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ABSTRACT

This report examines ways of improving women's productivity and education and the consequences for development in Peru. The research finds that women account for about 39 percent of family income in Peru. They carry the main responsibility for child care and heavily influence family decisions on children's education and family size. Improving opportunities for women thus can be a means to foster economic and social development as well as an end in itself. The main way to expand women's opportunities is through human capital investments, notably education beyond the primary level. This will increase women's earning capacity, broaden their labor force participation, and thereby promote economic growth, family welfare, and slower population growth. This report is comprised of seven articles: (1) "The Extent and Impact of Women's Contribution in Peru: A Descriptive Analysis" (M. Schafgans); (2) "Labor Market Participation, Returns to Education, and Male-Female Wage Differences in Peru" (S. Khandker); (3) "Modeling Economic Behavior in the Informal Urban Retail Sector in Peru" (J. Barry Smith; M. Stelcner); (4) "Household Production, Time Allocation, and Welfare in Peru" (J. Dagsvik; R. Aaberge); "Fertility Determinants in Peru: A Quantity-Quality Analysis" (M. Schafgans); (6) "Gains in the Education of Peruvian Women, 1940 to 1980" (E. King; R. Bellew); and (7) "Does the Structure of Production Affect Demand for Schooling in Peru?" (I. Gill). Numerous tables of data, figures, and diagrams appear throughout the report. A lengthy bibliography is included. (Author/DB)

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Women's Work, Education, and Family Welfare in Peru

Barbara K. Herz and
Shahidur R. Khandker, editors

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PREFACE

Based on evidence gradually emerging from the developing world, the World Bank believes that the main way to help women, and thereby contribute to poverty reduction, less environmental stress, and other development objectives, is to enable women to raise their own productivity and income. During the U.N. Decade for Women (1975-85), efforts were made to increase public awareness about the difficulties women face and to institute policies promoting expanded opportunities for women. But rigorous research remained scarce on how to do that and on what precisely the benefits would be. The World Bank has therefore begun to prepare some 23 country-level assessments and action plans and undertaken several research efforts using household-level sample surveys to demonstrate what can be done to improve opportunities for women and how that will contribute to development. Country assessments have been published for Bangladesh, Kenya, and Pakistan, and one on India is forthcoming. This report on Peru* is the first of the new wave of research to reach fruition. It does not answer all questions, of course, but sheds some light on what women's situation is, how it compares to that of men, what can be done to help, and what the results are likely to be.

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* This report refers to Intis at the official exchange rate of June, 1985 when one U.S. dollar equaled about 11 Intis.

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Contents

SUMMARY AND INTRODUCTION

Barbara K. Herz and Shahidur R. Khandker

This report examines ways of improving women's productivity and education and the consequences for development in Peru. It finds that women account for about 39 percent of family income in Peru. They carry the main responsibility for child care and heavily influence family decisions on children's education and family size. Improving opportunities for women can thus be a means to foster economic and social development as well as an end in itself. The main way to expand women's opportunities is through human capital investments, notably education beyond the primary level. This will increase women's earning capacity and broaden their labor force participation -- and thereby promote economic growth, family welfare, and slower population growth.

The report's findings are based on econometric analysis of the household survey data from the Peruvian Living Standards Survey (PLSS) conducted in 1985-86. The PLSS is a national probability sample of 5,100 families and 26,000 individuals.

Women's Contributions to Development

About 45 percent of Peru's total wage and self-employed labor force are women. Women contribute to GNP and earn income in a variety of ways. Some 57 percent of Peruvian women engage in economic activities - about 10 percent work in the wage sector, 30 percent as farmers, and 15 percent in the informal sector. Women's economic participation varies by where they live. In urban areas, some 14 percent work in the wage sector, while 10 percent are farmers and 19 percent work in informal activities. By contrast, in rural areas, only 4 percent work for wages, and 10 percent are self-employed in informal activities, while 56 percent are farmers. Women's employment options and productivity in Peru as elsewhere depend heavily on education, but Peruvian women have about five years of schooling, on average, compared to seven years for men. While only 8 percent of men did not attend school, 25 percent of women never enrolled. The gender differences in educational attainment are more pronounced in rural areas than in urban areas and among the children of the poor.

As women gain education and income, couples tend to opt for smaller families. Women's income and education matter in this regard more than men's because women tend to spend more time with children and, of course, bear the children. Educated mothers who can earn a substantial income prefer smaller families partly to make time for their income earning activities and for other interests. As the opportunity cost of the mother's time rises (as measured by the wage she could earn), her preference for a smaller family becomes stronger. Women with a secondary education have, on average, 3 children, while women with no education have 6 children. The relationship stands up when more sophisticated analysis takes account of other influences on family size. Parental education also influences children's schooling in different ways. Father's education usually matters more for boys than for girls, but the mother's education increases girls' school enrollment as much as 40 percent more than the father's education.

Raising Women's Income and Productivity

What are the most effective ways to increase women's income and productivity? The principal way, this research finds, is to educate women, especially at the secondary level. Education increases women's wage income at least as much as it increases men's. At the secondary level the returns to schooling for women are 15 percent compared to 9 percent for men. Primary education alone increases women's productivity in the informal activities. Education helps women break into the wage labor force and get better paying jobs afterwards in a variety of activities. Of course, women respond to offers of higher wages, but higher wages are justified and thus more likely to occur as women's productivity increases, and education is the main route to higher productivity. Yet human capital variables, notably education and experience, explain only one third of the male-female differences in wages in the labor market. Other constraints on productivity as yet to be identified or barriers to women's labor force participation presumably account for the remaining differences.

Providing credit to the self-employed woman working in Peru's vast and growing informal sector has a high pay-off. Poor women who operate small retail businesses can earn an 18 percent rate of return on credit funds provided to finance working capital. Women entrepreneurs do respond to economic incentives but tend to earn less than men. They are more concentrated in labor-intensive fields, accounting for some 70 percent of the work force in retail and textile activities which are the most labor-intensive activities in Peru. Women entrepreneurs have only one fourth of male entrepreneurs' fixed capital investment. Female entrepreneurs are also less educated than male entrepreneurs: Female retailers, on average, have 6 years of schooling compared to 8 years of schooling for male retailers. These differential factor endowments account for much of the male-female differences in earnings in informal activities.

In the country as a whole, women are more concentrated in services, while men predominate in industry. Of the employed female labor force, 72 percent of women are in the service sector, while only 15 percent are in industry. By contrast, 52 percent of the male labor force works in services and 24 percent in industry. Expanding services thus tends to increase women's employment opportunities and so raises the economic returns to female education more than expansion in industry, which tends to favor men. Whether this reflects different preferences, deficits in female education, or labor market barriers is not clear.

The Female Education Paradox

Even though female education has substantial economic returns and broader social benefits (for children's health and schooling and lower fertility), girls in Peru continue to receive less education than boys. In rural areas the "gender gap" in school enrollment is apparent even at the primary level, and nationally it is striking at the secondary level and beyond. The proportion of the school-aged children enrolled in secondary school is 9 percent higher for boys than for girls in Peru as a whole and in rural areas it is 17 percent. The data do not permit detailed analysis of the reasons for this gender gap. It is reasonable, however, to suppose that parents may be reluctant to incur the costs of educating girls because the social benefits accrue so far in the future and do not affect the parents much. The girls themselves, their children, and the society in which they live will reap the main benefits. Parents may also believe girls are less likely than boys to succeed in finding a good job once educated, because of discrimination reflecting traditional expectations about women's proper occupations. Moreover, traditional culture may favor the education of boys, and parents may have more concern for girls' physical safety or social reputation, particularly as the girls grow older.

While further research would help to diagnose the reasons for the gender gap in education, it is possible now to identify some policy measures that do help close the gap. The more educated parents are, the more willing they are to educate their daughters as well as their sons. Maternal education, as noted earlier, is especially important in this regard. The question then is how to achieve a generation of educated mothers. This report suggests four main policy measures. First, simply increasing the number of school places helps. Even though parents may prefer to educate sons before daughters, once most boys are in school, the additional places go to girls. Second, locating the schools closer to children's homes facilitates enrollment of all children but especially girls. Third, improving the quality of education is particularly important to increase girls' schooling. As quality improves (measured by the supply of text books or by the number of school teachers), parents become more willing to educate their girls, even more than their boys. In the 1960s Peru undertook a major initiative to expand the educational system, increasing school places as well as improving quality. The quality and quantity improvements helped increase girls enrollments and reduced the gender gap but were not enough to bridge the gender gap, especially in rural areas. Thus, additional steps such as scholarship for girls at the secondary level may be helpful. Since female education has more impact than male education on children's schooling and family size and these benefits exceed the private costs to parents, a special effort to educate girls is warranted on economic grounds. Finally, efforts to improve the earning capability of women may build parental willingness to educate their daughters, as parents see the economic returns to female education increase. In this regard, measures to assure women's equal access to the wage labor force may be helpful, as will measures to boost the earning capacity of the vast numbers of women employed in the informal sector.

Promoting Female Entrepreneurship

The importance of Peru's large and growing informal sector is well documented, and many Peruvians will doubtless continue to depend on it for their livelihood for some time to come. The informal sector can also serve as a stepping stone to more productive activities in the formal sector. Measures to strengthen the informal sector should therefore be undertaken in parallel with measures to open up women's opportunities in the wage labor market. Evidence reported in this report suggests that women's entrepreneurial activities are constrained by the scarcity of capital. While capital markets may not be designed deliberately to exclude women, that may be the practical result if women lack the collateral, financial experience, and education to cope with the formal credit system. This is particularly likely to be the case with poor women. Measures to target credit for the poor, male or female, may help them shift into more productive lines of work. Further research is needed on how to extend credit more effectively to the poor, but experience in several countries suggests that special measures may be needed to reach women, because of gender-specific barriers rooted in childbearing or tradition.[1] It bears emphasizing that such credit need not and probably should not be subsidized below normal commercial interest rates. The poor already pay exorbitant rates for whatever credit they can find in the informal sector, the record of subsidized credit programs is generally dismal, and the main need is for reliable and continued access to capital which can best be assured through credit programs that are financially sustainable. Easing other constraints to women entrepreneurial ability such as lack of skills and training is also worth considering. Policy makers may develop professional skills development policies for women.

The Underlying Model and Research Methods

The report's data analysis is based on econometric analysis of a household economic framework that suggests how to improve women's education and productivity and what the consequences of doing so will be. The contribution of women to development is assessed in the context of the family because women must balance the time they spend producing goods and services at home and in the marketplace with the demands of childbearing. An understanding of family economics is thus essential for analyzing household resource allocation by gender and may explain the gender gap in education and productivity. It may also help to show which government policies can encourage families to invest in women as well as men.

Two competing family models may be used--the usual "unified" and the more recent "bargaining" family model, both in the tradition of neoclassical consumer theory (Schultz 1989). The "unified" model assumes that family members agree on objectives and pool their resources to maximize a common family welfare function. (Alternatively, one dominant family member may impose his or her own preferences). This model assumes that market goods do not yield utility directly but require time to be spent to yield utility (Becker 1965). Thus, quantities consumed of any good depend on the opportunity cost of an individual's time, which reflects his or her market wage. Market wages depend in turn on education and market opportunities. Although education can increase women's productivity at home and in the market, the increase is thought to be more pronounced in the marketplace. Higher market wages for women can raise the relative opportunity cost of producing children and encourage families to invest more in the child's human capital.[2] Evidence also indicates that gains in women's education and income promote an intrahousehold resource allocation that is more equal between males and females (World Bank 1989).

In contrast, the key message of bargaining models (McElroy and Horney 1981; Manser and Brown 1980) is that people within families do not agree on

[1]Women with young children may have more trouble leaving home to seek credit or training.

[2]Women's education is the most important determinant of family welfare, in terms of fertility reduction, children's health, school and occupational promotion (Schultz 1989).

objectives, and women may influence family decisionmaking more as they gain control over resources. These models, which assume that individual members of a family have conflicting preferences, make it possible to see how individuals use their resources to benefit the family (or the reverse) (Schultz 1989). In some cultures women control unearned income and hence affect family's resource allocation (Schultz 1989; Duncan 1989). In others women's wages influence intrahousehold resource allocation (Rosenzweig and Schultz 1982). In a sense, the unified model is just a special case of the bargaining model, where people agree or where one bargainer dominates.

The unified household model has weaker data requirements. It can rely mostly on household-level information, while the bargaining family model requires more detailed individual-level information. The choice of model is therefore often driven by data availability.

Collection of individual-level information is not an easy task and is seldom attempted. Even collecting data at the household level is difficult. The Peruvian Living Standards Survey (PLSS) provides data primarily on households. It supplies some data on individuals but not enough to permit using the "individualistic" family model. The report therefore relies on the unified family model to document the relationships among women's work, education, and family welfare in Peru, but it does permit some indirect inferences that hint at underlying bargaining.

The data, which were collected by Peruvian Instituto Nacional de Estadistica and the World Bank in 1985-86, contain information on labor force participation and wages, income from various sources including agriculture, marital status, fertility, consumption, savings and credit. Because data on unearned income and assets were collected only for households, not for individuals, we were unable to examine the impact of individually owned assets on family decisions. Nor were we able to measure the extent and impact of gender bias in the allocation of resources for household consumption. While data on households often have information on individual labor supply and earnings, they do not cover individual consumption. Although attempts have been made to identify the extent of gender bias in household consumption by using aggregate family consumption data (Deaton 1988), this approach has serious limitations.[3] The report uses the individual and household information to explain gender differences in time allocation, school investment, productivity in formal and informal activities, and their effects on household outcomes such as fertility and school enrollment of children. Unfortunately, data on family planning services and contraceptive use are also missing from this sample survey. Thus, no attempt could be made in the report to understand how the provision of family planning and female education may reinforce each other or how family planning

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[3]The main criticism of adult-equivalent scales as proposed by Deaton (1988) and others is that one cannot separate the factors reflecting household technology ("needs") from those governing the intrahousehold distribution rule ("wants"). See Gronau (1989) for details.

alone influences fertility.[4] Similarly, because of a lack of data on agricultural extension and limitations on farm-level production and input use data, no attempt could be made to determine whether or how women's farm productivity is improved when women have better access to extension, credit and other public services.

Outline of the Report's Chapters

The report has seven chapters. A brief discussion of the contents and findings of each of the remaining chapters follows next. Schafgans (Chapter One) gives an overview of men's and women's labor force participation. She discusses possible associations between a woman's wage labor force participation and her observed fertility, education, marital status, spouse's economic activities, children's school enrollment and household characteristics. Schafgans also analyzes school enrollment by gender to identify male-female differences in school enrollment that may affect wage labor force participation and other outcomes.

Schafgans shows that 57 percent of women are economically active. Women are mostly self-employed, while men are mostly employed in the wage sector. Women's predominance in the self-employed sector reflects their lower education and household responsibilities. Recognizing self-employed women as a legitimate part of the labor force and their needs for improved productivity would clarify the potential benefits to be gained by improving women's productivity. Schafgans finds that education increases women's wage labor force participation at the expense of self-employed work in agriculture. Educated women also have fewer and better educated children. Moreover, the households headed by women have, on average, lower incomes and per capita expenditure than the households headed by men. Note, however, that both types of households have equal per capita food consumption.

Khandker (Chapter Two) analyzes wages and wage labor force participation to see what explains gender-related differences. In Peru as a whole women earn about half of men's wages. The wage labor market participation rate for women is 13 percent compared to 35 percent for men. Khandker estimates a wage equation to explain wages and, using the wage estimates, calculates the private returns to schooling for men and women. He also examines whether these returns influence school enrollment of boys and girls. He deals with two econometric issues that are often ignored in research on wage estimation. Sample selection bias may occur if one only considers wage workers, excluding those who are self-employed, because this procedure ignores reasons that may lead people to choose to stay out of the wage labor force. A better method is to estimate a wage equation along with an equation that predicts whether or not an individual will participate in the wage labor market at all (by using at least one other variable not in the wage function to identify the labor force equation). Khandker estimates the wage function with such a sample-selection correction and

[4]However, as information is available on community distance to family planning center for rural areas, an analysis is sought to explain the relative impact of education and the distance to family planning center on fertility behavior.

compares the estimates of schooling returns to those obtained without a sample-selection correction. He also deals with the unobserved variable bias that may arise if unobserved characteristics correlated with years of education also influence wages. He uses a household fixed-effect model to correct the wage gap and school-return estimates for unobserved household characteristics.

Khandker finds that the human capital model explains only about a third of male-female wage gap, although it substantially accounts for differences in men's and women's wage labor market participation. Thus, more education means women are more likely to work for wages. In estimating economic returns to education, correction for sample selection and unobserved household characteristics is found important for both women and men. This indicates that women as well as men who participate in the labor market are not representative of all women and men. Even after correcting the estimates for possible sample selection and unobserved variable bias, the economic returns to education are higher for women than for men in Peru. Another finding is that private schools are more effective than public schools in raising individual productivity. This implies that gender differences in productivity cannot be removed by educating girls in public schools unless government makes public schools more effective. Yet another finding of his chapter is that an extensive school system and well developed labor markets can help reduce the "gender gap" in school investment decisions of the parents.

Smith and Stelcner (Chapter Three) analyze women's participation and productivity in retail trade, which accounts for 46 percent of informal activities in Peru. They measure productivity of labor as the marginal revenue product of a unit of labor. Since retail businesses can be identified as either male- or female-owned or jointly owned, the study compares the major constraints to raising the productivity of male and female retailers. Smith and Stelcner obtain reasonable quantitative assessments of the relative productivity of men and women and explain gender-related differences in retail productivity. Using an econometric model of retail trade, they show the relative contribution of labor and other inputs. Retail trade is also subject to a selection procedure. The buyers' selection depends on many factors including the unobservable "sales effort" of a retailer. Smith and Stelcner develop a nonlinear revenue function to show the probability of a retailer's sales to potential buyers and the expected price per sale. The probability of sales depends on such characteristics as the retailer's education, experience, and capital as well as the factors that characterize the market forces, including the retailers' market outlets.

Smith and Stelcner show that primary education improves retail productivity but endowments of capital, expenses and labor have even greater influence on productivity variations than education or ownership of the firm - female, male, or mixed. Firms with smaller endowments typically have the higher productivity. They find no major differences in economic behavior between enterprises of male-only, female-only, and mixed units. Differences in the resource endowments of the firm lead firms to behave differently. The female-only enterprises often have less capital than their male-only counterparts. Simulation results indicate that both men and women entrepreneurs in different income groups are equally productive if their education is raised to the same level. When credit is given to finance working capital needs, the returns to working capital are lower for low-income female enterprises than for male enterprises of similar income class. This finding seems counterintuitive--if women have less capital, they should get a higher return to capital. One possible interpretation of this puzzle is that women entrepreneurs from the bottom income group may lack complementary inputs such as skills and training to effectively utilize the loan. However, for an equal amount of credit, male and female entrepreneurs of higher income groups do not behave differently.

Dagsvik and Aaberge (Chapter Four) analyze family behavior in household production, time allocation, and family welfare. They present the data analysis in three sections. First, they discuss the relationship between labor market participation and income inequality. They consider entrepreneurial income and wage earnings of household members (male, female and children) and the resulting economic contribution to family income. Second, they estimate an interdependent utility (that is, structural) model with household- and individual-specific information to explain household production, labor supply and consumption behavior. Third, they simulate the possible effects of an increase in wages and education on family welfare, measured by per capita income or expenditure. They also examine the possible reductions in income inequality because of changes in the education and wages of men and women.

Dagsvik and Aaberge indicate that family income would rise significantly as a result of increases in women's wages and education. Thus, a 20 percent increase in women's wages from its mean of 5.3 Intis in Lima increases women's labor force participation by about 4 percent, their total wage earnings by 25 percent, and women's share of family cash income by 5 percent. A similar percent increase in men's wages from its mean level of 6.4 Intis raises men's share of family income by 14 percent. Compared to women with no education, women with a least nine years of schooling have 22 percent greater labor market participation. The corresponding increases in women's wage earnings and share of family income, respectively, are 43 percent and 8 percent. A similar increase in men's education raises men's share in family income by 11 percent. On balance, improving women's education has a larger effect than improving wages in increasing women's contribution to family income. Note, however, that as education is the key to improving individual productivity, improving women's education will help increase both their productivity as well as share in the family's cash income. Dagsvik and Aaberge's simulation study also indicates that incomes are so unequally distributed that raising wages and education of men and women will not do much to reduce income inequality. Peru needs other policy measures such as assets redistribution to reduce its severe income inequality.

Schafgans (Chapter Five) examines the impact of women's and men's wages and education on the demand for a particular number of children as compared to the quality of children measured as schooling per child. She investigates the extent of a trade-off between the number of children and schooling per child that exists in Peru. The presence of such a trade-off is emphasized in the literature as an important factor in slowing population growth and promoting family welfare. Within the neoclassical household model framework, Schafgans estimates the reduced-form equations for the number of children and the schooling per child as functions of household income (alternatively, father's and mother's earned income), mother's age and education, other household characteristics, and community characteristics. The household income or father's income can have either a positive or negative effect on the number of children but should have a positive effect on schooling per child. But the mother's wage measures the opportunity cost of her time. Since women spend more time with children, the mother's wage should have a negative effect on family size and a positive effect on child quality. Similarly, the mother's education should have a negative effect on the demand for children and a positive effect on child quality as the opportunity cost of women's time in the home rises and as education promotes women's wage labor force participation and builds interest in modern and more effective contraceptives.

In implementing the model Schafgans uses both a linear and a discrete choice model to explain fertility behavior in Peru. She uses a linear and a household-fixed effect model to explain schooling decisions. Her results indicate that women's education increases children's schooling and reduces the quantity of children. When women earn higher wages, they demand fewer children and may demand more children's education. However, the father's wage has more influence than the mother's on children's education. In contrast, it is the mother's wage and education that influence family size more. Her study also shows that the distance to the family planning center in rural areas does not significantly affect fertility decisions, but the lack of further information on the nature and quality of family planning services prevents any solid inferences. Schafgans' analysis also clearly indicates that there is a gender preference (for sons) in parental investment in schooling. She did not pursue, however, whether father's or mother's preferences differ between bouts and girls in terms of schooling.

King and Bellew (Chapter Six) discuss the determinants of individuals' school attainment and enrollment over time and the role of government policies in closing the gender gap. They ask: How rapidly has the expansion of public education changed schooling attainment of boys and girls? Have additional opportunities for education been equitably distributed between men and women? What other aspects of public education policies influence the gender gap in education? What factors beside government policies explain variations in the levels of education between men and women? King and Bellew use the neo-classical household model to explain variations in school attainment, incorporating both the direct and indirect costs of schooling as well as individual learning ability. Why do boys and girls attain different levels of schooling even if they have the same learning ability? The authors suggest two possible explanations: Parents may have different preferences for boys' and girls' schooling; and labor markets may reward the education of boys and girls differently. Beyond this, parental preferences can interact with market forces. For example, a rise in female wages and new work opportunities can increase the returns to women's education, which may then encourage parents to educate daughters' even if they feel a systematic bias against daughters. The speed and magnitude of the response depend on the availability of jobs for girls as well as the price and income elasticities of their demand for education. Community characteristics such as school availability and school quality can also influence parents' investment on education.

King and Bellew find that both mother's and father's education heavily influence children's school enrollment. However, they find that the father's education influences boys' enrollment more than girls', while the mother's education influences girls' enrollment more than boys'. Also improving school quality proxied by the supply of text books, the number of grades, and the number of teachers increases girls' school enrollment more than boys'. Government policies aimed at increasing access to schooling have largely reduced the male-female gap at the primary school level but failed to do so at the secondary and postsecondary levels. King and Bellew's analysis indicates that the relative effect of parental education also differs in school attainment of daughters and sons. In the adult sample, for sons' education, father's education has twice as large an effect as the mother's education, while for daughters' education, mother's education has a larger influence. Similarly, in the youth sample, the mother's education has a stronger effect on the daughters' education attainment. "Quality variables" such as the supply of text books and the number of teachers are particularly important in persuading parents to educate their daughters. Perhaps parents' demand for daughters' education is more price elastic than their demand for boys' education.

Gill (Chapter Seven) also helps explain why parents invest less in daughters' education than in sons'. He develops an intrahousehold resource allocation model linked with the market demand for educated workers to see whether household demand for schooling depends on the jobs available in the community. He assumes that parents consider their own expectation about future labor activities when making schooling decisions for their children. He hypothesizes that parents want more education for their children if education-intensive sectors predominate in the local economy. He takes the shares of regional GDP generated in two education-intensive sectors -- services and industry -- to represent the demand for educated workers. He relates schooling attainment to shares of services and industry and looks for differences for women and men.

Gill finds that expansion in services or industry leads to an improvement in schooling levels of both boys and girls. However, expanding the service sector encourages more investment for girls, while industry encourages more for boys. Thus, a faster increase in women's human capital accumulation in comparison with men's can be associated with an increase in the relative share of the services in GDP. But expanding services may not be as productive for growth as it is for reducing male-female school gap. We are thus back to the classical dilemma: equity and growth may not be jointly maximized. Yet when human capital is a major constraint on a country's overall economic and social progress, reducing the male-female gap in human capital can have a large pay-off for development. Women are not only half the country's labor force but carry the main responsibility for children's care.

In summary, the findings demonstrate important relationships among women's education (especially at the secondary level), work choices, productivity and income, family welfare, and family size. Education improves women's labor force participation and productivity. It also raises children's human capital investments (especially for girls) and reduces family size. By improving economic productivity, education thus helps women in Peru to increase their share of family income and hence their contribution to development.

CHAPTER 1

A COMPARISON OF MEN AND WOMEN IN THE LABOR FORCE IN PERU*

Marcia Schafgans

1. Introduction

This chapter uses household survey data to compare the proportion of men and women in the labor force in Peru and to examine the hours spent on the job and in the home. It also explores the associations among education, employment, marital status, number of children, and school enrollment to evaluate the contribution of women to family welfare. The Peru Living Standards Survey, on which this analysis is based, was developed by the World Bank, the National Institute of Statistics in Peru, and the Central Bank of Peru to measure the major aspects of economic well-being at the household and community level. Two questionnaires were used: the first provides information on income, consumption, employment, schooling, health, fertility, housing, migration, and savings. These data were complemented by a survey of rural communities that gathered information on prices, transportation, communication, and public services.

The survey was conducted between June 1985 and July 1986. The sample of 5,120 households (26,000 individuals) interviewed reflects the distribution of the population living in urban and rural areas (towns with fewer than 2,000 inhabitants) and in natural regions (for a detailed description see Grootaert and Arriagada 1986). All monetary values are in June 1985 prices, at an exchange rate of about 10 intis to the U.S. dollar. For this study the population is grouped into three categories: metropolitan Lima, other urban areas, and rural areas.

The number of women in the work force in Latin America has been rising faster than the number of men. From 1970-80, the average annual rate of growth was 2.5 percent for men and 5.1 percent for women. In Peru women accounted for about 45 percent of the labor force in 1985-86, up from 24 percent in 1980 (IDB 1987). Most of these women are self-employed. Except in Lima, most men are also self-employed, although women make up the larger proportion of workers in this sector, a result of lower education as well as household responsibilities.

The type of activities women pursue differs considerably from the type that men select. Women are poorly represented in higher-paid jobs, and their wages in the formal sector are generally lower than the wages of men. As this analysis is purely descriptive, it gives only an indication of the possible reasons behind the differences in the contributions of men and women. Further

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The author is grateful to Jorge [illegible]stillo-Trentin, Barbara Herz, Shahid Khandker, Beth King, Jacques van der [illegible]aag, and Morton Stelcner for helpful suggestions, Ben Patterson for assista[illegible] with the graphs, and Eleanor Berg for her editorial assistance.

research is required to shed light on some of the issues highlighted here. For instance, how is an individual's work status affected by socioeconomic factors? What explains the participation of the individual in a particular sector? How can we explain differences in wages or incomes in formal and informal activities? We need to know more about the endowment in human capital, and the returns to education. Do parents make a trade-off between the number and quality of children? How do improvements in productivity affect the distribution of household income? These are important issues which are considered in the chapters of this report.

Men have higher rates of participation in the work force than women, and spend more hours on the job. Women devote more time to the household, and their jobs show a high level of compatibility with these household responsibilities, particularly in rural areas. Households headed by men are better off than those headed by women. But improvements in the economic status of women, for example shifts from agricultural work to the wage sector (or even to nonagricultural self-employment), reduces the difference in the per capita consumption expenditures of male- and female-headed households. Furthermore, this improved economic status has a positive effect on the children's welfare by increasing school enrollment, especially in rural areas. In general girls benefit more than boys from an improvement in the mother's education or employment.

1.1 Participation in the Labor Force

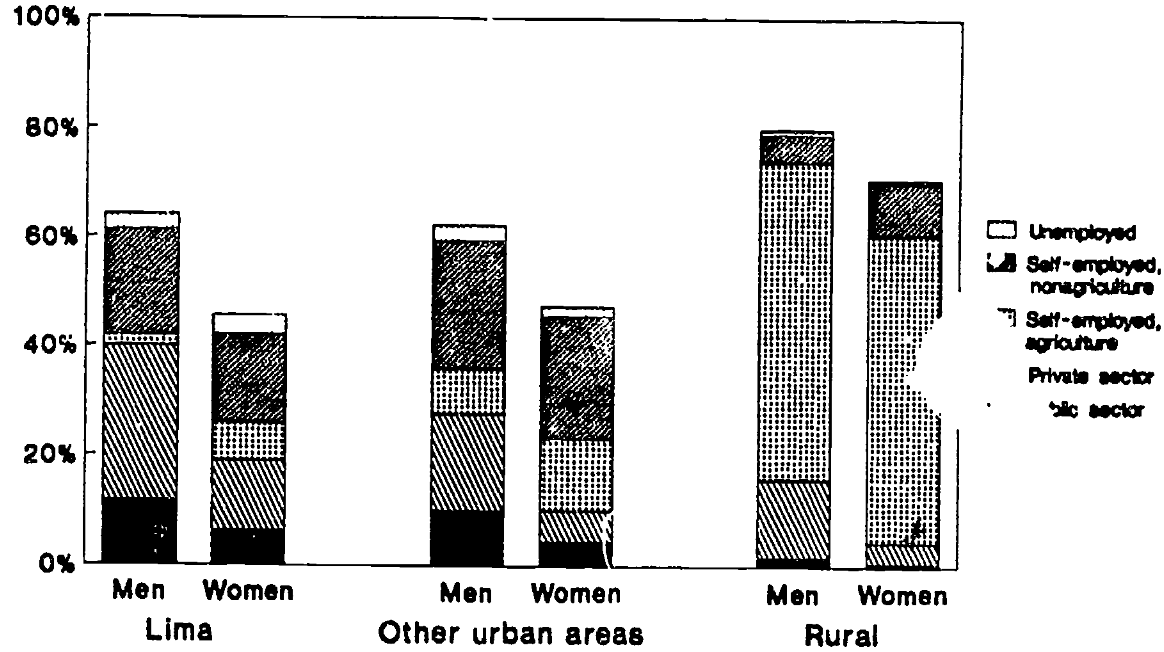
Buvinic and others (1983) point out that the division of labor in third world countries typically "assigns women to labor-intensive production, and the division of labor within the market restricts women to work characterized by low technology, inefficient production and marginal wages." Peru is no exception. Women make up about 45 percent of Peru's labor force.[1] Fifty-seven percent of women versus 71 percent of men are working.[2] The highest participation rates are in rural areas: 71 percent of all women and 80 percent of all men. Women in Lima record the lowest participation rates, with 46 percent in the labor force. The lowest rate for men (62 percent) is in other urban areas. The smallest difference is in rural areas; the largest difference is in Lima.

Most working women are self-employed. Employed men generally are also self-employed, while in Lima most work for wages. But the proportion of women who are self-employed is larger than that of men. In Lima, rural regions, and other urban areas, 55, 94, and 78 percent respectively of working women are

[1] A description of the data and employment definitions used in this analysis is given in appendix 1.

[2] Table A1 shows the distribution of the labor force calculated by dividing the number of employees in a given economic activity by the potential labor force. Figure 1 shows the employment figures in a stacked-bar graph, in which the labor force participation rates are indicated by the total length of each bar.

Figure 1: Labor force status of men and women, by region



Note: Main occupation last 7 days.

self-employed, while men in these regions record rates of 35, 80, and 54 percent respectively. In the wage sector, proportionately more women than men work in the public sector (see table A1).

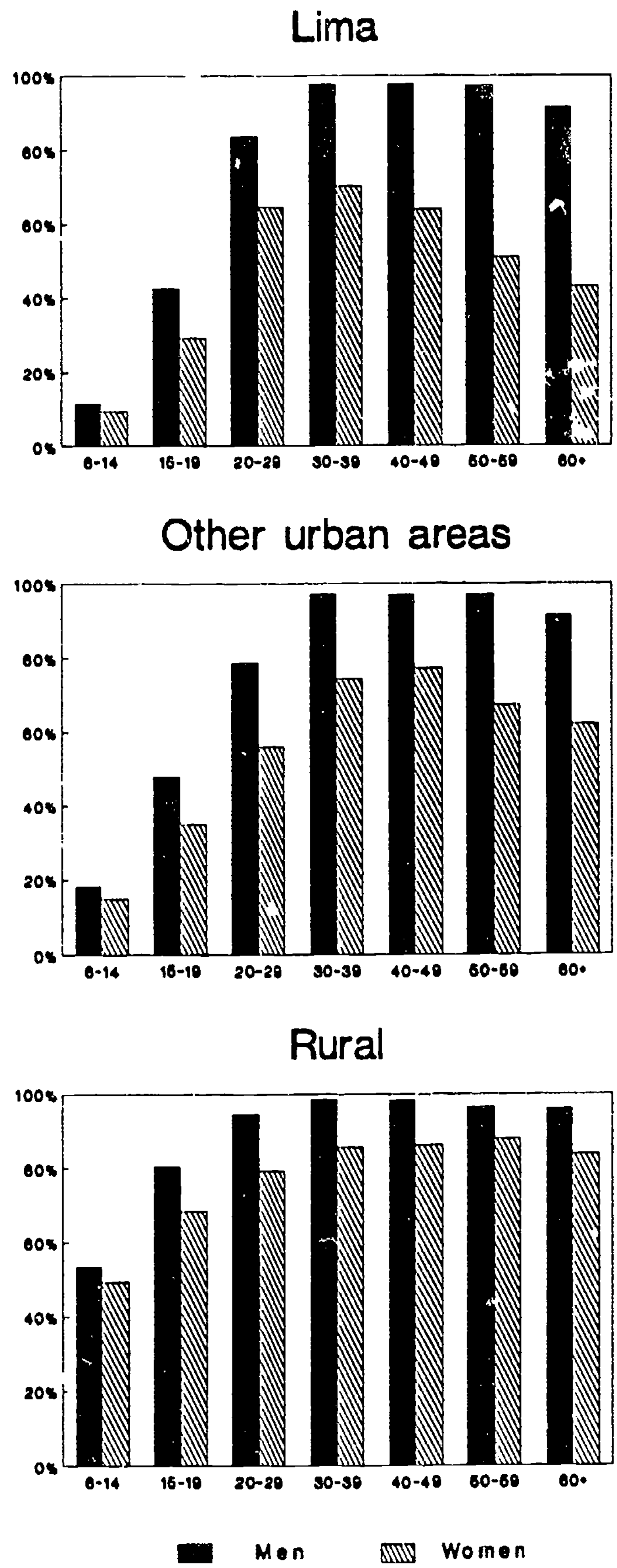
In Lima and other urban areas most workers are paid; in rural areas most of the work is unpaid. In all regions, a higher proportion of men than women (65 percent compared to 41 percent) report receiving wages (both salaried workers and self-employed individuals).[3]

Stelcner (1988) discusses the nonagricultural occupations of self-employed workers. He shows that the types of activities women pursue differ considerably from those of men (see table A2). In retail food and textiles, women account for about three-fourths of the workers; in retail nonfood and food processing, 60 to 70 percent; in personal services, about half, and in the remaining sectors (construction, transportation, primary industries (fishing, hunting, forestry, and mining), and other manufacturing) women account for only a small proportion of the workers. The same differences are also apparent in the wage sector, indicating that women are poorly represented in the higher-paid jobs.

Figure 2 and table A3 show the labor force participation rates of men and women by age cohort. Participation rates for all age groups are higher

[3] A clear definition of paid self-employment, however, is not available.

Figure 2: Labor force participation of men and women, by age cohort



in rural than in urban areas. There are more men than women in the labor force, although there is little difference in the rates of participation in rural areas. Participation in the economy declines with age, although the drop in the participation of women more than 40 years old is more pronounced in Lima.

1.1.1 Hours Worked i· Main and Secondary Jobs. Table 1 shows that men work more hours in their main job than women. In all regions men and women in the wage sector work longer hours (43 hours and 38 hours respectively) than their self-employed counterparts (38 hours and 28 hours); and women in the private sector work significantly more hours than women in the public sector.

Table 1: Average hours worked in the main job

	Males			Females		
Sector	Lima	Other urban areas	Rural	Lima	Other urban areas	Rural
Labor force	50.0 (0.5)	38.7 (0.5)	37.5 (0.3)	28.0 (0.6)	28.7 (0.6)	29.8 (0.3)
Wage workers	43.9 (0.6)	42.9 (0.7)	41.9 (0.7)	36.0 (0.8)	36.3 (1.0)	40.6 (1.4)
Public sector	42.1 (1.0)	41.1 (0.9)	37.4 (2.0)	29.9 (1.1)	30.9 (1.3)	29.6 (4.4)
Private sector	44.7 (0.7)	44.0 (0.9)	42.5 (0.8)	39.1 (1.0)	40.5 (1.5)	41.9 (1.4)
Self-employed	41.2 (1.0)	38.6 (0.8)	37.0 (0.4)	26.0 (0.9)	28.1 (0.7)	29.3 (0.3)
Agriculture	18.0 (2.9)	27.3 (1.3)	36.7 (0.4)	7.9 (0.4)	14.7 (0.6)	29.3 (0.3)
Nonagriculture	43.8 (1.0)	42.6 (0.9)	40.3 (1.4)	33.7 (1.1)	36.0 (0.9)	29.5 (0.9)

Note: Standard errors in parentheses.

Table A4 shows average hours worked in the main job by age cohort. In Lima and other urban areas, 6- to 14-year-olds work an average 17 hours a week; in rural areas they work an average 25 hours a week. The number of hours worked initially increases with age, although the rise is less pronounced for women. The reduction in the number of hours worked occurs in urban areas, primarily in the wage and self-employed nonagricultural sectors.

Table 2 shows the distribution of hours worked in second jobs. Thirteen percent of women and 12 percent of men have second jobs. This "moonlighting" is more common in rural areas, where 18 percent of women and 15 percent of men have a second job, than in Lima, where only 7 percent of women and 9 percent of men have additional jobs. Employed men spend an average 13 hours a week at their second jobs, significantly higher than women (except in rural areas). Women in Lima and other urban areas spend nine hours a week on average in a second job.

Table 2: Average hours worked at second jobs

Sector	Males			Females		
	Lima	Other urban areas	Rural	Lima	Other urban areas	Rural
Employed	12.4 (0.6)	12.1 (0.6)	13.4 (0.3)	8.1 (0.4)	9.5 (0.4)	13.6 (0.3)
Wage workers	15.0 (1.3)	14.4 (1.6)	15.5 (0.7)	11.5 (1.6)	8.7 (1.4)	20.1 (2.3)
Self-employed	11.6 (0.7)	11.7 (0.6)	12.7 (0.4)	7.6 (0.4)	9.5 (0.4)	13.3 (0.3)
Agriculture	6.7 (0.9)	10.9 (0.8)	13.2 (0.5)	6.2 (0.3)	8.2 (0.3)	12.8 (0.6)
Nonagriculture	13.3 (0.9)	12.2 (0.8)	12.1 (0.5)	9.5 (0.9)	11.4 (0.8)	13.6 (0.4)

Note: Standard errors in parentheses.

1.1.2 Hours Worked in the Household Table 3 shows the average number of hours worked at home by men and women in the labor force. There were no significant differences across regions in hours worked at home (unconnected with business). Women aged 20 to 59 devote most of their time to the family regardless of their status in the labor force. They spend an average 30 hours a week working at home, or four times more than men in that age-group. Self-employed women spend more hours in the household than women working for wages. And women who work on family-owned farms spend more hours on household activities than women in nonagricultural activities. Self-employed women spend five times more hours than self-employed men on household chores.

Young women also spend considerable time working in the home. Girls 6 to 14 years old work an average 12 hours a week (compared to 8 hours a week for boys); girls 15 to 20 years old spend an average of 21 hours a week (compared to 7 hours a week for boys).

Table 3: Average hours worked at home by gender

	Age cohort							
	Women				Men			
Sector	6-14	15-19	20-59	60+	6-14	15-19	20-59	60+
Labor force	12.3	20.7	30.5	26.4	8.2	7.0	6.2	7.8
	(0.30)	(0.59)	(0.31)	(0.79)	(0.22)	(0.28)	(0.12)	(0.37)
Wage workers	7.5	10.5	21.1	25.3	7.1	4.9	5.5	5.3
	(1.49)	(1.02)	(0.58)	(3.69)	(0.77)	(0.36)	(0.17)	(0.66)
Self-employed	12.5	22.4	33.1	26.5	8.3	7.7	6.6	8.4
	(0.31)	(0.64)	(0.35)	(0.81)	(0.22)	(0.37)	(0.17)	(0.42)
Agriculture	12.7	23.3	35.1	28.0	8.2	7.7	6.9	8.7
	(0.33)	(0.78)	(0.45)	(0.94)	(0.24)	(0.43)	(0.22)	(0.51)
Nonagriculture	11.2	20.7	30.3	23.1	8.8	7.8	6.2	7.7
	(0.81)	(1.09)	(0.54)	(1.53)	(0.71)	(0.74)	(0.27)	(0.72)

Note: Standard errors in parentheses.

1.1.3 Distribution of Earnings in the Formal Sector Table 4 shows average hourly wages of men and women in the formal sector. Services offer high wages for men and women; agricultural work is the most poorly paid. Men receive higher wages than women for all activities except manufacturing. Even holding constant for educational attainment, men receive higher wages than women. This indicates that women are working in lower salaried jobs than men, since differences in wages for similar jobs tend to diminish with increased education.

Table 4: Average hourly earnings in the formal sector, by educational attainment (in intis June 1985)

	All		Primary education		Secondary education		Postsecondary education	
Formal sector	Men	Women	Men	Women	Men	Women	Men	Women
Observations	2,431	947	806	220	1,029	422	504	256
All	6.18	5.09	3.74	1.80	5.74	4.83	11.19	8.26
	(0.19)	(0.21)	(0.15)	(0.16)	(0.29)	(0.25)	(0.54)	(0.56)
Commerce	5.59	3.54	3.19	2.66	4.93	3.48	9.61	4.75
	(0.43)	(0.24)	(0.40)	(0.24)	(0.41)	(0.29)	(1.41)	(0.83)
Services	7.34	5.94	4.10	2.66	7.31	5.01	8.60	9.20
	(0.44)	(0.33)	(0.23)	(0.24)	(0.91)	(0.33)	(0.37)	(0.74)
Manufacturing								
Nontextiles	5.81	5.54	4.58	3.79	4.48	6.42	12.67	n.a.
	(0.37)	(0.95)	(0.45)	(1.12)	(0.30)	(1.34)	(1.62)	
Textiles	4.53	3.39	3.19	1.34	4.29	3.26	n.a.	n.a.
	(0.63)	(0.40)	(0.65)	(0.19)	(0.47)	(0.43)		
Agriculture	2.57	1.75	2.24	2.81	3.62	2.14	n.a.	n.a.
	(0.18)	(0.10)	(0.11)	(0.36)	(0.75)	(0.14)		

Note: Standard errors in parentheses. n.a.= not available or too few observations

2. Socioeconomic Factors and the Composition of the Labor Force

A number of socioeconomic factors may influence the composition of the labor force including education, marital status, economic contribution, and number of children.

2.1 Education

Table 5 shows the rates of participation in the labor force for men and women aged 20 to 59, by the level of education.[4] The share of employed men and women in the wage sector increases with education at the expense of the self-employed workers in agriculture. Education does not appear to have a linear or even monotonic effect on the participation of women in the labor force. This finding appears to be in line with other studies on labor in Latin America (King 1989).[5]

Table 5: Labor force participation by education

	Peru		Lima		Other urban areas		Rural areas	
	Men	Women	Men	Women	Men	Women	Men	Women
Labor force participation rates								
Education:								
None	96.6	83.7	n.a.	66.7	94.1	75.3	97.2	86.4
Primary	97.2	76.2	96.3	64.3	97.3	70.3	97.3	85.8
Secondary	95.4	62.9	95.9	62.1	93.8	61.6	96.8	69.1
Postsecondary	97.9	76.4	99.1	75.7	96.2	77.3	100.0	74.1
Employment status:[a] Wage workers								
Education:								
None	26.5	4.6	n.a.	10.2	46.7	5.0	22.9	4.2
Primary	33.4	10.8	54.5	25.6	47.8	9.1	23.3	6.5
Secondary	57.5	40.2	72.0	55.3	55.4	33.2	34.4	11.8
Postsecondary	64.9	71.8	69.0	71.0	62.8	74.4	56.4	60.0
Employment status: Self-employed in agriculture								
Education:								
None	66.1	75.3	n.a.	32.7	16.7	42.0	73.8	82.4
Primary	46.9	52.9	3.5	23.1	12.3	29.4	69.6	75.5
Secondary	14.4	20.7	0.5	12.2	5.1	17.5	52.3	53.7
Postsecondary	6.6	7.1	0.0	8.0	5.0	5.0	36.4	15.0

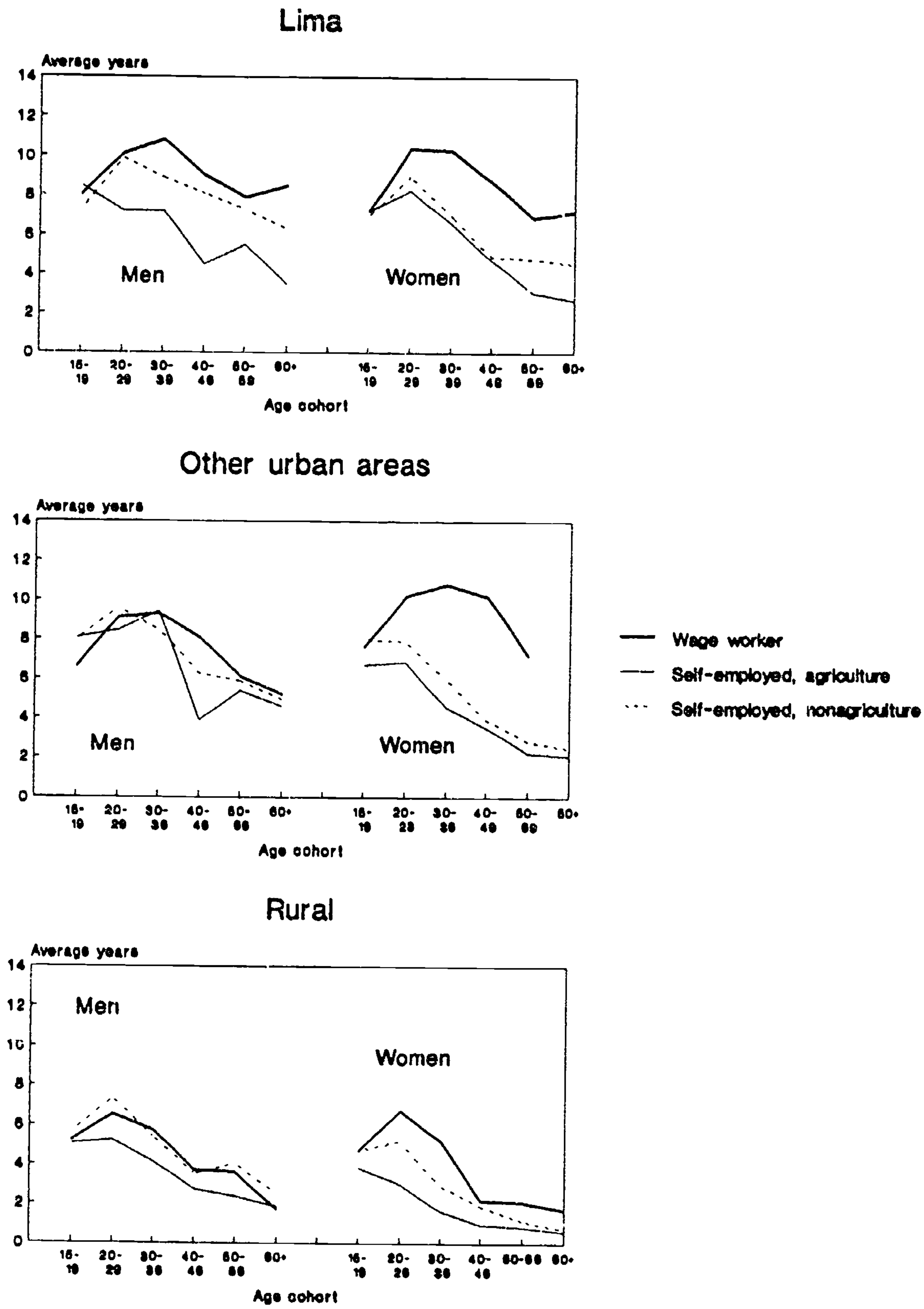
[a] As percentage of total employment
n.a. = not available or insufficient observations

Figure 3 and table A5 show the average years of schooling of men and women by status in the labor force. In all regions the most educated men and women work in the formal sector; the least educated are self-employed farmers.

[4] The figures for men in Lima with no education have been omitted because there were too few observations.

[5] "In Santiago, Chile, Castañeda (1986) found that ... women with no schooling and those with more than thirteen years of education tend to have larger probabilities of participating in the labor market than women with primary or secondary education."

Figure 3: Years of school for men and women by work status and age cohort



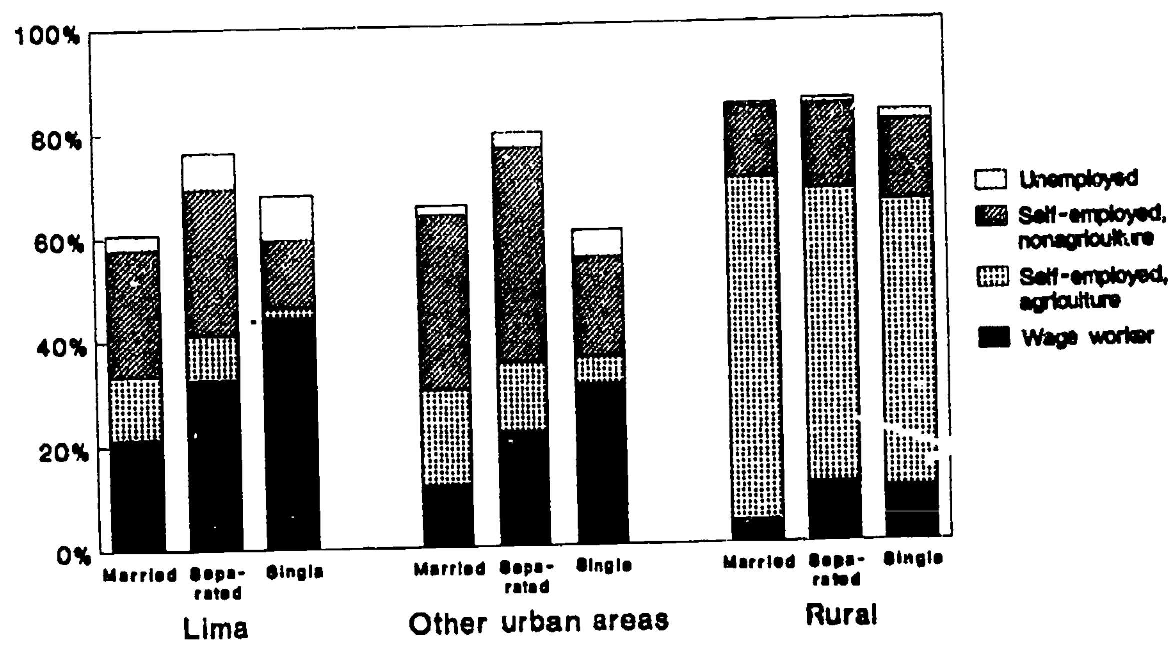
Self-employed women are usually less educated than men; women in the formal sector are usually better educated. Older workers tend to have less education than younger ones, indicating an increased investment in education (King 1989).

2.2 Marital Status

Figure 4 and table A6 show the labor force participation rates of women aged 20 to 59 by marital status. Sixty-seven percent of the women in Peru are married (or cohabiting), 14 percent are separated, and 19 percent are single.

Marital status has little effect on women's participation in the work force in rural areas, where most of the women are working. Separated women have the highest rates of participation because of their increased economic responsibility. In Lima fewer married women are working (about 61 percent), compared to 66 percent in other urban areas, and 84 percent in rural areas, an indication that the traditional male-female division of labor is sharper in Lima than elsewhere.[6] Even so, the data show the importance of the dual role of women in the economy, a finding consistent with other societies (Buvinic 1983).

Figure 4: Women in the labor force, by marital status



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6 In Lima 99 percent of married men participate in the labor force, in other urban areas 97 percent and in rural areas 98 percent.

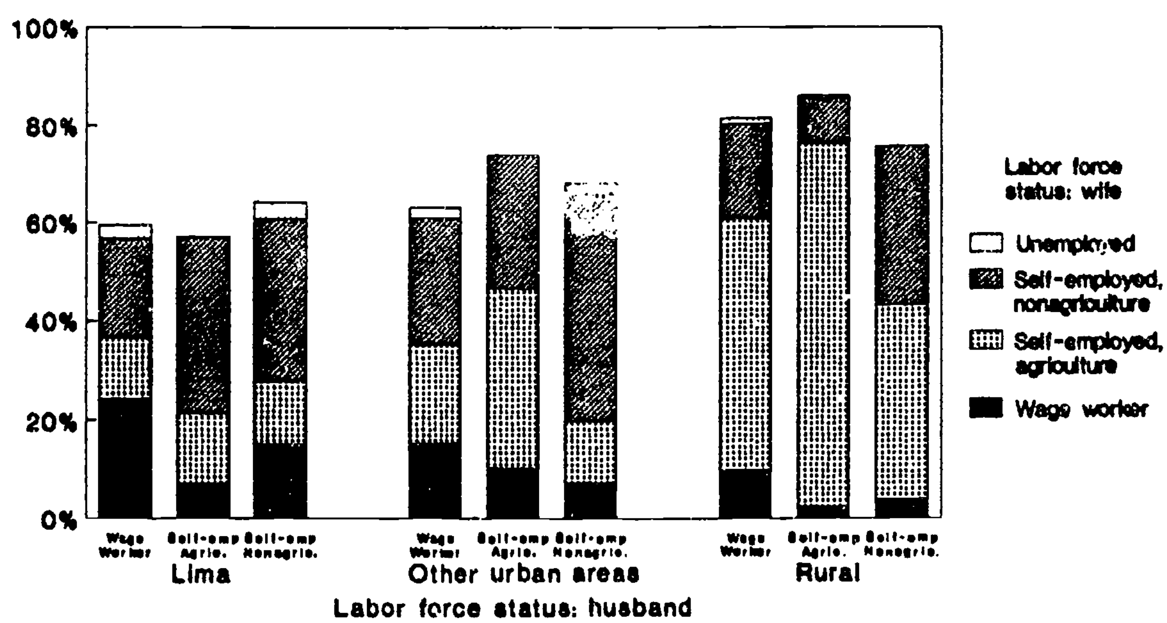
Marriage tends to move women out of the wage sector. In Lima 75 percent of single employed woman work for wages compared to only 37 percent of married women. In other urban areas the figures are 56 and 19 percent respectively, and in rural areas 13 and 5 percent.

Divorced or widowed women tend to move back to the wage sector. Forty-seven percent of separated women in Lima who are employed work for wages, higher than the 29 percent in other urban areas, and the 14 percent recorded in rural areas. More self-employed separated women than married women work in the nonagricultural sector.

2.3 Economic Activities of Wives and Husbands

Figure 5 and table A7 compare the labor market decisions of wives and husbands.[7] In Lima and in other urban areas, women are least likely to be in the labor force if their husbands are wage workers. In rural areas the wives of men in the nonagricultural activities record the lowest rates. Women whose husbands work in the wage sector are proportionally better represented in the wage sector than other women (43 percent in Lima, 35 percent in other urban

Figure 5: Labor force status of married women, by husband's labor force status



[7] Men in agricultural self-employment activities in Lima are not discussed since there are so few in this particular group.

areas, and 12 percent in rural areas). There is a high correlation between wives and husbands working on family farms or in self-employed nonagricultural activities. This correlation parallels a high correlation in education. Sixty-six percent of women with a primary school education are married to men with the same education. The figures for women with secondary education are 54 percent, and for a postsecondary education, 68 percent (see table A8).

2.4 Child Care

As shown in table A9, women in Peru (15 to 49 years old) have an average of 4.26 children (3.46 in urban areas and 5.24 in rural areas). Among women aged 45 to 49 only 1.5 percent are childless. The number of children born is inversely proportional to the mother's education. For instance, women in urban areas aged 35 to 39 with no education have on average 6 children, as shown in table A10. The number of children for women in the same age group with a primary education drops to 4.4, to 3.3 with a secondary education, and to 2.4 for postsecondary. Women in rural areas with no schooling bear 6.9 children, and the figure falls to 6.3 with a primary education, 3.8 with a secondary diploma, and three with a postsecondary education.

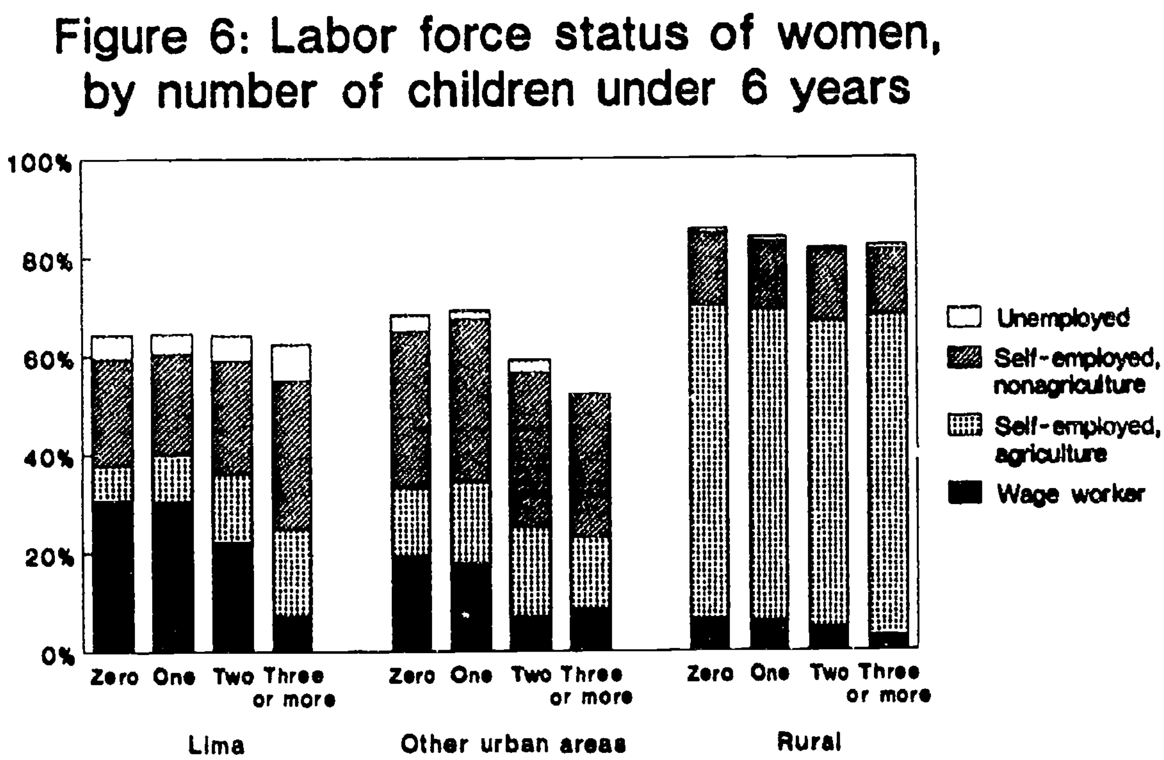
One manifestation of this burden is that women with young children are less likely to go to work. But unlike women in industrial societies where there is a strong trade-off between market work and child care, poor women in developing countries tend to sacrifice leisure time instead, since they are still responsible for the household (Buvinic 1983). Moreover, most women choose an occupation that is compatible with child care and household responsibilities. These are often low-paid informal activities. Because childbearing interrupts the career of women in the formal sector, more of them work at jobs that require lower qualifications and pay lower wages (Gronau 1988).

Using the number of children under age six as an indication of the amount of child care required, figure 6 and table A11 show the status of women with and without dependent children. As this number increases women tend to drop out of the labor force, which implies that some trade-off exists between market work and child care, although the trade-off is lower in rural than in urban areas.

Women in Lima without children or with only one child tend to work in the wage sector, while women with two or more children are likely to be self-employed, again, because of the compatibility between such work and care of children. The trade-off in the number of hours women work is shown in table 6.

2.5 School Enrollment

In many developing countries girls over 10 years old are often taken out of school because of financial restrictions, bad job prospects, or household responsibilities. This assumption is confirmed by Table 7, which shows that enrollment rates are about the same for boys and girls for the younger group, with 92 percent of the boys and 89 percent of the girls enrolled in school. The difference increases, however, for the older age cohort, with 72 percent of the boys and only 64 percent of the girls enrolled in school.



There are also important differences in enrollment by region. Attendance in Lima and other urban areas is higher than in rural areas, particularly for the older age cohorts, indicating that access to secondary

Table 6: Average female weekly hours of work by number of dependent children

Number of Children	Lima	Other urban areas	Rural
None	34.9	34.1	33.6
	(0.6)	(0.8)	(0.4)
One	33.4	31.2	32.2
	(2.6)	(1.4)	(0.6)
Two	25.6	29.3	30.4
	(4.0)	(4.4)	(0.8)
Three or more	26.1	27.4	28.1
	(32.5)	(16.8)	(1.7)

Note: Standard deviation in parentheses

Table 7: School enrollment

Age	Peru	Lima	Other Urban Areas	Rural
6 to 14 years				
Boys	92.4	98.4	97.3	86.8
Girls	89.1	98.3	96.4	80.5
15 to 19 years				
Boys	71.5	83.9	83.3	55.6
Girls	63.6	84.1	78.3	38.6

education is more equitable in urban areas.[8] And the gap between the enrollment of boys and girls is lowest in Lima and highest in rural areas. The gap is more profound for 15-to 19-year-olds, pointing to the fact that girls drop out of school earlier than boys.

As expected, school enrollment reduces the rates of participation in the work force (see figures 7, 8, and table A12), for all groups except boys 6 to 14 years old in rural areas.[9] In these regions 54 percent of the boys who attend school are employed (mostly on family farms), compared to 48 percent of nonenrolled boys. As they move out of school, rural boys start working forwages, although girls usually remain self-employed. In Lima, where there is a wider job market, students 15 to 19 years old work for wages.

3. Contribution to Family Welfare

Table 8 shows that per capita household expenditures are significantly higher in households headed by men (see Rosenhouse (1989)) than in those headed by women.[10] When adjusted for the age composition of the household, male-headed households spend an average 896.55 intis (or approximately U.S. $82) a month compared to 753.45 (or U.S. $69) intis a month for female-headed households. Per capita consumption of male and female headed households is similar where the workstatus is the same (either wage worker or

[8] King and Bellew (1988) observe that educational policies in Peru "... during the past three decades appear to have made access to primary schooling more equitable, while secondary (particularly upper secondary) and higher education largely remain an urban advantage."

[9] There were too few nonenrolled boys and girls to record for the younger age cohort in Lima.

[10] The head of the household is defined as the person who worked the greatest proportion of hours over the last 12 months. No significant differences arise using the definition of reported heads of households.

Figure 7: Labor force status of youths aged 6 to 14 by enrollment status

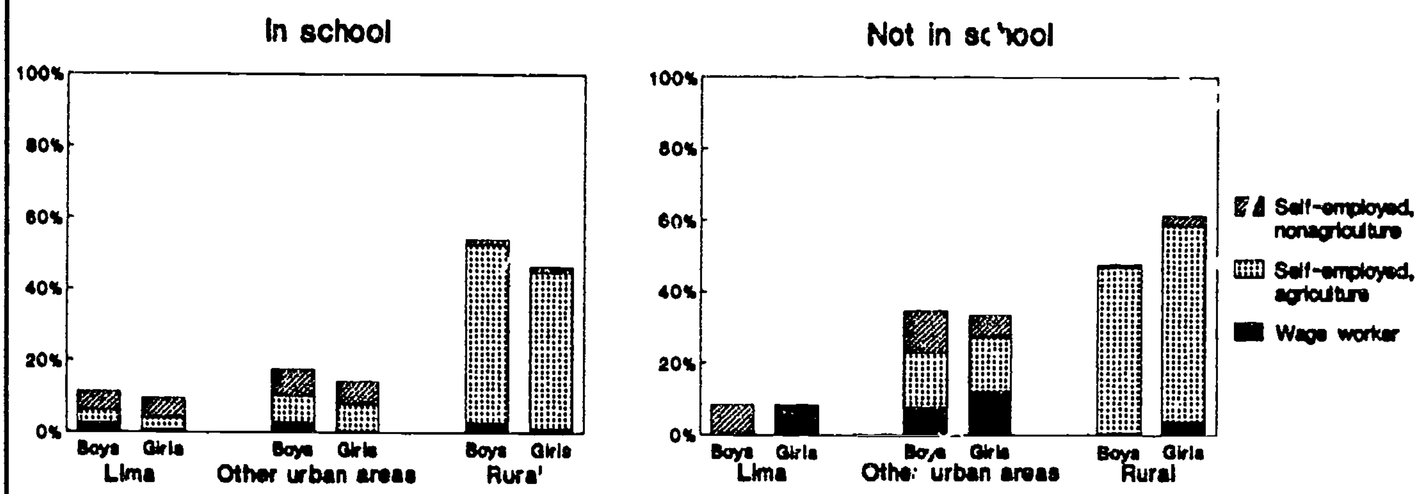


Figure 8: Labor force status of youths aged 15 to 19 by enrollment status

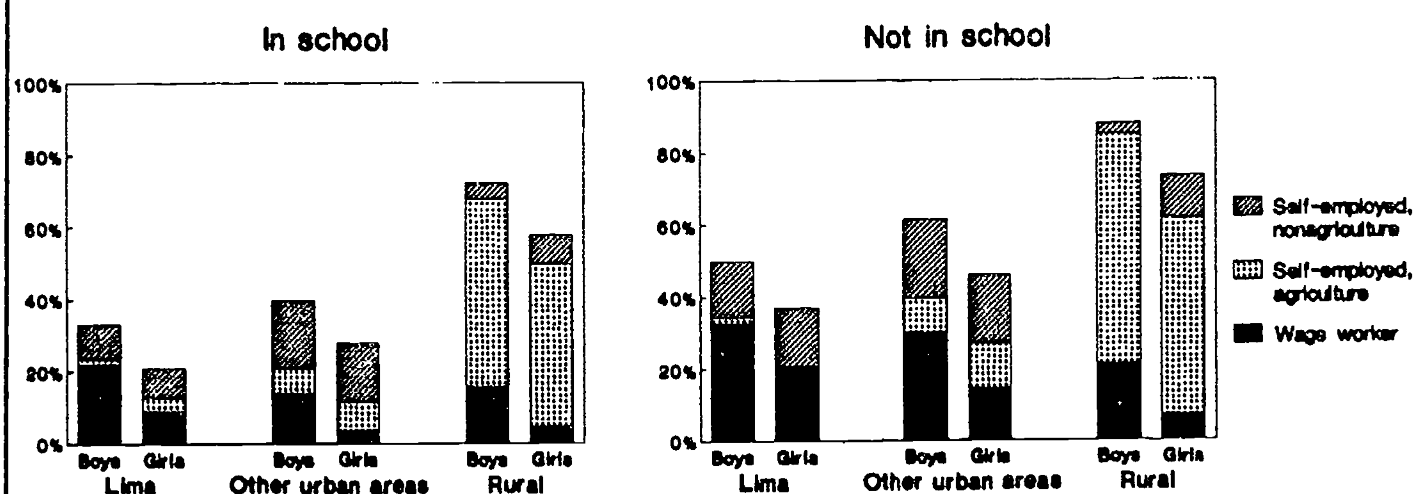


Table 8: Per capita household expenditures for single-earner households, headed by men or women by their work status

	Peru		Lima		Other urban areas		Rural areas	
	Male	Female	Male	Female	Male	Female	Male	Female
Work status								
In the labor force	699.35	629.31	871.87	930 [illegible]	678.97	675.89	499.22	393.79
	(31.81)	(52.81)	(62.36)	(148.22)	(52.74)	(92.43)	(37.22)	(31.39)
Wage workers	724.23	783.36	832.35	813.19	673.82	869.60	527.51	n.a.
	(44.08)	(88.41)	(67.46)	(84.63)	(75.60)	196.24	([illegible]1.88)	
Self-employed	638.94	569.01	844.50	1106.12	686.31	595.05	491.13	393.27
	(39.04)	(66.21)	(96.44)	(344.57)	(72.50)	(101.01)	(44.03)	(3[illegible].77)
Agriculture	541.26	466.71	n.a.	n.a.	n.a.	n.a	518.43	448.31
	(47.66)	(45.03)					(50.87)	(42.20)
Nonagriculture	709.14	673.78	810.32	1206.87	728.16	620.21	373.25	235.66
	(57.17)	(125.22)	(98.69)	(387.32)	(84.40)	(133.39)	(78.19)	(31.23)
				Adjusted[a]				
In the labor force	896.55	753.45	1103.41	1096.35	913.75	847.02	601.83	448.57
	(35.22)	(57.75)	(65.71)	(146.91)	(59.67)	(110.19)	(44.32)	(33.44)
Wage workers	962.08	976.56	1082.92	949.10	920.17	11[illegible]3.30	708.86	n.a.
	(47.61)	(104.32)	(72.54)	(85.46)	(80.91)	(238.10)	(82.04)	
Self-employed	784.07	661.57	1029.47	1291.38	904.23	[illegible]0.92	555.44	435.83
	(46.96)	(70.06)	(105.47)	(340.58)	(90.30)	(116.92)	(53.25)	(34.46)
Agriculture	627.90	507.83	n.a.	n.a.	n.a.	n.a.	585.30	487.62
	(58.60)	(44.35)					(62.92)	(41.76)
Nonagriculture	896.32	819.02	986.66	1403.30	960.04	789 [illegible]	426.30	287.53
	(67.62)	(132.57)	(105.87)	(381.58)	(105.94)	(159.21)	(76.06)	(46.89)

Note: a. All monetary values are in June 1985 prices, at an exchange rate of about 10 intis to the U.S.dollar. Per capita household expenditures are adjusted for household age composition.
n.a.= not available or insufficient observations.

self-employed) in nonagricultural activities. Self-employed households in agriculture headed by men are better off. Table A12 shows there are no significant differences in per capita food expenditures by households.[11]

3.1 School Enrollment of Children

Children whose parents work for wages have a higher probability of being enrolled in school than children of self-employed parents. Children of self-employed farmers have the lowest probability (see table 9). For instance, when the father is a nonagricultural self-employed worker and the mother is an agricultural worker, the probability that their children will go to school is

[11] Data on health and anthropometric measures were not available to assess the effect on the health and nutritional status of children.

Table 9: Probability of child school enrollment by work status of parents

Father's work status	Peru Boys	Peru Girls	Lima Boys	Lima Girls	Other urban areas Boys	Other urban areas Girls	Rural areas Boys	Rural areas Girls
Wage worker								
Work status mother:								
Not employed	0.937	0.942	0.972	0.980	0.910	0.952	0.892	0.789
	(0.013)	(0.014)	(0.012)	(0.012)	(0.028)	(0.022)	(0.040)	(0.061)
Wage worker	0.976	0.959	0.991	0.970	0.984	0.992	0.91[illegible]	0.847
	(0.011)	(0.016)	(0.009)	(0.020)	(0.016)	(0.008)	(0.04[illegible])	(0.079)
Self-employed Agriculture	0.840	0.839	0.920	0.980	0.885	0.883	0.792	0.768
	(0.021)	(0.021)	(0.039)	(0.014)	(0.037)	(0.039)	(0.031)	(0.033)
Self-employed Nonagriculture	0.914	0.898	0.948	0.953	0.918	0.945	0.842	0.681
	(0.018)	(0.019)	(0.024)	(0.020)	(0.026)	(0.022)	(0.056)	(0.069)
Self-employed agriculture								
Work status mother:								
Not employed	0.774	0.699	n.a.	n.a.	0.923	0.833	0.737	0.674
	(0.040)	(0.043)			(0.077)	(0.094)	(0.046)	(0.048)
Wage worker	0.881	0.867	n.a.	n.a.	n.a.	n.a.	0.931	0.846
	(0.070)	(0.091)					(0.047)	(0.104)
Self-employed Agriculture	0.775	0.705	n.a.	n.a.	0.906	0.731	0.770	0.703
	(0.016)	(0.019)			(0.050)	(0.098)	(0.017)	(0.019)
Self-employed Nonagriculture	0.749	0.796	n.a.	n.a.	0.861	0.922	0.709	0.750
	(0.041)	(0.040)			(0.050)	(0.061)	(0.051)	(0.049)
Self-employed nonagriculture								
Work status mother:								
Not employed	0.926	0.945	0.904	0.955	0.932	0.948	1.000	0.908
	(0.019)	(0.017)	(0.032)	(0.024)	(0.270)	(0.027)	(0.000)	(0.045)
Wage worker	0.943	0.992	0.979	0.988	0.882	1.000	n.a.	n.a.
	(0.033)	(0.008)	(0.021)	(0.012)	(0.081)	(0.000)		
Self-employed Agriculture	0.930	0.866	0.980	0.854	0.963	0.924	0.866	0.828
	(0.024)	(0.035)	(0.020)	(0.065)	(0.026)	(0.047)	(0.055)	(0.067)
Self-employed Nonagriculture	0.954	0.911	0.945	0.884	0.961	0.936	0.939	0.844
	(0.014)	(0.019)	(0.028)	(0.039)	(0.018)	(0.022)	(0.042)	(0.075)

Note: Standard errors in parentheses. n.a.= not available or insufficient observations

.930 for boys and .866 for girls. But if the mother is working for wages, the probabilities are respectively .943 and .992. Similarly, in rural areas the sonsof uneducated women are more likely to be enrolled in school than the daughters -- a difference that disappears in families where the mothers have a primary or secondary education (assuming no change in the father's education) (see table A14). In general, the enrollment of girls is more responsive than that of boys to improvements in the education or labor force status of the mother. It is apparent that an improvement in the economic status of women, assuming the husband's economic status is unchanged, will mean that more children, both boys and girls, will be enrolled in school.

3.2 Overview

Figure 9 shows the labor force participation rates of women (see figure 10 for the same data for men), the level of education of their children, and age-specific fertility rates. The data show that increases in the education of men and women improves their participation in the wage sector at the expense of self-employed work in agriculture. Second, the improved economic contribution of the parents, measured in educational status, has a positive impact on children's welfare by increasing the likelihood that they will be enrolled in school especially in rural areas. And last, educated women have lower age-specific fertility rates. These changes are more pronounced when women have access to a secondary school education. Thus an increased investment in education will give families access to higher-paid jobs, reduce the number of children per family, and indirectly enlarge the access of women to the wage sector. Improvements in the economic status of families enhances the educational attainment of the future generation -- both for boys and girls -- and makes access to education more equitable.

Figure 9: Women's contribution and the welfare of the family (children)

by level of education (percent)

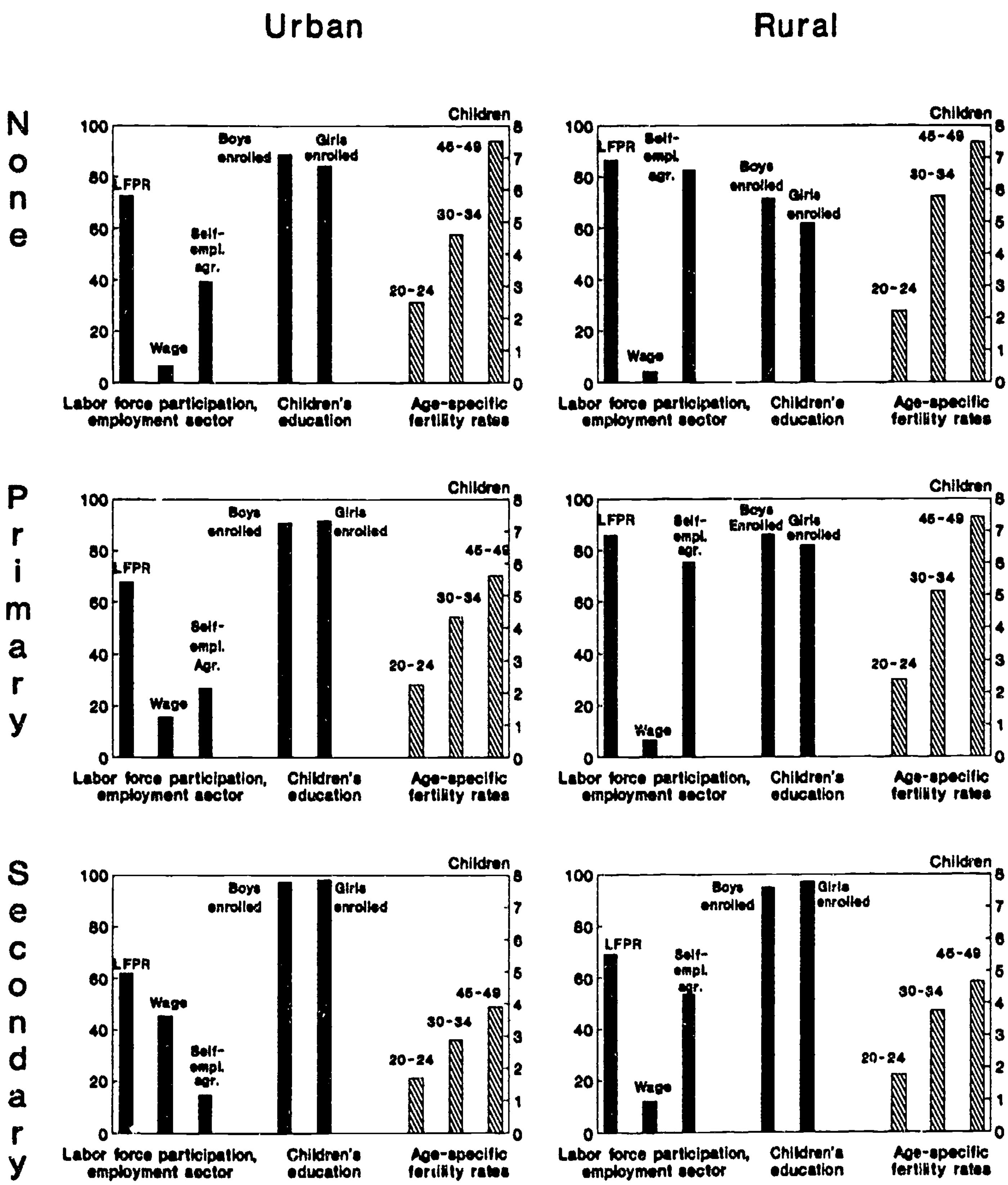
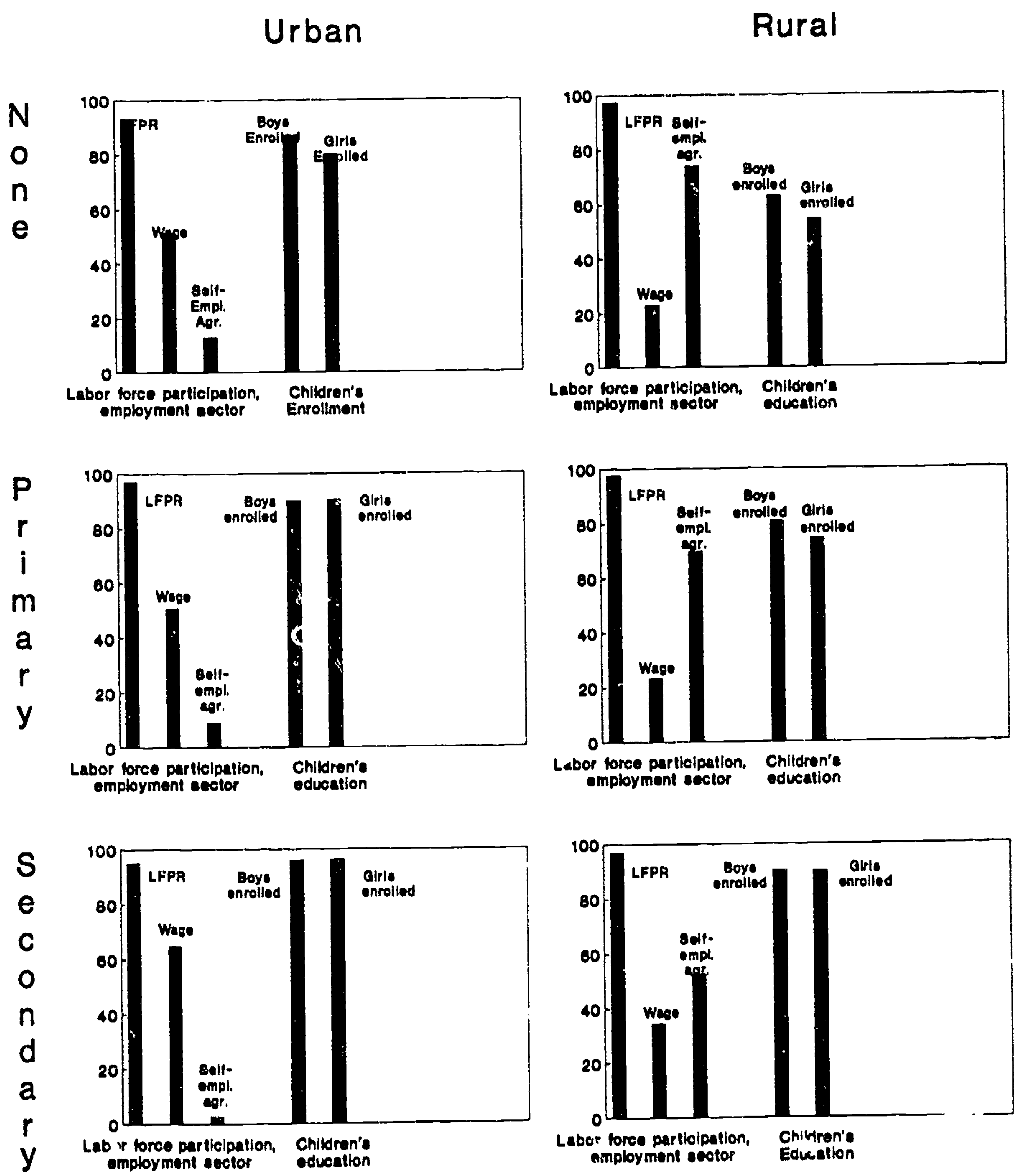


Figure 10: Men's contribution and the welfare of the family (children)

by level of education (percent)



APPENDIX 1: Sample Selection and Employment Definitions

The analysis in this chapter is confined to the potential labor force, which is defined as all persons over 5 years of age excluding retired and handicapped individuals. The sample consists of 10,573 men and 10,789 women.

Respondents were considered to be in the labor force if they (i) worked at least for one hour (with or without pay) in the last seven days, (ii) held a job but did not work because of illness or other reasons, (iii) were waiting to report to a new job, or (iv) did not work but looked for a job during the last seven days. Those in categories (i) and (ii) are employed; those in categories (iii) and (iv), unemployed. The different employment categories considered are the wage sector (public or private), and the self-employment sector (agricultural or nonagricultural).

The public sector comprises people working in the government, the army, or in a state-owned company; the private sector individuals are employed by private enterprises, cooperatives, or in private homes. Individuals working on their household farm are self-employed in the agricultural sector, and individuals working in their household business are self-employed in the nonagricultural sector.

The analysis uses the job status of individuals, according to the respondent's main economic activity during the 7 days prior to the first interview date.

Table A1: Labor force status of men and women, for main occupation, by region

	Peru Male	Peru Female	Lima Male	Lima Female	Other urban areas Male	Other urban areas Female	Rural Male	Rural Female
Potential labor force (=100)	10573	10789	2855	2958	3099	3218	4619	4613
Labor force	70.5	56.9	64.2	45.5	62.2	47.3	79.9	70.8
Unemployed	2.1	1.8	3.0	3.7	2.9	1.9	1.0	0.5
Total paid	45.6	23.5	56.2	30.1	47.1	25.7	38.1	17.7
Total unpaid	22.7	31.6	5.0	11.8	12.2	19.7	40.8	52.6
Wage workers	25.7	10.0	39.8	18.9	27.5	10.0	15.7	4.3
Public sector	6.9	3.3	11.7	6.4	10.0	4.4	1.8	0.5
Administration	5.5	2.9	9.6	5.7	7.6	3.9	1.5	0.4
State enterprise	1.4	0.4	2.0	0.7	2.5	0.5	0.3	0.0
Private Sector	18.8	6.7	28.1	12.5	17.5	5.6	13.9	3.8
Agriculture	4.8	1.1	0.7	0.1	2.3	0.3	9.0	2.3
Nonagriculture	14.0	5.6	27.4	12.4	15.2	5.3	4.9	1.5
Self-employed	42.7	45.0	21.4	22.9	31.8	35.4	63.2	66.0
Agriculture	28.5	29.9	2.1	6.9	8.3	13.1	58.3	56.4
Paid[a]	9.0	3.7	0.4	0.2	2.5	1.1	18.7	7.8
Unpaid	19.5	26.2	1.7	6.7	5.9	12.0	39.6	48.6
Nonagriculture	14.2	15.1	19.3	16.0	23.5	22.3	4.9	9.6
Paid[a]	11.0	9.8	16.0	11.0	17.1	14.6	3.7	5.6
Unpaid	3.3	5.4	3.3	5.0	6.4	7.7	1.2	4.0

a Individuals who reported receiving money from self-employment activities

Table A2: Percentage of women employed in nonagricultural family enterprises and in the formal sector, by industry and region

Sector	Nonagricultural family Enterprises			Formal sector		
	Lima	OUAs	Rural	Lima	OUAs	Rural
Manufacturing						
Food				22.4	21.1	4.3
Processing	71.9	58.3	69.2			
Manufacturing	10.0	8.3	8.8			
Other manufacturing	30.0	8.6	33.3	21.1	7.7	0.0
Textiles	75.4	73.0	74.5	42.9	47.2	52.9
Construction	3.3	0.0	6.7	7.4	1.5	3.4
Commerce						
Wholesale trade	22.5	28.0	33.3	31.2	23.8	16.7
Retail						
Nonfood	57.0	57.8	59.5	21.0	48.0	37.5
Food	73.9	73.1	83.1	38.4	33.7	8.3
Transportation	3.3	7.2	3.1	11.5	9.9	7.7
Financial services	13.8	22.9	n.a.	32.8	31.6	n.a.
Nonfinancial services						
Nonpersonal services	50.0	26.8	22.2	41.1	39.2	31.9
Personal services	39.9	44.5	48.1	59.0	42.0	74.5
Forestry/ Fishing	18.8	0.0	32.6	16.7	13.7	19.5

Source: Stelcner 1988
Note: n.a. = not available or insufficient observations

Table A3: Labor force participation rates by age cohort (in percent)

Age	Men			Women		
	Lima	Other urban areas	Rural	Lima	Other urban areas	Rural
6-14	11.42	18.23	53.31	9.44	14.90	49.27
15-19	42.50	47.83	80.46	29.05	34.76	68.42
20-29	83.46	78.56	94.62	64.54	55.83	79.18
30-39	97.70	97.14	98.54	70.23	74.36	85.57
40-49	97.64	97.02	98.31	63.95	77.17	86.04
50-59	97.29	96.96	96.29	50.94	67.23	87.88
60+	91.43	91.43	96.00	42.96	62.18	83.82

Table A4: Average hours worked in the main occupation by age cohort and labor status

Region	Males 6-14	Males 15-19	Males 20-59	Males 60+	Females 6-14	Females 15-19	Females 20-59	Females 60+
Lima								
Labor force	15.7	29.7	43.6	41.5	15.2	23.5	29.5	24.93
	(1.78)	(1.85)	(0.57)	(1.93)	(2.02)	(2.28)	(0.69)	(2.70)
Wage workers	29.4	40.4	44.7	40.9	n.a.	42.6	35.6	n.a.
	(4.24)	(2.03)	(0.60)	(2.56)		(3.18)	(0.80)	
Self-employed	12.2	25.0	46.7	43.9	13.2	17.6	28.4	23.81
	(1.70)	(3.10)	(1.10)	(2.73)	(1.88)	(2.88)	(1.10)	(2.95)
Other urban areas								
Labor force	17.70	27.00	43.10	38.90	18.91	24.47	30.53	27.97
	(1.07)	(1.43)	(0.59)	(1.75)	(1.50)	(1.64)	(0.68)	(1.99)
Wage workers	28.53	38.93	43.82	45.50	n.a.	40.65	35.61	39.33
	(2.80)	(2.08)	(0.72)	(2.01)		(3.55)	(1.06)	(5.93)
Self-employed	15.77	23.97	46.47	39.48	17.54	23.57	30.51	27.91
	(1.08)	(1.72)	(0.88)	(1.96)	(1.36)	(1.76)	(0.83)	(2.03)
Rural								
Labor force	24.74	34.28	43.09	40.34	24.54	30.49	31.55	30.51
	(0.61)	(0.83)	(0.40)	(0.97)	(0.65)	(0.93)	(0.41)	(1.06)
Wage workers	29.36	36.58	43.99	42.13	36.00	44.38	40.68	39.67
	(3.05)	(1.61)	(0.82)	(2.96)	(4.45)	(2.71)	(1.72)	(5.12)
Self-employed	24.59	34.24	43.66	40.60	24.14	29.67	31.16	30.44
	(0.62)	(0.96)	(0.44)	(1.00)	(0.65)	(1.00)	(0.42)	(1.07)

Note: Standard errors in parentheses
n.a. = not available or insufficient observations

Table A5: Average years of schooling of men and women, by age and labor force status

Men	Age Groups 6-9	10-14	15-19	20-29	30-39	40-49	50-59	60+
Lima								
Labor force	1.3	4.1	8.0	10.1	10.2	8.7	7.6	7.1
	(0.22)	(0.21)	(0.18)	(0.12)	(0.18)	(0.24)	(0.29)	(0.42)
Unemployed	n.a.	n.a.	8.9	10.3	9.7	9.9	9.4	n.a.
			(0.31)	(0.45)	(0.76)	(1.10)	(1.96)	n.a.
Wage workers	n.a.	3.7	8.0	10.1	10.8	9.0	7.9	
		(0.49)	(0.23)	(0.14)	(0.21)	(0.29)	(0.39)	[illegible]
Public sector	n.a.	n.a.	7.2	11.0	12.9	11.0	9.1	10.6
			(0.86)	(0.25)	(0.30)	(0.46)	(0.74)	(1.16)
Private sector	n.a.	3.7	8.1	9.9	9.6	8.0	7.3	7.0
		(0.49)	(0.24)	(0.16)	(0.24)	(0.35)	(0.44)	(0.82)
Self-employed	1.3	4.3	7.4	9.8	8.8	8.0	7.1	5.9
	(0.22)	(0.23)	(0.38)	(0.26)	(0.33)	(0.44)	(0.46)	(0.46)
Agriculture	1.1	4.4	8.5	7.2	7.2	4.5	5.5	3.4
	(0.23)	(0.42)	(0.85)	(1.39)	(1.16)	(0.50)	(0.96)	(0.67)
Nonagriculture	n.a.	4.3	7.2	9.9	8.9	8.1	7.2	6.3
		(0.29)	(0.42)	(0.26)	(0.33)	(0.45)	(0.48)	(0.51)
Other urban areas								
Labor force	1.4	3.9	7.6	9.2	9.0	7.0	5.8	4.9
	(0.18)	(0.16)	(0.15)	(0.13)	(0.20)	(0.26)	(0.28)	(0.29)
Unemployed	n.a.	n.a.	8.5	8.9	7.1	4.0	3.6	6.1
			(0.39)	(0.42)	(0.98)	(0.73)	(1.07)	(1.78)
Wage workers	n.a.	3.6	6.6	9.1	9.3	8.1	6.1	5.2
		(0.32)	(0.29)	(0.18)	(0.26)	(0.39)	(0.47)	(0.66)
Public sector	n.a.	n.a.	9.5	10.4	11.0	9.7	6.7	7.1
			(0.50)	(0.32)	(0.36)	(0.50)	(0.74)	(1.26)
Private sector	n.a.	3.6	6.6	8.7	7.9	5.9	5.7	4.3
		(0.32)	(0.29)	(0.21)	(0.33)	(0.50)	(0.59)	(0.71)
Self-employed	1.3	3.9	8.0	9.4	8.7	5.9	5.7	4.8
	(0.20)	(0.18)	(0.16)	(0.23)	(0.30)	(0.31)	(0.35)	(0.33)
Agriculture	0.8	4.2	8.1	8.5	9.4	3.9	5.4	4.6
	(0.16)	(0.27)	(0.29)	(0.75)	(0.90)	(0.53)	(0.57)	(0.59)
Nonagriculture	2.4	3.7	8.0	9.6	8.5	6.3	5.9	4.9
	(0.31)	(0.24)	(0.20)	(0.23)	(0.32)	(0.35)	(0.44)	(0.39)
Rural								
Labor force	0.9	2.8	5.1	5.8	4.7	3.0	2.8	1.9
	(0.05)	(0.07)	(0.11)	(0.13)	(0.16)	(0.13)	(0.16)	(0.12)
Unemployed	n.a.	n.a.	5.7	5.5	4.5	1.9	n.a.	n.a.
			(1.11)	(0.95)	(1.02)	(0.59)		
Wage workers	1.6	3.1	5.2	6.5	5.7	3.7	3.6	1.7
	(0.43)	(0.30)	(0.24)	(0.25)	(0.36)	(0.34)	(0.54)	(0.39)
Public sector	n.a.	n.a.	n.a.	9.8	8.0	8.0	10.8	n.a.
				(0.61)	(0.85)	(1.08)	(1.72)	
Private sector	1.6	3.1	5.1	6.1	5.1	2.9	2.4	1.3
	(0.43)	(0.31)	(0.24)	(0.26)	(0.38)	(0.30)	(0.37)	(0.23)
Self-employed	0.8	2.8	5.1	5.4	4.3	2.8	2.6	1.9
	(0.05)	(0.07)	(0.12)	(0.16)	(0.17)	(0.14)	(0.15)	(0.12)
Agriculture	0.8	2.8	5.1	5.2	4.1	2.7	2.4	1.9
	(0.05)	(0.07)	(0.13)	(0.17)	(0.18)	(0.14)	(0.15)	(0.13)
Nonagriculture	n.a.	3.7	5.6	7.3	5.4	3.5	4.0	2.5
		(0.37)	(0.48)	(0.40)	(0.51)	(0.41)	(0.48)	(0.35)

Note: Standard errors in parentheses
n.a. = not available or insufficient observations

(continued)

Table A5 Continued

Women	6-9	10-14	15-19	20-29	30-39	40-49	50-59	60+
				Age Groups				
Lima								
Labor force	1.6	3.6	7.4	9.7	8.5	6.3	4.8	4.3
	(0.16)	(0.23)	(0.21)	(0.14)	(0.24)	(0.29)	(0.36)	(0.53)
Unemployed	n.a.	n.a.	8.3	9.4	9.2	6.0	n.a.	n.a.
			(0.49)	(0.44)	(0.69)	(1.22)		
Wage workers	n.a.	3.6	7.2	10.4	10.3	8.7	6.9	7.2
		(0.92)	(0.35)	(0.17)	(0.34)	(0.53)	(0.68)	(0.98)
Public sector	n.a.	n.a.	7.9	11.3	11.8	10.9	6.0	n.a.
			(1.01)	(0.32)	(0.46)	(0.75)	(1.62)	
Private sector	n.a.	3.6	7.1	10.0	9.0	6.7	7.2	7.3
		(0.92)	(0.38)	(0.19)	(0.46)	(0.60)	(0.74)	(1.20)
Self-employed	1.6	3.6	7.0	8.8	6.9	4.9	4.1	3.9
	(0.16)	(0.24)	(0.31)	(0.26)	(0.30)	(0.30)	(0.40)	(0.57)
Agriculture	n.a.	3.7	7.2	8.3	6.6	4.7	3.1	2.7
		(0.37)	(0.32)	(0.45)	(0.62)	(0.47)	(0.58)	(0.81)
Nonagriculture	1.7	3.5	7.0	9.0	7.0	4.9	4.8	4.5
	(0.18)	(0.32)	(0.41)	(0.32)	(0.35)	(0.38)	(0.53)	(0.75)
Other urban areas								
Labor force	1.[illegible]	[illegible].6	7.7	8.6	7.3	5.0	3.0	2.3
	(0.1[illegible])	(0.19)	(0.19)	(0.19)	(0.25)	(0.29)	(0.25)	(0.26)
Unemployed	n.a.	n.a.	9.2	9.9	5.1	5.3	n.a.	n.a.
			(0.56)	(0.62)	(2.26)	(1.7[illegible])		
Wage workers	n.a.	n.a.	7.6	10.2	10.8	10.2	7.[illegible]	n.a.
			(0.56)	(0.34)	(0.38)	(0.74)	(1.30)	
Public sector	n.a.	n.a.	9.7	11.7	12.4	12.7	10.7	n.a.
			(0.33)	(0.42)	(0.36)	(0.51)	(1.69)	
Private sector	n.a.	n.a.	7.4	9.4	8.3	7.2	4.9	n.a.
			(0.61)	(0.44)	(0.66)	(1.21)	(1.45)	
Self-employed	1.4	3.7	7.6	7.6	5.6	3.8	2.5	2.3
	(0.20)	(0.19)	(0.21)	(0.23)	(0.26)	(0.24)	(0.22)	(0.26)
Agriculture	1.3	3.5	6.7	6.9	4.6	3.5	2.2	2.1
	(0.23)	(0.28)	(0.37)	(0.40)	(0.52)	(0.47)	(0.30)	(0.36)
Nonagriculture	1.7	3.9	8.0	7.9	6.0	3.9	2.8	2.4
	(0.41)	(0.26)	(0.23)	(0.28)	(0.30)	(0.29)	(0.33)	(0.36)
Rural								
Labor force	0.8	2.6	4.1	3.7	2.2	1.1	0.9	0.7
	(0.06)	(0.08)	(0.13)	(0.14)	(0.14)	(0.09)	(0.09)	(0.09)
Unemployed	n.a.	n.a.	5.2	4.6	n.a.	n.a.	n.a.	n.a.
			(1.11)	(1.91)				
Wage workers	n.a.	2.7	4.7	6.7	5.2	2.2	2.1	1.7
		(0.33)	(0.45)	(0.69)	(0.85)	(0.60)	(0.85)	(1.18)
Public sector	n.a.	n.a.	n.a.	10.5	n.a	n.a.	n.a.	n.a.
				(0.92)				
Private sector	n.a.	2.7	4.7	4.9	4.5	1.6	1.5	1.7
		(0.33)	(0.45)	(0.71)	(0.85)	(0.40)	(0.72)	(1.18)
Self-employed	0.8	2.6	4.0	3.5	1.9	1.1	0.9	0.6
	(0.06)	(0.08)	(0.14)	(0.14)	(0.13)	(0.09)	(0.09)	(0.09)
Agriculture	0.8	2.5	3.9	3.0	1.6	0.9	0.8	0.6
	(0.06)	(0.08)	(0.15)	(0.14)	(0.13)	(0.08)	(0.10)	(0.10)
Nonagriculture	0.5	3.7	4.7	5.2	2.9	1.9	1.1	0.8
	(0.50)	(0.29)	(0.37)	(0.34)	(0.35)	(0.41)	(0.23)	(0.21)

Note: S[illegible]dard errors in parentheses
n.a. = not available or insufficient observations

Table A6: Labor force status of adult men and women by marital status

Gender	Lima			Other urban areas			Rural		
	Married	Separated	Single	Married	Separated	Single	Married	Separated	Single
Women									
Potential labor force (=100)	1016	215	486	1098	237	334	1632	306	259
Labor force	60.5	76.3	68.0	65.7	79.4	60.5	84.1	84.9	82.6
Unemployed	2.9	7.1	8.7	2.0	3.0	5.4	0.5	1.0	1.9
Wage workers	21.5	32.7	44.5	11.9	21.9	31.0	4.1	11.4	10.4
Public sector	9.5	9.5	13.2	7.5	6.4	11.4	0.6	1.0	3.5
Private sector	12.0	23.2	31.3	4.3	15.5	19.6	3.6	10.4	6.9
Self-employed	36.1	36.5	14.8	51.8	54.5	24.1	79.4	72.6	70.3
Agriculture	11.9	8.5	1.9	18.4	13.3	5.1	65.8	56.2	54.8
Nonagriculture	24.3	28.0	13.0	33.4	41.2	19.0	13.7	16.4	15.4
Men									
Potential labor force (=100)	947	41	605	1048	42	458	1585	80	485
Labor force	98.6	90.2	81.5	97.0	95.2	73.1	97.8	96.2	93.6
Unemployed	2.3	4.9	5.3	2.9	2.4	6.6	1.1	2.5	2.5
Wage workers	64.9	61.0	50.0	50.0	42.9	38.6	25.3	25.1	26.9
Public sector	23.2	12.2	13.1	23.9	14.3	9.6	4.0	5.0	3.0
Private sector	41.7	48.8	42.1	26.1	28.6	29.0	21.3	20.0	24.0
Self-employed	31.4	24.4	21.0	44.2	50.0	27.9	71.4	68.8	64.2
Agriculture	1.1	0.0	1.3	8.0	4.8	5.2	63.5	60.0	58.3
Nonagriculture	30.3	24.4	19.7	36.2	45.2	22.7	7.9	8.7	5.9

Table A7: Cross-distribution of the labor force status of wives and husbands

	Labor Status Husband								
	Lima			Other urban areas			Rural		
Labor Status Wife	Wage	Self-employed Agric.	Self-employed Nonagric.	Wage	Self-employed Agric.	Self-employed Nonagric.	Wage	Self-employed Agric.	Self-employed Nonagric.
Potential labor force (=100)	611	14	298	506	88	382	374	1019	127
Labor force	59.4	57.1	64.1	63.0	73.9	68.1	81.5	86.0	75.6
Unemployed	2.8	0.0	3.4	2.2	0.0	2.1	1.1	0.4	0.0
Wage workers	24.1	7.1	15.1	15.2	0.2	7.3	9.6	2.2	3.9
Self-employed	32.6	50.0	45.7	45.7	63.7	58.7	70.8	83.4	71.7
Agriculture	12.6	14.3	12.8	20.0	36.4	12.6	51.3	74.2	39.4
Nonagriculture	20.0	35.7	32.9	25.7	27.3	46.1	19.5	9.2	32.3

Table A8: Cross-distribution of the education of wives and husbands

Education of Wife	Education of Husband None	Primary	Secondary	Post secondary
None	26.59	68.27	4.81	0.33
Primary	2.30	66.38	28.23	3.09
Secondary	0.71	12.38	53.77	33.14
Postsecondary	1.07	3.20	28.11	67.62

Table A9: Distribution of women, by number of children born, region, and mother's age group and education (percent)

	Average	Number of Children 0	1	2	3	4	5	6	7	8	9	10 or more
Peru	4.26	4.4	11.0	17.4	15.8	12.7	9.7	8.4	5.6	4.7	3.8	6.5
Urban	3.46	4.3	14.4	22.0	20.0	13.6	8.5	6.9	3.7	2.0	1.7	3.0
Rural	5.24	4.4	6.7	11.6	10.7	11.5	11.3	10.3	8.0	8.1	6.4	10.9
Age group												
15-19	1.00	30.7	45.5	18.8	3.0	2.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
20-24	1.95	9.7	29.0	32.1	18.6	7.6	2.8	0.3	n.a.	n.a.	n.a.	n.a.
25-29	3.15	5.0	13.4	20.9	20.7	18.0	11.7	6.5	2.7	0.8	0.4	n.a.
30-34	4.13	1.9	7.5	18.2	19.1	14.2	12.0	11.0	7.9	3.7	2.4	2.1
35-39	5.11	0.9	3.6	14.5	14.0	12.7	14.3	11.4	8.2	7.6	6.0	6.9
40-44	6.04	1.8	3.6	10.2	12.3	10.5	9.9	9.0	6.3	10.5	8.4	17.7
45-49	6.72	1.5	2.2	6.3	9.3	11.5	4.8	13.3	9.6	9.3	9.3	23.0
Education												
None	6.33	2.7	3.8	6.0	7.8	9.7	10.8	11.4	10.3	11.0	9.0	17.5
Primary	4.57	4.2	6.7	14.3	14.9	14.5	13.1	10.8	6.5	4.9	4.0	6.1
Secondary	2.69	4.7	20.1	27.6	22.1	12.3	5.6	4.6	1.8	0.7	0.3	0.1
Postsecondary	2.31	8.5	21.6	30.0	21.6	12.7	2.8	1.4	0.9	n.a.	0.5	n.a.

Table A10: Number of children born, by region, age group, and education of mother

Ages	Urban None	Urban Primary	Urban Secondary	Urban Post-secondary	Rural None	Rural Primary	Rural Secondary	Rural Post-secondary
Age Group								
15-19	1.0	1.4	1.2	n.a.	1.4	1.5	1.3	n.a.
20-24	2.5	2.3	1.7	1.2	2.2	2.4	1.8	1.5
25-29	3.4	3.2	2.4	1.8	4.[illegible]	4.0	2.7	1.2
30-34	4.6	4.3	2.9	2.2	5.8	5.1	3.8	2.4
35-39	6.0	4.4	3.3	2.9	6.9	6.3	3.8	3.0
40-44	7.1	5.5	3.3	2.9	7.7	4.7	4.7	1.0
45-49	7.5	5.6	3.9	3.1	7.5	4.7	4.7	n.a.

Note: n.a. = not available or insufficient observations

Table A11: Labor force status of women by number of children under six years

	Number of Children											
	Lima				Other urban areas				Rural			
Status	Zero	One	Two	Three or more	Zero	One	Two	Three or more	Zero	One	Two	Three or more
Potential labor force (=100)	1175	354	171	40	998	408	221	69	1018	544	451	198
Labor force	64.4	64.5	64.3	62.5	68.3	69.0	59.3	52.2	85.6	83.9	81.8	82.3
Unemployed	5.1	4[illegible]	5.3	7.5	3.4	2.0	2.7	0.0	0.7	0.9	0.4	1.0
Wage workers	30.7	30.4	22.2	7.5	19.5	17.9	7.2	8.7	6.6	6.3	4.9	3.0
Public sector	9.8	12.8	11.1	5.0	8.5	9.6	5.4	4.3	1.3	1.1	0.4	0.0
Private sector	20.9	17.6	11.1	2.5	11.0	8.4	1.8	4.3	5.3	5.2	4.4	3.0
Self-employed	28.6	29.8	36.8	47.5	45.4	49.1	49.3	43.5	78.4	76.7	76.5	78.3
Agriculture	7.3	9.7	14.0	17.5	13.8	16.5	18.1	14.5	63.5	63.0	62.1	65.2
Nonagriculture	21.3	20.2	22.8	30.0	31.6	32.7	31.2	29.0	14.9	13.7	14.4	13.1

Table A12: Labor force status of 6- to 19-year-olds by school enrollment

Status	Lima		Other Urban Areas		Rural	
	Enrolled	Not Enrolled	Enrolled	Not Enrolled	Enrolled	Not Enrolled
Boys 6-14						
Potential labor force (=100)	750	12	923	26	1362	208
Employed	11.1	8.3	17.5	34.6	53.9	47.6
Wage workers	2.7	0.0	3.0	7.7	3.0	0.5
Self-employed agric.	3.6	0.0	7.2	15.4	49.6	46.6
Self-employed nonagric.	4.8	8.3	7.3	11.5	1.3	0.5
Girls 6-14						
Potential labor force (=100)	698	12	880	33	1207	293
Employed	9.4	8.3	14.0	33.4	46.2	61.4
Wage workers	0.9	8.3	0.3	12.1	1.3	3.8
Self-employed agric.	3.3	0.0	7.6	15.2	43.4	54.9
Self-employed nonagric.	5.2	0.0	6.1	6.1	1.5	2.7
Boys 15-19						
Potential labor force (=100)	302	58	364	73	336	268
Employed	33.2	50.0	39.8	61.6	72.4	88.1
Wage workers	22.2	32.8	14.0	30.1	15.8	21.3
Self-employed agric.	1.7	1.7	7.1	9.6	52.1	63.8
Self-employed nonagric.	9.3	15.5	18.7	21.9	4.5	3.0
Girls 15-19						
Potential labor force (=100)	327	62	347	96	220	350
Employed	20.9	37.1	28.0	45.9	57.7	73.5
Wage workers	8.9	21.0	3.5	14.6	4.5	6.9
Self-employed agric.	4.0	0.0	8.1	12.5	45.5	54.9
Self-employed nonagric.	8.0	16.1	16.4	18.8	7.7	11.7

Table A13: Per capita household food expenditures for single-earner households

Sector	Peru Male headed	Peru Female headed	Lima Male headed	Lima Female headed	Other urban areas Male headed	Other urban areas Female headed	Rural areas Male headed	Rural areas Female headed
In the Labor Force	316.47	335.10	358.76	450.51	278.00	292.19	310.76	299.85
	(10.14)	(28.39)	(15.10)	(84.92)	(16.97)	(43.17)	(21.04)	(25.68)
Wage workers	306.82	349.09	352.33	368.13	269.41	346.43	260.65	n.a
	(12.16)	(46.59)	(17.16)	(35.50)	(21.86)	(109.83)	(22.03)	
Self-employed	325.99	332.09	364.89	571.55	284.68	271.15	338.57	303.25
	(17.22)	(36.09)	(30.93)	(201.29)	(26.61)	(38.85)	(29.64)	(27.79)
Agriculture	357.41	335.17	n.a	n.a	n.a	n.a	366.26	353.73
	(29.92)	(29.56)					(34.02)	(34.24)
Nonagriculture	303.13	(328.95)	350.41	622.97	291.69	259.13	219.00	158.69
	(20.15)	(66.72)	(29.48)	(227.06)	(30.82)	(48.13)	(51.00)	(26.06)
				Adjusted[a]				
In the Labor Force	405.95	392.62	466.97	533.91	376.30	352.10	363.98	338.57
	(11.21)	(28.74)	(17.00)	(84.53)	(18.74)	(43.59)	(22.58)	(26.44)
Wage workers	415.52	426.94	471.43	436.60	375.72	426.13	344.33	n.a
	(14.09)	(47.31)	(20.57)	(36.75)	(24.35)	(65.86)	(25.28)	
Self-employed	390.06	380.07	447.77	668.22	367.76	322.72	377.40	334.44
	(18.02)	(36.45)	(30.41)	(199.31)	(27.51)	(40.02)	(31.80)	(28.23)
Agriculture	404.68	364.65	n.a	n.a	n.a	n.a	408.13	383.76
	(31.68)	(29.25)					(36.86)	(34.00)
Nonagriculture	379.43	395.86	434.32	723.16	376.61	325.53	244.69	193.23
	(20.78)	(67.62)	(29.42)	(224.41)	(32.04)	(50.71)	(49.05)	(35.58)

a Per capita household expenditures are adjusted for household age composition. All monetary values are in June 1985 prices, at an exchange rate of about 10 intis to the U.S. dollar.

n.a.= not available or insufficient observations

Table A14: Probability of child school enrollment by education of parents

Education father	Peru Boys	Peru Girls	Lima Boys	Lima Girls	Other urban areas Boys	Other urban areas Girls	Rural Boys	Rural Girls
Primary education								
Education mother:								
None	0.783	0.718	0.911	1.000	0.879	0.885	0.757	0.675
	(0.018)	(0.020)	(0.052)	(0.000)	(0.041)	(0.039)	(0.020)	(0.023)
Primary	0.869	0.858	0.921	0.950	0.871	0.897	0.850	0.811
	(0.018)	(0.012)	(0.021)	(0.018)	(0.021)	(0.019)	(0.017)	(0.019)
Secondary	0.989	0.948	1.000	0.964	1.000	0.944	0.929	0.964
	(0.018)	(0.033)	(0.000)	(0.018)	(0.000)	(0.056)	(0.071)	(0.036)
Post-secondary	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Secondary education								
Education mother:								
None	0.926	0.844	n.a.	n.a.	n.a.	n.a.	0.867	0.856
	(0.044)	(0.072)					(0.077)	(0.093)
Primary	0.934	0.931	0.921	0.945	0.942	0.949	0.892	0.879
	(0.014)	(0.014)	(0.021)	(0.020)	(0.019)	(0.021)	(0.041)	(0.038)
Secondary	0.965	0.985	0.944	0.981	0.969	0.986	0.956	1.000
	(0.012)	(0.008)	(0.056)	(0.012)	(0.018)	(0.014)	(0.031)	(0.000)
Post-secondary	0.966	1.000	1.000	1.000	0.929	1.000	n.a.	n.a.
	(0.034)	(0.000)	(0.000)	(0.000)	(0.071)	(0.000)		

Note: Standard errors in parentheses
n.a.= not available or insufficient observations

Chapter 2:

LABOR MARKET PARTICIPATION, RETURNS TO EDUCATION, AND MALE-FEMALE WAGE DIFFERENCES IN PERU

Shahidur R. Khandker*

1. Introduction

This chapter estimates the differences between males and females in wage labor market participation, productivity (measured by wages) and economic returns to schooling. The purpose is to (a) identify those characteristics that enable some women, though not many, to participate in this sector, (b) determine whether the private economic returns to education vary by gender and influence school enrollment, and (c) evaluate the extent to which the male-female wage gap is caused by differences in human capital. The household survey data show that in Peru the labor market (i.e., wage sector) participation rate for women is 13 percent compared to 35 percent for men.[1] The data also indicate that women earn about half of men's wage in the wage sector. Thus, as women participate less as well as earn less compared to men in the wage sector, identifying the constraints that affect women's productivity and wage market participation may constitute an important policy exercise.

Results suggest that male-female differences in education account for some observed differences in labor market participation and productivity. The results on returns to education show that the private rate of return is generally higher for women than for men. However, school enrollment data indicate that girls enroll less than boys, especially in the secondary school. As the private returns to education are expected to influence school enrollment of boys and girls, this finding suggests that parents are perhaps not consistent in their behavior. However, when unobserved family characteristics that influence wage and return estimates are controlled, the economic returns to schooling are lower for girls than for boys in rural areas, especially at the secondary and post-secondary levels. Thus, parents have reasons, at least in rural areas, for investing less in daughters than sons. More research is necessary on the social and private benefits and costs of schooling to quantify the factors that influence this decision.[2]

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[1]In contrast, the labor force (which includes both wage and self-employment) participation rate for women is 57 percent compared to 71 percent for men.

[2]Behrman and Deolalikar (1988) report that lower investment in girls' schooling compared to boys' in Indonesia is consistent with relatively higher opportunity costs for females attending schools.

This chapter uses a human capital model to analyze wages and labor market participation in the wage sector that was developed by Becker (1964) and Mincer (1974). The focus is essentially on education as a determinant of labor market participation and productivity. Because the amount of schooling imparts different skills - and hence different wages - this model provides a framework to look at differences in the wages and labor market participation of men and women in terms of levels of schooling. The wage estimates help determine the private rate of returns to education for men and women. The school returns of men and women will then be contrasted with the respective school enrollments of boys and girls. The purpose is to see whether parents are responsive to the market incentives. Using the wage estimates, we can also identify how much variation in wages is due to differences in education.

The wage function and the estimates derived from this may suffer from two sources of bias. The first source is unobserved variable bias, which arises in the event that some variables may affect wages but are not included in the wage regression. A satisfactory analysis, therefore, requires identifying potentially observable characteristics other than human capital that can affect an individual's wage. These are not clearly understood and thus difficult to incorporate in the analysis (Schultz 1989). There are ways to reduce the impact of unobserved characteristics on wages and other related estimates. This chapter uses a household fixed-effect method to quantify the severity of this bias on the wage estimates. The second source produces a sample selection bias, which arises due to restricting the analysis to wage workers, thus ignoring information on workers who do not participate in the wage market.[3] The chapter identifies whether sample selection correction modifies the wage estimates and hence male-female difference in the economic returns to education and productivity.

Two earlier studies using the same household survey data from Peru have investigated the wage rate function for men and women (Stelcner and others 1988, King 1988). They did not, however, assess differences in wages and returns to schooling, or evaluate whether correcting for sample selection or unobserved variables systematically modifies the comparison of the estimated returns to education and productivity of men and women.

The chapter is structured as follows. Section Two explains the model specification and estimation strategy. Section Three discusses the data and highlights the differences between males and females in terms of wage-related characteristics. Section Four reports the results. Policy implications are in the concluding section.

2. Model Specification and Estimation Strategy

This section outlines a model framework to address participation in the labor market, the private economic returns to education, and a wage gap between males and females that is influenced by differences in job-related

[3]Note that unobserved variables bias may include selectivity controls so that two sources of bias may be correlated. However, controlling one bias may reduce severity of the problem, not necessarily control, for the other.

characteristics. It also discusses ways to reduce the impact of unobserved variable and sample selection bias from the wage estimates.

2.1. Wage Labor Market Participation

What influences women's participation in the wage labor market? Do women differ from men in responding to wage labor market opportunities? Does human capital (for instance, education) help women more than men to participate in the wage sector? Identifying these factors may help policymakers understand what promotes women's participation in the wage labor market.

The decision to join the wage labor market, given the time constraints, is based on an individual's income-leisure trade-off. A time allocation model can help identify the constraints that affect an individual's allocation of time (Becker 1965). This model identifies those individual characteristics, such as education and experience, household characteristics, including landholding and unearned income, and market conditions, such as wages, that influence an individual's allocation of time. Thus the time allocated to different activities, including leisure, can be drawn as a function of individual, household, and market characteristics. The time allocation data can produce a discrete choice structure of whether to participate in the wage labor market. The decision can be estimated using a probability function separately for males and females as follows:

$$Y_m = \tau_{om} + X_m\tau_{1m} + Z_m\tau_{2m} + e_m \qquad (1)$$

$$Y_f = \tau_{of} + X_f\tau_{1f} + Z_f\tau_{2f} + e_f \qquad (2)$$

where: $Y_j(j=m,f)$ are binary dependent variables with 1 if the jth individual participates in the wage labor market and 0 otherwise;[4] X is a vector of individual characteristics that influences an individual's time allocation; Z is a vector of household and market factors which also explains why an individual participates in the labor market; τ is the vector of coefficients to be estimated, and e is an error term.[5]

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[4]Y_j equal to zero includes individuals who are either self-employed (in family business and farming) or exclusively engaged in non-market home production. Representing self-employed and those who work exclusively for home non-market production under the same category may appear problematic if the decisions involved in these two alternatives are independent. The degree of independence between two alternatives such as self-employment and home production can be tested within a nested multinomial logit framework as done in Khandker (1987). No analysis of this sort has been done with the PLSS data. We assume for simplicity that the transactions costs of switching from home nonmarket production to self-employment are not high so that participation decisions in home production and self-employment are not independent.

[5]We are assuming that the disturbance errors e_m and e_f are independent. That is, labor market participation decision is an individual's decision. However, as individuals belong to a household where individuals' decisi--s may not be independent, the errors are then jointly rather than independently distributed.

Different reasons can justify the inclusion of individual (X), and household and market (Z) factors as explanatory variables in labor market participation equations (1)-(2). An individual characteristic, such as the level of education can be treated as an explanatory variable that may indicate the potential productivity of an individual at home and in market production. Holding market wages constant, an increase in the level of an individual's education can increase his or her probability of labor market participation if it increases the opportunity costs of staying at home. The household's constraints include such household asset variables as landholding, which may act as a proxy for productive household assets. The productive assets exert a price effect and an income effect on an individual's labor market participation. The price effect would raise the marginal product or "shadow price" of an individual's labor, while the income effect would encourage an individual to consume more of his or her leisure -- even at its given opportunity cost. The household's unearned income -- another household characteristic -- can influence labor market participation via a pure income effect. Such market factors as market wages exert an income and a substitution effect on an individual's time allocation. Market factors may also include community variables, such as the household's proximity to community services (schooling, health, and banking services). These variables measure the impact on time allocation of implicit prices of many goods and services the household uses for production and consumption.[6]

Because the dependent variable takes the value of 1 or 0 in both equations (1)-(2), the error structures yield heteroscedasticity. I will use the maximum likelihood method to estimate the labor market participation equations.

2.2. Returns to Education

A semilogarithmic wage function is a standard practice in the literature to estimate a wage equation which provides estimates of the economic returns to education. As Becker (1964) and Mincer (1974) argue, variations in wages arise from differences in investment in human capital, especially education and post-school experience. More formally,

$$\ln W_i = \alpha_{0i} + \beta_{1i}S_i + \beta_{2i}K_i + \beta_{3i}K^2_i + \epsilon_i \qquad (3)$$

where $\ln W_i$ is the natural log of the hourly wage rate of the ith individual (i=m for male, i=f for female wage worker); S is the individual's years of schooling, K is the individual's postschool experience (defined as age minus S minus school entry age, say, 6); K^2 is the individual's experience squared; α_0 and β_j (j=1,2,3) are, respectively, the intercept and slope coefficients to be estimated; and ϵ_i is the individual specific unobserved error.

Under the standard assumption that years of schooling and age and hence post-school experience are predetermined, the above equation (3) is thought of as an approximation to the wage function that determines an individual's wage in the paid labor market. Two possible interpretations of the wage equation (3) are found in the literature. The first is the hedonic price theory which

[6]No information on any of these market factors is available except for rural areas. Thus Z variables include only household-level variables.

interprets (3) as hedonic index on characteristics that affect the price of the individual's time (Rosen, 1974). The second interpretation is given by Mincer (1974) who viewed (3) as a generalization of the equilibrium relation between education and wages where the partial derivative of log wage with respect to schooling is the estimate of the private rate of return to the time spent in school instead of in the labor market.[7] Thus, according to Mincerian interpretation, if the error terms in (3) are independent and normally distributed, one can use ordinary least squares (OLS) technique to estimate (3) which yields a consistent estimate of the proportional increase in the wages associated with one year of education.[8]

Furthermore, as postschool experience increases, productivity and wages tend to rise. But further increases in postschool experience may lead to a decline in wages and productivity because of diminishing marginal returns. The concavity of the wage profile is thus captured by the quadratic experience terms. According to human capital theory, education and experience are likely to have major effects on productivity.

Three adjustments in the functional form of wage equation (3) are necessary, however.[9] First, there is a possibility that distinct regional labor markets may behave differently and hence yield quite different estimates. Three distinct labor markets (metropolitan Lima, other urban areas, and rural areas) have already been identified (Stelcner and others 1988). Further, there are perhaps structural differences in the labor markets for men and women in which case the wage rate and labor market participation equations are estimated separately for men and women in these three regions. While this method is preferred where there is no interregional migration, such migration does occur as educated workers move to higher wage markets.

But interregional migration may bias estimates of the returns to education as well as labor market participation. In Latin American countries as much as half the life-cycle returns of rural residents to schooling result from migrating to urban centers (Schultz 1988). The bias due to interregional migration could not be reduced even if the migrants' original location were known, because migration is a self-selection process. Using regional "shifters" in the wage equation (3) and in participation equation (1) or (2) fitted for the country as a whole, one can illustrate the potential severity of interregional

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[7]Mincer (1974) assumes the following to approximate this relat[illegible]p: (i) the only cost of schooling for an individual is his or her foregone earnings; (ii) individuals enter the labor force immediately after completion of schooling; and (iii) each individual's working a fixed number of years is independent of his or her years of education. To the extent that Mincer's assumptions do not hold in the real world, the estimated coefficient of schooling is an approximation of the internal rate of return to education.

[8]Note that the normality and independence assumption of the error structures may not hold if the errors contain unobserved ability, motivation and other individual and household variables which are correlated with S and K. One needs to test the validity of such an important assumption.

[9]These three adjustments are also applied to the labor market participation equations (1) and (2).

migration on the estimated returns to schooling and labor market participation. In particular, because high-wage urban regions have more and better schooling, introducing regional shift variables in the wage or labor market participation equation reduces the estimated returns to schooling, or the influence of schooling on participation in the labor market.[10]

Second, an adjustment is necessary to quantify the effect of the quality of education by grades on wages. Since different levels of school impart different skills and wages, it would be misleading to treat years of education as homogenous. Thus we include splines of years of education (both general and technical) in the wage function and labor market participation equations to account for the heterogenous quality of years of education.[11]

Third, an adjustment is also necessary to control for the effect on wages or labor market participation of the quality of education that individuals receive in schools. This chapter includes attendance or nonattendance in public school in the wage and participation functions to control for the influence of unobserved school quality. Parental characteristics often contribute to children's unobserved ability by giving them a better education (Schultz 1988). Thus by including this school quality variable in wage function (3), for example, we can reduce the impact of both school quality and parental characteristics on an individual's productivity and hence returns to education.[12]

The OLS estimation may yield inconsistent wage estimates if the wage equation (3) suffer from unobserved variable and sample selection bias. Omitted variables such as individual ability may overestimate school returns if school attainment is correlated with an individual's unobserved ability. We do not have individual-specific background information such as cognitive skill measures to control for unobserved individual ability which may influence the wage estimates (Griliches, 1977; Willis, 1986). Another source of bias is unobserved household and community characteristics which often relate to abilities, motivation, quality of schooling, employment opportunities, and role models that influence

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[10]In fact, most of what appears to be selectivity in migration in another Latin American country (i.e., Brazil) disappears with control for differential schooling quality (Behrman and Birdsall, 1983). Unfortunately, we do not have good information on the quality of schooling that we can use to control for the differences in self-selected migration.

[11]Note that splines do not control for differential schooling quality among schools of the same level; they control only differential quality by schooling levels. The splines of years of schooling estimate the returns to education for different school grades such as primary, secondary and post-secondary schooling.

[12]One may include parents' characteristics directly in the wage regression. Stelcner and others (1988) report that the wage regression that excludes parents' education overestimates returns to schooling by about 3 percent for males in Peru. They also find a strong correlation between the father's education and public school attendance. Furthermore, as the public-private schooling variable represents a choice, not of the students but of the parents, they are not choice variables like whether or not to participate in the wage labor market. One could also use other information such as availability of text books, etc. to control for differential quality across schools (King, 1988).

wages and hence returns to education. If these unobserved factors are correlated with years of schooling, the standard estimation procedure results in biased estimates of the impact of schooling and hence the returns to education (Behrman and Deolalikar 1990).[13] A household fixed-effect method is used to estimate the wage equation (3) to control for household and community heterogeneity.

Another potential source of OLS bias is the sample selection bias caused for endogeneity of the decision to participate in the labor market. Sample selection bias arises in equation (3), if it is estimated by ordinary least squares to include only wage-earners--thus excluding persons not reporting a wage yet part of the potential labor force. In Peru about 35 percent of all working males and about 13 percent of all working females are in the wage sector. The decision to join the labor market influences wages because the characteristics that affect labor market participation may also interact with wages. Thus the wage estimates need to be independent of the possible impact of these characteristics.

Estimating (3) in conjunction with labor market participation equation (1) or (2) may reduce sample selection bias from the wage estimates.[14] A maximum likelihood method, which jointly estimates the wage rate and probit functions by taking into account the correlation between the errors of wage and participation equations, is used to estimate (3) that yields consistent and efficient estimates.

An identification problem emerges, however. The variables that explain wages may also explain individual labor market participation. That is, the vector X and Z in (1) or (2) contains the variables included in the wage equation (3). Thus we need some identifying variables in equation (1) or (2) not included in the wage equation (3) to help distinguish a participant from a nonparticipant.

Three variables are considered for identifying labor market participation decision from wage equation. They are landholding, unearned income, and marital status. Landholding and unearned income are expected to influence the likelihood that a person will work for wages by affecting the person's reservation wage: If an individual has a considerable amount of land or unearned income, he or she will be less likely to work for wages because the returns in other activities are higher. On the other hand, marital status reflects people's preferences for jobs. For example, married couples can specialize more easily than unmarried individuals and thus marriage encourages husbands to work for wages and wives to work in the home (Schultz 1988). Marital

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[13]Behrman and Deolalikar (1990) found that these characteristics substantially influenced the wage estimates and hence returns to education. They did not, however, correct the wage estimates for the sample selection bias that arises for why a particular individual participates in the labor market.

[14]Note that sample selection correction does not predict the direction in which the wage estimates will be altered.

status may thus influence labor market participation, but not an individual's market productivity.[15]

2.3. Male-Female Wage Differences

A standard procedure to measure the male-female wage gap is to fit equation (3) by ordinary least squares to a sample of male (m) and female (f) workers:

$$\ln W_m = X_m \beta_m + \epsilon_m \quad (4)$$

and

$$\ln W_f = X_f \beta_f + \epsilon_f \quad (5)$$

where: β_m and β_f are the vector of unknown coefficients, including the intercepts, to be estimated; X_m and X_f are, respectively, the vector of males' and females' observed characteristics; and ϵ_m and ϵ_f are, respectively, the males' and females' individual specific error. A property of ordinary least squares is that the regression lines pass through the mean values of the variables so that

$$\ln \overline{W}_m = \overline{X}_m \hat{\beta}_m \quad (6)$$

$$\ln \overline{W}_f = \overline{X}_f \hat{\beta}_f \quad (7)$$

The hats denote the estimated values of the coefficients.

By simple manipulation of (6) and (7) the male-female wage gap function can be written as

$$\ln \overline{W}_m - \ln \overline{W}_f = \hat{\beta}_m (\overline{X}_m - \overline{X}_f) + (\hat{\beta}_m - \hat{\beta}_f) \overline{X}_f$$
$$= \hat{\beta}_f (\overline{X}_m - \overline{X}_f) + (\hat{\beta}_m - \hat{\beta}_f) \overline{X}_m \quad (8)$$

where the first part of the right-hand side of equation (8) measures the wage gap due to male-female differences in wage-related characteristics and the second part measures the gap explained by the differences in male-female wage structures for the same observed job-related characteristics. As we can see in (8), one

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[15] There is no clear notion in the literature that can guide one to determine what variables to include in the labor market participation decision that do not affect wages. Identification is thus often based on debatable assumptions. For example, landholding and unearned income may reflect asset accumulation from past labor earnings and hence correlated with wages. Similarly, marital status may affect wages as married people are more healthy than unmarried people and better health influences productivity.

can measure wage gap in two ways: using the male wage structure or alternatively, using the female wage structure.[16]

A large number of studies using this decomposition technique (8) find that only a portion of the wage gap is explained by differences in human capital and other observed job-related characteristics (Becker 1985, Gronau 1988, Mincer and Polachek 1974, Oaxaca 1973, Gannicott 1986). One can, in principle, make an accurate assessment of male's and female's productivity and hence of observed wages and private economic rates of return to education if one can measure their true productive capacities as perceived by employers. For various reasons, however, econometricians cannot include in the wage equation (3) all the variables that might influence individuals' productivity. Such unobserved characteristics as individual, family, or job-specific heterogeneity can make certain workers more productive than others.

We use a household based sample selection procedure here to estimate the wage gap between men and women.[17] Samples are chosen from households where at least one male and one female participate in the labor market. The restricted samples are comparable and hence may <u>reduce</u> the bias of unobserved household characteristics.[18] Using wage regression (3) and decomposition technique (8), we calculate the wage gap for this restricted sample and compare it with the one where full samples are used to estimate the wage gap. This selection procedure suffers from both sample selection and group bias. Sample selection bias is corrected; the group bias, however, cannot be corrected with the decomposition method.

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[16]Naturally the two procedures do not yield the same answer. Thus as the decomposition technique assumes a particular (either male or female) wage structure to calculate the wage gap, this method introduces a group bias in the intragroup wage comparison. To the extent that both male and female wages are affected by discrimination, Neumark (1988) shows how a weighted average of the male and female coefficients may approximate the competitive wage that would prevail in the absence of discrimination. Note also that the second component of equation (11) is often taken as reflecting wage discrimination. However, because it is difficult to remove the effects of all possible wage-determining factors, including those that may reflect female discrimination outside the labor market, one cannot possibly attribute the second component as a measure of discrimination (Gunderson 1989).

[17]One can, alternatively, restrict samples to a particular occupation (for instance, Birdsall and Fox (1985) for teaching) or to never married males and females whose household responsibilities (unobserved) are more similar than married individuals (Mincer and Polachek 1974, Robb 1978). This method, which reduces the impact of unobserved individual motivation or profession-related characteristics on the wage estimates, underestimates the wage gap for a random male and female with the same observed characteristics (Gunderson 1989). This procedure, therefore, must account for the sample selectivity bias.

[18]This method still suffers from bias due to unobserved individual characteristics. What this sample selection technique does is to reduce the intensity of the unobserved motivation or role models on the wage estimates, but does not remove their impact.

The group bias does not arise if we use a household fixed-effect method to estimate directly the wage gap, for the fixed-effect method does not need a particular wage structure. Moreover, the unobserved household and community characteristics that influence interfamily wage estimates no longer affect the estimates. To see how this method works, consider the following.

Let

$$\ln W_m = X_m \beta_m + \epsilon_{fam} + \epsilon_m \qquad (9)$$

and

$$\ln W_f = X_f \beta_f + \epsilon_{fam} + \epsilon_f \qquad (10)$$

be the wage equations, respectively, for males and females, where ϵ_{fam} is the unobserved family- and regional-specific error, and other variables are as defined earlier.

Taking difference of (9) and (10) yields the following:

$$\ln W_{mf} = \ln W_m - \ln W_f = X_m \beta_m - X_f \beta_f + \epsilon_{mf} \qquad (11)$$

where the family- and regional-specific unobserved effects cancel out and ϵ_{mf} is the error structure of the log wage differentials, $\ln W_{mf}$.

Model (11) estimates how much job-related characteristics explain male-female wage differences, assuming that wage structures for men and women are different. Thus, the unobserved household and regional characteristics that affect the interfamily wage estimates do not influence the intrafamily wage estimates. Moreover, differencing out male's and female's wages at the household level, unlike the decomposition method of (8), does not assume any particular wage structure to estimate the wage gap.

Further, if we assume that males and females receive the same returns for the same characteristics, equation (11) can be rewritten as:

$$\ln W_{mf} = (X_m - X_f)\, \delta + \epsilon_{mf} \qquad (12)$$

whence $\delta = \beta_m = \beta_f$.

Equation (12) estimates the variation in male-female wage differences which is caused by variation in job-related characteristics. Thus, by comparing estimates of models (11) and (12) we can identify how much of the wage gap is due to differences in the wage structures of men and women. Furthermore, the model (12) can identify individual sources of male-female wage variations that are explained by job-related characteristics.

The household fixed-effect method suffers from sample selection bias. To obtain efficient estimates of (11) or (12), we correct them for not only why an individual participates in the labor market but also why a particular male and a particular female from a particular household participate in the labor market. Correcting the second source of bias depends on the correlation of the error structures, e_m and e_f, in the participation equations of (1) and (2). If e_m and e_f are correlated which is likely the case, a joint estimation of the male-female wage gap equation (11) or (12) along with participation equations (1) and (2) must account for this correlation to yield efficient estimates.

3. Data Characteristics

The data used for this paper are drawn from the Peruvian Living Standard Survey (PLSS) household data collected jointly by the World Bank and the Peruvian Instituto Nacional de Estadistica (INE). These data provide detailed socioeconomic information on over 5,100 households and 26,000 individuals. The samples were drawn from a self-weighted national probability sample of Peruvian households and represent an approximate 1/100 sample of the population. The sampling frame is based on a 1984 National Health and Nutrition Survey. About 25 percent of the households in the PLSS were located in metropolitan Lima, 28 percent in other urban areas, and 47 percent in rural areas. The data were collected between June 1985 and July 1986 (see Grootaert and Arriagada 1986).

This chapter covers workers aged 14 to 60. The wage earner participation equation is estimated using information for all potential workers. The wage equation, however, is estimated only for those men and women who reported wage remuneration and hours worked in the wage sector as their main occupation during the week prior to data collection. Thus self-employed and unpaid family workers are excluded from this reduced sample. The wage sample consists of 2,255 men from 1,856 households and 898 women from 783 households, drawn from a total of 6,429 men from 4,142 households and 6,942 women from 4,387 households. Among the men, 994 from 789 households work in metropolitan Lima, 731 from 610 households work in other urban areas, and 530 from 457 households work in rural regions. Among the women, 485 from 403 households work in Lima, 281 from 262 households work in other urban areas, and 152 from 118 households work in rural Peru.[19] The wage labor market participation rate for women is 23 in Lima, 13 in other urban areas, and 5 in rural areas - an average of 13 percent. The rate for men is 53, 38, and 21, or an average of 35 percent. Table 1 gives the means and standard deviations of the variables by gender and by region.

Male wage earners are slightly more educated than women except in other urban areas. But employed women have more vocational training than employed men in all regions.[20] Women also come from relatively wealthier households (in terms of landholding and unearned income) and are the offspring of better-educated parents. The data suggest that more married (or cohabiting) men participate in the labor market than married (or cohabiting) women. And

[19]Note that rural women who participate in the wage sector are mainly salaried, like school teachers, and hence the difference in wages or characteristics may not be substantial.

[20]Note that this may rather highlight the male-female occupational differences. For example, women are concentrated in occupations such as secretarial jobs where training is essential for obtaining a job (Arriagada 1989).

women generally receive lower real hourly wages than their male counterparts.[21] Women's earnings, for example, are two-thirds of men's wages in Lima, one-fifth of men's wages in other urban areas, and one-half in the country as a whole (after wage differences are adjusted for male-female sample differences). Employed women are younger (measured by potential work experience, or age minus years of schooling minus 6), have less job-specific experience (although this variable is not used in the regression), and did not attend public school as long as their male counterparts. These differences in characteristics may explain part of the wage gap.

Table 1: Mean characteristics of full sample male and female wage earners

Variable description	All Peru		Lima		Other urban areas		Rural	
	Male	Female	Male	Female	Male	Female	Male	Female
Number of observations	2255	898	994	485	731	281	530	132
Log real hourly wage rate a/	1.340	1.158	1.606	1.289	1.343	1.268	0.838	0.446
	(0.934)	(0.966)	(0.806)	(0.868)	(0.890)	(0.881)	(1.010)	(1.161)
Years of potential work experience	18.902	15.614	17.398	14.519	19.172	15.569	21.351	19.727
	(12.620)	(11.124)	(12.156)	(10.567)	(12.351)	(10.095)	(13.430)	(13.982)
Years of job-specific experience	7.296	5.047	6.698	4.166	7.822	5.832	7.691	6.615
	(8.293)	(6.621)	(7.956)	(5.677)	(8.315)	(6.925)	(8.808)	(8.481)
Education								
Years of primary school	4.502	4.506	4.867	4.775	4.653	4.679	3.608	3.144
	(1.223)	(1.290)	(0.614)	(0.853)	(0.968)	(1.009)	(1.814)	(2.079)
Years of secondary school	2.870	3.398	3.680	3.746	2.881	3.754	1.336	1.356
	(2.271)	(2.187)	(1.948)	(1.978)	(2.269)	(2.043)	(2.038)	(2.112)
Years of post-secondary school	0.841	1.110	1.097	1.027	0.862	1.537	0.332	0.508
	(1.797)	(1.944)	(2.014)	(1.903)	(1.781)	(2.149)	(1.179)	(1.356)
Vocational training	0.309	0.518	0.406	0.645	0.321	0.473	0.109	0.144
	(0.462)	(0.500)	(0.491)	(0.479)	(0.467)	(0.500)	(0.313)	(0.352)
Secondary technical diploma	0.024	0.031	0.029	0.039	0.023	0.032	0.015	0.000
	(0.153)	(0.174)	(0.168)	(0.194)	(0.151)	(0.176)	(0.122)	(0.000)
Post-secondary diploma	0.032	0.074	0.030	0.060	0.047	0.103	0.017	0.061
	(0.177)	(0.261)	(0.171)	(0.237)	(0.211)	(0.171)	(0.129)	(0.239)
University diploma	0.082	0.117	0.112	0.107	0.073	0.171	0.038	0.038
	(0.274)	(0.322)	(0.315)	(0.309)	(0.259)	(0.377)	(0.191)	(0.192)
Attended public school	0.847	0.758	0.833	0.740	0.889	0.836	0.815	0.659
	(0.360)	(0.428)	(0.373)	(0.439)	(0.314)	(0.371)	(0.389)	(0.476)
Father's education	4.639	5.551	5.550	5.922	4.677	5.851	2.881	3.553
	(3.374)	(3.369)	(3.340)	(3.367)	(3.331)	(3.269)	(2.758)	(2.875)
Mother's education	2.909	3.449	3.632	3.621	2.854	3.673	1.628	2.349
	(2.752)	(2.663)	(2.878)	(2.629)	(2.706)	(2.735)	(1.999)	(2.364)
Total years of school	8.212	9.013	9.644	9.549	8.395	9.972	5.276	5.008
	(4.143)	(4.272)	(3.521)	(3.604)	(3.939)	(4.129)	(3.991)	(4.617)
Married or cohabiting	0.624	0.408	0.577	0.400	0.673	0.434	0.643	0.379
	(0.485)	(0.492)	(0.494)	(0.490)	(0.469)	(0.497)	(0.479)	(0.487)
Unearned real income x 1,000	2.164	2.980	3.008	3.975	1.561	2.258	1.411	0.858
	(11.433)	(8.555)	(9.319)	(10.822)	(4.859)	(4.814)	(18.945)	(3.092)
Landholding (hectares)	1.624	1.673	0.060	0.096	0.374	4.354	6.282	1.757
	(19.770)	(35.328)	(1.095)	(1.128)	(2.546)	(63.031)	(40.32)	(4.999)

Note: Numbers in parentheses are standard deviations.
a/ Intis at June 1985 prices.

[21]The real hourly wage rate, i.e., nominal hourly wages deflated at 1985 consumer price indices (RHW) is defined as RHW = AC/AH where:
AC = annual compensation = monthly pay x months worked in the past year;
AH = annual hours = weekly hours x months worked in the past year x 4.33.
Note that annual compensation includes regular wages and other benefits such as transport allowances and so on.

A comparison of the characteristics of employed and unemployed women as shown in appendix table A1 and table 1 suggests that the observed differences, with few exceptions, are consistent throughout the country. Education increases the participation of women in the wage sector. Employed women have almost twice as much schooling as those who do not participate. The figures are similar for women with vocational training. Fifty-two percent of women wage earners had such training, while only 20 percent of those who do not participate have had training. Seventy-eight percent of participating women attended public rather than private schools, compared to 68 percent of nonparticipating women. A higher percentage of married women do not participate in the labor force 58 percent not participating compared to 41 percent in the labor market. The parents of women in the labor force are, on average, more educated than the parents of nonparticipating women. And nonparticipating women are from wealthier families (in terms of landholding).

4. The Results

This section reports the results on labor market participation, returns to education, and male-female wage differences in Peru. First, it highlights the determinants of men's and women's participation and productivity in the formal sector. Second, it discusses the estimated returns to education for men and women. Third, it reviews the relationship between returns to education and school enrollment for boys and girls to see whether parents respond to private economic returns to education in sending children to school. Fourth, it discusses the estimates of the wage gap between men and women to examine the extent to which the human capital model explains the wage gap in Peru. We conclude that unobserved family and community characteristics have an important influence on wages, returns to education, and wage differences between males and females.

4.1 Determinants of labor market participation and productivity

Tables 2 and 3 report four wage rate specifications for men and women in each region and in the country as a whole. Also included are four probit equations that examine the probability that an individual will join the wage sector. Based on the Likelihood Ratio test, the hypothesis that marital status has no effect on labor market participation is rejected. Tables 2 and 3 are based on the preferred specification that includes marital status as well as landholding and unearned income as identifying variables in the probit equation.

Consider first the decision to join the wage labor market. Both general and technical education affect this decision. Vocational training and secondary education, however, increase women's labor market participation more than men's. Thus in Peru as a whole, the probability that a woman will join the formal wage market is about 10 percent higher if both men and women have vocational training. On the other hand, the probability that a woman will join the wage market is at least 5 percent higher if both women and men complete secondary school. This suggests that investment in women's education increases

Table 2: Maximum Likelihood estimates of Probit and Wage equations for male wage earners

Explanatory description	Lima Probit	Lima Wage Rate	Other Urban Areas Probit	Other Urban Areas Wage Rate	Rural Areas Probit	Rural Areas Wage Rate	All Peru Probit	All Peru Wage Rate
Constant	-0.949	0.804	-0.947	0.615	-1.128	-0.829	-0.784	0.269
	(-4.074)	(2.912)	(-5.494)	(3.101)	(-8.413)	(-2.025)	(-8.176)	(0.755)
Potential work experience	0.062	0.039	0.074	0.022	0.037	0.044	0.059	0.043
	(6.153)	(4.047)	(7.744)	(2.242)	(3.614)	(2.947)	(10.062)	(3.522)
Potential work experience squared x 100	-0.123	-0.045	-0.154	0.014	-0.075	-0.071	-0.117	-0.048
	(-5.951)	(-2.214)	(-7.862)	(0.672)	(-4.069)	(-2.489)	(-10.382)	(-2.014)
Education								
Years of primary school	-0.012	0.040	-0.021	0.101	0.017	0.062	0.005	0.093
	(-0.254)	(0.996)	(-0.617)	(2.943)	(0.679)	(1.625)	(0.290)	(5.629)
Years of secondary school	0.049	0.079	-0.004	0.119	0.058	0.088	0.033	0.088
	(2.508)	(5.521)	(-0.206)	(6.488)	(2.739)	(2.597)	(3.013)	(7.309)
Years of post-secondary school	0.059	0.080	-0.016	0.070	0.171	0.255	0.019	0.088
	(2.233)	(4.351)	(-0.526)	(1.984)	(2.270)	(3.510)	(0.988)	(5.039)
Vocational training	0.196	0.161	0.315	-0.068	0.297	0.616	0.263	0.166
	(2.908)	(3.405)	(4.782)	(-0.951)	(2.555)	(4.342)	(5.788)	(2.842)
Secondary t..hnical diploma	-0.018	0.016	0.287	0.042	0.691	0.426	0.230	0.068
	(-0.091)	(0.101)	(1.241)	(0.221)	(1.916)	(1.083)	(1.706)	(0.586)
Post-secondary diploma	0.328	0.164	0.676	0.017	-0.315	0.169	0.481	0.227
	(1.524)	(1.055)	(3.308)	(0.070)	(-0.754)	(0.178)	(3.518)	(1.367)
University diploma	0.061	0.384	0.491	-0.056	0.039	0.366	0.377	0.326
	(0.372)	(3.609)	(2.327)	(-0.235)	(0.085)	(0.879)	(3.084)	(2.884)
Attended public school	0.279	-0.199	0.008	-0.059	-0.187	-0.098	0.069	-0.101
	(3.403)	(-2.994)	(0.086)	(-0.594)	(-1.898)	(-0.707)	(1.293)	(-2.027)
Unearned income x 1000	-0.004		-0.001		0.005		-0.003	
	(-1.596)		(-0.286)		(0.666)		(-1.451)	
Landholding	-0.033		-0.034		-0.020		-0.001	
	(-1.624)		(-6.689)		(-2.587)		(-2.769)	
Married or cohabiting	0.197		0.194		0.020		0.134	
	(2.339)		(2.966)		(0.256)		(2 803)	
Residence - other urban area	-		-		-		-0.329	-0.136
	-		-		-		(-7.572)	(-2.102)
Residence - rural area	-		-		-		-0.737	-0.297
	-		-		-		(-15.178)	(-2.240)
Standard error of wage function	0.629		0.653		0.838		0.751	
	(23.051)		(26.023)		(25.913)		(45.648)	
Correlation between wage earner and wage rate errors*	-0.282		-0.613		0.566		-0.133	
	(-1.982)		(-10.576)		(2.940)		(-0.528)	
Log-likelihood	-2208.85		-1986.48		-1943.47		-6256.52	
Selected sample (sample size)	994 (1901)		731 (1941)		530 (2587)		2255	(6429)

Note: Numbers in parentheses are t-statistics.
*The sign of the coefficients determine the correlation between wage earner and wage rate errors.

the likelihood of women's participation in the wage labor market faster than a similar increase in men's education would affect their participation. Pub'lic school attendance is an important determinant of uen's labor market participation, but not of women's. Both unearned income and landholding (which measure the income effect on leisure) generally decrease the probability of t.ing in the labor market for both men and women. Landholding significantly reduces men's participation in the work force in all regions, but only affects women's participation in rural areas. Labor force participation for both genders is lower outside of Lima: 31 and 49 percent lower for women in other urban areas and rural areas respectively, and 33 and 74 percent lower for men in corresponding areas. This indicates that there is a higher probability that women will work for wages than men.

Table 3. Maximum Likelihood estimates of Probit and wage equations for female wage earners

Explanatory description	Lima Probit	Lima Wage rate	Other urban areas Probit	Other urban areas Wage rate	Rural areas Probit	Rural areas Wage rate	All Peru Probit	All Peru Wage rate
Constant	-1.205	-0.449	-2.202	-1.398	-2.037	-1.260	-1.614	-0.832
	(-6.105)	(-1.147)	(-11.002)	(-2.535)	(-9.819)	(-1.029)	(-14.218)	(-2.776)
Potential work experience	0.065	0.073	0.110	0.124	0.047	0.033	0.069	0.083
	(5.910)	(6.102)	(8.238)	(7.140)	(3.217)	(0.792)	(0.992)	(9 129)
Potential work experience squared x 100	-0.161	-0.130	-0.225	-0.232	-0.077	-0.063	-0.141	-0.150
	(-6.462)	(-4.073)	(-8.054)	(-5.802)	(-2.765)	(-0.766)	(-9.837)	(-7.100)
Education								
Years of primary school	-0.038	0.065	-0.029	0.083	0.110	0.083	0.012	0.094
	(-0.950)	(1.576)	(-0.695)	(1.201)	(2.589)	(0.825)	(0.546)	(3.629)
Years of secondary school	0.048	0.132	0.123	0.169	0.047	0.125	0.081	0.146
	(2.204)	(5.648)	(4.954)	(5.228)	(1.096)	(1.113)	(5.528)	(7.427)
Years of post-secondary school	0.042	0.098	0.109	0.093	0.192	0.268	0.076	0.100
	(1.228)	(2.837)	(2.623)	(1.400)	(1.770)	(1.018)	(3.073)	(2.846)
Vocational training	0.462	0.254	0.306	0.116	0.086	0.272	0.357	0.217
	(6.106)	(2.184)	(3.330)	(1.083)	(0.475)	(0.717)	(6.599)	(2.834)
Secondary technical diploma	0.235	-0.019	0.486	-0.289	-	-	0.308	-0.078
	(1.245)	(-0.093)	(1.712)	(-1.028)	-	-	(2.028)	(-0.419)
Post-secondary diploma	0.709	0.363	0.461	0.272	0.953	0.330	0.663	0.359
	(3.448)	(1.859)	(2.077)	(0.975)	(1.863)	(0.328)	(4.804)	(2.083)
University diploma	0.662	0.246	1.012	0.076	0.595	0.312	0.809	0.203
	(3.201)	(1.189)	(4.125)	(0.217)	(0.901)	(0.240)	(5.441)	(1.047)
Attended public school	0.056	-0.299	0.144	-0.096	-0.179	-0.260	0.055	-0.231
	(0.655)	(-3.859)	(1.211)	(-0.753)	(-1.114)	(-0.690)	(0.910)	(-3.401)
Unearned income x 1000	-0.003		-0.014		0.006		-0.006	
	(-0.957)		(-1.552)		(0.437)		(-2.102)	
Landholding	-0.027		0.001		-0.029		-0.0001	
	(-0.984)		(0.598)		(-4.785)		(-0.225)	
Married or cohabiting	-0.490		-0.713		-0.614		-0.574	
	(-6.662)		(-7.710)		(-5.888)		(-11.943)	
Residence - other urban area	-	-	-	-	-	-	-0.310	-0.129
	-	-	-	-	-	-	(-5.958)	(-1.878)
Residence - rural area	-	-	-	-	-	-	-0.486	-0.427
	-	-	-	-	-	-	(-7.574)	(-4.575)
Standard error of wage function	0.690		0.669		0.983		0.749	
	(33.003)		(20.045)		(15.922)		(46.632)	
Correlation between wage earner and wage rate errors*	0.178		0.291		0.524		0.259	
	(0.863)		(1.585)		(1.172)		(1.929)	
Log-likelihood	-1507.06		-942.16		-653.36		-3179.06	
Selected sample (sample size)	485 (2069)		281 (2116)		132 (275?)		898 (6942)	

Note: Numbers of parentheses are t-Statistics.
*The sign of the coefficients determines the correlation between wage earner and wage rate errors.

The wage function for men and women is estimated by a maximum likelihood method using the probit estimates of labor market participation.[22] The wage estimates indicate that human capital variables explain a substantial portion of the variation in wages.[23] Among the important determinants of

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[22]When normality tests (that is, skewness and kurtosis tests) of the log wage errors are carried out, the normality assumption is rejected for both men and women. Although this finding has severe adverse effects on the t statistics of an OLS method, the asymptotic property of maximum likelihood method reduces the severity of non-normality of the wage errors.

[23]The wage rate regression for rural women workers does not produce significance of any explanatory variable. This is not surprising, given the high standard error of the wage regression fitted for rural areas. The reason

productivity, educ tion and experience are crucial; returns to experience, however, are higher for women than for men. Education at all levels influences both men's and women's productivity in Peru, although the results vary by region. For example, primary school has no influence on productivity in Lima, while it has a significant impact, at least for men, in other urban and rural areas.

Technical education increases the labor market productivity of men and women. In Lima, women's wages increase by 25 percent and men's wages by 16 percent if they have had vocational training. But when gains from interregional migration are excluded, women's wage gains drop to 22 percent. In contrast, the wage increases of women with post-secondary diplomas do not change as a result of interregional migration. The returns to vocational training vary by region: wages of male workers with a secondary, post-secondary, or university diploma are 46 percent higher in rural areas than in Lima. Conversely, the wages of male university graduates are 5 percent higher in Lima than in Peru as a whole. This suggests the importance of Lima as an industrial and financial center for university raduates (Stelcner and others 1988).

Workers in Lima are paid more than their counterparts with the same education in other areas, as seen in the all-Peru wage equation. In Lima, male and female workers earn about 13 percent more than workers in other urban areas, and men and women earn 30 and 43 percent more respectively than rural workers. If migration or labor mobility across regions were not restricted, then the wage differences across regions would perhaps not occur. The results suggest that rural-urban migration is lower for women than for men. Rural women, however, while more likely to be in the wage sector than rural men, receive much lower wages.

In comparison with private schooling, the returns to public school attendance are lower for both male and female productivity. Wages in Lima are 20 percent lower for men and 30 percent lower for women who attended public school than for those who attended private school. When gains due to interregional migration are excluded, the wage differences fall to 10 percent for men and 23 percent for women, possibly due to less interregional mobility by women. The difference in the productivity of public versus private school graduates indicates that the public school system should be improved. This finding is consistent with other studies (Stelcner and others 1989, King 1988).

The sign of the coefficients of the correlation between wage earner and wage rate errors determines the type of selection that generates the group of workers. Tables 2 and 3 suggest that the most able men select non-wage employment in urban areas and wage employment in rural areas. Among women, on the other hand, the most able individuals seem to select wage employment in all regions of the country. The results also indicate that unobserved characteristics that influence labor market participation have an important influence on individual productivity.

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is perhaps because there are few women working in the wage sector in rural areas, and since most rural women work as teachers or clerks, the variation in wages is small.

4.2. Estimates of Returns to Schooling

Table 4 presents three sets of estimates of returns to education: ordinary least squares, maximum likelihood (from tables 2 and 3), and household fixed-effect.[24] A comparison of ordinary least squares and maximum likelihood results suggests that the estimates are sensitive to sample selection correction. The estimated private rates of return to schooling increase somewhat for men and women when controls are introduced for sample selection bias.[25] Men gain only from education in rural areas because of sample selection correction. Thus for males in rural Peru the returns increase from 6 to 9 percent at the secondary level, and from 21 to 25 percent at the post-secondary level. Women, on the other hand, gain in all areas, especially at secondary and post-secondary levels. The returns for women at the secondary level increase from 15 to 17 percent in other urban areas and from 10 to 13 percent in rural areas when the maximum likelihood method is used to correct the sample selection bias. At the post-secondary level the increase for women is also notable: 10, 9, and 27 percent, compared to 9, 7, and 20 percent respectively in Lima, other urban areas, and rural areas.

Both male and female educated workers gain if they migrate to urban areas. The gains are more substantial for men with a primary and secondary education if they migrate to other urban areas rather than to Lima. Similarly, women with a secondary education gain if they migrate to other urban areas from rural areas. The returns to schooling are, therefore, likely to be overestimated if the effect of interregional migration is not controlled for in the regional estimates. This is evident in the all-Peru wage estimates. When gains from interregional migration are excluded and sample selectivity bias is corrected, the private rates of return decrease for men and women.

The differences in returns to schooling for men and women are worth noting. In Lima the private rates of return at the primary school level are low, but higher for women than for men (7 percent compared to 4 percent).[26] At the secondary and postsecondary levels, however, the returns to schooling are high, and again, higher for women than for men: 13 and 10 percent respectively, compared to 8 percent in each case for men. In other urban areas the returns for men are 10 and 12 percent respectively at the primary and secondary levels, compared to 8 and 7 percent respectively for women. The returns drop at the postsecondary level for both genders in other urban areas -- to 7 percent for men and 9 percent for women. In contrast, the return to schooling is an increasing function of the level of education for both men and women in rural areas. If we exclude from the wage estimates gains due to migration, the private rate of return to schooling drops for men at the primary level and for both men and women at the secondary level, while increasing for both men and women at the postsecondary level.

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[24]Note that the household fixed-effect estimates reported in Table 4 are also corrected for sample selection bias.

[25]This is, however, not the case for the men in Lima regression.

[26]This pattern is different from that of Bogota (Mohan 1986).

Table 4: Estimates of private rates of return to schooling by gender, using alternative estimation methods

Region Estimation Method	Private rates of return by school level Primary Male	 Female	 Secondary Male	 Female	 Post-secondary Male	 Female
Lima Metropolitan Area						
Ordinary Least Squares	0.04 (0.95)	0.07 (1.48)	0.09 (6.16)	0.13 (5.56)	0.09 (4.95)	0.09 (2.87)
Maximum Likelihood	0.04 (1.00)	0.07 (1.58)	0.08 (5.52)	0.13 (5.65)	0.08 (4.35)	0.10 (2.84)
Household Fixed-effect	0.03 (0.81)	0.05 (1.16)	0.07 (3.83)	0.14 (5.80)	0.07 (3.17)	0.10 (2.84)
Other Urban Area						
Ordinary Least Squares	0.10 (2.70)	0.08 (1.54)	0.12 (7.07)	0.15 (4.90)	0.07 (2.51)	0.07 (1.79)
Maximum Likelihood	0.10 (2.94)	0.08 (1.20)	0.12 (6.49)	0.17 (5.23)	0.07 (1.98)	0.09 (1.40)
Household Fixed-effect	0.09 (2.46)	0.09 (1.55)	0.11 (6.24)	0.17 (5.10)	0.06 (2.29)	0.10 (2.29)
Rural Area						
Ordinary Least Squares	0.05 (1.56)	0.05 (0.63)	0.06 (2.26)	0.10 (1.11)	0.21 (2.29)	0.20 (1.30)
Maximum Likelihood	0.06 (1.63)	0.08 (0.83)	0.09 (2.60)	0.13 (1.11)	0.26 (3.51)	0.27 (1.02)
Household Fixed-effect	0.11 (3.20)	0.37 (5.73)	0.17 (3.46)	-0.02 (0.26)	0.42 (3.27)	0.26 (1.66)
All Peru						
Ordinary Least Squares	0.09 (5.08)	0.09 (3.06)	0.09 (8.98)	0.13 (7.28)	0.09 (5.61)	0.09 (3.30)
Maximum Likelihood	0.09 (5.63)	0.09 (3.63)	0.09 (7.31)	0.15 (7.43)	0.09 (5.04)	0.10 (2.85)
Household Fixed-effect	0.10 (5.35)	0.10 (3.25)	0.07 (5.30)	0.15 (7.98)	0.07 (4.30)	0.11 (3.82)

The returns to schooling are relatively higher for women than for men, especially at the secondary and post-secondary level. This finding contrasts with studies from other countries that suggest that the returns to schooling are similar for men and women (Schultz 1989).[27] The return to schooling is higher for women at the secondary level than at any other level, however, a finding that is consistent with other Latin American and Asian countries (Behrman and Deolalikar, 1988; Schultz 1988; Mohan 1986).

Do the findings differ when we correct the estimates for unobserved variable bias? A comparison between maximum likelihood (ML) and household fixed-effect results indicates that the differences in the return estimates are not substantial in Lima and other urban areas. In rural areas, however, both the OLS and ML estimates of returns to education are strongly biased downward for

[27]Exception is, however, the Indonesian study (Behrman and Deolalikar 1988). Behrman and Deolalikar observe that the marginal returns to schooling beyond the primary level are greater for females than for males.

men at all levels of schooling and for women at the primary level. The results seem to be biased upward for women at the secondary and post-secondary levels.[28] The results clearly indicate that the more highly developed labor markets and the more extensive school system have perhaps weakened the relative influence of family background variables on the returns to schooling in urban areas more than in rural areas. In rural areas the influence of unobserved family and community bias is strong. This perhaps indicates that improved labor market opportunities and education system for women in rural areas will reduce the influence of family role models in an individual's wages and hence returns to schooling. The difference in returns to education for men and women at the primary level, before and after the unobserved variable bias correction, is worth noting. The difference is only 2 percent under the ML regime, while it is 26 percent under the fixed-effect regime. The results indicate that the returns to women's education is much higher in rural areas even at the primary level. However, when gains from interregional migration are excluded from the household fixed-effect estimation, interregional migration reduces the impact of family and community role models on individual's productivity. As a result, correcting the estimates for unobserved family effects does not change the return estimates.

The household fixed-effect method, nevertheless, confirms that even if we correct the estimates for unobserved household heterogeneity, the economic returns to education are higher for women than for men, and the return to schooling is higher for women at the secondary level than at other levels in all except rural areas.

4.3. Returns to Education and School Enrollment of Children

Do parents respond to the private economic rate of return to education in sending their children to school? Parents invest in their children in the form of education. If parents make conscious investment decisions, then the private economic rate of return to education should influence the school enrollment of boys and girls.

Table 5 presents differences between males and females in school enrollment, and two estimates of private rates of returns to education--one based on maximum likelihood and the other on the household fixed-effect method (from table 4). As noted earlier, the maximum likelihood controls for sample selectivity bias, while in the household fixed-effect method we control for both unobserved family and community characteristics and sample selection rules. Both indicate that the returns to education are higher for women than for men (the exception is in rural areas for the fixed-effect estimates at the secondary and post-secondary levels).

Table 5 indicates that the school enrollment ratio is favorable for boys -- especially at the secondary level -- in all areas, suggesting that more boys are enrolled in school than girls. This appears inconsistent with the observed male-female differences in returns to education. In rural areas the

[28]Note that the difference in the return estimates at the post-secondary level is not substantial. Moreover, the household fixed-effect estimate is not significant at the secondary level.

school enrollment ratio, especially at the secondary and post-secondary levels, seems consistent with the higher returns recorded for boys. Thus at the post-secondary level, school enrollment of boys is 7 percent higher than girls', which is consistent with 16 percent higher returns for boys than for girls. The results suggest that unobserved family and community characteristics influence the parents' decision in rural areas to send more boys than girls to school, especially at secondary and post-secondary levels.

Table 5: Male-female differences in school enrollment and private rates of return to education

School level	Male-female difference		Peru	Lima	OUA	Rural
Primary	School enrollment ratio		0.01	0.01	0.00	0.02
	Private rate of return	I	0.00	-0.03	0.02	-0.02
	Private rate of return	II	0.00	-0.02	0.00	-0.26
Secondary	School enrollment ratio		0.09	0.01	0.04	0.17
	Private rate of return	I	-0.06	-0.05	-0.05	-0.04
	Private rate of return	II	-0.08	-0.07	-0.06	0.19
Post-secondary	School enrollment ratio		0.03	0.01	0.00	0.07
	Private rate of return	I	-0.01	-0.02	-0.02	-0.01
	Private rate of return	II	-0.04	-0.03	-0.04	0.16

Note: School enrollment ratio is defined as the proportion of the school-aged children enrolled in school. The differences in returns to schooling are based on estimates of ML (panel I) & household fixed-effect (panel II) from Table 4.

This finding has an important policy implication. The communities to which the households belong may differ in unobserved characteristics relating to labor markets and school system. They may influence wages and hence interact with the parents' decision regarding school investment. These factors seem to be less important in urban areas where both labor markets and extensive school system are well integrated with household decisions that they no longer play any major roles in influencing an individual's (either male or female) productivity and hence returns to education. Yet, in urban areas other than Lima the male-female differences in school enrollments at the secondary level are substantial; i.e., parents are not investing in girls of secondary school-age according to the marginal returns to education of women. This implies that parents need to be subsidized for girls' secondary education.[29] In rural areas, where the unobserved household and community factors are important as the paid labor market

[29]Behrman and Deolalikar (1988) observe a similar finding for Indonesian households. They explain that the rates of return are higher for females but enrollment rates are lower because of relatively higher opportunity costs for females attending schools (e.g., due to sex-specialization in sibling care).

and the school system are not well developed, parents have reasons for not investing for girls' schooling as much as for boys. In this case, improved labor market opportunities and hence wages for women may improve the returns to female secondary and post-secondary education. This may raise female school enrollment, but may not be enough to encourage parents to send their daughters to school. Subsidized education may be needed to reduce the cost for sending girls to school. Further research can shed light on what kind of government intervention is needed to promote female school enrollment, especially in secondary and post-secondary levels.

4.4. Determinants of Male-Female Wage Differences

Table 6 shows the overall interfamily wage variations between males and females explained by the human capital model under the ordinary least squares estimation method, with and without sample selection correction, for three sets of samples of men and women. The first set uses the full samples, the second set uses the husband-wife combinations, and the third set uses the combination of any male and female who both participate in the labor market from the same household. Sample selection correction is made in all cases using Heckman's two-

Table 6: Interfamily estimates of male-female wage gap by alternative sample selection and estimation methods using wage equation (3) and decomposition technique (8).

Region/sample selection rule	Sample size		Percentage explained by human capital variables using OLS method			
			Without sample selection correction		With sample selection correction	
	Men	Women	(A)	(B)	(A)	(B)
A. Metropolitan Lima						
Full samples	994	485	0	0	47	0
Restricted samples: Husband-wife combination	126	126	31	22	32	16
Restricted samples: Any male-female combination	332	315	15	7	17	25
B. Other urban areas						
Full samples	731	281	0	0	0	0
Restricted samples: Husband-wife combination	68	68	39	30	27	0
Restricted samples: Any male-female combination	145	128	25	36	0	63
C. All Peru						
Full samples	2,255	898	0	0	99	0
Restricted samples: Husband-wife combination	218	218	22	27	17	2
Restricted samples: Any male-female combination	535	502	11	12	0	10

Note: Two wage structures are used: (A) male wage structure, and (B) female wage structure.

step procedure, which has the ordinary least squares property to calculate the male-female wage gap according to the decomposition technique of equation (11).[30]

The ordinary least squares results for the full samples of men and women wage workers explain nothing in terms of male-female differences in human capital variables. But when the sample is restricted by household, the ordinary least squares technique now explains a sizable portion of the differences in wages in terms of the differences in job-related characteristics. For example, the human capital model explains a variation of 31 percent in Lima, 39 percent in other urban areas, and 22 percent in the country as a whole for the restricted samples of husbands and wives (assuming that wives are paid according to husband's wage structure). The results indicate that a comparable sample analysis may better explain male-female wage differences in terms of observable job-related characteristics than a noncomparable sample analysis.

But the ordinary least squares results suffer from sample selection bias. Does sample selection correction affect the estimates? Table 6 shows that sample selection correction remarkably changes both the noncomparable and comparable sample analysis. When the Heckman selection procedure is applied to the full samples, the decomposition technique (assuming that females are paid according to male's wage structure) explains 47 percent variation in Lima and 99 percent in the country as a whole.[31] In contrast, when sample selection correction is applied to the restricted sample size, the model explains 32, 27, and 17 percent of the husband-wife wage differences respectively, in Lima, other urban areas, and all-Peru (assuming that wives are paid according to husband's wage structure). Sample selection correction with the restricted sample size appears to reduce the explanatory power of the model. Table 6 also suggests that the results are quite sensitive to which wage structure is used to calculate the wage gap. Nevertheless the results suggest that such unobserved family characteristics as motivation or household role models have an important influence in determining individual wages and hence in the estimates of the wage gap between men and women.

One can use the fixed-effect method, equations (11) or (12), to quantify the extent of the impact of unobserved household or community bias on these estimates. But we need to test whether the model (12) or (11) is more appropriate to explain the difference in wages between men and women for the restricted samples. An F-test for testing the equality of male's and female's wages rejects the null hypothesis for the full samples of men and women. In

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[30]The estimates are not shown for rural areas because of insufficient observations. The wage estimates for the restricted samples are in appendix table A2 for husbands and wives, and in appendix table A3 for any male-female combination.

[31]This is an interesting finding because it does not include any controversial control variable in the wage regression. The wage function includes an additional variable--the sample selection correction factor--that accounts for the unobserved characteristics influencing labor market participation.

contrast, a similar test for the restricted samples cannot reject the hypothesis. This means that men and women participating in the wage sector from the same household face the same wage structure.

The fixed-effect model (12) is thus estimated for three areas and for two samples. A bivariate probit method is used to estimate the husband-wife difference equation, while Heckman's two probit method is used to estimate the male-female difference equation for any male and female combination. The difference is that unlike Heckman's two probit method, the bivariate method does not assume zero correlation between husband's and wife's participation errors[32] (see table 7). They suggest that the fixed-effect method explains 17 percent in Lima, 24 percent in other urban areas, and 16 percent in Peru as a whole of the wage gap in terms of male-female differences in human capital characteristics. These explained variations are net of the unobserved family and community characteristics that influence an individual's wages. Thus a comparison of this finding with the one reported in table 6 for the same samples indicates the extent of the wage variation due to unobserved family and community characteristics. The results suggest that if the unobserved household and community characteristics are not controlled in the wage regression, the model -- even with sample selection correction -- may overestimate the effect of job-related characteristics on an individual's productivity as much as 25 percent.

Table 7 also shows the sources of variation in the wage gap. The estimates are not qualitatively different for husband-wife and any male-female combination. They indicate that differences in human capital variables are important sources of wage differences between males and females. For example, a 1 percent reduction in the gap between male's and female's schooling at the primary level reduces the wage gap by 7 percent in Lima and 5 percent in Peru as a whole. A 1 percent reduction in the gap between male's and female's schooling at the secondary level reduces the wage gap by 7 percent in other urban areas. Improving women's vocational training can also reduce the wage gap. A 1 percent reduction in the vocational training differential reduces the wage gap by 25 percent in Lima, 31 percent in other urban areas, and 19 percent in Peru as a whole. A similar percentage reduction in achieving a post-secondary diploma reduces the gap even further: about 58 percent in Lima, 40 percent in other urban areas, and 35 percent in Peru as a whole. A reduction in the gap between men and women who achieve a university diploma, though, although it reduces the gap in wages between wives and husbands by 36 percent in Lima, increases the wage gap by 66 percent in other urban areas. This suggests that the returns to a university diploma are lower in other urban areas than in metropolitan Lima.

Public school attendance seems to increase the wage gap. Thus an increase in the number of girls enrolled in public school (while reducing the gap between males and females in public school enrollment) increases the male-female wage gap. This is perhaps true, since as we have seen, the returns to a public school education are less than the returns to a private school

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[32]The reason for not reporting bivariate probit results for any male-female wage difference equation is that the model did not converge. However, Heckman two probit method yields consistent estimates.

education. These findings call for policies to make public schools more effective in raising productivity.

Table 7. Fixed-Effect estimates of male-female wage differences in Peru

Variable description	Lima: Husband-Wife Differences	Lima: Male-Female Differences	Other urban areas: Husband-Wife Differences	Other urban areas: Male-Female Differences	ALL PERU: Husband-Wife Differences	ALL PERU: Male-Female Differences
Log wage differences	0.417	0.352	0.154	0.203	0.315	0.287
Constant	0.029 (0.106)	0.178 (0.931)	0.115 (0.469)	-0.009 (0.038)	0.150 (0.811)	0.408 (2.946)
Potential work experience	0.044 (1.262)	0.035 (2.673)	-0.022 (0.491)	0.033 (1.567)	0.019 (0.763)	0.023 (2.095)
Potential work experience squared x 100	-0.072 (0.957)	-0.050 (1.721)	0.001 (1.022)	-0.022 (0.489)	-0.023 (0.433)	-0.023 (0.949)
Education						
Years of primary school	0.091 (1.211)	0.072 (1.617)	0.093 (0.802)	0.081 (1.567)	0.034 (0.737)	0.053 (1.592)
Years of secondary school	0.084 (1.321)	0.040 (1.664)	-0.002 (0.034)	0.068 (1.689)	0.031 (0.632)	0.032 (1.599)
Years of post-secondary school	0.020 (0.439)	0.017 (0.719)	-0.016 (0.258)	0.033 (0.676)	0.030 (0.693)	0.018 (0.829)
Vocational training	0.249 (2.228)	0.035 (0.464)	0.073 (0.490)	0.308 (2.577)	0.193 (2.151)	0.072 (1.087)
Secondary technical diploma	-0.066 (0.296)	0.053 (0.267)	-0.690 (1.412)	-0.569 (1.214)	-0.081 (0.302)	-0.094 (0.501)
Post-secondary diploma	0.584 (1.839)	0.383 (2.277)	-0.125 (0.427)	0.402 (1.674)	0.361 (1.546)	0.349 (2.545)
University diploma	0.355 (1.949)	0.208 (1.375)	-0.662 (2.111)	-0.314 (1.237)	-0.005 (0.026)	-0.070 (0.522)
Public school	-0.202 (1.408)	0.025 (0.300)	-0.611 (3.127)	-0.280 (1.800)	-0.230 (1.916)	-0.044 (0.611)
Correlation between male wage earner and wage difference errors	0.732 (5.831)	-0.318 (1.287)	1.029 (1.661)	0.027 (0.075)	0.671 (5.693)	-0.651 (2.888)
Correlation between female wage earner and wage difference errors	0.019 (0.079)	0.312 (1.970)	0.132 (0.272)	0.098 (0.470)	-0.004 (0.028)	0.340 (2.671)
Correlation between male wage earner and female wage earner errors	0.162 (2.285)		-0.922 (1.583)		0.196 (4.338)	
Residence - other urban area	-	-	-	-	-0.317 (2.725)	-0.195 (2.378)
Residence - rural area	-	-	-	-	-0.289 (1.587)	-0.120 (0.792)
Standard error of wage difference equation/F-Statistic	0.807 (11.219)	5.299	- -	3.671 -	0.824 (12.748)	8.037
Selected sample (sample size)	126(860)	415(3369)	68(970)	153(3307)	218(3296)	637(10386)
R^2	0.07	0.14	0.21	0.24	0.15	0.15

Note: Table assumes that $\beta_m=\beta_f$; Absolute values of t-statistics are in parentheses.

The effects of sample selection correction on the male-female wage gap are shown by the sign of the coefficients of the correlation between the wage earner and wage difference errors. In Lima and all-Peru, unobserved factors that increase the participation of married men in the wage sector (with wives in the labor force) increase the wage gap. In contrast unobserved factors that increase any male's (female's) participation in the labor market reduce (increase) the wage gap in Lima. The results also confirm that the unobserved characteristics that increase the market participation of husbands encourages their wives to participate in the labor market.

5. Discussion

This chapter addresses a number of critical questions. First, does interregional migration affect wage estimates and thus estimated rates of return to education? The results show that interregional migration, when ignored, overestimates the returns to schooling. Interregional migration is perhaps more common for men than for women. Thus when gains from migration are excluded, the estimated returns to schooling decrease. The decline is sharper for men than for women. The results also suggest that both men and women can gain if they migrate from rural areas to other urban centers.

Second, what influences men and women to participate in the labor market? Although education and training raise labor market participation, vocational training and secondary school increase the labor market participation of women more than that of men. Thus improving education for women can increase their participation faster than a similar increase in men's education would affect the participation of men. Unearned income and landholding reduce the participation of both men and women. The probability of being in the wage sector is high for married men and low for married women, indicating an expected job specialization after marriage.

Third, what determines the productivity of men and women in the wage sector? Experience, education, and training are all effective. The quality of education is also significant: those employees educated in private schools are more productive than those with a public school education. Moreover there are sharp regional differences in productivity. Men and women from other urban areas and rural areas are paid less than their counterparts in Lima. The extent of male-female differences in productivity depends on the impact of sample selectivity bias.

Fourth, is there any systematic gender bias in the estimated returns to schooling if we ignore the possible sample selection rule of who is a wage earner? The results suggest that sample selection correction increases the returns to schooling for both men and women if we include the gains from interregional migration. When these gains are excluded, however, the sample selection correction reduces returns to schooling. Sample selection bias is substantial in rural areas for both men and women, showing that the selected wage earners are not a random sample. The magnitude and direction of the bias, however, vary by region and gender. For example, the returns to post-secondary education are more biased in rural areas because of the unrepresentative character of the sample. The returns to schooling are also more biased for women in Lima at the primary school level. The results confirm that sample selection bias is an important factor in labor market participation. The most able men select non-wage employment in urban areas, while the most able men in rural regions -- and women in all areas -- are likely to select wage employment.

Fifth, is there any observable effect of unobservable family and community characteristics on the estimates of returns to education? Unobserved family and community characteristics, when controlled in wage regression, may increase or even reduce the returns to women's education. Thus when such bias is removed from the returns estimates, the returns to education become higher rather than lower for males than for females, especially at the post-secondary level. Hence there are reasons for parents to send more boys than girls to school, especially in rural areas at secondary and post-secondary levels. This finding clearly indicates that improved labor market opportunities for women along with improved school system can reduce the male-female gap in school enrollments.

And finally, why do men earn more than women? Although there are some differences in human capital, the extent to which these differences explain the wage gap depends critically on the sample selection correction factor as well as which wage structure is used to calculate the wage gap. Thus when sample selection correction is not included in the wage regression of a random sample of males and females, the human capital model does not explain any portion of the wage gap. When the correction factor is included, however, the model explains 47 percent of the wage gap in Lima and 99 percent in all-Peru, when we use the male wage structure to calculate the wage gap. This suggests that the unobserved characteristics that influence labor market participation and productivity also affect the productivity differences between males and females. In contrast, when the female wage structure is used, even with sample selection correction, the model explains nothing in terms of observed and unobserved characteristics. Sample selection correction is important, but may overestimate the effect of individual characteristics if the influence of unobserved family and community characteristics is not controlled. Clearly it would be useful to identify ot[illegible] observable characteristics that affect wage differences. Sample restriction t[illegible] some extent increases the explanatory power of the human capital model, but involves sample selection bias and thus may not necessarily solve the puzzle of why women earn less than men.

Three policy implications result from these questions. First, since public schools are less effective than private schools in raising productivity and reducing the wage gap, policymakers should make the public school system more effective.

Second, investments in education and training for women raise their participation and productivity in the labor market more than similar investments in men's education. In addition, these investments reduce fertility and improve the education of children and the health and nutrition of all family members. Thus human capital investment in women is a high return activity and at least as good as an equivalent investment in men. The government must identify ways to channel more resources to women's education.

Third, as communities differ in labor market conditions and provision of school facilities, the family background variables tend to play important roles in parental investment in children's education. The results indicate that even if the rates of return are higher for females than for males, the school enrollment rates are lower for females than for males. When unobserved family and community characteristics are controlled in the wage regression, the association between school returns and enrollment appears consistent at least in rural areas. Further policy research is required to identify how households and communities affect parental decisions and determine how the government can interact in this important decisionmaking.

In particular, research is needed to address a number of related policy issues: How communities differ in characteristics (both observed and unobserved)? How do they influence the internal rate of return to education and hence the school enrollment of boys and girls? How can governments interact with parents' decision? What incentives are needed to encourage parents to send their daughters to school, especially at the secondary and post-secondary levels?

Table A1. Mean characteristics of nonparticipants by gender in Peru

Variable definition	All Peru Male	All Peru Female	Lima Male	Lima Female	Other urban area Male	Other urban area Female	Rural Male	Rural Female
Number of observations	4179	6044	907	1584	1210	1835	2057	2625
Years of potential work experience	18.450 (15.09)	20.859 (15.081)	14.111 (13.562)	18.033 (14.494)	15.349 (14.499)	18.724 (15.098)	22.188 (15.152)	24.057 (14.815)
Years of job-specific experience	-	-	-	-	-	-	-	-
Education								
Years of primary school	4.057 (1.603)	3.340 (2.090)	4.807 (0.747)	4.455 (1.339)	4.631 (1.045)	4.053 (1.681)	3.[illegible] (1.854)	2.169 (2.120)
Years of secondary school	1.946 (2.183)	1.558 (2.112)	3.369 (2.016)	2.701 (2.224)	2.819 (2.125)	2.135 (2.219)	0.804 (1.607)	0.465 (1.276)
Years of post-secondary school	0.328 (1.112)	0.201 (0.870)	0.641 (1.513)	0.376 (1.[illegible]76)	0.542 (1.365)	0.295 (1.026)	0.064 (0.516)	0.029 (0.344)
Vocational training	0.133 (0.339)	0.198 (0.398)	0.275 (0.447)	0.[illegible]93 (0.489)	0.172 (0.377)	0.238 (0.426)	0.048 (0.214)	0.052 (0.222)
Secondary technical diploma	0.009 (0.099)	0.009 (0.095)	0.021 (0.143)	0.023 (0.151)	0.010 (0.099)	0.009 (0.096)	0.003 (0.054)	0.004 (0.019)
Post-secondary diploma	0.009 (0.094)	0.010 (0.102)	0.013 (0.114)	0.013 (0.114)	0.013 (0.114)	0.020 (0.141)	0.004 (0.066)	0.002 (0.044)
University diploma	0.019 (0.139)	0.011 (0.105)	0.050 (0.217)	0.025 (0.156)	0.024 (0.153)	0.012 (0.109)	0.004 (0.066)	0.002 (0.044)
Attended public school	0.833 (0.373)	0.682 (0.466)	0.773 (0.419)	0.764 (0.425)	0.891 (0.312)	0.798 (0.402)	0.826 (0.379)	0.550 (0.498)
Father's education	3.899 (2.898)	3.929 (3.076)	5.432 (3.099)	5.466 (3.226)	4.684 (2.619)	4.561 (2.959)	2.761 (2.569)	2.559 (2.410)
Mother's education	2.257 (2.157)	2.258 (2.356)	3.366 (2.564)	3.309 (2.698)	2.788 (2.081)	2.72[illegible] (2.3[illegible]3)	1.455 ([illegible].625)	1.296 (1.656)
Total years of school	6.331 (3.856)	5.099 (4.100)	8.817 (3.248)	7.533 (3.636)	7.509 (3.509)	6.483 (3.88[illegible])	4.257 (3.102)	2.664 (3.057)
Married or cohabiting	0.498 (0.501)	0.578 (0.494)	0.376 (0.485)	0.[illegible]19 (0.499)	0.439 (0.496)	0.5[illegible] (0.490)	0.587 (0.493)	0.634 (0.482)
Unearned real income x 1,000	1.603 (7.696)	1.619 (6.607)	4.253 (12.882)	3.632 ([illegible]0.759)	1.[illegible]7 (7.[illegible])	[illegible] (5.466)	[illegible].304 (2.454)	0.338 (2.405)
Landholding (hectares)	5.997 (62.467)	3.959 (51.285)	0.187 (1.891)	0.138 (1.549)	2.169 ([illegible]1.036)	1.552 (2[illegible].913)	10.809 (85.471)	7.997 (74.669)

Note: Numbers in parentheses are standard deviations.

Table A2: Heckman Two-Step estimates of husband's and wife's wage equation (3)

Variable description	Lima Husband	Lima Wife	Other urban areas Husband	Other urban areas Wife	All Peru Husband	All Peru Wife
Constant	0.688	0.485	1.412	3.613	2.206	2.134
	(0.517)	(0.503)	(1.235)	(2.107)	(3.153)	(2.232)
Potential work experience	0.027	0.022	0.010	-0.062	0.006	0.003
	(0.634)	(0.475)	(0.168)	(0.703)	(0.157)	(0.076)
Potential work experience squared	0.014	-0.018	-0.011	0.159	0.000	0.000
	(0.164)	(0.196)	(0.095)	(0.922)	(0.459)	(0.163)
Education:						
Years of primary schooling	0.091	0.150	0.016	0.273	-0.097	0.173
	(0.363)	(1.674)	(0.094)	(2.244)	(1.164)	(2.910)
Years of secondary schooling	0.094	0.105	0.111	-0.024	0.099	0.061
	(2.347)	(2.213)	(1.679)	(0.261)	(2.627)	(1.326)
Years of postsecondary schooling	0.032	0.017	0.086	-0.043	0.057	-0.019
	([illegible].749)	(0.263)	(1.663)	(0.450)	(1.464)	(0.343)
Vocational training	0.128	0.347	-0.090	-0.144	0.113	0.127
	(1.267)	(2.427)	(0.626)	(0.819)	(1.194)	(1.071)
Secondary technical diploma	-0.032	-0.297	0.268	-0.400	0.082	-0.395
	(0.098)	(1.057)	(0.495)	(0.636)	(0.243)	(1.430)
Post-secondary diploma	0.211	0.383	0.005	0.326	0.161	-0.058
	(0.622)	(1.241)	(0.020)	(0.876)	(0.707)	(0.225)
University diploma	0.579	0.398	-0.154	-1.138	0.265	-0.289
	(2.614)	(1.232)	(0.672)	(2.447)	(1.385)	(0.967)
Public school	-0.303	-0.479	-0.242	-0.637	-0.175	-0.504
	(2.295)	(3.223)	(0.933)	(2.852)	(1.290)	(3.808)
Correlation between being married couple and wage errors	0.100	-0.187	-0.152	-0.119	-0.032	-0.273
	(0.620)	(0.886)	(0.531)	(0.325)	(0.209)	(1.573)
Correlation between both being in labor market and wage errors	-0.212	-0.148	-0.110	-1.082	-0.392	-0.837
	(1.137)	(0.520)	(0.670)	(3.371)	(2.686)	(3.084)
Residence - other urban area					-0.170	0.247
					(1.519)	(1.[illegible]09)
Residence - rural area					0.094	0.391
					(0.486)	(1.757)
Sample size	126	126	68	68	218	218
R^2	0.43	0.46	0.40	0.50	0.40	0.45

Note: Absolute values of t-statistics are in parentheses.

Table A3: Heckman Two-Step estimates of wage equation (3) for the restricted sample size of men and women

Variable description	Lima		Other urban areas		All Peru	
	Male	Female	Male	Female	Male	Female
Intercept	0.467	1.400	1.476	0.562	4.030	0.300
	(0.479)	(1.849)	(1.399)	(0.376)	(3.590)	(0.483)
Potential work experience	0.076	0.043	-0.008	0.059	-0.041	0.067
	(2.569)	(2.338)	(0.200)	(1.272)	(1.077)	(4.528)
Potential work experience squared	-0.126	-0.035	0.062	-0.046	0.103	-0.108
	(2.137)	(0.686)	(0.785)	(0.387)	(1.410)	(2.919)
Education:						
Years of primary schooling	0.032	0.080	0.019	0.148	-0.052	0.067
	(0.384)	(1.263)	(0.217)	(1.545)	(1.044)	(1.589)
Years of secondary schooling	0.094	0.127	0.179	0.055	0.060	0.136
	(2.843)	(4.044)	(4.526)	(0.579)	(2.052)	(4.569)
Years of postsecondary schooling	0.066	0.035	0.089	0.045	0.037	0.050
	(1.928)	(0.807)	(1.833)	(0.674)	(1.345)	(1.342)
Vocational training	0.083	-0.033	-0.026	0.136	-0.231	0.160
	(0.804)	(0.194)	(0.148)	(0.866)	(1.555)	(1.490)
Secondary technical diploma	0.047	0.217	-0.443	0.207	-0.340	-0.172
	(0.157)	(0.953)	(0.933)	(0.265)	(1.144)	(0.768)
Postsecondary diploma	0.319	-0.253	-0.058	0.317	-0.284	0.183
	(1.198)	(0.889)	(0.177)	(1.047)	(1.004)	(0.906)
University diploma	0.389	0.042	-0.280	-0.287	-0.112	0.138
	(2.517)	(0.151)	(0.964)	(0.790)	(0.517)	(0.653)
Public school	-0.241	-0.336	-0.290	-0.181	-0.326	-0.281
	(1.673)	(3.258)	(1.499)	(1.007)	(3.386)	(3.171)
Correlation between male wage earner and wage errors	0.282	0.307	-0.371	0.471	-2.180	-0.151
	(0.434)	(1.195)	(0.671)	(0.807)	(2.566)	(0.6[illegible])
Correlation between female wage earner and wage errors	0.248	0.214	0.274	0.366	0.096	0.203
	(1.055)	(0.776)	(1.340)	(1.076)	(0.640)	(1.034)
Correlation between joint participation and wage errors	-0.393	-1.150	-0.440	-1.000	-0.256	-0.398
	(1.287)	(3.086)	(1.353)	(1.672)	(1.221)	(1.369)
Residence - other urban area					0.258	0.070
					(1.459)	(0.562)
Residence - rural area					0.803	0.049
					(1.811)	(0.281)
Sample size	332	315	145	128	535	502
R^2	0.39	0.35	0.46	0.48	0.42	0.37

Note: Absolute values of t-statistics are in parentheses.

CHAPTER 3:

MODELING ECONOMIC BEHAVIOR IN THE INFORMAL URBAN RETAIL SECTOR OF PERU

J. Barry Smith and Morton Stelcner*

1. Introduction

Few topics in the literature on development economics have inspired as much interest, controversy, and rhetoric as the informal sector in developing countries.[1] Here the term is intended as a shorthand expression to describe the collection of loosely organized small-scale competitive family businesses. Such businesses rely little on nonfamily hired labor. Their technologies are labor intensive and they operate largely outside the legal, bureaucratic, and regulatory framework regarding such matters as licenses, taxes, and contractual obligations. An important characteristic of the informal sector is that the free play of market forces generally determines returns to productive factors, especially labor. The enterprises are usually concentrated in low-income areas of large metropolitan centers, but it is not uncommon to find rural households, for example in Kenya and Peru, that have joined the informal sector.[2]

There appears to be a consensus that the informal economy is a sizable and growing component of developing economies. It accounts for a substantial fraction of the labor force, especially in urban areas, and provides an important -- if not the sole -- income opportunity for growing numbers of the poor. But the debate about its role in economic development continues. There is considerable disagreement about whether measures should be taken to promote

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[1] For more recent literature see Bromley (1978), Cornia (1987), Hallak and Caillods (1981), Hart (1987), House (1984), IDB (1987a), Mattera (1985), Moser and Marsie-Hazen (1984), Sethuraman (1981), Stewart (1987), and Tokman (1978).

[2] For a discussion see Stelcner and Moock (1988), Moock, Musgrove, and Stelcner (1989), and Freeman and Norcliffe (1985).

informal activities as an impetus to economic growth and a strategy for improving the earnings of low-income households.

The place of the informal sector in development is all the more important because of the severe economic crisis in most third world economies. As Cornia (1987) discusses, households faced with sharply reduced employment and income prospects in the formal (or modern) sectors -- manufacturing, services, mining, and government -- tend to seek employment and income opportunities in the informal economy. The first to shift are those who have lost jobs in the formal sector. Next, employed formal sector workers, especially government employees, resort to moonlighting activities, most of which are informal. As household incomes decline, married women and children who previously did not work in the market are drawn into informal market activities, and soon new entrants to the labor force begin to find jobs in the informal rather than the formal sector.[3]

The rapid growth of the informal sector has led international aid agencies and governments to explore policies to improve the profitability of such businesses. This surge of interest, however, is not based on much empirical evidence about the underlying determinants of the performance of the firms.

Informals perform a remarkable array of activities, ranging from vending foodstuffs and prepared foods to consumer goods and services, including carpentry, tailoring, barbering, shoe-repair, domestic work, vehicle and tool repairs, and transport. In addition, small-scale entrepreneurs manufacture textiles, garments, footwear, household utensils, musical instruments, metal products, furniture and wood products, and leather goods. They process foods and beverages, and recycle junk.

This research analyzes the informal sector in Peru, particularly the role of women, based on a theoretical model of informal retail trade that uses data from the Peru Living Standards Survey (PLSS). Retailing is the dominant nonfarm family enterprise. The central questions are: What factors explain differences in the performance of retail businesses? Assuming that these considerations can be identified, what types of policy initiatives might improve the performance of firms, particularly those run by women? The analysis is confined to urban areas where most of these businesses are located.[4]

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[3] Several recent studies have identified these general patterns. See Cornia (1987), IDB (1987b), PREALC (1985), van der Gaag, Stelcner and Vijverberg (1989), and Tokman (1986).

[4] We attempted to provide an analysis of nonfarm enterprises in both urban and rural areas. But the limited size of the sample in rural areas precluded the estimation of a model that we were confident of using. The results for rural areas are in appendix B.

2. Some Stylized Facts on the Informal Sector

2.1 Magnitudes and Other Characteristics

Informal economic activity is a mainstay of the Peruvian economy. Its sustained growth stands in marked contrast to formal activity, which has deteriorated in tha last decade at an alarmingly rapid rate. There is extensive evidence that a high proportion of the labor force, especially the female component, is in informal activities. As Glewwe and de Tray (1989) and Suarez-Berenguela (1987) discuss, the majority of the bottom socioeconomic strata in urban areas earns a livelihood from self-employment in the informal sector.

Peru's shadow economy has recently attracted worldwide attention[5] as a result of the recent publication of El Otro Sendero: La Revoluciòn Informal[6] by Hernando de Soto, a businessman and president of the Instituto Libertad y Democracia (ILD) in Lima. He concludes that the informal sector is the dominant and most dynamic part of the economy, and believes that removing the burdensome obstacles to legitimacy (such as bureaucratic red tape) would considerably improve Peru's economic malaise.

Several other recent studies corroborate de Soto's view that a sizable portion, perhaps a majority, of the labor force is in the informal sector.[7] Surveys by the ILD in 1985 and 1986 show that the informal sector in Lima makes up almost half the labor force, accounts for 61 percent of the hours worked and generates an astounding 39 percent of GDP (1984). For such sectors as commerce and personal services the share of production exceeds 60 percent. Litan and others (1986) report that the official national accounts estimate of the informal sector's contribution to GDP in 1984 resulted in an understatement of total GDP by 23 percent. Perhaps even more striking is the estimate that 439,000 Lima residents depend on the underground commercial economy, and almost three-fourths (314,000) of these individuals depend on street sales. According to de Soto (1988), these activities generated about $25 million a month in gross sales in 1985 and an average net per capita profit of $58 a month, about 40 percent more than the legal minimum wage. The 314,000 street merchants, including 91,455 street vendors, comprise 42 percent of the Lima work force involved in commerce.

The ILD surveys show that women make up 54 percent of the street vendors. Eighty-six percent of the street merchants occupy curbside sites, while the remaining 14 percent rove the streets. Business is also conducted in

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[5] See The Economist, February 18 and September 23, 198°, and Leaders, March 1989 (12) 1.

[6] The English translation is The Other Path: The Invisible Revolution in the Third World. (See de Soto 1989).

[7] See Althaus and Morelli (1980), Kafka (1984), Litan and others (1986), Stelcner and Moock (1988), Moock, Musgrove, and Stelcner (1989), Strassmann (1987), Suarez-Berenguela (1987), Vargas Llosa (1987), Webb (1977), and World Bank (1987).

(illegal) cooperative markets -- collections of kiosks, stalls and booths. Of the 331 markets in Lima, 274 were put up illegally; only 57 were built by the government. It is estimated that $41 million has been invested in these illegal markets, which employ about 125,000 people (including some 40,000 vendors). More than 80 percent of the street vendors and 64 percent of the informal markets are found in low-income districts.

According to recent studies that used the Peru Living Standards Survey,[8] half of the 5,100 households surveyed owned at least one nonagricultural family enterprise. Of the 27,000 individuals in the survey, 13,600 were in the labor force and 97 percent were employed. More than 4,500 worked in nonfarm family businesses, and 3,100 worked in family enterprises as their main occupation. About 6,200 worked on family farms.

Metropolitan Lima accounted for 34 percent of nonfarm family businesses, other urban areas for 44 percent, and rural areas only 22 percent. Of course, a large fraction of rural households also operate farms. These proportions correspond closely to the distribution of family workers and households across regions. The average number of enterprises per household is 1.25.

These family businesses are dominated by retail trade, manufacturing (especially textiles), and personal services (mainly in urban areas). Retail trade encompasses small shops, inns and cafes, kiosks, stalls, and street vending. Nontextile manufacturing includes food, beverages, pottery, furniture, toys, novelties, and musical instruments. The textile sector includes spinning, weaving, and tailoring. Personal services range from laundries and hairdressers and barbers to entertainment, auto and electrical repairs, and cleaning services. Most businesses rely on just one or two family workers; the use of hired labor is negligible.

Many firms do not own any capital or inventory and often have no operating expenses. In the retail sector, selling is often on consignment or commission. Large factories, wholesalers, and stores in the formal sector often provide the goods and perhaps the cart, stall, or kiosk. The goods are sold either on straight commission, or on consignment: the sellers pay only for what they sell and return the unsold goods. Factories often subcontract textile, clothing, leather and footwear manufacturing to family enterprises, which they provide with materials and equipment. In the labor-intensive personal services sector, little use is made of capital equipment. Thus it is not surprising that many family businesses in the dominant sectors reported little or no capital, inventories, or operating expenses.

How much credit do informals use and obtain? The Peru Living Standards Survey provided information on the current debt position of each household and on the source and terms of loans obtained in the past year.

Only 10 percent of the households that operated businesses reported that they received loans or were in debt. This is not surprising for several

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[8] See Stelcner and Moock (1988), and Moock, Musgrove, and Stelcner (1989).

reasons. First, the PLSS was conducted when inflation rates were extremely high (June 1985-July 1986). (During the first half of 1985 the annual inflation was 200 percent, and in the first half of 1986 monthly inflation was 4 to 5 percent. Such high rates of inflation are unlikely to foster a willingness to lend, except at interest rates so high that few households would choose to borrow. Second, given a sensitivity to questions about indebtedness, the Peru Living Standards Survey probably underestimated the debt among respondents. (To preserve good will, questions on debt and credit were last in a long questionnaire). Third, given the uncertain legal position of family businesses, their ability to obtain credit from formal lending institutions is very restricted at best. As Carbonetto (1985), Mescher (1985), and Kafka (1984) document, only a minute fraction of informal sector firms in Lima borrow from financial intermediaries in the formal sector. Households that need to borrow must depend on loan sharks and pawnbrokers, or resort to a "pandeiro". This is a revolving fund to which members make a weekly contribution. A lottery determines the winner of the week's contributions.[9]

In Lima, retail trade, personal services, and manufacturing account for more than 80 percent of the businesses and almost 85 percent of the family workers (Table 1). The single most important activity is retail trade. The pattern is the same in the rest of Peru. In other urban areas the respective proportions are 86 percent of the businesses (retail trade comprising 52 percent of businesses) and 90 percent of the workers in these sectors. In rural areas 80 percent of entrepreneurial families and workers are in either retail trade (43 percent) or manufacturing, particularly textiles. These are typical informal sector endeavors in most developing countries. What distinguishes Peru from other countries is the unusually large proportion of women and households in these activities.

Table 1. Percentage distribution of informal family businesses by sector of activity

	Metro Lima	Other urban areas	All urban areas	Rural areas	Peru
No. of Observations	1045	1387	2432	692	3124
Retail Trade	40.7	51.5	46.8	43.1	46.0
Personal Services	19.8	12.4	15.6	4.5	13.1
Textile Manufacturing	10.9	12.2	11.6	26.4	14.9
Other Manufacturing	10.4	9.7	10.0	11.9	10.4
Subtotal	81.8	85.8	84.0	85.9	84.4
Other Sectors	18.2	14.2	16.0	14.1	15.6

Notes: Other Manufacturing includes food, beverages, furniture, wood products and miscellaneous items.
Other Sectors includes construction, transportation, wholesale trade, mining, fishing and hunting.
Source: Peru Living Standards Survey.

2.2 The Role of Women

The Peru Living Standards Survey shows that women dominate the informal economy. In Chapter One, Schafgans notes that women make up about 45

[9] See Mescher (1985), World Bank (1989).

percent of the labor force. The vast majority work in family-owned firms and farms. Table 2 shows that 82 percent of the 5,952 employed women worked in family-owned nonfarm businesses (28 percent) or on family farms (54 percent). The remaining 18 percent were wage earners, mostly in urban areas. In Lima 45 percent of employed women were wage earners in contrast to 19 percent in other urban areas. In rural areas only 5 percent of employed women worked as salaried employees, usually as school-teachers and clerks in the public sector. There is practically no labor market for women in rural areas. In Lima, 38 percent of the women were employed in nonfarm businesses and 17 percent in agricultural activities; in other urban areas the corresponding proportions were 44 and 37 percent, and in rural areas 11 and 84 percent.

Of the 7,238 employed men surveyed, 21 percent worked in nonfarm enterprises and 42 percent worked on family farms, while 38 percent worked as wage employees (65 percent in Lima, 42 percent in other urban areas, and 18 percent in rural areas). In Lima about 32 percent of employed men worked in family businesses and 3 percent on farms, while in other urban areas the proportions were 33 and 25 percent, respectively. In rural areas only 5 percent of men worked in nonfarm family businesses; 77 percent worked on family farms.

Table 2. Percentage distribution of employed labor force by type of employment

	Metro Lima		Other urban areas		All urban areas		Rural areas		Peru	
	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males
No. of Observations	1237	1747	1978	2450	3215	4197	2737	3041	5952	7238
NonFarm Sector	38.2	31.5	44.1	32.5	41.9	32.1	10.6	5.3	27.5	20.8
Farm Sector	16.5	3.4	37.0	25.1	29.0	16.1	84.0	77.0	54.4	41.7
Wage Sector	45.3	65.1	18.9	42.4	29.1	51.8	5.3	17.7	18.1	37.5

Notes: The nonfarm and farm sectors refer to self-employment; the wage sector refers to hired labor.
Source: Peru Living Standards Survey.

In the retail food and textile sectors, women account for three-fourths of the family workers. In retail nonfood and food processing sectors they make up 60 to 70 percent of the work force, and account for about half the workers in urban personal services. The remaining family businesses such as transportation, construction, wood and chemical manufacturing, wholesale trade, hunting and fishing, and professional services are dominated by men and employ only a small fraction of women. There appears to be a clear division of labor between men and women. The proportion of women employed in the formal sector is much smaller than that of men and the informal sector activities that women pursue are considerably different from those of men.

The role of women in family enterprises is also highlighted by the large proportion of family businesses in the dominant three sectors that employ exclusively women and children under 20. In urban and rural areas about half the family retail businesses rely only on women and children. About 40 percent of firms that provide services employ only women and children. In textiles, which are largely home-based, over 66 percent of the rural concerns employ only women and children. In Lima the proportion rises to 70 percent and in other urban areas to 75 percent. These data suggest that women not only make up a high proportion of family workers but also operate the family businesses.

Despite their importance in these businesses, the value of women's entrepreneurial activities is not adequately reflected, if at all, in the national accounts. There have been very few attempts to assess their contribution to the economy or to analyze the relative performance of men and women in the informal economy. This is particularly true in Peru and other Latin American countries where such work has gone largely unnoticed, with the possible exception of domestic work.

Moreover, official Latin America data[10] do not give accurate information about women's economic activities. Most of the empirical economic research on family businesses has focused on agricultural activities or on the activities of self-employed urban men. Agricultural research tends to ignore informal nonfarm economic activities in rural areas. And most of the research on the self-employed analyzes individuals rather than the enterprise, ignoring the contributions to income of capital, nonlabor inputs, and the labor of women and children. These last are typically excluded because most surveys report them as unpaid family workers, while men are usually reported as paid family workers (Chiswick 1983).[11]

This analysis focuses on the family business rather than the self-employed individual, thereby incorporating enterprise characteristics -- capital, location, nonlabor inputs -- and the labor of all family workers.[12]

3. Model Formulation and Concepts

The analysis of the model of the revenue process of retail enterprises includes a theoretical characterization of revenue generation by retailers as well as a basis for estimating economic magnitudes (such as productivity). The model incorporates three features of sales revenue: price, potential customers, and the process by which a potential customer becomes a purchaser, at a given price.

The traditional economic model of production is extended to explain the production process of firms that expend resources in selling as well as in producing goods or services. For example, consider a street vendor who sells pencils at a given price at a busy intersection. An important consideration involves measuring the vendor's output. To argue that output can be measured in terms of the number or constant dollar value of transactions (in this case,

[10] See Recchine de Lates and Wainerman (1986); Bunster and Chaney (1985); Babb (1984).

[11] Often it is not clear whether these self-employed earnings refer to the value of gross sales or to the value of net production, that is, sales less cost of materials and other inputs.

[12] For related approaches see Blau (1985), Chiswick (1983), Strassmann (1987), Vijverberg (1988), and Teilhet-Waldorf and Waldorf (1983).

pencils sold) is akin to measuring output by the value of inputs, and misses a vital feature of the retailing process. That is, in every attempt (whether successful or not) to convince a passerby to purchase a pencil, the vendor is also making a sales effort, that includes information about the product and its availability. To measure output by the volume or value of transactions measures only that part of the vendor's activity that is successful.

In our model we argue that an enterprise in the retail sector effectively "produces" the probability that a contacted customer will make a purchase. We argue further that the firm can adjust its inputs (including labor, capital, materials, and inventory) to change the likelihood that it will make a sale. Changing inputs may range from increasing inventories to providing more information to customers.

The model is not explicitly one of profit maximization and not necessarily one where optimization leads to a dual relationship between cost and production. The data (particularly on prices) are not sufficient to estimate such a model. More important, it is not clear whether the textbook model of cost-efficient production and profit maximization is a useful hypothesis. It may be more reasonable to assume simply that firms make efficient use of their inputs and then to test whether observed decisions are consistent with profit maximization. Since our goal is to provide an empirical model of production for retail firms, in our discussion of the theoretical model we will also refer to problems and limitations in the applied work.

3.1 Assumptions

Assume that potential shoppers arrive randomly at the location of a vendor. Thus the contacts between buyers and sellers is a random variable. The average number of such contacts will depend upon the characteristics of the firm, including its location and reputation.[13] There is no guarantee that a shopper arriving at an enterprise will decide to make a purchase. Of two seemingly identical shoppers, one may decide to buy while the other does not, independently of the characteristics of the enterprise. The fraction of shoppers that makes a purchase is thus a random variable.

We assume that at each point in time and for a given price and type of good, a customer has a random yet rationally determined threshold response level to the vendor's sales effort. Suppose shopper j has threshold level t_j. The decision by the customer whether or not to make the purchase involves a comparison of t_j with the variable T_i, defined as the index of sales effort produced by firm i. If $T_i > t_j$, then the arriving customer will buy from firm i. If customers have their threshold levels t_j distributed according to the same (distribution) function F, then a firm with sales effort T_i will make a sale to a randomly arriving customer with probability $F(T_i)$. This probability, $F(T_i)$, can also be thought of as the fraction of arriving customers that buy from the firm. Part of the firms' decisionmaking involves setting the level of T_i.

[13] No information is available concerning repeat buyers or customers who purchase more than one unit of a good.

The model described above is similar to stochastic choice models that have lately become quite popular in labor economics. By analogy, the decision to buy is like the decision to enter the labor force and the condition that $t_j < T_i$ is similar to the requirement that the reservation wage at zero work is less than the market wage.

The enterprise can change its operating characteristics to affect the fraction of shoppers that makes a purchase. For example, a business can increase its inventory or stay open longer. Such factors are considered productive if increasing them raises the fraction of potential consumers who make purchases or, equivalently, increases the probability that a given shopper will make a purchase. Since the fraction of shoppers who buy is bounded from above by unity, in the limit for large quantities of factors there must be zero returns at the margin to increasing the level of productive factors. Similarly, while enterprises may adopt different mixes of factors (perhaps due to financing restrictions), labor is a common feature; no retail firm can operate without labor. The fraction of shoppers making purchases will approach zero as the amount of labor input approaches zero. This need not be true, however, for such inputs as capital (for example, a cart or stall) or inventory. Without these factors a customer can still make a purchase. The model is not constrained ex ante to require profit maximizing decisions on the part of firms. We do, however, examine whether the properties of the estimated model are consistent with profit maximization.

In applied work, neither the total number of units sold nor the selling price per unit are generally known. Data sets typically do not contain this information. Similarly, information on the number of customer contacts and the fraction of shoppers who buy is not available. At most, information on revenues, costs, and other characteristics of factors employed by the firm will be available in cross-section or time series data sets. With cross-section data the absence of separate information on price and quantity may cause fewer problems than in a time series setting where constancy of price is difficult to justify as a working assumption.

3.2 Specific Aspects of the Model

The expected price per unit received by an enterprise is defined as p^E. It is assumed that agents treat p^E as independent of the decisions of individual enterprises and of customers.

The expected number of shoppers arriving at enterprise i is defined as $N^E(X^i)$. N^E is assumed to depend upon (a vector of) characteristics of firm i, X^i, one element of which, for example, would be location. Differences in the expected number of arrivals at firm i versus firm j are assumed to depend only on differences in the characteristics of vectors x_i and x_j. Because the total number of arrivals is subject to random effects, firm i will not in general observe arrivals equal to $N^E(X^i)$. In the applied work of subsequent sections it is assumed that the expected number of arrivals to firm i can be expressed as:

$$N^E(X^i) = \exp[a_0 + \sum_{j=1}^{n} a_j x_j^i] \qquad (1)$$

Thus,

$$\ln N^E(X^i) = a_0 + \sum_{j=1}^{n} a_j x_j^i \qquad (2)$$

where x_j^i is a measure of the j^{th} characteristic in firm i. The specification of $N^E(X^i)$ is seen to be linear in its logarithm and introduces the ex ante restriction that the number of arrivals is nonnegative.

The fraction of shoppers that make a purchase or, equivalently, the probability that firm i makes a sale to a randomly arriving customer, is given by $F(T(Z^i))$. F depends upon a vector of firm i's characteristics, Z^i, which includes labor, materials/expenses, capital, and inventories.

In keeping with the discussion of the previous section, F can be written as a function of T_i where T_i is an index of sales effort and output produced by firm i and given by:

$$T_i = T(Z^i) \qquad (3)$$

F will be a nondecreasing function of T_i, bounded from below by 0 and from above by 1. Indeed, F is just the cumulative distribution function for the random variable t representing individual consumer purchasing thresholds. A drawing of t for a given customer j (t_j) shows the level of (an index of) sales effort needed to guarantee that individual j will make a purchase.

By adopting the above characterization of retailing, we obtain a model whereby something can be produced (sales effort or the probability of a purchase) with no guarantee that any consumer will make a purchase or that a firm will be observed to make a transaction. This will occur when the level of (the index of) sales effort produced by a given firm falls short of the threshold level necessary to convince the customer to buy. In the applied research it is assumed that the cumulative distribution function, F, is given by the logistic function.[14] :

$$F(T_i) = \frac{1}{1 + \exp[-T_i]} \qquad (4)$$

From (3) it will be recalled that the index T_i is a function of a vector of characteristics Z^i of firm i. This function must reflect the fact that labor is indispensable to the activity but that other factors are not. If we define z_1^i as the labor component of Z^i, the indispensability of labor can be introduced by requiring T_i to be an increasing function of the logarithm of z_1^i. Introducing the remaining factors affecting T_i in a linear fashion leads to the specification:

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[14] This specification of a logistic probability distribution function has proved valuable in other areas of applied economic research and it has the added benefit that it leads to applied models that are somewhat easier to estimate than those based upon the cumulative normal distribution function.

$$T_i = b_0 + b_1 \ln z^i_1 + \sum_{j=2}^{n_F} b_j z^i_j \tag{5}$$

where n_F is the number of factors used in the production of T_i. Given that $b_1 > 0$, labor will be an indispensable factor with a positive marginal product in terms of increasing the index T_i. As labor becomes small, T_i decreases without bound and $F(T_i)$ approaches zero. Any other factor z^i_j will be productive as long as $b_j > 0$. The parameter b_0 is the value of the index when labor is equal to one unit and all other factors are zero. It is reasonable to expect b_0 to be negative and large enough in absolute value such that $\exp[-b_0]$ is large and $F(T_i)$, the average frequency of sales, is small when almost no factors are allocated to sales.

As a final point, it is possible to extend the production analogy to consider isoquants which, in this case, are isoprobability contours of F. Since F is a monotonic increasing transformation of T_i, isoquants of T_i will coincide with isoquants of F. These isoquants will be straight lines for pairs of inputs, excluding labor. Alternatively, for pairs of inputs one of which is labor measured on the vertical axis, the isoquants are horizontally parallel and intersect the vertical axis. Production processes such as this are called quasi-linear.

3.3 The Revenue Function of the Firm

The discussion contained in the foregoing sections leads to the specification of a revenue function for a representative firm in the retail sector. This function is comprised of both a deterministic and a stochastic component. The expected revenue of firm i, R^E_i, is given by the product of the expected price and the expected number of buyers. The latter quantity is itself given by the product of the expected number of arriving customers and the fraction of customers who make purchases. In terms of the notation introduced above,

$$R^E_i = p^E N^E(X^i) F(T(Z^i)) \tag{6}$$

We assume that the stochastic influence on revenues enters multiplicatively. Thus observed revenues of firm i, R_i, are given by:

$$R_i = R^E_i \exp[v_i] \tag{7}$$

where v_i is a random variable incorporating uncertainties in the price level and the unforecastable factors affecting the number of customer contacts with the firm. We assume that v_i is such that $E[\exp[v_i]] = 1$. Our applied work will involve estimating the revenue function in logarithmic form. In terms of the specification of N^E and $F(T_i)$ in previous sections, the estimating equation will be of the form:

$$\ln R_i = \ln p^E + a_0 + \sum_{j=1}^{n} x^i_j - \ln(1 + \exp[-(b_0 + b_1 \ln z^i_1 + \sum_{j=2}^{n_F} b_j z^i_j)]) + v_i \tag{8}$$

A nonlin least squares algorithm is used to obtai point estimates of the parameters of the model. Since independent information on average price is not available, the coefficient estimate of a_0 will not identify the parameter a_0.

3.4 Marginal Revenue Products and Profit Maximization

The derivative of the expected revenue function with respect to a right-hand side variable (such as labor or capital) can be interpreted as the expected marginal revenue product of the variable. In cases where the unit price of the factor is known, the expected marginal revenue product can be compared with this magnitude to partially assess the efficiency of the firm. For example, if a firm is maximizing expected profits, the factor price and the marginal revenue product should, on average, coincide. In cases where data on factor prices are not available (a common occurrence in the informal sector), the derivative of the expected revenue function can be considered the shadow price of the factor. This shadow price is the amount of money that would be paid to the factor if the existing situation represented profit-maximizing behavior. In both situations the results lead to interesting insights for policy analysis.

The model is quite flexible with respect to possible relationships between revenue and such productive factors as labor, capital, and expenses. The fact that $F(T_i)$ is strictly bounded from above and below introduces some features into the relationship between factors that often do not arise in standard models of production. To highlight some of these properties, we present the following example of an expected revenue function.

Suppose that a simplified expected revenue function with two factors (x and y) is given by:

$$R = 1/(1 + \exp[a - x - y]), \quad a \geq 0 \tag{9}$$

where R is (expected) revenue, price and customer effects are fixed (in this example) and (a, -1, -1) are the estimated coefficients of the model. The (expected) marginal revenue product of factor x, R_x, is the derivative of the right hand side of (9) with respect to x and is given by:

$$R_x = R - R^2 \tag{10}$$

The marginal revenue product of x will be positive as long as the right hand side of (10) is positive. Given the definition of R in (9), this will always be the case because R < 1.

The response of the marginal revenue product function to changes, ceteris paribus, in x and y is important for determining the suitability of any profit maximization hypothesis and for determining the relationships between productive factors. The slope of the marginal revenue product function is given by the derivative of the right hand side of (10) with respect to x. Denoting this slope by R_{xx}, differentiation yields:

$$R_{xx} = R_x(1 - 2R) \tag{11}$$

Eventually, the marginal revenue product curve will slope downwards as R becomes larger than .5. There may be a range of x values where the marginal revenue product curve is upward sloping. This would be the case, for example, if when $x = 0$, the value of the expression $(a - y)$ exceeds 0 (and hence, $R < .5$ when $x = 0$). Thus the slope of the marginal revenue product curve for x depends in part on the quantity of the other productive factors. Within a profit maximization setting, the marginal revenue product curves must be downward sloping if the optimality conditions are to be satisfied.

It was noted above that the levels of other factors affect the slope of the marginal revenue product curve for a given factor. The position of the marginal revenue product curve for a given factor is influenced by the quantities of the other factors as well. This effect can be illustrated by considering the change in the marginal revenue product of x as y changes. Denoting this effect by R_{xy}, the right hand side of (10) can be differentiated with respect to y to obtain:

$$R_{xy} = R_y(1 - 2R) = (R - R^2)(1 - 2R) \quad (12)$$

where R_y is the marginal revenue product of y. Thus in this simple example, as long as $R < .5$, increasing y makes x more productive. Eventually, though, as y becomes increasingly large, more of the factor y will exert a negative effect on the (marginal) productivity of x. The explanation lies in the fact that the probability of making a sale (in this case $1/(1 + \exp[1 - x - y])$ is bounded from above by 1. The only way this condition can be met for increasing values of y and fixed x is if both factors are made less productive. If this were not to happen then x could be increased over a feasible range of values and the probability could be made greater than 1.

4. Description of the Data and Variables

The theoretical model is applied to data from the Peru Living Standards Survey (PLSS). The survey results provide information on a variety of topics: household composition, demographics, housing conditions, health, education, migration, labor force activities, housework, farm and nonfarm businesses, and household expenditures (see Grootaert and Arriagada 1986; INE 1988).

The survey modules on nonfarm family businesses, labor force behavior, and the personal characteristics of household members are particularly useful. For each family enterprise the PLSS gives the labor inputs of family workers, the value of output sold or consumed by the household, expenditures on purchased inputs, and the value of assets. The survey does not contain information on physical units and prices of output and nonlabor inputs, rather only total values. The survey shows how long each business has been open, the type of output, how many months it operated in the past year, and whether the business is in the home, at other fixed premises, or has no fixed premises. The information covers 3,360 businesses: 1,178 in metro Lima, 1,480 in other urban areas, and 702 in rural areas. The most popular activity is retail trade: 425 firms in Lima, 714 in other urban areas, and 298 in rural areas. In the analysis of the retail sector we excluded 51 observations urban because i) only children under 15 were employed (five in Lima, four in other urban areas, seven in rural areas), ii) no sales revenue was reported (nine in Lima, eight in other urban areas, three in rural areas), and iii) values of capital or expenses were more than 100,000 intis (six in Lima and nine in other urban areas). This reduced the sample to 1,386 firms: 405 in Lima, 693 in other urban areas, and 288 in rural areas.

A novel feature of this study is that it explicitly addresses the predominate role of women in the retail sector by distinguishing among three types of businesses: 1) female-only firms (possibly with children), 2) male-only firms (perhaps with children), and 3) mixed firms. Most retail firms employ only one or two family workers and do not use hired laborers. (See Table 3)

We use the following variables in the empirical analysis. The dependent variable is the logarithm of monthly gross revenues, which is the value of output. The set of regressors can be grouped into two categories: those that describe customer arrivals and those that affect the probability of a purchase. The former group includes the age of the enterprise in years, which can be interpreted as a reflection of the reputation of the firm and perhaps as a predictor of learning by doing in attracting clients. Also included is the place of operation as a proxy for ease of access by customers. Two dummy variables, "in the home" and "at a fixed location" (a kiosk or stall), incorporate the site information. Itinerant operations with no fixed location (such as peddling and street hawking) are excluded.

The following variables are deemed to affect the probability of a purchase. First, the value of capital, which includes land, buildings, furniture, tools, machinery, equipment and vehicles. Second, the value of inventory stocks and third, monthly operating expenses which measure the cost of goods purchased for resale, raw materials, and such items as repairs, utilities, and fuel. The timeframe of this variable corresponds to that of the dependent variable. The fourth variable is labor input, measured by the logarithm of monthly hours devoted by all family workers in the enterprise. The annual hours of farming labor are divided by the months of operation. Other aspects of managerial or sales skills are described by two proxies: 1) total work experience (in years) of the most experienced adult family worker in the firm and 2) the level of educational attainment of the most educated adult family worker in the firm. Work experience is entered with linear and quadratic (scaled by 100) terms. The effects of educational attainment are entered in two alternative ways. First, we use three dummy variables - primary school completed, secondary school completed, and postsecondary school completed; the excluded category is less than primary schooling. Second, we use three splines: years of primary school (zero to five), secondary school (six to ten) and postsecondary school (more than 10 years). Finally, the effects of vocational training are reflected by a dummy variable that takes a value of unity if any adult family worker in the enterprise had vocational training, or a value of zero otherwise.

Table 3. Descriptive statistics of urban retail sector

Type of Firm		Metro Lima				Other urban areas				All urban areas			
		Female	Male	Mixed	Total	Female	Male	Mixed	Total	Female	Male	Mixed	Total
Number of Firms		203	98	104	405	375	132	188	693	576	230	292	1098
Place of operation	%												
Home		25.1	8.2	24.0	20.7	37.5	18.2	34.6	33.0	33.2	13.9	30.8	28.5
Fixed location		21.2	18.4	37.5	24.7	25.5	25.8	31.9	27.3	24.0	22.6	33.9	26.3
Itinerant (Streets)		53.7	73.5	38.5	54.6	37.0	56.1	33.5	39.7	42.9	63.5	35.3	45.2
Months operated during year		8.8 (3.9)	9.2 (3.8)	10.0 (3.0)	9.2 (3.7)	9.7 (3.6)	9.6 (3.8)	10.1 (2.9)	9.8 (3.4)	9.4 (3.7)	9.4 (3.8)	10.1 (3.0)	9.6 (3.6)
1 - 6 months	%	28.1	27.6	14.4	24.4	22.0	22.7	11.2	19.2	24.1	24.8	12.3	21.1
6 - 9 months		16.3	9.2	17.3	14.8	9.1	8.3	18.1	11.4	11.6	8.7	17.8	12.7
9 -12 months		55.7	63.3	68.3	60.7	68.9	68.9	70.7	69.4	64.2	66.5	69.9	66.2
Age of firm (Years)		6.0 (8.8)	7.8 (10.1)	8.8 (9.1)	7.1 (9.3)	7.7 (9.8)	9.3 (11.5)	10.8 (11.8)	8.9 (10.8)	7.1 (9.5)	8.7 (10.9)	10.1 (10.9)	8.2 (10.3)
Less than 4 months	%	12.3	8.2	4.8	9.4	9.4	9.8	4.3	8.1	10.4	9.1	4.5	8.6
4 months - 1 year		14.3	13.3	9.6	12.8	[illegible]	7.6	3.2	7.1	10.8	10.0	5.5	9.2
1 - 3 years		27.1	24.5	19.2	24.4	23.1	18.2	14.4	19.8	24.5	20.9	16.1	21.5
3 - 5 years		14.3	17.3	15.4	15.3	14.5	14.4	15.4	14.7	14.4	15.7	15.4	14.9
5 - 10 years		11.8	7.1	17.3	12.1	16.9	17.4	22.9	18.6	15.1	13.0	20.9	16.2
Over 10 years		20.2	29.6	33.7	25.9	27.3	32.6	39.9	31.7	24.8	31.3	37.7	29.6
Monthly revenues	$	2731 (5489)	4328 (6110)	8300 (12138)	4548 (8178)	1889 (4262)	5961 (21147)	4801 (6337)	3455 (10406)	2186 (4743)	5266 (16501)	6048 (8988)	3858 (9655)
$ 1 - 500 Revenues	%	24.6	20.4	2.9	18.0	32.7	28.0	12.2	26.3	29.9	24.8	8.9	23.2
500 - 1000		19.7	16.3	9.6	16.3	19.8	12.9	12.2	16.5	19.8	14.3	11.3	16.4
1000 - 2000		21.2	14.3	11.5	17.0	22.5	12.9	14.9	18.6	22.0	13.5	13.7	18.0
2000 - 4000		17.7	20.4	25.0	20.2	15.5	18.9	25.0	18.8	16.3	19.6	25.0	19.3
More than 4000		16.7	28.6	51.0	28.4	9.4	27.3	35.6	19.9	12.0	27.8	41.1	23.0
Log of revenues	$	7.0791 (1.2895)	7.4453 (1.5110)	8.3448 (1.1663)	7.4927 (1.4142)	6.7389 (1.2733)	7.2857 (1.6530)	7.7911 (1.2595)	7.1285 (1.4224)	6.8588 (1.2882)	7.3537 (1.5926)	7.9883 (1.2536)	7.2629 (1.4296)
Monthly expenses	$	1874 (3394)	2491 (4177)	5633 (8076)	2988 (5391)	1294 (3552)	3399 (8032)	4376 (8927)	2531 (6513)	1498 (3505)	3012 (6671)	4824 (8640)	2700 (6125)
Spline 2 expenses > 830	$	1331 (3265)	1945 (4029)	4919 (8000)	2401 (5273)	819 (3455)	2883 (7910)	3696 (8860)	1993 (6415)	1000 (3395)	2483 (6548)	4132 (8570)	2143 (6020)
Spline 3 expenses > 2000	$	960 (2977)	1489 (3715)	4133 (7780)	1903 (4994)	550 (3276)	2343 (7699)	3013 (8676)	1560 (6211)	695 (3177)	1979 (6320)	3412 (8372)	1686 (5792)
$ 0 Expenses	%	1.5	5.1	1.0	2.2	2.7	9.1	0.5	3.3	2.3	7.4	0.7	2.9
1 - 500		42.4	38.8	15.4	34.6	48.8	32.6	20.2	38.0	46.5	35.2	18.5	36.7
500 - 1000		18.2	9.2	11.5	14.3	19.8	7.6	11.7	15.3	19.3	8.3	11.6	14.9
1000 - 2000		14.8	19.4	11.5	15.1	13.1	13.6	23.9	16.2	13.7	16.1	19.5	15.8
2000 - 4000		10.3	10.2	25.0	14.1	9.1	19.7	18.6	13.7	9.5	15.7	20.9	13.8
Over 4000		12.8	17.3	35.6	19.8	6.4	17.4	25.0	13.6	8.7	17.4	28.8	15.8
$ 0 - 830	%	57.6	51.0	23.1	47.2	66.8	47.0	28.7	52.7	63.5	48.7	26.7	50.6
Over 830		42.4	49.0	76.9	52.8	33.2	53.0	71.3	47.3	36.5	51.3	73.3	49.4
Over 2000		23.2	27.6	60.6	33.8	15.5	37.1	43.6	27.3	18.2	33.0	49.7	29.7

Notes: All monetary values in the table are in June 1985 Intis. The exchange rate was $1.00 US = 11 Intis.
Standard deviations are in parentheses.

Table 3. (Contd)

Type of firm		Metro Lima Female	Metro Lima Male	Metro Lima Mixed	Metro Lima Total	Other urban areas Female	Other urban areas Male	Other urban areas Mixed	Other urban areas Total	All urban areas Female	All urban areas Male	All urban areas Mixed	All urban areas Total
Number of firms		203	98	104	405	375	132	188	693	576	230	292	1098
Total capital	$	2191	8603	10523	5882	3264	8175	9195	5808	2886	8358	9668	5836
		(7733)	(21303)	(18407)	(15474)	(8173)	(19969)	(13732)	(13040)	8030	20504	15541	13980
Spline 2 total capital > 1000	$	1693	8110	9683	5298	2715	7555	8327	5159	2355	7792	8810	5210
		(7610)	(21103)	(18320)	(15325)	(8011)	(19819)	(13649)	(12893)	7880	20333	15457	13833
$ 0 total capital	%	15.3	23.5	0.0	13.3	6.4	12.1	2.1	6.3	9.5	17.0	1.4	8.9
1 - 250		26.1	20.4	10.6	20.7	29.8	19.7	7.4	21.8	28.5	20.0	8.6	21.4
250 - 500		13.8	11.2	6.7	11.4	14.5	9.8	4.3	10.8	14.2	10.4	5.1	11.0
500 - 2000		24.1	17.3	22.1	22.0	19.8	14.4	17.0	18.0	21.4	15.7	18.8	19.5
2000 - 4000		10.8	5.1	15.4	10.6	11.3	13.6	20.2	14.1	11.1	10.0	18.5	12.8
4000 - 12000		5.9	8.2	21.2	10.4	10.7	13.6	26.1	15.4	9.0	11.3	24.3	13.6
Over 12000		3.9	14.3	24.0	11.6	7.5	16.7	22.9	13.4	6.3	15.7	23.3	12.8
$ 0 - 1000	%	65.5	64.3	27.9	55.6	60.6	47.0	20.2	47.0	62.3	54.3	22.9	50.2
Over 1000		34.5	35.7	72.1	44.4	39.4	53.0	79.8	53.0	37.7	45.7	77.1	49.8
Total capital excl. stock	$	1559	5750	7050	3983	2004	4459	5044	3296	1847	5009	5759	3550
		(5386)	(17125)	(14833)	(12130)	(5657)	(13907)	(10553)	(9268)	(5563)	(15338)	(12262)	(10416)
Stock (Inventory)	$	632	2853	3473	1899	1260	3716	4151	2512	1039	3349	3910	2286
		(2874)	(8422)	(6634)	(5835)	(3913)	(10140)	(7048)	(6555)	(3592)	(9436)	(6899)	(6303)
Monthly profits	$	858	1838	2667	1560	595	2562	425	924	688	2253	1224	1158
		(3475)	(4172)	(7519)	(5021)	(2198)	(19426)	(8850)	(9790)	(2717)	(14946)	(8456)	(8357)
Profits > 0	%	84.7	88.8	84.6	85.7	79.1	80.3	73.4	77.8	81.1	83.9	77.4	80.7
Family workers		1.4	1.2	2.8	1.7	1.5	1.3	2.7	1.8	1.5	1.3	2.8	1.8
		(0.9)	(0.6)	(1.3)	(1.1)	(0.9)	(0.6)	(1.0)	(1.1)	(0.9)	(0.6)	(1.1)	(1.1)
1 worker	%	72.9	85.7	0.0	57.3	68.1	75.0	0.0	50.9	69.8	79.6	0.0	53.3
2 workers		16.7	9.2	57.7	25.4	19.6	18.2	56.9	29.4	18.6	14.3	57.2	28.0
3 workers		5.4	4.1	23.1	9.6	7.0	6.1	23.9	11.4	6.4	5.2	23.6	10.7
4 or more workers		4.9	1.0	19.2	7.7	5.4	0.8	19.1	8.2	5.2	0.9	19.2	8.0
Adult male workers only	%	0.0	92.9	0.0	22.5	0.0	81.8	0.0	15.6	0.0	86.5	0.0	18.1
Male workers only		0.0	96.9	0.0	23.5	0.0	94.7	0.0	18.0	0.0	95.7	0.0	20.0
Adult female workers only		76.4	0.0	0.0	38.3	73.5	0.0	0.0	39.5	74.5	0.0	0.0	39.1
Female workers only		89.2	0.0	0.0	44.7	88.2	0.0	0.0	47.5	88.5	0.0	0.0	46.4
Adult workers only		76.4	92.9	70.2	78.8	73.5	81.8	69.1	73.9	74.5	86.5	69.5	75.7
Monthly hours of labor		200.3	227.6	499.5	283.7	210.1	227.6	459.0	281.0	206.7	227.6	473.4	282.0
		(172.0)	(186.5)	(289.1)	(246.4)	(162.7)	(172.3)	(259.2)	(223.3)	(166.0)	(178.1)	(270.4)	(232.0)
1 - 100 Hours	%	32.5	25.5	1.0	22.7	28.4	25.8	2.7	20.9	29.9	25.7	2.1	21.6
100 - 200 Hours		28.1	23.5	9.6	22.2	27.3	19.7	12.8	21.9	27.6	21.3	11.6	22.0
200 - 300 Hours		15.8	20.4	17.3	17.3	20.6	25.0	12.8	19.3	18.9	23.0	14.4	18.6
300 - 400 Hours		11.8	19.4	16.3	14.8	11.5	18.2	15.4	13.9	11.6	18.7	15.8	14.2
400 - 500 Hours		4.9	7.1	12.5	7.4	5.9	5.3	17.6	8.9	5.6	6.1	15.8	8.4
Over 500 Hours		6.9	4.1	43.3	15.6	6.2	6.1	38.8	15.0	6.4	5.2	40.4	15.2
Log monthly hours		4.8406	5.0002	6.0544	5.1909	4.9867	5.0871	5.9532	5.2680	4.9352	5.0501	5.9893	5.2396
		(1.1192)	(1.1016)	(0.5902)	(1.1265)	(0.9735)	(0.9464)	(0.6361)	(0.9822)	(1.0286)	(1.0140)	(0.6210)	(1.0379)
Adult male/total Hours	%	0.0	95.8	48.3	35.6	0.0	91.6	46.3	30.0	0.0	93.4	47.0	32.1
Adult female/total Hours	%	91.6	0.0	46.9	58.0	89.8	0.0	46.3	60.9	90.5	0.0	46.5	59.8
Child hours/total Hours	%	8.4	4.2	4.8	6.4	10.2	8.4	7.4	9.1	9.5	6.6	6.5	8.1

Table 3. (Contd)

Type of Firm	Metro Lima Female	Metro Lima Male	Metro Lima Mixed	Metro Lima Total	Other urban areas Female	Other urban areas Male	Other urban areas Mixed	Other urban areas Total	All urban areas Female	All urban areas Male	All urban areas Mixed	All urban areas Total
Number of Firms	203	98	104	405	375	132	188	693	576	230	292	1098
Education (Most educated worker)												
Years of schooling	6.2 (3.8)	7.6 (3.6)	9.1 (3.3)	7.3 (3.8)	5.7 (4.0)	7.2 (3.9)	8.6 (3.6)	6.8 (4.1)	5.9 (4.0)	7.3 (3.8)	8.8 3.5	6.9 4.0
Spline 0 - 5 years of school	4.0 (1.7)	4.5 (1.1)	4.9 (0.5)	4.4 (1.4)	3.7 (1.8)	4.3 (1.4)	4.7 (0.8)	4.1 (1.6)	3.8 (1.8)	4.4 (1.3)	4.8 (0.7)	4.2 (1.5)
Spline 6 -10 years of school	1.9 (2.2)	2.6 (2.3)	3.5 (2.1)	2.5 (2.3)	1.6 (2.2)	2.3 (2.3)	3.2 (2.2)	2.2 (2.3)	1.7 (2.2)	2.4 (2.3)	3.3 (2.2)	2.3 (2.3)
Spline 10 + years of school	0.2 (1.0)	0.5 (1.3)	0.7 (1.6)	0.4 (1.3)	0.3 (1.1)	0.5 (1.3)	0.7 (1.5)	0.5 (1.3)	0.3 (1.1)	0.5 (1.3)	0.7 (1.6)	0.4 (1.3)
Highest education level completed												
None %	8.9	2.0	0.0	4.9	12.3	3.8	0.5	7.5	11.1	3.0	0.3	6.6
Primary	42.9	37.8	23.1	36.5	47.7	39.4	28.7	41.0	46.0	38.7	26.7	39.3
Secondary	40.9	44.9	57.7	46.2	31.1	40.9	47.9	37.5	34.5	42.6	51.4	40.7
Post-secondary	7.4	15.3	19.2	12.3	8.8	15.9	22.9	14.0	8.3	15.7	21.6	13.4
% of family workers who:												
Attended public schools	77.6	85.9	80.7	80.4	79.8	87.6	86.5	83.1	79.0	86.9	84.4	82.1
Have vocational training	32.8	27.7	34.8	32.1	22.6	13.5	17.8	19.6	26.2	19.6	23.9	24.2
At least 1 family worker has vocational training %	39.4	28.6	60.6	42.2	27.[illegible]	15.2	37.8	28.1	31.9	20.9	45.9	33.3
Age of oldest worker (Years)	39.1 (11.8)	40.7 (15.4)	44.0 (11.8)	40.7 (12.9)	41.8 (13.2)	42.2 (15.8)	44.1 (12.6)	42.5 (13.6)	40.9 (12.8)	41.5 (15.6)	44.0 (12.3)	41.8 (13.4)
Job experience (Most experienced worker)												
Years	9.7 (9.9)	14.8 (13.3)	18.6 (11.3)	13.2 (11.8)	15.1 (14.2)	19.4 (14.8)	21.2 (12.7)	17.6 (14.1)	13.2 (13.1)	17.4 (14.3)	20.3 (12.3)	16.0 (13.5)
Years squared/100	1.9 (3.3)	4.0 (6.3)	4.7 (5.2)	3.1 (4.8)	4.3 (6.9)	5.9 (7.3)	6.1 (7.2)	5.1 (7.1)	3.5 (6.0)	5.1 (6.9)	5.6 (6.6)	4.4 (6.4)

5. The Empirical Model

This section reports the specification and estimation of the revenue model for the informal retail sector. In contrast to popular approaches to estimating the properties of production technologies, we introduce no assumptions about the optimizing behavior of agents. One reason for this is that there are seldom well-developed markets for the factors employed by these firms and thus no way to construct independent measures of the opportunity cost necessary for optimizing models.

Our work uses the revenue function specified in equation (8). Ultimately, though, the statistical process of specification, estimation, diagnostic analysis, and nonlinearity analysis that we employ is iterative. In our case there were iterations with respect to both model specification and inclusion/exclusion of data points in the sample reflecting the inflow of information from the battery of diagnostic tests to which the model and data were subjected. Since our model is nonlinear in some parameters it was necessary to estimate the extent of this nonlinearity to determine whether the local diagnostic analysis, based on a version of the model linearized about the least squares optimum and other measures of goodness of fit and precision, retained its traditional meaning. It is known, for example, that as the measured degree of model/parameter nonlinearity increases, traditional confidence ellipsoids may become distorted, with the result that traditional measures of (joint) significance of parameters lose their validity.

We describe below the iterations of testing and diagnostic analysis that separate the initial model from the final model for which parameter estimates are reported. The approach led to a model that is extremely robust, provides an excellent fit of the data, and is very close to the initial model in both specification and sample. Two versions of the final model are reported: the difference between the two lies in the measurement of education -- dummy or splined variables. Finally, as a further test of validity, we analyzed the data using nonparametric techniques (see Appendix B). The results are discussed below.

5.1 Initial Specification

The initial model was given by:

$$\ln R_i = a_0 + a_1 \text{LOCTION\_HOME} + a_2 \text{LOCATION\_FIXED} + a_3 \text{FIRM\_AGE} - \ln(1 + e^{-T_i}) + V_i \qquad (13)$$

where:

$$T_i = b_0 + b_1 \text{EXPENSES} + b_2 \text{CAPITAL} + b_3 \text{STOCK} + b_4 \ln(\text{LABOR}) + b_5 \text{TRAINING} + b_6 \text{SCHOOL\_PRIMARY} + b_7 \text{SCHOOL\_SECONDARY} + b_8 \text{SCHOOL\_POSTSEC} + b_9 \text{EXPERIENCE} + b_{10} \text{EXPERIENCE}^2 \qquad (14)$$

The model was fitted to three subsamples of the data: Lima, other urban areas, and rural areas. All the first round point estimates of the parameters (obtained by a nonlinear least squares Gauss-Newton algorithm) had the correct signs and between 50 and 60 percent of the variance in the logarithm of revenues was explained.

5.2 Preliminary Tests for Aggregation and Pooling

The initial results showed similar patterns in the estimated parameters of the Lima and other urban areas models. Some parameters from the rural model were similar to their counterparts for Lima and for other urban areas. These results led to the hypothesis that an aggregate model based on a pooled sample could be estimated. At the same time it was necessary to determine whether we were justified in pooling data among female, male, and mixed enterprises. This question was particularly important given that one of our goals was to estimate women's productivity. Finally, regardless of the outcome of these initial hypothesis tests, all of the tests would have to be redone since the model specification and the data set might change as a result of information obtained from the diagnostic analysis (see below). All hypotheses were tested using the sample likelihood ratio statistic compared with its 1 percent critical value.

Table 4 gives the test results.[15] We could not reject the hypothesis of equality of parameters or structure in Lima and other urban areas. All pooling that included rural data, however, was rejected. That is, the structure of rural firms was found to be different from that of urban firms. Finally, we could not reject the hypothesis of equal parameters in the three classes of enterprises: male, female, and mixed.[16] For these reasons our urban model is estimated on a sample pooled with respect to enterprise and location (Lima and other urban areas). Tables B1 - B3 in appendix B give the results for the rural model.

5.3 Diagnostic Analysis

Our analysis involved assessing the sensitivity of parameter estimates to what we term "data problems." Although the PLSS is an unusually clean data set, where much effort was devoted to correcting anomalies, it is still open to a variety of impurities due to, inter alia, measurement errors, data entry, and inaccurate reporting by respondents and enumerators. Advances in statistical research have made it possible to implement set of data diagnostic tests to reveal statistical problems arising from im. fect data or highly influential sets of observations. These tests provide another useful way to assess the reliability of a given model.[17]

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[15] The results correspond to the final estimated model where education is represented by dummy variables. The pattern of results is similar to that obtained with the initial version of the model.

[16] This hypothesis was tested on the pooled Lima and other urban areas samples.

[17] For an excellent discussion of these issues, see Belsley, Kuh, and Welsch (1980), and Chatterjee and Hadi (1988).

Table 4. Summary tests of pooling and structure

Hypothesis	Test statistic	Critical value	Decision
1. Lima, other urban areas, and rural areas can be aggregated.	83.040	56.123	REJECT
2. Lima and other urban areas can be aggregated.	25.041	33.409	DO NOT REJECT
3. For Lima and Other Urban Areas, Female, Male and Mixed Firms can be aggregated.	52.800	56.123	DO NOT REJECT

The diagnostic techniques involve searching the data for single observations or sets of observations that differ significantly from the "average" data point and may have an excessive influence on the regression results. Parameter estimates that are highly dependent on the properties of small subsamples of the data should be treated with caution. For this reason the isolation and careful study of influential observations is an important task in applied modeling. The theory behind these tests for linear models has been developed extensively in the statistics literature. For our nonlinear model, the tests were performed on a version of the model linearized about the nonlinear least squares optimum.

Two possible sources of influential observations are high leverage points and outliers. A high leverage point is an observation for which the vector of independent variables is "far" from the rest of the data. In the leverage analysis, the data were searched for points that were farthest from the center of the remaining data. Since leverage points need not be influential points, these observations were iteratively dropped and the model reestimated to see if the points were particularly influential in determining the overall fit. The second test involved plotting residuals against leverage values to identify outliers, that is, those observations where the residuals were large. We isolated observations where the fitted values of the model were farthest from the actual values of the dependent variables. These observations were removed from the data set and the model was reestimated to evaluate their influence on the regression results. This process was repeated several times because the removal of any one high leverage point can, and generally does, cause a change in the set of high leverage points.

Finally, we examined the plots of the studentized residuals against the independent variables and against the fitted values of the dependent variable. The first set of plots was studied for patterns (for example, positive residuals for large values of the variables) that might indicate that the specification was not robust. The second plots provided information about possible nonlinear relationships in the residuals.

Ultimately the analysis showed that 15 data points were influential. That is, their removal from the sample led to significant changes in the parameter estimates for capital, stock, and expenses. All the influential observations we isolated had extremely large values for capital, stock, or expenses (more than 100,000 intis). We chose not to include these 15 data points in the estimation of subsequent models.

In studying the stability of the estimated parameters, we were particularly concerned about their sensitivity to restrictions on the capital, stock, and expenses variables. Our analysis involved setting critical values for these variables and dropping observations in excess of these values. When we reestimated the model for successively smaller critical values, we found that the parameters associated with capital, stock, and expenses were quite sensitive to these restrictions, but that other parameters were stable. The parameter estimates for capital, stock, and expenses tended to increase as the independent variables were restricted.

These results suggest that a model with constant coefficients for capital, stock, and expenses might not be appropriate. The coefficients should be given the flexibility to decrease as the variables increase.[18] The economic interpretation of these results was that there were variable returns to these factors beyond what the original specification of the model could encompass.

We reestimated the model with piecewise linear splines for capital, stock, and expenses. Because the nonlinear nature of the model combined with the large sample size made estimation somewhat expensive, we undertook only limited experimentation on determining the knots of the splines. Up to three segments appeared necessary to remove a large amount of the instability of the coefficients.

The parameter instability that remained appeared to involve a trade-off in the values of the parameters of the stock and the capital variables, similar to a multicollinearity problem. Independent of the choice of knot points, the spline coefficients for the stock variables were never significant and typically had t-statistics less than 0.5. The estimated coefficients were of the wrong sign as well. But if the added spline variables for stock were removed, an unstable but statistically significant coefficient of the correct sign arose for the remaining stock variable.

We resolved this problem by aggregating the stock and capital variables into a single variable called total capital. We reasoned that statistical testing based on the likelihood ratio test provided no clear evidence against the aggregation decision. Whether or not the test rejected or did not reject aggregation depended on the number of spline variables introduced. In no case was aggregation as strongly rejected as the competing hypothesis that the stock variable should simply be dropped from the model. Second, the model with

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[18] We also estimated the model with quadratic terms for capital, stock, and expenses, but the parameter instability remained. Box-Cox transformations were not possible because these variables often had values of zero.

capital and stock aggregated was characterized by stable and significant parameter estimates of the correct sign. Third, prior to aggregation the nonlinearity tests (see below) indicated that the model was highly nonlinear in terms of the curvature properties of the estimated revenue function. After aggregation this problem disappeared.

5.4 Analysis of Nonlinearity

The diagnostic analysis is based on the assumption that the underlying regression model is linear in the parameters. Other statistics, such as confidence intervals about the point estimates of the parameters, assume that the model is linear. This linearity assumption is violated in the strict sense, but there is a linearized version of the model around the nonlinear least squares optimum. The important question to raise is whether the linearized version of the nonlinear model is accurate over a sufficiently large range of the parameter space so as to include confidence intervals measured in the standard way. Alternatively, the model may be so nonlinear that the linear approximation model becomes unacceptably inaccurate within the range of the traditionally (linearly) measured confidence intervals.

Current research in the statistics literature has been aimed at resolving such questions using differential geometry. This branch of mathematics has well-developed notions and measures of curvature and nonlinearity. Nonlinearity of statistical models has been reduced, in part, to the study of the radius (of curvature) of the largest approximating ball "covered" by the estimated model. Intuitively, the larger the radius of curvature, the better the local linear approximation to the model will be and the more confident one can feel about results based on the linearized model. The total curvature of a model can be decomposed to three parts: one representing the intrinsic curvature of the model (and about which nothing can be done short of respecification) and the other two representing parameter effects curvature (which can, to some degree, be mitigated by reparameterization of the model without distorting the specification). Statistical tests of the extent of curvature relative to the distance of the estimated model from the dependent variable can be performed and the significance of deviations from linearity can be assessed (see Bates and Watts 1980).

Table 5 shows the nonlinearity analysis arising from the last diagnostic iteration. All the parameters of the model fell within acceptable limits for nonlinearity. Those parameters for which the curvature measures were greatest were associated with the spline variables for capital and expenses. These results confirm our finding that it was inappropriate to specify constant coefficients for the aggregate expenses and capital variables. They also suggest that the spline approach leads to a model with a sufficiently accurate linear approximation around the nonlinear least squares optimum. The nonlinearity analysis increased our confidence in the quality of the estimated model and in the validity of applying traditional statistical tests to the model.

Table 5. Analysis of nonlinearity

		Curvature Type		
Parameter Considered	Total	Intrinsic	Geodesic	Acceleration
CONSTANT2 (b_0)	.036	.020	.014	.027
EXPENSES_1	.286	.119	.180	.187
EXPENSES_2	.385	.172	.216	.269
EXPENSES_3	.551	.271	.247	.411
CAPITAL_1	.311	.199	.088	.223
CAPITAL_2	.327	.211	.080	.236
LABOR	.023	.006	.015	.016
SCHOOL_PRIMARY	.022	.013	.010	.015
SCHOOL_SECONDARY	.034	.017	.015	.025
SCHOOL_POSTSEC	.065	.041	.019	.047
TRAINING	.018	.003	.012	.012
EXPERIENCE	.030	.018	.015	.019
EXPERIENCE^2	.041	.030	.016	.023

Notes:

1. Curvature numbers should be compared to: $lambda_c = F(17,1081;\alpha)^{-.5}$. When $\alpha = .05$, $lambda_c = .778$; when $\alpha = .01$, $lambda_c = .705$.

5.5 Distribution of the Errors

The specified form of the (logarithmic) model in (13) contains the representative error term v_i. The error term is unobserved but the regression residuals (that is, the differences between the dependent variable, $\ln R_i$, and its fitted value, $\ln \hat{R}_i$) provide information about the distribution of the error terms. Using the standard Shapiro-Wilk test (based upon order-statistics), we could not reject the hypothesis that the residuals were normally distributed.[19] This in turn suggests that the multiplicative error term for total revenues given by $\exp[v_i]$ in equation (7) is lognormally distributed.

There are two implications of these distribution results. First, because the error term appears to be normally distributed in the logarithmic

[19] An examination of the normal probability plot of the residuals as well as the shape of the plotted density function for the residuals confirms this finding.

model, the least squares parameter estimates are also maximum likelihood estimates.

The second point is technical but important for the simulation analysis. In some of the simulation work it is necessary to construct an estimate of R^E_i (the expected value of revenue for the i^{th} firm). Given that the model is estimated with the logarithm of revenues as the dependent variable: $\ln R_i = h(x_i) + v_i$, then, because the v_i appear to be normally distributed, the appropriate estimate for R^E_i is given by:

$$\hat{R}^E_i = \exp[\hat{h}(x_i)]\exp[\hat{\sigma}^2/2]$$

where $\hat{\sigma}^2$ is the estimated variance of v_i. The second exponential term is a scaling factor arising in the transition from a normally distributed random variable to one that is lognormally distributed. In the empirical work we found that $\hat{\sigma}^2$ was about equal to 0.773 and thus that the scaling factor was about 1.47. If this scaling factor were ignored, the estimate of expected revenue would be biased downward by approximately 47 percent.

6. Empirical Findings and Interpretation

We first present regression results for the final models for urban areas and comment on some (ex post) tests for aggregation and pooling. Second, we discuss the factor productivity of labor, expenses, and capital, and explain the distributions of productivity overall and by type of enterprise. Finally, we report some simulation experiments in which we provide loans to selected groups of firms. We use information from the estimated revenue model to assess the firms' ability to repay these loans. We also consider simulations that change the level of schooling and the number of labor hours available to the firm.

The exact form of the final regression model is given by:

$$\ln R_i = a_0 + a_1 LOCATION\_HOME + a_2 LOCATION\_FIXED + a_3 FIRM\_AGE - \ln(1 + e^{-T_i}) + v_i \qquad (15)$$

where:

$$T_i = b_0 + b_1 EXPENSES\_1 + b_2 EXPENSES\_2 + b_3 EXPENSES\_3 + b_4 CAPITAL\_1 + b_5 CAPITAL\_2 + b_6 \ln(LABOR) + b_7 TRAINING + b_8 SCHOOL\_PRIMARY + b_9 SCHOOL\_SECONDARY + b_{10} SCHOOL\_POSTSEC + b_{11} EXPERIENCE + b_{12} EXPERIENCE^2 \qquad (16)$$

The introduction of spline variables increased the number of expenses variables to three and the number of capital variables to two. The capital variable now includes the values of both physical capital and stock. Finally, we consider two versions of the model: one in which the schooling variables are measured as splines, and the other in which binary variables are used to distinguish levels of schooling.

Tables 6 and 7 present the regression results. The t-statistics suggest that most of the parameters are significantly different from 0 at the 1 percent level. In addition, each model explains about 60 percent of the variation in the dependent variable. This is high by cross-section standards.

The pattern of signs and relative magnitudes of the estimated parameters is quite reasonable. All levels of schooling and vocational training have positive impacts on revenues in the binary variable model. The results suggest there are diminishing benefits at the margin for postsecondary schooling. The spline model tells an identical story. The fact that the third spline coefficient is not significantly different from zero suggests that there is no important difference (in terms of revenues) between secondary and postsecondary education.

As the sign of the linear term suggests, there are positive returns to work experience. While these returns may initially increase, they ultimately diminish. The fact that the quadratic term is negative implies that diminishing returns set in more quickly. There appears to be a distinct disadvantage to operating a business from the home as opposed to being itinerant. Finally, the older the firm, the greater are the estimated revenues.

Labor, expenses, and capital variables continue the reasonable pattern of results. The labor parameter has the correct sign and is highly significant. With respect to the expenses parameters, their pattern and relative sizes are sensible. The two spline knots for expenses were at 830 and 2,000 intis respectively. Thus a firm with less than 830 intis in expenses will have an expenses coefficient of 1419.004. This drops to 316.666 for a firm with between 830 and 2,000 intis of expenses, and to 234.397 for a firm with more than 2,000 intis of expenses. The fact that the coefficients decline, however, does not guarantee that there is everywhere diminishing marginal productivity for expenses. Eventually though, the marginal products will decline. The same is true for capital. Here the spline knot is at 1,000 intis. Thus, a firm with less than 1,000 intis in stock and capital has a coefficient of 474.017 for aggregate capital, and when the firm has aggregate capital in excess of 1,000 intis, the coefficient is 18.003. There will eventually be diminishing returns to this factor for all firms. Some firms in the sample, though, may be operating in a range of increasing marginal productivity for capital.

The (ex post) tests for aggregation and pooling are identical to the ex ante results. The hypothesis of equal structures in Lima and OUAs could not be rejected. Similarly, the hypothesis that male, female, and mixed enterprises have similar structures could not be rejected for all urban areas.[20] An important implication of the last test is that productivity does not differ by type of firm. A female firm with the same factor endowments and other characteristics as a male or mixed firm will have the same revenues, on average, as other businesses.

[20] In all cases rural firms had significantly different structures. (See Table 4).

Table 6. Regression results - all firms (Binary Schooling Variables)

CONSTANT1(a_0)	9.703 (57.818)
LOCATION_HOME	-0.360 (-5.180)
LOCATION_FIXED	-0.033 (-0.449)
FIRM_AGE	0.006 (2.079)
CONSTANT2(b_0)	-5.289 (-21.478)
EXPENSES_1	1419.004 (10.044)
EXPENSES_2	-1102.338 (-4.926)
EXPENSES_3	-82.269 (-0.654)
CAPITAL_1	474.017 (5.269)
CAPITAL_2	-456.014 (-5.013)
LABOR	0.215 (6.494)
SCHOOL_PRIMARY*	0.194 (1.696)
SCHOOL_SECONDARY	0.356 (2.759)
SCHOOL_POSTSEC	0.402 (2.659)
TRAINING	0.113 (1.521)
EXPERIENCE	0.022 (3.025)
$EXPERIENCE^2/100$	-0.058 (-4.049)
LLF	-1419.360
SSR	852.963
Adjusted R-squared	0.61614
Mean Dependent Variable	7.26285
St. Dev.	1.42960

Notes: t-statistics are in parentheses.
* Excluded category is less than primary schooling completed.

Table 7. Regression results (Spline Schooling Variables)

Type of firm	Total	Female	Male	Mixed
Number of firms	1098	576	230	292
CONSTANT1(a_0)	9.720	10.035	9.406	9.835
	(57.079)	(22.131)	(32.539)	(40.607)
LOCATION_HOME	-0.363	-0.302	-0.464	-0.431
	(-5.224)	(-3.329)	(-2.072)	(-3.292)
LOCATION_FIXED	-0.030	-0.074	0.176	-0.147
	(-0.419)	(-0.737)	(0.929)	(-1.123)
FIRM_AGE	0.006	0.014	0.003	-0.007
	(2.003)	(3.179)	(0.439)	(-0.136)
CONSTANT2(b_0)	-5.281	-5.338	-5.806	-5.839
	(-22.362)	(-10.989)	(-9.556)	(-7.458)
EXPENSES_1	1422.047	1498.644	1861.097	823.518
	(10.108)	(8.858)	(4.515)	(2.545)
EXPENSES_2	-1105.146	-1072.956	-1987.134	-354.705
	(-4.962)	(-4.022)	(-2.893)	(-0.736)
EXPENSES_3	-88.862	-263.425	505.992	-233.278
	(-0.713)	(-1.745)	(1.262)	(-0.991)
CAPITAL_1	468.985	303.434	522.262	844.269
	(5.243)	(2.691)	(2.225)	(3.963)
CAPITAL_2	-451.513	-269.499	-500.477	-837.998
	(-4.992)	(-2.332)	(-2.106)	(-3.912)
LABOR	0.210	0.160	0.323	0.282
	(6.361)	(3.977)	(3.911)	(2.598)
SCHOOL_PRIMARY	0.046	0.051	0.053	0.016
	(2.007)	(2.015)	(0.719)	(0.155)
SCHOOL_SECONDARY	0.041	0.007	0.093	0.087
	(2.258)	(0.309)	(1.867)	(2.231)
SCHOOL_POSTSEC	-0.005	0.036	-0.109	-0.010
	(-0.157)	(0.848)	(-1.376)	(-0.215)
TRAINING	0.080	0.057	0.200	0.227
	(1.078)	(0.615)	(0.844)	(1.580)
EXPERIENCE	0.022	0.014	0.032	0.041
	(3.096)	(1.587)	(1.484)	(2.565)
EXPERIENCE^2/100	-0.058	-0.048	-0.065	-0.085
	(-4.058)	(-2.640)	(-1.516)	(-2.914)
LLF	-1416.23	-710.608	-320.041	-356.472
SSR	848.114	397.669	217.710	196.461
Adjusted R-squared	0.61614	0.57[illegible]	0.59712	0.54541
Mean Dependent Variable	7.26285	6.8[illegible]	7.35373	7.98832
St. Dev.	1.42960	1.[illegible]	1.59263	1.25358

Notes: t-statistics are in parentheses.

6.1 Factor Productivities

The estimated revenue function provides some insights into the behavior of factor productivity, particularly the marginal revenue products of factors. The derivative of the revenue function with respect to a right-hand side variable is the marginal revenue product of that variable. These derivatives will differ from observation to observation and thus we can determine their distribution separately for all firms, female-only firms, male-only firms, and mixed firms. The derivatives are the product of the (unknown) price and the marginal product of the factor. Despite the fact that the marginal products of these factors remain unobservable, some interesting related results can be obtained for the expected marginal revenue products.

The marginal revenue products can be thought of as shadow input prices. A profit maximizing firm in a competitive setting would attempt to equate the marginal cost of factors (prices) with corresponding marginal revenue products. The shadow price for a factor is deduced from the marginal revenue product as the amount the firm would be paying for the factor if the firm were being observed at a profit-maximizing equilibrium.[21]

For labor, expenses, and capital we can make some conjectures about the size of the marginal revenue products. For example, one might expect the marginal revenue product of labor in the informal sector to be less than the wage in the formal sector. With respect to expenses, we might expect the shadow price to be close to unity. Except for that part of current expenses going to purchase stock,[22] we would not expect any firm to spend one more inti on expenses unless it also expected to recoup it in revenues.

For aggregate capital the case is less clear. It is difficult to deduce dynamic effects from a static model. Nonetheless the marginal revenue product of capital, for example, can be thought of as the rate of return to having one more unit (inti) of, say, stock in the firm. This is over and above the price that a firm will get when it sells the unit currently in stock. Table 8 shows the measured marginal revenue products.

A feeling for the results can be obtained by considering the row of means. For the total sample of firms, the mean marginal revenue product for expenses is 1.170 intis and is slightly in excess of the value of one inti suggested above.[23] The mean rate of return to capital is 38.5 percent and the shadow wage for one hour of labor is .535 inti. Before considering comparative returns in different types of enterprises, it is useful to determine the extent to which the mean values are informative. Table 8 also shows the cumulative distribution (by decile) of the marginal revenue products for each factor and

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[21] A further restriction for these results to hold is that the marginal revenue product curve is downward sloping at the profit maximizing equilibrium. If this condition is violated then the firm is not maximizing profits.

[22] Unsold goods purchased with current expense money enter the inventories of firms. Our data set does not contain any information about inventory policies.

[23] As discussed earlier, these estimates are unbiased with respect to the expected revenue component.

Table 8. Distribution of marginal revenue products of Labor (L), Expenses (E) and Capital (K)

Type of firm	Total			Female			Male			Mixed		
Decile	L	E	K	L	E	K	L	E	K	L	E	K
1	.054	.490	.021	.057	.468	.019	.057	.492	.019	.049	.601	.096
2	.087	.638	.038	.088	.584	.037	.093	.629	.038	.079	.763	.037
3	.115	.751	.057	.116	.675	.062	.138	.713	.066	.101	.884	.050
4	.147	.860	.078	.150	.814	.132	.110	.817	.094	.125	.985	.060
5	.190	.992	.116	.200	.925	.232	.375	.957	.178	.147	1.091	.069
6	.245	1.127	.253	.263	1.067	.315	.321	1.067	.266	.185	1.204	.082
7	.322	1.300	.391	.360	1.266	.433	.415	1.225	.404	.226	1.352	.100
8	.456	1.536	.590	.498	1.494	.603	.645	1.470	.848	.306	1.614	.398
9	.916	1.945	1.069	1.188	1.882	1.010	1.601	1.765	1.367	.431	1.418	1.183
10	67.053	7.247	3.550	67.053	4.542	3.202	7.835	7.247	3.550	6.980	6.396	3.363
Mean	.535	1.170	.385	.646	1.096	.385	.632	1.154	.467	.249	1.327	.322
St. Dev.	2.253	.801	.568	3.000	.642	.488	1.152	.927	.676	.497	.944	.614
Obs.	1098	1098	1098	576	576	576	230	230	230	292	292	292

by each type of enterprise. It is clear that all of the distributions are highly skewed and that the mean value is typically not encountered until the seventh or eighth decile. Thus for policy purposes the mean is not an informative statistic. Moreover, before policy questions can be answered, it is necessary to determine which firms are in the tails of the distributions (high versus low returns at the margin), their characteristics, and the extent to which having a high (or low) return for one variable coincides with a high (low) return for another variable.

We analyzed the distribution of the marginal revenue products of capital, expenses, and labor for the four sample groups: (1) all firms, (2) female-only firms,(3) male-only firms, and (4) mixed firms. We also examined the relationship of the marginal revenue products of factors by firm to the levels of all productive factors. The results are presented in a set of 12 diagrams labelled C1, C2, C3, C4; E1, E2, E3, E4; and L1, L2, L3, L4. The letter refers to the productive factors, capital, expenses, and labor; the number refers to the relevant subgroups of firms above. Thus Diagram L2 shows the marginal revenue product of labor for women-only firms.

In a representative diagram the information is: In diagram C1, the relevant sample is all firms, ordered from largest to smallest according to the size of the estimated marginal revenue product of the relevant factor (in this case, capital). Thus the firm with the largest marginal revenue product of capital becomes the first firm and the firm with the smallest marginal revenue product becomes the 1,098th firm. The marginal revenue product of capital is

DIAGRAM C1

MARGINAL REVENUE PRODUCT OF CAPITAL SAMPLE VALUES: ALL ENTERPRISES

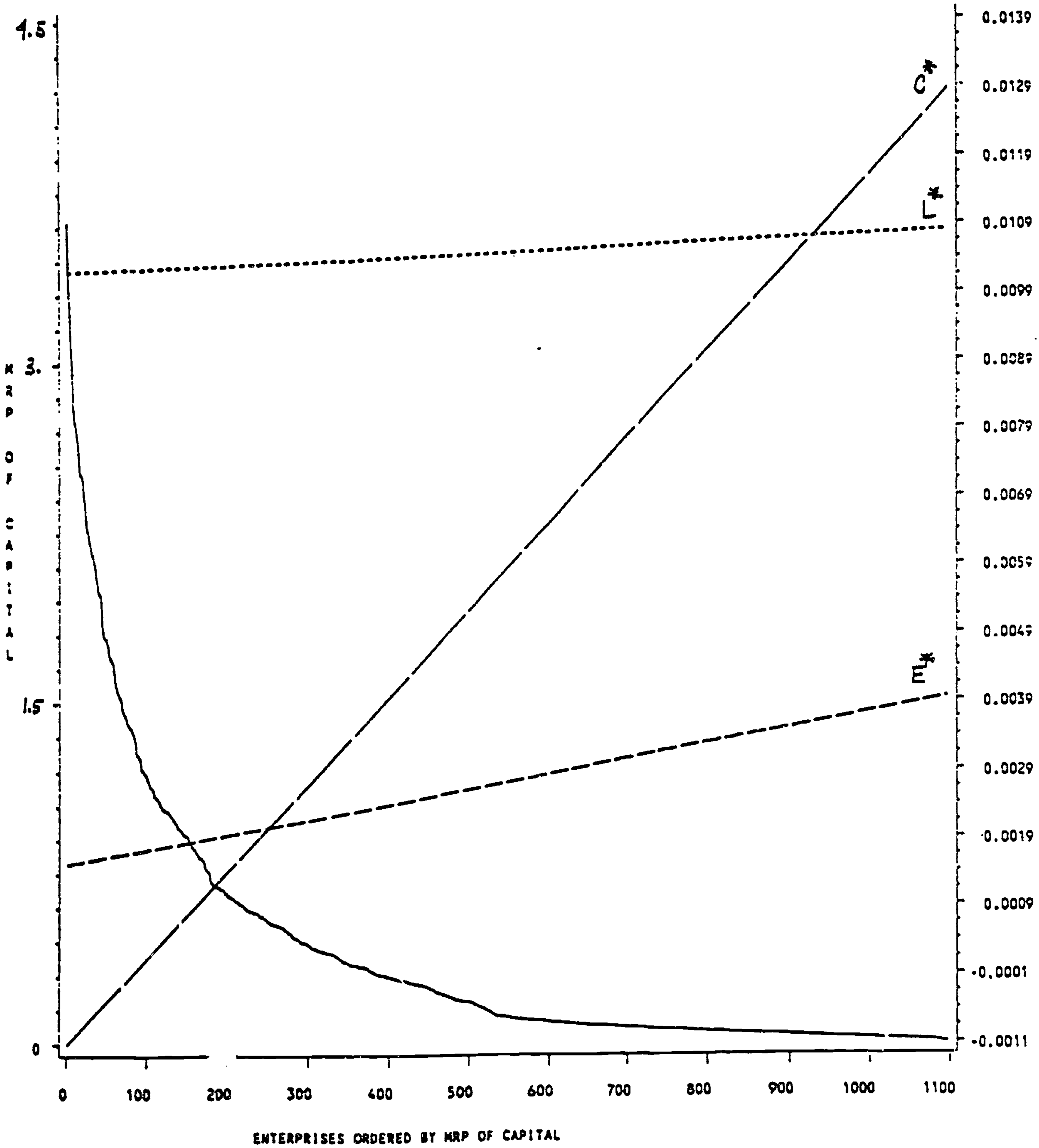


DIAGRAM C2

MARGINAL REVENUE PRODUCT OF CAPITAL SAMPLE VALUES: FEMALE ENTERPRISES

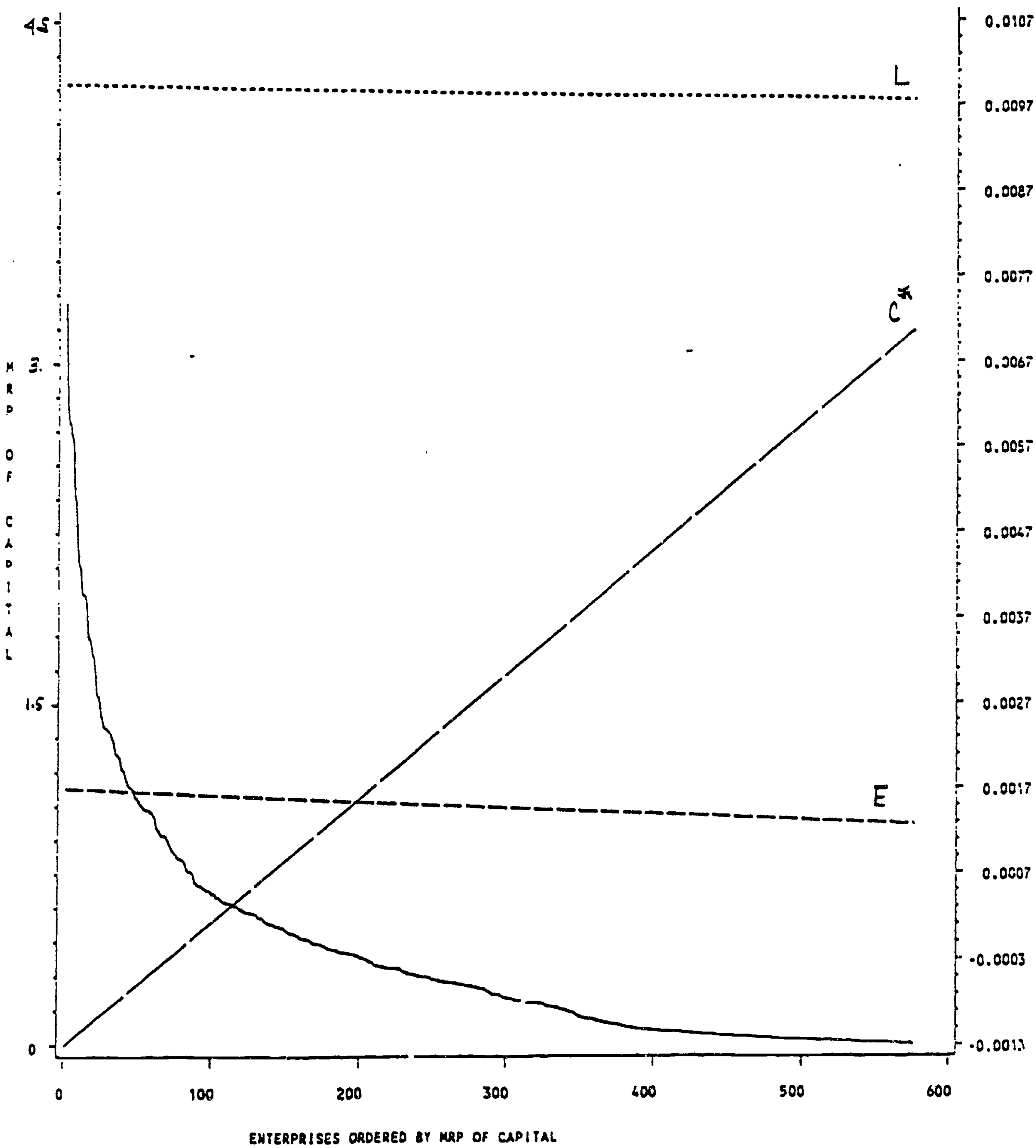


DIAGRAM C3

MARGINAL REVENUE PRODUCT OF CAPITAL SAMPLE VALUES: MALE ENTERPRISES

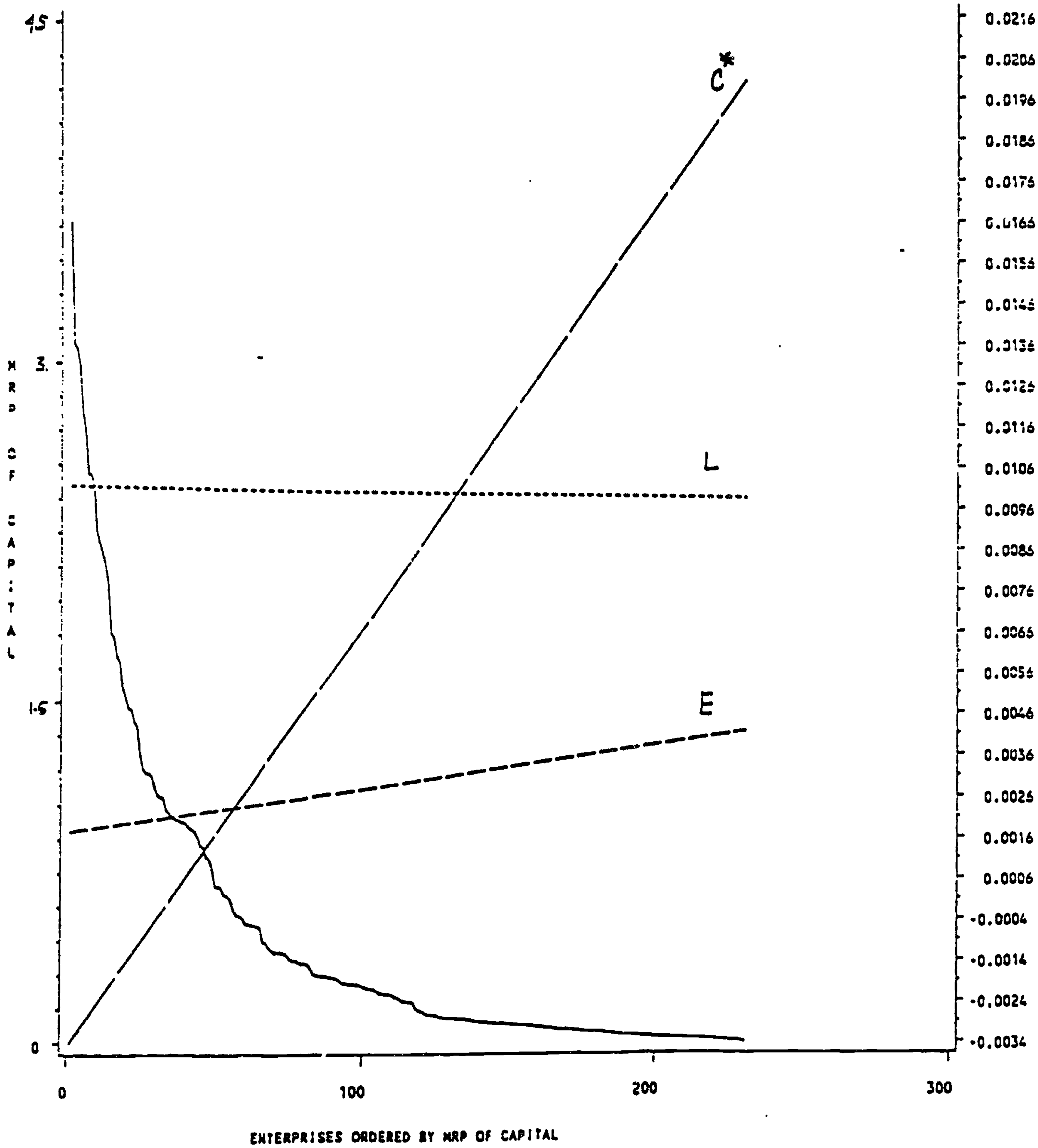


DIAGRAM C4

MARGINAL REVENUE PRODUCT OF CAPITAL SAMPLE VALUES: MIXED ENTERPRISES

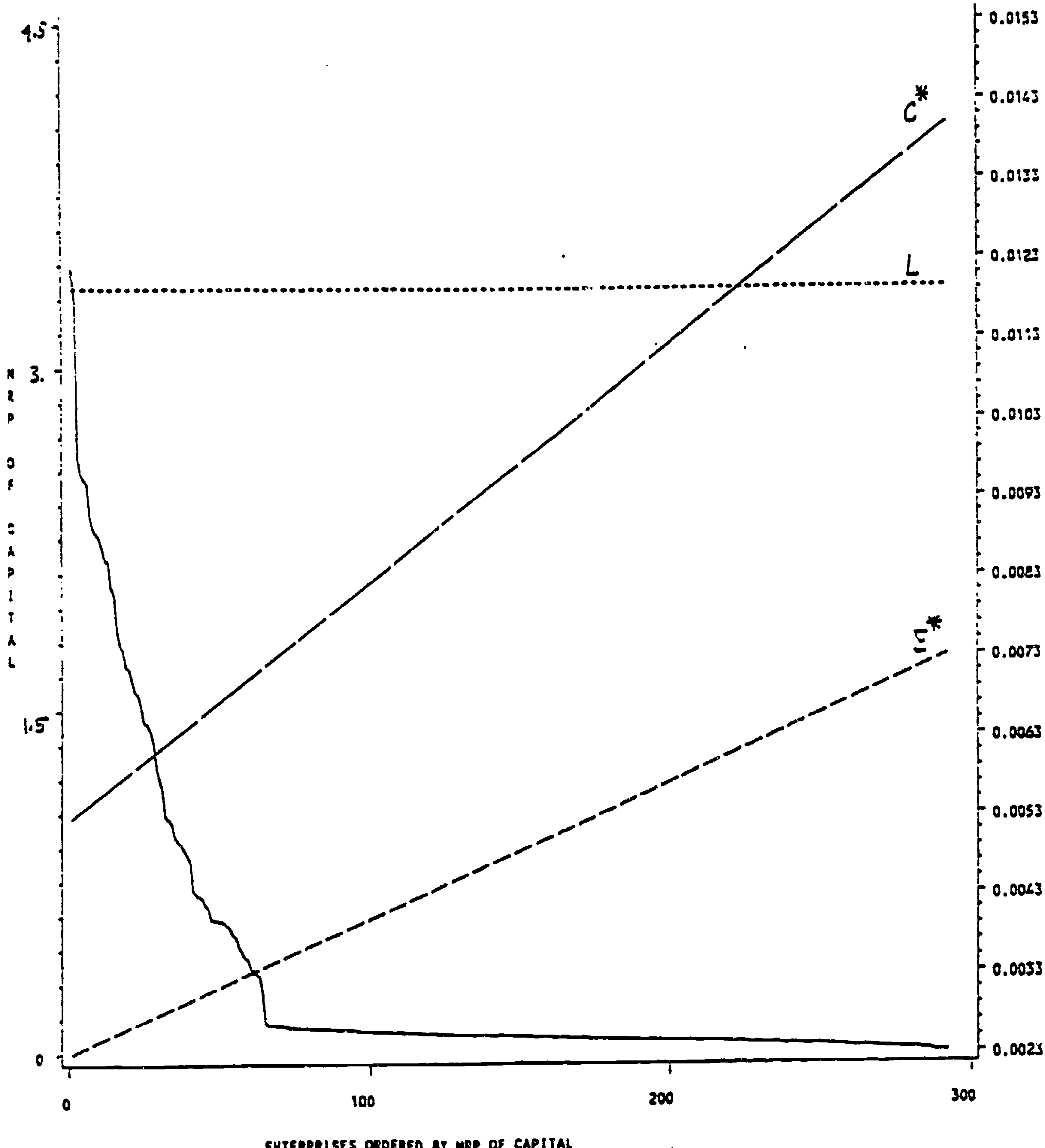


DIAGRAM E1

MARGINAL REVENUE PRODUCT OF EXPENSES
SAMPLE VALUES: ALL ENTERPRISES

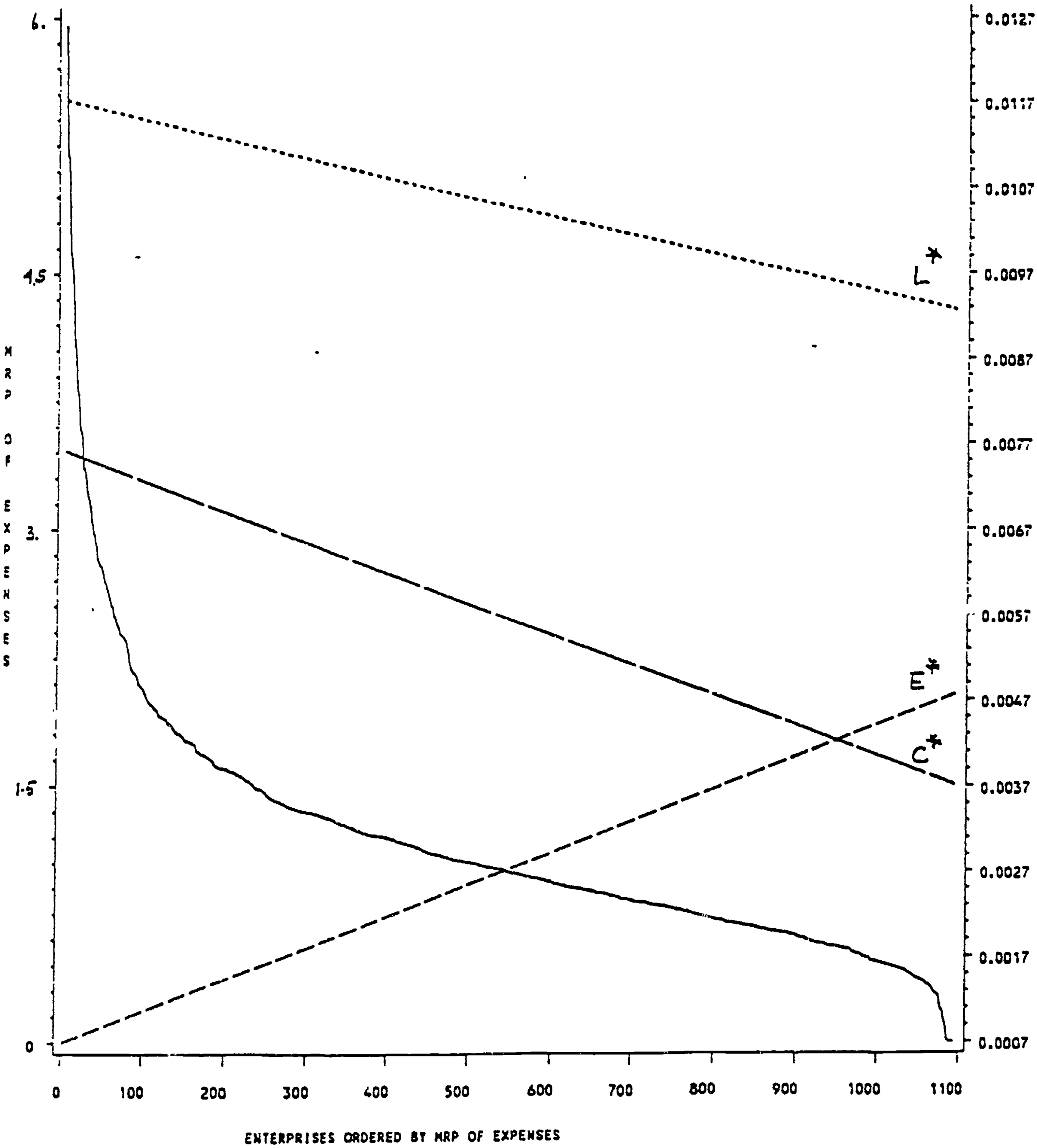


DIAGRAM E2

MARGINAL REVENUE PRODUCT OF EXPENSES SAMPLE VALUES: FEMALE ENTERPRISES

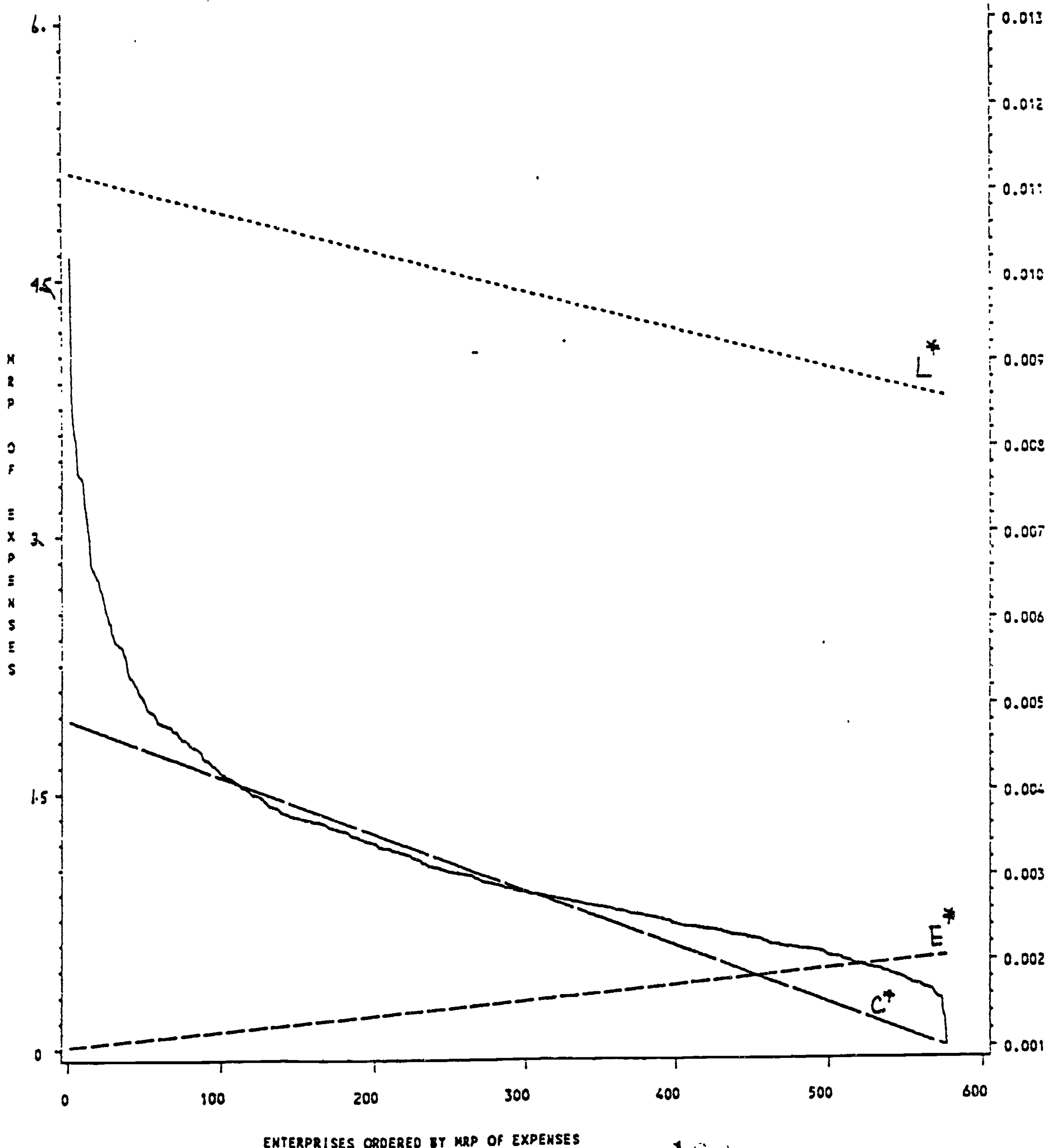


DIAGRAM E3

MARGINAL REVENUE PRODUCT OF EXPENSES SAMPLE VALUES: MALE ENTERPRISES

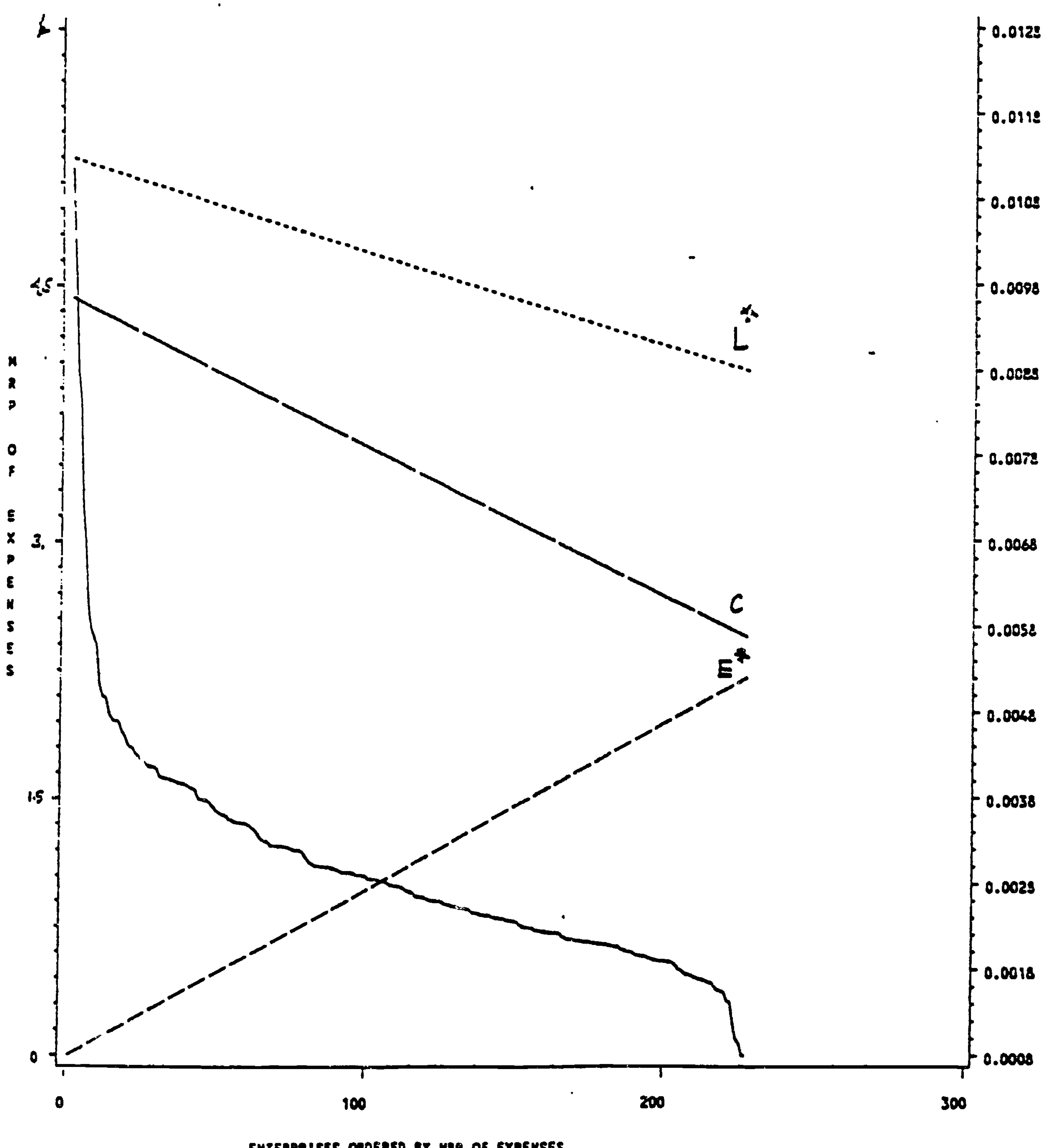


DIAGRAM E4

MARGINAL REVENUE PRODUCT OF EXPENSES SAMPLE VALUES: MIXED ENTERPRISES

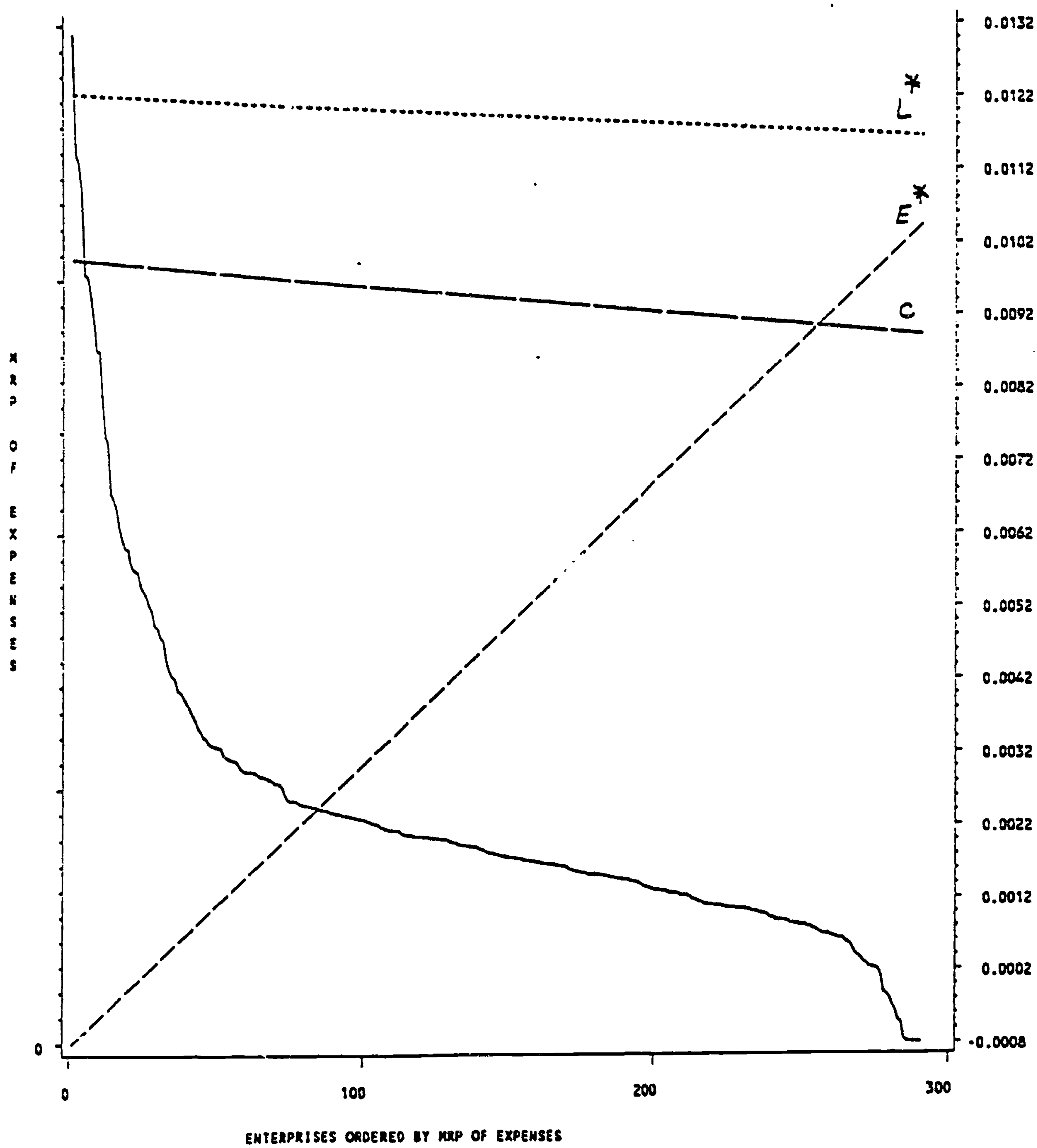


DIAGRAM L1

MARGINAL REVENUE PRODUCT OF LABOUR SAMPLE VALUES: ALL ENTERPRISES

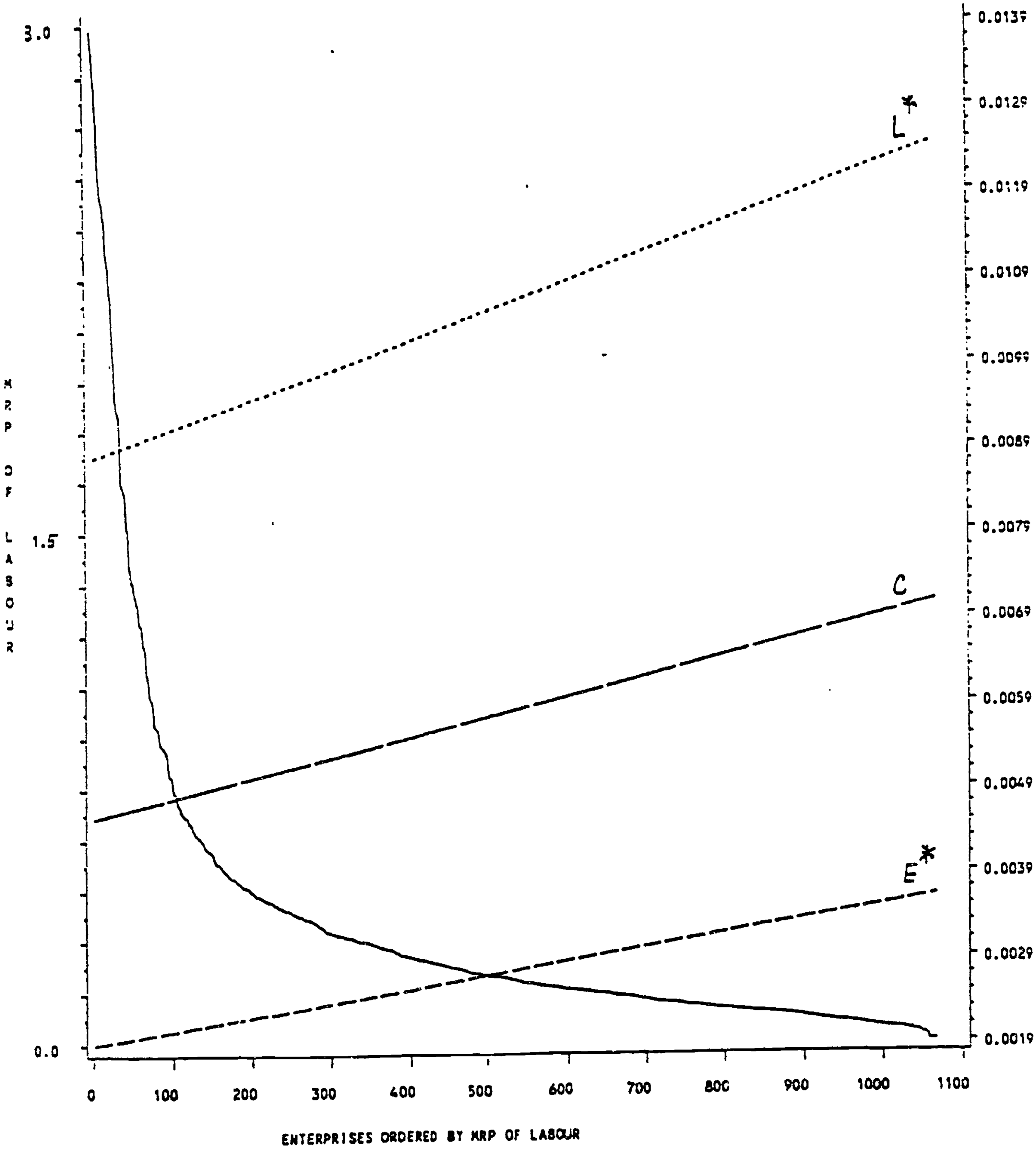


DIAGRAM L2

MARGINAL REVENUE PRODUCT OF LABOUR SAMPLE VALUES: FEMALE ENTERPRISES

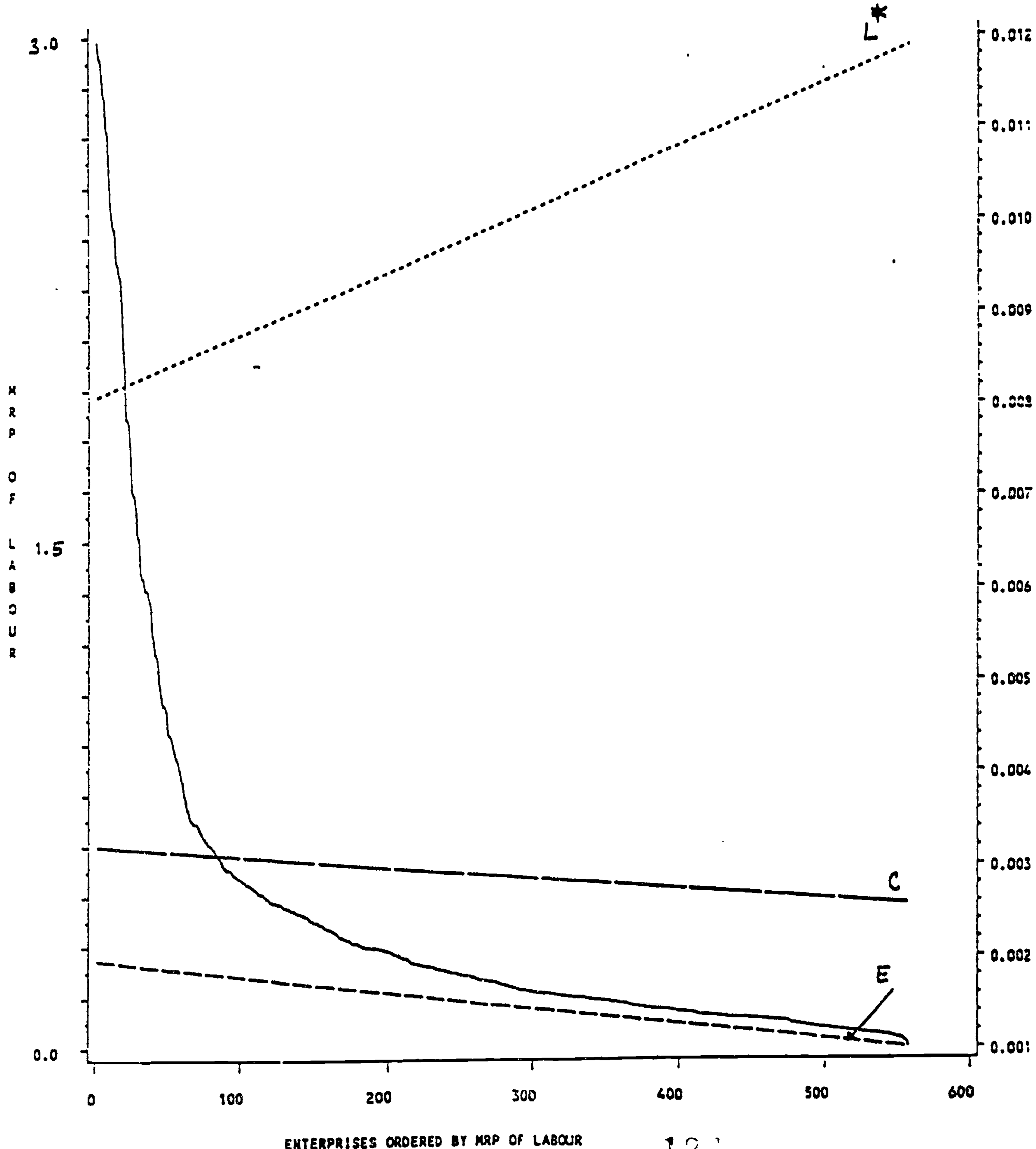


DIAGRAM L3

MARGINAL REVENUE PRODUCT OF LABOUR SAMPLE VALUES: MALE ENTERPRISES

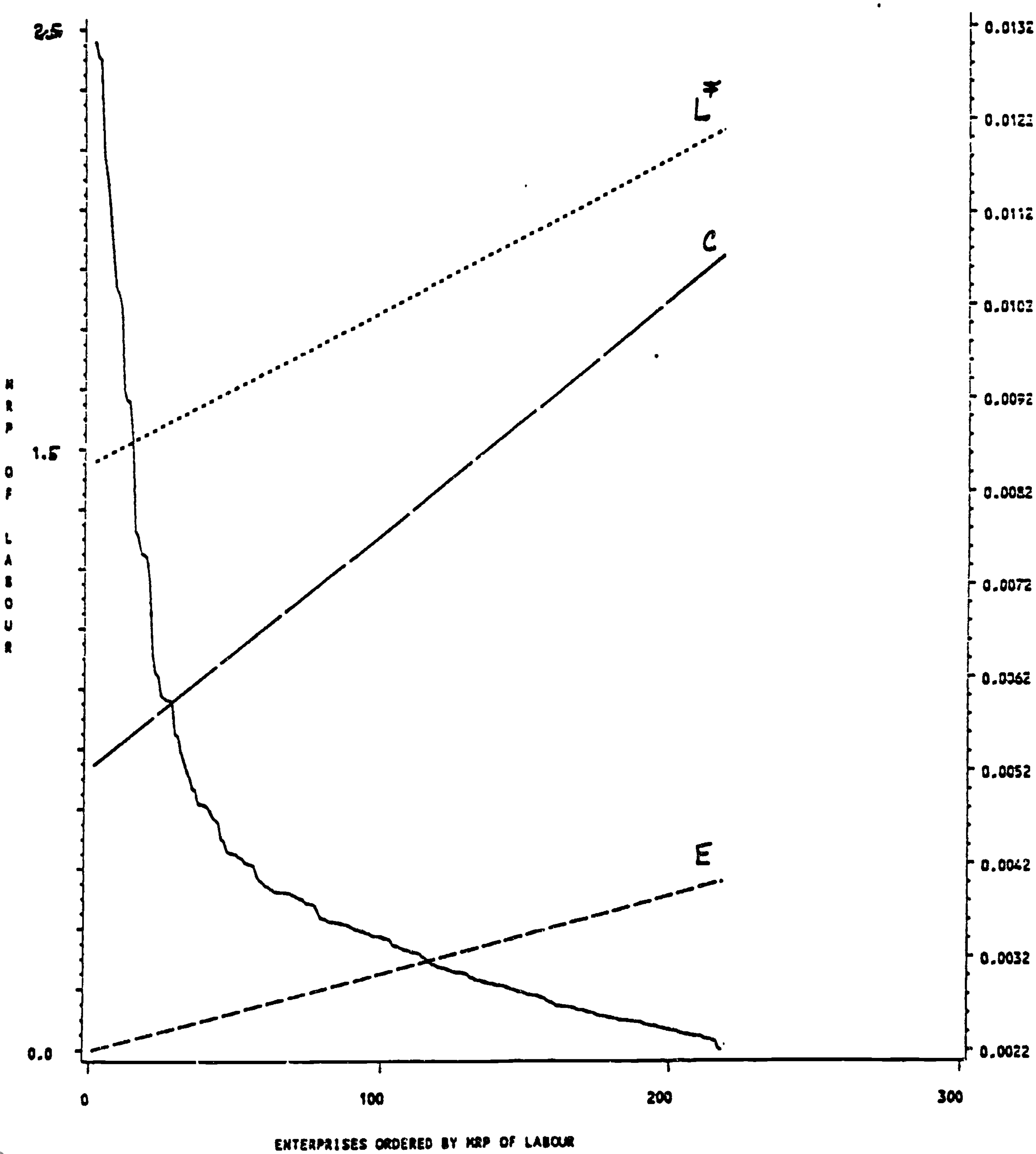
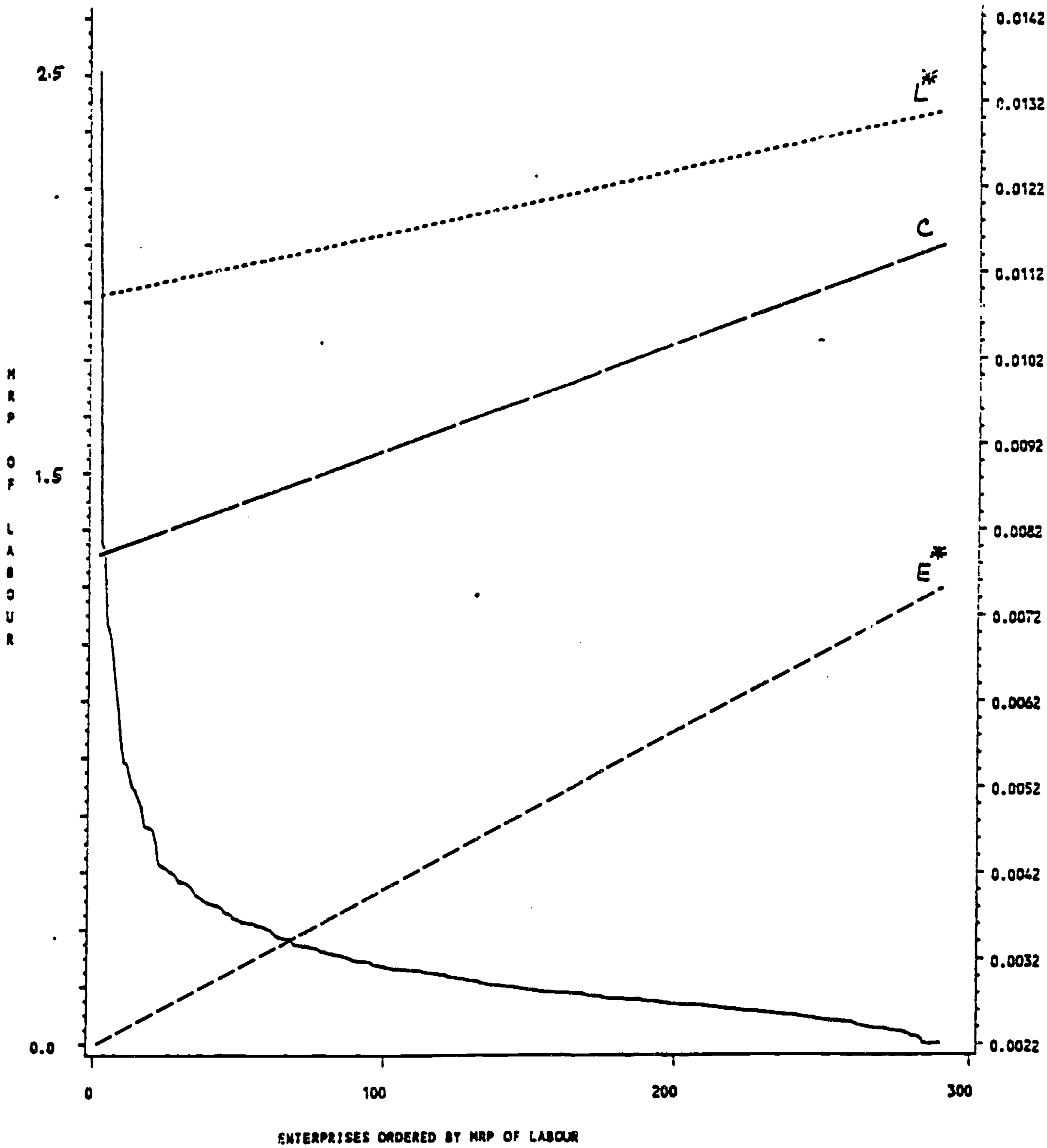


DIAGRAM L4

MARGINAL REVENUE PRODUCT OF LABOUR SAMPLE VALUES: MIXED ENTERPRISES



measured on the left-hand vertical axis and, by construction, the plotted values of the marginal revenue product of capital will decrease as higher-numbered firms are encountered. The median firm is the 549th and for this firm the marginal revenue product is about .15 inti. Notice how quickly the marginal revenue product of capital by firm declines as we consider the first 200 firms.

Next consider the relationship of the marginal revenue products to the levels of the productive factors. Capital, expenses, and labor variables are all measured on the right-hand vertical axis. The variables were scaled to all fit on these axes. The lines C, E and L represent the lea squares regression lines of the capital, expenses, and labor variables respectively of firm i on the rank (1 to 1,098) of firm i. The rank of a firm continues to be determined by the size of its marginal revenue product. An asterisk in the label of a regression line indicates that the slope of the regression line is significantly different from zero.

These regression lines provide a considerable amount of additional information that explains the distributions of the marginal revenue products. In diagram C1 we see that firms with high marginal revenue products of capital also had significantly lower endowments of capital. They also tended to have significantly lower quantities of expenses and labor. Extending the analysis to capital input for female enterprises (diagram C2), we see that firms with high marginal revenue products of capital had significantly lower endowments of capital. There is, however, no significant relationship between the distribution of the marginal revenue products and either expenses or labor.

Two patterns can be isolated in the marginal revenue product diagrams. First, for all groups of firms and for all productive factors there is a significant relationship between the marginal revenue product of a factor and the amount of the factor. Firms with smaller amounts of a given factor tend to have higher marginal revenue products for the factor. Second, in about 75 percent of the cases where a significant relationship exists, there is an inverse relationship between the marginal revenue product of one factor and the quantities of the other factors. This suggests that small firms are the most productive in terms of measured marginal revenue products.

These results have important implications for the competitive structure of the informal urban retail sector. The sector's rapid growth may well signal a greater degree of competitiveness in retail trade, and large incumbent firms may be feeling the pressure of both inefficient size and falling (real) prices. Leaner and more aggressive small firms appear to be making significant inroads. Some supporting evidence for this view comes from examining the location structure of firms in the upper and lower 20 percent tails. Firms with low returns to labor and capital are much more likely to operate out of homes and fixed locations while those with high returns are mobile. For the capital variable, firms in the upper tail are twice as likely to be mobile as firms in the lower tail. And female-only firms tend to have lower capital, labor, and expenses than male-only and mixed firms. It appears that women are good candidates for the high rates of return obtained by smaller firms. It may be however, that these returns at the margin can be further increased. Female firms may be operating where marginal revenue product curves have a positive slope. In this case, growth would tend to make these firms even more productive.

6.2 Nonparametric Evidence

These estimates are based on parametric methods. The results below are based on a nonparametric approach (described in appendix B). That estimates marginal revenue products and revenue without having to specify (parametric) model. In the nonparametric analysis all the variables appearing in the parametric model were included except dummy variables. Since the nonparametric technique is robust to data transformations, the capital and expenses variables were not transformed as splines. Graphs B1 to B6 show that the order of magnitude and the direction of the estimates from the two approaches are consistent. These results support the validity of the parametric specification.

Diagrams B1 and B2 show plots of the fitted values of the dependent variable against the sample values. The parametric model (B1) on average does not over- or underestimate. The nonparametric model (B2) tends to overestimate for smaller values of the dependent variable and underestimate for larger values. Initially the cloud of points lies mostly on the 45-degree line and then drops below it. The mean value of the dependent variable is about 7.2.

A plot of the residuals from the two models (B3) shows that they also move in the same direction. The residuals are plotted as pairs for the same enterprise. Positive (negative) errors in the parametric model coincided with positive (negative) errors in the nonparametric model. This suggests that the approaches estimated similar relationships.

Diagrams B4, B5, and B6 show plots, by enterprise, of marginal revenue products from the two models. Using the 45-degree line as a reference point, the marginal revenue product of expenses tends to be higher in the parametric model, while those of labor tend to be lower. The marginal revenue product for capital in the nonparametric model is initially greater and then smaller than those in the parametric model.

These findings come from a first application of the nonparametric technique. Nonetheless we conclude that the directions and orders of magnitudes of the parametric model estimates are supported.

DIAGRAM B1
PARAMETRIC FIT

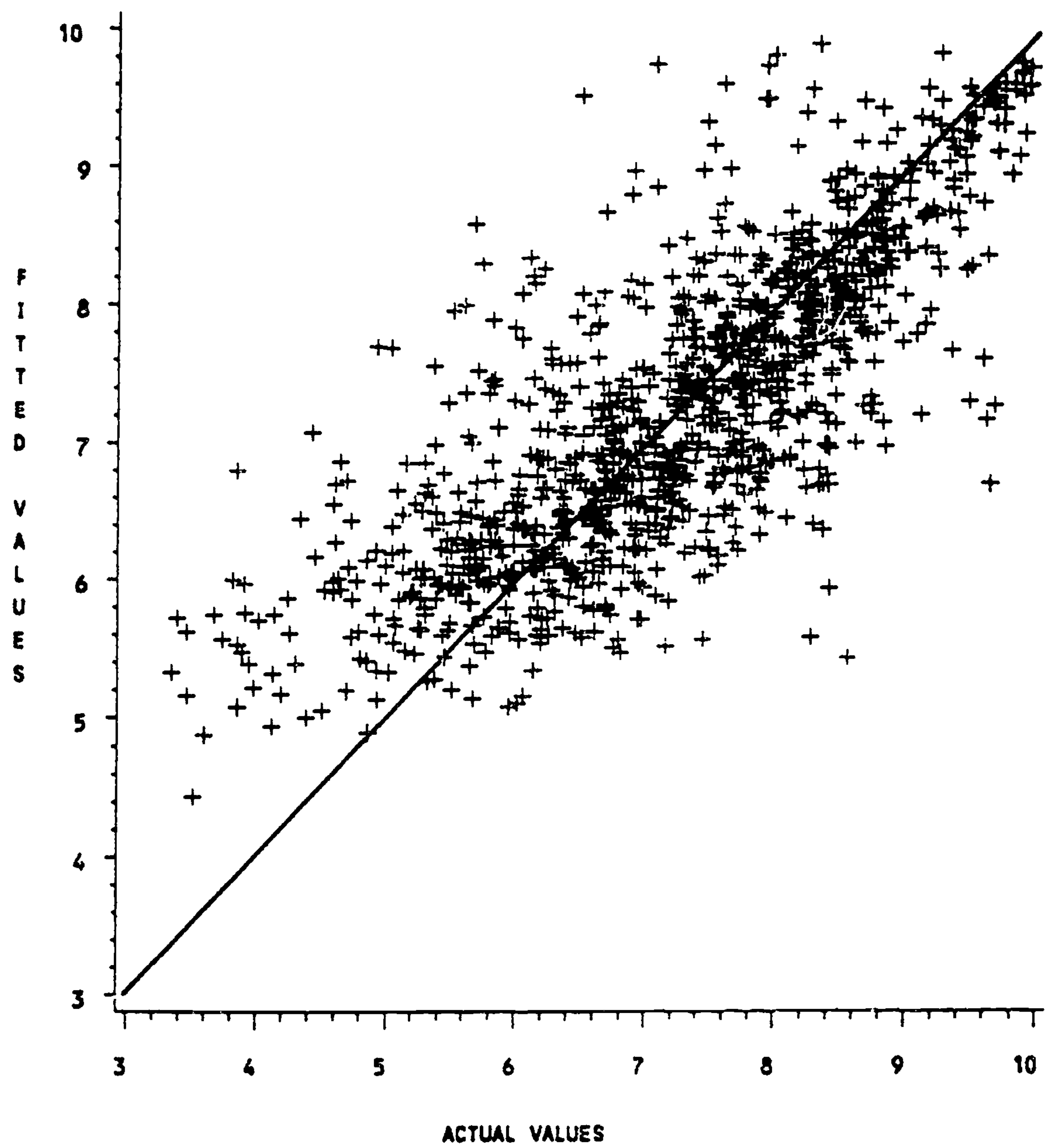


DIAGRAM B2
NONPARAMETRIC FIT

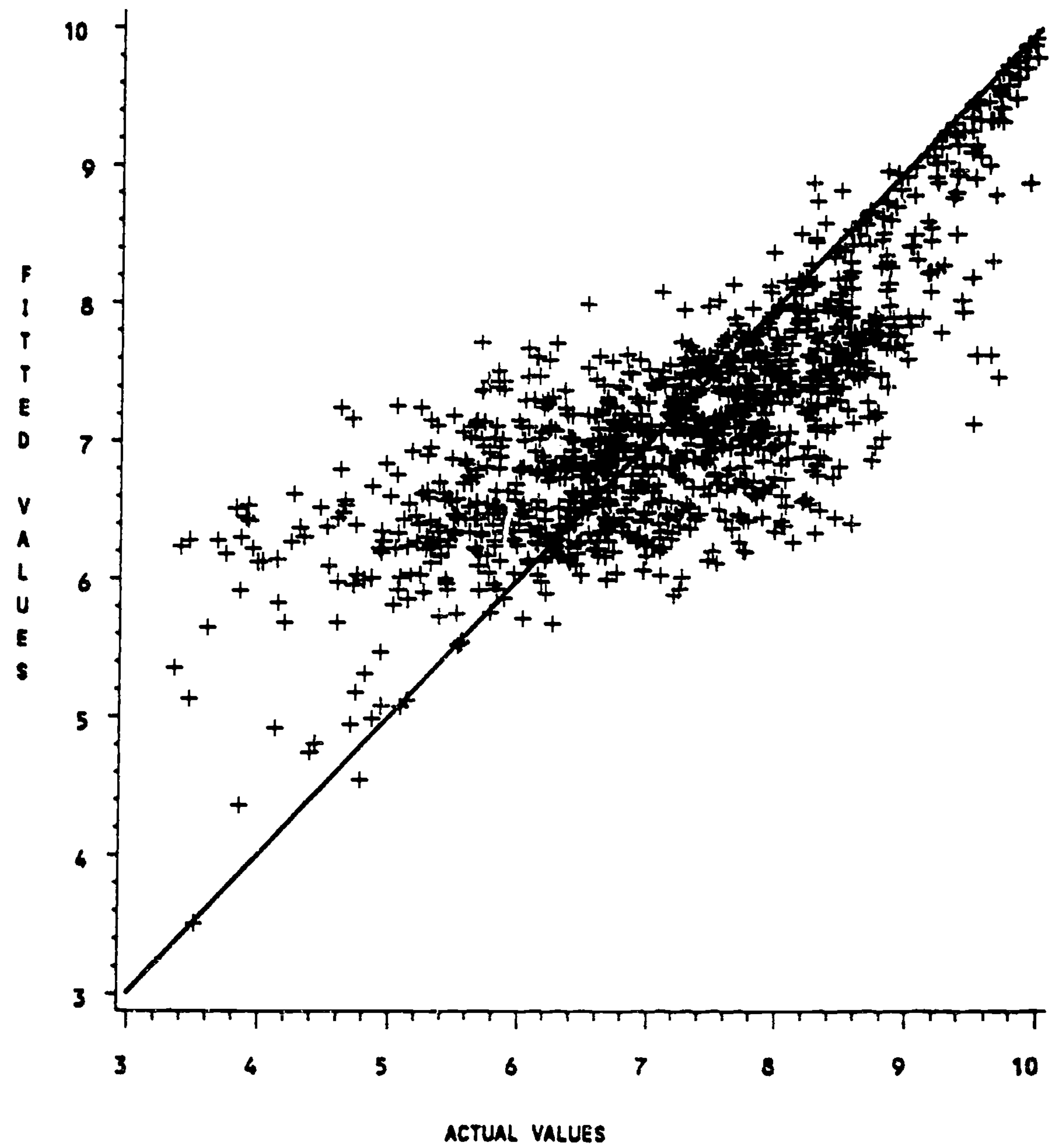


DIAGRAM B3

COMPARISON OF MODELS
RESIDUALS

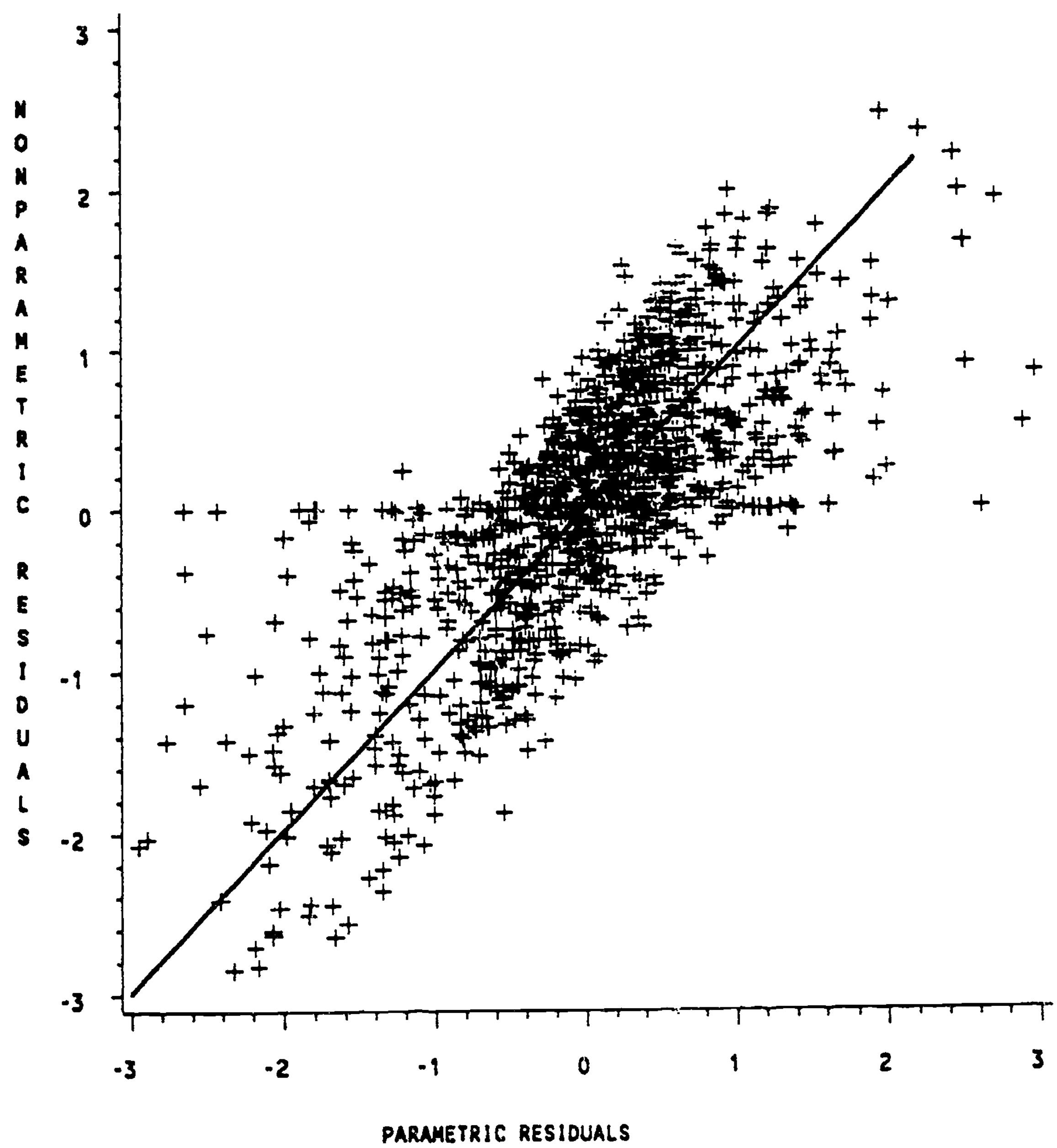


DIAGRAM B4
COMPARISON OF MODELS
EXPENSE MARGINAL PRODUCTS

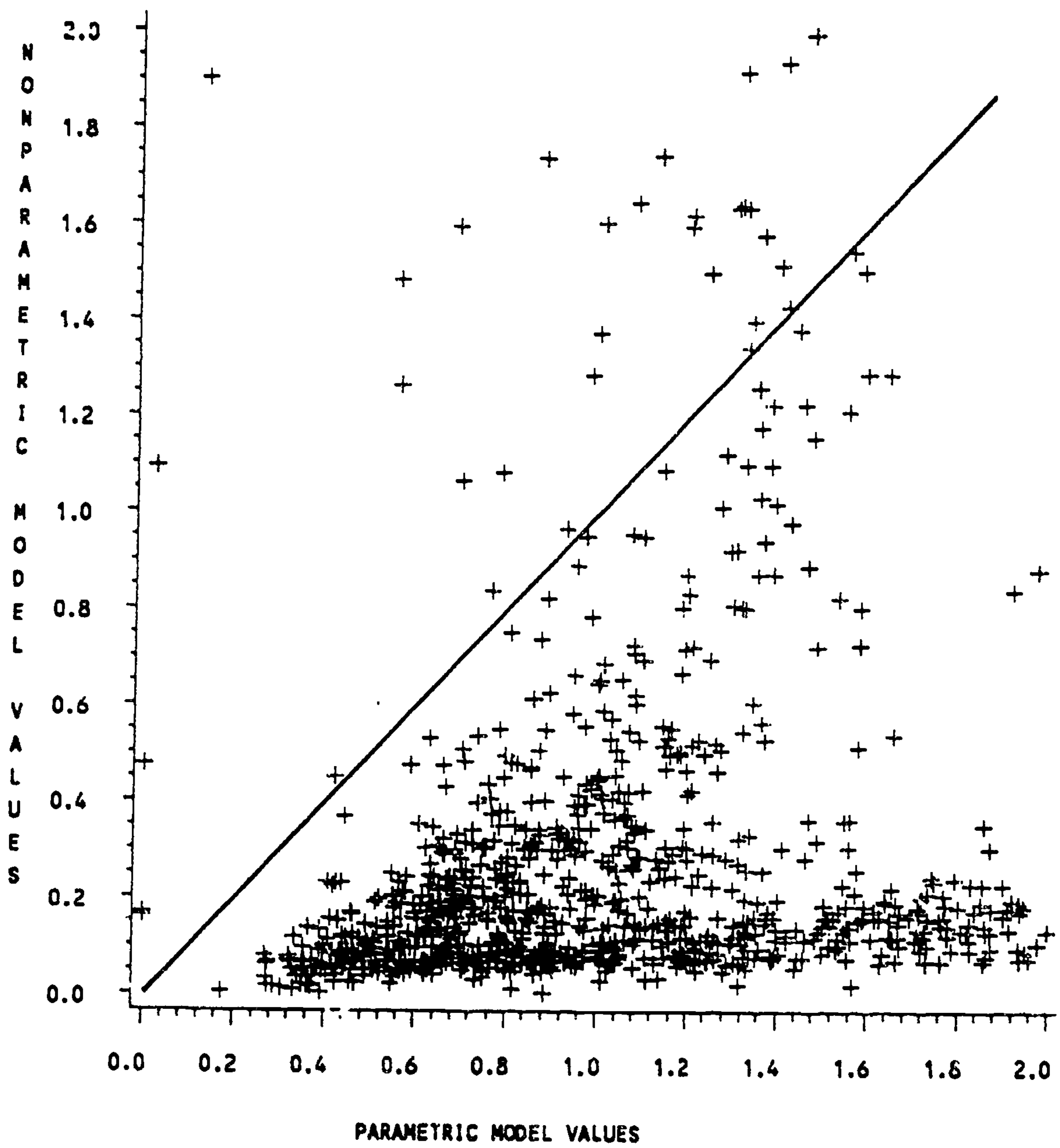


DIAGRAM B5
COMPARISON OF MODELS
LABOUR MARGINAL PRODUCTS

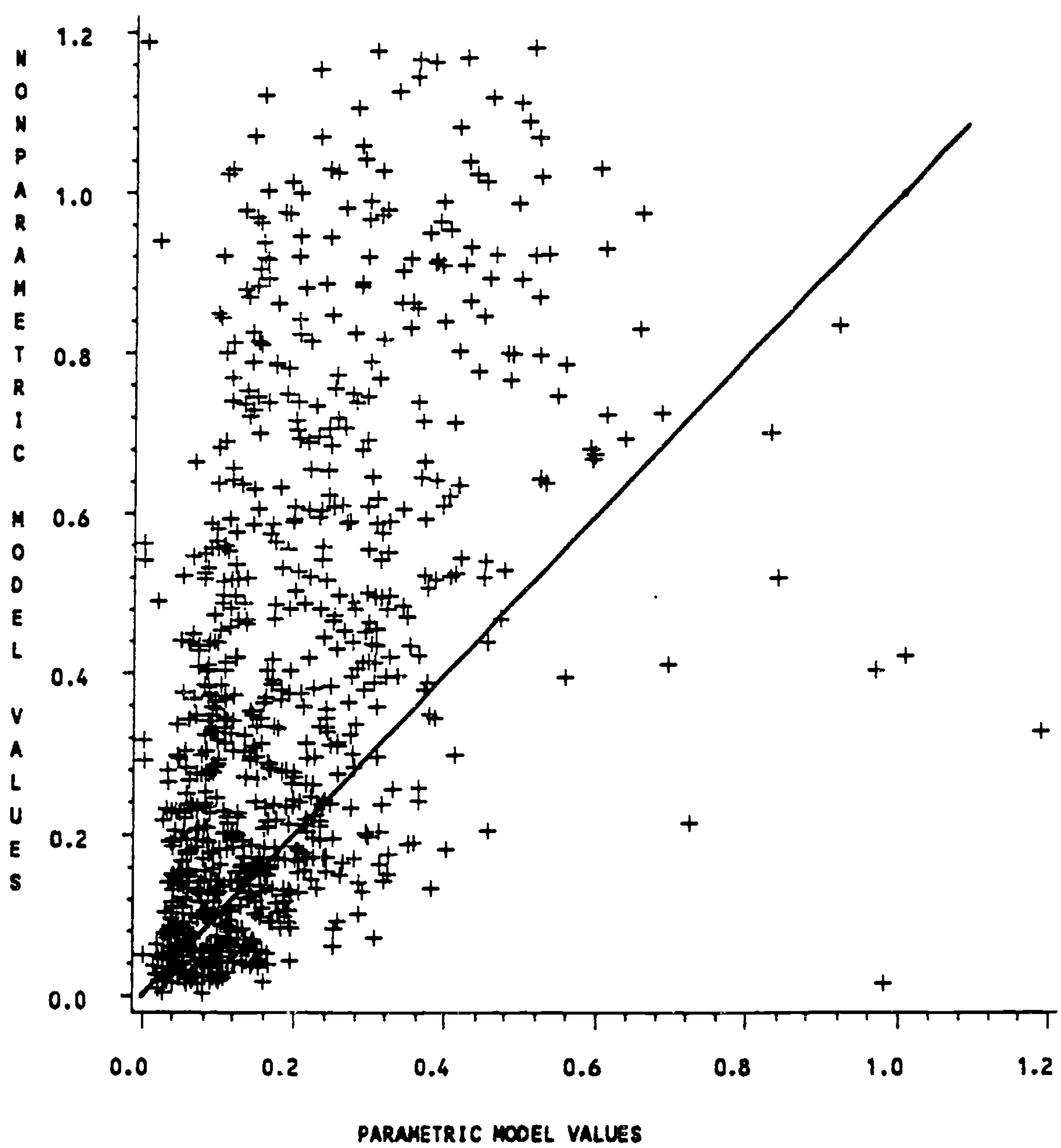
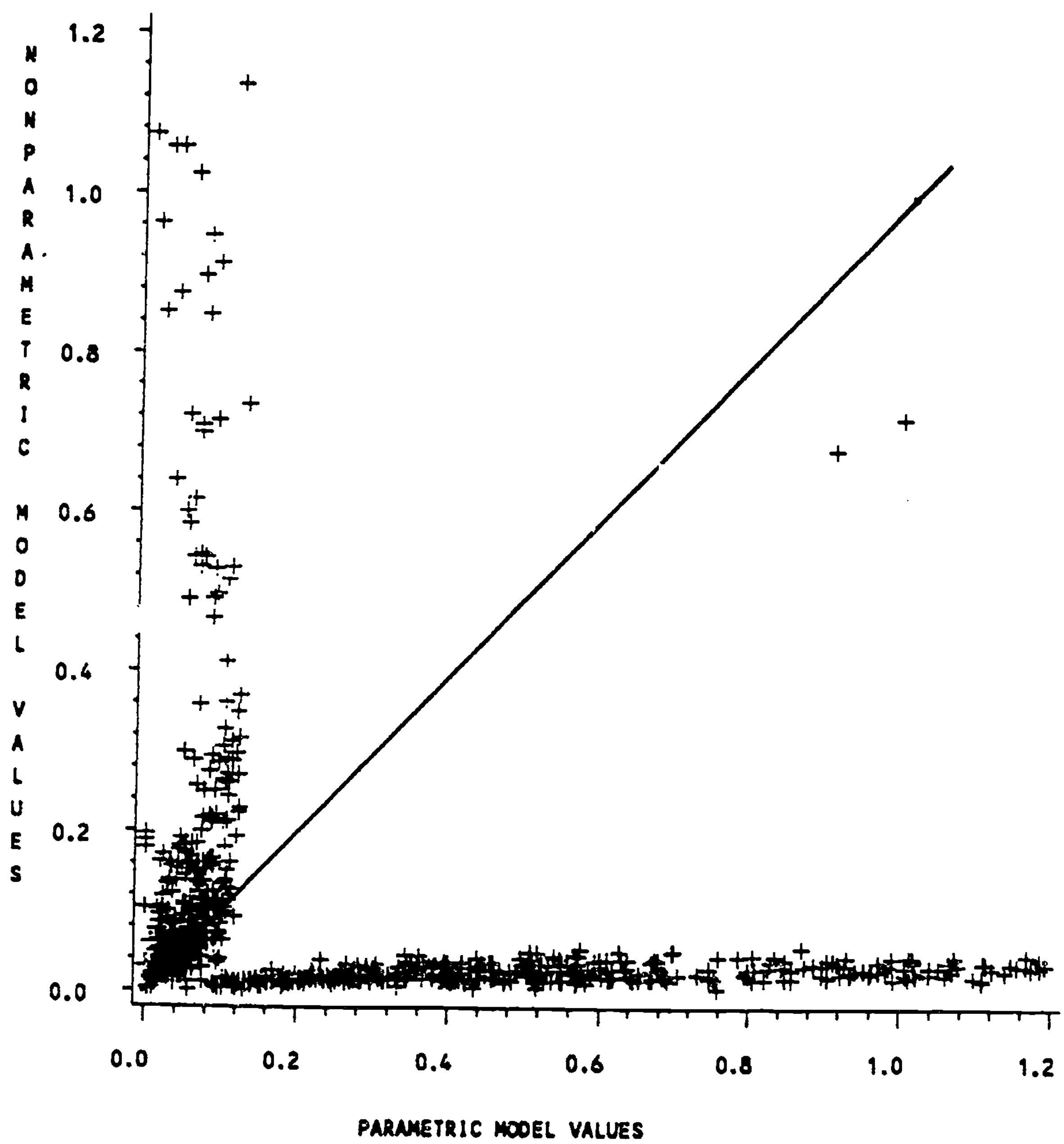


DIAGRAM B6
COMPARISON OF MODELS
CAPITAL MARGINAL PRODUCTS



6.3 Simulation Experiments

The estimated revenue model can address a variety of other questions. For example, it can assess the impact of policies that affect the amount, quality, and distribution of productive factors such as loans (either unrestricted or factor-specific) to a given subgroup. Evaluating such a credit policy would involve estimating the effects on expected revenues and determining the payback period for the loan. Policymakers can also assess the revenue impact of social policies that raise education levels or allow family members to substitute work in the family business for housework (perhaps through child care programs).

Table 9 shows the effects on expected revenues, averaged over firms, of seven different policy experiments. The first four experiments are "simple" in that only one underlying variable is changed. The other four experiments are 'compound' in that more than one variable changes. For example, in the first experiment, the most educated individual in the firm is given two more years of schooling if the number of years of schooling is less than nine. The group of firms receiving this education changes from all firms, to the bottom 50 percent (in terms of education), and then to the bottom 25 percent (in terms of education) and finally, for comparison purposes, to the top 25 percent. Within each group, the effects on all, female firms, male firms, and mixed firms are calculated separately. The effect of formal schooling on revenues is 100 to 200 intis a month.

The second simulation increases the amount of labor by 100 hours a month. This could be accomplished by policies that reduce the costs of noncompliance, encourage bulk purchasing by cooperatives, and offer management training. The time devoted to business activities by women could be increased by providing cooperative child care and facilities for meals. This experiment suggests that revenues will increase by a respectable 200 to 300 intis a month, especially among firms in the bottom 50 and 25 percent (in terms of labor).

The third simulation lends 1,000 intis to selected firms for operating expenses. The results are impressive. If all firms receive the loan, on average they will be able to repay the loan, retaining 79 intis as net profit for the month. Alternatively, because they are more productive when only the lowest quartile (in terms of expenses) receive the loans the average net profit is 409 intis. The small number (40 firms) of mixed enterprises in this quartile would be the most successful, with an average net profit of 1,285 intis for the month, compared to 176 intis for the 163 female businesses, and 449 intis for the 71 male firms.

When interpreting the fourth experiment, (each firm receives 1,000 intis for capital expansion), the fact that the average return is less than 1,000 intis does not mean the policies are not successful. The funds would be used to acquire capital that would not completely depreciate in a month. In fact, the ratio of 1,000 intis to the average monthly increase in revenues is the average payback period for the loan in months assuming zero economic depreciation. For example, all enterprises would take just over three months (1,000/314) on average to repay the loan. It should be noted, however, that firms with low capital endowments, mostly female firms, tend to perform better than those with high endowments. Two-thirds of the firms in the lowest quartile are female businesses,

Table 9. Simulation results - effects on revenues

Increase in	By	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
Years of schooling			2		.		.		.		.		.		2
Monthly hours			.		100		.		.		.		100		100
Expenses	$		.		.		1000		.		500		500		500
Total capital	$		.		.		.		1000		500		500		500
		Nobs	$	Nobs	$	Nobs	$	Nobs	$	Nobs	$	Nobs	$	Nobs	$
Given to all firms															
All enterprises		1098	103	1098	187	1098	1079	1098	314	1098	843	1098	1100	1098	1245
Female enterprises		576	97	576	182	576	988	576	323	576	828	576	1101	576	1250
Male enterprises		230	112	230	237	230	1136	230	399	230	907	230	1255	230	1377
Mixed enterprises		292	109	292	157	292	1213	292	231	292	820	292	1001	292	1130
Given to bottom 50 % of firms															
All enterprises		528	157	546	239	549	1279	549	578	755	872	845	1001	926	1039
Female enterprises		343	126	366	218	361	1102	358	495	471	810	514	977	538	1057
Male enterprises		100	175	127	299	111	1394	125	690	165	908	195	1030	209	1074
Mixed enterprises		85	260	53	243	77	1944	66	816	119	1070	136	1052	179	943
Given to bottom 25 % of firms															
All enterprises		242	144	274	284	274	1409	274	641	446	669	541	737	637	695
Female enterprises		180	119	197	257	163	1176	182	588	281	567	347	650	411	615
Male enterprises		40	199	67	363	71	1449	72	671	109	729	131	843	145	832
Mixed enterprises		22	248	10	267	40	2285	20	1011	56	1068	63	998	81	853
Given to top 25 % of firms															
All enterprises		146	42	274	115	274	978	274	58	421	334	522	330	577	309
Female enterprises		47	32	75	104	81	973	82	49	138	296	181	270	210	239
Male enterprises		36	40	27	114	61	988	59	58	96	328	108	321	121	299
Mixed enterprises		63	50	172	120	132	975	133	64	187	364	233	382	246	374

Notes: The bottom 50% refers to those firms that have less than the median value of the variables) of interest for all firms. For example, if $1000 of expenses is provided, then only those firms with less than the median value of expenses ($806) receive the $1000. The same applies to the bottom 25% and the top 25%. The median and quartile values are:

		Median	Bottom 25%	Top 25%
Years of Schooling		7.0	4.0	10.0
Monthly Hours		234.0	113.6	386.3
Expenses	$	805.6	247.2	2478.3
Total Capital	$	967.7	170.5	4337.8

with an estimated payback period of less than two months (1,000/588). The payback period for firms in the top quartile is about 18 months (1,000/58).

The remaining "compound" experiments (five, six, and seven) largely confirm the 'simple' ones. The effects on predicted revenues of firms with lower endowments of expenses, capital, and labor are generally higher than the effects on the better-endowed firms.

Finally, in comparing the simulated increases in revenues it is important to examine more than just the average increases. There are distributions associated with these point estimates. Standard statistical testing shows few significant differences among the three types of firms, but this was not the case among firms in different quartiles.

The simulation results in Table 9 are quite similar to those obtained in the analysis of factor productivity discussed earlier. These results are very helpful in terms of quantifying the effects of policies for the informal sector.

It appears a policy of loans to poorly endowed firms, most of which are female businesses, could offer significant social gains.

7. Policy Implications

The extent to which estimated productivity differs among male, female, and mixed firms appears to be due more to the distribution of factors across enterprises than to any inherent advantage or disadvantage in the type of firm. On average, the productivity of female firms is neither better nor worse than that of male or mixed firms with the same factor endowments (capital, expenses, and labor). The influence of these endowments, however, affects productivity more than the gender or education of the entrepreneurs. Firms with smaller endowments tended to have higher factor productivity. Thus the process of retailing is the same among firms, but the endowment effect makes them different. Put another way, firms with less capital, expenses, or labor usually have higher returns at the margin but typically lower revenues. As seen in Table 3 or Table 9, a high proportion of female firms, but a much smaller proportion of male and mixed firms, have low amounts of capital, expenses, and labor. In our sample, about one-fourth of the businesses had little or no capital and about one-third carried no inventories, of which, most of these were female firms. The empirical analysis suggests that proactive policies would increase substantially the productivity of small businesses. Providing assistance to small businesses makes good economic sense, particularly if directed to those with low factor endowments.

The ultimate objective of policy measures is to alleviate poverty and improve household welfare. Improving productivity in the informal sector helps to achieve this goal. While we do not elaborate on implementation, two directions will be effective. First enterprise-specific policies that directly affect productivity, and second, sets of policies aimed at women that address the competing demands on their time.

7.1 Enterprise-Specific Policies

Governments and international donors have primarily assisted small businesses by providing low-cost credit to firms that do not have access to formal financial markets. Loans are small, being usually less than $500, but there are many beneficiaries. Results have been good and the repayment rate often exceeds 90 percent. Our estimates of productivity confirm that channeling credit to small businesses is effective in raising productivity. Examples of different credit programs include the Grameen Bank in Bangladesh, the Self-Employed Women's Association in India, the Banco Popular in Costa Rica, the Badan Kredit Kecamatan in Indonesia, the Northeast Union of Assistance to Small Businesses in Brazil, the Institute for the Development of the Informal Sector in Peru, Fondo de Fomento para la Pequena Industria y la Artesania in Ecuador, and the Small Projects Program of the Inter-American Development Bank.[24]

[24] See Cornia (1987), Everett and Savara (1986), Herz (1989), Hossain (1987), IDB (1988), Tendler (1983), United Nations (1985), and World Bank (1989).

Another way to help small businesses is by promoting cooperatives and self-help associations. In addition to providing credit these organizations can make bulk purchases from wholesalers, provide storage facilities for perishable or nonperishable commodities, and establish markets for entrepreneurs (see Bunster and Chaney 1985, de Soto 1989).

Technical assistance programs are a third option, offering short-term instruction in basic management, including keeping records, marketing, purchasing, and dealing with municipal authorities and other formal sector institutions. Inter-American Development Bank (1988a) notes that instruction can be provided informally at neighborhood markets or at the business site.

Most family businesses in Peru are operations that generally avoid complying with regulations. The performance of these businesses could be improved by reducing the costs of noncompliance. This would mean eliminating various forms of harassment by local authorities, and simplifying the process of conforming to the laws (for example, by making it easier and less costly to obtain a business license).[25]

7.2 Women-Specific Policies

Although enterp- specific policies can improve the productivity, specific policies may be needed for women-only enterprises. As seen earlier, the female-only enterprises often have less capital than their male-only counterparts. But yet when credit is offered to finance their expenses, women-only enterprises do not perform well compared to men-only enterprises. Thus pro-skills development policies designed for women are needed to promote women's entrepreneurship. Furthermore, provision of childcare, prepared food, and basic health care services in the neighborhood may improve women's productivity in informal activities.

This study suggests that proactive policies and projects to help small firms will result in social gains, contribute to the alleviation of economic hardship, and enable the disadvantaged, especially women, to become effective agents in the development process.

[25] For discussions see Bunster and Chaney (1985), de Soto (1989), Mescher (1985), Tinker (1987), and World Bank (1987).

Appendix A: Nonparametric Analysis

A nonparametric approach provides an alternative to the parametric model presented in the paper. The specification of functional forms is not required in nonparametric modeling, while in parametric modeling a functional form is explicitly defined. Also, under certain regularity conditions, the nonparametric estimates are consistent. This contrasts with the least squares approach where any misspecification of the functional form, however minor, will lead to inconsistent parameter estimates. It is not possible to say that nonparametric methods are more or less powerful than parametric methods -- the technique may provide a different explanation of the data. When parametric and nonparametric models provide similar results, it is reasonable to hold a stronger belief in the validity of the parametric specification.

Nonparametric Modeling

Consider the model:

$$Y_i = g(X_i) + u_i \quad i = 1,\ldots,n \tag{17}$$

where Y_i is the i^{th} observation of the dependent variable Y and X_i is the i^{th} row of the matrix of explanatory variables, X. There are k explanatory variables and n observations on each dependent and independent variable. The unobserved error term for the i^{th} observation is u_i.

The parametric approach to estimating this model involves specifying a functional form for g() and then applying a least squares or maximum likelihood algorithm to obtain point estimates of the parameters. The results of such an approach were presented in the paper.

The nonparametric approach to estimating (17) starts with the observation that the model could be written equivalently as:

$$\begin{aligned} Y_i &= g(X_i) + u_i \\ &= E(Y_i|X_i) + u_i \end{aligned} \tag{18}$$

where $g(X_i) \equiv E(Y_i|X_i)$ is the expectation of Y_i conditional upon X_i. This is also called the conditional mean of Y_i. The researcher estimates the model in (17) or (18) and its properties by estimating the conditional mean and how the conditional mean depends upon the conditioning variables. Techniques exist for estimating the conditional mean without specifying a particular functional form for g(). Of course, different distribution and regularity assumptions are introduced. In particular, the independent variables (drawings from which form the conditioning matrix X) are typically assumed, but not required, to be jointly distributed random variables. As well, continuity and differentiability assumptions are often implicit in the estimation of the conditional mean function.

The following is a brief description of the nonparametric approach. The reader is referred to Ullah (1988) for a more complete discussion of the development and use of nonparametric techniques in economics.

Defining Conditional Means and Their Properties

Suppose that the vector of random variables (Y, X) has a joint density function given formally by:

$$f(y,x) = \frac{dProb[(Y,X) < (y,x)]}{d(y,x)} \tag{19}$$

The marginal density function for X is defined by:

$$f_1(x) = \int f(y,x)dy \tag{20}$$

Finally, the conditional density function of Y given X is defined by:

$$f(y|x) = \frac{f(y,x)}{f_1(x)} \tag{21}$$

Using these definitions, the conditional mean introduced in (18) is given by :

$$E(y|x) = \int yf(y|x)dy$$

$$= \int y\frac{f(y,x)}{f_1(x)}dy \tag{22}$$

In a similar fashion, the vector of changes or responses of the conditional mean to a change in the vector of realizations of X_i is given by:

$$\frac{dE(Y|X)}{dx_i} = \frac{d}{dx_i}\int y\frac{f(y,x_i)}{f_1(x_i)}dy \tag{23}$$

The parametric analogue of the vector of derivatives of the conditional mean with respect to the realizations of the explanatory variables is the vector of derivatives of the dependent variable with respect to the independent variables. In terms of our revenue model, they are the marginal revenue products of the factors.

Estimating Conditional Means and Derivatives

Equations (22) and (23) show that the only information required to estimate the conditional means and the derivatives is the joint density function f(y,x). Once this is available, the marginal density can be computed (as in (20)) and all the right hand side of (22) is known. As (21) shows, the derivative on the right hand side of (23) can be computed and the integral can then be evaluated.

There are many ways to estimate a multivariate density function. For example it is possible to generalize the one-dimensional technique for obtaining histograms. However, the resulting density estimate will not be differentiable. More popular techniques involve kernel estimators. Formally, the estimate of the multivariate density f(w) = f(y,x), where $W_i = (Y_i, X_i)$ is given by:

$$\hat{f}(w) = (1/nh^q)\sum_{i=1}^{n} K((W_i - w)/h) \quad (24)$$

where: h is the window width, n is the number of observations, q is the number of elements in any W_i (equal to the number of explanatory variables, k, plus one for the dependent variable) and K() is the kernel function. The kernel function is typically taken from the set of many times differentiable multivariate density functions. One popular kernel function is the multivariate normal or Gaussian density. Note, however, that the choice of a Gaussian kernel in no way restricts the estimated density. Indeed, it would appear that density estimates are much less sensitive to the kernel function than they are to the window width, h. The choice of the window width determines, in part, the degree of smoothing of the density estimate. Recent work by Racine (1989) has examined the optimal window width, h, in the sense of integrated mean square error. The results for the Peru Living Standards Survey data make use of this optimal window width and a Gaussian kernel.

Appendix B: The Rural Model

We have attempted to fit the revenue model to the rural data.[26] The results show definite similarities to the results arising in the urban data, but we are somewhat less confident that the rural results are robust.

Table B2 shows the parameter estimates for the model.[27] It is apparent that the pattern of signs for those parameters estimated with some precision (that is, those with t-statistics more than 2) is similar to that in the urban data. For example, labor, capital and expenses (materials) have positive marginal products everywhere. But only 7 of 17 parameters are estimated with precision as opposed to 13 of 17 in the urban data. The model explains 59 percent of the variation in the dependent variable. This compares well with the corresponding 61 percent for the urban model.

We computed values for the marginal revenue products of labor, capital, and expenses for every observation in the sample of 288 rural businesses. Table B3 gives the means, standard deviations, and decile values for the distributions of these derivatives in the sample. These values can be compared with corresponding results for the urban model presented in Table 4. In general, the marginal revenue products for rural firms are lower than those for urban firms; the rural values for labor and expenses are about 80 percent of the urban levels, and the rural values for capital are almost the same as the urban levels. The troubling statistical feature of the rural model is that many of the data points may be highly influential. Of the 288 observations, 56 data points (20 percent of the sample) need detailed examination. Our concern arises from two sources: the data have high measured leverage, and the regression residuals are large in absolute value. The sheer number of these points combined with the costs of reestimating the nonlinear model to examine the importance of these points individually and in groups led us to concentrate our efforts instead on the urban model.

We do not argue that the estimates of the rural model are wrong. Indeed, as noted above, the pattern of results and other similarities with the urban results provide strong indirect evidence of their quality. We note, however, that the diagnostic evidence in support of the rural model is not as strong as that for the urban model.

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[26] Table B1 contains information on the variables entering the rural model; the format is identical to that of urban areas.

[27] We present results for the case where dummy variables are used to distinguish schooling levels.

Table B1. Descriptive Statistics of Rural Retail Sector

Type of firm Number of firms		Female 151	Male 90	Mixed 47	Total 288
		%	%	%	%
Place of operation	%				
Home		31.8	28.9	25.5	29.9
Fixed Location		19.2	5.6	25.5	16.0
Itinerant (Streets)		49.0	65.6	48.9	54.2
Mon.hs operated during year		9.5 (3.7)	8.1 (4.2)	9.7 (3.4)	9.1 (3.9)
1 - 6 months	%	23.2	40.0	21.3	28.1
6 - 9 months		11.3	7.8	8.5	9.7
9 -12 months		65.6	52.2	70.2	62.2
Age of firm (Years)		8.6 (11.2)	9.5 (13.7)	12.4 (15.1)	9.5 (12.7)
Less than 4 months	%	7.9	7.8	2.1	6.9
4 months - 1 year		5.3	7.8	6.4	6.3
1 - 3 years		25.8	18.9	14.9	21.9
3 - 5 years		12.6	18.9	8.5	13.9
5 - 10 years		19.2	22.2	25.5	21.2
Over 10 years		29.1	24.4	42.6	29.9
Monthly revenues	$	1047 (2233)	1574 (2642)	1902 (2541)	1351 (2433)
$ 1 - 500 Revenues	%	59.6	47.8	38.3	52.4
500 - 1000		17.9	14.4	14.9	16.3
1000 - 2000		10.6	15.6	14.9	12.8
2000 - 4000		6.6	11.1	19.1	10.1
More than 4000		5.3	11.1	12.8	8.3
Log of revenues	$	5.9191 (1.4161)	6.3073 (1.5782)	6.7357 (1.3940)	6.1737 (1.4911)
Monthly expenses	$	774 (1849)	1731 (3015)	1455 (2126)	1184 (2350)
Spline 2 expenses > 830	$	432 (1702)	1239 (2849)	1000 (1906)	777 (2180)
Spline 3 expenses > 2000	$	285 (1480)	893 (2527)	627 (1530)	531 (1891)
$ 0 expenses	%	8.6	12.2	10.6	10.1
1 - 500		59.6	33.3	44.7	49.0
500 - 1000		14.6	15.6	6.4	13.5
1000 - 2000		9.9	16.7	12.8	12.5
2000 - 4000		3.3	11.1	12.8	7.3
Over 4000		4.0	11.1	12.8	7.6
$ 0 - 830	%	80.8	56.7	59.6	69.8
Over 830		19.2	43.3	40.4	30.2
Over 2000		7.3	22.2	25.5	14.9

Notes: All monetary values in the table are in June 1985 intis.
The exchange rate was $1.00 US = 11 intis.
Standard deviations are in parentheses.

Table B1. (Contd)

Type of firm Number of firms		Female 151	Male 90	Mixed 47	Total 288
Total capital	$	1695	1990	6079	2503
		(4016)	(5362)	(15081)	(7504)
Spline 2 total capital > 1000	$	1313	1561	5501	2076
		(3783)	(5173)	(14916)	(7331)
$ 0 Total capital	%	13.9	17.8	14.9	15.3
1 - 250		44.6	33.3	23.4	37.3
250 - 500		7.3	12.2	6.4	8.7
500 - 2000		15.9	11.1	21.3	15.3
2000 - 4000		7.9	14.4	6.5	10.1
4000 - 12000		5.3	7.8	12.8	7.3
Over 12000		5.3	3.3	12.8	5.9
$ 0 - 1000		74.8	70.0	53.2	69.8
Over 1000		25.2	30.0	46.8	30.2
Total capital excl. stock	$	1033	761	4500	1508
		(3[illegible]31)	(2070)	(14217)	(6386)
Stock (Inventory)	$	662	1249	1579	995
		(1533)	(4495)	(2602)	(2952)
Monthly profits	$	272	157	447	167
		(1001)	(2285)	(1984)	(1681)
Profits > 0	%	76.2	67.8	74.5	73.3
Family workers		1.3	1.1	2.8	1.4
		(0.6)	(0.3)	(1.3)	(0.9)
1 worker	%	80.1	92.2	0.0	70.8
2 workers		15.2	6.7	63.8	20.5
3 workers		4.0	1.1	17.0	5.2
4 or more workers		0.7	0.0	19.1	3.5
Adult male workers only	%	0.0	91.1	0.0	28.5
Male workers only		0.0	95.6	0.0	29.9
Adult female workers only		80.8	0.0	0.0	42.4
Female workers only		95.4	0.0	0.0	50.0
Adult workers only		80.8	91.1	70.2	82.3
Monthly hours of labour		141.7	122.3	356.8	170.7
		(135.7)	(116.4)	(314.2)	(191.0)
1 - 100 Hours	%	49.0	54.4	17.0	45.5
100 - 200 Hours		27.8	22.2	17.0	24.3
200 - 300 Hours		12.6	15.6	19.1	14.6
300 - 400 Hours		4.6	5.6	17.0	6.9
400 - 500 Hours		3.3	0.0	6.4	2.8
Over 500 Hours		2.6	2.2	23.4	5.9
Log monthly hours		4.5265	4.3565	5.5194	4.6354
		(0.9902)	(.0399)	(0.9029)	(1.0663)
Adult male/total Hours	%	0.0	94.3	45.9	37.0
Adult female/total Hours	%	90.7	0.0	46.0	55.1
Child hours/total Hours	%	9.3	5.7	8.1	8.0
Education (Most educated worker)					
Years of schooling		3.1	3.8	5.3	3.7
		(3.2)	(2.5)	(3.0)	(3.1)
Spline 0 - 5 years of school		2.5	3.3	4.0	3.0
		(2.2)	(1.7)	(1.6)	(2.0)
Spline 6 -10 years of school		0.6	0.5	1.3	0.7
		(1.7)	(1.2)	(1.9)	(1.6)
Highest education level completed					
None	%	34.4	6.7	6.4	21.2
Primary		47.7	73.3	57.4	57.3
Secondary		17.9	20.0	36.2	21.5
% of family workers who:					
Attended public schools		57.8	87.2	71.9	69.3
Have vocational training		7.4	8.9	7.1	7.8
At least 1 family worker has vocational training		9.9	8.9	12.8	10.1
Age of oldest worker (Years)		40.8	39.5	44.0	40.9
		13.7	14.5	13.1	13.9
Job experience (most experienced worker)					
Years		18.4	24.0	25.2	21.2
		(14.3)	(15.7)	(12.6)	(14.8)
Years squared/100		5.4	8.2	7.9	6.7
		(7.2)	(9.7)	(7.0)	(8.1)

Table B2: Regression results rural areas - All firms (Binary schooling variables)

CONSTANT1(a_0)	9.486 (7.993)
LOCATION_HOME	-0.191 (-1.197)
LOCATION_FIXED	-0.112 (-0.600)
FIRM_AGE	-0.002 (0.291)
CONSTANT2(b_0)	-5.361 (-4.620)
EXPENSES_1	2068.170 (7.318)
EXPENSES_2	-1450.507 (-3.029)
EXPENSES_3	-522.151 (-1.714)
CAPITAL_1	673.694 (3.265)
CAPITAL_2	-657.124 (-3.135)
LABOR	0.168 (2.633)
SCHOOL_PRIMARY	0.181 (1.141)
SCHOOL_SECONDARY	0.212 (0.973)
SCHOOL_POSTSEC	----- -----
TRAINING	0.247 (1.093)
EXPERIENCE	0.033 (0.277)
EXPERIENCE^2/100	-0.023 (-1.045)
LLF	-386.738
SSR	247.340
Adjusted R-squared	0.59000
Mean Dependent Variable	6.17370
St. Dev.	1.49111

Notes: t-statistics are in parentheses.

Table B3. Distribution of marginal revenue products of Labor, Expenses, and Capital - Rural areas

Decile	Labor	Expenses	Capital
1	.028	.302	.016
2	.051	.386	.046
3	.070	.468	.074
4	.103	.596	.130
5	.131	.777	.167
6	.179	.953	.221
7	.251	1.097	.310
8	.390	1.379	.499
9	.896	1.776	1.101
10	16.085	5.007	3.358
Mean	.427	.964	.379
St Dev	1.183	.747	.556
Obs	288	288	288

CHAPTER 4:

HOUSEHOLD PRODUCTION, TIME ALLOCATION, AND WELFARE IN PERU

John Dagsvik and Rolf Aaberge*

1. Introduction

This chapter uses the Peruvian Living Standard Survey (PLSS) data to analyze (a) inequality in the distribution of income, (b) labor market participation of men and women and the variations in hours of work, and (c) the relationship between variations in labor supply and income inequality. We use a decomposing method to analyze income inequality. Furthermore, we utilize a structural neo-classical model to analyze household production, consumption, time allocation and welfare. The purpose is to study the effect on production, consumption, and time allocation of changes in education and wage rates. For example, how many men and women would participate in wage work if education were increased? And how would policy changes affect the mean level and the degree of inequality in the distribution of economic welfare?

Most of the available information on economic inequality in developing countries refers to the distribution of income among earners. Although this information constitutes an important element for understanding the labor market and the related distribution of income, it is less helpful in the analysis of inequality as a welfare issue. A more relevant indicator of welfare is per capita (or per adult equivalent) household income or consumption. This chapter uses this indicator in an analysis of economic inequality. Our methodological approach is based on a summary measure of inequality which is closely related to the Gini coefficient. The essential difference is that our proposed measure of inequality gives more weight than the Gini coefficient to transfers related to the very poor.

Based on the estimates of an econometric model of production, consumption and time allocation, we have examined the impact of changes in wage rates and education on economic inequality. In particular we demonstrate how female labor and education affect economic inequality among households.

The structural econometric model we develop and estimate is convenient for simulating certain types of policy experiments. It is of labor supply response and the corresponding impact on economic welfare from various policy measures. Specifically, given similar economic conditions in Peru as of 1985, our study suggests what we may be able to achieve, and how, for example, different measures would affect economic inequality.

The theoretical model is based on the neoclassical model for consumption and time allocation. Provided the data are not corrupted by measurement error, this framework is useful since:

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- No one can spend more than his or her income. (In other words the budget constraint plays a role.)

- There is also a time constraint of 24 hours a day.

- It is reasonable to assume that people are not indifferent with respect to different levels of leisure and consumption. Thus we introduce the notion of preferences and represent them by utility indexes.

In standard models of labor supply the decision-maker is assumed to maximize utility with respect to leisure and consumption (subject to the budget constraint). One objection to this framework, however, is that individuals and households in developing countries can hardly be viewed as having full freedom of choice. On the contrary their job and production opportunities are often severely constrained. An individual's opportunities are influenced by education and experience, by the structure of the economy, and by government and sector-specific policies. Thus it is crucial that a realistic economic model of household behavior accommodate variations in opportunities across households.

The econometric model used in this study differs somewhat from the standard models in that the underlying decision variable is latent and is denoted position. By position we mean a particular combination of market and nonmarket activities, such as agricultural production combined with work in a wage-earning job. A position is characterized by specific attributes, like type and level of output and input factors, hours of work, wage rates, and so on. These attributes are assumed fixed, given the position. The choice problem is viewed as one in which the household selects the best "package" of attributes from a set. This choice set is known to the household but is unobservable to econometricians.

The set of household-specific feasible positions is represented in the model by a distribution function called the <u>opportunity distribution</u> (density). The opportunity density represents an aggregate measure of choice opportunities and it is defined as the fraction of positions with specified levels of attributes that are feasible to the household. For example, if the attributes are job-specific hours, wages, and profits in own-farm production, the opportunity density measures the amount of positions with a specific level of wages, hours, and profits that is feasible. Due to unobserved heterogeneity in opportunities across households, it is natural to interpret the opportunity density as a <u>probability density</u>. Specifically, it is the probability that a particular position-specific combination of attributes is feasible to a (randomly selected) household.[1]

The econometric model is simultaneous in consumption, hours of work, wage rates, and profit conditional on family size and schooling. By conditional we mean that we have specified a conditional density for chosen hours of work,

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[1] This approach was developed and applied by Dagsvik (1988) and Dagsvik and Strøm (1989), and it is related to the models developed by McFadden (1973) and Ben-Akiva and others (1985).

consumption, wage rates, and output given the chosen family size and schooling. Thus the model is consistent with the notion of simultaneous choice in all the attributes including schooling and family size.

While the introduction of the opportunity distribution in addition to the specification of a household utility function is appealing, it raises problems of functional form and the identification of parameters of the opportunity density and utility function. Even if these parameters cannot be fully identified without strong assumptions, the formulation has the advantage in that it suggests a natural and convenient way of taking into account unobserved heterogeneity in opportunities and introduces variables for individual qualifications as well as variables that characterize the community and the environment. At this stage the opportunity density is specified as a function of the individual's education. Specifically, the fraction of feasible wage work positions is specified as a function of years of schooling. Similarly the fraction of nonagricultural self-employment positions is specified as a function of level of schooling. This enables us to simulate the effect of increased education on the allocation of time in different sectors while keeping wage rates and preferences fixed. We can also study the effect of schooling through increased wages while keeping the opportunity density fixed.

The labor supply functions that correspond to the utility function are not linear in the parameters. But our assumptions imply convenient expression of the (observed) consumption and labor supply probability distribution. This distribution is a function of the parameters of the utility function and it is used in a maximum likelihood estimation procedure. Once the parameters of the utility function have been estimated, we can simulate individual household response.

This chapter is organized in the following way. Section two presents a brief discussion on the methodology of measuring economic inequality and then applies the methodology on observed distributions of hours of work, household income, and per capita income as a measure of welfare. Section three outlines the structural econometric model. Section four reports the estimation results for the econometric model. Section five discusses the policy simulation results. The results are summarized and policy implications discussed in the concluding section of the paper.

2. Labor Market Activity, Income Formation, and Welfare

This section supplements the information on labor market activity and distribution of welfare reported in Newman (1987) and Glewwe (1987). One objective is to examine the relative differences in hours of work among employed males and females by estimating the inequality in the actual distribution of hours of work. For this purpose we employ a Gini-related measure of inequality, which also represents our basis for studying the distribution of income and welfare.

Second, we identify the contribution from wage work, agricultural self-employment, nonagricultural self-employment, and unpaid family work to the distribution of hours of work by employed males and females. More precisely we decompose the inequality in the actual distribution of hours of work. We use a similar approach to assess the contribution of wage earnings of males, females, and children to the level of inequality in the distribution of household consumption. In this way we obtain important information about economic structure and the functioning of the labor market. This information is, however, less helpful in the analysis of economic inequality from a welfare perspective. A more relevant indicator of welfare is per capita household income, which also constitutes the basic variable in our study on welfare.

2.1 Measurement and Decomposition of Inequality

A common approach for measuring inequality in distributions of income is to employ the Gini coefficient, which satisfies the principles of scale invariance and transfers. The principle of scale invariance states that inequality should remain unaffected if each income is altered by the same proportion and it requires, therefore, the inequality measure to be independent of the scale of measurement. The principle of transfers implies that if a transfer of income takes place from a richer to a poorer person without changes in the relative positions, the level of inequality diminishes. The reader is referred to Sen (1972) for a more comprehensive discussion of the normative implications of different measures of inequality.

The Gini coefficient (G) is related to the Lorenz curve (L) in the following way

$$G = \int_0^1 [1-2L(u)]du. \qquad (2.1)$$

The Gini coefficient offers a method for ranking distributions and quantifying the differences in inequality between distributions. This strategy, however, suffers from certain inconveniences. Evidently no single measure can reflect all aspects of inequality of a distribution, it can only summarize it to a certain extent. Consequently, it is important to have alternatives to the Gini coefficient. As pointed out by Atkinson (1970), the Gini coefficient assigns more weight to transfers in the center of a unimodal distribution than at the tails. As an alternative to the Gini coefficient, we will employ an inequality measure - the A-coefficient - that assigns more weight to transfers at the lower tail than at the center and the upper tail.

The A-coefficient (see Aaberge 1986) has a similar geometric interpretation and relation to the inequality curve M defined by

$$M(u) = \frac{E\,[X \mid X \leq F^{-1}(u)]}{EX}, \qquad 0 \leq u \leq 1, \qquad (2.2)$$

as the Gini-coefficient has to the Lorenz curve. Here X has distribution function F. The A-coefficient is defined by

$$A = \int_0^1 [1-M(u)]du. \qquad (2.3)$$

If X is an income variable, then M(u) for a fixed u expresses the ratio of the mean income of the poorest 100u percent of the population to the mean income of the population. The egalitarian line of the Lorenz curve is the straight line joining the points (0,0) and (1,1). The egalitarian line of the M-curve is the horizontal line joining the points (0,1) and (1,1). Thus the universe of M-curves is bounded by a unit square, while the universe of Lorenz curves is bounded by a triangle. Therefore, there is a sharper visual distinction between two different M-curves than between the two corresponding Lorenz curves. Note that the M-curve will be equal to the diagonal line (M(u)=u) if and only if the underlying distribution is uniform (0,a) for an arbitrary chosen a. The A-coefficient then takes the value 0.5, while the maximum attainable value is 1 and the minimum attainable value is 0.

Note that M(u) = L(u)/u, which implies

$$A = \int_0^1 \left[\frac{1-L(u)}{u}\right] du \,. \tag{2.4}$$

Alternative expressions for G and A are given by

$$G = \frac{1}{EX}\int_0^\infty \int_0^y (y-x)\,dF(x)\,dF(y) = \frac{1}{EX}\int_0^\infty y(2F(y)-1)\,dF(y) \tag{2.5}$$

and

$$A = \frac{1}{EX}\int_0^\infty \int_0^y \frac{(y-x)}{F(y)}\,dF(x)\,dF(y) = \frac{1}{EX}\int_0^\infty y(1+\log F(y))\,dF(y), \tag{2.6}$$

respectively.

Given the inequality in the distribution function F measured by A or G, the next step is to identify the sources that make substantial contri[illegible]ons to the inequality. Assume that the main variable X is the sum of s differe[illegible] [illegible]ctor components,

$$X = \sum_{i=1}^{s} X_i \tag{2.7}$$

According to Aaberge (1986), A and G satisfy the following decomposition rules

$$A = \sum_{i=1}^{s} \frac{\mu_i}{\mu}\,\alpha_i \tag{2.8}$$

where μ_i / μ is the ratio between the means of X_i and X, respectively, and α_i is, loosely spoken, the conditional A-inequality of factor i given the units rank order in X. Analogously,

$$G = \sum_{i=1}^{s} \frac{\mu_i}{\mu} \gamma_i \qquad (2.9)$$

where γ_i related to G has a similar interpretation as α_i related to A.

Notice that α_i and γ_i are measures of interaction between factor i, X_i, and the sum X. Assume for example that $\mu_i > 0$. Then, a negative value of α_i or γ_i expresses negative interaction and means that factor i has an equalizing effect on the inequality in the distribution F of X. A positive value expresses a disequalizing effect on the inequality in F. For $\mu_i < 0$, then positive values of α_i and γ_i express an equalizing effect on the inequality in F. For $\mu_i < 0$, then positive values of α_i and γ_i express an equalizing effect on the inequality in F.

2.2 Inequality in Distributions of Hours of Work for Males and Females

In this section we focus on the distribution of hours of work among employed persons. The objective is to estimate inequality in distributions of hours of work, i.e., relative differences in hours of work among employed persons. A similar study for children and households is reported in Dagsvik and Aaberge (1989).

Table 1: Employment rates, annual mean hours of work and A-inequality in distributions of hours of work for males and married and unmarried females, by region

	Males			Females								
				All			Married			Unmarried		
	Employment rates	Annual mean hours	A-inequality	Employment rates	Annual mean hours	A-inequality	Employment rates	Annual mean hours	A-inequality	Employment rates	Annual mean hours	A-inequality
Peru	.82	2,351	.396(.004)	.64	1,746	.521(.004)	.69	1,728	.521(.005)	.57	1,775	.521(.006)
Lima	.77	2,356	.398(.008)	.51	1,594	.569(.008)	.55	1,580	.586(.011)	.47	1,611	.547(.012)
Other urban	.76	2,286	.434(.008)	.56	1,656	.563(.007)	.62	1,613	.573(.009)	.49	1,717	.546(.011)
Rural	.91	2,388	.370(.006)	.79	1,868	.467(.005)	.81	1,844	.455(.066)	.75	1,912	.483(.008)

Note: Numbers in parentheses are standard deviations.

Table 1 examines regional employment and regional distributions of hours of work for employed males and females aged 15-70.[2] The participation rates for males and females are considerably higher in rural than in urban areas. Rates for married females are higher than those for unmarried females, perhaps due to an income effect. Females in rural areas work considerably longer than females in urban areas. Males also work longer in rural areas, but the difference is less significant.

The figures in table 1 may cover large individual differences in hours of work. We now employ the A-coefficient as a measure of the relative differences in hours of work (see section 2.1); corresponding results based on the Gini coefficient are given in Appendix A. The estimates of the A-coefficient are displayed in table 1.

The inequality estimates show large individual variations in hours of work, particularly among females. Except for rural women, the inequality in the distribution of hours of work is significantly higher than if the individual hours of work were generated randomly, i.e. from a uniform (0,a) distribution for an arbitrary a. There are not, however, significant discrepancies in inequality between the distribution of hours of work for married and unmarried females. Inequality is lowest in the rural area for both males and females.

The observed distribution of hours of work is the result of a process where the individuals make decisions on hours of work in each sector simultaneously. The sectors are defined as (1) wage work, (2) nonagricultural self-employment, (3) agricultural self-employment, and (4) unpaid family work. By decomposing the overall inequality in the distribution of hours of work with respect to these sectors, we obtain information about the contribution of each sector to the overall inequality. (It is understood that the behavioral labor market adjustments are given).

By applying the decomposition method for the A-coefficient, we obtain the results in table 2. For females the first and third column (second and fourth for males) give the relative contribution from each sector to overall inequality and to total hours of work, respectively. The fifth and sixth column give the interaction coefficients. The positive interaction coefficients demonstrate that each sector has a disequalizing influence on the distribution of hours of work in each region. Note that the sectoral contribution to overall inequality for females is equal to the products of the figures in columns three and five divided by 100. Consequently, the sum of the first four sectoral inequality contributions for females in table 2 is equal to the overall inequality (0.521) in the distribution of hours of work for females in Peru.

[2] Individuals are classified as employed if they worked one hour or more during the seven days or 12 months prior to the survey. The definition and measurement of annual hours of work are reported in Appendix 2.

Table 2: Decomposition of the A-inequality in distributions of hours of work for females and males, with respect to (1) wage work, (2) nonagricultural self-employment, (3) agricultural self-employment and (4) unpaid family work, by region

Region (level of inequality for females and males)	Employment sector	Sectoral fraction of overall inequality (percent)		Sectoral fraction of total hours of work (percent)		Interaction coefficient	
		Female	Male	Female	Male	Female	Male
Peru (0.521) (0.396)	1	21.9	39.9	22.0	42.9	0.518	0.368
	2	28.5	27.2	24.1	20.3	0.618	0.531
	3	7.5	17.7	7.8	16.1	0.501	0.435
	4	42.1	15.2	46.1	20.7	0.476	0.292
Lima (0.569) (0.398)	1	53.2	58.3	52.8	66.6	0.573	0.348
	2+3	37.8	40.4	33.0	29.8	0.653	0.539
	4	9.0	1.3	14.2	3.6	0.360	0.144
Other urban (0.563) (0.434)	1	25.4	44.7	26.1	50.4	0.547	0.385
	2+3	53.8	50.7	45.8	39.4	0.661	0.558
	4	20.8	4.6	28.1	10.2	0.417	0.195
Rural (0.467) (0.370)	1	8.6	26.8	7.5	24.4	0.536	0.403
	2	13.1	8.3	11.2	6.8	0.543	0.451
	3	13.2	35.2	13.6	31.9	0.455	0.409
	4	65.1	29.7	67.7	36.9	0.449	0.298

Note: $\text{Fraction of overall inequality} = \left(\frac{(\text{Fraction of total hours of work}) \times (\text{Interaction coefficient})}{\text{Overall inequality}} \right)$

Example: Wage sector's fraction of overall inequality for females in Peru = $\frac{22.0 \times 0.518}{0.521} = 21.9$

According to table 2, wage work plays a predominant role for males and females in Lima and for males in other urban areas. In rural areas males and females work mainly in the agricultural sector, but the wage work accounts for almost 25 percent of the total hours of work for rural men.

The large interaction coefficients in table 2 suggest that females with long total hours work more hours in each sector than females with short total hours of work. To a certain extent this conclusion is also valid for males. For males, however, there is a weak interaction between the hours worked as an unpaid family worker and total hours of work. This means that males with short total hours of work do nearly as much unpaid family work as males with long total hours of work. Note that the self-employment sectors have the largest interaction coefficients, which implies that these sectors make the largest contributions to the observed differences in hours of work among both sexes.

2.3 Inequality in distribution of household consumption

This section deals with measurements of economic inequality. Such studies depend on the definition of income, the unit of observation, the period of time over which the chosen income variable is measured, and a summary measure of inequality.

We define the basic income variable as consumption defined as:[3]

consumption = Σ wage earnings

+ Σ net entrepreneurial income

+ Σ other income.

In this definition savings are included in consumption. Note that consumption of home-grown food and other in-kind income is given a monetary value so that net entrepreneurial income includes consumption of these items. The unit of observation is the household and the reference period is one year. The "Σ" in the definition of consumption means sum over all persons who lived in the household during the year in question.

As a supplement to the information on individual variations in hours of work given in section 2.2 we give estimates of the A-coefficient for the regional distributions of hours of work among households:

Peru	Lima	Other urban areas	Rural areas
0.487	0.497	0.492	0.458
(0.004)	(0.009)	(0.008)	(0.006)

(Standard deviations in parenthesis)

The figures for Lima and other urban areas are approximately equal to the inequality in a uniform (0,a) distribution. When we plot the respective underlying inequality curves, however, we find that households in the lower and upper tails of the observed distribution have longer hours of work than in the uniform (0,a) distribution. As for the distribution of hours of work among individuals (see table 1) the inequality in the corresponding distribution among households is lowest in rural areas.

In spite of large inequality in the household distribution of hours of work, we cannot automatically ascertain the immediate implication for the inequality in the corresponding distribution of household consumption. The distribution of consumption is the result of preferred hours and offered wages and prices, and will therefore depend on the wage rate, the returns to self-employment activities, the hours of wage work and self-employment, and nonlabor income as well as the interdependence among these variables. For example, if households with high returns to self-employment activities work longer hours than households with low returns to their self-employment activities, and if in

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3 See appendix 2 for details.

addition a positive relationship exists between wage rates and the household's hours of work in the wage sector, then we must expect more inequality in consumption than in the distribution of hours of work.

Table 3 shows mean and median household consumption and inequality in the distribution of consumption among households. Note that these estimates are based on fewer observations than the estimates used in tables 1 and 2 because we have excluded households with observed negative net entrepreneurial income. The large figures of the A-coefficient in table 3 reveal extreme income inequality. The mean consumption of the richest 5 percent of the households is 128 times the mean consumption of the poorest 50 percent of the households, and 1,355 times the mean consumption of the poorest 10 percent.

Table 3: Mean and median distribution of household consumption (in intis), and A-Inequality among households, by region

	Peru	Lima	Other urban areas	Rural areas
Number of observations . . .	4,622	1,287	1,316	2,019
Mean	42,500 (10,066)	40,120 (2,250)	71,104 (32,912)	25,373 (8,273)
Median	11,433	22,344	15,660	4,423
A-inequality	0.864 (0.033)	0.680 (0.016)	0.892 (0.049)	0.895 (0.034)

Note: In intis (Peruvian Currency) at June 1985 prices. Standard deviations in parentheses.

The results in Table 3 show that the inequality in the distribution of consumption is considerably higher in rural areas than in Lima, even though hours of work were more equally distributed in rural areas. To obtain information on why inequality varies across distributions, we will examine the impact of different income sources on overall inequality. By decomposing the inequality in the actual distribution of consumption by males, females, and children's wage earnings, and by households' net entrepreneurial income, we may see why the consumption distributions differs across regions. By applying the decomposition method for the A-coefficient, we obtain the results in table 5. The interpretation is analogous to the interpretation of table 2. To give an impression of the variations behind the coefficients for Peru in table 5, table 4 displays mean household consumption by deciles, corresponding mean earnings for males, females, and children, mean entrepreneurial household income and mean other income for each decile. Since the decile-specific mean wage earnings for females increases with increasing deciles, the corresponding interaction coefficient takes a large positive value, which is in accordance with the estimate (0.842) in table 5. But if the decile-specific means are equal, then the corresponding interaction coefficient would become zero or approximately zero.

Table 4: Mean consumption for households living in Peru by deciles decomposed with respect to females, males and children's wage earnings and with respect to the households net entrepreneurial income and other income

Decile	Mean household consumption	Decile specific mean wage earnings for Females (15-70)	Males (15-70)	Children (7-14)	Decile specific mean net entrepreneurial income for households	Decile specific mean of other income for households
1	397	13	40	2	324	18
2	1,700	80	222	15	1,296	87
3	3,443	192	793	27	2,268	163
4	6,077	387	1,984	42	3,270	394
5	9,478	884	3,634	29	4,203	718
6	13,643	1,367	6,086	63	5,244	883
7	19,082	1,741	8,220	35	7,630	1,456
8	27,073	4,665	10,902	214	10,723	1,924
9	41,140	4,718	15,592	53	16,970	3,807
10	302,982	20,460	31,874	326	242,670	7,651
All	42,500	3,315	7,948	85	29,461	1,691

Note: Intis at June 1985 prices.

Table 5: Decomposition of the A-inequality in the distribution of consumption by males, females, and children's wage income, and by net entrepreneurial household income plus other income, by region.

Region (Level of inequality)	Income (consumption) factor	Fraction of overall inequality (percent)	Fraction of consumption (percent)	Interaction coefficient
Peru (0.864)	Females (15-70) wage earnings .	7.6	7.8	0.842
	Males (15-70) wage earnings . .	16.0	18.7	0.742
	Children's (7-14) wage earnings	0.1	0.2	0.635
	Households net entrepreneurial income	72.7	69.3	0.9[illegible]
	Other income	3.6	4.0	0.767
Lima (0.680)	Females (15-70) wage earnings .	18.5	17.0	0.741
	Males (15-70) wage earnings . .	35.9	39.5	0.618
	Children's (7-14) wage earnings	0	0.1	-0.076
	Households net entrepreneurial income	38.2	34.9	0.744
	Other income	7.4	8.5	0.596
Other urban (0.892)	Females (15-70) wage earnings .	5.1	5.6	0.805
	Males (15-70) wage earnings . .	8.1	11.5	0.629
	Children's (7-14) wage earnings	0.1	0.1	0.741
	Households net entrepreneurial income	84.8	80.2	0.943
	Other income	1.9	2.6	0.665
Rural (0.895)	Females (15-70) wage earnings .	2.2	2.4	0.829
	Males (15-70) wage earnings . .	9.7	10.9	0.795
	Children's (7-14) wage earnings	0.3	0.4	0.774
	Households net entrepreneurial income	85.7	84.1	0.911
	Other income	2.1	2.2	0.866

Male wage earnings in Lima provide almost 40 percent of household consumption which is attained at the expense of about 43 percent of the households' total hours of work in wage employment by male members of the household. For females, the corresponding figure is about 17 percent, which reflects 17 percent of the households' hours of work. Despite the fact that this particular structure in the distribution of hours of work among households is maintained in the distribution of consumption among households, consumption is considerably more unequal than hours of work. The explanation is that the interaction coefficients referring to the consumption distribution for Lima, given in table 5, are considerably larger than the corresponding interaction coefficients related to the distribution of hours of work reported in Dagsvik and Aaberge (1990). This result is due to skew distributed wage rates and a positive correlation between wage rates and hours of work. By applying a particular non-linear decomposition method (not reported here) we also found that the wage rates contributed more strongly to inequality in the distribution of household consumption than hours of work in the wage sector. These effects are stronger for females than for males.

Note that the interaction coefficient for children's wage earnings in Lima is weakly negative, which means that children's wage earnings have a modest equalizing effect on the distribution of consumption among households. This effect is in contrast with the effect of children's wage work on the inequality of the corresponding distribution of hours of work and is mainly due to nonworking children of rich households with low or medium total hours of work. In both cases the children's contribution to overall inequality is of minor importance, as shown in the first column of table 5.

In contrast to the results for Lima, wage earnings in other urban areas yield a modest contribution to total household consumption, compared to the contribution of the household's hours in wage work to the households' total hours of work. The fractions are, respectively, 17 and 40 percent. As in the case for Lima, the interaction coefficients related to the distribution of consumption are considerably larger than the corresponding interaction coefficients for the distribution of hours of work. Similar results hold for the rural areas, although the distribution of household consumption seems to a greater extent to reflect the distribution of household hours of work.

2.4 Inequality in Distributions of Per-Capita Household Consumption

The information in section 2.3 about the economic structure of the labor market must be interpreted cautiously when analyzing welfare because of the variations in household composition and size. To allow tor the fact that some households have several persons while others have just one, we need an alternative to household consumption as an indicator of welfare. Clearly, an index of welfare using the information on household size and composition is required. In the PLSS data an equivalence scale accounts for this heterogeneity. Specifically, the costs of children are specified in terms of fractions of one adult. The weights are 0.2 for a child under 7 years old, 0.3 for a child aged 7 to 12, 0.5 for a child 13 to 17, and 1 for a person over 17. The sum of these weights for each household is used as the scale. Consumption per capita is defined as household consumption relative to the equivalence scale and it is used as an indicator of household welfare. Note that these weights are consistent with the weights estimated for Sri Lanka and Indonesia by Deaton and Mullbauer (1986) and have been applied by Glewwe (1987) in analyzing the distribution of welfare in Peru in 1985-86. Glewwe's analysis is based on expenditure data rather than on income data.

The lack of sufficient data makes it impossible to distinguish consumption levels among members of the household. Therefore we have to assume that the welfare level of an individual is equal to the per capita consumption of the household. It is particularly interesting to examine the relationship between the distribution of per capita household consumption among households and the distribution of per capita household consumption among persons.

Table 6 shows average welfare levels for Lima, other urban areas, and rural areas. The figures show considerable differences in welfare between adults and children, and between urban and rural areas. The large differences between corresponding medians and means indicate extremely skewed distributions, which are confirmed by the estimates of the A-coefficient in table 7.

Table 6: Mean and median per capita consumption among persons by sex, age, and region

Population	Peru		Lima		Other urban areas		Rural areas	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
All	11,692	3,332	10,668	5,983	19,139	4,190	7,454	1,404
	(24,126)		(6,541)		(6,952)		(10,633)	
Females	13,282	3,508	10,406	6,036	25,154	4,143	6,654	1,332
	(7,376)		(2,256)		(2,185)		(2,935)	
Males	12,207	3,820	11,529	6,418	20,013	4,423	7,097	1,516
	(7,004)		(2,090)		(2,054)		(2,860)	
Children[a]	10,118	2,965	10,118	5,404	13,630	3,945	8,150	1,380
	(9,746)		(2,195)		(2,713)		(4,838)	

Note: Intis figures at June 1985 prices. Number of observations in parentheses.
[a] Less than 15 years old.

Table 7 shows only insignificant differences in inequality across per capita household consumption among households and persons. This is in line with the results reported by Berry (1988). More surprising is the finding that the inequality in per capita household consumption differs little from inequality in the corresponding distribution of total household consumption (compare tables 3 and 7). This result is due to an extremely unequal distribution of consumption (income) in Peru in 1985-86. Glewwe (1987) reports that this was also the case in 1966, when the Gini-coefficient for per capita income inequality among persons was 0.666. We estimate the Gini-coefficient of the distribution of per capita household consumption among persons in 1985-86 to be 0.789 (see Appendix A, table G3).

Table 7: A-inequality in distributions of per capita consumption among households and persons, by region

	Peru	Lima	Other urban areas	Rural
Households	.857 (.029)	.676 (.017)	.881 (.048)	.895 (.032)
Persons	.856 (.014)	.662 (.008)	.883 (.021)	.888 (.016)

Note: Standard deviations in parentheses.

3. The Econometric Framework of a Structural Neoclassical Model

3.1. Theoretical Model

This section focuses on the essential features of our framework and its relationship to the traditional approach in the empirical analyses of labor supply (see Killingsworth 1983). For the sake of simplicity we take the case of one individual. The traditional approach starts by postulating a direct (or indirect) utility function in leisure (nonmarket activities) and consumption from which the labor supply function is derived by maximizing utility subject to the budget constraint. (Alternatively, the labor supply function is postulated directly so that it is consistent with a well-defined utility function). In this approach it is assumed that the individual is free to adjust his or her hours of work. The notion of rationing with respect to job offers or hours of work is rarely taken into account. Another feature of most empirical models is the assumption of linear labor supply curves. Linear supply functions imply a particular and quite restrictive form of the utility function that seems unjustified *a priori*. For example it implies that the "backward bending case" is excluded *a priori*.

The alternative empirical approach we use here is consistent with neoclassical theory but it departs from the econometric specifications used by others. We assume that the essential choice variable is "job" or "position" and that hours of work and wage rates are determined once the position is given. By position we understand a particular combination of market and nonmarket activities. For example, one position may be defined as specific farmwork tasks combined with a particular wage work job. Thus hours of work and wage rates are attributes that characterize the positions. Let (H_j, W_j) be the hour-wage combination of position. Here j is an indexation of the position. For nonmarket positions, W_j=0. The choice set is assumed known to the individual but is unobserved by the econometrician. Only the hours of work and wage rates are observed. That is, the hour-wage combination associated with the chosen position is observed.

To make the exposition as simple as possible, we assume that the set of feasible positions, B, (choice set) is finite (relative to the individual).

The individual's maximization problem can be described as follows. The budget constraints are given by

$$h = H_j \qquad (3.1)$$

$$C = H_j W_j + I \qquad (3.2)$$

$$j \in B \qquad (3.3)$$

where I is nonlabor income. Equation (3.1) states that for a given position j, hours of work are given. The third equation states that B is the set of feasible positions. Equation (3.2) is the standard economic budget constraint.

Let

$$U(h,C,j) = v(h,C) + e_j$$

be the individual's utility of hours of work, h, consumption, C, and position, j. We assume that this utility can be decomposed in a structural term, v(h,C), (common to observationally identical individuals) and a random term, e_j, that reflects individual preferences for positions with the same level of hours and consumption. Thus e_j takes into account heterogeneity in tastes across individuals with respect to positions as well as the unobserved attributes of the positions.

The random term e_j is assumed independent of the choice set of feasible positions. Thus our approach is in fact a type of disequilibrium model in which the choice opportunities are considered fixed. The individual's problem is to find the position $j \in B$ that maximizes

$$v(H_j, H_j W_j + I) + e_j.$$

Now let B(h,w) be the set of positions for which $H_j = h$, $W_j = w$, $j \in B$ and let n(h,w) be the number of positions in B(h,w).

Formally, the probability that the optimal position has hour-wage combination (h,w) is expressed as

$$\phi(h,w) = P\{ \max_{j \in B(h,w)} (v(H_j, H_j W_j + I) + e_j) = \max_{j \in B} (v(H_j, H_j W_j + I) + e_j) \}.$$

Moreover, if we assume that the random preference terms e_j are independent, extreme value distributed across positions, we get immediately from the formal theory of discrete choice as developed by McFadden (1973) (see Maddala, 1983) that

$$\phi(h,w) = \frac{n(h,w)\exp(v(h,hw+I))}{\sum_{x,y} n(x,y)\exp(v(x,xy+I))}. \qquad (3.4)$$

Let

$$g(h,w) = \frac{n(h,w)}{\sum_{x,y} n(x,y)}$$

be the fraction of positions with hours and wages equal to (h,w) that are feasible. By inserting in (3.4) we get

$$\phi(h,w) = \frac{g(h,w)\exp(v(h,hw+I))}{\sum_{x,y} g(x,y)\exp(v(x,xy+I))} . \qquad (3.5)$$

This model is analogous to the one developed by Ben-Akiva et al. (1985). The function ϕ expresses the labor supply density. Its observable counterpart is the fraction of individuals who work h hours at wage rate w. Instead of the usual specifications where the labor supply density is expressed as a function of the parameters of the labor supply function we realize from (3.5) that in our model the density is expressed as a function of the structural part of the utility function.

Moreover, this model allows the notion of rationing. Specifically, (3.5) expresses the aggregate labor supply as a simple function of the mean utility, v, and the opportunity density, g(h,w).

Let us consider a particular extension to the case where the individual has the choice of participating in two sectors -- wage work and informal self-employment. In this case the set of feasible positions consists of combinations of market activities and type of production. Thus a specific position defines the type of wage work, type of production, and so on. To a position j there correspond attributes

$$(\bar{H}_j, H^*_j, W_j, T_j)$$

where $\bar{H}_j$ and H^*_j are hours of work in wage work and self-employment, W_j is the wage rate, T_j is a variable characterizing technology (unobservable) associated with position j.

Now the budget constraints take the form

$$C = \bar{H}_j W_j + Y_j + I \qquad (3.6)$$

$$Y_j = F (H^*_j) T_j \qquad (3.7)$$

where $F(H^*_j) T_j$ is a profit function conditional on hours and Y_j is the profit. (For analytical convenience we assume the structure to be of the multiplicative form.)

The essential postulate that ensures identification is that the opportunity density with respect to offered hours is assumed to be uniform. We assume no constraints on hours of work (given that work in the respective sectors is available). The offered distribution of wages across positions (conditional on education) is assumed to be log normal with mean dependent on experience and level of schooling (splines). The opportunity density of the profit (conditional on hours) is assumed log normal with mean that is log linear with an interaction term in hours. Unlike Jacoby (1988) our approach accounts for possible simultaneous equation bias, and does not distinguish between output from agricultural and nonagricultural self-employment. In the actual empirical application below a continuous analogue to the discrete model above has been estimated. For details we refer to Dagsvik and Aaberge (1989).

3.2. Model specification

The preferences are represented in the model by a Box-Cox type utility function that is additively separable in consumption and in each of the individual's leisure. The leisure terms are parameterized as a function of age and for females we have added the number of children below six years of age in interaction with hours of work in the wage sector. Thus the systematic term, v, of the utility function is assumed to have the form:

$$v(h, \bar{h}_F, C, f) = \alpha_2 \frac{((1+\frac{C}{1000})^{\alpha_1} - 1)}{\alpha_1}$$

$$+ \sum_j (\alpha_4 + \alpha_5 \log A_{jM} + \alpha_6 (\log A_{jM})^2) \frac{(L_{jM}^{\alpha_3} - 1)}{\alpha_3}$$

$$+ \sum_j (\alpha_8 + \alpha_9 \log A_{jF} + \alpha_{10} (\log A_{jF})^2) \frac{(L_{jF}^{\alpha_7} - 1)}{\alpha_7}$$

$$+ \alpha_{11} \sum_j \bar{h}_{jF} f_j + \alpha_{12} \sum_j D_{jM} \qquad (3.8)$$

where L_{jr} is defined by

$$L_{jr} = 1 - \frac{h_{jr}}{8760}, \; r = F, M,$$

C = per capita household consumption,

f_j = number of children less than six years,

A_{jr} = age of household member j, gender r = F,M,

h_{jr} = total annual hours of work for household member j, gender r

$\bar{h}_{jF}$ = annual hours of wage work, female j,

and

$$D_{jM} = \begin{cases} 1 \text{ if male j has hours of work in } (2475,\ 2525) \\ 0 \text{ otherwise.} \end{cases}$$

Except for the term $\alpha_{11}\ \Sigma\ \bar{h}_{jF}\ f_j$, utility is assumed additively separable in consumption and leisure[1]. Note that apart from the peak at full-time (2475,2525) the utility of consumption is concave and increasing when $\alpha_1 < 1$, $\alpha_3 < 1$, $\alpha_7 < 1$,

$$\alpha_4 + \alpha_5 \log A_{jM} + \alpha_6 (\log A_{jM})^2 > 0$$

and

$$\alpha_8 + \alpha_9 \log A_{jF} + \alpha_{10} (\log A_{jF})^2 > 0.$$

The dummy variable, D_{jM}, allows males to have a particular preference for total hours of work in the interval (2475, 2525). The motivation for introducing this dummy is that the data shows a marked concentration of hours in this interval both for males that are engaged in wage work as well as in farm and nonfarm self-employment. This can only occur

(1) if males have a particular preference for full-time work,

(2) if there are constraints on hours (there are more full-time work positions relative to other positions),

(3) if the data are corrupted by measurement errors.

The estimated model is consistent with all these explanations but we are not able to identify which is the true one.

The conditional profit function for the rural area given inputs is specified as

$$\log Y = \beta_0 + \beta_1 \log(1+h^*_M) + \beta_2 \log(1+h^*_F) + \beta_3 \log(1+h^*_C) \qquad (3.9)$$
$$+ \beta_4 \log(1+h^*_M)\log(1+h^*_F) + \beta_5 \log(1+\text{TOT[illegible]})$$
$$+ \beta_6 \log(1+\text{TOTDRIED}) + \beta_7 \text{MAXED} + T$$

where

Y = profit of household from self-employment (both farm and nonfarm)

h^*_M = total male hours of work in self-employment

h^*_F = total female hours of work in self-employment

h^*_c = total child hours of work in self-employment

TOTWET = total area of watered land

TOTDRIED = total area of dry land

MAXED = length of schooling of most educated member of the household

T = random error term - normally distributed.

T is supposed to account for unobserved choice variables that affect the production technology. The distribution of the technology attribute, T, is assumed to be normal N(0,t), and it is assumed to be independent of other input factors. Note that the land variables appear only in agricultural production, not in nonfarm production.

The conditional profit function for Lima is specified as

$$\log Y = \beta_0 + \beta_1 \log(1+h^*_M) + \beta_2 \log(1+h^*_F) + \beta_3 \log(1+h^*_M) \log(1+h^*_F) + \beta_4 \text{ MAXED} + T . \quad (3.10)$$

Let g_y be the fraction of all self-employment positions that are feasible for the household. Let g_r be the fraction of feasible positions for an individual of sex r, r=F,M, that are nonfarm self-employment positions. Let g^{**}_r, and g_r be defined analogously as the corresponding opportunity probabilities for farm self-employment and wage work, respectively.

We have parameterized g_y as

$$1 - g_y = \frac{ß}{a+ß(1-a)} , \quad (3.11)$$

where

$$ß = \prod_{r=F,M} [(1-g^*_r)(1-g^{**}_r)]^{m_r}$$

and m_F, m_M are the numbers of females and males in the household and $1 \geq a \geq 0$ is a parameter. The case a=1 corresponds to the case in which all self-employment opportunity sets are independent across household members. The particular parametrization (3.11) has been chosen for computational convenience. Finally, we have introduced g_s which is the fraction of feasible self-employment positions that yields positive profit during a period (one year). The rationale behind g_s is that in addition to a limited set of feasible self-employment positions is the fact that a successful business does not necessarily yield positive profit through every period. In fact the data demonstrate that profit is negative for some households during the period of the data collection. We may interpret alternatively as the (average) fraction of the year the business is likely to operate with positive profit. A rigorous treatment of the choice of self-employment activity would of course require a model for decision under uncertainty.

The offered wage densities are assumed log normal where the means depend on experience, SPLYRSC1, SPLYRSC2, SPLYRSC3 where experience is defined as age minus length of schooling minus 6 and

$$(\text{SPLYRSC1, SPLYRSC2, SPLYRSC3}) = \begin{cases} (x,0,0) & \text{if } x \le 5 \\ (5,x-5,0) & \text{if } 5 < x \le 10 \\ (5,5,x-10) & \text{if } x > 10 . \end{cases}$$

4. Summary Statistics and Parameter Estimates

The summary statistics of the variables generated from the household survey data are presented in Table 8 for Lima and rural areas. There are differences in observed household behavior in production and consumption, and in individual and household attributes. For example, consumption (income) per capita is much higher in Lima than in rural areas. Women in Lima spend more hours in wage work than women in rural areas; women in rural areas spend more hours in self-employment. However rural households record higher profits from self-employment than do households in Lima. This is not surprising given that nonfarm production is dominant in Lima while agricultural production is the leading activity in the self-employment category. Interestingly, female wage workers earn more in rural areas than male wage workers. When evaluated women's and men's total hours of work in wage and self-employed work in terms of the market wages they receive we find that women contribute about 27 percent to the total household income in Lima, and about 47 percent in rural areas of Peru. Women's total contribution to family income is thus higher than their corresponding wage contribution to total income as reported in section 2.3 earlier. When both self-employed and wage work are considered, women seem to contribute on average about 39 percent to family income in Peru. For more details see section 2 and Aaberge and Dagsvik (1989).

The parameters of the opportunity density and of the utility function are estimated simultaneously by a modified maximum likelihood procedure. The estimates of the utility function are presented in Table 9, while the estimates of the opportunity density are given in Table 12. The estimates of the wage and profit functions are shown in Tables 10 and 11 respectively. We have also estimated the wage equations and the profit function by ordinary least squares. This procedure may lead to biased estimates since it does not account for the fact that households do not maximize profit but the utility of consumption and leisure. Consequently, the conditional expectation of the error term

Table 8: Household and individual sample statistics

Variables	Lima, Mean (Standard deviation)		Rural areas, Mean (Standard deviation)	
Household statistics				
Number of households 898				
Consumption per capita (intis)	6,900	(150)	2578	(86)
Female hours of work in wage work (yearly)	832	(44)	101	(13)
Female hours of work in self-employment (yearly)	638	(44)	2232	(49)
Male hours of work in wage work (yearly)	2,171	(61)	594	(29)
Male hours of work in self-employment (yearly)	907	(50)	2724	(51)
Children's hours of work in self-employment (yearly)	53	(10)	4	(0.1)
Total gross revenue from self-employment (intis)	10,700	(600)	9056	(385)
Total profit from self-employment (intis)	6,300	(400)	7183	(311)
Number of children below 7	0.84	(0.03)	1.34	(0.03)
Number of children below 14	1.08	(0.04)	1.39	(0.03)
Number of females 15-70	1.79	(0.04)	1.52	(0.02)
Number of people above 70	0.09	(0.01)	0.08	(0.01)
Equivalence scale	4	(0.10)	3.7	(0.04)
Individual Statistics				
Number of females 15-70, 1,611				
Number of males 15-70, 1,539				
Participation rates in				
wage work for females	0.32	(0.01)	0.07	(0.01)
self-employment for females	0.35	(0.01)	0.85	(0.01)
wage work for males	0.63	(0.01)	0.34	(0.01)
self-employment for males	0.35	(0.01)	0.89	(0.01)
Hours of work in				
wage work for females (yearly)	463	(21)	67	(7)
self-employment for females (yearly)	356	(20)	1477	(25)
wage work for males (yearly)	1,267	(32)	387	(17)
self-employment for males (yearly)	529	(27)	1777	(25)
Wage rate, females (intis per day)	5.25	(0.40)	7.38	(2.45)
Wage rate, males (intis per day)	6.41	(0.20)	7.98	(0.30)

in the profit function given the hours is in general a function of these hours because they enter the utility function through consumption and leisure. The results are reported here only for Lima and rural areas.

The estimates of Table 9 imply that the systematic term (3.8) of the utility function is strictly concave and increasing in consumption and leisure. The estimates also show that the utility of leisure is U-shaped as a function of age with a minimum at 40.6 years for males and 37.4 for females in Lima. In rural areas the corresponding ages are 40.3 and 47.8. Moreover, the impact of small children seems to be the same in Lima as in rural areas.

The functional form (3.8) implies that the corresponding labor supply functions are highly non-linear and cannot be expressed in closed form. As a consequence the parameters of Table 9 do not have a simple interpretation in terms of elasticities. Table 10 shows that education and experience are very important determinants for the wage rate in the wage work sector of Lima. It also shows that the selectivity bias is negligible for Lima but for rural areas OLS seems to underestimate the effect of education for females. The bias is however

Table 9: Parameter estimates for the utility function

Variables	Coefficients	Lima Estimates (t-values)	Rural Areas Estimates (t-values)
Consumption	α_1	-0.776 (7.9)	-12.941 (4.0)
	α_2	4.832 (7.3)	35.891 (2.0)
Leisure, males	α_3	-3.605 (9.5)	-7.680 (14.9)
	α_4	43.258 (5.4)	3.189 (3.3)
	α_5	-23.194 (5.3)	-1.704 (3.3)
	α_6	3.134 (4.1)	0.231 (3.3)
Leisure, females . . .	α_7	-1.454 (5.7)	-5.380 (12.6)
	α_8	86.655 (5.5)	5.057 (2.8)
	α_9	-46.354 (5.3)	-2.475 (2.5)
	α_{10}	6.369 (3.2)	0.320 (2.3)
$10^{-3} \Sigma \tilde{h}_{JF} f_J$	α_{11}	-0.149 (2.3)	-0.152 (2.2)
ΣD_{JM}	α_{12}	2.234 (18.8)	2.231 (19.7)

Note: t-values in parentheses.

not significantly different from zero. Due to a lack of a sufficient number ofobservations, experience has been excluded from the wage equations for the rural areas. In addition SPLYRSC1 and SPLYRSC2 have been excluded for females in rural areas for the same reason. The justification for imposing the same coefficient of SPLYRSC1 as of SPLYRDSC2 is that preliminary estimation runs produced estimates that were quite close. For the rural areas the model is estimated conditional on farms with positive profit from self-employment. The reason for this is that there are few observations with zero or negative profit for households with self-employment activity. More important, preliminary estimation results suggest that the type of farms with reported zero or negative self-employment are essentially different from the rest of the sample.

Although the difference between the OLS and the ML estimates in Table 11 is not statistically significant the results seem to indicate that in the rural areas OLS seems to underestimate the impact of male and female labor, and the education variable MAXED (the length of schooling of the highest educated member of the family). In Lima, OLS seems to underestimate the impact of male and female labor and overestimate the impact of MAXED. Recall that the OLS estimates may be biased (i.e., simultaneous equation bias) while the ML estimates are obtained by a procedure that take into account that the input factors are endogenous.

Table 10: Wage equations for Lima, simultaneous ML estimation procedure versus Ordinary Least Squares

	Lima				Rural areas			
	Males		Females		Males		Females	
	OLS	Simul-taneous ML	OLS	Simul-taneous ML	OLS	Simul-taneous ML	OLS	Simul-taneous ML
Intercept	0.049 (0.4)	-0.105 (0.8)	-0.596 (3.5)	-0.674 (3.8)	0.352 (6.2)	0.395 (5.4)	0.473 (4.0)	0.451 (3.2)
SPLYRSC1+ SPLYRSC2	0.092 (8.4)	0.100 (8.2)	0.126 (8.2)	0.125 (7.9)	0.040 (3.5)	0.034 (2.3)	-	-
SPLYRSC3	0.117 (10.1)	0.136 (9.9)	0.126 (6.2)	0.150 (6.5)	0.284 (6.1)	0.306 (4.8)	0.303 (3.0)	0.540 (3.4)
Experience	0.050 (8.8)	0.038 (5.7)	0.056 (5.7)	0.050 (5.0)				
$(\text{Experience})^2/100$	-0.060 (5.3)	-0.039 (3.1)	-0.073 (3.5)	-0.063 (3.1)				
Standard error	0.659	0.660 (40.4)	0.780	0.753 (32.9)	0.888	0.933 (34.4)	1.856	1.316 (17.7)
R^2	0.27		0.25		0.09		0.06	

Note: t-values in parentheses.

Table 11: Parameter Estimates of the Conditional Profit Function

	Lima				Rural areas			
Variable	OLS		Simultaneous ML estimate		OLS		Simultaneous ML estimate	
Intercept	2.681	(5.9)	3.078	(7.1)	4.246	(7.1)	2.181	(2.5)
Male labor	0.756	(13.3)	0.572	(10.5)	0.329	(4.3)	0.543	(4.9)
Female labor	0.756	(11.0)	0.487	(8.7)	0.222	(2.7)	0.393	(3.4)
Interaction, female-male labor	-0.085	(9.8)	-0.061	(7.6)	-0.031	(3.0)	-0.053	(3.5)
Child labor					-0.0004	(0.4)	-0.010	(0.7)
Watered land					0.419	(7.5)	0.443	(5.2)
Dry land					0.264	(7.6)	0.249	(4.8)
Maxed	0.047	(2.4)	0.072	(4.0)	0.578	(9.7)	0.734	(7.3)
Standard error	1.356		1.257	(31.9)	1.303		1.445	(31.3)
R^2	0.33				0.18			

Note: t-values in parentheses.

The profit-function estimates also imply that the Cobb-Douglas structure is rejected, since there is a strong negative interaction between male and female hours of work. In contrast to the result for the rural areas, MAXED seems to be of little importance for the level of the profit in Lima. Thus the return to education in self-employment is much higher in rural areas (0.7) than in Lima (0.1). The estimates of the opportunity probabilities in Table 12 show that length of schooling has a substantial effect on the opportunities for wage work, particularly for females in Lima and in rural areas. Recall that the parameter a accounts for possible dependence in self-employment opportunities across family members where a = 1 corresponds to independence. Since a is estimated to be 0.577, independence is ruled out. The last line of Table 12 implies that g_s is estimated to be 0.87. Thus, on average, the self-employment businesses in Lima will produce positive profit a fraction of 0.87 per year (given that labor input take place).

5. Policy Simulation Results for Lima

Using the econometric framework above we can perform complex simulation experiments that take into account the household budget constraint, differences in age, schooling, and household size and composition. In addition we are able to account for unobserved heterogeneity, represented in the model by random error terms associated with the wage, conditional profit, and utility function. After the model has been estimated it is possible to perform simulations since we then "know" the parameters of the structural part of the utility, the wage, and the profit function, and the probability distributions of the related random terms.

In practical policy simulation experiments we proceed as follows. For each household the respective random terms are drawn from the corresponding probability distributions. The maximization of the utility function is a pure numerical problem given the observed household characteristics. The resulting hours that maximize utility are the female and male labor supply in each sector. This procedure is performed for each household in the sample to obtain participation rates, distribution of labor in each sector, and consumption and profits from self-employment. Note that this procedure implies exact aggregation. Unfortunately, since the model is so rich it is quite costly to perform precise simulations. We have therefore only carried out approximate simulations in which the approximation error is of moderate size. Figures 1-6 in Appendix C show the observed and simulated distribution of male and female hours of work and per capita consumption. These figures demonstrate that the model is capable of reproducing the survey data fairly well.

We confine the analysis to households with at least one female and one male adult, where per capita household consumption does not exceed 20,000 intis. Note that this selection was not made in Section 2.

The simulation experiments relate to the effect of changes in wages and education on labor supply, wage earnings, profit from self-employment, and distribution of economic welfare.

Table 12: Estimates of the opportunity probabilities

Sector	Opportunity Probability Function	Lima	Rural areas
Agricultural self-employment males .	$\log \left[\frac{g^{**}_{1M}}{1-g^{**}_{1M}}\right]$	-2.804 (19.3)	1.932 (24.0)
Nonagricultural self-employment males .	$\log \left[\frac{g^{*}_{1M}}{1-g^{*}_{1M}}\right]$	-0.197 (2.5)	-1.501 + 0.027S (13.0) (1.5)
Wage work, males .	$\log \left[\frac{\bar{g}_{1M}}{1-\bar{g}_{1M}}\right]$	-0.438 + 0.103S (2.6) (5.4)	-0.545 + 0.042S (5.5) (1.9)
Agricultural self-employment, females	$\log \left[\frac{g^{**}_{1F}}{1-g^{**}_{1F}}\right]$	-1.198 (12.5)	1.656 (24.0)
Nonagricultural self-employment, females	$\log \left[\frac{g^{*}_{1F}}{1-g^{*}_{1F}}\right]$	0.007 (0.1)	-0.516 (9.4)
Wage work, females	$\log \left[\frac{\bar{g}_{1F}}{1-\bar{g}_{1F}}\right]$	-1.236 + 0.152S (7.0) (8.1)	-2.656 + 0.162S (15.2) (4.7)
Household profit from self-employment .	a	-0.577 (8.0)	
Positive profit from self-employment .	$\log \left[\frac{g_{,}}{1-g_{,}}\right]$	1.884 (12.2)	

S = Length of schooling.
Note: t-values in parentheses.

5.1. Wage effects

Table 13 reports the effect of wage changes on participation probabilities and on mean hours worked in each sector. The table shows that a 20 percent increase has only a small effect on labor supply. For the females, mean hours of work and participation in the wage sector increase by 5.8 and 3.2 percent respectively. The effect on mean hours and participation in self-employment is almost negligible. The cross effect on male participation rates and mean hours of work in each sector is negligible.

Recall that the sum of the participation rates across sectors may be greater than one because many individuals work in both sectors. When male wages are increased by 20 percent, their participation and mean hours of work in the wage sector increase by 1.6 and 2.7 percent respectively. In the self-employment sector, male participation and mean hours of work fall by 1.2 and 2 percent respectively, while female participation and mean hours of work fall by 2 and 2.4 percent. The drop in female labor supply reflects the income effect that stems from the increase in male wages. When both male and female wages increase by 20 percent, the impact is similar but weaker.

Table 13: Changes in participation rates, annual hours of work, earnings, and consumption as a result of wage increments (percentage changes from base case)

Percentage increase	Sector specific participation				Sector specific annual hours of work (unconditional)		Wage earnings (unconditional)*) (intis)		Wage earnings (intis)		Consumption (intis)	
	Wage work		Self-employment		Wage work		Self-employment					
	F	M	F	M	F	M	F	M	F	M	F	M
Base case	0.32	0.62	0.34	0.35	414	1165	414	492	2300	8100	17900	27800
20 percent increase in female wages	3.2	-0.6	-0.9	-1.2	5.8	-0.7	-0.5	-0.4	30.0	-1.2	6.3	5.0
20 percent increase in male wages	-1.9	1.6	-2.0	-1.2	-2.2	2.7	-2.4	-2.0	-4.6	22.3	17.1	11.9
20 percent increase in both female and male wages . .	0.6	0.6	-1.8	-1.4	1.9	1.9	-1.5	-2.4	19.8	20.5	21.2	11.5
Female wage rates increased by 20 percent of the mean wage	3.8	-1.4	-0.9	0	8.0	-1.4	-1.5	0	25.0	-0.8	5.0	4.7
Male wage rates increased by 20 percent of the mean wage	-2.9	2.1	-0.9	-2.3	-3.6	3.8	-0.5	-3.5	-4.5	17.6	14.0	7.0
Female and male wage rates increased by 20 percent of the mean wage	1.6	1.0	-2.3	-2.9	3.4	2.0	-2.7	-4.3	19.7	15.1	16.2	8.6

*) Recall that conditional hours in the respective sectors can be obtained by dividing the unconditional hours by the corresponding participation rates.

The largest effect is obtained when the female wages go up by 20 ^R percent of the mean wage. Then participation and mean hours in wage work rise 3.8 and 8 percent, respectively. Table 13 shows that mean hours in the wage sector increase by 4 percent. The drop in participation and mean hours recorded in self-employment sector, however, is small. The change in male labor supply is also small.

When males wages increase by 20 percent of the mean level, their participation and hours of work in the wage sector increase by 2.1 and 3.8 percent respectively. In the self-employment sector, their participation and mean hours decrease 2.3 and 3.5 percent. The corresponding income effect implies

that female participation and mean hours in the wage sector decrease 2.9 and 3.6 percent respectively, while there is almost no change in female participation and mean hours in the self-employment sector.

Table 14 demonstrates that wage changes have a modest effect on inequality in the distribution of per capita consumption among households. A 20 percent increase has very little distributional impact, reducing inequality by 3 percent (A-coefficient). This reduction corresponds to introducing a proportional tax of 3 percent and then increasing each household's per capita consumption by an equal share of the total tax revenue. In other words the transfer to each household is equal to 3 percent of the mean consumption per capita (before taxes). A similar increase in female wages increases the mean level of the household's per capita consumption by 4.9 percent, while the level of inequality is not influenced. This result corresponds to increasing each household's per capita consumption by 4.9 percent. Note that the relative changes in inequality are larger when inequality is measured by the Gini coefficient than by the A coefficient, particularly when female wages are increased by 20 percent. This means that the central part of the distribution of per capita consumption is more strongly influenced by wage changes than the lower part of the distribution.

Table 14: Changes in mean level and inequality in the distribution of per capita household consumption as a result of wage increments (percent change)

	Mean level	A-coefficient	Gini coefficient
Base case	7,600 (in intis)	0.566	0.438
20 percent increase in female wages . . .	5.3	2.1	3.2
20 percent increase in male wages	11.9	0.5	0.7
20 percent increase in both female and male wages	11.6	-1.[illegible]	-1.6
Female wage rates increased by 20 percent of the mean wage	4.9	0	0.7
Male wage rates increased by 20 percent of the mean wage	6.4	-3.0	-3.4
Male and female wage rates increased by 20 percent of the mean wage	8.6	-3.0	-3.4

Note that we only report aggregate effects here. We have also done wage change simulations for a two-person family for the particular case in which all the random terms are equal to zero and without any choice constraints. The results are not reported here. (See Dagsvik and Aaberge, 1989). These simulations demonstrate that the elasticities of hours are highly dependent on the level of the wage rates. The reason the corresponding aggregate effects are much smaller may be due to the large heterogeneity in wage rates and the fact that in many families one or more persons are "stuck" in corner solutions, that is, they participate at most in one sector. Such families are therefore less responsive to wage changes than families where all members work in both sectors. In addition, restrictions on opportunities prompt a large number of corner solutions.

5.2. Education effects

Table 15 shows the impact of education through the opportunity probabilities. Here the wage rates and the education variable (MAXED) in the conditional profit function are kept unchanged. Thus we study the pure "opportunity" effect. Contrary to the wage simulations above, we obtain a large effect from increased education. If female education is increased by one year, female participation in the wage sector increases by 9.2 percent. The change in the participation rate in self-employment, however, is within the simulation error margin. If male education is increased by one year, participation in wage work increases by 3.4 percent, and remains unchanged for the self-employed. If the minimum education for females is increased to nine years, female participation in the wage sector increases by 19 percent. When males' level of schooling is increased analogously, male participation in the wage sector increases by 3.9 percent. The cross effects appear to be negligible.

Table 16 reports the impact of increased education on labor supply. Here only MAXED is kept unchanged. In other words the increase in schooling affects both wages and the choice set of work positions. The first line demonstrates that the wage effect seems to be small compared to the impact through the opportunity probabilities. In Table 15 we found that the corresponding female participation rate increased 18 percent, or only 3.5 percentage points less than we obtained by increasing minimum schooling to nine years without keeping the wage rate fixed. The subsequent effect on mean hours of work in the wage sector is a 25.6 percent increase for females and a 2.7 percent decrease for males. The corresponding increase in the conditional mean hours given participation in the wage work sector for females is 3.3 percent. The other income and cross effects on hours are small. The mean wage earnings for females increases dramatically to 42.6 percent.

If the minimum level of schooling for males is increased to nine years the impact on labor supply is much less. In this case participation in wage work rises 5.6 percent for males and falls 3.5 percent for females. Mean hours of wage work increase 6.7 percent for males and decline 4.4 percent for females. Other income and cross effects on labor supply are small. Wages increase by 14.8 percent for males and fall by 5 percent for females. But the total effect on household income is larger than it was when the minimum education for females was raised to nine years.

Table 15: Effects of education on sector-specific participation rates when wages are fixed (percentage change)

	Sector-specific participation rates			
	Wage work		Self employment	
	F	M	F	M
Base case	0.32	0.62	0.34	0.35
One year of additional schooling for females	9.2	-1.4	0	0
One year of additional schooling for males	-1.3	3.4	0	-0.6
One year of additional schooling for both males and females . .	7.6	2.4	0	-0.9
Nine years of schooling as a lower limit for females	19.0	-1.0	0	-0.3
Nine years of schooling as a lower limit for males	-1.3	3.9	0	-0.9
Nine years of schooling as a lower limit for both males and females	18.0	3.5	0	-1.2

Table 16: Changes in participation rates, annual hours of work, earnings and consumption as a result of additional schooling and subsequent increase in wage rates. (percentage changes from base case)

Percentage increase	Sector specific participation				Sector specific annual hours of work (unconditional)*		Wage earnings (unconditional) (intis)		Wage earnings (intis)		Consumption (intis)	
	Wage work		Self-employment		Wage work		Self-employment					
	F	M	F	M	F	M	F	M	F	M	F	M
Base case	0.32	0.62	0.34	0.35	414	1,165	414	492	2,300	8,100	17,900	27,800
Nine years of schooling as lower limit for females . .	21.5	-1.8	1.2	-0.6	25.6	-2.7	-1.5	0	42.6	-2.0	8.4	6.5
Nine years of schooling as lower limit for males . . .	-3.5	5.6	0	-1.7	-4 4	6.7	0	-3.5	-5.0	14.8	11.2	7.6
Nine years of schooling as lower limit for both males and females	19.0	3.7	0.9	-1.4	20.5	3.0	-1.2	-2.4	33.9	11.1	17.3	11.2

When both males and females have at least nine years of education, female participation and mean hours in wage work increase by almost the same amount as in the "marginal" case reported in the first line of Table 16. Male participation and mean hours in wage work increase by 3.7 and 3 percent respectively, which is much less than the response in the "marginal" case (second line).

We have also carried out simulations in which MAXED is increased. The results (not reported here) show a very small impact on profits.

Earlier we concluded that the impact of wage changes on inequality in the distribution of per capita consumption is modest. Table 17 demonstrates that this is also the case when schooling is increased. In spite of a considerable increase in mean per capita consumption, the reduction of inequality in the distribution of per capita consumption is surprisingly small. Since the changes in inequality are the same whether it is measured by the Gini coefficient or the A-coefficient, we can conclude that changes in schooling have the same impact on the lower part of the distribution of per capita consumption as on the central part of this distribution.

Table 17: Effect of education on mean level and inequality in the distribution of per capita consumption among households with a subsequent increase in wage rates. (percentage changes from base case)

	Mean level	A-coefficient	Gini coefficient
Base case	7,600	0.566	0.438
Nine years of schooling as lower limit for females	5.3	0	0
Nine years of schooling as lower limit for males	6.6	-1.8	-1.8
Nine years of schooling as lower limit for both males and females . .	10.5	-3.0	-3.2

6. Conclusion

The data show that male wages play a dominant role in household consumption in Lima, while entrepreneurial income is the most important income source in rural and in other urban areas. In Lima males wage earnings contribute almost 40 percent of the household's consumption, which seems to reflect their share of total household hours of work. For females the corresponding shares are about 17 percent for both Lima and other urban areas. The same relationship holds for rural areas. Despite the similarity, consumption is considerably less equally distributed than hours of work. This is also the case when we examine the distribution of welfare. As an indicator of welfare we apply household consumption relative to an equivalence scale. This indicator accounts for some of the heterogeneity in household demographic composition.

The estimated structural model departs from the assumption that the members of a household behave so as to maximize a household utility function, given available work resources and production opportunities. The corresponding econometric approach differs from the traditional labor supply models in the literature. Our particular approach has the advantage of being well-suited for taking into account latent opportunity constraints, the interdependence between each person's activities in different sectors, and the interdependence between household members. Since many households have more than two adults, this is a major challenge.

It may not be obvious that the neoclassical type model used in this analysis is appropriate for examining Peru's labor market. The analysis rests on the assumption that the data reflects the heterogeneity of preferences and opportunities to a "large" extent. For example, it may be questionable if essential background information about the heterogeneity in customs and value systems across social classes, ethnic groups, and "professions" is reflected in the data. It is also essential that the data on hours, participation and economic variables are not corrupted by measurement errors. Such errors in economic variables may occur if, for instance, household members are engaged in black-market activities, or if a substantial part of the goods and labor markets operates by trading services and goods without explicit prices. This is particularly relevant in countries where inflation is high, as in Peru. Also we assume that the average number of feasible wage positions with low (offered) hours is the same as the number of feasible wage positions with high offered hours. Under the assumption that there are no restrictions on hours of work in the self-employment sector, it is possible to test this assumption.

If we are willing to accept the neoclassical point of departure as well as the assumptions about the data and the choice environment, the estimation results reported here demonstrate that the parameters are determined with remarkable precision and have the expected signs according to economic theory. The model also reproduces the aggregate distributions of hours and consumption fairly well.

The simulation results for Lima demonstrate that proportional wage changes have only a small effect on behavior. It is also remarkable that the wage increases have very little effect on the inequality in the distribution of per capita consumption. Even when wage rates are increased by the same amount the indirect effect is small. This increase does, however, moderately reduce the inequality in the distribution of per capita consumption.

These simulation exercises show that it is very difficult to reduce inequality in per capita consumption by changing wage and education policies.

APPENDICES

APPENDIX A. Estimates of inequality based on the Gini coefficient

The tables below correspond with the following tables for the A-coefficient: Table G1 corresponds to table 1, table G2 corresponds to the data in table 6, and table G3 to table 3.

Table G1: Gini-Inequality in Distribution of Hours of Work for Males and Married and Unmarried Females, by Region

Region	Males (15-70)	Females (15-70)		
		All	Married	Unmarried
Peru	.249	.362	.364	.359
Lima	.251	.404	.426	.379
Other urban	.275	.404	.415	.387
Rural	.231	.318	.312	.328

Table G2: Gini-Inequality in Distribution of Hours of Work among Households, by Region

Peru	Lima	Other urban	Rural
0.344 (0.003)	0.349 (0.007)	0.351 (0.007)	0.320 (0.005)

Note: Numbers in parenthesis are standard deviations.

Table G3: Gini-Inequality in Distribution of Per Capita Consumption among Households and Persons by Region

Consumption by	Peru	Lima	Other urban	Rural
Households	.787 (.043)	.567 (.021)	.830 (.068)	.843 (.048)
Persons	.789 (.020)	.553 (.010)	.835 (.030)	.835 (.023)

Note: Numbers in parenthesis are standard deviations.

APPENDIX B: Definition of main variables

The model used here follows the definitions in the Peru Living Standards Survey. We record information on the two most important jobs held by each individual in the last seven days and in the last 12 months prior to the survey. Therefore annual hours of work and wage earnings are defined by (A.1) and (A.2).

Table A1: Measures of annual hours of work and wage earnings

	Last 7 days			Last 12 months		
	Weekly hours of work	Weekly wage earnings	Number of weeks	Weekly hours of work	Weekly wage earnings	Number of weeks
Main job	h_1	k_1	r_1	h_2	k_2	r_2
Second job . . .	h_3	k_3	r_3	h_4	k_4	r_4

$$\text{Annual hours of work} = \sum_{i=1}^{4} r_i h_i \qquad \text{(A.1)}$$

and

$$\text{Annual wage earnings} = \sum_{i=1}^{4} r_i k_i. \qquad \text{(A.2)}$$

To illustrate we show three possible outcomes of h_1, h_2, r_1 and r_2 in Table A2.

Table A2: Three examples of observations of main jobs in the course of 12 months

	Last 7 days		Last 12 months	
Outcome	Weekly hours of work	Number of weeks	Weekly hours of work	Number of weeks
1	40	50	0	0
2	0	0	40	50
3	40	28	30	24

Based on wage earnings and annual hours of work, wage rate is given by:

$$\text{wage rate} = \frac{\text{Annual earnings}}{\text{Annual hours of work in wage sector}}$$

Table A3 shows how profits from farm and non-farm production are measured.

Table A3: Measure of Profits from Farm and Nonfarm Production

	Farm	Nonfarm
Revenue	TOTREV	REVCONS
Expenses	EXFARM = (TOTINP + TPTLIVST)	EXPENSES = (TOTAL MTHLY EXPENSES*NO. MTHS ENTERPRISE OPEN IN LAST YEAR)
Value added	PROFARM = TOTREV - EXPFARM	PROFITS = REVCONS - EXPENSES

APPENDIX C: Figures

Figure 1. Observed and simulated distributions of annual hours of work for females living in rural areas.

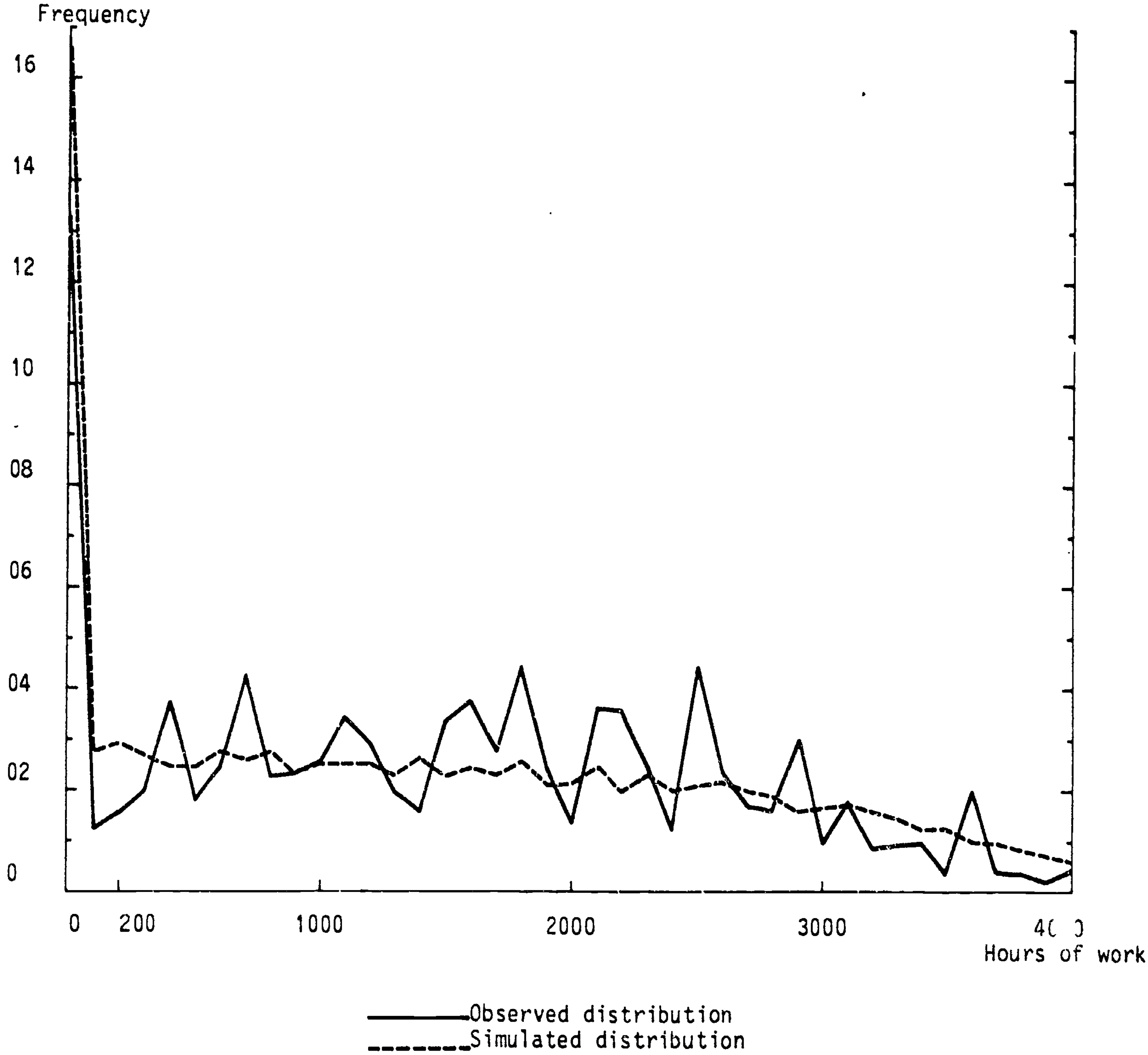


Figure 2. Observed and simulated distributions of annual hours of work for males living in rural areas.

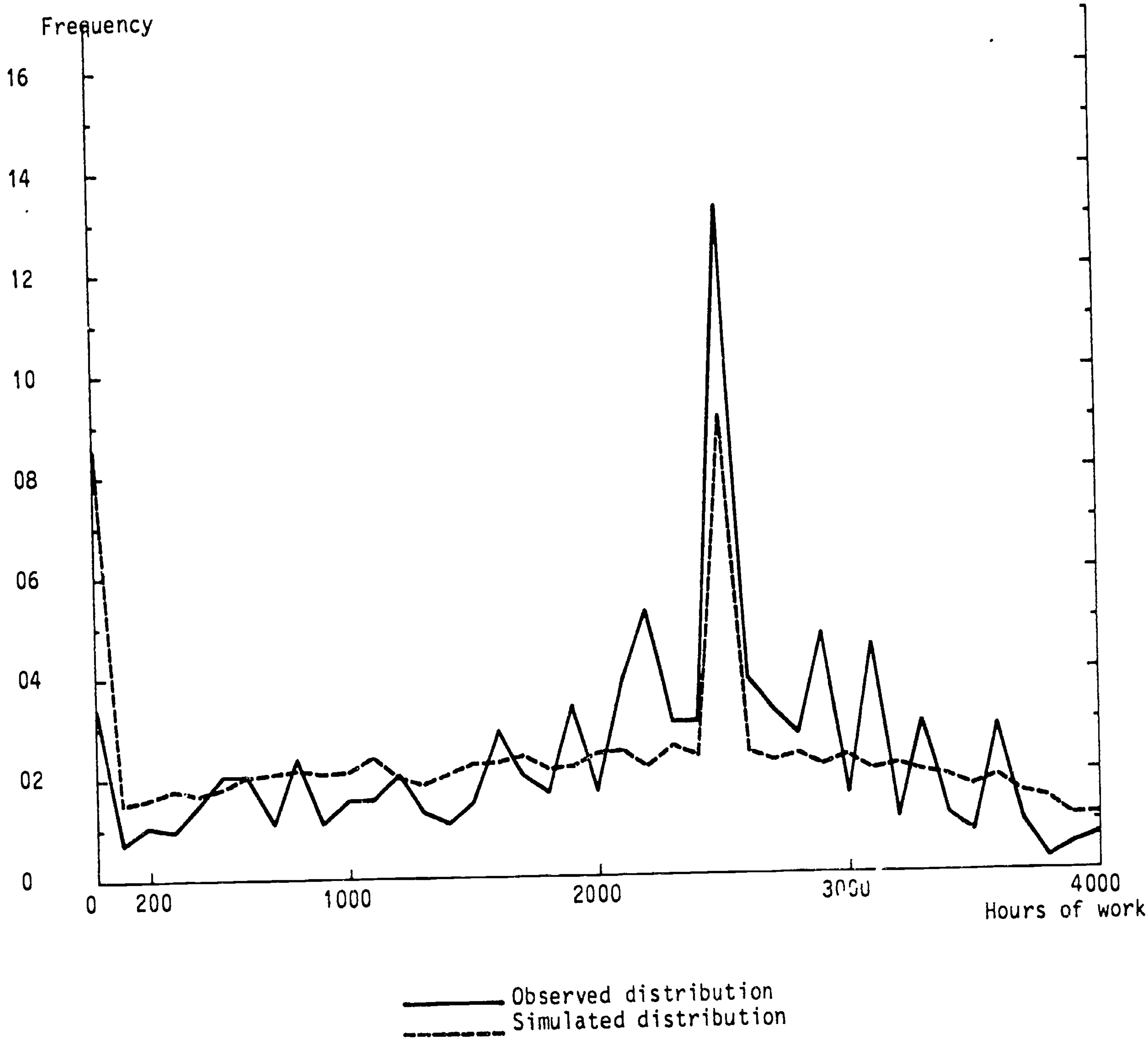


Figure 3. Observed and simulated distributions of per capita consumption among households living in rural areas.

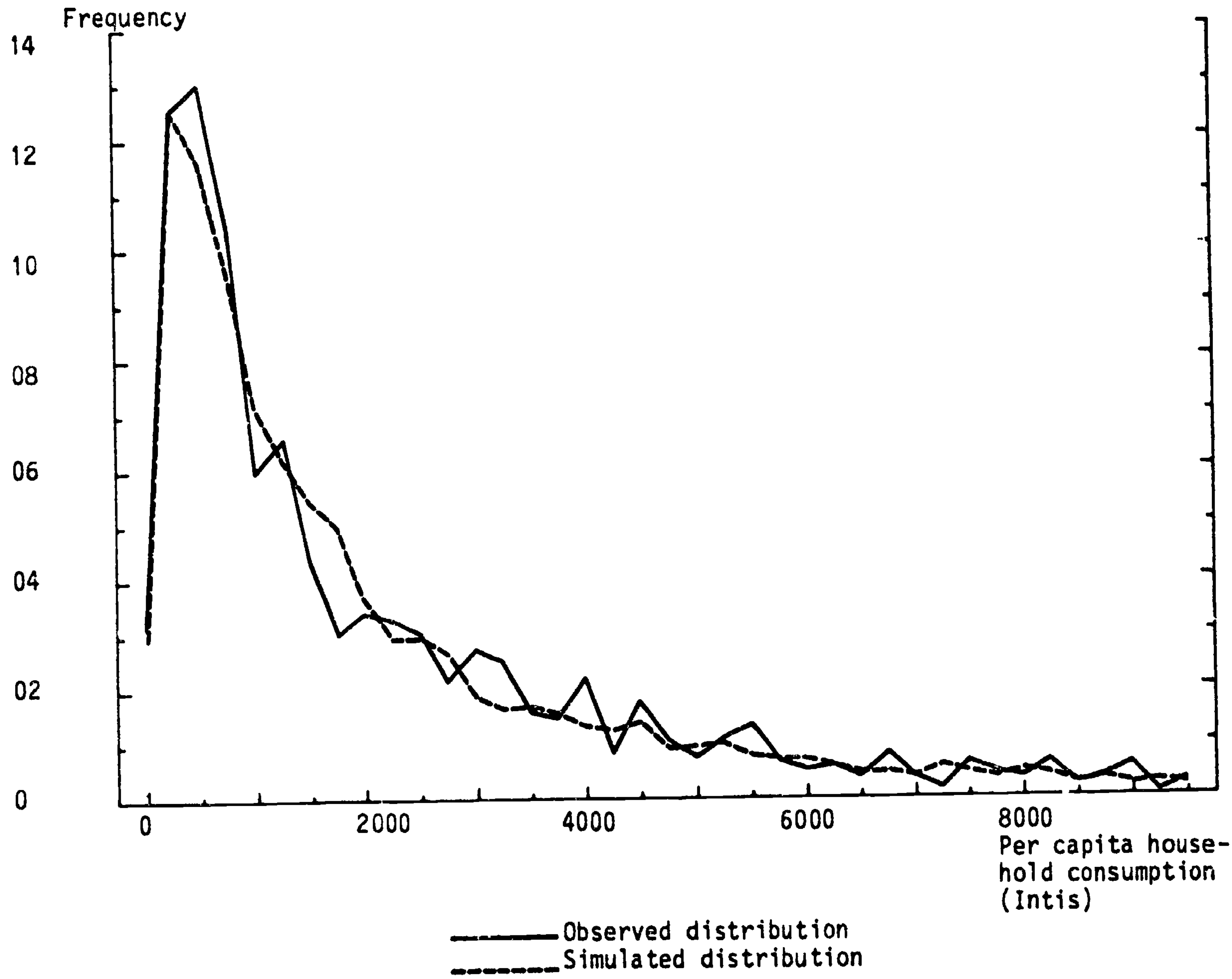


Figure 4. Observed and simulated distributions of hours of work for females living in Lima

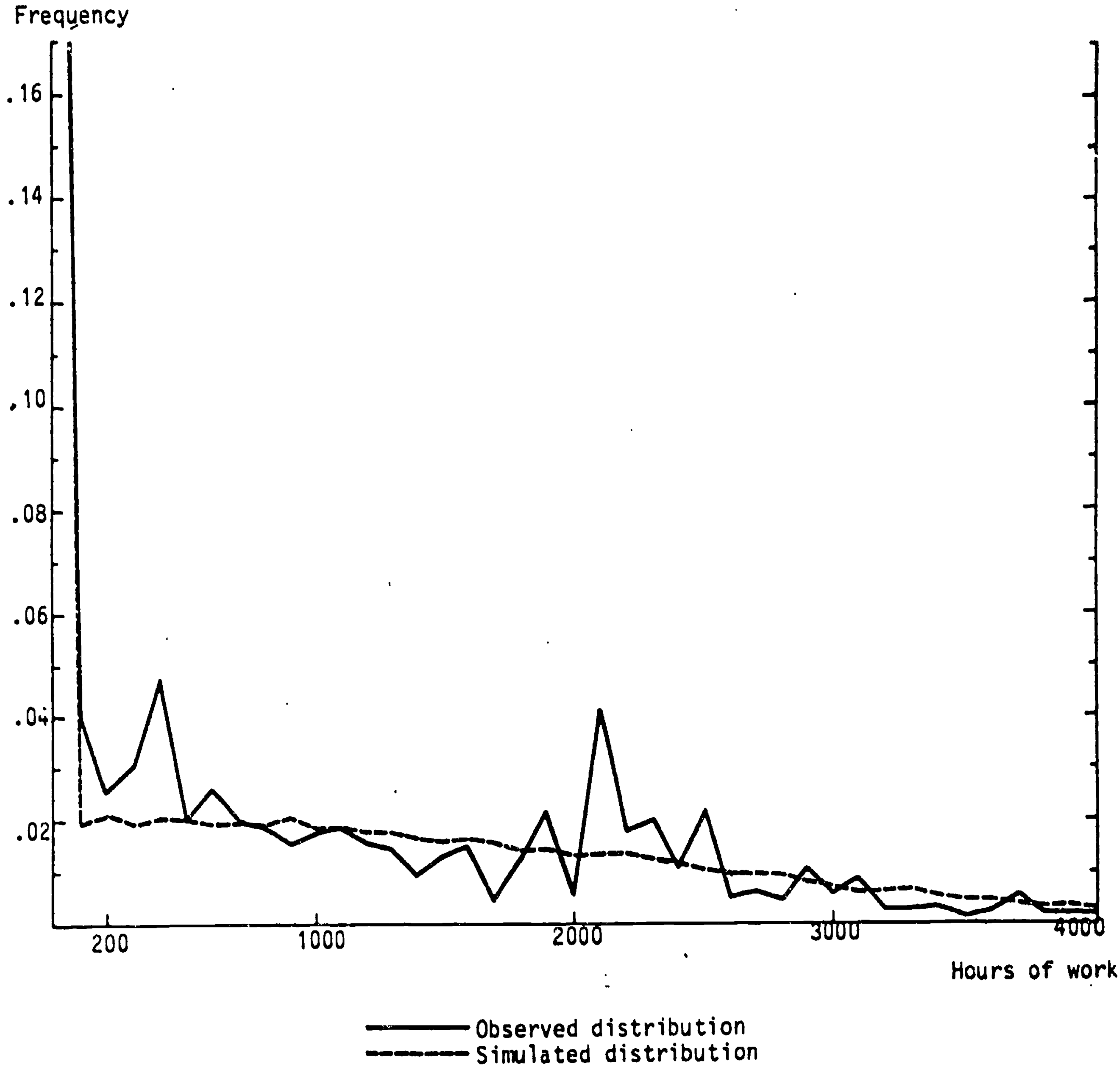


Figure 5. Observed and simulated distributions of hours of work for males living in Lima

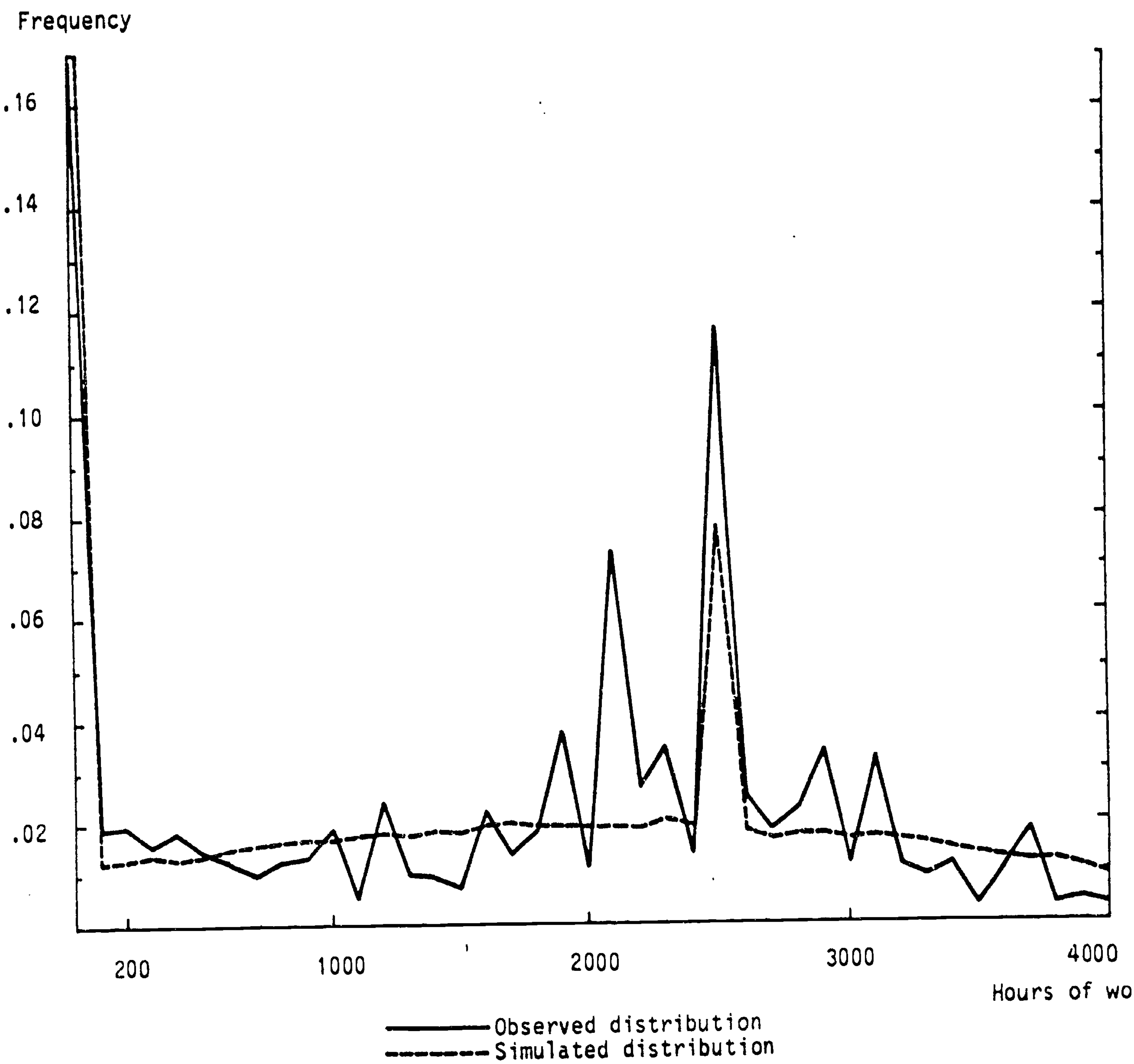
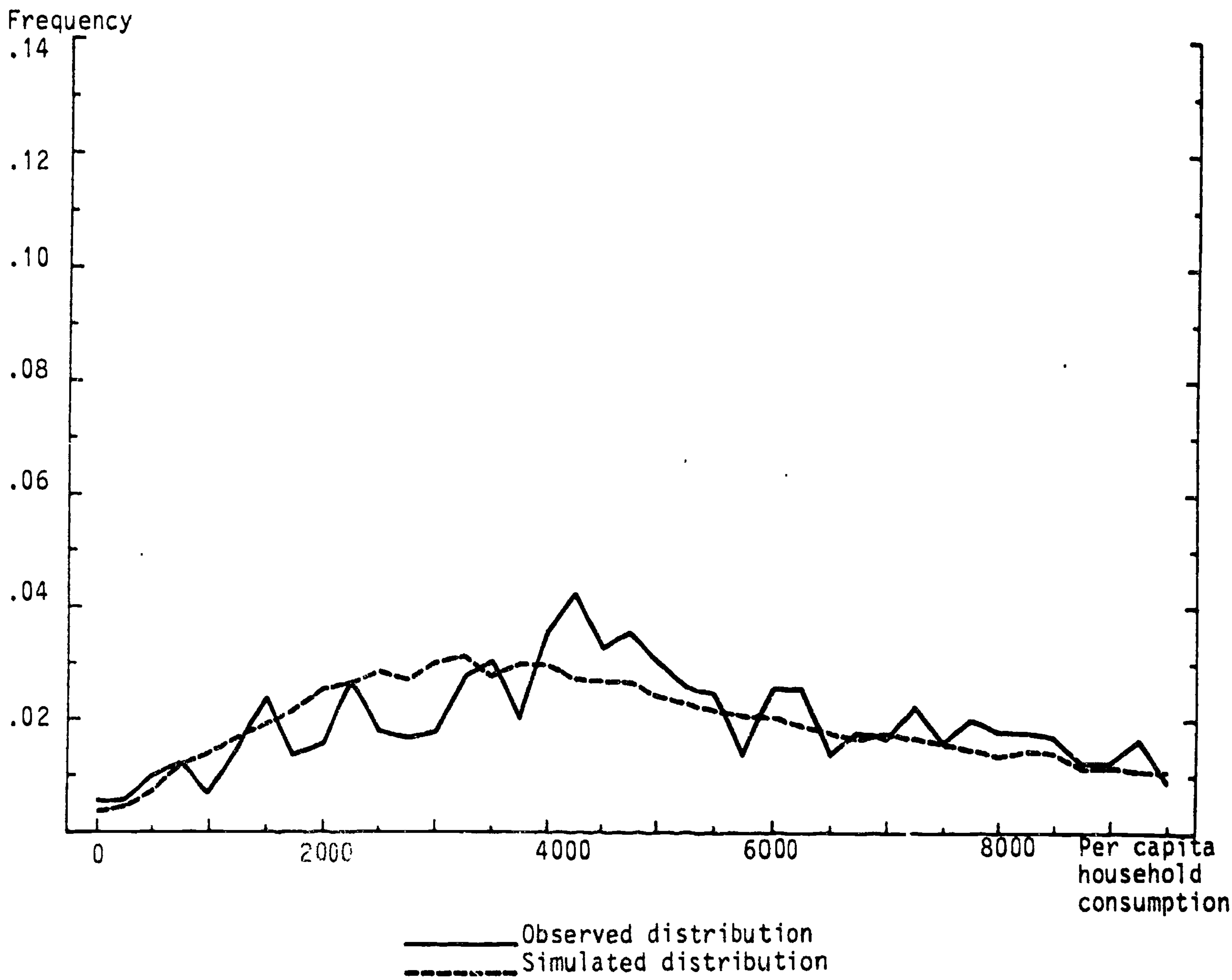


Figure 6. Observed and simulated distributions of per capita consumption among households living in Lima



CHAPTER 5

FERTILITY DETERMINANTS IN PERU: A QUANTITY-QUALITY ANALYSIS*

Marcia Schafgans

1. Introduction

The economic model of marital fertility discussed in this chapter is a one-period, full-certainty model, that seeks to explain the number of children born and the "quality" of those children.

The framework applies the quantity-quality model initiated by Becker (1960) and uses data from the Peru Living Standards Survey (1985-1986). The model assumes that parents maximize their joint utility, which is a function of the number of children, the quality per child, and the quantity of goods they consume. Educational attainment is a proxy for the quality per child.

One shortcoming of this approach as well as many other models based on the "new home economics theory" is its staticity. The data used in this analysis, however, do not permit a dynamic analysis of fertility. The long time-horizon of fertility decisions also poses problems in defining the "lifetime income" variable in the fertility model. Furthermore, the model does not incorporate uncertainty with respect to contraceptive failure, randomness of the sex of children, and mortality experience, all of which influence the number of children (see Rosenzweig and Schultz 1987, and Cochrane and Zachariah 1983). The available data for this type of research generally do not include information on the types of family planning services that are available. Last, the interaction between husband and wife in deciding on the number and quality of children (bargaining process) has not been taken into account (see Manser and Brown 1980).

Over the last decade fertility in Peru has declined about 23 percent (ENDES 1986). The drop has not been evenly distributed, however, with urban areas recording a sharper 31 percent decrease in fertility, and rural areas showing a 15 percent decrease. Women in Peru have 4.1 children on average at the end of their reproductive cycle, with 3.1 in urban areas, and 6.3 in rural areas. If Peru is to reduce fertility while effectively improving the quality of all children, it is of major importance to understand what factors influence parents' decisions on the quantity and quality of children, and what are the tradeoffs between them. Some of these factors, including age, education, income,

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location (urban or rural), and infrastructural variables are discussed here.

The models show the following results:

- The number of children born increases monotonically with female age, at a decreasing rate for older women.
- There is a negative relation between the mother's education and the number of children, and a positive relation between the mother s and the children's education.
- Higher levels of female and male hourly wages, unearned income, and household expenditures per adult are correlated with fewer children and higher levels of child education.
- Rural parents have more children, and the demand for children's education is lower than in urban areas.
- The distance to a family planning center (a proxy for the price of contraception) showed no effect on the number of children, though it has a negative effect on the quality of children.[1]
- The distance to secondary school (a proxy of the cost of education) had a negative effect on the number of children, but no effect on education.

The chapter is structured as follows. First, we give a short history of the fertility model and describe the economic model of the determinants of fertility and the estimation strategy. Section 3 discusses the empirical results and tests several hypotheses. Section 4 examines several simulations and discusses the implications for policy measures to improve household welfare. Last, Section 5 reports the conclusions.

2. The Economics of Fertility

The systematic development of the economics of the family dates from the late 1950s when Leibenstein (1957) and Becker (1960) addressed the determinants of fertility behavior within the framework of consumer theory.

According to Becker, fertility decisions are economic in that they involve a search for an optimum number of children in the face of economic limitations. Becker holds that parents derive fulfillment from the number of children, the quality of those children, and the quantity of goods consumed, but are constrained by their lifetime income. In his original approach little was said about the opportunity costs of childbearing. But recognizing the economic importance of the close connection between women's labor-force participation and their levels of fertility, Becker (1965), as well as other economists (such as Mincer 1963), later built the opportunity cost of women's time into the theory.

[1] No information is available on what family planning services are offered at the centers.

Women's parenting responsibilities (more than men's) compete with other activities, such as labor force participation. Later papers further elaborated on the basic model. Willis (1973) developed a theoretically complete model of the demand for children, and others introduced such elements as uncertainty and educational aspirations (see Michael and Willis 1975, De Tray 1973, and Becker and Lewis 1973).

Proponents of Becker's 1960 article frequently refer to it as the new home economics model (Chicago School). An alternative theory, developed by Easterlin (1969), synthesizes economic and sociological approaches to fertility. This model, quite consistent with the new home economics model, is more elaborate. It introduces a wide range of questions associated with the "supply" side of fertility, in which biological and cultural factors determine the natural fertility of the population and define the upper limit to family size.

The model discussed in the next section follows Becker's demand-driven quantity-quality approach.

2.1 An Economic Model of the Determinants of Fertility

This analysis is a one-period, full-certainty model that seeks to explain the number of children ever born to married women over the life-cycle, and the quality of those children. It is assumed that parents maximize their joint utility function, which is believed to have three arguments (Becker 1960): the number of children (C), the quality per child (Q), and the quantity of goods they consume (G), or,

$$\text{Max } U(C,Q,G) \tag{1}$$

The technology of household production is described by linear homogeneous production functions of the form:

$$\begin{aligned} C &= C(x_c, T_{m,c}, T_{f,c}) \\ Q &= Q(x_q/C, T_{m,q}/C, T_{f,q}/C) \\ G &= G(x_g, T_{m,g}, T_{f,g}) \end{aligned} \tag{2}$$

The inputs consist of market-purchasable commodities, x_i, and available time of each parent, $T_{j,i}$, where i=C,Q and G, and j=m (male) and f (female).

The total time that men and women have for various activities, including market wage work $T_{j,w}$, is restricted by their lifetime hours, T, as follows:

$$T = T_{m,c} + T_{m,q} + T_{m,g} + T_{m,w} = T_{f,c} + T_{f,q} + T_{f,g} + T_{f,w} \tag{3}$$

It is generally accepted that $T_{m,c}+T_{m,q} < T_{f,c} + T_{f,q}$ to account for the fact that in the production of child services, S = C*Q, women's time is utilized more intensively.

The total potential income constraint parents face, evaluated in terms of shadow prices of commodities, is:

$$I = TW_m + TW_f + V = \pi_c C + \pi_q Q*C + \pi_g G \qquad (4)$$

where:

$$\pi_c C = T_{m,c}W_m + T_{f,c}W_f + p_c x_c$$
$$\pi_q Q*C = T_{m,q}W_m + T_{f,q}W_f + p_q x_q$$
$$\pi_g G = T_{m,g}W_m + T_{f,g}W_f + p_g x_g.$$

The shadow prices π_c, π_q, and π_g refer respectively to the number of children, the quality of those children, and other goods; W_j is the market wage rate of parent j; and P_c, P_q, and P_g are the prices of market inputs associated with each function argument.

Maximization of the joint utility function (1) subject to the production functions (2) and the lifetime income constraint (4) yields first-order necessary conditions for an (assumed) interior maximum, from which demands for C, Q, and G can be obtained as functions of total full income, and the prices of time and market inputs. These first-order conditions are:

$$U_C - \delta(\pi_c + \pi_q Q) = 0$$
$$U_Q - \delta\pi_q C = 0$$
$$U_G - \delta\pi_g = 0$$
$$\pi_c C + \pi_q Q*C + \pi_g G - I = 0,$$

where δ, the Lagrange multiplier, is nonnegative. Full income is a function of nonlabor income, V, and the prices of parental time. Therefore we can write the demand functions for the number and quality of children and household commodities as:

$$C = C(W_f, W_m, p_c, p_q, p_g, V)$$
$$Q = Q(W_f, W_m, p_c, p_q, p_g, V) \qquad (5)$$
$$G = G(W_f, W_m, p_c, p_q, p_g, V)$$

In the production of child services, it is assumed that parents can substitute quality for number of children (quality-quantity interaction hypothesis).

2.2 Empirical Specification

To estimate the reduced forms for children ever born and the quality of those children, the price equations for market inputs p_c, p_q, and, p_g need to be specified in terms of observable variables.

In this analysis it is assumed that p_g is constant across families in the same period, whereas p_c is assumed to vary with the age of the mother, her education, the degree of urbanization, and distance to a family planning center[2]. Due to differences in the risk of pregnancy it is hypothesized that the number of children increases with the age of the mother (the biological capacity

[2] Father's education is not included as it is highly correlated with the education of the mother (R^2=0.8).

effect). In Peru, older women on average married earlier in life than the young women do, thereby lengthening their fertile period.[3] Besides from the wealth and time-price effects of education on the quantity of children, high levels of education are postulated to be associated with fewer children as a result of a) lower child mortality and fewer unwanted children; b) better knowledge and practice of family planning;[4] and c) increased child spacing.[5] The fact that higher education is positively associated with the age of marriage also supports the assumed negative relationship between fertility and women's education.[6] Furthermore, because of differences in the possibility of child employment and the cost of locally produced public and private goods, it is hypothesized that the cost of raising children is lower in rural and other urban areas than in Lima. Last, the distance to a family planning center, which gives us a proxy of knowledge concerning methods of contraception, is expected to be positively related with the number of children; if a family planning center is far away it is less likely that the woman will be informed about methods of contraception.

The price of market inputs for child quality, p_q, is also assumed to vary by degree of urbanization as well as with the distance to the nearest secondary school.[7] Because of higher productive benefits of children in rural areas, it is assumed that the quality of children will be lower in these areas. The distance to the nearest secondary school, an indication of the accessibility of schooling, is also taken as a proxy of the opportunity cost of education in rural areas; the farther the distance, the less likely the parents will invest in the children's education.

The analysis uses two alternative specifications. The first model,

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[3] The ENDES (1986) showed that 37 percent of all women of fertile age (15-49 years old) married (or started living together) before they were 20 years old; the percentage rises for older age cohorts. Appendix table A.1 reports the age at the first conjugal union.

[4] In 1986 46 percent of married (or cohabiting) women were using a method of birth control. The rhythm method is preferred. Modern methods, especially the pill and the IUD, are used mainly by women between 25 and 34 years old, and sterilization i more common among women between 35 and 44 years old. Table A.2 reports the contraceptive use by women in Peru. Only 19 percent of married or cohabiting women with no education use contraception, versus 39, 62, and 69 percent of women, respectively, with primary, secondary and post-secondary education. (ENDES 1986)

[5] The questionnaire does not contain information on availability or use of contraceptives.

[6] In Peru the median age of first onjugal union for women between 25 and 50 years with no education is 18.7. For women with primary, secondary, and post-secondary education, the age is 19.[illegible], 22.2, and 25.3 years, respectively. (ENDES 1986)

[7] Most villages in rural areas have a primary school. Distance to primary school, therefore, is not considered a cost of children's education.

subsequently referred to as model I, conforms to the description given in Section 2.1 above. It uses the potential male and female hourly market wage (opportunity cost of their time) and unearned income, respectively denoted as W_m, W_f, and V. The other specification (model II) instead uses total household expenditures per adult. This alternative definition of income better corresponds to the lifetime horizon of fertility decisions. It is based on the fact that fertility decisions are probably not particularly responsive to transitory variations in household income (Schultz 1988), and will therefore be more closely associated with a more permanent concept of income. Total household expenditures are used as a proxy for permanent income because they tend to fluctuate less over the life cycle than current income.

The evidence from both time-series (e.g. the demographic transition) and cross section analysis (e.g. the numerous studies showing that families with high status have fewer children than do low status families) indicates a negative relationship between income and fertility. As Mincer (1963) points out, the adverse substitution effect of income on fertility (the price of a child increases as the opportunity cost of child care rises) tends to outweigh the favorable income effect (the family's resource constraint relaxes).

The cost of a woman's time, or opportunity cost, is determined by her market wage rate, W_f, because of the assumed interior solution in lifetime hours of work. An increase in her market wage increases the price of children, which reduces the quantity demanded. As it is generally accepted that the production of child services (S = C*Q) utilizes women's time more intensively than male time, one can expect a less negative (perhaps even a positive) effect of the cost of male time on fertility compared with the cost of female time (Rosenzweig and Evenson 1977).

Income is expected to increase the quality per child since the expenditure that the parents consider to be necessary is likely to rise with income (Duesenberry 1960).

The following two sections describe the estimation methods applied to the reduced form equations of the quantity and quality of children.

2.3 Estimation of the Quantity of Children

This equation uses several econometric approaches: ordinary least squares, a Poisson count model, and a sequential logit model.

The ordinary least squares model has been used frequently in fertility analysis. It estimates the number of children using the linear model $y=X'\beta+\epsilon$, in which y equals the number of children, X is a matrix of the exogenous variables, β the parameter vector, and ϵ a disturbance term (including nonobservable variables like tastes) which is normally distributed with mean zero and variance σ^2. A major shortcoming of using the ordinary least squares model is that the number of children is not a continuous variable with a full range of values (including negative), as assumed by this specification.

In qualitative response models, also known as quantal, categorical, or discrete models, the endogenous variables take on only discrete values.[8] Two cases can be distinguished: one in which the dependent variable, y, is categorical, and another in which y is a noncategorical variable. In categorical discrete models, individuals are grouped in different categories (for example, 0 children, 1 child, 2 children and so on) whereas in noncategorical discrete models the endogenous variable denotes the number of children born during a fixed time interval. If we assume that the number of children is a noncategorical variable, then a Poisson regression (estimated using the maximum likelihood method) would be an appropriate approach. Thus the number of children ever born can be thought of as a process that generates a number of changes (births) in a fixed interval of time. The model can be expressed as:

$$Pr(y_i) = \frac{\exp(-\alpha_i)\,\alpha_i^{y_t}}{y_i\,!}$$

The parameter of the Poisson distribution, α_i, is assumed to be log-linearly dependent on the explanatory variables, or,

$$\ln(\alpha_i) = X_i'\beta.$$

The Poisson distribution model, however, also has some drawbacks. First, its usefulness is limited by the fact that the variance is equal to the mean. Second, births cannot occur independently since a period of at least nine months must elapse between them, although in a low fertility population this problem should be less serious (Schultz 1988). A final limitation of the Poisson model is the assumption of a constant (through time) rate of birth arrivals. Reducing the fixed time interval (for example, to five or ten years before the survey) would reduce this error.

Alternatively, the sequential response model assumes that the number of children is a categorical variable. Underlying this method is the assumption that parents make the decision of having C children sequentially, first deciding whether or not to have children at all, then deciding to have more than 1 child, and so on.[9] This model can be maximized by repeatedly optimizing the likelihood functions of dichotomous models. Carliner et al (1980) used a sequential logit model for fertility where the dependent variables are the natural logarithms of the odds of having at least j+1 children for families having at least j children. Thus,

$$y_j = \log\ (\text{odds of having at least } j+1 \text{ children}) = X_j'\beta_j,$$

where X_j and β_j respectively represent the exogenous variables and the logit coefficients from the regression run on the sample of women with at least j children.

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[8] An extensive survey on these models can be found in Amemiya (1981) and Maddala (1983).

[9] According to Leibenstein (1957), the early decision in a family-building experience may be irrational or unplanned, and rational decisions need be assumed only for marginal children.

2.4 Estimation of the Quality of Children

An unresolved issue in many papers dealing with the relationship between the family and the welfare of its children is the operational definition of child quality. Frequently, though, educational attainment of the children is taken as a proxy of child quality (see for example Chernichovsky 1981, De Tray 1978 and Rosenzweig and Wolpin 1980). In this chapter the reduced form equation of quality is estimated using various techniques, with the years of child schooling normalized by age as the dependent variable.[10] In addition to using ordinary least squares (OLS), the error components method and fixed effect method are used.

In the error components model the observations for the quality of children are pooled by households. The justification for the model lies in the fact that the behavior of the disturbances over the child quality is likely to be different from the behavior of the disturbances over households. The model assumes that children with the same characteristics (age and sex) have equal quality, provided that households have the same endowments and tastes. The regression equation for this type of approach can be written as:

$$y_{i,h} = \beta_{0,h} + \beta_1 x_{ih,1} + \beta_2 x_{ih,2} + \ . \ . \ . \ + \beta_k x_{ih,k} + \epsilon_{i,h},$$

where $i=1,2,..,C$ refers to a child of a particular household $h=1,2,..,H$; $y_{i,h}$ is an observation on the dependent variable, years of schooling, for the i^{th} child of household h; $\beta_{0,h}$, $h=1,..,H$, are the intercept terms that are assumed to be different for each child but constant over households; $x_{ih,k}$ is an observation of the k^{th} explanatory variable for the child i of household h; β_k, $k=1,..,K$, are the slope coefficients and are assumed to be constant by household and children; and $\epsilon_{i,h}$ is the random error.

For testing purposes we also estimated a variant of the error components model, known as the fixed effect model, where the intercept terms are assumed fixed. These household fixed parameters, $\beta_{0,h}$, are assumed random, i.e. $\beta_{0,h} = \beta_0 + u_h$, with u_h independent identically distributed random variables with mean zero and constant variance. They are expected to be influenced by characteristics of the household, like mother's education, income, degree of urbanization, and infrastructural variables. The variables that influence intrahousehold variation in the level of education, β_k, $k=1,...,K$, are the age and sex of the children. The model is estimated using the generalized least squares (GLS) procedure.

3. Empirical Results

Information on live births is based on interviews with 4,102 women, 15 to 50 years old, randomly selected in each household.[11] The analysis is

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[10] For every child between 7 and 20 years old, the years of schooling normalized by age, Q_i, is calculated by dividing the actual years of schooling of the child,
$Q_{i,a}$, by the average years of schooling for the child's specific age, $\bar{Q}_a$, i.e.:
$Q_i = Q_{i,a}/\bar{Q}_a$.

[11] Miscarriages and still births are excluded.

confined to the subgroup of married (or cohabiting) women who are currently living with their spouses. The sample comprises 2,494 women, with 26 percent (650) residing in metropolitan Lima, 29 percent (733) in other urban areas, and 45 percent (1,111) in the rural areas.[12]

The means and standard deviations of the variables used in the empirical analysis are shown in table A.3. The dependent variables in the analysis are the children ever born and the years of schooling of those children normalized by age. The reduced form quality equation is estimated only for children between the ages of 7 to 20 years old living both in or outside the household.

Within this framework of analysis, the female and male hourly wages and the household expenditures per adult are endogenously determined variables. We use a two-stage estimation to calculate the reduced forms for the number of children and children's education, and generate predicted values using various instruments. For the hourly wages, separate wage equations are estimated for men and women by region, with corrections for sample selectivity (see Chapter Two). These estimated equations are used to provide a potential wage -- the wage predicted as obtainable in the wage sector.[13] The total household expenditures per adult[14] (aged 15 years and over) are instrumented using husband's age, education, training, and unearned income.[15] Table A.4 gives the OLS estimation.

3.1 Quantity

Table 1 reports the OLS estimates of the quantity equation for all Peru, Lima, other urban areas, and rural areas. Because all OLS regressions exhibited heteroscedasticity, White's (1980) heteroscedastic-consistent covariance matrix is used in calculating the t-statistics. An F-test on the OLS regressions found significant structural differences at the .01 level of significance between urban and rural subsamples. The test did not detect significant structural differences between Lima and other urban areas even at the .05 level of significance.[16]

[12] The total randomly selected group consisted of 4,102 women, of whom 2,630 were married (or cohabiting). For 2,500 women a matched spouse was available, but six were excluded for data reasons.

[13] See Chapter Two (Khandker) for regression results.

[14] Food expenditures including food and self-supply expenditures and food expenditures outside the household, and nonfood expenditures, include semi-durables and durables, fuel expenditures, rent, and utilities.

[15] Includes miscellaneous income items such as interest, dividends, rentals, pensions, unemployment benefits, alimony, children's allowance, and insurance.

[16] Because of structural differences between Lima and other urban areas in the quality regressions, the subsamples considered are nevertheless: Lima, other urban areas, and rural areas.

Table 1: Ordinary Least Squares estimates for the number of children born

Model / Variable	I: Peru	I: Lima	I: Other urban	I: Rural	I: Rural	II: Peru	II: Lima	II: Other urban	II: Rural	II: Rural
Constant	-6.352	-2.049	-4.277	-7.925	-7.901	-3.613	1.416	-0.333	-7.598	-8.685
	(10.865)	(1.874)	(3.870)	(9.972)	(7.777)	(3.310)	(0.773)	(0.201)	(4.198)	(3.600)
Mother's age	0.529	0.312	0.449	0.627	0.625	0.503	0.317	0.389	0.629	0.631
	(14.328)	(4.474)	(6.423)	(11.786)	(9.280)	(13.110)	(4.243)	(5.492)	(11.472)	(9.045)
Mother's age squared	-0.508	-0.261	-0.416	-0.606	-0.609	-0.483	-0.278	-0.337	-0.611	-0.621
	(8.779)	(2.323)	(3.971)	(7.139)	(5.660)	(8.061)	(2.347)	(3.156)	(7.050)	(5.620)
Mother's years of schooling	-0.205	-0.285	-0.210	-0.077	-0.104	-0.196	-0.268	-0.251	-0.066	-0.094
	(6.404)	(4.236)	(2.997)	(1.444)	(1.271)	(5.803)	(3.821)	(3.738)	(1.223)	(1.243)
Mother's years of schooling squared	0.005	0.007	0.005	-0.011	-0.009	-0.000	0.004	0.004	-0.015	-0.011
	(2.222)	(1.796)	(1.401)	(2.277)	(0.955)	(0.168)	(1.160)	(1.110)	(3.393)	(1.603)
Mother's wage hourly	-0.211	-0.079	-0.210	-0.058	-0.026					
	(5.161)	(1.183)	(2.757)	(0.843)	(0.155)					
Father's wage hourly	-0.025	-0.025	-0.023	-0.006	0.039					
	(1.290)	(1.006)	(0.513)	(0.215)	(0.701)					
Unearned income ('000 intis)	-0.016	-0.006	-0.015	-0.049	-0.043					
	(3.156)	(1.080)	(1.353)	(3.489)	(4.123)					
Household expenditures per adult (logs)						-0.420	-0.568	-0.460	-0.074	0.126
						(2.483)	(2.055)	(1.763)	(0.233)	(0.297)
Distance to secondary school					-0.065					-0.064
					(1.609)					(1.604)
Distance to family planning					0.013					0.013
					(1.249)					(1.265)
Other urban areas	0.520					0.498				
	(5.059)					(4.880)				
Rural areas	0.868					0.874				
	(6.836)					(6.299)				
Observations	2494	650	733	1111	692	2494	650	733	1111	[illegible]
R^2	0.497	0.384	0.437	0.478	0.474	0.491	0.385	0.433	0.476	[illegible]

Note: The t-statistics (in absolute terms) are in parentheses. They are corrected for heteroscedasticity using the White heteroscedastic-consistent covariance matrix.

For all subsamples the number of children ever born increases monotonically with mother's age at a decreasing rate for older women. This can be the result of two factors. First, delayed marriage by younger women effectively shortens their active reproductive cycle. Second, the relatively younger women have not fully completed their fertile cycles and are likely to bear more children in the future.

The education of the mother is, as hypothesized, significantly negatively related to the number of children. In the rural areas the reduction in the number of children is stronger with each additional year of schooling; in urban areas, the reduction is approximately linear. In Lima one additional year of schooling reduces the number of children by about 0.27 births at the mean; in other urban areas by 0.25, and in rural areas by 0.09 births.

Female and male hourly wages, as well as unearned income, generally decrease the number of children. Female hourly wages reduce the demand for children significantly in Peru and in other urban areas, while unearned income reduces it in Peru as a whole and in rural areas. The point estimates of the female's cost of time (that is, wage) show a stronger negative effect on fertility than the cost of male time, another expected result as noted earlier. Significant differences occur only in Peru as a whole and in other urban areas. The parameters of total household expenditures per adult also suggest a significant negative effect of income on the number of children. Only in rural areas is this negative effect insignificant. The income elasticities of demand for children in all Peru, Lima, and other urban areas are -0.10, -0.18, and -.12, respectively (that is, a 100 percent increase in the household expenditures per adult decreases the demand for children by 10, 18, and 12 percent respectively). The observed negative wealth elasticities of demand for the number of children, however, both in model I and II in Peru (except in rural areas), do not necessarily mean that the number of children, in the conventional sense, is an inferior commodity. The actual wealth elasticities simply may differ from the observed ones (quality-quantity interaction hypothesis) (Willis 1973).

The estimates for the degree of urbanization are significant and of the expected sign. The lower cost of raising children in rural areas combined with the higher productivity benefits of children in rural areas are reflected in a larger number of children per family. At the mean, parents in other urban areas and in rural areas respectively have 0.5 and 0.9 more children than parents in Lima.

The infrastructural variables, distance to the nearest secondary school and distance to a family planning center, do not significantly influence the number of children (though they are of the expected sign). The distance to the nearest secondary school, a proxy of the cost of quality, is negatively related to the number of children; the distance to a family planning center, a proxy for the cost of children, is positively related to the number of children.

The Poisson count estimates and the sequential logit estimates of the reduced form for children ever born are reported in tables 2 and 3. In the appendix the sequential logit estimates are given by regions (see tables A.5 to

A.8). The parameters in these tables reflect the marginal effects, which are comparable with the OLS results.

Little difference is found between the OLS and the Poisson count results. The magnitude of the effects change little and the signs of the effects generally do not change. In Peru as a whole, however, education squared shows a significant negative effect both in model I and II, implying a stronger reduction in the number of children as a result of an increase in the mother's education than in the OLS results. The significance of the income variables in all of Peru and in other urban areas disappears in the Poisson regressions. Additionally, the distance to secondary school significantly reduces the number of children in rural Peru.

The logistic fertility results are also generally similar to the OLS results. Both imply that the effect of education on fertility is negative and significant at most parity levels, and the age, or biological capacity, effect is positive and significant.

The logistic fertility results, however, do uncover some interesting nonlinearities. For instance, parents in other urban and rural areas without children do not perceive a significantly higher probability of the first child than parents in Lima, whereas those parents with at least one child have a higher probability of an additional child than corresponding parents in Lima. This is consistent with the fact that for Peru as a whole, only 1.6 percent of women at the end of their reproductive cycles are childless. Although the OLS regressions imply that unearned income does not significantly affect the number of children in urban areas, the bivariate logit estimates do reveal a significant reduction in the probability of the first child in Lima and the fourth child in other urban areas as a result of an increase in unearned income. In rural areas the household expenditures per adult significantly increase the probability of the first three children and reduces that of the fourth child, a nonlinearity not captured in the OLS results.

3.2 Quality

Table 4 shows the OLS estimates of the quality model. White's (1980) heteroscedastic-consistent covariance matrix is used again as these regressions also exhibited heteroscedasticity. An F-test showed significant structural differences at the .01 level of significance between urban and rural subsamples, and between Lima and other urban areas.

The results show that boys have significantly more education than girls of the same age in Peru as a whole, in other urban areas, and in rural

Table 2: Poisson Count estimates for the number of children born (dependent variable)

Model	I					II				
Variable	Peru	Lima	Other urban	Rural		Peru	Lima	Other urban	Rural	
Constant	-10.131 (11.792)	-5.470 (3.308)	-6.873 (4.086)	-13.535 (9.520)	-13.448 (7.370)	-8.539 (6.521)	-2.814 (1.310)	-4.587 (1.950)	-14.115 (6.518)	-15.168 (5.232)
Mother's age	0.781 (16.121)	0.474 (5.062)	0.615 (6.271)	1.081 (13.575)	1.085 (10.804)	0.773 (16.383)	0.500 (5.767)	0.599 (7.107)	1.074 (13.383)	1.080 (10.790)
Mother's age squared	-0.890 (13.381)	-0.513 (4.058)	-0.681 (5.142)	-1.256 (11.434)	-1.264 (9.155)	-0.882 (13.582)	-0.549 (4.641)	-0.665 (5.710)	-1.246 (11.273)	-1.257 (9.165)
Mother's years of schooling	-0.100 (3.166)	-0.146 (2.563)	-0.148 (2.348)	-0.001 (0.009)	-0.049 (0.524)	-0.090 (2.752)	-0.124 (2.153)	-0.148 (2.514)	0.007 (0.110)	-0.037 (0.434)
Mother's years of schooling squared	-0.006 (2.197)	-0.003 (0.593)	-0.001 (0.126)	-0.022 (2.979)	-0.017 (1.218)	-0.009 (3.501)	-0.003 (0.815)	-0.001 (0.365)	-0.026 (3.950)	-0.021 (2.071)
Mother's wage hourly	-0.082 (1.499)	0.005 (0.065)	-0.071 (0.633)	-0.087 (0.658)	-0.091 (0.289)					
Father's wage hourly	-0.012 (0.512)	-0.020 (0.707)	-0.005 (0.101)	0.014 (0.270)	0.054 (0.656)					
Unearned income ('000 intis)	-0.015 (1.400)	-0.005 (0.421)	-0.017 (0.882)	-0.060 (2.026)	-0.034 (0.387)					
Household expenditures per adult (logs)						-0.256 (1.448)	[illegible] ([illegible])	-0.333 (1.022)	0.101 (0.323)	0.299 (0.720)
Distance to secondary school					-0.057 (2.043)					-0.056 (2.002)
Distance to family planning					0.011 (1.153)					0.011 (1.165)
Other urban areas	0.597 (5.171)					0.571 (4.928)				
Rural Areas	0.928 (7.475)					0.904 (6.383)				
Observations	2494	650	733	1111	692	2494	650	733	1111	692
Pseudo R2	0.204	0.143	0.158	0.195	0.191	0.204	0.144	0.158	0.194	0.191

Note: Reported coefficients are the marginal effect of the independent variable, i.e. $ß_i$*exp(X'ß), where $ß_i$ is the Poisson estimate. The t-statistics (in absolute terms) are in parentheses.

Table 3: Sequential Bivariate Logit estimates for the number of children born (dependent variable) in Peru as a whole

Model	I PARITY					II PARITY				
Variable	N=0	N=1	N=2	N=3	N=4	N=0	N=1	N=2	N=3	N=4
Constant	-9.394	-10.841	-7.996	-9.917	-11.274	-10.747	-10.621	-8.569	-5.331	-12.10[illegible]
	(6.871)	(9.136)	(6.665)	(6.437)	(5.639)	(3.755)	(5.112)	(4.634)	(2.452)	(4.481)
Mother's age	0.702	0.727	0.515	0.567	0.611	0.698	0.725	0.503	0.612	0.589
	(7.702)	(9.542)	(7.136)	(6.342)	(5.430)	(7.534)	(9.452)	(6.970)	(6.859)	(5.244)
Mother's age squared	-0.884	-0.888	-0.601	-0.646	-0.703	-0.886	-0.885	-0.587	-0.716	-0.676
	(6.023)	(7.435)	(5.662)	(5.086)	(4.517)	(5.958)	(7.431)	(5.517)	(5.656)	(4.353)
Mother's years of schooling	0.173	-0.092	-0.205	-0.134	-0.082	0.156	-0.089	-0.216	-0.094	-0.084
	(2.123)	(1.427)	(3.954)	(2.473)	(1.382)	(1.851)	(1.332)	(4.009)	(1.667)	(1.362)
Mother's years of schooling squared	-0.020	-0.005	0.002	-0.000	-0.004	-0.020	-0.006	0.002	-0.003	-0.008
	(3.595)	(1.251)	(0.500)	(0.100)	(0.808)	(3.984)	(1.477)	(0.567)	(0.686)	(1.720)
Mother's wage (hourly)	-0.064	-0.017	0.001	-0.042	-0.116					
	(0.574)	(0.210)	(0.015)	(0.606)	(1.338)					
Father's wage (hourly)	0.078	0.002	-0.015	-0.038	0.009					
	(1.222)	(0.050)	(0.574)	(1.275)	(0.242)					
Unearned income ('000 intis)	-0.036	0.008	0.006	-0.028	-0.011					
	(3.189)	(0.540)	(0.563)	(2.295)	(0.639)					
Household expenditures per adult (logs)						0.258	-0.033	0.114	-0.867	0.161
						(0.578)	(0.106)	(0.448)	(3.090)	(0.470)
Other urban areas	0.364	0.649	0.605	0.552	0.529	0.320	0.643	0.636	0.511	0.537
	(1.240)	(3.498)	(3.891)	(3.225)	(2.502)	(1.118)	(3.512)	(4.102)	(2.985)	(2.544)
Rural Areas	0.179	0.871	0.619	0.980	0.851	0.190	0.858	0.688	0.737	0.997
	(0.537)	(3.789)	(3.314)	(4.855)	(3.745)	(0.512)	(3.325)	(3.301)	(3.308)	(3.832)
Pr (having N+1 children)	0.956	0.885	0.795	0.765	0.753	0.956	0.885	0.795	0.765	0.753
Pseudo R2	0.217	0.269	0.204	0.213	0.175	0.208	0.268	0.204	0.213	0.174
Observations	2494	2385	2111	1678	1283	2494	2385	2111	1678	1283

Note: Reported coefficients are the marginal effect of the independent variables, i.e. β_i*P*(1-P), where β_i is the logit coefficient and P is the probability of having one or more additional children. The t-statistics (in absolute terms) are in parentheses.

Table 4: Ordinary Least Squares estimates for the quality of children

Model	I					II				
Variable	Peru	Lima	Other urban	Rural		Peru	Lima	Other urban	Rural	
Constant	1.319	1.556	1.898	0.746	0.535	-0.858	1.055	-0.121	-2.768	-3.331
	(10.698)	(7.165)	(8.622)	(4.035)	(2.202)	(3.366)	(2.646)	(0.287)	(6.626)	(6.725)
Mother's years of schooling	0.070	0.026	0.022	0.101	0.108	0.056	0.023	0.007	0.078	0.077
	(11.365)	(2.292)	(1.844)	(8.803)	(6.602)	(8.441)	(2.010)	(0.613)	(6.612)	(4.821)
Mother's years of schooling squared	-0.002	-0.000	0.000	-0.005	-0.009	-0.003	-0.000	0.001	-0.004	-0.007
	(4.153)	(0.007)	(0.029)	(3.258)	(4.422)	(5.791)	(0.627)	(0.671)	(2.860)	(3.543)
Mother's wage hourly	-0.024	-0.014	0.001	-0.013	0.045					
	(2.627)	(1.198)	(0.072)	(0.753)	(1.364)					
Father's wage hourly	0.022	0.003	0.033	0.054	0.077					
	(5.235)	(0.562)	(3.781)	(4.969)	(4.363)					
Unearned income ('000 intis)	0.004	0.002	0.007	-0.008	0.007					
	(1.318)	(1.403)	(1.197)	(0.608)	(0.372)					
Household expenditures per adult (logs)						0.350	0.077	0.342	0.608	0.687
						(9.460)	(1.361)	(5.334)	(9.372)	(9.224)
Age child	-0.066	-0.073	-0.134	-0.022	-0.008	-0.071	-0.075	-0.136	-0.027	-0.010
	(3.578)	(2.243)	(4.003)	(0.790)	(0.216)	(3.869)	(2.288)	(4.085)	(0.964)	(0.294)
Age child squared	0.002	0.003	0.004	0.001	0.000	0.003	0.003	0.005	0.001	0.000
	(3.531)	(2.408)	(3.687)	(0.821)	(0.219)	(3.882)	(2.449)	(3.875)	(1.011)	(0.322)
Sex child (1=female 0=male)	-0.061	-0.005	-0.055	-0.089	-0.084	-0.060	-0.005	-0.058	-0.086	-0.084
	(3.992)	(0.189)	(1.982)	(3.835)	(2.946)	(3.924)	(0.167)	(2.072)	(3.772)	(3.011)
Distance to secondary school					0.005					0.007
					(0.851)					(1.077)
Distance to family planning					-0.004					-0.004
					(5.035)					(4.483)
Other urban areas	0.086					0.110				
	(4.174)					(5.276)				
Rural areas	-0.177					-0.052				
	(6.951)					(1.845)				
Number of children	4421	999	1236	2186	1355	4421	999	1236	2186	1355
Number of parents	1706	425	484	797	489	1706	425	484	797	489
$R2$	0.232	0.039	0.128	0.132	0.101	0.242	0.039	0.134	0.152	0.125

Note: The t-statistics (in absolute terms) are in parentheses. They are corrected for heteroscedasticity using the White heteroscedastic-consistent covariance matrix.

areas, with the largest difference occurring in the rural areas.[17] Interestingly, there were no significant gender differences in school attendance in Lima. These results are consistent with enrollment ratios in Peru shown in Chapter 1. In the rural areas the normalization of education has ruled out all age effects of differences in education between children; in urban areas, however, the quality of children initially decreases by age and increases afterwards.

As expected, the quality of children is positively related to the education of the mother. The relation appears linear in urban areas and nonlinear in rural areas, where a mother's education increases her children's education at a decreasing rate.

The results of model I suggest that the father's wage has a positive effect on children's education. Unearned income also increases children's education, but its effect is relatively minor. The opportunity cost of a woman's time does not significantly affect the quality of her children, except in all of Peru. The negative effect of women's wages on children's education may be caused by the structural differences that exist between the subsamples considered. An increase in household expenditures per adult significantly incr ases the quality of children. The income elasticities of the demand for children's education for all Peru, other urban areas, and rural areas at the mean are 0.34, 0.27, and 0.75 respectively. As income increases, therefore, parents will increase the quality of their children, supporting the hypothesis that the expenditures per child that parents consider necessary rises with income.

The urbanization dummies show a significant negative effect in rural areas on the demand for children's education, and important positive effect in other urban areas. The need for children on the farm might account for the lack of interest in education in rural Peru. At the mean, the quality of children in rural areas is about 36 percent lower than that of children in urban areas. And since there is little difference between the quality of children in Lima and in other urban areas, the significant positive parameter for the other urban areas dummy might merely reflect structural differences between the quality regressions for Lima and other urban areas.

The distance to secondary school, which can be considered an opportunity cost for child quality, reduces the quality of children, though the effect is not strong. The distance to a family planning services center, which is a direct cost of the number of children, is negatively related to the quality of children.

Table 5 presents the results of the error components model. The Hausman test did not reject the hypothesis that the error components model was the right specification (at the .01 level of significance) compared against the fixed effect model. These generalized least squares results are very similar to the OLS estimates. The magnitude of the effects shows little change, and the signs remain the same.

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[17] An F-test, however, did not show structural differences at the .05 level of significance between boys' and girls' subsamples.

Table 5: The Error Components Model estimates for the quality of children

Variable \ Model	I					II				
	Peru	Lima	Other urban	Rural		Peru	Lima	Other urban	Rural	
Age child	-0.054 (3.875)	-0.067 (2.488)	-0.129 (4.856)	-0.011 (0.531)	0.000 (0.004)	-0.056 (4.047)	-0.069 (2.566)	-0.129 (4.886)	-0.014 (0.647)	-0.001 (0.051)
Age child squared	0.002 (3.391)	0.003 (2.505)	0.004 (4.120)	0.000 (0.354)	-0.000 (0.099)	0.002 (3.568)	0.003 (2.560)	0.004 (4.200)	0.000 (0.465)	-0.000 (0.043)
Sex child (1=female 0=male)	-0.058 (4.242)	-0.004 (0.140)	-0.060 (2.324)	-0.086 (4.143)	-0.093 (3.514)	-0.057 (4.174)	-0.003 (0.098)	-0.061 (2.376)	-0.083 (4.031)	-0.092 (3.490)
Constant	1.286 (13.192)	1.540 (8.979)	1.888 (11.170)	0.710 (5.394)	0.513 (2.843)	-0.815 (2.268)	1.061 (2.189)	-0.012 (0.022)	-2.717 (4.794)	-3.256 (4.716)
Mother's years of schooling	0.069 (7.432)	0.028 (1.841)	0.016 (1.018)	0.099 (6.561)	0.108 (4.554)	0.055 (5.6[illegible]3)	0.026 (1.624)	0.002 (0.123)	0.075 (4.887)	0.078 (3.414)
Mother's years of schooling squared	-0.002 (2.537)	0.000 (0.101)	0.000 (0.341)	-0.004 (2.432)	-0.009 (2.594)	-0.002 (3.748)	-0.001 (0.635)	0.001 (0.929)	-0.003 (2.319)	-0.007 (2.162)
Mother's wage hourly	-0.030 (2.188)	-0.023 (1.353)	0.005 (0.186)	-0.018 (0.726)	0.045 (0.778)					
Father's wage hourly	0.021 (3.237)	0.002 (0.370)	0.028 (2.269)	0.050 (3.857)	0.072 (3.340)					
Unearned income ('000 intis)	0.003 (1.237)	0.001 (0.542)	0.008 (2.182)	-0.017 (1.145)	-0.007 (0.304)					
Household expenditures per adult (logs)						0.333 (6.115)	0.071 (0.993)	0.320 (3.748)	0.589 (6.344)	0.668 (5.946)
Distance to secondary school					0.008 (0.986)					0.010 (1.210)
Distance to family planning					-0.005 (2.080)					-0.004 (1.858)
Other urbar areas	0.078 (2.323)					0.100 (2.970)				
Rural areas	-0.200 (5.134)					-[illegible].074 ([illegible].709)				
Number of children	4421	999	1236	2186	1355	4421	999	1236	2186	1355
Number of parents	1706	425	484	797	489	1706	425	484	797	489
R2	0.198	0.183	0.190	0.106	0.090	0.202	0.183	0.119	0.116	0.102
Hausman Test X2(3)	5.051	3.143	0.777	6.662	1.437	5.051	3.143	0.777	6.662	1.437

Note: The t-statistics (in absolute terms) are in parentheses.

3.3 Quality-Quantity Interaction

All calculated elasticities of the demand for quality and quantity are given on table 6.[18] The observed income elasticities are shown first. Assuming no changes in the marginal cost of the number and quality of children, the income effects indicate that parents generally substitute quality for quantity as income increases. Since quality and quantity enter multiplicatively into the household budget constraint, this substitution of more quality for less quantity of children will change the price of the number of children relative to quality of children. For instance, if the income-elasticity of quality is greater than the income-elasticity of quantity, then an increase in income will tend to increase ratio Q/C. This will then tend to increase the cost of the number of children relative to the quality of children, p_c/p_q, which will induce a further substitution of quality for the number of children.[19] Table 6 confirms that the income elasticities of the demand for quality are higher than the demand elasticities for quantity (although the 90 percent confidence interval of the elasticities of the demand for quality and quantity for unearned income generally overlap). This points to a substitution of quality for quantity as income increases. In other urban areas, for instance, a 1 percent increase in household expenditures per adult increases the ratio Q/C by 49 percent, which causes the cost ratio p_c/p_q to rise by the same percentage.

Table 6 also gives price elasticities corresponding to the mother's education (assumed to be a cost of the number of children, p_n) for model II.[20] These are given by the uncompensated price elasticities.[21] The compensated price elasticities measure the percentage change in number (or quality) of children caused by a given percentage change in p_n, mother's education, holding utility, p_q, and other prices constant. These are also called the own- (or cross-)

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[18] For calculating these elasticities, the OLS estimates of the quantity regression have been reestimated using the same sample as in the quality regression. The result of these estimates are in appendix table A.9. An F-test pointed to structural differences between these two samples at the .05 level of significance.

[19] See Becker and Lewis (1974), Willis (1974), and Rosenzweig and Wolpin (1980) for details of this quantity-quality interaction.

[20] Using the Slutsky equation, the uncompensated price effect of the mother's education on quantity and quality can be decomposed in a substitution price effect and an income effect:

$$\frac{\delta g_i}{\delta p_j} = \left.\frac{\delta h_i}{\delta p_j}\right|_U - \left.\frac{\delta g_i}{\delta y} q_j\right|_P = s_{ij} - q_j \delta g_i/\delta y ,$$

in which s_{ij} is the substitution effect of the price change and $(-q_j\delta g_i/\delta y)$ the income effect of the price change.

[21] In observing the low price elasticity of the demand for children in rural areas, it should be noted that this point estimate is enclosed in the interval estimates for Lima and other urban areas.

Table 6: Elasticities of the demand for quantity and quality

Variable	Quantity: Peru	Quantity: Lima	Quantity: Other urban	Quantity: Rural	Quality: Peru	Quality: Lima	Quality: Other urban	Quality: Rural
Income elasticities :								
Unearned income (Model I)	-0.001 [-.003,.00]	(-0.001) [-.007,.004]	(-0.002) [-.005,.002]	-0.004 [-.007,-.001]	(0.003) [-.001,.006]	(0.002) [-.00,.005]	(0.006) [-.002,.015]	(-0.002) [-.007,.003]
Household expenditures (Model II)	-0.12 [-.19,-.05]	-0.17 [-.32,-.02]	-0.15 [-.27,-.02]	(-0.07) [-.18,.04]	0.34 [.28,.40]	(0.06) [-.01,.13]	0.27 [.19,.35]	0.75 [.62,.88]
Uncompensated price elasticities :								
Mother's education (Model II)	-0.17 [-.24,-.08]	-0.52 [-.84,.05]	-0.27 [-.56,.02]	-0.02 [-.09,.00]	0.13 [.07,.20]	0.13 [-.10,.29]	(0.06) [-.10,.23]	0.15 [.08,.22]
Cost of parental time (Model I)								
Mother's wage (hourly)	-0.09 [-.13,-.04]	(-0.08) [-.21,.05]	-0.14 [-.27,-.02]	-0.03 [-.06,-.00]	-0.06 [-.10,-.02]	(-0.05) [-.11,.02]	(0.004) [-.09,.10]	(-0.03) [-.08,.03]
Father's wage (hourly)	(-0.02) [-.05,.01]	(-0.05) [-.14,.04]	(-0.07) [-.16,.03]	(0.01) [-.02,.03]	0.09 [.06,.11]	(0.01) [-.03,.05]	0.13 [.08,.19]	0.17 [.11,.22]
Distance to secondary school[a] (Model I)				(-0.02) [-.04,.01]				(0.02) [-.01,.04]
Distance to family planning center[a] (Model I)				(0.01) [-.00,.03]				-0.03 [-.04,-.02]
Compensated price elasticities[b] :								
Mother's education (Model II)	-0.56 [-.87,-.25]	-1.21 [-2.15,-.02]	-0.90 [-1.72,-.08]	-0.02 [-.48,.08]	0.34 [.25,.45]	0.13 [-.12,.46]	0.31 [.11,.64]	0.35 [.25,.46]
Cost of parental time (Model I)								
Mother's wage (hourly)	-0.11 [-.18,-.04]	0.00 [-.28,.08]	-0.14 [-.35,.01]	-0.24 [-.41,-.07]	-0.06 [-.11,-.00]	0.00 [-.11,.03]	0.00 [-.10,.17]	0.00 [-.13,.05]
Father's wage (hourly)	-0.03 [-.12,.01]	0.00 [-.24,.10]	0.00 [-.26,.06]	-0.32 [-.56,-.07]	0.09 [.06,.15]	0.00 [-.03,.08]	0.13 [.06,.28]	0.17 [.04,.26]
Distance to secondary school (Model I)				0.00 [-1.01,.06]				0.00 [-.07,.13]
Distance to family planning center (Model I)				0.01 [-2.14,.15]				-0.03 [-.15,.16]

Note: The figures in brackets present the interval estimates of the elasticities, which are calculated using the 90 percent confidence interval boundaries for each individual parameter. The figures in parentheses are elasticities calculated using parameters that are not significant at the 10 percent level of significance.

[a] The elasticities for these variables are calculated using the reduced rural sample size.

[b] Only parameters at the 10 percent significance level are used in calculating the point estimates of the

substitution elasticities. In Peru as a whole the own-substitution elasticity of the mother's education is -0.56, and the cross-substitution elasticity is 0.34. Consequently, a 1 percent increase in mother's education (holding constant for utility and other prices) decreases the demand for children by 0.56 percent and increases the demand for children's education by 0.34 percent. The positive sign of the cross-substitution elasticities indicates that the number of children and children's education are substitutes. The 90 percent confidence intervals are all above zero, except for Lima. The income effect of the price increase on the demand for quantity is positive, whereas the effect is negative on the demand for children's education. Comparing the point estimates of the compensated price elasticities of the demand for quantity with those for quality, we find a further substitution of child quality for number of children as mother's education increases (quantity-quality interaction).

Table 6 also gives the uncompensated and compensated price elasticities of parental time for the quantity and quality of children using model I. These indicate that parents demand more quality against less quantity as the cost of parental time increases (although the 90 percent confidence intervals for mother's cost of time usually overlap). The compensated cross-price elasticities indicate that the father's and mother's labor force participation are substitutes for the number of children, and father's labor force participation and the quality of children are complements. As the cost of parental time increases, the opportunity cost of child care rises; thus, as parents spend more time in market activities, the demand for children falls. An increase in the father's opportunity cost of child care will increase his time in market activities and his demand for children's education. As expected, the mother's cost of time has a stronger effect on the number of children than the father's cost of time, though the latter has a larger effect on children's education than the former. The compensated price elasticities of the demand for children are smaller than those of the demand of children's education, which suggests a further substitution of quality for quantity as the parental cost of time increases.

The uncompensated and compensated price elasticities of the distance to the family planning center indicate that parents demand more education per child and fewer children as the distance to family planning centers decreases. The own-substitution elasticity of the distance to a family planning center is positive, 0.1, and the cross-elasticity is -.03, which again indicates that the number of children and children's education are substitutes (although both 90 percent confidence intervals do enclose values of the opposite sign).[22] The relative magnitudes of these point estimates of the compensated price elasticities indicate a further substitution of education for the number of children as the distance to a family planning center falls.

[22] The distance to a family planning center is a negative influence on the cost for the number of children; that is, the farther the distance the more children demanded.

4. Simulation and Policy Implications

The ultimate objective of policy measures is to alleviate poverty and improve household welfare. Reducing fertility and increasing the amount of education help achieve this goal. Given the demand for children and for children's education are jointly determined by the parents, policies that directly affect the number or quality of children will induce tradeoffs, as noted in the previous section. It is important to take these tradeoffs into consideration when evaluating the direct effects of these policies.

In table 7 we examine the direct effect of several policies on the number of children, children's education, and child services.[23] These policies include increasing women's education by two years, expanding family income (unearned income by 600 intis or expenditures per adult by 200 intis), raising the hourly wages of the parents 0.6 intis, or improving the accessibility to family planning services by two hours of travel time.[24] Columns 1 through 5 in the table give the simulation results using the model I specification, and columns 6 through 8 using model II. Assuming no changes in the marginal cost of the number and quality of children, the results in all regions show that a two-year increase in the mother's education reduces demand for children more sharply than alternative policies. Similarly, the most significant increase in the children's education is a result of an increase in the mother's education. Supposing that parents try to maximize their children's education, however, its increase is not strong enough to compensate for the reduced number of children in Lima and in other urban areas. Increasing the mother's education by two years at the mean reduces the combined quality of all of her children (child services). In rural areas, the increase in the mother's education improves the combined children's education more than any of the other policy variables. An expansion in the household expenditures per adult, which has little effect on reducing fertility, does induce a stronger rise in the combined children's education. In all-Peru the same reasoning holds, although the differences between the policy outcomes are greatly reduced. In other urban areas an increase in the family's financial resources, particularly the household expenditures per adult, or raising the parents' hourly wages (particularly the father's), tend to increase the combined children's education more than an increase in the education of the mother. In Lima the policies examined do not lead to an increase in the combined children's education, although they do imply a drop in fertility and an increase in children's education.

As discussed in the previous section the impact of the interaction between quality and quantity will generally cause a further substitution of education for the number of children as the mother's education increases, the cost of parental time increases, the family's unearned income or household expenditures per adult increase, or the distance to a family planning center

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[23] Child services are defined as the quality of all children in a household, that is, quantity multiplied by quality. For comparison of figures see average per capita household expenditures, by region, in Chapter One (Schafgans), Table A13.

[24] On average, a household has three adults ag 5 years and over.

decreases. The impact on the combined education of all children in a household will depend, of course, on the relative changes in quality and quantity caused by the induced change in the marginal costs. If, for instance, the quality increases relatively more than the demand for children falls, the effect of the proposed policies will be stronger. Further research on this point is vital.

5. Conclusions

During the last decade fertility has dropped 23 percent in Peru with urban areas recording an even larger decrease of 31 percent. Women still have on average 4.1 children in all Peru, 3.1 in urban areas, and 6.3 in rural areas.

This chapter has identified the factors influencing the demand for children and the demand for the education of children by married women in Peru in 1985-1986 as well as the possible trade-offs between them. The framework for this analysis was a one-period, full-certainty model, in which parents maximize their joint utility function.

The results show that unearned income as well as higher household expenditures per adult mean smaller families with better-educated children. The results are consistent with other findings, and imply that parents substitute quality for quantity as the income in the household rises. This negative income effect is reinforced by the income elasticity of quality being greater than the income elasticity of quantity. A rise in income will tend to increase Q/C, which induces a rise in p_c/p_q (quality-quantity interaction hypothesis).

According to prior expectations, educated mothers appear to have fewer and better educated children. One reason may be due to lower child mortality. Moreover, these mothers might have fewer unwanted children due to a knowledge and proper use of modern family planning practices. The compensated cross-price elasticities of mother's education for the demand of quality are positive, which indicate that quality and quantity are substitutes. The mother's education own-price elasticities of demand for children (negative) are smaller than the cross-price elasticities, which indicates a further substitution of children's education for the number of children as the mother's education increases.

The demand for more child education and fewer children appears to coincide with increases in the cost of parental time. The cost of the mother's time has a stronger impact on the number of children than the cost of the father's time, while the latter has a stronger impact on children's education than former. The elasticities of the demand for children are smaller than those of the demand for children's education, which implies a further substitution of education for the number of children as the cost of the parent's time increases.

Rural areas have a higher demand for children and less demand for children's education than urban areas. This finding reflects the higher productive benefits and lower costs of children in rural areas. The distance to a family planning center (a proxy of the price of contraception) had no effect on the quantity of children, but a negative effect on the quality of children; the distance to secondary school (a proxy of the cost of education) showed a

Table 7: Simulation results: Effects on the quantity of children, quality of children, and children's services[a]

	Model I					Model II			
	(1)	(2)	(3)	(4)	(5)[b]	(6)	(7)	(8)[b]	
Increase in:									
Years of schooling	2	.	.	.	.	2	.	.	
Unearned income (intis)	.	600	.	.	.	.	.	.	
Mother's hourly wage (intis)	.	.	0.6	.	.	.	.	.	
Father's hourly wage (intis)	.	.	.	0.6	.	.	.	.	
Household expenditures per adult(intis)	.	.	.	.	.	.	200	.	
Distance family planning center (hrs)	.	.	.	.	-2	.	.	-2	
									Averages
Peru									
Quantity	5.00	5.38	5.28	5.37		4.95	5.20		5.38
Quality	1.13	1.04	1.02	1.05		1.10	1.14		1.04
Child services	5.67	5.60	5.41	5.65		5.43	5.93		5.59
Lima									
Quantity	3.59	3.96	3.92	3.95		3.54	3.83		3.96
Quality	1.31	1.26	1.25	1.26		1.29	1.28		1.26
Child services	4.71	5.00	4.90	4.98		4.57	4.88		5.00
Other urban areas									
Quantity	4.49	4.77	4.66	4.74		4.38	4.61		4.77
Quality	1.31	1.27	1.27	1.29		1.30	1.35		1.27
Child services	5.89	6.07	5.92	6.10		5.68	6.22		6.05
Rural									
Quantity	6.12	6.43	6.43	6.52	6.75	6.15	6.34	6.61	6.51(6.65)
Quality	0.96	0.80	0.80	0.84	0.76	0.92	1.03	0.78	0.81(0.77)
Child services	5.85	5.16	5.14	5.48	5.15	5.64	6.55	5.16	5.26(5.14)

Note: Figures in parentheses are averages for the reduced rural sample.

[a] Child services are the total quality of the children in a household, that is, (quantity*quality).

[b] The effects from these simulations are calculated using the reduced rural sample size.

negative effect on the number of children but no impact on the children's education.

The different estimation methods applied to the quantity or quality reduced form did not alter the results drastically. Generally the magnitude of the effects change little and the signs of the effects do not change. The Poisson estimates did, however, produce a stronger reduction in the number of children through an increase in the mother's education than the OLS regressions, and also displayed a lower significance of the income variables. The bivariate logit estimates uncovered the following interesting nonlinearities: a) parents in rural areas without children do not exhibit a significantly higher probability of having a first child than parents in urban areas, in contrast to the probability of parents with children having an additional child; and b) household expenditures per adult in rural areas increase the probability of the first three children and reduce the probability of the fourth child.

The simulations showed that increasing the mother's education influenced the demand for children and their education by more than any of the other policy variables.[25] In rural areas and Peru as a whole, however, this increase also has the greatest impact on the combined children's education in a household (child services). In other urban areas an increase in family resources, particularly the expenditures per adult, or a raise in the parents' hourly wages, tend to improve the combined children's education by more than the effect of increasing the education of the mother. In Lima the policies examined here do not lead to an increase in children's services, although they do demonstrate a decline in fertility and an improvement in children's education.

[25] The simulations were performed under the assumption that the marginal cost of the demand for children and children's quality is constant.

APPENDIX

Table A.1: Percentage of women by age of first conjugal union

Age of First Conjugal Union	Age group							
	All	15-19	20-24	25-29	30-34	35-39	40-44	45-49
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Single	35.2	87.1	51.1	23.5	9.9	5.2	3.1	4.1
Ever married[a]	64.8	12.9	48.9	76.5	90.1	94.8	96.9	95.9
Younger than 15	4.0	2.4	2.3	3.5	4.8	6.1	5.5	6.9
15-17	18.8	7.7	17.9	21.3	21.9	22.4	23.3	29.2
18-19	14.3	2.8	15.7	16.8	17.3	18.7	19.8	19.3
20-21	10.3	-	9.8	14.7	15.6	14.6	12.3	14.0
22-24	9.7	-	3.2	14.1	16.1	16.5	18.0	12.5
25 or older	7.7	-	-	6.1	14.4	16.5	18.0	14.0
Observations	4,999	1,104	940	808	688	577	489	393

Source: ENDES 1986
Note: Figures below the line correspond to cohorts with incomplete experience.
[a] Includes married, cohabiting, divorced, and separated

Table A.2 : Percentage of married women using various methods of contraception

Age	Total	Modern Method							Traditional Method			
		Pill	IUD	Injection	Vaginal*	Condom	Sterilization Female	Sterilization Male	Rhythm	Withdraw	Others	Observations
Total	65.1	22.1	11.6	8.9	8	9.7	6.1	0.0	39.8	18.8	9.2	2,900
15-19	42.0	6.9	2.3	4.6	1.5	5.3	0.0	0.0	26.0	16.8	3.8	131
20-24	64.2	21.2	10.3	7.9	5.1	7.9	0.0	0.0	38.0	19.2	8.7	416
25-29	70.3	25.6	14.8	12.5	9.4	12.8	1.6	0.0	42.7	23.0	9.8	562
30-34	71.8	28.7	16.2	10.4	10.9	10.9	5.8	0.0	46.8	21.3	8.8	568
35-39	67.1	22.7	12.7	9.8	9.2	10.0	10.8	0.0	40.2	17.8	11.6	490
40-44	65.1	20.9	8.9	7.4	7.6	9.3	13.5	0.0	40.5	17.7	7.6	407
45-49	51.8	12.6	4.9	4.0	5.5	5.8	8.3	0.3	28.5	10.1	10.1	326

Source: ENDES 1986.
Note: Includes women cohabiting with their spouses
* Diaphragm, spermicide

Table A.3: Sample means and standard deviations

Variable	Peru Mean	Peru Standard Deviation	Lima Mean	Lima Standard Deviation	Other Urban Mean	Other Urban Standard Deviation	Rural Mean	Rural Standard Deviation
Children ever born	4.256	2.892	3.102	2.211	3.786	2.505	5.240	3.145
Quality of children Years of schooling[a]	1.039	0.583	1.260	0.445	1.268	0.523	0.808	0.580
Age	33.010	8.100	33.251	7.451	32.838	8.082	32.984	8.472
Years of schooling	5.040	4.352	7.785	3.826	6.663	4.221	2.363	2.985
Female hourly wage	2.848	1.890	3.940	2.114	3.585	1.758	1.723	1.024
Male hourly wage	4.220	2.885	6.348	3.152	4.754	1.964	2.622	2.224
Unearned Income ('000 intis)	1.016	5.274	1.955	7.828	1.195	4.917	0.348	3.118
Household expenditure per adult (logs)	6.417	0.439	6.807	0.314	6.603	0.327	6.066	0.263
Distance to secondary school (hours)							2.165	2.800
Distance to family planning center (hours)							4.887	9.283
Observations	2494 (4421)[b]		650 (999)		733 (1236)		1111 (2186)	

[a] Years of schooling normalized by age.
[b] The observations of children from parents with at least one child 7 years and older are in parentheses.

Table A.4: Ordinary Least Squares estimates of total household expenditures per adult (in logs)

Variable	
Constant	4.821
	(28.133)
Assets	
Unearned income ('000 intis)	0.009
	(3.419)
Husband characteristics	
Age	0.061
	(7.348)
Age squared	-0.001
	(6.836)
Years of schooling	0.070
	(18.290)
Training	0.114
	(3.361)
Degree of urbanization	
Other urban areas	-0.088
	(2.463)
Rural areas	-0.305
	(7.948)
Total household expenditures (logs)	
Mean	6.416
Standard deviation	(0.784)
R^2	0.311
Observations	2463

Note: The t-statistics (in absolute terms) are in parentheses.

Table A.5: Sequential Bivariate Logit estimates for the number of children born in Lima

Model	I					II				
	Parity					Parity				
Variable	N=0	N=1	N=2	N=3	N=4	N=0	N=1	N=2	N=3	N=4
Constant	-8.984	-8.065	-1.487	-6.322	-6.364	-5.979	-3.013	1.694	-3.815	-8.156
	(3.006)	(3.605)	(0.600)	(1.807)	(1.224)	(1.131)	(0.874)	(0.509)	(0.897)	(1.353)
Mother's age	0.670	0.577	0.163	0.402	0.332	0.679	0.634	0.205	0.407	0.374
	(3.321)	(4.082)	(1.124)	(2.026)	(1.147)	(3.292)	(4.493)	(1.441)	(2.106)	(1.331)
Mother's age squared	-0.720	-0.675	-0.120	-0.436	-0.368	-0.795	-0.728	-0.159	-0.453	-0.421
	(2.187)	(3.151)	(0.578)	(1.598)	(0.948)	(2.363)	(3.393)	(0.775)	(1.701)	(1.113)
Mother's years of schooling	0.157	-0.234	-0.311	-0.270	-0.034	0.093	-0.162	-0.265	-0.248	-0.062
	(0.692)	(1.659)	(2.643)	(2.306)	(0.242)	(0.396)	(1.142)	(2.259)	(2.033)	(0.445)
Mother's years of schooling squared	-0.018	0.002	0.004	0.008	-0.014	-0.018	0.003	0.006	0.004	-0.009
	(1.581)	(0.204)	(0.515)	(0.912)	(0.942)	(1.571)	(0.367)	(0.861)	(0.505)	(0.841)
Mother's wage (hourly)	-0.247	0.176	0.136	-0.106	0.096					
	(1.351)	(1.271)	(1.292)	(0.836)	(0.430)					
Father's wage (hourly)	0.070	-0.068	-0.042	-0.009	0.034					
	(0.810)	(1.486)	(1.088)	(0.186)	(0.507)					
Unearned income ('000 intis)	-0.046	0.013	0.007	-0.007	-0.007					
	(2.799)	(0.600)	(0.402)	(0.455)	(0.407)					
Household expenditures per adult (logs)						-0.414	-0.984	-0.639	-0.420	0.209
						(0.595)	(1.951)	(1.510)	(0.887)	(0.347)
Pr (having N+1 children)	0.952	0.821	0.675	0.603	0.609	0.952	0.821	0.675	0.603	0.609
Pseudo R2	0.265	0.203	0.144	0.146	0.090	0.233	0.204	0.144	0.145	0.088
Observations	650	619	508	343	207	650	619	508	343	207

Note: Reported coefficients are the marginal effect of the independent variable, that is, $\beta_i * P * (1-P)$, where β_i is the logit coefficient and P is the probability of having one or more additional children. The t-statistics (in absolute terms) are in parentheses.

Table A.6: Sequential Bivariate Logit estimates for the number of children born in other urban areas

Model	I					II				
	PARITY					PARITY				
Variable	N=0	N=1	N=2	N=3	N=4	N=0	N=1	N=2	N=3	N=4
Constant	-7.257	-8.582	-8.567	-6.581	-6.186	-2.585	-12.301	-10.917	-1.308	-3.991
	(2.040)	(3.869)	(3.909)	(2.372)	(1.546)	(0.444)	(3.496)	(3.501)	(0.363)	(0.839)
Mother's age	0.464	0.617	0.599	0.415	0.341	0.456	0.580	0.598	0.446	0.267
	(1.821)	(4.380)	(4.481)	(2.527)	(1.481)	(1.829)	(4.328)	(4.725)	(2.900)	(1.261)
Mother's age squared	-0.328	-0.756	-0.748	-0.434	-0.317	-0.370	-0.690	-0.735	-0.499	-0.229
	(0.723)	(3.565)	(3.939)	(1.902)	(1.011)	(0.847)	(3.310)	(3.974)	(2.293)	(0.782)
Mother's years of schooling	0.483	-0.132	-0.323	-0.142	-0.083	0.481	-0.171	-0.323	-0.117	-0.106
	(2.546)	(0.906)	(2.711)	(1.299)	(0.681)	(2.651)	(1.199)	(2.852)	(1.135)	(0.904)
Mother's years of schooling squared	-0.033	-0.004	0.008	0.003	-0.001	-0.034	-0.003	0.008	0.001	-0.005
	(2.936)	(0.484)	(1.265)	(0.479)	(0.141)	(3.131)	(0.350)	(1.295)	(0.178)	(0.635)
Mother's wage (hourly)	-0.233	-0.104	0.017	-0.055	-0.269					
	(0.695)	(0.625)	(0.124)	(0.372)	(1.253)					
Father's wage (hourly)	-0.032	0.198	0.067	-0.086	0.096					
	(0.188)	(1.921)	(0.914)	(1.258)	(1.113)					
Unearned income ('000 intis)	-0.022	0.021	0.002	-0.069	-0.059					
	(0.894)	(0.628)	(0.114)	(2.035)	(1.036)					
Household expenditures per adult (logs)						-0.749	0.751	0.398	-0.953	-0.145
						(0.868)	(1.429)	(0.904)	(2.011)	(0.250)
Pr (having N+1 children)	0.960	0.875	0.774	0.706	0.682	0.960	0.875	0.774	0.706	0.682
Pseudo R2	0.214	0.223	0.176	0.150	0.171	0.212	0.218	0.176	0.141	0.163
Observations	733	704	616	477	337	733	704	616	477	337

Note: Reported coefficients are the marginal effect of the independent variable, that is, $\beta_i * P * (1-P)$, where β_i is the logit coefficient and P is the probability of having one or more additional children. The t-statistics (in absolute terms) are in parentheses.

Table A.7: Sequential Bivariate Logit estimates for the number of children born in rural areas

Model		I				II				
			Parity					Parity		
Variable	N=0	N=1	N=2	N=3	N=4	N=0	N=1	N=2	N=3	N=4
Constant		-14.491 (7.209)	-9.165 (4.952)	-13.218 (5.357)	-14.611 (5.357)	-17.603 (4.090)	-17.248 (4.603)	-13.991 (4.326)	-5.821 (1.634)	-17.122 (4.180)
Mother's age		1.029 (7.385)	0.613 (5.203)	0.728 (4.968)	0.847 (5.380)	0.775 (6.124)	1.014 (7.327)	0.577 (4.897)	0.799 (5.512)	0.791 (4.953)
Mother's age squared		-1.343 (6.091)	-0.733 (4.093)	-0.842 (3.905)	-1.026 (4.663)	-1.069 (5.365)	-1.323 (6.060)	-0.686 (3.834)	-0.954 (4.521)	-0.950 (4.256)
Mother's years of schooling	n.a.	0.090 (0.779)	-0.091 (1.045)	0.106 (0.977)	0.000 (0.003)	-0.010 (0.077)	0.112 (1.035)	-0.118 (1.359)	0.057 (0.589)	-0.035 (0.341)
Mother's years of schooling squared		-0.022 (1.945)	-0.008 (0.974)	-0.034 (2.299)	-0.015 (1.355)	-0.012 (1.140)	-0.028 (3.445)	-0.011 (1.527)	-0.014 (1.601)	-0.018 (1.568)
Mother's wage (hourly)		-0.175 (0.933)	-0.085 (0.623)	0.764 (1.966)	-0.012 (0.085)					
Father's wage (hourly)		0.042 (0.588)	0.020 (0.380)	-0.098 (1.388)	-0.061 (0.963)					
Unearned income ('000 intis)		-0.006 (0.183)	-0.002 (0.071)	-0.136 (1.701)	0.054 (0.384)					
Household expenditures per adult (logs)						1.387 (1.887)	0.472 (0.812)	0.900 (1.800)	-1.259 (2.390)	0.567 (0.931)
Pr (having N+1 children)	0.956	0.929	0.869	0.861	0.825	0.[illegible]	0.929	0.869	0.861	0.825
Pseudo R2		0.368	0.217	0.232	0.165	0.2[illegible]	0.368	0.221	0.219	0.164
Observations	1111	1062	987	858	739	1111	1062	987	858	739

Note: Reported coefficients are the marginal effect of the independent variable, i.e. $\beta_i * P * (1-P)$, where β_i is the logit coefficient and P is the probability of having one or more additional children. The t-statistics (in absolute terms) are in parentheses.
n.a.= not available

Table A.8: Sequential Bivariate Logit estimates for the number of children born in rural areas, with infrastructural variables

Model	I					II				
	PARITY					PARITY				
Variable	N=0	N=1	N=2	N=3	N=4	N=0	N=1	N=2	N=3	N=4
Constant	-12.888		-9.276	-16.683	-17.185	-21.119	-25.448	-19.213	-9.617	-18.327
	(4.586)		(3.916)	(5.238)	(4.661)	(3.500)	(4.223)	(4.337)	(1.985)	(3.316)
Mother's Age	0.761		0.598	0.956	0.941	0.805	1.073	0.582	1.018	0.940
	(4.601)		(4.034)	(5.077)	(4.496)	(5.080)	(5.554)	(3.960,	(5.432)	(4.492)
Mother's Age squared	-1.059		-0.722	-1.172	-1.156	-1.127	-1.413	-0.698	-1.267	-1.163
	(4.008)		(3.196)	(4.302)	(3.984)	(4.503)	(4.705)	(3.127)	(4.710)	(4.011)
Mother's Years of schooling	-0.208	n.a.	-0.182	0.168	0.013	-0.280	0.461	-0.174	0.146	-0.075
	(0.683)		(1.320)	(1.045)	(0.076)	(1.244)	(2.474)	(1.456)	(0.991)	(0.481)
Mother's Years of schooling squared	0.000		-0.002	-0.042	-0.008	0.018	-0.070	-0.009	-0.029	0.004
	(0.001)		(0.102)	(1.854)	(0.262)	(0.676)	(3.862)	(0.734)	(1.717)	(0.186)
Mother's wage (hourly)	0.631		-0.609	0.594	0.735					
	(0.430)		(1.114)	(1.020)	(1.146)					
Father's wage (hourly)	1.680		0.652	-0.125	-0.148					
	(2.120)		(2.605)	(1.174)	(1.238)					
Unearned Income ('000 intis)	0.853		-0.052	-0.039	0.023					
	(0.448)		(1.319)	(0.750)	(0.130)					
Household expenditures per adult (logs)						2.001	1.701	1.783	-1.231	0.344
						(1.949)	(1.837)	(2.617)	(1.803)	(0.442)
Distance to Secondary School	-0.061		-0.013	-0.017	-0.049	-0.064	-0.051	-0.010	-0.024	-0.046
	(0.923)		(0.255)	(0.314)	(0.889)	(0.968)	(0.597)	(0.193)	(0.426)	(0.839)
Distance to Family Planning Center	-0.008		-0.001	-0.001	0.013	-0.007	0.010	-0.001	-0.000	0.014
	(0.422)		(0.047)	(0.039)	(0.560)	(0.380)	(0.263)	(0.074)	(0.017)	(0.588)
Pr (having N+1 children)	0.954	0.941	0.868	0.857	0.834	0.954	0.941	0.868	0.857	0.834
Pseudo R2	0.284		0.240	0.263	0.158	0.264	0.392	0.231	0.263	0.153
Observations	693	661	622	540	463	693	661	622	540	463

Note: Reported coefficients are the marginal effect of the independent variable, that is, β_i*P*(1-P), where β_i is the logit coefficient and P is the probability of having one or more additional children. The t-statistics (in absolute terms) are in parentheses.
n.a.= not available.

Table A.9: Ordinary Least Squares estimates for the quantity of children

Model / Variable	I: Peru	I: Lima	I: Other urban	I: Rural	I: Rural	II: Peru	II: Lima	II: Other urban	II: Rural	II: Rural
Constant	-2.107	6.460	2.469	-7.316	-7.446	1.989	10.739	7.867	-4.772	-5.437
	(1.441)	(2.219)	(0.933)	(3.522)	(2.714)	(1.034)	(3.059)	(2.569)	(1.551)	(1.322)
Mother's age	0.325	-0.120	0.134	0.640	0.641	0.302	-0.125	0.060	0.640	0.653
	(3.912)	(0.726)	(0.880)	(5.320)	(4.040)	(3.614)	(0.752)	(0.405)	(5.302)	(4.115)
Mother's age squared	-0.255	0.306	-0.019	-0.648	-0.660	-0.230	0.304	0.061	-0.646	-0.676
	(2.195)	(1.326)	(0.092)	(3.841)	(2.966)	(1.972)	(1.301)	(0.292)	(3.828)	(3.046)
Mother's years of schooling	-0.261	-0.323	-0.299	-0.140	-0.195	-0.231	-0.293	-0.326	-0.100	-0.185
	(6.392)	(3.987)	(3.445)	(2.079)	(1.662)	(5.362)	(3.421)	(4.002)	(1.410)	(1.566)
Mother's years of schooling squared	0.007	0.008	0.011	-0.009	0.003	0.001	0.005	0.009	-0.013	0.004
	(2.326)	(1.768)	(2.291)	(1.345)	(0.164)	(0.553)	(1.052)	(1.871)	(2.198)	(0.243)
Mother's wage hourly	-0.166	-0.082	-0.186	-0.133	0.071					
	(3.419)	(1.041)	(1.849)	(1.785)	(0.296)					
Father's wage hourly	-0.029	-0.030	-0.063	0.013	-0.000					
	(1.220)	(0.944)	(1.194)	(0.409)	(0.004)					
Unearned income ('000 intis)	-0.008	-0.003	-0.007	-0.129	-0.207					
	(1.391)	(0.430)	(0.802)	(2.384)	(1.476)					
Household expenditures per adult (logs)						-0.635	-0.673	-0.693	-0.461	-0.358
						(2.797)	(1.835)	(1.949)	(1.075)	(0.636)
Distance to secondary school					-0.051					-0.051
					(1.088)					(1.077)
Distance to family planning					0.019					0.020
					(1.503)					(1.529)
Other urban areas	0.593					0.524				
	(4.493)					(3.991)				
Rural areas	1.051					0.957				
	(6.427)					(5.316)				
Observations	1706	425	484	797	489	1706	425	484	797	489
R^2	0.398	0.285	0.322	0.283	0.254	0.395	0.288	0.321	0.279	0.250

Note: Sample size is consistent with the quality regressions. The t-statistics (in absolute terms) are in parentheses.

CHAPTER 6:

GAINS IN THE EDUCATION OF PERUVIAN WOMEN, 1940 to 1980*

Elizabeth M. King and Rosemary Bellew

Over the past few decades, expanding and improving the quality of public education have been important components of the Peruvian government's plan to accelerate economic development and redistribute income. This chapter addresses the following questions: How rapidly have educational opportunities and schooling levels changed over time? Have they become more equitably distributed between men and women? Have women benefited from recent educational policies as much as men? What other factors (for instance, family background and community characteristics) explain variations in the levels of education between men and women?

This chapter is organized as follows. We first trace the expansion of education in Peru and discuss the patterns by gender. Section 2 presents an empirical model of schooling choice within the family and defines the variables used. Section 3 discusses the findings in light of educational change and development, and Section 4 describes gender differences in the education of the present generation.

1. Trends In Education

Educational opportunities in Peru have changed tremendously since 1940 as a result of major economic changes and reforms in education policy.[1] In the early 1940s few Peruvians attended school. More than half of all adults were illiterate (table 1);[2] only one child in three was enrolled in primary or lower secondary school (table 2). Moreover, raising school attendance was particularly challenging since two-thirds of all Peruvians were scattered in rural areas, and 35 percent of the population spoke only Quechua or Aymara--the two main Indian languages--while the language of the schools was Spanish (Government of Peru 1981).

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[1] Due to a lack of data prior to 1950, most of the discussion pertains to 1950-1980. For these decades educational trends are traced by five-year periods to capture the effects of different administrations on levels of educational attainment. To explain variations in adult educational attainment, each five-year period is matched with the birth cohort whose educational experience corresponds to that period.

[2] Among Latin American countries only El Salvador, Nicaragua, Honduras, Bolivia, Guatemala, and the Dominican Republic had higher illiteracy rates than Peru in the early 1940s (Drysdale and Meyer 1975).

Table 1: Education of males and females, aged 15 and over, 1940-81

	1940	1961	1972	1981
<u>Percent literate</u>	42	61	73	82
Males	55	74	83	90
Females	31	48	62	75
Urban	.	82	88	92
Rural	.	41	49	62
<u>Mean years of schooling</u>	1.9	3.1	4.4	6.0
Males	2.4	3.8	5.1	6.7
Females	1.4	2.4	3.6	5.4
<u>Highest level of education attended</u> (percentage)				
No school	58	39	27	16
Males	45	26	16	9
Females	69	52	37	23
Primary	34	48	48	42
Males	47	58	54	44
Females	27	38	42	40
Secondary	1	2	5	10
Males	6	14	24	35
Females	3	9	17	28
Postsecondary	1	2	5	10
Males	2	3	6	12
Females	0.3	1	3	9

Sources: Literacy Rates: Government of Peru 1981, Fernandez 1986.

Since that time educational opportunities have expanded considerably. Appendix figures 1A-3B show the rapid rise in enrollment and in gross enrollment ratios between 1950 and 1980. At the primary level the rise in girls' enrollment came after the increase in boys' enrollment. In 1950 only 69 percent of all girls were enrolled compared to 100 percent of the boys.[3] At other levels there

[3] Gross enrollment ratios are computed as the ratio of total enrollment to the population aged 6 to 11. When under- or over-age students are enrolled, owing to repetition, early or delayed entry, or re-entry, the ratio can exceed 100 percent. On the other hand, net enrollment ratios exclude over- and under-aged youths. They are computed as the ratio of 6- to 11-year olds enrolled in school to the 6- to 11-year-old population. To gauge how these two ratios differ, Peru's 1980 net enrollment ratio was 85 percent, compared to a gross enrollment ratio of 115 percent. Therefore, in 1980, approximately 30 percent of all students were either under- or over-age, but we do not know the share attributable to repetition, delayed or early entry, or re-entry.

Table 2: Percent of children aged 6-14 and 15-19 enrolled in school, 1940-81

Age Groups	1940	1961	1972	1981
Ages 6 to 14				
Total	30	58	78	90
Males	34	62	82	91
Females	26	53	75	88
Urban	-	-	90	96
Rural	-	-	63	79
Ages 15 to 19				
Total	17	33	49	56
Males	23	41	57	61
Females	11	26	41	52
Urban	-	-	54	63
Rural	-	-	17	24

Source: Government of Peru 1981, Fernandez 1986.

was less difference between males and females; educational opportunities were still very limited for both sexes.

The data show that more girls who were of school age during the late 1950s and 1960s (that is, cohorts born between 1950 and 1964) enrolled in primary school than earlier cohorts. As a result enrollment ratios for girls rose from 65 percent in 1955 to 99 percent by 1970, narrowing the difference in enrollment between boys and girls. Males born between 1955 and 1964 show the largest enrollment increases, but since men began the 1950s with already high rates of enrollment, their gains were far less dramatic than those achieved by women.

Educational gains were not limited to primary education. In the 1960s more students went on to secondary school. Men and women born between 1950 and 1959 registered the largest proportional increases in secondary school attendance. Enrollment in higher education began a strong upward trend in 1960 that continued throughout the subsequent decade. But at this level of education, the gap between the percentage of males and females enrolled widened.

Throughout the years of expansion, rural children were less fortunate than those in urban areas, where many of the new schools were concentrated. In 1972 only 63 percent of rural children aged 6 to 14 were enrolled in primary and lower secondary schools, compared to 90 percent of urban youths. Opportunities for upper secondary and tertiary education were rare in rural communities; only 17 percent of rural youths aged 12 to 17 were enrolled in such schools, compared to 54 percent of the same age group in urban areas (table 2). From 1970, however, an increasing number of rural parents sent their children to primary and lower secondary school. By 1981 the gap in school attendance between urban and rural children was closing. At the upper levels, though, rural residents made little progress. In 1981 only 24 percent of the relevant school-age population attended an upper secondary or tertiary institution, compared to 63 percent of their urban counterparts.[4]

Changes in education levels mirror these enrollment patterns. The average years of schooling of persons aged 15 and above has increased steadily over time and the proportion of adults who did not attend school has fallen from 58 percent in 1940 to 16 percent in 1981. The strong growth in female enrollment in primary school during the 60s and the trend toward secondary and higher education are particularly evident. The proportion of adult women whose formal education stopped at primary school rose from 38 percent in 1960 to 42 percent in 1972. By that time, 24 and 18 percent of all men and women, respectively, had attended secondary school, compared to 6 and 3 percent in 1940. By 1981 these proportions rose by 10 percentage points, reflecting comparable enrollment growth for women and men. Higher education showed a similar pattern.

We shall next examine the impact of school expansion policies on the educational levels of men and women in the context of family resources and preferences for schooling. These influences add to our understanding of the effectiveness of policy reforms.

2. A Household Model of Education with Gender Differences

The human capital theory identifies the principal benefit from education as raising productivity. In the workplace this increased productivity translates into higher earnings (Becker 1964, Mincer 1974); at home it means more efficient home production, such as child care (Gronau 1977). The hypotheses that more highly educated people learn (that is, produce even greater human capital) more effectively (Ben-Porath 1967), or are better able to deal with problems or "disequilibria" in their lives (Schultz 1975) are related to this model. The model assumes that the decision to begin or continue schooling is a function of returns and costs. Returns are usually measured as expected earnings in the labor market corresponding to given levels of education. Costs, which include both direct outlays and indirect (time) costs, are often measured by the availability of, or distance to, school. A few studies have estimated the effect of the opportunity cost of schooling on enrollment or attainment in developing countries and have found a negative effect (for instance, Rosenzweig and Evenson 1977).

Other factors may also influence enrollment and attainment decisions. A household choice model of schooling investments implies that family background is an important determinant of enrollment and attainment not only because it may reflect the student's schooling preferences and income but also because it

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[4] See table A.1.

measures the support for education in the home. Studies of parental influence report strong positive effects. For example, Heyneman and Loxley (1983) found that four family background variables (mother's and father's education, father's occupation, and books in the home) explained an average of 18 percent of the variance in student achievement in a study of nine developing countries, compared to the 24 percent that was explained by school characteristics. Although research in this area has shifted recently to exploring such questions as the relative effects on achievement of alternative inputs, material versus nonmaterial inputs, or administrative and teaching quality (Lockheed and Komenan 1987), sufficient data to support studies of this genre are harder to come by. Last, genetically determined ability also affects learning and educational attainment (and thus income), but due to limited data on cognitive ability, the effect of this factor on income has been neglected in most studies.[5]

This framework implies that schooling decisions are influenced by a host of factors, including learning ability, wages in the labor market, proximity of the school, and school inputs. But do these factors have a different effect on men and women? What accounts for gender differences in the amount of schooling?

In a household model of schooling choice, gender can be introduced in several ways. One is to assume that parents do not necessarily have the same preferences for their sons' and daughters' education. Several studies have found that parents tend to favor sons in certain societies (Greenhalgh 1985; Rosenzweig and Schultz 1982). In an economic model this can be shown by representing the household utility as a function of two different commodities--the human capital stock of sons and daughters (Rosenzweig and Evenson 1977, Rosenzweig and Schultz 1980). While serious gender inequality is pernicious, this preference does not necessarily imply discrimination by parents. The unequal treatment of sons and daughters might simply be a rational or efficient response to family resource and technological constraints, and to market conditions, rather than a reflection of their own tastes or preferences. This distinction is helpful in formulating policy.

The human capital model illustrates that where the labor market rewards the education of males more than that of females, parents may respond by giving daughters less education. Human capital theory also suggests that if the costs associated with schooling were reduced sufficiently, girls' educational levels would rise even without a corresponding increase in female wages. A government school-building program, for example, could yield such a result. Or, if the demand for male child labor increases, the opportunity cost of educating daughters may be sufficiently smaller than for sons (barring strong cultural prohibitions against girls' education).

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[5] Griliches and Mason (1972) estimated that failure to control for the effect of ability overstates the estimated rate of return to education by between 7 and 15 percent. In a study on Tanzania and Kenya, Boissiere and others (1985) found that controlling for ability lowered the rate of return by about 60 percent.

In certain settings cultural forces, such as norms proscribing women's economic and familial roles, influence parents by imposing a heavy cost (for instance, ostracism) on nonconformist behavior. With economic development and increasing work opportunities for women, tension might build up between traditional social norms and the family's desire to benefit from changing conditions. Which families will respond to these changes, and when? Economic theory does not deal formally with the impact of sociocultural forces but it does predict behavioral adjustments to changes in prices and income. For example, we would expect that a rise in female wages that increases the returns to their education would tend to increase the parents' desire to invest in their daughters' education. The magnitude and speed of the response depends on the acquisition of new information and the price and income elasticities of their demand for education.

2.1 Empirical Model

There are several indicators of the amount of educational investment, including school enrollment and number of years of education. The framework above implies the following empirical model of demand for schooling:

$$E = \alpha' X + \epsilon_i \qquad (1)$$

where E is the educational investment; X is a vector of explanatory variables; and, ϵ_i is a random disturbance term. Since parents may or may not invest as much in the education of daughters as in sons, this equation should be estimated separately for males and females to allow the α coefficients to vary between the sexes.

We estimate demand for schooling for two samples of the Peru Living Standards Survey (PLSS): a sample of adults aged 20-59,[6] and a sample of youths aged 5-19. For the adult sample we examine the determinants of the highest level of schooling completed; for the youth sample we explain school enrollment or participation.

The explanatory variables X include birth cohort, parental background, and community characteristics. Birth cohort reflects changes in aggregate conditions during different periods. They serve as a crude measure of shifts in the labor market, changes in the economy, or reforms in education that have affected school availability. Because the effects of these events are confounded in the estimates of α, the results are illustrative and meaningful only if they are linked to historical events. Early in our study we found strong cohort differences. Rather than simply measure these effects as intercepts, we estimated the equation separately for six birth cohorts. For the adult sample, each group corresponds to a five-year period (except for the earliest and most

[6] Although 23 percent of those aged 20-24 were still enrolled in school when the data were collected, the proportion is much higher at younger ages.

recent periods).[7] Since the youth sample spans a much shorter period, we include birth cohort as an explanatory variable, defined as age splines.

Parents' characteristics in the equations include years of schooling completed. Parents' education captures several factors--taste for schooling, which may be passed on to children, ability to supervise children's education, and income, which determines ability to pay for education. Although these are different factors, their effects are all predicted to be positive and thus difficult to disentangle. No better measures for each effect were available.

Whether the child lived with the mother and/or father shows who was present to supervise the child's schooling, and more importantly, captures the effect of family stability. Unfortunately, if the child did not reside with the parents, we do not know the reason for the separation nor do we know if the separation was permanent or temporary. In any case, we expect a stable family environment and parental supervision to have positive effects on school attainment.

Parents' income is not included in the analyses for several reasons. First, we have no data in the adult sample for respondents who were not living with their parents. Moreover, current measures of parents' incomes are not likely to reflect true cross-sectional differences at the time of schooling. In both the adult and youth samples only paid employment is included as parental income. In lieu of income, we use parents' occupation as a proxy in the adult sample. The occupational categories are broad but reflect those occupations pursued for most of their lifetime. In the youth sample, we have better measures of the family's wealth at the time of schooling. As explanatory variables we include number of rooms in the house, whether the house is electrified or not, and the size of farm land cultivated. Since the land variable is a sum of leased and owned land, it confounds both a (positive) wealth effect and an (negative) opportunity cost effect.

Community characteristics at the time of schooling capture the effect of differences in levels of economic development, public services, and school availability. The level of community economic development determines opportunities for work in the local labor market, and thus returns to education in the area. In the absence of public community characteristics, we use two city-noncity dummy variables. The premise is that city dwellers generally have greater access to public facilities, i.e. schools, and more active labor markets. To the extent that the availability of schools influences an individual's choice of residence, these variables may be endogenous. But, this is less likely to be the case for 8- and 13-year-olds than for older youths.

For a smaller sample, those who have attended school, we estimate a second equation that examines the effect of specific school characteristics. Data on school characteristics are available only for this group. This

[7] Those born in 1925-39 were grouped together because there were fewer observations for the oldest cohorts, and the lack of data prior to 1950 makes it impossible to link the educational experiences of this group to historical events.

regression, however, is likely to yield biased coefficients with the bias stemming from the fact that the sample would be drawn on the basis of enrollment as a dimension of schooling choice. To remove that bias, we apply a method similar to Heckman's (1979) two-step sample selection bias correction:

$$E = \alpha' X + \beta' Z + \delta\lambda + \epsilon_2 \qquad (2)$$

where Z pertains to characteristics of the primary school attended. By including λ in equation (2), we estimate the coefficients of primary school characteristics on educational attainment given that the error term is associated with the probability of having attended school.[8] Our results indicate that estimating the effects of the included factors on years of schooling based only on the sample of adults who attended school yields biased estimates. The coefficients of λ in both the male and female regressions are significantly different from zero, and the estimated coefficients of a few included variables are significantly different in the specifications with and without λ.[9]

The variables Z refer to the school the respondent attended, not to the primary school that is generally available to the community. Thus it can be argued that the values of these variables are themselves a result of family decisionmaking that would bias their estimated coefficients. To the extent that only one primary school is available in many communities, however, we need not worry about this statistical problem. The variables include the availability of reading material and/or math books, the availability of furniture in the

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[8] We define a variable that captures the probability of being in the sample. The variable is obtained from the first step of the procedure which estimates the following relationship underlying the probability S of having attended school:

$$S^* = \gamma' Z + \mu$$

and

$$S = 1 \text{ if } S^* > 0$$
$$S = 0 \text{ otherwise,}$$

where W is a vector of variables that explain school entry and μ is a random error term. From probit estimates we compute λ which is the ratio of the ordinate of the standard normal distribution to the cumulative normal.

[9] The coefficients of λ in table 7 are statistically significant and negative in sign. Due to data limitations we do not have variables beside the school characteristics to identify the choices of entry to school and years of schooling. We compared the estimates from the specifications with and without λ to examine the selection bias. The coefficients of two family background variables were significantly different when comparing the two sets of specifications: first, "mother has no job" in the regression for males, and second, "lived in a city at age 13" in the regressions for males and females. Their coefficient estimates are much larger in the specification without λ, implying that their impact on years of schooling comes primarily from their effect on entry to school. Without λ, the coefficients of the school variables are also numerically larger, though not significantly.

school, and the number of teachers and grades in the school. The availability of textbooks and school furniture measures school quality and is expected to have a positive effect on school achievement.[10] These material inputs are also likely to have a positive effect on attainment levels, though the linkage is less clear. The number of teachers and grades offered is a crude measure of school size and supply. Given the number of grades offered, the number of teachers indicates both the number of school places and the quality of the school. However, without information on class size, we cannot draw any conclusions about quality from this variable. The number of grades offered roughly measures supply. A grade-four student who wants to continue on to grade five cannot do so if the available and affordable primary school does not offer grade five.

Next, we present empirical findings for the adult and youth samples. We discuss first the education levels attained and then the estimates of the above model.

3. Empirical Results from the Adult Sample

The adult sample consists of 5,644 women aged 20-59. For comparison we also analyzed a sample of 5,241 men of the same ages. Table A.2 shows the sample by current place of residence and by birth year. The individuals in the sample are, on average, nearly equally distributed across Lima, other urban areas, and rural areas, with a slightly larger proportion in rural areas.[11] The spatial distribution of the sample, however, differs by cohort. More than 40 percent of the oldest men and women live in rural areas, compared to about a third of the youngest adult cohorts.

3.1 Educational Profiles by Gender and Residence

Table 3 gives the educational profiles of the sample by gender and place of residence. There are clearly large differences in levels of education between men and women. Women have completed an average of only five and a half years of school, compared to seven years for men. While only 8 percent of the men did not attend school, 25 percent of the women never enrolled. The percentage of women with some secondary and higher education was 28 and 12, respectively, compared with corresponding percentages of 35 and 18 for men. These results are very similar to the 1981 census results (table A.1). Since 1981, however, the average number of years of schooling has risen slightly; a smaller proportion of students drop out after primary school and a slightly larger proportion continue on to higher education.

The largest gender differences in educational attainment are between rural and urban areas. Lima residents have the highest levels of education

[10]See Fuller 1985 for a review of past studies.

[11]We do not estimate the models separately by current residence because this location could differ from the place of residence at the time of schooling. Thus place of residence is included as an explanatory variable in the regressions.

Table 3: Educational levels in Lima, other urban areas, and rural areas (percentage)

Educational attainment	Females	Males	Lima	Other urban areas	Rural areas
Average years of schooling	5.5 (4.6)	7.1 (4.4)	8.8 (3.9)	7.5 (4.3)	3.2 (3.5)
Level of schooling					
Never attended	24.3	7.7	3.2	7.3	33.2
Primary	35.9	39.4	24.0	34.9	50.2
Secondary	28.2	35.3	48.9	37.4	13.8
Postsecondary	11.7	17.7	23.9	20.4	2.9

Note: Numbers in parentheses are standard deviations.

(about nine years). In contrast those in rural areas have completed, on average, only three years of schooling. Moreover, 33 percent of all rural adults have never been to school; and only 14 and 3 percent have continued to secondary and higher education, respectively, compared to 49 and 24 percent of adults in Lima. The relatively high proportion of Lima residents with some secondary and postsecondary education reflects both the greater availability of such schools in Lima as well as the decision to migrate to Lima in search of more advanced education or better employment opportunities.

3.2 Changes in Educational Levels

The PLSS data confirm that schooling levels have increased steadily for men and women. But since the rise has been more rapid for women than for men, the gender gap in schooling has narrowed. Women born during 1945-59 showed the largest percentage increase in number of years of schooling completed (table 4). Trends for men followed a slightly different pattern; their years of schooling increased earlier, but their gains tapered off with the cohort born in 1955-59.

This trend was the result of increasing enrollment rates and higher probability of continuing on to secondary and higher education. The proportion of women who never attended school fell dramatically from over 40 percent in the two oldest cohorts to only 8 percent in the youngest cohort. For men, the proportion never enrolled in school fell from 15 percent of the oldest to 3 percent of the youngest cohort. The proportion of adults with some secondary schooling more than tripled. The effect of the expansion of educational opportunities was particularly evident for individuals born between 1945 and 1959, that is, those who were of secondary school age during the late 50s and 60s. Similarly, women born between 1950 and 1954, and who were of tertiary

Table 4: Highest level of education, by birth cohort and sex (percentage of sample)

	BIRTH COHORT					
	1925-39	1940-44	1945-49	1950-54	1955-59	1960-66
Females						
No school	43.0	36.5	28.1	19.7	12.6	8.3
Primary	40.7	42.5	39.6	37.1	32.2	27.6
Secondary	12.5	15.0	22.7	28.0	38.3	46.5
Postsecondary	3.8	6.0	9.7	15.2	16.9	17.6
Average years attended	3.1	3.2	4.8	6.6	7.0	7.6
Males						
No school	15.2	10.8	8.5	3.9	2.6	3.3
Primary	57.9	53.8	42.7	34.1	25.2	24.0
Secondary	18.5	19.9	32.4	36.4	45.1	54.6
Postsecondary	8.4	15.5	16.4	25.6	27.1	18.1
Average years attended	4.8	6.6	6.8	8.3	8.7	8.3

school age during the 60s, also showed a significant increase in postsecondary schooling.

3.3 What Explains Educational Attainment?

The strong time trend resulting from policy reforms argues for estimating the schooling function separately for birth cohorts. Moreover, testing the homogeneity of results across birth cohorts shows that the cohort effects were not limited to shifts in the intercept but also influences the effects of other variables. To simplify the presentation of results for two sets of regression models estimated for each birth cohort, we focus on a few variables that show interesting cohort patterns. Tables 5 and 6 show the results for women and men, respectively. The means of all variables by cohort are in tables B.2 and B.3.

Table 5: Determinants of school attainment levels: regression results for adult females

Variable	Birth cohort: 1925-1939 Estimated coefficient	1940-1944 Estimated coefficient	1945-1949 Estimated coefficient	1950-1954 Estimated coefficient	1955-1959 Estimated coefficient	1960-1966 Estimated coefficient
Intercept	-0.448**	-0.390	0.342	0.736	2.145**	3.569**
Mother's years of schooling a/	0.490**	0.466**	0.460**	0.442**	0.317**	0.270**
Father's years of schooling a/	0.263**	0.325**	0.362**	0.329**	0.325**	0.201**
Lived with mother at age 10	0.792**	0.883*	0.783*	0.275	-0.535	-0.024
Lived with father at age 10	0.199	0.183	0.414	0.541	1.398**	0.202
Occupations: b/						
Mother is a white-collar worker	0.854	1.173*	0.903	0.940*	1.180**	1.053**
Mother is a blue-collar worker	0.222	0.460	-0.052	0.144	0.157	0.249
Mother has no job	0.786	0.925	0.360	0.827**	0.209	0.608**
Father is a white-collar worker	1.078	0.919*	1.251**	1.958**	1.354**	1.388**
Father is a blue-collar worker	0.895	0.168	0.966**	1.612**	1.279**	1.597**
Lived in a city at age 8	1.259	-0.350	0.219	0.077	0.563	1.498**
Lived in a city at age 13	0.353	2.078*	1.366**	1.607**	1.055*	0.116
Adjusted R^2	0.608	0.584	0.553	0.620	0.504	0.491

a/ A dummy variable taking on the value of 1 if years of schooling was missing was also included. The estimated coefficients are not reported here.
b/ Omitted category is mother or father is an agricultural worker. Also included in the regressions is a missing data category; results not shown.

* Statistical significance at 5 percent in a two-tailed test.
** Statistical significance at 1 percent in a two-tailed test.

Table 6: Determinants of school attainment level: regression results for adult males

Variable	Birth cohort: 1925-1939 Estimated coefficient	1940-1944 Estimated coefficient	1945-1949 Estimated coefficient	1950-1954 Estimated coefficient	1955-1959 Estimated coefficient	1960-1966 Estimated coefficient
Intercept	-1.867**	2.170**	2.248**	4.386**	4.465**	4.501**
Mother's years of schooling a/	0.388**	0.356**	0.263**	0.208**	0.272**	0.161**
Father's years of schooling a/	0.382**	0.452**	0.503**	0.451**	0.193**	0.231**
Lived with mother at age 10	0.223	-0.255	0.600	-0.068	0.692	0.063
Lived with father at age 10	0.273	0.867	0.548	0.258	0.189	0.591*
Occupations: b/						
Mother is a white-collar worker	0.042	0.515	1.747**	-0.063	0.850*	0.931**
Mother is a blue-collar worker	-0.426	-0.934	-0.279	0.667	-0.241	0.484
Mother has no job	0.323	0.446	0.754*	0.225	0.620*	0.523*
Father is a white-collar worker	1.366**	1.736**	0.513	1.560**	1.407**	0.757**
Father is a blue-collar worker	0.286	1.125**	0.832*	1.607**	1.335**	1.089**
Lived in a city at age 8	0.358	-0.413	-0.457	-0.054	0.808	-0.540
Lived in a city at age 13	1.499**	2.057**	1.771**	0.693	0.594	1.596**
Adjusted R2	0.490	0.501	0.46	0.465	0.402	0.406

a/ A dummy variable taking on the value of 1 if years of schooling was missing was also included. The estimated coefficients are not reported here.
b/ Omitted category is mother or father is an agricultural worker. Also included in the regressions is a missing data category; results not shown.

* Statistical significance at 5 percent in a two-tailed test.
** Statistical significance at 1 percent in a two-tailed test.

<u>3.3.1 Influence of parents on education</u>. While the effect of parents' education on years of schooling completed is positive and statistically significant in each cohort regression, the effect diminishes over time. For both men and women, the effect of parents' education is smaller for the younger cohorts than for the older ones. The decline occurs after cohorts 1950-54 and 1955-59 for women and men, respectively. (The government's expansionist education policies in the mid-50s and 60s could have affected youths in the early years of schooling.) One interpretation of this result is that school reforms have improved access to education among broad sectors of the population, thereby weakening the linkage between socioeconomic status and education. Another explanation is that demand for education, influenced by higher market and nonmarket returns to education has increased across generations. This happened over a period when the parents' educational attainment had also risen. A third interpretation is that as education becomes more nearly universal and compulsory, the parents' attitudes toward schooling matter less.

There are no clear patterns pertaining to residence with parents at age 10, except for women who lived with their mothers. This relationship had a large positive effect on schooling for the older cohorts, but not for the younger ones. These results may stem from the fact that a larger proportion of the younger females in the sample lived with their mothers at age 10,[12] so there is less variance in the younger cohorts. Another possible explanation is that young daughters who lived away from home were more likely to have made the move for educational reasons. In the older cohorts, because there was less demand for female education, this was less likely to have been the case.

The conclusion that the link between socioeconomic background and educational attainment is weakening is based on an examination of the effects of parents' occupation on female schooling. Parents' occupation and education should be correlated positively, but since we also control for parents' education, occupation presumably captures other effects. For example, mothers with no occupation could indicate greater inputs to the training of children.

The results show that daughters of mothers with white-collar occupations have significantly higher levels of schooling than farmers' daughters--about one more year. The magnitude of this effect seems to have been relatively stable across cohorts. Second, daughters of mothers with no jobs have significantly more education than farmers' daughters. But the point estimate for the youngest cohort suggests that this difference may have narrowed.

In contrast the coefficient estimates for "father is a white-collar worker," which are higher, increase significantly over time up to cohort 1950-54, and decline thereafter. These estimates indicate a widening of the schooling gap up to cohort 1950-54 between women whose fathers were white-collar workers and those whose fathers were farmers. This gap is widest for the 1945-50 cohorts, which were the first potential beneficiaries of the early primary education programs. As attitudes toward the education of girls changed in rural

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[12]Table A.3 shows that 94 percent of women born between 1960-66 lived with their mother at age 10, whereas only 86 percent of women born in 1925-39 did.

areas, however, the gap narrowed among younger cohorts. Our results for men also indicate that those whose fathers held white or blue-collar jobs had an edge over farmers' sons, and while the former group's enrollment increased first, as noted above, it eroded earlier than the women's.

These results show that the education policies of the mid-50s and 60s had an equalizing effect across broad segments of the population. But the initial impact of relaxing the supply constraint through building more schools was to worsen the inequality among groups with divergent views on the benefits of education and therefore different demands. Perhaps the persistent message about the importance of education in Peru's development increased the demand from women and rural residents.

3.3.2 Effects of school inputs. The primary school inputs that affect years of schooling are textbooks, teachers, and the number of grades offered. Consider the statistically significant coefficient estimates for the textbook variable. First, for both males and females, the estimates increased numerically in the younger cohorts (that is, up to cohort 1955-59). These estimates suggest that, as primary schools became more available, textbooks had more impact on schooling attainment. Second, the textbook effect was larger for females than males. Perhaps because there was less interest in the education of girls, the quality of the learning process was more impr 'ant in determining how many years of schooling girls had.

Table 7: Effects of school inputs on educational level: regression results for adults

Variable / Birth cohort:	1925-1939 Estimated coefficient	1940-1944 Estimated coefficient	1945-1949 Estimated coefficient	1950-1954 Estimated coefficient	1955-1959 Estimated coefficient	1960-1966 Estimated coefficient
A. Females a/						
Had reading and/or math book(s)	0.636**	0.692*	0.891**	-0.065	1.145**	0.725**
Number of grades in school	0.466**	0.282	0.523*	0.493	0.838**	1.138**
School had furniture	0.410	0.704	0.912*	-0.329	-0.484	0.223
School served free food	-0.456	0.029	-0.330	0.723**	-0.012	-0.054
Number of teachers in school						
1 - 3 Teachers	0.290*	0.058	0.162	0.510**	0.217	-0.035
4 - 6	0.011	0.584	0.118	0.088	0.117	0.039
6 +	0.031	0.149	0.034	0.106*	0.076	0.055
Lambda	-0.180	-0.192	-1.855**	-2.115**	-6.217**	-6.806
Adjusted R2	0.482	0.533	0.502	0.580	0.506	0.523
B. Males						
Had reading and/or math book(s)	0.542**	0.249	0.307	0.583**	0.918**	0.316
Number of grades in school	0.565**	0.848**	0.955**	1.198**	1.214**	1.342**
School had furniture	0.425	0.740	0.342	0.627	0.611	-0.139
School served free food	-0.191	0.523	0.076	0.188	-0.262	-0.034
Number of teachers in school						
1 - 3 Teachers	0.212	0.036	0.273	0.172	0.480**	0.411**
4 - 6	0.113	0.134	0.089	0.109	-0.039*	-0.010**
6 +	0.104	0.062	0.048	0.062	0.018**	0.025*
Lambda	0.296	-1.307	-3.002**	-3.206*	0.533	-5.688**
Adjusted R2	0.513	0.521	0.472	0.486	0.460	0.465

a/ Other included variables are the same as in tables 5 and 6.

* Statistical significance at 5 percent in a two-tailed test.
** Statistical significance at 1 percent in a two-tailed test.

The number of grades in primary school has a large positive effect that increases across cohorts. For males born before 1940, adding a grade would have increased schooling levels by half a year. For males born in the 60s, adding a grade would have raised attainment levels by 1.3 years. The increase in this effect is largest for the cohort whose schooling years coincided with the early period of school expansion. A similar pattern emerges for females, but the increase occurs later. These results suggest that supply was a principal constraint in the older cohorts. Additional school places met some of the existing demand for education; in addition, they raised schooling levels by generating a higher demand in the younger cohorts.

Holding constant the number of grades offered in a primary school, more teachers per school tended to increase the number of years students spent in school. The coefficients are considerably smaller when increasing the number of teachers beyond three. The few statistically significant coefficients suggest that this factor may have been more important in the younger cohorts. Since we controlled for the number of grades, the teacher variable provides a rough measure of quality. That is, increasing the number of teachers raises the likelihood that one teacher taught one class at a time. The cohort trend, though weak, suggests that school quality had become more important in explaining the variance in educational attainment.

4. Results from the Youth Sample

The education levels of females continues to rise in the younger cohorts, and the gender gap appears to be narrowing (table 8). The principal findings are as follows:

- The higher proportion of 8- to 10-year-olds enrolled than 5- to 7-year-olds (and even 11- to 13-year-olds) suggests a later age of entry in school than the prescribed ages five or six.
- By ages 8-10, most children are in school. Enrollment ratios for girls and boys are nearly equal, though still somewhat lower for girls in both urban and rural areas.
- From ages 11-13, enrollment by gender diverges, especially in rural areas. Whereas more boys are entering school even at that age, girls have started to drop out: by ages 14-16 the gap is more than 20 percentage points.
- From ages 17-19, even boys are leaving school, leveling out enrollment ratios between the sexes. In Lima and other cities, more than half the students of this age are still in school. In rural areas, however, only about a fifth of the girls and a third of the boys are still enrolled. Applying these cross-section enrollment ratios to a synthetic cohort, they are consistent with expected attainment levels by age 19 (10.7 years for girls and 11.4 years for boys). These levels are about three years more than the average number of years completed by adults aged 20-26, and the female-male ratio has improved slightly from 0.92 to 0.94.

Table 8: School enrollment by region
(percentage)

Age Group	Females	Males
Ages 5-7		
Lima	84.8	87.9
Other urban areas	75.2	73.9
Rural	47.1	46.9
Total	66.5	65.3
Ages 8-10		
Lima	96.5	98.8
Other urban areas	93.2	94.1
Rural	82.0	83.7
Total	89.0	91.1
Ages 11-13		
Lima	97.1	97.4
Other urban areas	92.1	93.8
Rural	78.2	90.3
Total	87.7	92.8
Ages 14-16		
Lima	91.5	95.9
Other urban areas	83.8	86.9
Rural	44.4	68.8
Total	69.3	81.0
Ages 17-19		
Lima	65.3	64.8
Other urban areas	54.8	61.8
Rural	22.3	32.2
Total	45.3	50.3

The reduction in the proportion of youths who never attended school is further evidence of educational progress (table 9). Aside from the five- to seven-year-old group, the percentage is lower for female youths than any adult cohort.[13] This improvement is most evident among rural girls, attesting to the rural schools' success in drawing a larger fraction of children, especially girls.

[13]Because of late entry into school especially in areas where compulsory schooling may be difficult to enforce, the enrollment ratio among very young children is a poor measure of the proportion of youths who will never attend school.

Table 9: Percentage of youths who have never attended school by region (percentage)

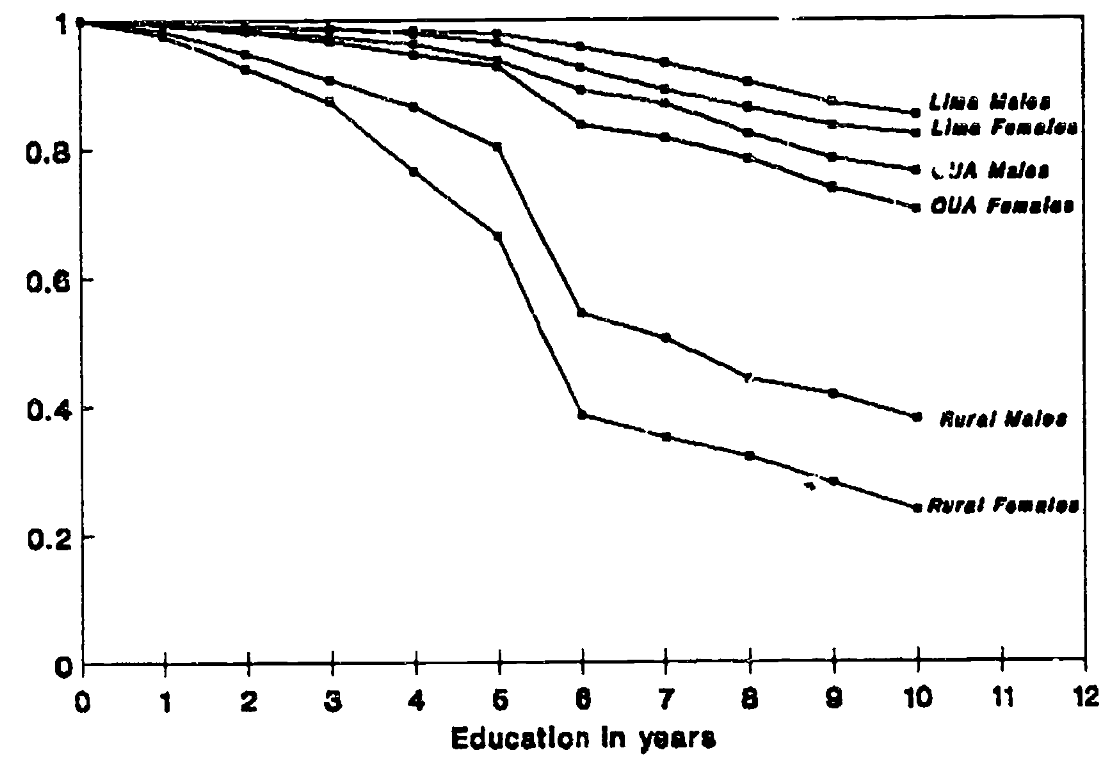
Age group	Lima F	Lima M	Other urban areas F	Other urban areas M	Rural F	Rural M	All Peru F	All Peru M
Ages 5- 7	13.4	8.9	21.3	23.0	50.0	49.4	30.3	31.1
Ages 8-10	0.8	0.0	2.1	1.1	10.2	10.2	5.0	4.3
Ages 11-13	0.4	0.0	1.0	0.4	7.1	1.4	3.2	0.7
Ages 14-16	0.0	0.0	0.8	0.3	8.5	1.1	3.2	0.5
Ages 17-19	0.4	0.4	1.1	0.0	9.8	3.2	3.2	1.1

Although most girls enter school, many do not remain until completion. With higher dropout rates, girls still have fewer years of schooling (table 10). Twenty-eight percent of girls aged 14-16 had already dropped out compared to 19 percent of boys, and 53 percent of 17- to 19-year-old females were no longer in school compared to 49 percent of males. Moreover, urban-rural differences in dropout rates are large: 52 percent of rural girls aged 14-16 had dropped out compared to 8 percent of girls in Lima and 16 percent of those in other urban areas. Of those aged 17-19, 75 percent of rural girls were no longer in school, compared to 34 and 45 percent of those residing in Lima and other urban areas, respectively. Figure 1 illustrates the lower school survival probabilities of girls at each grade level. Furthermore, rural girls (and boys) are much less likely to enroll in secondary school than urban girls, as shown by the steep drop in survival rates between grades five and six.

Table 10: Percentage of school dropouts by region

	Areas							
	Lima		Other urban		Rural		All Peru	
Age	F	M	F	M	F	M	F	M
5-7	2.1	3.5	4.4	4.0	5.7	7.3	5.2	4.5
8-10	2.8	1.2	4.8	4.8	8.7	6.7	4.8	6.3
11-13	2.5	2.6	6.9	5.8	15.8	8.4	6.6	9.4
14-16	8.5	4.1	15.5	12.9	51.5	30.4	18.6	28.4
17-19	34.4	35.0	44.6	38.2	75.3	66.8	49.1	53.2

Figure 1: Progression Probabilities



4.1 What Factors Explain School Enrollment?

We estimated equation (1) for the youth sample, with the dependent variable being school participation, as a logistic function. Table 11 shows the parameter estimates for girls and boys.

Given the age of the child, parents' education has a strong influence on children's schooling. The mother's education exerts a stronger effect on daughters than the father's, but the father's presence at home is an important factor in girls' education. Two reasons can be cited for this result. In families where income is unstable because of the absence of the father, girls' education is more likely to suffer than boys'. And, since the mother may be the family's primary breadwinner, daughters are needed to substitute at home.

The family's wealth and standard of living, as measured by whether the home has electricity and the number of rooms in the house, are positively and significantly associated with school enrollment, although these factors affect daughters more than sons. For example, if the household uses electricity, daughters are 2.2 times more likely to be enrolled than not, while sons are 1.8 times more likely. These results indicate that wealthier families are more likely to send their daughters to school.

Table 11: Determinants of school enrollment: Logistic regression results for youth sample, males and females

Variables	Females Beta	Females s.e.	Males Beta	Males s.e.
Years of schooling	0.426	0.31	0.584	0.32
Age splines:				
8 to 10	-0.070	0.13	-0.052	0.14
11 to 13	-0.448	0.08	-0.185	0.09
14 to 16	-0.543	0.06	-0.527	0.07
17 to 19	-0.497	0.06	-0.610	0.06
Mother's years of schooling	0.077	0.02	0.021	0.02
Father's years of schooling	0.054	0.02	0.095	0.02
Lived with mother at age 10	0.087	0.20	0.049	0.20
Lived with father at age 10	0.286	0.14	0.249	0.14
Has electricity at home	0.76	0.15	0.602	0.16
Number of rooms in home	0.141	0.03	0.075	0.04
Dry land farmed by household	0.001	0.00	0.000	0.00
Wet land farmed by household	0.025	0.02	0.016	0.02
Resides in other urban area (Dummy)[a]	-0.304	0.15	-0.320	0.16
Resides in rural area (Dummy)	-0.641	0.19	-0.296	0.21
Had reading and/or math book(s)	0.277	0.14	-0.005	0.15
Number of grades in school	0.282	0.06	0.278	0.06
School had furniture	-0.062	0.22	0.045	0.21
School served free food	0.116	0.11	-0.048	0.11
Number of teachers in school	0.109	0.04	0.087	0.04
4-6 Teachers	-0.109	0.06	0.047	0.06
6+	-0.105	0.05	-0.079	0.05
-2 Log-likelihood	1445.5		1065.46	
Sample size	3855		3960	

Note: Data is for youths aged 8 to 19.
[a] Omitted category is Resides in Lima.

When expressed as percentages of urban children in school, rural percentages are lower for both boys and girls (74 and 55 percent, respectively). The amount of land farmed by the household does not appear to affect enrollment. Children in urban areas outside Lima are also less likely to be enrolled than children in Lima, but not to the same extent as in rural areas.

Finally, the logit coefficient estimates for the school-related variables indicate that schools and textbooks are more important factors in girls' than in boys' enrollment probability. If the primary school attended supplies a free textbook, girls are 1.3 times more likely to be enrolled, whereas it has no effect on boys' enrollment. Whether the school serves a free lunch has no significant impact. A complete primary school increases the likelihood of enrollment by 28 percent for both girls and boys. The number of teachers, which is another measure of school availability, school size, and the number of school places[14] has a larger positive effect on girls' enrollment, thus emphasizing the importance of the number of places and quality of schools in increasing girls' enrollment.

4.2 Nonschool Activities of Females

To understand how families choose their children's schools, it is important to consider what these children do in addition to, or in place of, going to school. The amount of time girls spend either working or out of the household indicates that the opportunity cost of their time in school may be quite high and thus may explain why fewer girls than boys attend school. Of those not in school during the survey week, many reported working (table 12). Thirty percent of girls aged 5-7 and 50 percent of those aged 8-10 reported positive hours in the market, constituting slightly higher percentages than for boys of similar ages. In the group aged 11-13, a greater proportion of girls than boys reported market work, and only 26 percent of girls had zero market hours, compared to 35 percent of boys. Of those working, girls had longer market hours as well. Most girls, especially in the oldest group, were employed as unpaid workers on or off the farm. About 8 percent of the youngest girls were employed as paid workers in family enterprises or domestic work. In the teenage groups, a higher fraction of out-of-school boys were working in the labor market than girls. At these ages, marriage and motherhood are likely to be the reason for girls being both out of school and outside the labor force.

Table 12 shows that even girls in school were working; 11, 25, and 34 percent of those aged 5-7, 8-10, and 11-13, respectively. These rates are a few percentage points lower than for boys. In older age groups, there is a much wider spread, and teenage boys aged 14-19 are more likely to have positive work hours.

In addition to market work, girls from age 8, in school or not, work many more hours at home than boys (table 13). Thirty-eight percent of girls aged 8-10 who were out of school worked at least 15 hours a week in the market and 23 percent worked at least the same number of hours at home. In comparison the corresponding percentages for boys of the same age are 41 and 15 percent, respectively.

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[14] We control for number of students in the school only roughly through the inclusion of number of grades offered. If this sufficiently distinguishes schools by class size, then number of teachers could be interpreted as an indicator of school quality.

Table 12: Labor participation and weekly work hours, All Peru

Age	Females 0	Females 1-14	Females 15-28	Females 29-42	Females 42+	Males 0	Males 1-14	Males 15-28	Males 29-42	Males 42+
	Weekly Hours Worked									
	(In-school youths)									
5- 7	89.4	5.8	3.0	0.9	0.9	81.0	10.9	5.7	1.4	1.1
8-10	75.4	12.7	7.5	2.8	1.6	72.3	12.8	8.3	3.6	2.9
11-13	66.4	14.8	11.1	3.9	3.7	61.9	15.7	11.8	5.7	4.8
14-16	68.0	17.3	8.1	3.3	3.3	53.6	14.9	14.0	8.4	9.1
17-19	71.7	12.2	7.5	3.9	4.7	52.7	15.6	9.8	6.5	15.4
All	73.4	13.0	7.9	3.0	2.7	64.8	14.1	10.2	5.2	5.8
	(Out-of-school youths)									
5- 7	69.6	5.4	8.1	9.5	7.4	71.5	9.3	7.0	7.6	4.7
8-10	50.4	10.4	12.2	13.9	13.0	51.6	7.5	9.7	11.8	19.4
11-13	25.6	17.4	12.4	16.5	28.1	34.7	16.7	16.7	12.5	19.4
14-16	32.0	13.2	13.9	15.0	25.9	17.1	6.3	10.8	25.3	40.5
17-19	38.9	11.8	11.5	16.6	21.2	29.3	4.8	10.6	15.4	39.9
All	41.2	11.7	11.8	14.9	20.4	38.2	7.2	10.3	15.0	29.2

Table 13: Hours a Week Spent By Youths in Household Work, All Peru

Age	Females 0	Females 1-14	Females 15-28	Females 29-42	Females 42+	Males 0	Males 1-14	Males 15-28	Males 29-42	Males 42+
	Weekly Hours Worked									
	(In-school youths)									
5- 7	45.7	49.1	4.5	0.6	0.2	45.6	49.3	4.6	0.5	0.0
8-10	18.0	67.3	11.7	2.2	0.8	28.0	62.5	8.0	1.2	0.3
11-13	9.0	64.4	20.4	4.7	1.5	19.0	66.4	12.2	1.9	0.5
14-16	7.7	54.9	26.7	8.0	2.7	21.2	66.2	11.1	1.4	0.1
17-19	8.3	44.2	29.4	14.3	3.9	30.2	56.7	10.7	1.9	0.5
All	16.9	58.7	17.8	5.1	1.6	27.1	61.7	9.6	1.4	0.3
	(Out-of-school youths)									
5- 7	37.8	53.4	6.1	2.0	0.7	37.2	55.8	7.0	0.0	0.0
8-10	9.6	67.8	13.9	5.2	3.5	13.8	74.5	9.6	2.1	0.0
11-13	8.1	54.5	21.1	12.2	4.1	15.3	69.4	15.3	0.0	0.0
14-16	9.3	34.3	28.7	19.8	7.8	31.0	61.4	7.0	0.6	0.0
17-19	6.9	27.0	30.5	19.8	15.8	41.0	45.7	9.6	2.9	0.8
All	12.2	40.0	23.9	14.9	9.0	33.4	55.6	9.1	1.6	0.3

These work patterns differ across regions. Youths in Lima are the least likely to be employed in the labor market, followed by those in other urban areas and in rural areas. Seventeen percent of girls in Lima aged 8-10 who were not in school were employed in the labor market, compared to 27 and 59 percent of girls living in other cities and rural areas, respectively (table 14). Of rural girls in this age group, 48 percent worked at least 15 hours in the week prior to the survey. Regional differences, though not as large, are also evident in the number of hours spent in household work (table 15). Twenty-five percent of rural girls out of school, aged 8-10, worked 15 hours or more a week in the household, compared to 19 percent of girls in other cities.

Table 14: Labor participation of females and weekly work hours, by region

	Weekly Hours Worked									
	In-school youths					Out-of-school youths				
Age	0	1-14	15-28	29-42	42+	0	1-14	15-28	29-42	42+
5- 7	100.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
8-10	92.8	5.9	0.8	0.0	0.4	83.3	16.7	0.0	0.0	0.0
11-13	87.2	8.8	1.8	0.9	1.3	40.0	20.0	0.0	0.0	40.0
14-16	83.0	10.1	2.3	1.8	2.8	53.3	6.7	6.7	0.0	33.3
17-19	79.7	8.2	3.8	2.5	5.7	66.7	7.7	5.1	5.1	15.4
Lima	88.2	7.1	1.7	1.0	1.9	67.0	8.0	4.5	3.6	17.0
5- 7	91.8	5.2	2.6	0.4	0.0	83.3	0.0	8.3	5.6	2.8
8-10	84.8	9.2	4.6	1.1	0.3	73.1	7.7	7.7	3.8	7.7
11-13	75.2	13.0	6.5	3.5	1.8	44.4	18.5	0.0	7.4	[illegible]
14-16	70.6	16.7	7.7	2.0	3.0	47.3	16.4	10.9	9.1	16.4
17-19	75.1	10.2	7.9	3.4	3.4	47.8	10.9	10.1	12.3	18.8
Other urban areas	79.4	11.2	5.8	2.1	1.6	54.3	11.0	8.9	9.6	16.3
5- 7	77.2	11.4	6.0	2.4	3.0	62.5	7.7	8.7	11.5	9.6
8-10	55.7	20.3	14.4	6.1	3.5	41.0	10.8	14.5	18.1	15.7
11-13	42.6	21.0	22.5	6.5	7.4	19.1	16.9	16.9	20.2	27.0
14-16	42.4	28.5	17.1	7.6	4.4	26.0	12.8	15.3	17.9	28.1
17-19	34.0	32.0	18.0	10.0	6.0	22.0	14.0	15.0	24.0	25.0
Rural	52.1	20.9	16.1	6.1	4.8	31.4	12.6	14.3	19.0	22.6

Table 15: Hours a week spent by females in household work by region

	Weekly Hours Worked									
	In-school youths					Out-of-school youths				
Age	0	1-14	15-28	29-42	42+	0	1-14	15-28	29-42	42+
5- 7	56.1	42.4	1.4	0.0	0.0	50.0	25.0	25.0	0.0	0.0
8-10	23.4	69.0	5.9	0.8	0.8	16.7	83.3	0.0	0.0	0.0
11-13	11.0	64.3	22.0	1.8	0.9	16.7	83.3	0.0	0.0	0.0
14-16	9.1	55.9	26.4	5.0	3.6	6.7	60.0	13.3	0.0	20.0
17-19	6.3	46.8	29.1	15.2	2.5	9.0	26.9	25.6	17.9	20.5
Lima	19.2	57.7	17.3	4.2	1.6	12.4	37.2	21.2	12.4	16.8
5- 7	49.1	46.1	3.9	0.9	0.0	36.1	55.6	5.6	2.8	0.0
8-10	20.1	65.9	11.7	2.0	0.3	11.5	69.2	11.5	3.8	3.8
11-13	9.7	66.1	17.7	5.6	0.9	18.5	55.6	18.5	0.0	7.4
14-16	6.7	52.5	29.4	9.7	1.7	8.8	28.1	26.3	24.6	12.3
17-19	9.6	38.4	31.6	14.7	5.6	5.8	27.3	25.2	20.9	20.9
Other urban areas	18.2	56.3	18.2	5.9	1.4	11.9	37.5	21.1	15.8	13.7
5- 7	32.3	58.7	7.8	0.6	0.6	37.5	54.8	4.8	1.9	1.0
8-10	12.5	67.5	15.5	3.2	1.3	8.4	66.3	15.7	6.0	3.6
11-13	6.8	62.7	22.2	5.9	2.5	4.4	52.2	23.3	16.7	3.3
14-16	7.6	58.2	22.2	8.9	3.2	9.7	34.2	30.6	19.9	5.6
17-19	10.0	56.0	22.0	10.0	2.0	6.9	26.7	36.1	19.8	10.4
Rural areas	13.0	62.8	17.6	4.7	1.9	12.3	41.5	25.5	15.0	5.8

5. Conclusions

Since the mid-50s the government of Peru's education policies have been designed to raise skill levels and make education available to broader segments of the population. Those policies rested primarily on expanding the number of schools. As a result school enrollment rates and attainment levels rose. But an apparent preference to educate sons more than daughters meant that male schooling levels rose more quickly than female schooling levels. For females, especially those in rural areas, these policies were not sufficient to bring girls' schooling even with male levels. This was particularly true in rural areas. Better provision of such school inputs as textbooks, as well as a change in attitudes and better economic opportunities for educated women appear to have been important in strengthening the demand for educating rural girls.

Parents' years of schooling and their occupations were significant determinants of educational levels. The impact of these socioeconomic factors lessened over time as the number of schools expanded and primary education became more available. The relative effect of parents' education differed for daughters' and sons' schooling. In our adult sample, both parents' education had strong positive effects on daughters; for sons, the father's education had twice as large an effect as the mother's education. In the youth sample, the mothers' education had a stronger effect on their daughters' education. These differential effects reflect a preference on the part of fathers to send their sons to school, while mothers partly counterbalanced this preference.

Educational policies in Peru have reduced the direct costs associated with going to school. Time allocation patterns reveal, however, that the opportunity cost of school attendance to the family could be an effective barrier to further improvements in school enrollment and continuation rates. Even at a young age, girls, especially in rural families, participate in labor market activities and also contribute substantially to productive work at home. School quality, measured crudely by the supply of textbooks and the number of teachers, appears to have a positive effect on the schooling of females. These findings suggest the direction of future intervention programs.

Textbooks at the primary level contributed to raising enrollment and schooling levels. In our adult sample women who had a textbook for their own use in primary school attained over half a year more schooling than those who did not. This positive effect is noted among young students as well.

Appendix A

Table A.1: Trends In Peruvian education: selected indicators, 1950-1980 (in thousands)

	1950	1955	1960	1965	1970	1975	1980
Primary							
Schools	10.5	11.2	14.2	18.5	18.4	19.7	20.8
Teachers	23.2	28.2	38.5	53.1	66.0	72.6	84.4
Student enrolled	1,010	1,128	1,358	1,901	2,341	2,841	3,161
Percent female	40	41	44	45	46	47	48
Secondary							
Teachers	5.4	9.0	15.8	22.3	31.6	34.1	45.1
Students enrolled	72.5	112.2	174.8	324.5	546.2	813.5	1,152
Percent female	35	37	40	41	43	44	45
Postsecondary							
Universities a/	8	9	10	27	31	33	43
Faculty	2.5	2.5	3.1	.	11.7	13.2	18.3
Students enrolled	17.4	20.2	35.0	80.1	133.6	216.5	290.8
Percent female	23	17	29	34	34	32	35
Enrollment Ratios							
Primary enrollment as a percent of population aged 6-11							
Males	100	95	98	111	114	119	117
Females	69	65	77	93	99	108	111
Secondary enrollment as a percent of population aged 7-12							
Males	9	12	16	25	34	42	53
Females	5	7	11	18	27	35	46
Tertiary enrollment as a percent of population aged 18-22							
Males	4	4	6	10	14	20	22
Females	1	1	2	5	8	10	12

Sources: Ministerio de Planification; World Bank 1988.

a/ Figure includes private and state universities only. Faculty and student totals include all postsecondary institutions.

Table A.2: Sample distribution by gender, cohort, and region

Females								
Birth year		1925-39	1940-44	1945-49	1950-54	1955-59	1960-66	All
All regions	Number	1,306	619	715	808	907	1,289	5,644
	Row %	23.1	11.0	12.7	4.3	16.1	22.8	100
Lima	Number	343	193	205	252	316	431	1,740
	Row %	19.7	11.1	11.8	4.5	18.2	24.8	100
	Column %	26.3	31.2	28.7	1.2	34.8	33.4	30.8
Other urban areas	Number	380	150	221	246	293	406	1,696
	Row %	22.4	8.8	13.0	4.5	17.3	23.9	100
	Column %	29.1	24.2	30.9	0.4	32.3	31.5	30.0
Rural areas	Number	583	276	289	310	298	452	2,208
	Row %	26.4	12.5	13.1	4.0	13.5	20.5	100
	Column %	44.6	44.6	40.4	8.4	32.9	35.1	39.1

Males								
Birth year		1925-39	1940-44	1945-49	1950-54	1955-59	1960-66	All
All regions	Number	1,265	582	654	712	812	1,216	5,241
	Row %	24.1	11.1	12.5	13.6	15.5	23.2	100
Lima	Number	323	165	180	241	286	405	1,600
	Row %	20.2	10.3	11.3	15.1	17.9	25.3	100
	Column %	25.5	28.4	27.5	33.8	35.2	33.3	30.5
Other urban areas	Number	359	147	188	219	253	392	1,558
	Row %	23.0	9.4	12.1	14.1	16.2	25.2	100
	Column %	28.4	25.3	28.7	30.8	31.2	32.2	29.7
Rural areas	Number	583	270	286	252	273	419	2,083
	Row %	28.0	13.0	13.7	12.1	13.1	20.1	100
	Column %	46.1	46.4	43.7	35.4	33.6	34.5	39.7

Table A.3: Means and standard deviations of variables: adult females

Variable (Birth cohort:)	1925-1939 Mean	1925-1939 std	1940-1944 Mean	1940-1944 std	1945-1949 Mean	1945-1949 std	1950-1954 Mean	1950-1954 std	1955-1959 Mean	1955-1959 std	1960-1966 Mean	1960-1966 std
Years of schooling	3.123	3.83	3.667	4.19	4.815	4.59	6.006	4.92	6.977	4.58	7.603	3.98
Mother's years of schooling	1.532	2.65	1.683	2.85	2.006	2.95	2.593	3.28	2.839	3.39	3.100	3.43
Father's years of schooling	2.560	3.62	2.767	3.44	3.249	3.69	3.926	3.83	4.342	3.78	4.777	4.11
Lived with mother at age 10	0.859	0.35	0.868	0.34	0.853	0.35	0.879	0.33	0.902	0.30	0.936	0.24
Lived with father at age 10	0.750	0.43	0.753	0.43	0.761	0.43	0.786	0.41	0.800	0.40	0.845	0.36
Mother is a white-collar worker	0.047	0.21	0.069	0.25	0.071	0.26	0.115	0.32	0.139	0.35	0.168	0.37
Mother is a blue-collar worker	0.089	0.28	0.095	0.29	0.074	0.26	0.093	0.29	0.109	0.31	0.147	0.35
Mother has no job	0.436	0.50	0.391	0.49	0.488	0.50	0.394	0.49	0.356	0.48	0.199	0.40
Mother's occupation is missing	0.054	0.23	0.060	0.24	0.073	0.26	0.089	0.29	0.108	0.31	0.160	0.37
Father is a white-collar worker	0.137	0.34	0.129	0.34	0.147	0.35	0.167	0.37	0.191	0.39	0.206	0.40
Father is a blue-collar worker	0.149	0.36	0.183	0.39	0.213	0.41	0.224	0.42	0.288	0.45	0.310	0.46
Father's occupation is missing	0.030	0.17	0.026	0.16	0.039	0.19	0.043	0.20	0.039	0.19	0.043	0.20
Lived in a cith at age 8	0.265	0.44	0.281	0.45	0.322	0.47	0.382	0.49	0.437	0.50	0.479	0.50
Lived in a city at age 13	0.281	0.45	0.315	0.46	0.362	0.48	0.436	0.50	0.477	0.50	0.504	0.50
Had reading and/or math book(s)	0.384	0.49	0.459	0.50	0.534	0.50	0.632	0.48	0.723	0.45	0.793	0.41
Number of grades in school	4.918	0.60	4.872	0.61	4.920	0.46	4.902	0.48	4.947	0.37	4.972	0.27
School had furniture	0.502	0.50	0.582	0.49	0.662	0.47	0.754	0.43	0.819	0.39	0.867	0.34
School served free food	0.091	0.29	0.150	0.36	0.221	0.42	0.337	0.47	0.398	0.49	0.407	0.49
Number of teachers in school	3.472	6.22	3.911	5.07	4.599	5.05	6.006	5.94	7.020	6.28	8.263	7.12

Table A.4: Means and standard deviations of variables: adult males

Variable (Birth cohort:)	1925-1939 Mean	1925-1939 std	1940-1944 Mean	1940-1944 std	1945-1949 Mean	1945-1949 std	1950-1954 Mean	1950-1954 std	1955-1959 Mean	1955-1959 std	1960-1966 Mean	1960-1966 std
Years of schooling	4.838	4.18	5.897	4.63	6.780	4.55	8.257	4.46	8.707	4.01	8.248	3.37
Mother's years of schooling	1.558	2.75	1.735	2.72	1.959	3.02	2.617	3.42	2.835	3.44	3.059	3.39
Father's years of schooling	2.515	3.44	2.890	3.44	3.194	3.49	4.058	4.00	4.340	3.94	4.731	4.02
Lived with mother at age 10	0.843	0.36	0.835	0.37	0.856	0.35	0.914	0.28	0.925	0.26	0.940	0.24
Lived with father at age 10	0.743	0.44	0.741	0.44	0.755	0.43	0.803	0.39	0.841	0.36	0.863	0.34
Mother is a white-collar worker	0.053	0.22	0.077	0.27	0.090	0.29	0.121	0.32	0.128	0.33	0.171	0.38
Mother is a blue-collar worker	0.076	0.27	0.082	0.28	0.087	0.28	0.096	0.29	0.090	0.28	0.124	0.33
Mother ha no job	0.469	0.50	0.469	0.50	0.448	0.49	0.389	0.48	0.331	0.47	0.187	0.39
Mother's occupation is missing	0.031	0.17	0.043	0.20	0.052	0.22	0.105	0.30	0.145	0.35	0.168	0.37
Father is a white-collar worker	0.128	0.33	0.155	0.36	0.149	0.36	0.192	0.39	0.192	0.39	0.209	0.41
Father is a blue-collar worker	0.169	0.38	0.201	0.40	0.215	0.41	0.270	0.44	0.302	0.45	0.325	0.47
Father's occupation is missing	0.022	0.15	0.036	0.19	0.024	0.16	0.043	0.20	0.045	0.20	0.040	0.20
Lived in a city at age 8	0.269	0.44	0.285	0.45	0.325	0.47	0.396	0.48	0.431	0.49	0.465	0.50
Lived in a city at age 13	0.309	0.46	0.339	0.47	0.383	0.49	0.445	0.49	0.474	0.50	0.493	0.50
Had reading and/or math book(s)	0.540	0.50	0.596	0.49	0.642	0.48	0.742	0.44	0.815	0.39	0.846	0.36
Number of grades in school	4.770	0.93	4.723	0.84	4.841	0.65	4.919	0.46	4.931	0.41	4.948	0.37
School had furniture	0.693	0.46	0.761	0.43	0.803	0.40	0.869	0.34	0.893	0.31	0.915	0.28
School served free food	0.125	0.33	0.235	0.42	0.320	0.47	0.426	0.49	0.394	0.49	0.393	0.49
Number of teachers in school	4.402	5.06	5.227	5.96	6.083	6.64	6.954	6.00	8.139	6.97	8.706	7.31

CHAPTER 7

DOES THE STRUCTURE OF PRODUCTION AFFECT DEMAND FOR SCHOOLING IN PERU?*

Indermit Gill

1. Introduction

Analyses of gender differences in investments in human capital typically emphasize family resources as the determining factor. (See Schultz and Rosenzweig (1982), Gertler and Alderman (1989) for investment in health, and King and Bellew in Chapter 6 for investment in schooling.) These studies approach the problem as one of investment by parents in the human capital of male and female children. These studies usually find that investments in male offspring are greater, that these differences narrow as the level of household wealth increases, and that the composition of household wealth (proxied by either the amount earned by the mother and/or her education level) affects equity as well.

There are two major drawbacks in these analyses. First, the empirical segments confound the effects (a) of a gender bias inherent in the utility function of parents, (b) of gender differences in market returns to human capital, and (c) of gender differences in appropriability of returns to investments by parents in children. This chapter does not address this issue. Second, these analyses contain no explicit consideration of the factors determining the demand for schooling and health, other than tastes, and why this differs for males and females. It is the second shortcoming that this chapter seeks to rectify.[1]

In this chapter I use the regional structure of the economy, proxied by the shares of services and industry in regional gross domestic product (GDP), as an indicator of the demand for educated workers. By examining whether the level of schooling as a function of shares of services and industry differs for men and women, we can detect gender bias in the demand for schooling.

Based on the theoretical framework developed in Gill and Khandker (1990), I estimate schooling demand functions for males and females using data for Peru in the 1980s. A separate estimate covers households and provinces (called "departments" in Peru). Household data are from the Peruvian Living Standards Survey (PLSS); information on the provinces is based on census data.

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[1] It should be mentioned here that the absence of explicit consideration of demand-side factors in the market for labor is a weakness of much of neoclassical labor economics.

Findings confirm the results obtained in Gill and Khandker using country-level data for about 100 countries in 1965 and 1987. The primary findings are:

- As services and industry increase their shares of GDP, relative to the share of agriculture, the demand for schooling of both males and females increases.

- As the share of services in GDP increases compared to agriculture (holding the share of industry constant), the demand for schooling by women increases more than the demand for schooling by men.

- An increase in the share of industry relative to agriculture (holding the share of services constant), is more closely associated with an increase in the demand for schooling of men than of women.

- A decrease in the supply price of schooling increases the level of schooling attained by both sexes, but the gain is larger for women.

- Increases in wealth, ceteris paribus, are associated with increases in the demand of both sexes for schooling.

The plan of the chapter is as follows. Section 2 introduces the basic theory. A representative family is assumed that has an adult couple and one female and one male child. The issue of fertility is thus entirely sidestepped. Parents are assumed to be the decisionmakers regarding investments in human capital of children. This role arises from their concern over the attained utility of their children. Attained utility depends upon the income of children when they become adults and such income in turn depends upon the human capital that was invested in them by their parents. Thus, the demand for schooling of children is focused upon. Schooling is demanded differentially in different sectors of the economy: industry and services reward education more than agriculture.[2] Parents form expectations about the sector of the economy that their children are likely to work in as adults, and choose levels of schooling for each child accordingly.

In the basic model, parents use their own time allocation as a proxy for the time-allocation patterns that their children will choose. In section 3 this last assumption is amended. Parents form expectations of time-use of children as adults based on both their own work experience and the general pattern in the region of residence, as well as the probability of migration to other regions. Section 3 also discusses the implications of adding sector-specific work experience (job training) as an additional component of human

[2] Schultz (1975) argues that this demand for education reflects the higher rates of change in industry. Mincer and Higuchi (1988) and Gill (1989) find that sectoral rates of technical change in the U.S. economy between 1960-1985, were related positively to the rates of return to education. Welch (1970) found similar relationships in U.S. agriculture. These results imply that the rates of return to schooling, and therefore the demand for educated workers, would be highest in industry (especially manufacturing), lower in trade and services, and lowest in agriculture.

capital.

Section 4 uses household data from the PLSS to test the implications of the theoretical framework developed in sections 2 and 3. The advantages of using household data are that the schooling attainment of children is directly observed, and the effects of intrahousehold factors on the demand for schooling of boys and girls can be accounted for by including household information such as the education and occupation of parents.

In section 5, I test the implications of the theory using provincial data for 25 departments in Peru in the 1980s. Illiteracy rates are used as a proxy for investment in schooling. I conduct tests to ensure that department illiteracy rates are satisfactory measures of department schooling attainment. The findings confirm the main implications of the theory, and add to the evidence from household analysis.

Section 6 discusses the policy implications of the study. The policy implications are of two types: supply-related and demand-related. Supply-related policy prescriptions are those targeted towards lowering the supply price of schooling, such as improving the access to secondary schooling. Demand-related policies aim at increasing the demand for education. The main policy recommendation entails the expansion of the services sector. This contradicts policy advice given by the World Bank and the IMF that developing countries foster the growth of tradables to service their external debt. Another policy implication emphasizes the importance of information about the rates of return to schooling in the market and the home sector.

2. The Theoretical Framework

Human capital is assumed to consist of two components: schooling and health.[3] Parents value only their own consumption and the attainable utility -- that is, the full income -- of their children as adults. Assume that a couple has only one female and one male child.[4] The parents' utility function is

$$U = U(C, R_f, R_m) \,. \qquad (1)$$

where C is the quantity of a general consumption good consumed by the parents, and R_f and R_m are the "full" incomes of the girl and boy respectively when they are adults.

R depends on the human capital of children and gender based opportunities. Human capital has several observable components, e.g., schooling,

[3] The theoretical framework for this paper departs considerably from previous theoretical attempts to analyze gender differences in investments in human capital, such as Gertler and Alderman's (1989) analysis of investments in health.

[4] The issue of fertility is ignored here. See Becker and Tomes (1976) for a theoretical discussion of fertility and quality-quantity tradeoffs, and Chapter 5 of this book for an empirical treatment by Schafgans using Peruvian data.

health and job training. I assume here that schooling (S) is the only form of human capital. The terms human capital and schooling will be used interchangeably unless otherwise indicated. Thus the returns to human capital functions for the girl and the boy are

$$R_f = R_f(S_f) \quad (2a)$$
$$R_m = R_m(S_m) \quad (2b)$$

The budget constraint of the household is

$$Y = C + P_s(S_f + S_m) \quad (3)$$

where P_s represents the price of schooling, and the price of the consumption good has been normalized to equal 1.

There are two main sectors of employment: home and the market. The rates of return to human capital are sector-specific. Thus overall returns to schooling depend upon the extent to which time is allotted between the household and the market (all nonhousehold) activities. In this chapter market activities are subdivided into agriculture, services, and industry, identified as follows

0 = Household
1 = Agriculture
2 = Services
3 = Industry

Total returns to human capital are a time-weighted sum of returns in each sector. I assume Cobb-Douglas return functions

$$R_f = t_{f0} S_f^{\alpha} + (t_{f1} S_f^{\beta} + t_{f2} S_f^{\gamma} + t_{f3} S_f^{\delta}) \quad (4a)$$

$$R_f = t_{m0} S_m^{\alpha} + (t_{m1} S_m^{\beta} + t_{m2} S_m^{\gamma} + t_{m3} S_m^{\delta}) \quad (4b)$$

where t_{fi} and t_{mi} is the fraction of time devoted to activity i by female and male children respectively when *they are adults*,[5] and

$$\sum_{i=0}^{3} t_{fi} = \sum_{i=0}^{3} t_{mi} = 1. \quad (5)$$

The following assumptions are made:

(i) $t_{f0} > \overline{t_0}$: Everybody gets married and has children, and women spend more time at home than men. This could be because bearing and rearing children is more demanding of women's time. (See, for related examples, Becker 1985). This raises the issue of endogeneity, since women may choose not

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[5] Alternatively, t_i can be interpreted as the *probability* of the child being employed in sector i as an adult.

to have children. In that case, from the viewpoint of this theory, the difference between men and women disappears. Alternatively, it can be explained as a cultural or institutional constraint. In any case, because of time constraint (5), women generally have less time for market activities than men.

(ii) $\beta < \gamma < \delta$: The rates of return to schooling are high in the industrial and service sectors and low in the agricultural sector.[6] However, these rates of return do not depend upon the sex of the workers: there is no sex discrimination in the marketplace.[7] Since the productivity of schooling at home, α, is not easily or directly observable, nothing is assumed about the magnitude of α relative to β, γ, and δ.

It is important to remember that t_{fi} and t_{mi} are not choice variables for the parents. These are time-allocation decisions by children when they become adults.[8] The only choice variables in the current framework are S_f, S_m, and C. Parents may *impute* the values of t_{fi} and t_{mi} from their own experiences and expectations of market conditions when their children will work. This point will be discussed later.[9]

Parents maximize their (one-period) utility function given in equation (1) subject to the budget constraint (3). The first order conditions for maximization are :

$$\frac{\partial U}{\partial R_f} \cdot [\, t_{f0}\alpha S_f^{\alpha-1} + (\, t_{f1}\beta S_f^{\beta-1} + t_{f2}\gamma S_f^{\gamma-1} + t_{f3}\delta S_f^{\delta-1})] - \lambda P_s = 0 \qquad (6a)$$

$$\frac{\partial U}{\partial R_m} \cdot [\, t_{m0}\alpha S_m^{\alpha-1} + (\, t_{m1}\beta S_m^{\beta-1} + t_{m2}\gamma S_m^{\gamma-1} + t_{m3}\delta S_m^{\delta-1})] - \lambda P_s = 0 \qquad (6b)$$

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[6] Although I do not have measures of the rates of return to schooling in agriculture compared to the other two sectors, there is strong evidence for Peru that supports this assumption. In Chapter 1, Schafgans finds that labor force participation of both men and women in agriculture declines with education, and participation in the nonagricultural wage sector (sectors 2 and 3 in this chapter) increases as the education of workers increases.

[7] The point is not that there is *in fact* no discrimination against women. The rationale for this assumption is simply that discrimination (either at home or in the market) is a very difficult concept to quantify. Since the focus of this chapter is empirical, I abstract from assertions that are unverifiable either in principle or in practice.

[8] This assumes that there is no bargaining about transfers from the children to the parents. Suppose instead that contracts bind children to support their parents when they are old. Then parents may in fact decide t_{fi} and t_{mi} as well.

[9] Notice that there is a self-fulfilling nature to the parents' decision. If parents choose the schooling levels under the assumption of a set of t_{fi} and t_{mi}, and if they are correct about the rates of return to schooling in each sector, children cannot do better than allocate their time exactly as their parents expected.

$$\frac{\partial U}{\partial C} - \lambda = 0 \tag{6c}$$

$$Y - C - P_s(S_f + S_m) = 0 \tag{6d}$$

We can solve for the demand functions for S_f, S_m and C. The schooling demand functions will be of the form

$$S_f^* = S\,(Y,\ P_s,\ \bar{t}_0,\ t_1,\ t_2,\ t_3) \tag{7a}$$

$$S_m^* = S\,(Y,\ P_s,\ t_0,\ t_1,\ t_2,\ t_3) \tag{7b}$$

where t_i, $i = 0,1,2,3$, are combinations of t_{if} and t_{im} for each i. Note that since both parents have the same utility function, only aggregate t_i enters the schooling demand functions. These can be written as

$$S_f^* = S_f(Y,\ P_s,\ t_1,\ t_2,\ t_3) \tag{8a}$$

$$S_m^* = S_m(Y,\ P_s,\ t_1,\ t_2,\ t_3)\ . \tag{8b}$$

Equations (8a) and (8b) incorporate the additional constraint faced by women, $t_{f0} \geq \bar{t}_0$ (that they must spend at least a fixed fraction t_0 of their time at home), in the functional form, $S_f(.)$. Since females are expected to marry and become mothers, the functional form of schooling demand will differ from that of males. Other than this restriction, however, there is no difference between boys and girls.

The signs of $\partial S_f^* / \partial P_s$ and $\partial S_f^* / \partial Y$ (and $\partial S_m^* / \partial P_s$ and $\partial S_m^* / \partial Y$) are predicted by standard consumer theory as being negative and positive respectively, if quality of children is a normal good. Assuming that parents value the happiness of male and female children equally,[10] the theory predicts that these coefficients will be roughly equal in magnitude if the curvature in the utility function is small. That is, if the second derivatives, $\partial^2 S_f^* / \partial P_s^2$ and $\partial^2 S_f^* / \partial Y^2$ (and $\partial_2 S_m^* / \partial P_s^2$ and $\partial^2 S_m^* / \partial Y^2$) are close to zero. If these coefficients are different for males and females, and since we know that mean levels of S_f are small compared to S_m, this is indicative of curvature in the utility function.

However, the theory as it stands contains no predictions regarding the magnitudes of $\partial S_f^* / \partial t_1$, $\partial S_f^* / \partial t_2$ and $\partial S_f^* / \partial t_3$ relative to $\partial S_m^* / \partial t_1$, $\partial S_m^* / \partial t_2$ and $\partial S_m^* / \partial t_3$ respectively. More structure is needed to determine whether, for example, an increase in the time spent by parents in sectors 2 and 3 (relative to sector 0 and/or 1) increases or decreases the demand for children's education and whether these magnitudes of response are different for females than for males.

[10] Following Becker (1981), parents are altruistic toward their children.

3. Some Theoretical Extensions

The theory predicts that within a region, as a sector with a relatively high rate of return to education increases its share in total employment, demand for the education of children in that region will rise.[11] The limitations of the framework are:

(1) The theory contains no implications for the gender composition of this increase in demand for schooling: It assumes that if an education-intensive sector (say, industry) increases in importance, the demand for schooling of boys and girls will rise symmetrically. The theory is now extended to allow for systematic differences across sex to such shifts in the demand curve for schooling.

(2) The theory assumes that the local structure of the economy (t_1, t_2, and t_3 of the parents) determines the demand for education. This raises the question of how parents form expectations regarding their children's future. Issues such as the likelihood and ease of migration may be significant, and these factors may not be gender-neutral. Also, since the rate of return to schooling in the home sector, α, is not observed directly (that is, in terms of wages), perceptions regarding α may be related to household attributes such as the education of the mother.

3.1 Experience as a Factor of Production

The only distinction between men and women is that, in general

$$\sum_{i=1}^{3} t_{fi} < \sum_{i=1}^{3} t_{mi} , \qquad (9)$$

since $t_{f0} \geq \bar{t} > t_{m0}$; women must spend more time at home than men. Suppose now that experience in sector 3 (time allocated to sector 3 activities) adds to the returns to schooling in that sector, but the other sectors' rates of return to schooling are not dependent on the time spent. That is

$$\delta = \delta\ (t_3), \quad \delta' > 0 \qquad (10)$$

So the returns to schooling functions (equations (4a) and (4b)) are rewritten as

$$R_f = t_{f0}S_f^{\alpha} + [\ t_{f1}S_f^{\beta} + t_{f2}S_f^{\gamma} \quad t_{f3}S_f^{\delta(tf3)}\ ] \qquad (11a)$$

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[11] If the industrial sector increases in importance, relative to services and/or agriculture, we expect schooling to rise. Similarly, if the service sector's share rises *relative to agriculture, with no change in the share of the industrial sector,* then the demand for education will unambiguously increase. However, if the share of industry declines at the same time that the share of services rises, the effect on aggregate schooling demand is ambiguous.

$$R_m = t_{m0}S_m^{\alpha} + [\, t_{m1}S_m^{\beta} + t_{m2}S_m^{\gamma} + t_{m3}S_m^{\delta(t_{m3})} \,] \qquad (11b)$$

Combined with restriction (9), equations (11a) and (11b) imply that males will allocate more time to the industry sector than *equally schooled* females because, holding educational attainment constant, women spend less time in market activities than males. This implies that men have a comparative advantage in working in market sectors where the returns to schooling increase with time spent.[12]

For example, assume there are two levels of education: high and low. Industry and services use only workers with high levels of education, while agriculture uses workers with low levels of education (regardless of sex). Assume that experience is rewarded in industry and not in services (a simplification). More schooled workers with higher amounts of allocable market time (males) will be employed in industry. More schooled females will work in the services sector, where the returns to schooling do not depend on experience.

One consequence is that an increase in the industrial sector's share of GDP will raise the demand for education by both males and females, but more for males. Conversely, a rise in the service sector's share in total employment will increase the demand for schooling by both male and females, but more for females. These are testable implications of the theory.

3.2 Forming of Expectations

The model assumes that parents, in deciding how to educate their offspring, base the decision on the amount of time the parents spend on four areas (household activities, agriculture, services, and industry) and the rates of return to schooling in each of these sectors. For example, they expect daughters to allocate time the same way as the mother, and sons to follow their father's patterns. They further expect that the relative rates of return to schooling in each sector will remain unchanged. In the context of Peru in the 1980s this assumption is likely to be incorrect, since a large flow of migrants moves between rural and urban areas.

This sub-section modifies the theory to allow for migration. Parents have some information about potential work opportunities for their children (other than their own occupations) and incorporate this information into the decision on their children's education. So, for example, parents may use the average levels of t_{fi} and t_{mi} in the region or country to determine the probability of employment of female and male children in sector i. Parents may use t_i (averaged over both sexes) in deciding how much to educate their children. This may entail migration by children when they are adults; this migration may or may not be gender-neutral.

[12] Alternatively, the comparative advantage of women in services may simply be due to the fact that services provide more opportunities to work close to home than does industry (Smith and Stelcner 1990).

Vector Z is added as an argument in the two schooling equations

$$S_f^* = S_f(Y,\ P_s,\ t_1,\ t_2,\ t_3,\ Z) \qquad (12a)$$

$$S_m^* = S_m(Y,\ P_s,\ t_1,\ t_2,\ t_3,\ Z) \qquad (12b)$$

where Z represents both "infrastructural" variables (Z_1) that represent the ability of adults to migrate, and household-specific variables (Z_2) that represent the ability of the parents to decode information regarding potential opportunities for children. Z includes both factors that determine the degree to which employment in each sector is perceived as possible (t_{fi} and t_{mi}, for i = 0,1,2,3) and factors that determine the accuracy with which parents observe the true rates of return to schooling (α, β, γ and δ).

In the empirical sections, both equations (8) and (12) will be estimated to see whether or not these variables Z have independent and gender-variant effects on investment in schooling. These equations were estimated both by ordinary least squares (OLS) and two-stage least squares (TSLS) techniques to account for possible endogeneity of household income. The results were very similar. In this chapter only the TSLS results are reported.

4. Household Level Empirical Evidence

Analysis at the household level has several advantages. First, since the theoretical model is one of household decisions, empirical testing should be done at the household level. Second, it is possible to quantify the effect of intrahousehold distribution of potential or actual earnings (for instance, the education or earnings of the mother compared to the father's) on investment in the human capital of children. Third, the measure of investment is more reliable for the households than the illiteracy rates used in Section 5 of this chapter, and the primary and secondary school enrollment rates used in Gill and Khandker (1990).

The sample should ideally consist of households in the PLSS that have at least one male and one female child of school age. But when the sample was restricted to such households, the number of observations dropped significantly.

4.1 Definition of Dependent Variable: Schooling Shortfalls

The problems in comparing schooling levels of boys and girls are:

- Each boy and girl is likely to have different levels of access to schooling, such as household income, distance from school, quality of schools available, and so on.
- The boy and girl being compared are likely to differ in age, and hence on this account alone would differ in years of completed schooling. Thus we need to use a measure of educational attainment adjusted for age.

- A related complication is that time or cohort effects will be confused with the true schooling differentials. Suppose, for example, that the government makes primary school attendance compulsory for all children between 5 to 10 years of age in year t. Then comparing the adjusted schooling attainment of a girl who is 10 years old in year t+5 with a boy who is 15 in the same year is likely to understate the actual difference in the schooling of girls. Conversely, comparing a boy who is 10 in year t+5 with a girl who is 15 in the same year will overstate this difference. It is important to weed out these cohort-specific effects.

To resolve the first problem, we have included family characteristics in the regression. Regarding the second problem, the comparison is not between attained schooling but *shortfalls* in schooling attainment of boys and girls. This shortfall, for a child j, is defined as

$$(\text{Age}_j - 5) - (\text{Schooling in Years})_j = (\text{Schooling Shortfall})_j, \text{ for } j = f,m.$$

That is, the shortfall is equal to potential schooling (age - 5) minus actual schooling (alternatively, the highest grade completed).[13] The nice thing about this measure is that it is a familiar one: it is identical to Mincer's (1974) definition of potential work experience for adults. The only difference is in its application. We deal with the third problem by estimating cohort-specific schooling equations, estimating separately for each of five age groups: 6-15 years, 16-25 years, 26-35 years, 36-45 years and 46-65 years.[14]

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[13] Within the household, it is also possible to compare the quality of schools attended by male children versus the quality of schools attended by female children. For example, in the PLSS, it is possible to determine whether the child attended a private or a public school. Indices of quality of schooling of and school-related expenditure on male and female offspring can be incorporated to make the schooling differential variable better approximate differential investment in schooling rather than differential schooling attainment.

[14] Ideally, to purge cohort effects from the comparison of male and female schooling levels, the following procedure should be adop d. The average schooling shortfall for male children in each cohort group is first calculated. Then the difference of the schooling shortfall of each child i, male *and* female, from the average schooling shortfall of male children in the cohort that child i belongs to, is defined as

$$(\text{Schooling Shortfall})_j - \sum_{k=1}^{M(t)} (\text{Male Schooling Shortfall})_k \,/\, M(t) = S_j,$$

$$j = m, f; \text{ and } k = 1,2,\ldots\ldots, M(t)$$

where j denotes the male children in the cohort, t, that i belongs to, and M (t) is the number of males in cohort t.

4.2 Definitions of Independent Variables

Y: *Household income* is proxied by using total (food and nonfood) expenditures in the household. The advantages of using expenditures rather than income are that: (a) expenditures are less subject to errors in reporting, since they are reported by component. Each component (food, clothing, and so on) is less likely to be systematically under- or over-reported; and (b) total expenditures are a better proxy for permanent income, which is generally the relevant budget constraint.

The disadvantages are that: (a) since expenditures on schooling are a component of the total, the issue of endogeneity of a right-hand side variable becomes a problem; and (b) schooling levels and household income may be jointly determined by other variables, and this results in simultaneous equations bias. (See Schultz 1989 for a discussion of this problem for fertility decisions.)

To overcome these problems, the estimation is done in two stages. The first stage consists of estimating household expenditures per adult from the following regression

$$\begin{aligned}\text{Expenditures/Adult} = \xi_0 &+ \xi_1\text{Age} + \xi_2\text{Age}^2 + \xi_3\text{Schooling} \\ &+ \xi_4\text{Schooling}^2 + \xi_5\text{Training} + \xi_6\text{Public School?} \\ &+ \xi_7\text{Landholding} + \xi_8\text{Unearned Income} \\ &+ \xi_9\text{Rural} + \epsilon \qquad (13)\end{aligned}$$

Age, **Schooling** and **Training** are the age, education, and training of the head of the household and the spouse, **Public School?** is a binary variable that asks whether the head and spouse attended a private or a public school, **Rural** is a region dummy which equals 1 if the region of residence is rural, and 0 otherwise, **Landholding** is the total area of land sown or rented out by the household, and **Unearned Income** is the sum of all income other than wage and salaries. The fitted values used are from a regression that excludes **Landholding**, because the sample was reduced to one-third of its size when landholding was included. The full regression results are in Appendix I.

t_i: The structure of the economy, or the time spent in each of the three market sectors, t_1, t_2, and t_3, is proxied by their *Share in Departmental GDP*.

- t_1 = Share of agriculture (farming, fishing and forestry),
- t_2 = Share of services (personal and business services, health care, hotels, tourism, and so on),
- t_3 = Share of industry (manufacturing, mining, construction, and so on),

averaged over 1979-85. Ideally, I would also have experimented with the share of each sector in department *employment*, but data were not available. It may be more appropriate to use sector shares in income, since it is the earning power of children that parents are concerned about, not hours worked. Using sectoral shares in departmental GDP as proxies for t_i assumes that within each sector, the labor intensity of production does not change as sectoral output changes.

P_s: Changes in P_s are proxied by a *rural-urban dummy* variable. I assume that the price of schooling is lower in urban than in rural regions. This could be because the average distance to school in rural regions is greater than that in urban regions.[15] Thus within each department, the parameter P_s varies with region of residence.

Z_2: The estimation in this section uses household data from the PLSS for subset Z_2 variables, as follows:

(1) *Highest level of education completed by Mother*
(2) *Highest level of education completed by Father*
(3) *Mother's Longest Occupation*
(4) *Father's Longest Occupation*

The level of education of the parents is measured as follows:

-1 = Never attended, 0 = None, 1 = Initial, 2 = Primary, 3 = Regular secondary, 4 = Technical secondary, 5 = Postsecondary Non-university, 6 = University.

The occupation of the parents is measured as follows:

1 = Did not work, 2 = Missing and not elsewhere classified, 3 = Agriculture, Fishing and Forestry, 4 = Sales vendors, 5 = Service workers, 6 = Production & Transportation, 7 = Clerical, 8 = Professional and Government.

The education levels of the mother and father are included to capture information-processing abilities of the household. Educated parents are likely to be better informed about the true rates of return to their children's education. The occupation of each parent is included to test whether parents base their expectations for their children on their own experiences, or whether the crucial determinant is the general structure of production in the region of residence (as proxied by province t_i ratios).[16]

4.3 Results of the Schooling Regressions

The general form of the estimated equations is

[15] Alternatively, it could be because rural areas are generally agricultural, and urban areas are more industrial. If children's labor is more valuable in agrarian economies, then the price of schooling would include the higher opportunity cost in rural areas. This effect confounds the structure of the economy with the rural-urban decomposition, and is ignored here.

[16] The education of the mother relative to that of the father, when their wages or incomes are not included, may also indicate the extent of female control of the household budget Y. Occupations of the mother and father are more likely to proxy share in *actual* earned income of the household. Education, when occupation is included, better proxies *potential* earned income. To the extent that the "bargaining position" of females depends on the income-earning capability of the mother, and not income actually earned, the mother's schooling will have an independent effect on gender equity in child investments. Studies have also found that the father's education has significant positive effects on the schooling of children. (See for example, Moock and Leslie 1986.) The education of both parents is hypothesized to have a positive effect on the schooling of both sons and daughters.

$$S_f^* = S_f(Y, P_S, t_1, t_2, t_3, Z) \text{ for females,} \quad (14a)$$

$$S_m^* = S_m(Y, P_S, t_1, t_2, t_3, Z) \text{ for males,} \quad (14b)$$

Since the t_i as measured add up to 1, only two of the three shares can be included in a regression. The aim is to examine the relative increases in the demand for schooling as education-intensive sectors grow in importance, and particularly whether industrial growth raises the demand for boys' education more than girls'. To hold the share of services constant while increasing the share of industry, we must include both the high education sectors in the regression, and omit the low education sector.

Another aspect of the problem of multicollinearity is that the share of agriculture in GDP (the omitted class) and the degree of urbanization are highly (negatively) correlated. Since the share of agriculture is equal to 1 minus the sum of the shares of services and industry, this leads to a high degree of multicollinearity in the above regressions. To overcome this problem, I use a four-way classification, with government services as the fourth category. The results below are computed with two classes, industry and nongovernment services, and two omitted classes, agriculture and government services. Since the share of government services is about .07, it is not a very important category quantitatively, but it helps to overcome the multicollinearity problem.[17]

The regressions estimated for females are:

$$\begin{aligned} S_f = \phi_0 &+ \phi_1\text{Household-Income} + \phi_2\text{Share-of-Industry} \\ &+ \phi_3\text{Share-of-Services} + \phi_4\text{Urbanization} \\ &+ \phi_5\text{Father's Education} + \phi_6\text{Mother's Education} \\ &+ \phi_7\text{Father's Occupation} + \phi_8\text{Mother's Occupation} + \epsilon \quad (15a) \end{aligned}$$

and for males are:

$$\begin{aligned} S_m = \mu_1 &+ \mu_1\text{Household Income} + \mu_2\text{Share-of-Industry} \\ &+ \mu_3\text{Share-of-Services} + \mu_4\text{Urbanization} \\ &+ \mu_5\text{Father's Education} + \mu_6\text{Mother's Education} \\ &+ \mu_7\text{Father's Occupation} + \mu_8\text{Mother's Occupation} + \epsilon \quad (15b) \end{aligned}$$

The primary hypotheses to be tested are:

H1. $\phi_1 < 0$, $\mu_1 < 0$: Schooling of the girl and the boy are normal goods.

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[17] To test whether multicollinearity was severe, I used the singular value decomposition technique advocated by Belsley and others (1980). This test is essentially a measure of the sensitivity of coefficients to changes in the matrix of independent variables. This sensitivity is summarized as (square root of) the ratio of the largest eigenvalue of the X'X matrix to the smallest, and is called a "condition index." Condition indices of less than 30 are considered good, and those between 30 to 100 are considered to be indicative of moderate to strong multicollinearity (see Judge and others 1985). The largest condition index for the regression in this paper was about 26.

H2. $\phi_1 < \mu_1$: Since levels of schooling of girls are lower to begin with, this would imply that equity in human capital investments across sexes is a normal good.

H3. $\phi_2 < 0$, $\mu_2 < 0$: Demand for schooling increases as the share of industry increases at the expense of agriculture, while holding the share of services constant.

H4. $\phi_2 > \mu_2$: Men have a comparative advantage in industry, since it rewards work experience as well as schooling. So when the share of industry rises holding the share of services constant, the demand for male schooling rises by more than the demand for female schooling.

H5. $\phi_3 < 0$, $\mu_3 < 0$: Demand for schooling increases as the share of services rises at the expense of agriculture, holding the share of industry constant.

H6. $\phi_3 < \mu_3$: Women have a comparative advantage in services, since the rate of return to schooling in the services sector is independent of the time spent working in this sector. So when the share of services rises, holding the share of industry constant, the demand for female schooling rises by more than the demand for male schooling.

H7. $\phi_4 < 0$, $\mu_4 < 0$: A fall in the supply price of schooling associated with greater urbanization, holding the demand schedule for schooling constant, will raise schooling investments in both girls and boys.

H8. $\phi_4 \lesseqgtr \mu_4$: The theory has no predictions about the relative magnitudes of the responses of male and female schooling to changes in the supply price of schooling.

Table 2 shows the results for the entire sample and separately for each of five age-groups: 6-15 years, 16-25 years, 26-35 years, 36-45 years, and 46-65 years. Schooling decisions of those who are more than 35 years old were made when the structure of the province's economy was different. We expect to find the strongest results for groups that are finishing school (16-25 years) and that have just finished school (26-35 years).

The results indicate that for the sample as a whole, increases in the share of services are significantly and negatively correlated with schooling shortfall for females, but not for males. The share coefficient in the female regressions is greater in magnitude for the services sector than for industry. For males, on the other hand, it is the share of industry that is significant (at the 5 or 10 percent level). This is exactly what our theory predicted.

Results by age group show that coefficients for the shares of services and industry are insignificant for the age groups 6-15, 36-45, and 46-65 years. For the group 16-25 years old, the coefficient for the share of services is significant at the 1 or 5 percent level. For the group 26-35 years old, the share of industry and services show strong results. Reassuringly, the correlation between the share of services and schooling seems to be stronger for females than for males. However, the magnitude is greater for the services sector for *both* sexes -- a contradiction of the theory. For each of the age groups, the coefficient for the share of industry is never significant for females. However, for males in the age groups 26-35 and 36-45 years, the coefficient of the share of industry is significantly negative at the 10 percent level of significance.

For the age-specific estimates, the degree of urbanization decreases the schooling shortfall of females, but not necessarily that of males. Surprisingly, urbanization has a strong unfavorable influence on the schooling shortfall for males in the pooled regressions. In the context of our model, where the rural dummy proxies the price of schooling, this implies that lowering the price of schooling increases the schooling of females more than males.

The education of both father and mother have significant positive effects on schooling. The education of the mother is more closely associated with the schooling of daughters, and the education of the father with the schooling of sons. The occupation of the mother never matters, while the occupation of the father seldom matters, with higher occupation implying a lower schooling shortfall for both female and male offspring. Household income has a strong beneficial effect on all groups except children aged 6-15 years. A surprising finding was that household income has a stronger effect on schooling of male children than female children. Thus while investment in education is a normal good, the data reject the view that gender equity is a normal good *when demand-side factors are included*. That is, increases in household income per se will not lower the gender gap in schooling.

Table 1. Means and standard deviations of variables by households

Variables	Mean	Standard deviations
Department-level RHS variables:		
Share of industry in Dept. GDP	0.36	0.14
Share of agriculture in Dept. GDP	0.18	0.13
Share of services etc.in Dept. GDP	0.39	0.13
Share of govt. services in Dept. GDP	0.07	0.03
Degree of urbanization	66.99	25.49
Household-level RHS variables:		
Predicted household income	787.26	385.13
Place of residence (Dummy: 1=Rural, 0=Urban)	0.43	0.49
Household size	6.48	2.75
Total landholding (Acres)	9.21	76.01
Individual-level RHS variables:		
Father's education level	1.48	1.76
Mother's education Level	0.48	1.68
Father's occupation	4.28	1.67
Mother's occupation	2.98	1.63
Individual-level LHS variables:		
Female: education in years	4.59	4.10
Male : education in years	5.49	4.13
Female: highest level of education completed	1.94	1.69
Male : highest level of education completed	2.43	1.50
Female: age in years	26.70	16.04
Male : age in years	26.12	16.13
Female schooling shortfall: 6-15 years	2.76	1.92
Male schooling shortfall: 6-15 years	2.57	1.73
Female schooling shortfall: 16-25 years	7.89	4.35
Male schooling shortfall: 16-25 years	7.34	3.75
Female schooling shortfall: 26-35 years	18.76	5.84
Male schooling shortfall: 26-35 years	16.89	5.28
Female schooling shortfall: 36-45 years	31.01	5.67
Male schooling shortfall: 36-45 years	29.02	5.76
Female schooling shortfall: 46-65 years	46.33	7.03
Male schooling shortfall: 46-65 years	44.54	7.13

Table 2. Household-level schooling regressions

Independent Variables	Equation 1 Female	Equation 1 Male	Equation 2 Female	Equation 2 Male	Equation 3 Female	Equation 3 Male
			All age groups			
Constant	-5.043*** (0.64)	-3.841*** (0.62)	-5.342*** (0.62)	-3.665*** (0.62)	-5.031*** (0.64)	-3.899*** (0.64)
Industry share	-1.640** (0.68)	-1.310** (0.67)	-1.002* (0.67)	-1.166* (0.67)	-0.943 (0.67)	-1.172* (0.67)
Services share	-3.215*** (0.83)	-1.281* (0.82)	-2.251*** (0.81)	-1.112 (0.81)	-2.165*** (0.82)	-1.216 (0.82)
Rural dummy	0.836*** (0.20)	-0.527*** (0.20)	0.233 (0.20)	-0.678*** (0.21)	0.197 (0.21)	-0.715*** (0.21)
Household income	-0.007*** (0.00)	-0.010*** (0.00)	-0.006*** (0.00)	-0.010*** (0.00)	-0.006*** (0.00)	-0.010*** (0.00)
Father's education			-0.419*** (0.06)	-0.304*** (0.06)	-0.388*** (0.06)	-0.302*** (0.06)
Mother's education			-0.574*** (0.06)	0.007 (0.06)	-0.556*** (0.06)	-0.005 (0.06)
Father's occupation					-0.129*** (0.06)	0.022 (0.06)
Mother's occupation					-0.015 (0.05)	0.085* (0.05)
Age group	11.251*** (0.06)	11.181*** (0.06)	11.091*** (0.07)	11.116*** (0.07)	11.096*** (0.07)	11.120*** (0.07)
Adjusted R^2	0.885	0.899	0.892	0.900	0.892	0.900
Sample size	4281	4024	4281	4024	4281	4024

Note: Dependent variable is schooling shortfall = age - schooling - 5

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level.
Standard errors in parentheses.

Table 2. (Continued) Household-level schooling regressions

Independent variables	Equation 1 Female	Equation 1 Male	Equation 2 Female	Equation 2 Male	Equation 3 Female	Equation 3 Male
		Population aged 6 to 15 years				
Constant	0.765	2.768**	1.448	3.378***	1.595	3.209***
	(1.40)	(1.41)	(1.38)	(1.00)	(1.39)	(1.03)
Industry share	2.474	1.201	2.047	1.152	2.518*	1.106
	(1.58)	(1.31)	(1.52)	(1.24)	(1.56)	(1.24)
Services share	1.680	-0.297	3.101*	0.179	3.827*	0.071
	(2.00)	(1.65)	(1.92)	(1.57)	(2.05)	(1.60)
Rural dummy	1.928***	0.168	1.383***	0.142	1.424***	0.125
	(0.49)	(0.40)	(0.49)	(0.38)	(0.49)	(0.38)
Household income	0.001	-0.000	0.000	0.000	0.000	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Father's education			-0.042	-0.309**	-0.010	-0.335***
			(0.14)	(0.12)	(0.14)	(0.13)
Mother's education			-0.465***	-0.163	-0.433***	-0.193
			(0.12)	(0.10)	(0.13)	(0.11)
Father's occupation					-0.129	0.027
					(0.11)	(0.11)
Mother's occupation					-0.056	0.109
					(0.10)	(0.09)
Adjusted R^2	0.092	-0.009	0.191	0.102	0.189	0.101
Sample size	156	170	156	170	156	170

Note: Dependent variable is schooling shortfall = age - schooling - 5

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level.
Standard errors in parentheses.

Table 2. (Continued) Household-level schooling regressions

Independant variables	Equation 1 Female	Equation 1 Male	Equation 2 Female	Equation 2 Male	Equation 3 Female	Equation 3 Male
Population aged 16 to 25 years						
Constant	14.305*** (1.13)	14.296*** (1.26)	14.038*** (1.08)	14.353*** (1.24)	14.689*** (1.11)	14.039*** (1.31)
Industry share	-1.173 (1.23)	-0.866 (1.57)	-0.912 (1.21)	-0.355 (1.52)	-0.813 (1.21)	-0.388 (1.52)
Services share	-5.117*** (1.61)	-4.939*** (1.70)	-4.479*** (1.52)	-4.084*** (1.66)	-4.106*** (1.53)	-4.243*** (1.66)
Rural dummy	2.333*** (0.41)	1.927*** (0.45)	1.828*** (0.39)	1.383*** (0.45)	1.685*** (0.39)	1.336*** (0.45)
Household income	-0.003*** (0.00)	-0.004*** (0.00)	-0.002*** (0.00)	-0.004*** (0.00)	-0.001*** (0.00)	-0.003*** (0.00)
Father's education			-0.404*** (0.11)	-0.416*** (0.12)	-0.340*** (0.11)	-0.420*** (0.13)
Mother's education			-0.616*** (0.10)	-0.282** (0.12)	-0.573*** (0.11)	-0.304*** (0.12)
Father's occupation					-0.328*** (0.11)	0.031 (0.11)
Mother's occupation					0.123 (0.08)	0.117 (0.09)
Adjusted R^2	0.286	0.359	0.366	0.399	0.374	0.399
Sample size	645	445	645	445	645	445

Note: Dependent variable is schooling shortfall = age - schooling - 5

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level.
Standard errors in parentheses.

Table 2. (Continued) Household-level schooling regressions

Independent variables	Equation 1 Female	Equation 1 Male	Equation 2 Female	Equation 2 Male	Equation 3 Female	Equation 3 Male
	Population aged 26 to 35 years					
Constant	26.685***	26.601***	25.919***	26.117***	26.662***	26.230***
	(0.99)	(0.93)	(0.95)	(0.92)	(1.00)	(0.97)
Industry share	-1.384	-1.733*	-0.542	-1.590*	-0.470	-1.384
	(1.12)	(1.01)	(1.07)	(1.00)	(1.07)	(1.00)
Services share	-3.845***	-2.639**	-3.233***	-2.170*	-3.311***	-2.124*
	(1.38)	(1.32)	(1.30)	(1.30)	(1.31)	(1.31)
Rural dummy	1.862***	0.525*	1.130***	0.305	1.029***	0.226
	(0.35)	(0.33)	(0.34)	(0.33)	(0.34)	(0.34)
Household income	-0.006***	-0.008***	-0.004***	-0.007***	-0.004***	-0.007***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Father's education			-0.538***	-0.303***	-0.471***	-0.272***
			(0.10)	(0.09)	(0.10)	(0.09)
Mother's education			-0.606***	-0.262***	-0.576***	-0.261***
			(0.10)	(0.09)	(0.10)	(0.09)
Father's occupation					-0.245**	-0.121***
					(0.10)	(0.09)
Mother's occupation					0.031	0.093
					(0.07)	(0.07)
Adjusted R^2	0.404	0.500	0.462	0.515	0.464	0.515
Sample size	1148	957	1148	957	1148	957

Note: Dependent variable is schooling shortfall = age - schooling - 5
* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level.
Standard errors in parentheses.

Table 2. (Continued) Household-level schooling regressions

Independent Variables	Equation 1 Female	Equation 1 Male	Equation 2 Female	Equation 2 Male	Equation 3 Female	Equation 3 Male
	Population aged 36 to 45 years					
Constant	38.049***	39.942***	36.471***	39.570***	36.795***	39.437***
	(0.97)	(0.84)	(0.93)	(0.85)	(0.97)	(0.89)
Industry share	-0.730	-1.850**	0.073	-1.404*	0.074	-1.448*
	(1.15)	(0.94)	(1.10)	(0.94)	(1.10)	(0.93)
Services share	-0.005	-1.650	1.033	-1.360	1.136	-1.407
	(1.36)	(1.18)	(1.29)	(1.17)	(1.30)	(1.18)
Rural dummy	0.930***	-0.547*	0.346	-0.738**	0.272	-0.734
	(0.35)	(0.30)	(0.34)	(0.31)	(0.34)	(0.31)
Household income	-0.009***	-0.011***	-0.006***	-0.010***	-0.006***	-0.010***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Father's education			-0.382***	-0.294***	-0.339***	-0.303***
			(0.09)	(0.09)	(0.09)	(0.09)
Mother's education			-0.778***	-0.095	-0.756***	-0.102
			(0.10)	(0.09)	(0.10)	(0.09)
Father's occupation					-0.174*	0.044
					(0.10)	(0.09)
Mother's occupation					0.088	0.010
					(0.08)	(0.07)
Adjusted R^2	0.435	0.610	0.493	0.617	0.494	0.616
Sample size	1064	1030	1064	1030	1064	1030

Note: Dependent variable is schooling shortfall = age - schooling - 5

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level. Standard errors in parentheses.

Table 2. (Concluded) Household-level schooling regressions

Independent variables	Equation 1 Female	Equation 1 Male	Equation 2 Female	Equation 2 Male	Equation 3 Female	Equation 3 Male
		Population aged 46 to 65 years				
Constant	54.175***	54.047***	52.687***	54.174***	52.731***	53.386***
	(1.29)	(1.14)	(1.28)	(1.15)	(1.36)	(1.22)
Industry share	-3.200**	-1.246	-2.321	-1.227	-2.353	-1.282
	(1.56)	(1.36)	(1.55)	(1.36)	(1.55)	(1.36)
Services share	-4.428**	1.215	-2.814	1.153	-2.696	0.910
	(1.91)	(1.66)	(1.89)	(1.66)	(1.90)	(1.67)
Rural dummy	0.093	-0.947**	-0.498	-0.993**	-0.430	-0.996
	(0.45)	(0.40)	(0.45)	(0.40)	(0.46)	(0.40)
Household income	-0.008***	-0.013***	-0.006***	-0.012***	-0.006***	-0.013***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Father's education			-0.307***	-0.233**	-0.331**	-0.257**
			(0.13)	(0.11)	(0.13)	(0.12)
Mother's education			-0.636***	0.176	-0.647***	0.151
			(0.16)	(0.13)	(0.16)	(0.13)
Father's occupation					0.091	0.191
					(0.14)	(0.13)
Mother's occupation					-0.146	0.127
					(0.11)	(0.10)
Adjusted R^2	0.201	0.381	0.227	0.382	0.227	0.383
Sample size	1264	1418	1264	1418	1264	1418

Note: Dependent variable is schooling shortfall = age - schooling - 5

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level.
Standard errors in parentheses.

5. Province Level Empirical Evidence

Evidence from provincial data confirms the findings of the previous section. Because literacy and income data are based on the census, the results do not reflect any sampling bias in the PLSS. In the last section the focus was on household level variables (the subset Z_2). In this section I experiment with various infrastructural parameters (Z_1), indicating the degree of development of transport and communications in each province or department.

Using data from the department level is tantamount to assuming that households within a department are identical with respect to the parameters they face: income (Y), the rates of return to schooling in the three sectors (β, γ, and δ), and the time-allocation parameters (t_i). However, each department has two regions, rural and urban. As in the previous section I assume that the price of schooling (P_s) is lower in urban than in rural regions.

5.1 Definitions of Dependent Variable: Illiteracy Rates

$S_{f,m}$: The census data do not provide gender-specific schooling attainment or enrollment by age group for each department. Since illiteracy rates are available at the required level of disaggregation, I use cohort-specific illiteracy rates as a proxy for investment in schooling in the department. Clearly, literacy rates are a gross approximation for schooling levels. There are two defenses for this procedure. First, the study focuses on the differences in human capital between males and females. Even though illiteracy rates do not reflect absolute levels of human capital of each sex, they may provide reliable estimates of relative levels. Second, total illiteracy rates are highly negatively correlated with initial, secondary, postsecondary, and vocational enrollment ratios across departments (see Table 3). University level enrollment ratios are weakly negatively correlated with illiteracy rates, but this is not surprising. Somewhat puzzling is the finding that primary school enrollment ratios are *positively* correlated with illiteracy rates. This is probably due to the fact that high actual primary school enrollment relative to the number that should be enrolled may indicate that students have fallen behind in the curriculum.

5.2 Definitions of Independent Variables

Y: Departmental *gross domestic product per capita* is used as the measure for household income.

t_i: The structure of the economy, or the time spent in each of the three market sectors, t_1, t_2, and t_3, is proxied by their *Share in departmental GDP*. These variables are defined as in the previous section:

t_1 = Share of Agriculture (farming, fishing and forestry),

t_2 = Share of Services (personal and business services, health care, hotels, tourism, and so on),

t_3 = Share of Industry (manufacturing, mining, construction, and so on), averaged over 1979-85.

Table 3. Correlation between Enrollment Ratios and Illiteracy Rates: Peru, 1985-86

Enrollment Ratio (by school group)	Total	Cohort Group (in years) 15-19	20-24	25-29	30-34	35-39	40+
Initial	-.596	-.538	-.552	-.460	-.597	-.616	-.587
Primary	.694	.694	.691	.327*	.691	.711	.691
Secondary	-.815	-.881	-.847	-.639	-.829	-.851	-.812
Postsecondary	-.669	-.696	-.672	-.516	-.682	-.714	-.658
University	-.402*	-.444	-.439	-.332*	-.394*	-.406*	-.412
Other	-.725	-.663	-.689	-.483	-.731	-.751	-.736

Notes: 1. All correlations except those marked by an asterisk are significant at the 5 percent level. All correlations are significant at the 10 percent level. The test used to determine statistical significance of the correlation is the t-statistic :

$t = [(n-2r)/(1-r^2)]^{0.5}$.

n is the number of observations, r is the computed correlation coefficient, and (n-2) is the number of degrees of freedom.

2. The number of observations is 23. Lima and Callao, and Loreto and Ucayali are aggregated to maintain conformity with available GDP accounts.

3. Enrollment Ratios are calculated as ratios of total enrollment in the department to total population.

Sources: For illiteracy rates, enrollment and population, *Peru: Compendio Estadistico 1987*, Systema Estadistico Nacional, Instituto Nacional de Estadistica.

P_s: Changes in P_s are proxied by the Degree of Urbanization (percentage of total department population living in urban areas) in 1985. The degree of urbanization is a continuous variable. Therefore P_s ($0 \le P_s \le 100$) is a continuous variable. I also experimented with a rural-urban dummy variable (P_s = r,u, where r and u are the price of schooling for a child in rural and in urban areas respectively). This is done by estimating male and female schooling regressions separately for rural and urban schooling levels across departments. However, income per capita, Y, and the potential work opportunities by sector, t_i, are still department-level: department GDP figures are not available separately for each region. Thus it is assumed that t_i do not vary across regions within a department, but P_s does. This assumes that, within a department, it is costless for an adult to migrate from rural to urban regions (or vice versa), but the cost of sending a child to school from rural to urban regions is very high.

Z : The vector of department-level infrastructural variables Z_1 include *Roads per Square Kilometer*, and *Post Offices per Square Kilometer*. I also experimented with *Telegraph Offices per Square Kilometer*, *Telephone Lines per Capita*, and some other variables. Since household specific variables Z_2 are only available in a household-level survey, this section only employs department-level infrastructural variables (subset Z_1) in the schooling regressions.

5.3 Description of the Data

Table 4 shows the means and standard deviations of the dependent and all the independent variables used in the illiteracy regressions. Industry's share is the largest, but is also relatively more variable across departments than the share of services (as evidenced by values of the coefficients of variation of 0.54 and 0.36 respectively). The share of agriculture in GDP (CV= 0.61) is also highly variable across sectors. It seems that the share of industry increases most rapidly at the expense of the share of agriculture.

Average illiteracy rates for all ages and for both sexes are higher in rural areas. The aggregate gender differential (female illiteracy divided by male illiteracy) is lower for rural (2.52) than for urban areas (3.54). Given the values of the standard deviations, this difference appears to be statistically significant. A plausible (demand-side) explanation of this finding is that agricultural activities are less education-intensive for women and men. That is, the predominance of a sector with low education intensity in a region will result in low demand for education in that region, but, under reasonable assumptions, in higher equity across sexes in investment in schooling. Since the supply price of education is probably lower in urban areas, and if the lower price prompts a greater response from girls than boys, the ratio between male and female illiteracy rates should be lower in urban areas. This points out a weakness of studies that focus only on shifts in supply of schooling, and highlights the importance of studying the determinants of shifts in the schooling demand curves.

When we examine the patterns across cohorts, we find a small difference for the younger age groups (15 to 29 years) in this ratio across regions, and a significantly larger difference for people 30 years and older. One interpretation of this finding is that over time, the gender differences in urban areas have narrowed more rapidly than in rural areas. Again, a demand side explanation seems plausible. The rapid growth of services in urban areas can account for greater equity even if the supply price of schooling is constant over time, if women have a comparative advantage over men in working in services (see section 3).[18] It is difficult to rule out a supply-side explanation here. It may be that the supply price of schooling has fallen relatively more in urban than in rural areas over time, and that female schooling has a higher price elasticity than male schooling, analogous to Gertler and Alderman's (1989) arguments for health.

Table 4. Means and standard deviations of variables by department, 1981-82

Variables	Means and Standard deviations	
	Mean	S.D.
RHS Variables:		
Per capita GDP (current prices)	174.46	148.65
Share of industry in dept. GDP	0.37	0.20
Share of agriculture in dept. GDP	0.23	0.14
Share of services etc.in dept. GDP	0.33	0.12
Share of govt. services in dept. GDP	0.07	0.03
Degree of urbanization	55.66	21.76
Roads per 1000 square kilometers	785.06	2258.45
Post offices per 1000 Sq. Km.	2.82	1.92

	Urban		Rural	
	Mean	S.D.	Mean	S.D.
LHS Variables:				
Female illiteracy rate: All ages	18.67	10.84	46.22	16.76
Male illiteracy rate: All ages	5.44	3.12	19.43	9.09
Female/Male illiteracy ratio: All	3.54	0.87	2.52	0.51
Female illiteracy rate: 15-19 years	3.80	2.24	18.42	11.20
Male illiteracy rate: 15-19 years	1.62	0.74	6.96	3.55
Female/Male illiteracy ratio: 15-19	2.45	0.83	2.55	0.63
Female illiteracy rate: 20-24 years	5.85	3.99	26.19	14.42
Male illiteracy rate: 20-24 years	1.62	0.89	7.58	4.47
Female/Male illiteracy ratio: 20-24	3.81	1.47	3.93	1.44
Female illiteracy rate: 25-29 years	8.75	5.67	34.50	17.13
Male illiteracy rate: 15-19 years	1.95	1.09	10.25	5.93
Female/Male illiteracy ratio: 25-29	4.96	2.31	3.84	1.42
Female illiteracy rate: 30-34 years	13.88	9.04	44.94	18.56
Male illiteracy rate: 30-34 years	3.04	1.83	14.40	8.22
Female/Male illiteracy ratio: 30-34	5.01	2.30	3.72	1.77
Female illiteracy rate: 35-39 years	22.08	12.77	55.89	17.56
Male illiteracy rate: 35-39 years	4.52	2.54	19.83	9.93
Female/Male illiteracy ratio: 35-39	5.27	2.07	3.23	1.17
Female illiteracy rate: 40+ years	37.72	17.76	59.69	17.04
Male illiteracy rate: 40+ years	12.00	6.54	34.01	12.95
Female/Male illiteracy ratio: 40+	3.34	0.88	2.17	0.44

[18] Note that men may still have an *absolute* advantage in *both* industry and services.

Notes: Means are unweighted averages.

5.3 Results of the Schooling Regressions

The general form of the estimated equations for females and males respectively is

$$S_f = \phi_0 + \phi_1\text{Per-Capita-GDP} + \phi_2\text{Share-of-Industry} + \phi_3\text{Share-of-Services} + \phi_4\text{Urbanization} + \epsilon \quad (16a)$$

$$S_m = \mu_0 + \mu_1\text{Per-Capita-GDP} + \mu_2\text{Share-of-Industry} + \mu_3\text{Share-of-Services} + \mu_4\text{Urbanization} + \epsilon \quad (16b)$$

The first three slope coefficients in each equation measure demand shifts, while the last coefficient measures supply price effects. Since S stands for illiteracy rates, a negative coefficient implies a favorable effect on education levels. In this section, I refer to the absolute magnitudes of the coefficients when using the phrases "greater than" or "less than."

Table 5 reports the results of the regressions. The first two rows report the results of the regressions (16a) and (16b). The results for the sample as a whole indicate no significant support for hypotheses H1 to H6 listed in section 4. The only significant variable is urbanization, although the signs of the other coefficients conform with the theory.

The insignificance of results using a sample of all ages is not surprising. Schooling decisions of age groups 35 years and above were made two decades ago. The structure of the department's economy and hence the demand for schooling is likely to have changed since then. It is more sensible to look at the relationship between the illiteracy of younger cohorts and department income, demand structure, and degree of urbanization. The relationships are likely to be strong for the youngest cohort group, and to diminish as the age of the cohort increases.

Results support this argument: for all but the oldest groups (35-39 years and 40 years and above) there is reasonably strong evidence that a rise in the share of the services sector, holding the share of industry constant, raises the schooling levels of females and males. As predicted by the theory, the coefficient for females is (2.5 to 5 times) larger in magnitude, and intermittently significant at the 10 percent level of significance for a one-tailed test. The coefficient for industry's share is always greater in magnitude for females but never significant. This evidence, combined with the fact that the variance of the share of industry is in fact larger than that of the service sector is evidence consistent with the view that a rise in the share of services in GDP leads to greater increases in the education of women than an equivalent increase in the share of industry. The coefficient for the degree of urbanization is always negative for both females and males, always greater in magnitude for females, and statistically significant at the 5 percent level for a one-tailed test.

Given the high degree of multicollinearity between the share of industry and the rate of urbanization, the high standard errors of the coefficients are not surprising. To increase the degrees of freedom (a common solution for multicollinearity), the female and male schooling equations are estimated separately for rural and urban regions, thus allowing the omission of the urbanization variable. This is roughly equivalent to treating the urbanization variable as a binary variable. It is a test of the alternative view that, within a department, it is costless for an adult to migrate from rural to urban regions (or vice versa), but the cost of sending a child for schooling from rural to urban regions is very high. The estimated equations for urban areas are

$$\text{Urban } S_f = \phi_0 + \phi_1\text{Per-Capita-GDP} + \phi_2\text{Share-of-Industry} + \phi_3 \text{ Share-of-Services} + \epsilon_{uf} \quad (17a)$$

$$\text{Urban } S_m = \mu_0 + \mu_1\text{Per-Capita-GDP} + \mu_2\text{Share-of-Industry} + \mu_3 \text{ Share-of-Services} + \epsilon_{um} \quad (17b)$$

and for rural areas

$$\text{Rural } S_f = \phi_0 + \phi_1\text{Per-Capita-GDP} + \phi_2\text{Share-of-Industry} + \phi_3 \text{ Share-of-Services} + \epsilon_{rf} \quad (18a)$$

$$\text{Rural } S_m = \mu_0 + \mu_1\text{Per-Capita-GDP} + \mu_2\text{Share-of-Industry} + \mu_3 \text{ Share-of-Services} + \epsilon_{rm} \quad (18b)$$

The results for urban areas are rows 3 and 4; for rural areas, rows 5 and 6 in Table 5.

Regressions for groups aged 15-19, 20-24, and 25-29 years confirm the theory. The coefficients for the share of services in GDP are significant and larger in magnitude for females than for males, and larger in rural than in urban areas. The coefficients for the share of industry in GDP are generally insignificant for female schooling, and generally significant for urban male schooling. This seems to confirm the hypothesis that industry rewards schooling more than the main omitted class, agriculture, and that men have a comparative advantage in industry. Women, on the other hand, have a comparative advantage in services. The sign and magnitude of the coefficient for GDP indicate that female schooling increases by more than male schooling when income increases, and that the increases are larger for both females and males in rural areas.

Regressions that include variables proxying Z_1, roads per square kilometer, telephone lines per capita, and post offices per square kilometer, were also estimated. The coefficients were insignificant, and the coefficients for per capita GDP, shares of services and industry, and urbanization were left largely unchanged.[19]

The major limitation of this analysis is that the shares of each sector in a department may be jointly determined with education levels of men and women. For example, services may require more educated women than educated men, so provinces that have relatively more educated women will tend to have a larger share of services in GDP. The issue of causality between share of

[19] These results, which are not reported here, are available from the author.

services and the demand for education of women is left unresolved. This is a crippling limitation for purposes of deciding policy.

I address this issue by estimating regressions by cohorts. Assuming that the sectors' shares in GDP are relatively stable across departments, the correlation between schooling and sectoral share should be stronger for younger cohorts if a higher share of services and industry leads to a higher demand for education. On the other hand, if education intensive activities are concentrated in areas with high exogenous education levels, this would imply uniformly strong correlations between education levels and structure of the economy across all age groups. The regressions discussed above indicate that the correlations are weak for older cohorts, implying support for the view that causality runs from economy structure to schooling levels, and not vice versa.

The results in this section are similar to those found in Gill and Khandker (1990) for a sample of about 100 countries in 1965 and 1987. Migration is likely to be more frequent within a country than across national boundaries. The similarity of results by country and by province implies that the possibility of cross-department migration does not seem to be a significant factor in schooling decisions. This issue needs more examination, though, before any conclusive statement can be made on the effects of migration on the rates of return to human capital.

Table 5. Cross-section schooling regressions

Dependent variable	Constant	Per Cap. GDP	Industry Share	Services Share	Degree of Urbanizn.	Unadj. R-Sqr
			All ages			
1.Female total illiteracy rate	73.713	-0.019 (0.02)	9.196 (17.61)	-13.378 (31.28)	-0.647*** (0.15)	.817
2.Male total illiteracy rate	33.479	-0.013 (0.01)	-0.584 (10.42)	-13.979 (18.49)	-0.239*** (0.09)	.714
3.Female urban illiteracy rate	50.189	-0.040*** (0.02)	-8.892 (13.72)	-60.113*** (17.42)		.545
4.Male urban illiteracy rate	15.010	-0.012*** (0.00)	-4.410 (3.76)	-16.739*** (4.77)		.587
5.Female rural illiteracy rate	86.408	-0.049* (0.03)	-3.506 (25.73)	-80.723*** (32.67)		.354
6.Male rural illiteracy rate	42.407	-0.030* (0.02)	-4.380 (14.61)	-44.040*** (18.56)		.362

Note: Sample consists of 23 departments in Peru

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level. Standard errors in parentheses.

Table 5. (Continued) Cross-section Schooling Regressions

Dependent Variable	Constant	Per Cap. GDP	Industry Share	Services Share	Degree of Urbanizn.	Unadj. R-Sqr
			Population aged 15-19 years			
1.Female total illiteracy rate	38.562	-0.012 (0.01)	-7.420 (10.10)	-26.313 (17.94)	-0.237*** (0.09)	.774
2.Male total illiteracy rate	11.364	-0.004 (0.01)	0.618 (4.04)	-5.171 (7.18)	-0.083*** (0.03)	.658
3.Female urban illiteracy rate	10.945	-0.009*** (0.00)	-2.472 (2.65)	-13.242*** (3.36)		.623
4.Male urban illiteracy rate	3.687	-0.002 (0.00)	-0.947 (1.42)	-3.786*** (1.80)		.280
5.Female rural illiteracy rate	54.960	-0.040** (0.02)	-14.039 (15.80)	-69.955*** (20.06)		.524
6.Male rural illiteracy rate	15.962	-0.015** (0.01)	0.583 (6.02)	-18.415** (7.64)		.396
			Population aged 20-24 years			
1.Female total illiteracy rate	55.657	-0.013 (0.01)	-13.596 (12.65)	-37.260* (22.46)	-0.237*** (0.11)	.816
2.Male total illiteracy rate	14.941	-0.006 (0.01)	-2.693 (4.54)	-11.878* (8.07)	-0.073* (0.04)	.691
3.Female urban illiteracy rate	20.624	-0.012** (0.01)	-9.157** (4.52)	-27.038*** (5.74)		.655
4.Male urban illiteracy rate	4.951	-0.002 (0.00)	-2.873** (1.14)	-5.568*** (1.45)		.576
5.Female rural illiteracy rate	72.187	-0.048** (0.02)	-19.606 (19.98)	-86.341*** (25.36)		.511
6.Male rural illiteracy rate	18.686	-0.019** (0.01)	0.037 (7.58)	-21.900** (9.63)		.387

Note: Sample consists of 23 departments in Peru

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level.
Standard errors in parentheses.

Table 5. (Continued) Cross-section schooling regressions

Dependent Variable	Constant	Independent Variables Per Cap. GDP	Industry Share	Services Share	Degree of Urbanizn.	Unadj. R-Sqr
		Population aged 25-29 years				
1.Female total illiteracy rate	65.174	-0.017 (0.02)	-7.644 (15.14)	-29.348 (26.88)	-0.488*** (0.13)	.825
2.Male total illiteracy rate	19.725	-0.010* (0.01)	-2.674 (5.77)	-15.610* (10.24)	-0.096* (0.05)	.718
3.Female urban illiteracy rate	26.485	-0.021*** (0.01)	-7.588 (6.93)	-32.347*** (8.79)		.585
4.Male urban illiteracy rate	6.026	-0.004*** (0.00)	-2.351** (1.08)	-7.235*** (1.37)		.734
5.Female rural illiteracy rate	85.822	-0.056** (0.03)	-18.634 (23.83)	-97.214*** (30.26)		.483
6.Male rural illiteracy rate	25.492	-0.027** (0.01)	0.314 (9.25)	-29.957** (11.74)		.452
		Population aged 30-34 years				
1.Female total illiteracy rate	84.684	-0.021 (0.03)	-18.090 (22.99)	-62.375* (40.83)	-0.451** (0.20)	.724
2.Male total illiteracy rate	28.882	-0.011 (0.01)	-6.516 (8.03)	-20.340 (14.26)	-0.156** (0.07)	.738
3.Female urban illiteracy rate	40.319	-0.031** (0.01)	-10.513 (12.05)	-48.771*** (15.30)		.509
4.Male urban illiteracy rate	10.001	-0.005*** (0.00)	-5.422*** (1.78)	-11.570*** (2.25)		.738
5.Female rural illiteracy rate	93.902	-0.059* (0.03)	-11.044 (27.84)	-94.348*** (35.35)		.397
6.Male rural illiteracy rate	37.853	-0.033** (0.01)	-6.396 (12.29)	-43.207*** (15.60)		.470

Note: Sample consists of 23 departments in Peru

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level.
Standard errors in parentheses.

Table 5. (Continued) Cross-section schooling regressions

Dependent Variable	Constant	Per Cap. GDP	Industry Share	Services Share	Degree of Urbanizn.	Unadj. R-Sqr
		Population aged 35-39 years				
1.Female total illiteracy rate	81.797	-0.015 (0.02)	17.634 (17.97)	4.990 (31.91)	-0.845*** (0.15)	.855
2.Male total illiteracy rate	36.829	-0.012 (0.01)	-5.359 (10.29)	-19.729 (18.28)	-0.235*** (0.09)	.744
3.Female urban illiteracy rate	55.197	-0.046** (0.02)	-8.302 (17.42)	-61.856*** (22.11)		.463
4.Male urban illiteracy rate	12.569	-0.010*** (0.00)	-4.472* (2.71)	-13.281*** (3.44)		.667
5.Female rural illiteracy rate	94.333	-0.057* (0.03)	1.534 (29.64)	-74.458** (37.63)		.294
6.Male rural illiteracy rate	47.133	-0.038** (0.02)	-7.004 (15.87)	-49.919** (20.15)		.416
		Population aged 40 & more years				
1.Female total illiteracy rate	87.159	-0.018 (0.02)	41.269* (21.93)	18.442 (38.94)	-0.885*** (0.19)	.792
2.Male total illiteracy rate	51.328	-0.017 (0.02)	8.004 (16.89)	-5.877 (30.00)	-0.442** (0.15)	.698
3.Female urban illiteracy rate	80.244	-0.068** (0.03)	2.073 (23.09)	-86.466*** (29.32)		.487
4.Male urban illiteracy rate	27.812	-0.025** (0.01)	-4.198 (8.87)	-27.254** (11.27)		.459
5.Female rural illiteracy rate	94.272	-0.056* (0.03)	26.476 (30.11)	-56.789 (38.23)		.265
6.Male rural illiteracy rate	62.652	-0.044* (0.02)	-0.332 (21.75)	-54.795** (27.61)		.308

Note: Sample consists of 23 departments in Peru

* Significant at 10 percent, ** at 5 percent level, *** at 1 percent level. Standard errors in parentheses.

6. Conclusions and Policy Implications

The main question addressed in this chapter is: Do parents consider future labor activities when making schooling decisions for their children? To the extent that current demand for labor and remuneration reflect economic patterns in the future, the answer seems to be that they do.

The main new policy implication that emerges from this chapter and from Gill and Khandker (1990) is that the expansion of the service sector raises the levels of schooling of both men and women, but has a larger effect on women. That is, both increased human capital and equity between the sexes are associated with an increase in the service sector's share in GDP, at the expense of agriculture. This is probably an intermediate stage. As this structural transformation continues, the share of the industrial sector begins to play the role that services played at the earlier stage.

This is in marked contrast to policy that emerges from well-known theories of economic growth, including Rostow (1960), Rosenstein-Rodan (1961), and others. It has been argued that in the process of growth, agriculture is the primary stage, industry the secondary stage, and services the tertiary stage. But two points should be kept in mind. First, the policies recommended here are not aimed at economic growth *per se*, but *economic growth with increases in equity across gender*. Second, the nature of the services sector is very different in low-income countries.

This policy also contradicts the World Bank's advice that developing countries need to increase the production of tradables. But at least as far as gender equity in earnings potential is concerned, it would be better to encourage the expansion of sectors producing nontradables. Another implication of the findings in this chapter is that extending schooling facilities significantly raises investment in schooling, and lowers the gender gap as well. The third implication is that information about the rates of return to schooling in home activities will raise the schooling levels of females by more than those of males.

Appendix I: Results of household expenditure regressions

Independent Variables	Equation 1	Equation 2
Constant	86.043 (184.04)	-179.871 (223.50)
Age of Household Head	27.226*** (8.25)	24.423* (13.28)
Age^2 of Household Head	-0.325*** (0.09)	-0.276* (0.15)
Schooling of Household Head	-8.889 (11.66)	-29.887*** (14.13)
Schooling of Household Head	5.459*** (0.70)	4.941*** (0.82)
Training of Household Head	75.001** (33.51)	61.105* (36.97)
Did Household Head Attend Public School ?	-16.308 (36.20)	35.729 (41.78)
Age of Spouse		10.090 (11.69)
Age^2 of Spouse		-0.141 (0.14)
Schooling of Spouse		47.378*** (15.14)
$Schooling^2$ of Spouse		0.351 (0.97)
Training of Spouse		108.219*** (38.99)
Did Spouse Attend Public School?		-113.510*** (41.23)
Unearned Income	0.008*** (0.00)	0.006*** (0.00)
Rural Dummy	-153.257*** (30.07)	-44.299 (35.87)
Adjusted R^2	0.192	0.244
Sample Size	4377	3325

Note: Dependent variable is total household expenditure per adult
* Significant at 10 percent, ** at 5 percent, *** at 1 percent level.
Standard errors in parentheses.

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