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HOW MUCH TO INVEST AND WHAT DEGREE TO GET?: EDUCATION AS A STRATEGY ON THE LABOUR MARKET SCALE

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ABSTRACT

When workers hear about a possible promotion, it is common for them to get training, and they can do so through education. However, there is the possibility that the worker needs to receive a salary according to the knowledge acquired in such training. In this study, considering a population of employed workers with incomplete secondary school, we apply game theory concepts to explore whether workers can train through study. If so, the model shows the percentage of the salary the worker is willing to invest in his education. Furthermore, the cost of studying implicitly involves an opportunity cost, deduced quantitatively in the model. In conclusion, our article defines specific thresholds to decide if the worker should study, the economic investment, and the time he would spend on it, depending on how strict the company is in auditing. The analysis does not define a Nash equilibrium since the company's reaction is not considered.

KEYWORDS

Asymmetric information, education, game theory, labour market, wages

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Highlights

- *The percentage of income the workers assign to finish their studies can exceed 50% as long as the company's audit is low.*
- *Workers can spend up to 75% of their income on education only if they achieve a master's degree and the company's audit is low.*
- *If the audit is intense, the worker will not exceed more than 30% of his income to continue his education.*
- *Workers are committed and responsible in their training when faced with companies that do not audit and distinguish significant wage increases.*
- *The opportunity cost of studying for a worker decreases as companies are more intense in auditing and distinguishing through wages.*

INTRODUCTION

Job training takes time, money, and effort. Fortunately, most of the time, such training brings rewardsin the short or medium term, either through a promotion or a wage increase. Such worker training is necessary for the company since companies' success relies on their workers' performance, mainly linked to their education and training (Flegl, Depoo, and Alcázar, 2022). Offering a promotion as a reward, a company could make two possible mistakes: ignore the talent acquired during the training and not value other skills based on cognitive abilities, such as experience and innate abilities (Armour, Button, and Hollands, 2018).

Concerning the first error, the fact that the company needs to consider the talent acquired in training could motivate a brain drain since there are always markets looking for new talent and qualified resources. In this sense, Fan and Yakita (2011) comment that skilled labour will emigrate if the foreign wage rate is higher than the local rate and if local companies do not recognize and value their workers. In this sense, Fischer and Lipovská (2015) comment on the brain drain specifically of Slovak students at an early age and with a high educational level in the Czech Republic. Noting that Slovak students not only finish their studies at Czech universities but also enter the Czech labour market.

Training involves a cost, usually covered by the company, which can be based on the salary paid to the worker. For example, Mehra et al. (2014) comment that training paid for by companies is desirable because it improves human capital and companies' income. In addition, they recommend that the investment in training be accompanied by a salary

increase, which would imply a more significant commitment from the workers and better productivity.

Although investing in staff training is essential for the company's success, there are always obstacles. Blatter et al. (2016) comment on the inverse relationship between hiring qualified workers and the costs of training personnel. Based on an analysis of Swiss companies, they comment that since hiring costs are constantly increasing, investing more in worker training is advisable. Now, if the training is through education, it also involves costs that are not monetarily observed. These expenses are called opportunity costs, which generally represent the public benefits lost when the worker is unemployed (Chodorow-Reich and Karabarbounis, 2016).

This study proposes training workers through education, whose costs are covered by themselves. Although our model does not consider a distribution of benefits for the talent acquired and applied in productivity, the model assumes the company will bring an incentive to the trained workers. However, the fact that the stimulus is not necessarily achieved generates uncertainty for the worker if the company recognizes this training or not.

We involve game theory concepts and subjective beliefs to model this scenario with uncertainty. In addition, the action of auditing or not of the company is considered as a sign that will distinguish between those who take the training and those who do not. Methodologically, this signal transforms subjective beliefs into objective ones. In general, the analysis shows the percentage of the salary the worker may invest to achieve a better level of education.

The paper has the following structure: the first section shows the literature review of the relationship between the labour market, education, and training. The second section analyses the game theory methodology, particularly concepts of best response and asymmetric information. The third part consists of the development of the model, and the fourth section corresponds to the applications of the model. The fifth section corresponds to the discussion of the results. Finally, we present the conclusion, limitations, and future work.

LITERATURE REVIEW

According to Borghans, Ter Weel, and Weinberg (2014), the skills learned by workers during training are crucial in occupational choice and wages; even more, those skills have helped to reduce the wage gap between men and women. Job training is recommendable to increase a worker's productivity, but due to internal or external crises, sometimes it is impossible to cover their costs. In a panel data analysis of 16,000 German firms, Bellmann, Gerner, and Leber (2014) studied the economic crisis's effect on workers' continuous upskilling. They found that the firms that were more affected by the crisis trained their personnel to a lesser extent and that the less affected firms focused their training on more experienced personnel rather than on their new employees.

Our study proposes training through education for employed workers; to achieve promotion and a possible increase in their income. Although sometimes, the training can have non-remunerated purposes, as Mendoza-Cota and Cabrera-Pereyra (2014) mentioned. Based on a panel data analysis applied to the labour market on the northern border of Mexico, the authors commented that the percentage of the population with secondary education increased by 5% because workers considered education as empowerment, regardless of the work incentive they could achieve.

One aspect that our model considers is the cost of training, which the company usually covers. In this sense, McCausland and Theodossiou (2004) state that the relationship between wage increases and unemployment is altered since the cost of training modifies the labour demand, and due to the incentives generated by the training and education of workers, the labour supply also changes. Meanwhile, using a programming model, Azizi and Liang (2013) recommend the rotation of workers' tasks to determine what type of training they require and, therefore, minimize the training costs and productivity loss.

On the other hand, it is recommended for the company to remunerate according to the talent acquired in training. Otherwise, in addition to causing brain drain, it could lead to higher unemployment. For example, Liu-Farrer (2009) comments on the migration of Chinese students to Japan, where the receiving country absorbs the graduates and delivers qualified labour to the Japanese labour market. It should be noted that the leave of workers is due to low benefits and contributions, such as insurance, bonuses, etc., and not just the low wages (Frazis and Loewenstein, 2013).

There are diverse ways of training. Yet, training through education always represents an extra benefit to the worker. In this sense, Naroş and Simionescu (2019) mention the experience of Romanian entrepreneurs recognized for having secondary and tertiary education. They emphasize that training through education is important to make the labour market more dynamic. This training through education always involves an *additional cost for the worker*, which is not perceived monetarily and is called *opportunity cost*. There are other ways to interpret the opportunity costs. Chodorow-Reich and Karabarbounis (2016), through a time series analysis of national accounts, modelled a job opportunity cost involving variables such as taxes, eligibility, benefits, and time, among others.

Our study assumes that the worker covers the training costs. This situation is acceptable, as long as the training is in line with the needs of the participants. For example, Pena-Shaff et al. (2020) comment on training based on a financial education program for low-income communities in Ithaca, New York, emphasizing that the educational program was successful, particularly in the confidence and financial planning of the communities. On the other hand, the fact that the worker covers the training costs reduces potential biases in the selection process, which could happen if the company covers the costs. In this regard, Cutuli and Guetto (2013), based on an econometric model applied to the European Social Survey, comment that the selection bias in training workers is due to the type of contracts, particularly fixed-term contracts.

The selective choice of workers could result from an asymmetry of information and subjectivity on the company's part. Armour, Button, and Hollands (2018) comment that hiring economically active personnel with disabilities is only 34%, compared to 74.2% of those without disabilities. Under this

selective choice, companies could lose several benefits. Instead, a non-subjective selection would imply a more outstanding labour commitment of the workers and an advantage in their training. In addition, it could avoid possible shortsightedness of the company in assigning better salaries.

Companies generally have asymmetric information about their workers, but the opposite can happen. The workers need to recognize how the company will act. This scenario could explain why some people want to avoid accessing the labour market or education. For example, Loprest, Spaulding, and Nightingale (2019) comment that many young people need to be more connected to work and school. Therefore, these authors analyse policies for the inclusion of this population in the labour market based on training and education programs. In the same sense, Ruesga, da Silva-Bichara, and Monsueto (2014) mention that promotions are not egalitarian, and sometimes the firm does not observe workers' talent, education, and discipline, or it is indifferent to those qualities. In particular, it is possible that the company only attends if the worker has an advantage resulting from some training.

To reduce the asymmetry of information workers face, our model involves signals to know the firms with which they are dealing. These signals can mitigate any event involving wage inequality and economic stagnation. Naidu, Posner, and Weyl (2018) consider signals as policies and analytical methods to avoid the market power of firms and some mergers between them, which could cause imbalances in the labour market. Other indications to establish equilibrium in the labour market can be considered. For example, Popov and Bernhardt (2012) comment that companies consider the fraternity membership of students and fraternity admission options as signals to hiring students. This fraternity is regarded as having a high socialization value, but students must gain it to appear strong and not be hired.

Our analysis is based on Spence (1973). He considers that the agent with asymmetric information is firm since he does not know the quality of the potential worker to be hired, so it incorporates education as a signal. Hopkins (2012) shows a model of matching among workers who have confidential information regarding their capacity and develops another type of application of Spence. Such ability is used as a signal for the most qualified workers to be chosen by the best firms. Along the same path, Coles, Kushnir, and Niederle (2013) model a situation where workers send signals that interest employers, making job search and occupation matches easier. Finally, Andrade and Lomelí (2022) apply Spence to evaluate the efficiency and responsibility in education in the worker's training.

A similar analysis, where the company has confidential information, is shown in Andrade (2021). The author proposes a game to model the optimal decision of government support to help Mexican companies face the COVID-19 pandemic effects. Andrade concludes that the need for more information about the companies makes it impossible for the Government to provide efficient support.

MATERIALS AND METHODS

Game theory concepts

The decisions made by the company and the worker are strategies that can be analysed through game theory. Thus, we have the following definition,

Definition 1 (Nicholson and Snyder 2008). – A game is a strategic interaction between two economic agents, called players, represented as follows:

$$\Gamma = \left\{2, A_1, A_2, U_k(a_i, a_j)\right\},$$

Where A_1 and A_2 denote the strategy sets of players 1 and 2, respectively; $a_i \in A_1$ (with $I = 1, 2,\ldots, m$) denotes the possible strategy of player 1; $a_j \in A_2$ (with $j = 1, 2,\ldots, n$)[1] denotes the possible strategy for player 2 and $U_k(a_i, a_j)$ denotes the payoff function of player $k = 1, 2$.

To analyse if the performance of a player is the best according to the actions of his counterpart, it is necessary to define the following concept:

Definition 2 (Mas-Colell, Whinston, and Green, 1995). – Let $\Gamma = \left\{2, A_1, A_2, U_k(a_i, a_j)\right\}$ denote the simultaneous game, a strategy *ai* is the best response of player 1 to any strategy a_j of player 2, denoted as $a_i = BR_1(a_j)$, if[2]

$$U_1\left(a_i, a_j\right) \geq U_1\left(a_i', a_j\right), \ \forall \ a_i' \in A_1 \qquad (1)$$

One of the classic representations of a game, in particular for two players, is shown in Table 1, called a normal-form game. The rows determine the strategies of player 1 (i.e., *a* and *b*), and the columns represent the strategies of player 2 (i.e., *c* and *d*). The values within the matrix are the payoffs according to the strategies. For example, $U_1(a, c) = 3$ is the payoff for player 1 when he chooses strategy *a* and player 2 chooses strategy *c*.

Now suppose that in the game shown in Table 1, player 1 values his utility in two different ways under the strategy profile (a, c), that is,

$$U_1(a,c) = t, \text{ where } t = \begin{cases} 3 \text{ if Player 1 is type 1} \\ 0, \text{ if Player 1 is type 2} \end{cases}$$

That is, if player 1 values with $t = 3$, it is called type 1, and when it values with $t = 0$, it is called type 2. Both players know

		Player 2	
		c	*d*
Player 1	*a*	3, 2	-1, -1
	b	1, 1	2, 3

Table 1: Representation of a normal-form game for two players (source: own elaboration)

1 Players can have several strategies. In this case, m and n represent the number of strategies of player 1 and player 2, respectively, and can be equal.

2 Similarly, we can define the best response for player 2.

the values of t[3]; the difference in a game with complete information is that player 2 is still determining if Player 1 will act as type 1 or type 2. Hence, there needs to be more information or asymmetric from P2 towards the types of Player 1.

Player 2 can assign subjective beliefs, to reduce uncertainty about what type of player 1 he faces. These beliefs are based on statistics, reports, or experience and represent probabilities of behaviours (types) of player 1, i.e.,

$$P(P1 \text{ is type } 1) = p \text{ and } P(P1 \text{ is type } 2) = 1 - p, \qquad (2)$$

The above analysis is a game theory problem with asymmetric (incomplete) information, defined as follows,

Definition 3 (Riascos, 2016).- A game with incomplete information (asymmetric) is a strategic game under uncertainty, represented by,

$$\Gamma = \left\{2,\ A_1, A_2,\ T_k,\ P_2\left(t_{1h}\right),\ U_k\left(a_i, a_j, t_{1h}\right)\right\}$$

Where T_k denotes the set of types of each player $k = 1, 2$. P2(t_{1h}) is the belief assigned by player 2 to the person type $t_{1h} \in T_1$, which he does not know.[4] Finally, $U_k(a_i, a_j, t_{1h})$ is the payoff of player k for each of his types t_{kh}, for $h = 1, 2,\ldots, N$.

The beliefs or probabilities shown in (2) are subjective and assigned by the player with asymmetric information, in our case, P2. To make these beliefs more "reliable," player 1 sends signals to P2 so that the latter includes them, thereby updating them. To turn subjective beliefs into objective ones, we apply Bayes' theorem. In reality, these objective beliefs are conditional probabilities, where the condition is the signal, i.e.,

$$P(T1 \mid signal) = q \text{ and } P(T2 \mid signal) = 1 - q \qquad (3)$$

The game in definition 3, with the new probabilities shown in (3), is called the Bayesian game, and the equilibrium is called the Bayesian Nash equilibrium (Osborne, 2004).

THE MODEL

Population and training of workers

Training workers is a key element when the company decides to give a promotion and/or a salary increase. More specifically, the worker's training will be considered the investment the worker makes in his education. The objective of such investment is for the worker to complete his secondary education up to a possible postgraduate degree. Thus, the population under study involves company workers with incomplete secondary education. This vision of training through education involves years and costs that will be key in analysing this work.

The Story

The story of this analysis is as follows: the employed worker is willing and able to train through education, with the primary goal of obtaining a promotion and, thus, a salary increase. However, the worker needs to know if the company will consider this training sufficient for the promotion. Sometimes, companies need to think if the worker has more studies or better training than others. In this sense, Rodríguez (2004) comments that the fact that people are more or less trained does not guarantee to get a promotion to a new position or a better salary. That is, the assignment of jobs generally does not commensurate with the worker's skills.

Thus, the worker observes two types of firms: those indifferent toward the worker's training and those who appreciate it and make a distinction. This is,

Type 1) Firm is indifferent to training (*Ind*),

Type 2) Firm distinguishes the trained worker (*Dist*)[5]

The worker knows about these two types of firms, but they are not aware of which type of company he is facing, particularly whether it values his studies. Therefore, the worker faces a problem of asymmetric information, which we shall now analyse. In principle, the worker's strategies are[6],

1. Study (S)
2. Do not study (NS)

The objective is to analyse the worker's best response to face companies that value or not the additional years of study, from finishing their secondary education onwards. Such an optimal strategy will provide a threshold that defines whether investing in education is feasible. To do this, we need to represent the worker's benefits based on requirements and contracts between the worker and the two types of existing companies.

Beliefs and signals

Thus, let $P(Ind)$ and $P(Dist)$ the subjective beliefs the worker assigns when facing the two types of companies. Where $P(Ind) + P(Dist) = 1$, because the kinds of firms are disjoint events.

The uncertainty the worker faces, derived from the lack of information regarding the companies he meets, is incorporated in the expected payoff of the worker, $EU_{w.}$ Then, when the worker decides to study, we have that,

$$EU_W(S) = P(Ind)U_W(S, Ind) + P(Dist)U_W(S, Dist) \qquad (4)$$

Now, when he decides not to study, we have,

$$EU_W(NS) = P(Ind)U_W(NS, Ind) + P(Dist)U_W(NS, Dist) \qquad (5)$$

Where $U_w()$ is the worker's benefit function.

We must emphasize that subjective beliefs can lead to drastic errors, especially regarding investments. For example, if the worker invests his entire money in education, assuming that the firm will make distinctions based on quality and then fails to do so, the worker will be financially affected.

Another perception error would be that the worker did not want to continue his studies, hoping the company would be indifferent to his training. Still, in the end, it values and distinguishes trained workers.

Naturally, companies like to retain the best workers, either for their knowledge or their studies, because it is an advantage over their competitors in terms of quality and sales. However, there

3 Although the analysis in this paper is through incomplete information games, the fact that all the elements are of common knowledge makes the asymmetric information problem manageable through an incomplete information problem (Riascos, 2016; Harsanyi, 1967). In this sense, the concepts are similar.

4 The value t_{1h} indicates the different types or behaviors of player 1, that is, $t_{11}, t_{12}, t_{13}, \ldots, t_{1N}$.

5 We must remember that training is equivalent to studying for 2, 3, 4, etc. years.

6 Although the company's strategies are not necessary in this scenario to formalize the game concept, the strategies could be promoted or not promoted.

is uncertainty among workers about the decision to study since they still need to thoroughly identify whether the company will value such training in remuneration. Workers need companies to send signals about their kind to reduce this uncertainty about the type of companies they face.

In this work, we consider the action of auditing by the company to its workers as the signal. Figure 1 shows the extensive form of the model. At first, the firm knows whether it is type 1 (Ind) or type 2 (Dist). Then, the worker decides whether to study (*S*) or not to study (*NS*), but not before knowing that the firm audits (*A*) or does not audit (*NA*). Finally, at the end of the branches, the payments for the firm and the worker are shown, which are explained later.

The objective changes, that is, we are interested in knowing what happens with the worker's decision, knowing that the company audits (*A*) or does not audit (*NA*). Note, then, that the expected payoffs (4) and (5) change when the firm's signal is included, if the company audits,

$$EU_W(S) = P(Ind|A)U_W(S, Ind) + P(Dist|A)U_W(S,Dist) \quad (6)$$

and also,

$$EU_W(NS) = P(Ind|A)U_W(NS, Ind) + P(Dist|A)U_W(NS,Dist) \quad (7)$$

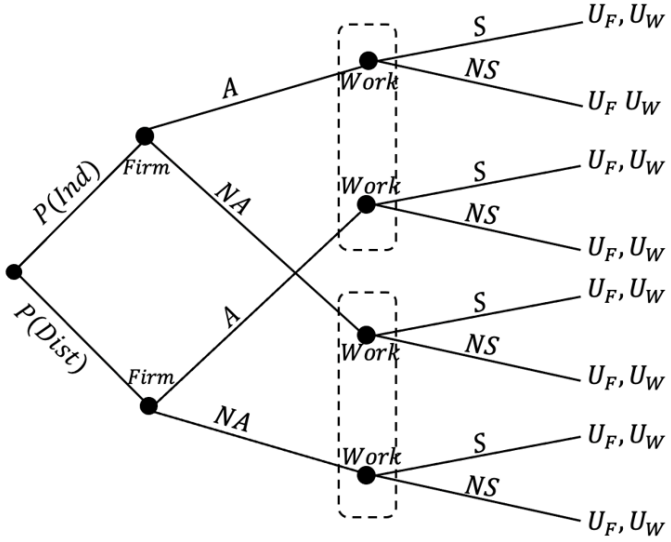

Figure 1: Asymmetric information game for the training of the worker, considering the audit of the company as a signal (source: own elaboration)

And in case the workers have information that the company does not audit (*NA*), we have the following:

$$EU_W(S) = P(Ind|NA)U_W(S, Ind) + P(Dist|NA)U_W(S,Dist) \quad (6a)$$

$$EU_W(NS) = P(Ind|NA)U_W(NS, Ind) + P(Dist|NA)U_W(NS,Dist) \quad (7b)$$

Construction of benefits

The payments will be based on the following criteria,

1. If the company is indifferent (Ind) about whether someone is training (studying), the payment is *w*,
2. When the company makes a distinction (Dist) between those who study and those who do not, it classifies the workers as low quality (They do not study) or high quality (They study).

Low-quality workers' wages are f_t, and high-quality workers receive an additional incentive on *w* of ε_t. Where $f_t < w < w + \varepsilon_t$, and the subindex *t* denotes the years studied.

3. Training through the study costs *C* and is covered by the worker.

Consequently, the benefit of a worker who studies and faces a company that is indifferent to this characteristic will be

$$U_W(S, Ind) = w - C, \quad (8)$$

But when the worker deals with a company that distinguishes between skilled and unskilled workers, then,

$$U_W(S, \text{Dis}) = w + \varepsilon_t - C, \quad (9)$$

Now, if the worker does not study, his payment when the company is indifferent is,

$$U_W(NS, \text{Ind}) = \text{w}$$

and

$$U_W(NS, Dist) = f_t,$$

when the firm makes a distinction.

Results

Considering the uncertainty of the worker due to the type of companies they may face. We will deduce a threshold to decide if studying (training) is a better option for the worker than not doing so. This is

$$EU_W(S) > EU_W(NS)$$

In principle, we will deduce the threshold knowing that the company audits (*A*); that is, replacing the expressions (6) and (7), we have

$$P(Ind|A)U_W(S, Ind) + P(Dist|A)U_W(S,Dist) >$$

$$P(Ind|A)U_W(NS, Ind) + P(Dist|A)U_W(NS,Dist)$$

of the payments of the worker when studying and not studying, and facing the diverse types of firms, we have

$$P(Ind|A)(w-C)+P(Dist|A)(w+\varepsilon_t-C)>P(Ind|A)w+P(Dist|A)f_t \quad (10)$$

Given that $P(Ind|A)+P(Dist|A)=1$, then (10) results in

$$w-C+P(Dist|A)\varepsilon_t>P(Ind|A)w+P(Dist|A)f_t \quad (11)$$

If we group similar terms in (11), we have

$$w(1-P(Ind|A))+P(Dist|A)(\varepsilon_t-f_t)>C$$

And since, $P(Dist|A)=1-P(Ind|A)$,

$$P(Dist|A)(w+\varepsilon_t-f_t)>C$$

The above analysis leads to the following result:

Result 1. Assuming that the company audits, then the best strategy for the employee is to study if and only if,

$$P(Dist|A)>\frac{C}{w-f_t+\varepsilon_t} \quad (12)$$

A similar analysis, knowing that the company does not audit (*NA*) (second branch of Figure 1), gives us,

$$P(Dist|NA)>\frac{C}{w-f_t+\varepsilon_t} \quad (12a)$$

APPLICATIONS

Based on (12 or 12a), we derive specific values for the incentive ε_t and the payment that is received for not studying, f_t.

Thus, we can represent it as:

$\varepsilon_t=\theta w$, with, $0<\theta<1$ the additional share for studying.

To obtain a numerical value for ε_t, we consider the OECD report (2019), which states that young workers with higher education could earn up to 78% more than their peers with high school education. Therefore, and according to IIPE-UNESCO (2019), which states that on average, higher education begins after middle school and consists of three years of high school, four years of bachelor's degrees, two years of master's degrees, and three more years for doctoral degrees. That is, after middle school, which is the grade of our target population, it is necessary to invest nine years in education to obtain a master's degree (see Table 2).

Educational attainment	Years of study	Education incentive
	2	0.3279
High school graduate	3	0.4755
	4	0.5726
	5	0.6402
	6	0.6896
Bachelor's degree	7	0.7272
	8	0.7567
Master's degree	9	0.7805
	10	0.8001
	11	0.8165
Doctorate degree	12	0.8304

Table 2: Incentives for education after middle school [source: own elaboration based on information reported by OECD (2019) and IIPE-UNESCO (2019)]

Hence, Table 2 highlights the value of 78%, the additional income perceived by an individual with a master's degree (OECD, 2019). Based on the nine years required, from middle school, to obtain a master's degree, we can express the value of 78% as follows,

$$\varepsilon_t=e^{-2.23/9}w=0.78w \quad (13)$$

In general, the value of ε_t can be represented as,

$$\varepsilon_t=e^{-2.23/t}w \quad (13a)$$

Where t denotes the years of study, hence the values in column 3 in table 2.

To find the value of f_t, which refers to the payment when the company makes a distinction, and the workers did not study beyond secondary education, we rely on the reports by PRESTY (2019), which defines wages beyond middle school degrees (column 3, table 3).

Based on these salaries (column 3), the calculations in column 4 of Table 3 were made as follows:

Educational attainment	Years beyond high school education	Profit according to the study	Profit loss percentage	Approximate value
Just middle school		2191		
High school graduate	3	7200	0.6957	0.6271
	4			0.7047
	5			0.7558
	6			0.7919
Bachelor's degree	7	12200	0.8204	0.8187
	8			0.8395
Master's degree	9	14800	0.8520	0.8559
	10			0.8694
	11			0.8805
Doctorate degree	12			0.8899

Table 3: Profit loss percentages after middle school [source: own elaboration based on information reported by PRESTY (2019)]

$$\text{Percentages} = \frac{w_f - w_i}{w_f}$$

where w_f is the final study payment (high school, bachelor, or master) and w_i is the initial wage (middle school). The value of f_t can be expressed as,

$$f_t = e^{-1.4/t}w \tag{14}$$

Expression (14) was derived similarly to (13), that is, an exponential expression with an estimated exponent that will return a value close to 85% (row highlighted in grey). Such value corresponds to the percentage of income an employee with secondary education would not receive if he does not attain a master's degree.

Substituting the expressions (13a) for the incentives ε_t and (14) for the loss for not studying f_t, in (12), we have,

$$1 > P(\,Dist|A) > \frac{C}{w - f_t + \varepsilon_t} = \frac{C}{w - e^{-1.4/t}w + e^{-2.23/t}w} = \frac{C}{w\left(1 - e^{-\frac{1.4}{t}} + e^{-\frac{2.23}{t}}\right)} \tag{15}$$

Factoring the value of the wage w and since $P(\,Dist|A) < 1$, we have,

$$\frac{C}{w} < 1 - e^{-\frac{1.4}{t}} + e^{-2.23/t} \tag{16}$$

which leads to the following result.

Result 2. Suppose that the worker knows that the company audits (or does not audit)[7], then studying is the worker's best strategy if and only if the percentage of income that he invests in studying is bounded by (16).

Since the threshold defined in (16) depends on the years of study the worker wants to achieve. We can construct the percentages that workers would spend on their salary (table 4) to accomplish these studies. In particular, it is observed in Table 4 that if a worker who currently has a high school degree wants to study and finish a degree, they would have to invest 90% of their income. Alternatively, if they intend to reach the master level, they must invest 92% of their income.

Although Table 4 shows a strategic scenario of how much to invest in wages, the threshold is constructed based on something other than the value of the subjective belief: $P(\,Dist|A)$. The reports in Table 4 only consider cases where the belief $P(\,Dist|A)$ in (16) is less than 1. Even the result loses meaning because it also applies when the company does not audit.

Educational attainment	Years of study	C/W: Percentage of income invested in education
	2	0.8313
High school graduate	3	0.8484
	4	0.8680
	5	0.8844
	6	0.8977
Bachelor's degree	7	0.9085
	8	0.9173
Master's degree	9	0.9246
	10	0.9308
	11	0.9360
Doctorate degree	12	0.9405

Table 4: Percentages of investment in education [source: own elaboration based on expression (16)]

To include the subjective belief in the application of (12), we rely on the reports of INEGI (2018), which supports that approximately 33.5% of SMEs monitor with key performance indicators, while 66.5% do not monitor. Therefore, $P(A) = 0.335$ and $P(NA) = 0.665$.

Now, Forbes (2022) comments that by 2023, 16.2% of the companies in Mexico could give an increase of 3 and 4%, while 41.7% could raise it between 5 and 6%. And considering that by law, every year, there is a 5% increase in workers' salary (INEGI, 2018), regardless of their performance, the previous reports do not imply any audit.

Thus, the percentage of companies that distinguish their workers with an increase of 3 to 4% and do not audit is $P(Dist \cap NA) = 0.162$. While the percentage of companies that distinguish their workers with an increase between 5 and 6%, and do not audit, is: $P(Dist \cap NA) = 0.417$. We will call case 1 companies that are not flexible in wages and case 2 companies that are flexible in wages.

Also, Forbes reports that 27.3% of employers will give a salary increase between 7 and 8%, and only 13.1% of companies will give their workers a raise of 9% or more. And considering that increases after 5% will require audits and performance indicators (INEGI, 2018). Then, the percentage of companies that distinguish their workers with an increase between 7% and 8% and audit is $P(Dist \cap A) = 0.273$. In contrast, the percentage of companies that distinguish their workers with an increase

7 Since the threshold was obtained from $P(Dist|A) < 1$, result 2 also applies when we know that the company does not audit since $P(Dist|NA) < 1$. To or not to audit will become relevant when objective beliefs are built.

of 9% or more and audit is $P(Dist \cap A) = 0.131$. We identify the first case as a low audit and the second as an intense audit, considering that the increase is more significant.

Based on the above, we build the objective beliefs, $P(\ Dist|A)$ and $P(\ Dist|NA)$. The calculations are shown in Table 5.

Probability of auditing: $P(A)$=0.335	**Probability of auditing and making a wage distinction:** $P(Dist \cap A)$	**Objective belief:** $P(\ Dist|A) = \frac{P(Dist \cap A)}{P(A)}$
0.335	Percentage of companies that assign increases between 7 and 8% and audit = 0.273	0.814
0.335	Percentage of companies that assign increases of more than 9% and audit = 0.131	0.391
Probability of not auditing: $P(NA)$=0.665	Probability of not auditing and making a wage distinction: $P(Dist \cap NA)$	Objective belief: $P(\ Dist|A) = \frac{P(Dist \cap A)}{P(A)}$
0.665	Percentage of companies that assign an increase between 3 and 4 % without auditing = 0.162	0.243
0.665	Percentage of companies that assign an increase between 5 and 6 % without auditing = 0.418	0.628

Table 5: Modelling of the objective belief according to the expression (12) [source: own elaboration based on Forbes (2022) and INEGI (2018)]

Considering the values of the objective beliefs in Table 5, we can find thresholds for the percentage of income allocated to education and the number of schooling years that can be achieved more realistically.

In principle, column 3 of Table 6 shows the same values as Table 4, the additional observation in Table 6 is the application of subjective beliefs and the opportunity cost, which we explain later. By applying the subjective beliefs, we will obtain more specific thresholds for the percentage of income invested in education, applying the expression:

$$\frac{C}{w} < \left(1 - e^{-\frac{1.4}{t}} + e^{-\frac{2.23}{t}}\right) P(\ Dist|A) \qquad (17)$$

So, from the right-hand side of the inequality (17), table 6 shows more specific thresholds for how much to invest in education when the audit is low (column 4), and the percentage of income allocated to education when the audit is intense (column 6).

The exciting thing about Table 6 is that if the worker considers the auditing of the company (column 4 and column 6), he invests less than if he only considered that. The probability is less than one (column 3 in Table 6 and column 3 in Table 4). Thus, by considering how the firm acts, the worker is less risky at investing; and less risky when the audit is intense (column 6).

The cost of studying in column 3 of Table 6 is a cost that does not consider what the company does. For example, the cost of obtaining a high school or bachelor's or master's degree is 84%, 90%, and 92%, respectively, which is relatively high. But, considering the company audits, the costs decrease (column 4 and column 6). Thus, we can deduct an opportunity cost (column 5 and column 7), defined as the difference between the cost of not considering what the company does and the cost of considering what the company does.

For example, if the firm's audit is low, the opportunity cost of having a bachelor's degree will be 16.9% of their income. In comparison, the opportunity cost of obtaining a master's degree will be 17.2%. But, if companies are harder to make a distinction when they audit, the percentage decreases to 35.5% and 36.1%, respectively. Therefore, the opportunity cost of the workers ranges from 55% to 56% (column 7, table 6, upper box).

In the same table, but in the lower part, we observe the cases when the company does not audit and its plan to distinguish through salaries, little flexible and very flexible (columns 4 and 6). It is noteworthy the low percentage that the worker allocates to education when the company is inflexible in granting significant salary increases and causing a remarkably high opportunity cost for education.

But the most notable in Table 6 are columns 5 and 7 at the bottom. If the company is flexible in granting significant salaries, the worker reacts by investing more in education, and therefore his opportunity cost is meagre (column 7). This aspect shows the commitment and loyalty of the worker for not feeling pressured (free of audit) and with a relatively significant increase in salary (about 6%).

Continuing the analysis, the worker will only study if expression (17) holds. Thus, if the percentage of income the worker spends on education is known, we can determine if it is convenient to study according to the objective beliefs the worker considers about the firm, which are reported in Table 7.

When the signal is: to audit

Educational attainment	Years of study	$1-e^{-\frac{1.4}{t}+e^{-\frac{2.23}{t}}}$	$P(Dist\|A)$ =0.814 Low audit	Opportunity cost	$P(Dist\|A)$ =0.391 Intense audit	Opportunity cost
	2	0.8313	0.6767	0.1546	0.3251	0.5063
High school graduate	3	0.8484	0.6906	0.1578	0.3317	0.5167
	4	0.868	0.7065	0.1614	0.3394	0.5286
	5	0.8844	0.7199	0.1645	0.3458	0.5386
	6	0.8977	0.7307	0.167	0.351	0.5467
Bachelor's degree	7	0.9085	0.7395	0.169	0.3552	0.5532
	8	0.9173	0.7467	0.1706	0.3587	0.5586
Master's degree	9	0.9246	0.7526	0.172	0.3615	0.5631
	10	0.9308	0.7576	0.1731	0.3639	0.5668
	11	0.936	0.7619	0.1741	0.366	0.57
Doctorate degree	12	0.9405	0.7656	0.1749	0.3677	0.5728

When the signal is: do not audit

Educational attainment	Years of study	$1-e^{-\frac{1.4}{t}+e^{-\frac{2.23}{t}}}$	$P(Dist\|A)$=0.243 Little flexible	Opportunity cost	$P(Dist\|NA)$ =0.628 Very flexible	Opportunity cost
	2	0.8313	0.202	0.6293	0.5221	0.3093
High school graduate	3	0.8484	0.2062	0.6423	0.5328	0.3156
	4	0.868	0.2109	0.657	0.5451	0.3229
	5	0.8844	0.2149	0.6695	0.5554	0.329
Bachelor's degree	6	0.8977	0.2181	0.6796	0.5638	0.3339
	7	0.9085	0.2208	0.6877	0.5705	0.3379
	8	0.9173	0.2229	0.6944	0.576	0.3412
Master's degree	9	0.9246	0.2247	0.6999	0.5806	0.3439
	10	0.9308	0.2262	0.7046	0.5845	0.3462
	11	0.936	0.2274	0.7086	0.5878	0.3482
Doctorate degree	12	0.9405	0.2285	0.712	0.5907	0.3499

Table 6: Thresholds regarding the percentage of income allocated to education and opportunity costs (source: own elaboration based on values shown in Table 5)

If C=0.5w and the signal is that the company audits

Years of study	$1-e^{-\frac{1.4}{t}+e^{-\frac{2.23}{t}}}$	With low audit	Decision	With Moderate audit	Decision	Under intense audit	Decision
2	0.8313	0.6766782	Study	0.5004426	Do not study	0.3250383	Do not study
3	0.8484	0.6905976	Study	0.5107368	Study	0.3317244	Do not study
4	0.868	0.706552	Study	0.522536	Study	0.339388	Do not study
5	0.8844	0.7199016	Study	0.5324088	Study	0.3458004	Do not study
6	0.8977	0.7307278	Study	0.5404154	Study	0.3510007	Do not study
7	0.9085	0.739519	Study	0.546917	Study	0.3552235	Do not study
8	0.9173	0.7466822	Study	0.5522146	Study	0.3586643	Do not study
9	0.9246	0.7526244	Study	0.5566092	Study	0.3615186	Do not study
10	0.9308	0.7576712	Study	0.5603416	Study	0.3639428	Do not study
11	0.936	0.761904	Study	0.563472	Study	0.365976	Do not study
12	0.9405	0.765567	Study	0.566181	Study	0.3677355	Do not study

If C=0.75w and the signal is that the company audits

Years of study	$1-e^{-\frac{1.4}{t}}+e^{-\frac{2.23}{t}}$	With low audit	Decision	With Moderate audit	Decision	Under intense audit	Decision
2	0.831	0.6766782	do not Study	0.5004426	do not study	0.3250383	do not study
3	0.848	0.6905976	do not Study	0.5107368	do not study	0.3317244	do not study
4	0.868	0.706552	do not Study	0.522536	do not study	0.339388	do not study
5	0.884	0.7199016	do not Study	0.5324088	do not study	0.3458004	do not study
6	0.8977	0.7307278	do not Study	0.5404154	do not study	0.3510007	do not study
7	0.9085	0.739519	do not Study	0.546917	do not study	0.3552235	do not study
8	0.9173	0.7466822	do not Study	0.5522146	do not study	0.3586643	do not study
9	0.9246	0.7526244	Study	0.5566092	do not study	0.3615186	do not study
10	0.9308	0.7576712	Study	0.5603416	do not study	0.3639428	do not study
11	0.936	0.761904	Study	0.563472	do not study	0.365976	do not study
12	0.9405	0.765567	Study	0.566181	do not study	0.3677355	do not study

If C=0.5w and the signal is that the company does not audits

Years of study	$1-e^{-\frac{1.4}{t}}+e^{-\frac{2.23}{t}}$	Little flexible	Decision	Moderately flexible	Decision	Very flexible	Decision
2	0.8313	0.2020059	do not study	0.3624468	do not study	0.5220564	Study
3	0.8484	0.2061612	do not study	0.3699024	do not study	0.5327952	Study
4	0.868	0.210924	do not study	0.378448	do not study	0.545104	Study
5	0.8844	0.2149092	do not study	0.3855984	do not study	0.5554032	Study
6	0.8977	0.2181411	do not study	0.3913972	do not study	0.5637556	Study
7	0.9085	0.2207655	do not study	0.396106	do not study	0.570538	Study
8	0.9173	0.2229039	do not study	0.3999428	do not study	0.5760644	Study
9	0.9246	0.2246778	do not study	0.4031256	do not study	0.5806488	Study
10	0.9308	0.2261844	do not study	0.4058288	do not study	0.5845424	Study
11	0.936	0.227448	do not study	0.408096	do not study	0.587808	Study
12	0.9405	0.2285415	do not study	0.410058	do not study	0.590634	Study

Table 7: Final decisions comparing the investment threshold to the beliefs about the firms [source: own elaboration based on the expression (17)]

For example, suppose that the worker spends half of his income on training, that is, $\frac{C}{w}=\frac{0.25w}{w}=0.5$, and he believes that he is facing a company that he audits, then the worker will study if and only if,

$$0.5<\left(1-e^{-\frac{1.4}{t}}+e^{-\frac{2.23}{t}}\right)*P(Dist \mid A), \qquad (17.1)$$

The calculations of (17.1) are shown in columns 3, 5, and 7 at the top of Table 7. In particular, it is observed that the worker will always want to study (column 3) if the company audit is low. On the other hand, when the company is intense in the audit (column 7), the worker will decide not to study. In conclusion, the worker will consider the company's pressure through the audit, which is crucial to opt for the training.

Under the same beliefs, but considering that the worker spends 75% of his income on education, then he will study if the following is true,

$$0.75<\left(1-e^{-\frac{1.4}{t}}+e^{-\frac{2.23}{t}}\right)*P(Dist \mid A) \qquad (17.2)$$

The calculations are shown in the middle box of Table 7. Note now that under this required percentage of income to study, the worker will study only if he gets beyond a master's degree, if the audit is low.

Finally, the lower part of Table 7 shows when the company does not audit, and the worker allocates 50% of his income to study. That is, the worker will study if and only if,

$$0.5<\left(1-e^{-\frac{1.4}{t}}+e^{-\frac{2.23}{t}}\right)*P(Dist \mid NA) \qquad (17.3)$$

In this case, the worker will always decide to study when the company is very flexible in the distinction of salaries due to the worker's achievements. This situation reiterates the worker's commitment to the trust and credibility that the company shows toward him.

DISCUSSION

Our initial proposal is that training of the workers should be through education, in the sense that the workers will take a position of greater responsibility. For example, Atibuni (2019) comments that the training of teachers in an educational system must be efficient and responsible because

trained teachers would opt for positions of higher hierarchy. In the same sense, Adejare et al. (2020), through an analysis of structural equations applied to non-academic employees of Nigerian universities, conclude that training affects the managerial efficiency and quality of services of non-academic workers if external experts conduct the training.

Another assumption of our work is that the worker covers the cost of the training to avoid a bias on who takes the training or who does not, the bias that occurs when the company covers the cost (Cutuli and Guetto, 2013). In addition to what Folz and Shults (2018) point out, although professional training is essential for the management and organizational performance of the company, these programs are the first to disappear when the company goes bankrupt.

On the other hand, note in Table 4 that completing high school involves 84% of the worker's wage, a bachelor's degree 90%, and a master's degree 92%, which, could be very high. However, it is important to emphasize that in addition to the economic cost, we are considering the time required for this aim, known as opportunity cost. In this regard, Curtis, Moriarty, and Netten (2012) state that when adding up all the possible training costs, including the opportunity cost, this sum could be almost three times the visible monetary costs.

Another way of looking at opportunity costs is the cost of efficiency and responsibility that workers learn during their education, allowing them to enter the labour market early. In this sense, Zając, Jasiński, and Bożykowski (2018), analysing the educational system in Poland, comment that private school students tend to have better opportunities in the labour market because they are involved from their final stage of education. Showing a strategy, in terms of efficiency in education towards the labour market, that some schools have. In addition, the value of training through education is related to economic performance and institutional responsibility (Tomlinson, 2018).

In addition to the opportunity cost and considering that in our article, the workers themselves assume the training costs, it could be considered a tax credit paid in some countries. For example, Leuven and Oosterbeek (2004) state that Dutch companies can claim a tax refund when they train their workers over 40. Related to the above, our analysis involves an incentive that would be granted by the firm, linked to the audit of the company and the training. Leuven and Oosterbeek (2004) comment that if a tax rebate is obtained for the training firms provide, they can increase wages to encourage such training.

For the results, we build subjective beliefs because the company makes a distinction in wages, which generates uncertainty for workers. To reduce this uncertainty, we transform the beliefs into objectives, considering the audit (evaluation) of the company as a sign that the workers are trained and that they can improve productivity. Although many workers might be uncomfortable with such audits, these could have benefits at some point. For example, Chung et al. (2021), through an analysis between Korean companies and suppliers, commented that the audit of the companies helped the suppliers to improve their efficiency in human resources and that the companies did not impose sanctions. In addition, the audit implied that the contracts between both parties were not interrupted.

In the final decision of workers regarding education, our results show that the worker decides to train (study) by predicting a low audit by the company and that in addition to the incentive granted by the company (additional 7-8%) in the long term could suit the worker. In this sense, Juravich (2017) analyses what happened with the closure and restart of a furniture factory. When it was sold, the new owners valued the skills learned for years by the workers of the old factory and not only re-hired them but used them as trainers for new workers.

Our analysis shows the preparation of the worker in terms of more years of education. Also, we consider a signal that the firm audits so that the worker qualifies for better pay. Contrasting our analysis, Assaad, Krafft, and Salehi-Isfahani (2018) discuss the mismatches in the labour market and its relationship with the higher education system for the labour market in Egypt and Jordan. They emphasize that hiring decisions are not based solely on whether the worker studied in a public or private school; other issues, such as the family nucleus, are considered.

That is, the uncertainty about the possibility that the company does not value the worker's training is due to the lack of knowledge of the company towards its workers. In this sense, Bol et al. (2019), based on a relationship between the educational sector and the labour market in France, Germany, and the United States, comment that the knowledge of the companies towards the workers, through a match between the occupations and the educational level of the workers, implies an increase in the productivity and salary of the worker.

In addition, income could increase if workers' educational credentials were better appreciated in the labour market. Then, it is recommended that employers make a difference between their skilled and unskilled workers since it would increase workers' educational levels (Fan and Yakita, 2011).

Table 7 shows the main findings of our work, highlighting that workers consider education (training) more efficiently and responsibly when companies trust them and lighten their audit probability. Based on a sample of Portuguese universities, Bruckmann and Carvalho (2018) conclude that university institutions have a greater effect on the labour market, considering a mix of teaching between the traditional school and a managerial approach. They end up calling this hybrid-teaching archetype: efficient-collegiality.

$0.5 <$

$0.75 <$

$0.5 <$

Therefore, a low and reliable audit implies efficient training, coupled with the cost and time in the years invested (see Table 7). Furthermore, it can motivate employees. For example, Budiyanti et al. (2020) comment on leadership education and training programs carried out for 500 HR employees in Indonesia, with low cost and without restrictions, which had a positive effect mainly on the confidence and motivation of the participants.

Finally, our work defines specific thresholds to decide if the worker should study, depending on the company's approach to auditing and the years of education invested. The work is related to Andrade and Lomelí (2022) results, in which the authors consider that companies invest in training and decide to promote the trained worker when the benefit obtained by the promotion substantially exceeds the training cost.

CONCLUSION

This model was designed to show the best response from workers when facing the uncertainty of whether the firms value training. Among the results, we showed the percentage of income workers who invest in education when training is the best option.

Since training costs are high, the model considers the existence of other immersed costs, which we approximate and define as opportunity costs. Such opportunity costs are inferred when workers consider signs about the companies' behaviours if they value training, signs that workers use to build subjective beliefs.

Another result of our work is the percentage of income that the worker assigns to his training. We show that when the firm sends signals, through a low audit, that it will consider the training to grant an incentive, the worker could invest 75% of their income in training. With such an investment, the worker would prefer to study only if he achieves a master's degree or higher.

The analysis recommends that workers consider factors such as uncertainty, time, costs, and when they will be trained, mainly when they absorb the cost of training. Also, it is helpful for the company to know the approximate costs of training its workers and the approximate times if it was to bear the costs.

However, the analysis reveals some limitations, ranging from considering the basic levels of education for a certain sector, such as the Mexican society; since starting from secondary school, three years are considered to reach high school, seven to obtain a bachelor's degree and nine years to obtain a postgraduate degree. In addition, since there is no specific percentage of firms who audit their workers, we considered percentages of evaluations that firms make in general to their workers, along with the fact that wage increases were set considering that firms evaluated their workers simultaneously. In other words, the information was approximate according to the data found. We could have modelled more precise situations by programming or generating random numbers. Furthermore, we do not find a Nash equilibrium. We only show the decision under uncertainty of a single player: the worker. The solutions to the limitations are pending for future work.

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