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ABSTRACT

When changes occur in the number of credit hours demanded of a teaching unit, understanding of the sources of change is valuable policy making. Acceptable methods of determining sources of variance are not intuitively obvious, nor are the limitations of the simplest approaches. Sources of variance, not their causes, are discussed. Identification of a decrease in the proportion of credits taken in a college as the source of load decrease will not explain why less of that college's courses are being selected. However, the sources of variance can be of great policy interest and can make the search for causes more efficient. Often decision makers are unaware of the real sources of variation. Planning regarding curricular structure and recruiting may take different directions if the nature and relative strength of the various sources are clearly understood. The mechanistic sources of load change are enrollment, mean load per student, and proportion of load taken in the unit under study. Each may be analyzed in terms of any student sets for which data are available. Equations are given for such computations and an actual example of this method is discussed using data from selected colleges at the University of Minnesota. (Author)

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Sources of Change in Student Credit Hour Demand in Multi-Campus Colleges and Universities

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Abstract

When changes occur in the number of credit hours demanded of a teaching unit, understanding of the sources of change is valuable in policy making. Acceptable methods of determining sources of variance are not intuitively obvious, nor are the limitations of the simplest approaches.

Sources of variance, not their causes, are discussed. Identification of a decrease in the proportion of credits taken in a college as the source of load decrease will not explain <u>why</u> less of that college's courses are being selected. However, the sources of variance can be of great policy interest and can make the search for causes more efficient. Often decision makers are unaware of the real sources of variation. Planning regarding curricular structure and recruiting may take different directions if the nature and relative strength of the various sources are clearly understood.

The mechanistic sources of load change are enrollment, mean load per student, and proportion of load taken in the unit under study. Each may be analyzed in terms of any student sets for which data are available. Equations are given for such computations and an actual example of this analytic method is discussed.

The purpose of this paper is twofold. The first part outlines a method of analyzing the sources of changes over any given period of time in the number of credit hours taught by a college or other teaching unit within a complex University. Such analysis may be of considerable assistance in policy making. The second part provides an example of the use of this analytic technique, studying the source of changes in credit hours taught by three colleges of the University of Minnesota from Fall term 1971 to Fall term 1976.

The analysis of Credit Hour Changes

Considered from the standpoint of a total university, there are two possible sources of change in the number of credit hours taught. Such variation results from the combined effect of changes in headcount registration and changes in the mean number of credits carried per headcount student. If the analysis is focused on a single college or department, however, a third source of variance, the proportion of its total credits which a given group of students takes from the teaching unit under study, is introduced.

It should be noted that the analysis discussed in this paper is concerned with the sources, not the causes of variance. To know that the principal source of a decrease in credit hours taught is a decrease of students registered in the college will not explain why fewer students are registering in that college; if loads have risen because non-majors are taking more of a department's courses, we still have not established a causal explanation for that increased interest.

The sources of variance, however, can frequently be of great policy interest and make the search for causes more efficient. Frequently, teaching units as well as administrative officers are unaware of the true sources of variation in teaching demand. Planning regarding curricular structure and recruiting may take entirely different directions if the true nature and relative strength of the various proximate sources of load changes are clearly understood.

The mechanistic sources of load change over any time period are three: enrollment, mean load, and proportion of load carried in the unit being studied. These three mechanistic sources can, in turn, be studied in relation to various student populations as, e.g., majors in the home department, non-major students in the home college, and all other students in the University. These particular populations would yield nine load changes. In tabular form we could represent this analysis as follows:

	Enrollment	Mean Student Load	Proportion of Load
Majors			
Collegiate Non-Majors			
All Other Students			

Each element in the table is the change in credit hours (positive or negative) associated with the load and population factor in the particular column and row.[1] The sum of all elements is equal to the total change in credit hours in the unit under study.

This design is, in theory, indefinitely expansible in terms of student groups. If the data are available, e.g., in place of majors and two classes of non-majors, one could have each separate major within the university, or each separate college. These could be separated into male and female students or by student level or both.[2] Other student population groupings which are of analytic interest may be used as long as the set of population groupings defined includes all students who take course work in the teaching unit under study. While the discussion which follows uses total student credit hours and students classed in two groups, a college's own students and all other university students, the formulas are readily adaptable to more complex analysis.

The method to be described can be used to analyze changes over any time period, subject only to data availability. Differences between Fall term and Spring term may be of interest. Trends over a period of years will often be revealing, particularly when compared to parallel trends in other teaching units.

Formulas to Compute Sources of Credit Hour Change

Let: E^{1x} = Headcount enrollment, base period, student set x.

E^{Nx} = Headcount enrollment, Nth period, student set x.

L^{1x} = Mean credit load, base period, student set x.

L^{Nx} = Mean credit load, Nth period, student set x.

P^{1x} = Proportion of total credits taken in the teaching unit being analyzed, base period, student set x.

P^{Nx} = Proportion of total credits taken in the teaching unit being analyzed, Nth period, student set x.

C^{1x} = Credits taught to set x students, base period.

C^{Nx} = Credits taught to set x students, Nth period.

δ = Difference in credits taught = $|C^{Nx}-C^{1x}|$.

T^E = Credit change attributable to enrollment change.

T^L = Credit change attributable to load change.

T^P = Credit change attributable to proportion change.

R^E = Percentage effect attributable to enrollment change.

R^L = Percentage effect attributable to load change.

R^P = Percentage effect attributable to proportion change.

Then in the simplest approach:

(1) $T^E = \left(\frac{E^{Nx}-E^{1x}}{E^{1x}}\right)(C^{1x})$

(2) $T^L = \left(\frac{L^{Nx}-L^{1x}}{L^{1x}}\right)(C^{1x}+T^E)$

(3) $T^P = \left(\frac{P^{Nx}-P^{1x}}{P^{1x}}\right)(C^{1x}+T^E+T^L)$

(4) $C^{Nx}-T^E-T^L-T^P=C^{1x}$

(5) $R^E = \frac{T^E}{\delta}$

(6) $R^L = \frac{T^L}{\delta}$

(7) $R^P = \frac{T^P}{\delta}$

This first approach, sufficient for many practical applications, is oversimplified and may produce misleading results. It will be seen that T^E, T^L, and T^P might be determined in different orders. One could, e.g., calculate T^P first as $\frac{P^{Nx}-P^{1x}}{P^{1x}}(C^{1x})$ in which case the two following equations are altered. The value of T^P will be different if it is computed first than if it is computed last. There is no apparent reason to prefer one order of computation to another.

The underlying problem is that there are not three but seven sources of change which are schematically represented in Figure 1.

To simplify computation, let:

$$e = \frac{E^{Nx}-E^{1x}}{E^{1x}}$$

$$l = \frac{L^{Nx}-L^{1x}}{L^{1x}}$$

$$p = \frac{P^{Nx}-P^{1x}}{P^{1x}}$$

Then:

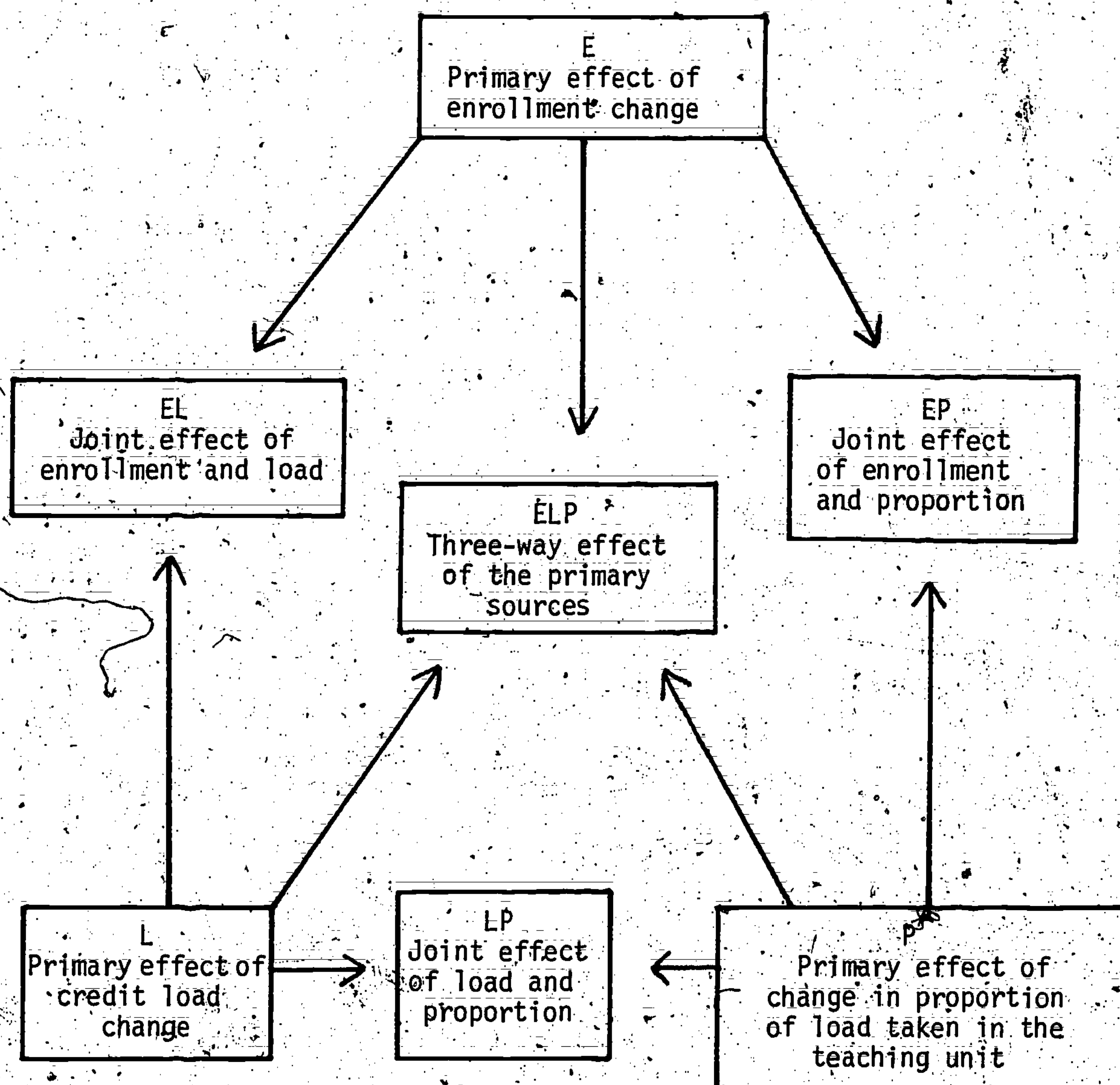
$$\left.\begin{aligned} (8)\quad T^E &= e(C^{1x}) \\ (9)\quad T^L &= l(C^{1x}) \\ (10)\quad T^P &= p(C^{1x}) \end{aligned}\right\}\quad \text{Primary effects, modified by}$$

$$\left.\begin{aligned} (11)\quad T^{EL} &= el(C^{1x}) \\ (12)\quad T^{EP} &= ep(C^{1x}) \\ (13)\quad T^{LP} &= lp(C^{1x}) \end{aligned}\right\}\quad \text{Two-way joint effects, modified by}$$

$$(14)\quad T^{ELP} \quad elp(C^{1x})\ \}\quad \text{Three-way joint effect}$$

Schematic Representation of Sources

of Change in Credit Hours Taught



It is possible to produce equations that would allocate the joint effects to the primary effects; the authors have done so. However, all such efforts are conceptually unsatisfying since the joint effects are truly dependent on the interaction of more than one change in the primary measures. Furthermore, the credit hour value of a joint effect may sometimes be greater than that of one of the primary effects. Allocating the joint effects can produce analytically misleading information in some cases. Thus we prefer to state all seven sources of change separately.

An Example Using Selected Colleges at the University of Minnesota

This section analyzes the sources of credit hour load changes from Fall term, 1971 to Fall term, 1976 for the colleges of Liberal Arts, Technology, and Education at the University of Minnesota. For each teaching unit the student sets analyzed are, students registered in that unit and all other students on the Twin Cities campus of the University of Minnesota. The two figures for headcount enrollment add in every case to the total campus enrollment for that term.

Table 1 displays the computational data. The credit hours shown are those taught by each enrollment unit to its own students and to all other students. The mean credit load data show the average number of <u>all</u> credits taken by the students in each set (not, it should be noted, the mean load taken in the teaching unit. The latter data are added in the following two lines in order to produce the proportion taught within the teaching unit by dividing mean total credit load by mean credit load in the teaching unit. The change ratios (e, l, p) are calculated for each of the six student sets.

Table 1

Computational Data for Determining

Sources of Change in Credit Hours Taught by Selected

Units of the University of Minnesota

Fall Terms of 1971 and 1976

	Liberal Arts		Technology		Education	
	Liberal Arts Students	All Other Students	Technology Students	All Other Students	Education Students	All Other Students
Raw Data - Fall Terms						
Credit Hours Taught, 1971 (C^{1x})	195,928	66,037	43,515	51,699	21,141	16,647
Credit Hours Taught, 1976 (C^{Nx})	157,586	55,781	45,205	60,573	19,377	15,030
Headcount Enrollment, 1971 (E^{1x})	17,501	25,560	3,938	39,123	2,851	40,210
Headcount Enrollment, 1976 (E^{Nx})	17,220	28,568	4,122	41,666	2,764	43,024
Mean Credit Load, 1971 (L^{1x})	14.19	12.37	14.47	12.97	13.12	13.11
Mean Credit Load, 1976 (L^{Nx})	13.03	12.33	13.98	12.45	10.25	12.74
Mean Credit Load in College, 1971	11.20	2.58	11.05	1.32	7.42	.414
Mean Credit Load in College, 1976	9.15	1.95	10.97	1.45	7.01	.349
Proportion in College, 1971 (P^{1x})	.789288	.208569	.763649	.101773	.565549	.031579
Proportion in College, 1976 (P^{Nx})	.702226	.158151	.784692	.116466	.683902	.027394
Change Ratios						
Change in Enrollment (e)	-.016056	+.117684	+.046724	+.065000	-.030516	+.069983
Change in Credit Load (l)	-.081748	-.003234	-.033863	-.040093	-.218750	-.028223
Change in Proportion in College (p)	-.110304	-.241733	+.027556	+.144370	+.209271	-.132525

Table 2 displays the results of the source of change computations using the method discussed above. Sources of change are shown in absolute credit hours and in terms of percentage of the total change. Each of the sets of credit hour calculations should add to the absolute change in credit hours taught and each of the sets of percentage calculations should add either to +100% or -100% if no rounding errors were present. Each percentage shown is to be interpreted as the effect on total credit hour load of that source or combination of sources of change if no other source of change were operant. Thus the sum of all change vectors will be +100% where credit hours have increased and -100% where they have decreased.

The results show various patterns. The drop in Liberal Arts load stems mostly from the tendency of both its own students and other students to take more of their work elsewhere. The uncritical assumption that enrollment decline was the main source is not supported since the effect of headcount decline in Liberal Arts is more than offset by increases elsewhere.

The increase in Technology teaching load follows from headcount increases both within and without the college but more significantly from the tendency of all students, but particularly non-Technology students, to take more work in Technology as opposed to other colleges. The suggestion is that the curriculum, or perhaps the teaching quality, in Technology has become more attractive. There are, of course, other possibilities. Has grade inflation played a part? Is Technology teaching courses which are close competitors with the offerings of other colleges? Are the offsetting changes in Liberal Arts and Technology related? The merit of the technique

Table 2

Calculations to Arrive at Absolute and Percentage

Sources of Change in Credit Hours Taught by

Selected Units of the University of Minnesota

Fall Term, 1971 to Fall Term, 1976

		Liberal Arts		Technology		Education	
		Liberal Arts Students	All Other Students	Technology Students	All Other Students	Education Students	All Other Students
Absolute Credit Hour Changes Attributable to:							
Primary Effect of Enrollment Change	(T^E)	- 3,146	+ 7,771	+ 2,033	+ 3,360	- 645	+ 1,165
Primary Effect of Credit Load Change	(T^L)	-16,017	- 214	- 1,474	- 2,073	- 4,625	- 470
Primary Effect of Change in Proportion in College	(T^P)	-21,612	-15,963	+ 1,199	+ 7,464	+ 4,425	- 2,206
Joint Enrollment and Load Effect	(T^{EL})	+ 257	- 25	- 69	- 135	+ 141	- 33
Joint Enrollment and Proportion Effect	(T^{EP})	+ 347	- 1,879	+ 56	+ 485	- 135	- 154
Joint Load and Proportion Effect	(T^{LP})	+ 1,767	+ 52	- 41	- 299	- 968	+ 62
Three-way Joint Effect	(T^{ELP})	- 28	+ 6	- 2	- 19	+ 30	+ 4
Percentage Effect Attributable to:							
Enrollment Change	(R^E)	- 6.5%	+ 16.0%	+ 19.2%	+ 31.8%	- 19.1%	+ 34.5%
Credit Load Change	(R^L)	- 33.0%	- .4%	- 14.0%	- 19.6%	- 136.8%	- 13.9%
Proportion in College Change	(R^P)	- 44.5%	- 32.8%	+ 11.3%	+ 70.7%	+ 130.9%	- 65.2%
Enrollment and Load Change Jointly	(R^{EL})	+ .5%	- .1%	- .7%	- 1.3%	+ 4.2%	- 1.0%
Enrollment and Proportion Change Jointly	(R^{EP})	+ .7%	- 3.9%	+ .5%	+ 4.6%	- 4.0%	- 4.6%
Load and Proportion Change Jointly	(R^{LP})	+ 3.6%	+ .1%	- .4%	- 2.8%	- 28.6%	+ 1.8%
Enrollment, Load, and Proportion Jointly	(R^{ELP})	- .1%	-	-	- .2%	+ .9%	+ .1%
		-100.4%		+ 99.1%		-100.8%	

The sums of the percentage changes vary slightly from 100% because of roundings in the mean credit load figures.

discussed here is in making the search for the underlying causes of change a more efficient process. Note that more detailed analysis would reveal which colleges' students are finding Technology courses more attractive and/to what degree.

In Education a decline in proportion of Education credits taken by non-Education students is overwhelmed by an increased concentration of course work within the college by its own students. The major influence on the overall decline is the sharply decreased total credit load of Education students. The pattern of change sources suggests a sharp shift from traditional undergraduate full-time teacher preparation toward service to part-time students whose interests are narrowly concentrated on courses within the College of Education. The inference is that the customers of the Education college are increasingly in-service teachers seeking maintenance and upgrading of their skills. This suggests the possibility of further source of change analysis using separate student sets for those Education students with and without teaching certificates or the Bachelor's degree in Education.

Conclusion

Source of change analysis offers a technique for quick isolation of the mechanistic influences which lead to enrollment change and the assessment of the relative significance of each. It is a generalizable method which can be applied to virtually any time span or selection of student sets for which the underlying raw data are available. It is readily adaptable to computer programming and with minimal additional effort time series showing trends in the influence of the various change sources on selected student sets can be produced.

Careful and selective use of source of change analysis has the potential to eliminate expensive and time consuming survey research or at least to disclose where the latter may be most efficiently employed. What students do is frequently more revealing and more dependable than what they say and direct behavioral observation, where it is feasible, should always precede, and sometimes can replace, less objective approaches.

As competition for students increases in the coming decade, understanding of the patterns of student choice will become increasingly critical to maintaining volume and understanding internal competitive patterns will be important to controlling costs. Source of change analysis offers a primary approach to the identification of problems and opportunities.

Footnotes

[1] The teaching load to be studied can be expressed in credit hours, weekly student class hours, course registrations, or any other student demand measure for which data is available. Various course levels can be separately analyzed.

[2] As a practical matter, extreme disaggregation can lead to mathematical complexity and episodal results which may conceal rather than elucidate trends.