Demand for Labor in a Nonprofit Market: University Faculty

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DEMAND FOR LABOR IN A NONPROFIT MARKET: UNIVERSITY FACULTY

The allocation of resources and setting of wages in markets where employers are nonprofit institutions has received considerable professional and public attention. In what way do nonprofit factor demands and wage policies differ from those of for-profit enterprises? How do 'nonprofit labor markets' compare to for-profit markets?

This paper investigates these issues, with special reference to the college and university system, in two stages. Section I is a theoretic analysis of nonprofit demand for labor (or other inputs) in which administrators make the key budgetary and employment decisions and sell at least some outputs in the market. The analysis is applicable to a wide variety of nonprofit market settings, in addition to that for university faculty, but not to 'cooperative enterprises' where nonprofit staff dominates decisions, dividing "profits" in the workers' management fashion. Section II deals more narrowly with the college and university system: The goals of institutions, internal compensation and employment rules, and the capital goods and demographic features of the academic market place.
SECTION I

Nonprofit institutions and markets have, from the perspective of this study, four important characteristics which distinguish them from comparable for-profit firms. First, and most obviously, nonprofit enterprises operate, by definition, under the budget constraint that profits, receipts less expenditures, be zero in equilibrium. Second, in the absence of profits, the motivation for the entry of new institutions will differ from that in for-profit markets. Third, receipt of endowment or subsidy income, which is not dependent on institutional performance, relieves nonprofit enterprises from some market pressures. Fourth, despite problems in specifying an appropriate utility function for nonprofit social organizations, it is natural to regard them as behaving as utility-maximizers.

In this section we investigate the way in which each of these features influences nonprofit demand for labor, using demand by competitive firms as the benchmark for comparison. To isolate the effects of the various factors, nonprofit and for-profit enterprises are assumed identical in all respects beyond that under consideration. The comparisons are limited to situations in which all enterprises are of one form or the other; the complex question of competition between for and non-profit institutions in the same market lies beyond the scope of the essay.
The major points of the analysis, to be developed in detail below, can be summarized briefly as follows: The nonprofit budget constraint leads to short-run factor demand, employment, wage and price behavior that differ from those in for-profit markets; subsidies to nonprofit institutions, generally awarded for specific activities, establish subsidy markets with shadow (subsidy) prices attached to various outputs or activities; long-run entry conditions are identical in nonprofit and profit markets when subsidizing organizations form new institutions to maximize the effect of their subsidy funds; and, finally, in the utility maximizing context, nonprofit enterprises can be viewed as profit-maximizers who spend profits (including endowments, gift, and related non-market incomes) according to an institutional utility maximand.

1. Nonprofit Budget Constraint

The chief characteristic of nonprofit enterprises, yielding important insights into their distinctive market behavior, is the requirement that profits be zero in equilibrium. For concreteness, the constraint of a college or university, may be written as:

\[ P_c G + S + rA = W_f F = P_{R} \]

where

- \( P_c \) = tuition and fees
- \( G \) = enrolled students
- \( S \) = subsidies from governments or philanthropic sources
- \( r \) = return on endowments, including capital gains
- \( A \) = endowment assets
- \( W_f \) = faculty wage
F = number of faculty
\( \bar{R} \) = wage of other resources
R = quantity of other resources

Adherence to constraints like (1) requires production and employment decisions that differentiate nonprofit operations from those of comparable for-profit firms. In particular, the absence of profits implies that in the short run:

(a) Nonprofit output and employment exceeds that of for-profit enterprises.
(b) Nonprofit supply schedules are determined by average rather than marginal cost conditions.
(c) Factor demand schedules are more elastic with respect to wages and shifts in output.
(d) Nonprofit prices are more responsive to changes in costs and less responsive to changes in demand than profit market prices.
(e) Shifts in the supply of workers and demand for output have greater effects on wages and employment in the nonprofit case.

**Enterprise Behavior: (a) and (b)**

Following the strategy described earlier, we assume that for-profit and nonprofit enterprises are identical save for the nonprofit constraint. This means that they produce the same good, pay the same
wages, have equally efficient management, receive all funds from market sales \([P, G \text{ in } (\quad)]\), and that the nonprofit enterprise concerned with the single output being produced, has no other arguments in its utility function. The output might be number of graduates with specified skills, for example.

Under these conditions, the absence of a normal or abnormal profits implies greater nonprofit than profit output [point (a) above]. With no required entrepreneurial return, the nonprofit cost curve \([AC',\text{ in figure 1}]\) lies below the profit cost curve \([AC]\), so that at any price — say \(P_0\) — output is higher \([Q_2 > Q_0]\). Even when nonprofit enterprises require a 'normal return', output exceeds profit output in the region \(P > P_0\), due to the absence of extra profits.\footnote{At \(P_4 > P_0\), for example, the for-profit firm produces \(Q_4\), earning \(Q_4 [P_1 - AC_4]\) abnormal profits. The nonprofit firm, by contrast, produces \(Q_3\) and has zero profits.}

Differences in the response of nonprofit and profit enterprises to short-run changes in prices [proposition (b)] can also be shown in the figure. While for-profit firms produce so that \(MC = P\), nonprofit firms, obeying the zero profit constraint, will operate along the average cost curve in regions of potentially positive profits; and, assuming loss minimization, along the marginal curve \([MC]\) only when profits are negative.

If initial output is at the minimum on the same or parallel cost schedules \((AC\text{ or }AC')\), the fact that the marginal curve increases more
Figure 1: Production Under the Zero-Profit Constraint

For-profit short-run supply curve
Nonprofit short run supply curve
Net of entrepreneurial income
than the average to the right of the minimum point implies greater
nonprofit responsiveness to price changes. More generally, with a
U-shaped cost curve having returns to scale \( \eta [\equiv \% \Delta \text{ output/proportion-
ate } \% \Delta \text{ inputs}] \) above when \( MC < AC, 1 \) at minimum average cost, and
below 1 when \( MC > AC \), the elasticity of the marginal cost curve \( (\epsilon_M) \)
will exceed that of the average cost curve \( (\epsilon_A) \) by the absolute value
of the scale elasticity \( \eta (\epsilon_\eta) \). Since the supply elasticity is the
inverse of the cost elasticity, output and employment responses to
short-run changes in price will be greater in nonprofit than profit
enterprises as asserted \( (c), (d), \) and \( (e) \).

**Market Behavior**

In the short run, when the number of firms is fixed, the
market implications of average as opposed to marginal cost behavior
can be readily determined. Assume, for simplicity, homothetic pro-
duction processes so that the level of output does not influence
factor ratios, and an exogeneous change in wages and shift in the
market demand curve. Costs and prices in nonprofit and for-profit
markets will then respond to the change in wages and in output ac-
cording to:

\[
(2a) \quad EP = EC = aEW + cEG
\]

where

\[
E = DLog \ [\equiv \% \Delta ] \]

\[
P_t = \text{Price of output}
\]

\[
a = \text{share of the input (say faculty) in cost}
\]

\[
G = \text{output (training of a student)}
\]
E = elasticity of cost schedule \( \frac{EC}{EG} \)

- \( e_A \) in the nonprofit case, where A refers to the average cost curve
- \( e_m \) in the profit case, where m refers to the marginal curve.

The change in demand is represented by shift (ED) in a constant elasticity (\( \gamma \)) demand schedule:

\[ 2b) \quad EG = Eb - \gamma EP \]

Finally, demand for input (faculty) will depend on the level of output and substitution with other resources, according to a constant elasticity of substitution \( \alpha \):

\[ 2c) \quad EF = \frac{1}{\pi} \quad EG - (1 - \alpha) \quad \alpha EW \]

Solving the system (2a-2c) yields equations for EF, EP, and EG:

\[ 3a) \quad EF = \left[ \frac{1}{\pi} \quad (1 + e\eta) \right] \quad ED - \left( \frac{\alpha \pi}{(1 + e\eta)} \right) + (1 - \alpha)\alpha \quad EW \]

\[ 3b) \quad EG = \frac{1}{1 + e\eta} \quad ED - \frac{\alpha a}{1 + e\eta} \quad EW \]

\[ 3c) \quad EP = \frac{c}{(1 + e_m)} \quad ED + \frac{\alpha}{1 + e\eta} \quad EW \]

where the distinctive feature of the nonprofit market is that the elasticity of cost to output is smaller than under profit maximizing conditions \((e_A < e_m)\). As a result of the different cost elasticities,
the coefficients on ED and EW in equations (3a) and (3b) will be
greater in the nonprofit market, implying more elastic factor demand
and output responsiveness in the for-profit market (point c). Moreover,
in (3c) EP/ED will be smaller and EP/EW larger in the nonprofit case
so that short-run prices will be more cost and less demand-sensitive
(point d). 9

When wages are made endogeneous with the addition of a
faculty supply relation, shifting at a rate ES,

(2d) \[ EF = ES + \phi EW \]

the equilibrium changes for the faculty input are:

(4) \[ EW = (\eta_D ED - ES)/\eta_e + \phi \]
(4') \[ EF = (\eta_D \hat{ED} + \eta_e + \phi) \]

where \[ \eta_D = \frac{1}{\pi} - (1 + c) \eta \]
\[ \eta_e = a \eta_D + (1-a) \eta \]

are greater for nonprofit than profit enterprises, with the consequence
that employment in nonprofit markets will be more responsive to shifts
in short-run supply or demand than in profit markets while wages will
be relatively more responsive to demand shifts and less to supply
shifts. 10 Moreover, both ES and ED produce greater changes in output
and prices in the nonprofit case.
2. Non-Market Receipts and Subsidies

The dependence of nonprofit budgets on endowment income received independently of current output, and subsidy income, not directly linked to output, has additional implications for institutional and market performance. In the extreme case where all nonprofit funds are exogeneous, total spending would be fixed and demand for inputs of 'wages fund' type, with unit elasticity if cost shares were constant ($\sigma = 1$ in equation 2c). If some receipts were variable, on the other hand, demand would be of the usual form (equation (3c) in the short run) but market equilibrium would require significant change in the prices associated with such receipts. Assume, for example, that only student tuition and fees are variable in the long run, while subsidy income is fixed. Then a change in wages will, by the balanced budget condition (1), cause the following change in tuition:

\[ EP = \frac{\alpha_t}{\alpha_f} EW_f \]

where $\alpha_t$ is the share of tuition in cost. By contrast, in the absence of subsidies, the elasticity of prices with respect to wages would be $\alpha_f$ ($< \alpha_f/\alpha_t$ since $\alpha_t < 1$). Thus fixed endowment or subsidy incomes imply greater changes in nonprofit than profit prices to long run as well as short run changes in costs. Moreover, if $\alpha_f > \alpha_t$, a one per cent changes in wages will produce changes in prices of greater than one per cent, which could not occur in unsubsidised profit markets.
The Market for Subsidy Funds

While endowment, gifts, and some subsidies may be awarded to nonprofit institutions irrespective of their specific activities, the bulk of governmental and private support is given for particular outputs (more graduates, higher faculty salaries, new curriculum). Subsidisers can be viewed as purchasing these goods from the nonprofit enterprise, thereby establishing a market for subsidies. In this market, university outputs receive shadow subsidy prices; and institutions face horizontal subsidy supply schedules linking subsidy income ($S$) to outputs [say G and Q (= quality of education)] according to prices $P_{sg}$ and $P_{sQ}$ and some fixed support ($S$)

$$S = S + P_{sg} G + P_{sQ} Q$$

The supply of subsidies to the entire higher education system (set by the demand of subsidisers for outputs) will be an upward sloping curve:

$$S = S[G, Q] = S_f + S_g + S_p$$

Since state ($s$), federal ($f$) and private ($p$) subsidisers have different interests,(7) breaks up the total subsidy supply curve into federal ($S_f$), state ($S_g$) and private ($S_p$) components. If subsidy markets are, as appears to be the case, segmented with state funds going largely to state institutions, the shadow price may differ by source and institution.

The fact that subsidies have a price attached to them enhances the 'market' behavior of institutions by making the bulk of receipts dependent on services performed rather than exogeneous funding. The similarity between for-profit and nonprofit enterprises is, as a consequence increased, with the latter obligated to react to
market incentives as 'profit-maximizers' to raise revenues. Moreover, university activity will differ under alternative financing arrangements. A dollar of tuition income, a dollar of endowment, and a dollar of federal support will entail different activities. In the extreme case of restricted or tied monies (donations for buildings, professorial chairs in American studies, etc.), there is a one-to-one correspondence of funds to inputs or outputs. If, as seems to be true, donors prefer tangible capital goods to less tangible purchases of, say, student or faculty quality, the price of such capital will be low and buildings, stadia and the like, excessive in terms of optimum (unrestricted) budget decision-making. Physical plant may, accordingly be 'underutilized'.

In the context of price theory, subsidy prices are analogous to other prices, producing income and substitution effects when institutions maximize utility. It is thus possible for increased subsidies to reduce the output desired by subsidisers in the short-run (the income effect is negative and greater than the substitution effect. In the long-run, however, entry conditions guarantee a positive response to additional subsidies, for new institutions will eliminate the extra income (see section 1.3).

Differences in sources of funds - in the subsidy prices facing institutions and in endowment incomes - offer an explanation for the differential outputs of state, public, 2-year, and 4-year colleges and universities. State institutions presumably face relatively high subsidies for numbers of graduates (P_{SG}); private
institutional endowments and foundation support are likely to favor quality, and so forth, motivating their choice of outputs. Since changes in subsidy prices affect institutions differently, depending on current source of funds, different elasticities of response are also likely. The empirical problem in using subsidy prices to explain differences in institutional behavior is the absence of explicit price data and possible confounding of differences in prices and in utility functions.

3. Nonprofit Entry and Entrepreneurship

Long run output, factor demands, and efficiency depend on exit and entry conditions. We argue in this section that when the organizations subsidizing nonprofit operations perform the entrepreneurial function of forming new enterprises, nonprofit entry conditions mirror those of profit industries. In both cases, whenever costs rise above minimum average cost, new institutions will enter, driving costs back to the minimum point. As a result, the only source of efficiency differences between the two organizational forms will be in the quality and behavior of entrepreneurs and managers.

The argument for similar nonprofit and profit entry conditions is simple. Assume, as before, that institutions produce a single output G which enters the subsidizers' utility function (U) and that subsidy and tuition income are the sole source of receipts. Subsidisers will maximize the net benefit of their support:
\[ \mathcal{U}[G] - S = \mathcal{U}[G] - (S/C) G = \mathcal{U}[G] - [AC - P_L] G \]

where \( S \) is total subsidy payments, and \( S/C \), subsidy per student, necessary equals average cost less tuition. Since maximizing \( G \) requires a subsidy scheme that minimizes costs of production, subsidisers will form, if possible, new institutions when costs exceed minimum average cost \( (AC) \). When \( AC > AC \) they obtain more \( G \) per dollar (of \( 1/AC - 1/AC \)) by reducing subsidies to existing institutions and using the funds to form new ones. Rational subsidy behavior guarantees an infinitely elastic supply of institutions at \( AC = AC \), so that \( AC \) is the long run production point, just as in the competitive "free entry" case.

The factor demand implications of such long-run market behavior are clear: substitution effects will depend on the elasticity of substitution at \( AC \) while "scale effects" will be a function of numbers \( (n) \) of firms, rather than the elasticity of cost schedules. Formally, the long-run demand is

\[(Sa) \quad EL = En + EG_o - (1-\alpha) \sigma EW = En - (1-\alpha) \sigma EW\]

where \( G_o = \text{fixed minimum cost output (} EG_o = 0) \)

\[(1-\alpha) \sigma EW = \text{change in labor demanded per firm}\]

\( En = \text{change in number of firms} \)
The change in price is set by:

(8b) \[ EP = EC = aEW + \epsilon G_o = aEW \]

and market clearing by:

(8c) \[ EG = En + EG_o = En = ED - \eta EP \]
with total output of \( nG_o \)

Solving \((8a - 8c)\) for factor demand and number of firms yields:

(9) \[ EL = ED - (\alpha \eta + (1-\alpha)\sigma) EW \]

(9') \[ En = ED - \alpha \eta EW \]

With the addition of a supply equation [(4d) \( EL = ES + \theta EW \)] we can further solve the long run system for the effect of \( ES \) and \( ED \) on number of institutions as well as employment and wages.

Since the basic condition for long run "constant returns" factor demand is that firm output be fixed at \( G_o \), the analysis is readily generalized to the situation in which the supply of enterprises is infinitely elastic at some \( AC > \overline{AC} \). The only requirement is that there exist some price or cost which triggers entry. The model is thus applicable to inefficient \( AC > \overline{AC} \) as well as efficient markets. If, on the other hand, the supply of entrants is less than infinitely elastic, demand will be a weighted average of the short run demand (3) and equation \( \Theta a \), with weights a function of the elasticity of entrants to changes in cost.
While the model focuses on average cost as the motivating force, the particular way in which $AC > \bar{AC}$ influences behavior will depend on the institutional structure of the market. If, for example, tuition ($P_t$) is fixed (as in some state universities), shifts in the demand for education will not alter $AC$ but rather the number of applicants rejected by universities. The resultant "shortage" of places will then motivate entry in the same manner as excessive cost in the preceding discussion. Geographic transportation and residence costs, coalescing in demands for local colleges offer another specific impetus for new colleges and universities. Detailed analysis of the actual formation of nonprofit institutions, which is beyond the scope of this study, would seem to have a significant research pay-off.

Managerial Quality

Finally, the absence of normal entrepreneurial or abnormal profits can be expected to affect the quality and behavior of nonprofit managers. Assuming that the supply of 'able' managers depends on their rewards, and that nonprofit institutions do not substitute salary for ownership income by enough to counterbalance the absence of the latter, nonprofit organizations will be unable to attract high quality management talent. Exceptionally able businessmen, adept at cost - minimization/profit-maximization, will concentrate in for-profit firms where their talents are richly remunerated, not in nonprofit enterprises. In addition, equally able administrators will tend to operate less efficiently in nonprofit settings in the absence of a link between efficiency and remuneration, as provided by ownership, stock options, etc.
Differences in entrepreneurial/managerial ability and incentives would, according to these arguments, be the prime cause of oft-alleged nonprofit "inefficiencies".

4. Utility-Maximization: Two-Stage Model

Despite the problem of specifying an appropriate utility function, utility-maximization provides a useful framework for investigating nonprofit behavior. We consider next a two-stage variant of the usual utility-maximizing model that highlights the major behavioral difference between nonprofit and for-profit enterprises; and examine ways of determining the arguments in the nonprofit utility function.

Two-Stage Maximization

Consider a nonprofit utility maximizer whose utility depends on an output $G$ sold in the market for price $P_t$ and an additional output $Q$ having zero market value. The outputs use a single input 'faculty' in quantities $F_G$ and $F_Q$, with $F_G + F_Q = F$, total number of faculty. Maximization of $u[G,Q]$ subject to the production functions $G = G(F_G), Q = Q(F_Q)$ and the nonprofit budget constraint yields the following equilibrium employment condition

\[
(10) \quad W_f = P_t \left( \frac{\partial G}{\partial F_G} + \frac{\partial G}{\partial F_Q} \right) \lambda + \frac{\partial Q}{\partial F_Q} \lambda
\]

where $u_G$ and $u_Q$ are the partial derivatives of the utility function with respect to the outputs and $\lambda$ is the marginal utility of 'profits' derived from the constraint $P_t G + S = W_f F$. By contrast, the equilibrium
of the profit-maximizer requires the equating of marginal value
product and factor prices:

\[(10)' \quad W_f = P_t \frac{\partial G}{\partial F_G} \]

Equation (10) has the same initial term as (10)' plus additional
terms reflecting the 'extra' contribution of the input to utility

\[\lambda \left( \frac{U_G \frac{\partial G}{\partial F_G}}{\lambda} + \frac{U_A \frac{\partial G}{\partial F_A}}{\lambda} \right).\]

Since the latter terms are positive, nonprofit employment will be
greater, as argued in I.1, than for-profit employment.

The distinction in (10) between the normal marginal value
productivity of workers \([P_t \frac{\partial G}{\partial F_G}]\) and their contribution to non-
profit utility suggests that we decompose the demand for labor into
two stages: Stage I, in which enterprises hire workers at the profit
maximizing level by setting \(W_f = P \frac{\partial G}{\partial F_G}\); and Stage II, where profits
are 'spent' on additional inputs, according to the utility maximand.

Formally, any utility-maximization process is decomposable into two
stages of this type, with (I) yielding the initial profit maximizing
equilibrium, \(\nu^*, G^*, F^*, R^*\) and (II) additional outputs and inputs
as the enterprise maximizes \(U[G^* + G^{**}, F^* + F^{**}] = U[G^{**}, F^{**}]\)
where ** refers to increments from first-stage values, subject to
the profit constraint: \(\nu^{**} = pG^{**} - W_f F^{**} - W_R R^{**}\) and the production
relation \(G^{**} = G[F^{**}, R^{**}] - G[F^{**}, R^{**}]\). Subsidy or endowment income
that is received independently of G is to be counted as part of \( \pi^* \) with an effect solely on second-stage behavior.

Several aspects of nonprofit behavior are highlighted in the two-stage approach. First, there is the oft-neglected similarity of interest between nonprofit and profit enterprises in maximizing profits or discretionary funds. By the first term on the right hand side of (10), it is apparent that nonprofit enterprises are interested in obtaining revenues and that such interest entails marginal value product behavior. Second, the two-stage analysis shows that the fundamental cause of nonprofit and profit differences in behavior is that the former spend profits in the production process rather than remitting them to stock holders. While various for-profit enterprises may also spend some profits 'on-the-job', the budget constraint (1) requires such expenditures by nonprofit institutions. Third, the analysis directs attention to the income and price elasticities of the utility function arguments. These parameters determine profit expenditure patterns and factor demand responses to changes in prices. When, as is likely, the utility function of the nonprofit enterprise differs from that of the average (representative) consumer, the mix as well as the quantity of output in nonprofit markets will be different from that in profit markets. In the extreme case where the nonprofit maximand depends solely on some output Q which has no market value, the institution produces the market good G to obtain profits for the purchase of Q. As a result, it will operate at the profit maximizing \( f_{\pi^*} \) for G, just as the competitive firm, but employ additional resources
from profits to obtain the desired output. Production will seem inefficient, with input/G-output ratios above cost - minimizing levels when, in fact, production is efficient but choice of output is, in some sense, not.

Nonprofit Outputs

The major problem in empirical analysis of utility maximizing behavior is determining the relevant argument in the institutional maximand. Very broadly, the maximand of a university might include, along with recognizable outputs (quantity, quality of education or of research), the level of inputs (due to the pleasure of a large staff and buildings (Veblen [1914]) and prices or wages (concern with tuition charges to needy student and with worker well-being):

(11) \( U = U \{ G (P,R), F, R, \omega_f, P_e, Q \} \)

where the previously undefined variable \( \omega_f \) refers to 'philanthropic wage payments', wages above market requirements.17

Inclusion of these variables in the maximand complicates behavior and analysis by making input/output distinctions fuzzy and factor prices endogeneous. Potentially complex interactions between variables like number of faculty and philanthropic wages may
lead to complicated patterns of behavior. In addition, nonprofit costs and factor ratios will differ from those of for-profit firms, as the nonprofits spend money on higher factor prices and 'excessive' inputs. The income elasticities and substitution possibilities between diverse goals must be brought into the picture. In the market, low tuition and excessively high wages will produce disequilibria, with applicants for places exceeding institutional availabilities, at least in the short run.

There are several ways in which observed outputs of nonprofit institutions can be related to other variables to yield more specific information about the goals of institions. First, the effect of 'profits' on the purchase of outputs can be examined cross-sectionally to determine which are normal components in the utility function. Endowment income, in particular, requiring no specific behavior will have a pure 'income effect' on institutional outputs. Barring complex quality/quantity, or factor price/input-output interactions - to be examined in Section II - outputs which do not depend on 'profits' can be ruled out of the utility function. Time-series data using total university receipts can also yield income effects, with purchases of outputs in the utility function rising in periods of high profits and income (such as the early 1960's), and declining in periods of relative decline. Finally, by comparing nonprofit and for-profit institutions of the same type - say profit and nonprofit hospitals, junior and community colleges and proprietary schools - it should
also be possible to pin down the utility maximand (and other factors) causing the distinctive nonprofit behavior.

Summary

The analysis of nonprofit institutions in this section has provided the basic rationale for nonprofit demand for labor and turned up several differences between these demands and those of for-profit enterprises resulting from the zero-profit budget constraint and expenditure of profits on outputs. On the basis of this analysis, it is reasonable to expect: different elasticities of response in non-profit and profit market; nonprofit outputs to vary with sources of funds and shadow subsidy prices; entry of nonprofit institutions when costs rise above minimum average cost; larger differences between nonprofit and for-profit outputs, the larger are endowment (non-market) incomes and potential profits.
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SECTION II

Some specific features of the college and university system that impact on the faculty labor market are considered next: (1) The quality of faculty inputs and educational or research outputs; (2) Internal wage and employment policies of institutions; (3) Production of faculty in academia, and dependence of demand for education on a narrow age spectrum of students.

1. Quality of Inputs and Outputs

The concern of high educational institutions, students, subsidisers, and faculty with the quality of education is best considered in the context of the quality-of-goods model of Houthakker (98), Theil (94), and Becker-Lewis (97). The main feature of this model is an interaction between quantity and average quality of goods with the cost of quality (quantity) dependent on the level of quantity (quality). The interaction can yield 'anamolous' market adjustments - reductions in employment in response to wage declines; increases in some university outputs when 'profits' or endowment income falls, and so on. In addition, faculty concern with peer quality will drive a wedge between the marginal cost of employment and the wage rate.

The Basic Interaction

To see how quality-quantity interactions can affect the labor market, consider a university which hires numbers of faculty (F)
and average quality \( (Q_f) \) to produce graduates \( (G) \) and quality of education per graduate \( (Q_g) \). The wage of a unit of 'quality-quantity' is a fixed price in the market, \( \omega_f \), so that two workers of unit quality can be hired for the same cost as one employee with twice as much quality. The maximization problem is:

\[
\begin{align*}
\text{(12) Max } & \quad U \quad [G, Q] \\
\text{s.t. } & \quad G = G \quad [F_G, Q_f, R_G] \\
& \quad Q = Q \quad [F_Q, Q_f, R_Q] \\
& \quad PG+Q = \omega_f FQ_f + \omega_R R = \omega_f Q_f [F + F_G] + \omega_R [R + R_G]
\end{align*}
\]

where subscripts relate to the use of the inputs in the \( G \) or \( Q \) functions and, for simplicity, the institution is assumed to have a uniform quality of faculty \( (Q_f) \) enters both \( G \) and \( Q \). In addition, quality is produced solely for its value to the university, having zero market price. Extension in the cases where persons of one quality are employed for producing \( G \) and another for \( Q \) and where quality of education has a market value are direct. 19

What is distinctive about (12) is the hyperbolic cost function \( (\omega_f FQ_f) \), which makes the cost of quality or quantity a function of the level of the other, as well as the market wage. Differentiating \( \omega_f FQ_f \) with respect to \( Q_f \) yields \( \omega_f F \) as the marginal cost of quality, which increases as \( F \) increases. The relative cost of quality to quantity is \( F/Q_f \), an increasing function of the relative employment. One implication is that changes in \( Q_f \) or \( F \), due to changed purchases of outputs, will alter the relative cost, with 'secondary price effects'. 20
Because of these effects declines in wages could decrease rather than increase employment. The scenario is: Lower wages → increased 'profits' of universities → increase in the purchase of the income elastic output, say Q → additional employment of Q_{f} relative to F, assuming Q is quality-intensive → increase in the relative cost of quantity → reduction in faculty employment. The critical conditions for such responses are that the Q_{f} intensive good be income-elastic and that Q_{f} - F substitutions dominate the employment adjustment. As the quality of education is probably both income-elastic in the university utility function and faculty-quality intensive in production and as faculty-quality and numbers are potentially good substitutes, 'perverse' wage-employment patterns are not implausible. In general, declines in faculty wages are more likely to lead to improvement in the quality of appointments than in the number of additional hires.

The potential disemployment of faculty when wages decrease depends critically, it should be noted, on the assumption that quality and quantity have a joint cost \( (Q_{f} F_{f}) \) with relative costs varying only when relative employments vary. If the analysis is modified to allow for independent changes in the wage of quantity and quality with, say, the former dependent on \( \bar{W}_{F} \) and the latter on \( \bar{W}_{Q} \) some of as well as on \( W_{Q_{f}} \) or \( W_{N} \) the burden of adjustments will fall on these wage rates. A uniform decline in wages which, by the preceding analysis, raises the relative demand for quality would reduce the ratio
of \( \bar{W}_Q \) to \( \bar{W}_Q' \), as well as that of \( F \) to \( Q \), inducing additional employment of faculty. Still, however, the wage decline is likely to increase the quality of faculty more than employment. 22

Analysis of university employment and wage behavior in the 'philanthropic wage' situation, where wages (or prices) enter utility functions because of concern for workers' well-being, follows an analogous line of reasoning. The cost function is hyperbolic with the price of philanthropic wages dependent on the number of employees and the cost of employment a function of these wages.

**Quality, Supply Price, and Rationing**

When faculty value the quality of their peers (for productivity interaction or prestige reasons), wages will vary in the market, being lower to institutions with higher-quality faculty. Assuming a hyperbolic cost function and \( W_f = W(Q_f) \), the marginal costs of

\[
\begin{align*}
\frac{\partial c}{\partial Q_f} &= fW + Q_fFW' \\
\frac{\partial c}{\partial F} &= WQ
\end{align*}
\]

Appointments raising quality cost less than those lowering it due to the change in supply prices (\( w' \)). As a result, universities will **ration** jobs, refusing employment to low quality workers whose marginal cost exceeds their going wage rate. High-quality faculty are also likely to concentrate in a small number of major institutions, whose 'endowment' permits accumulation of quality: When the supply price of
quality workers is very high to low-quality schools - counterbalancing
the reduction in the wage of current employees - such institutions
will be unable to attract top faculty.\textsuperscript{23}

Similarly, if the tuition students are willing to pay de-
pends on the quality of their peers, places are likely to be rationed
and the more able concentrated in a limited number of colleges.

2. Internal Labor Market Policies

There are two distinctive features to the internal labor
market policies of colleges and universities: desire for an 'equitable'
wage structure which rewards faculty roughly equally across specialties;
and tenure, which guarantees lifetime employment.

\textbf{Equitable Wage Structure}

That most colleges and universities would like to pay
faculty of similar work, experience, and academic ability but dif-
ferent specialization, the same basic salary is evident from expressed
salary goals. A 1973 Dartmouth College compensation committee, for
example, stated that "since institutions constitute essential com-
munities of scholars, there is a general feeling of what may be termed
academic equity -- that differences of compensation among faculty
members of equal experience and standing within their own special
fields should be as small as is consistent with maintenance of high
quality faculty in each department".\textsuperscript{24} National Education Association
surveys show that nearly all institutions have explicit faculty salary schedules, providing for minimum-maximum or average pay based on merit, rank, and experience, applying equally across fields. 25

As the Dartmouth statement suggests, the equity notion involves rejection of market valuation of various intellectual endeavors and affirmation of an alternative nonprofit academic value structure. While faculty are to be judged by their scholarly output, differences in the market price of this output (which will be substantial between such fields as economics and Hittite archeology) are to be ignored, when feasible, in the determination of marginal revenue productivity and wages.

Another factor underlying the equitable wage goal is the tendency for university administrators and members of faculty committees to come from various departments. The Dartmouth compensation committee, for example, included professors of economics, French mathematics, and sociology, among other fields. Explicit or implicit bargaining on such committees or in administrative decision-making is unlikely to lead to policy favoring some fields at the expense of others. When faculties are divided by schools, on the other hand, as among law, business, medicine, and Arts & Sciences, pressures for wage equity across disciplines will be attenuated.

Whatever the cause, the desire for inter-field equity in salaries exacts a cost on the university system when non-academic opportunity wages differ. This cost must be traded off against other
goals and expenditures in the decision process. The use of resources to purchase equity in salaries will produce a narrower inter-field dispersion of salaries in academia than in industry; shortages (surpluses) in specialties where opportunity wages are high (low), and reliance on compensatory remuneration schemes to alleviate market problems by widening the real incentive structure, despite the constraint on salaries. Such compensation policies would include differential work conditions (office space, secretarial aid), speeds of promotion, liberal outside time rules, permitting allocation of effort to consulting activities, provision of special professorial chairs, of laboratories, etc. As these rewards are possible in the absence of the 'constraint' on salaries and are not perfect substitutes for flexible salaries, they will only partly alleviate the manpower problems created by the equity goal.

To obtain some notion of the effect of an 'equitable' salary policy on the university pay structure, table 1 records salaries of specialists in thirteen scientific fields in 1970 in industry and higher education and by degree or level of experience; unfortunately the published date do not give cross-tabulations of salaries by degree and experience or rank. In each of the groups considered, the salary structure for academics is much more narrowly dispersed than that for industry. Among Ph.D.'s, for example, the range of academic year salaries is just $2100, from $12,900 to $15,000; while the range
<table>
<thead>
<tr>
<th>Field</th>
<th>Academic Year Salaries</th>
<th>Industrial Salaries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ph.D</td>
<td>Master's</td>
</tr>
<tr>
<td>All</td>
<td>13.5</td>
<td>10.2</td>
</tr>
<tr>
<td>Chemistry</td>
<td>12.9</td>
<td>10.2</td>
</tr>
<tr>
<td>Earth Sci,</td>
<td>13.5</td>
<td>10.0</td>
</tr>
<tr>
<td>Space &amp; Atmospher Sci</td>
<td>14.8</td>
<td>10.6</td>
</tr>
<tr>
<td>Physics</td>
<td>13.5</td>
<td>10.4</td>
</tr>
<tr>
<td>Math</td>
<td>13.2</td>
<td>10.0</td>
</tr>
<tr>
<td>Computer Sci.</td>
<td>15.0</td>
<td>10.2</td>
</tr>
<tr>
<td>Agric. Sci.</td>
<td>12.9</td>
<td>11.2</td>
</tr>
<tr>
<td>Bio Sci.</td>
<td>13.0</td>
<td>10.3</td>
</tr>
<tr>
<td>Psychol</td>
<td>13.5</td>
<td>10.7</td>
</tr>
<tr>
<td>Statist.</td>
<td>14.0</td>
<td>10.9</td>
</tr>
<tr>
<td>Econ.</td>
<td>15.0</td>
<td>11.0</td>
</tr>
<tr>
<td>Sociology</td>
<td>14.0</td>
<td>9.7</td>
</tr>
<tr>
<td>Politic Sci.</td>
<td>13.0</td>
<td>9.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Levels, 1970</th>
<th>Academic</th>
<th>Industry</th>
<th>Government</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph.D</td>
<td>.054</td>
<td>.096</td>
<td>.091</td>
</tr>
<tr>
<td>Master's</td>
<td>.043</td>
<td>.114</td>
<td>.089</td>
</tr>
<tr>
<td>2-4 years Experience</td>
<td>.060</td>
<td>.125</td>
<td>.091</td>
</tr>
<tr>
<td>20-24 years Experience</td>
<td>.081</td>
<td>.123</td>
<td>.154</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>.041</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>.050</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Full Professor</td>
<td>.065</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Same as Table 1 for 1970 data

NSF American Science Manpower: 1964 (NSF 66-29) for 1964 data
in industry is $7500. Similarly, among master's graduates, the inter-
field range is $1200 in academia compared to $3400 in industry. More
formally, the coefficients of variation given in table 2 show less
dispersion in academic than industry or government pay structures, by
a considerable amounts in each of the categories. Young academics -
assistant professors, those with 2 - 4 years experience - have the
narrowest interfield structure - with a coefficient of variation one-
half that in industry and two-thirds that in government. A similar
pattern is found when percentage changes in academic salaries are
compared to those in other sectors in the 1960's. From 1964 to 1970,
the coefficient of variation in the change of academic salaries varied
from .081 (professors) to .115 (assistant professors) while comparable
industrial variations were on the order of .183 and governmental vari-
ation of .144. While other factors might possibly cause a narrower
structure in the educational sector, the figures are consistent
with a sizeable internal salary policy effect.
The posited effect of the internal policy on recruitment of faculty can also be examined with available data. Comparisons of vacancy rates in universities, defined as the ratio of unfilled budgeted positions to new hires plus unfilled slots, and opportunity wages show a sizeable positive correlation: the ratio of nonacademic to academic salaries is rank correlated with vacancies at 0.88 for eight fields in 1964 when such data are available.27

The way in which a rigid university salary structure affects market adjustments can be examined further in terms of its implicit impact on elasticities of responses. If, under a flexible wage regime, a 1 per cent change in wages would clear the market in a specialty accounting for α per cent of the faculty budget, the required adjustment in the average faculty wage would be α per cent. Under a policy of rigid wages among fields, the same adjustment involves an overall change of 1 per cent - 1/α times as great. Formally, the constraint reduces the elasticity of demand or supply in a field from say γ and α to αγ and αα, necessitating the greater change to attain equilibrium.

Tenure

Tenure, which guarantees lifetime employment to the faculty except for reasons of institutional financial crisis or personal incompetence, is much criticized feature of the academic market.28 What function does tenure perform? How does it affect the operation of the labor market? We argue in this section that whatever its rule
as guardian of academic freedom, tenure is a basic element in the system of decision-making by which faculty decides appointments; without tenure, it would not be feasible to have university employees control the hiring process. It is further argued that tenure substitutes for pecuniary income and creates market adjustment problems, especially in periods of change.

It is important to recognize at the onset the similarity between tenure and the normal seniority system in industry, which also protects older workers against the vagaries of the market. Since few older workers in industry are disemployed except when plants close down, tenure is not 'out of line' with other industrial relations rules. It is likely, however, that faculty have greater job security than industrial employees because unlike firms, nonprofit universities rarely close down unprofitable departments. In addition, with a relatively short job ladder in academia (nontenure faculty, tenure faculty, administration, chaired professor are the principal 'rungs') the possibility of differentiating among permanent employees by promotion, differential assignment of tasks, and the like is relatively small, making bad tenure decisions relatively more costly. Not that an institution cannot 'encourage' tenured faculty to leave—by reducing office and related facilities, failing to award 'normal' salary increases, and so forth, or as a last resort 'buying out' a position. They can and do engage in such activities. The cost, both pecuniary and nonpecuniary, is however considerably greater than in industrial settings with lengthy hierarchies.
The major difference between tenured faculty and other senior employees is that faculty have the power to hire additional faculty who do essentially the same work and could replace them on the job. It is this power which makes university departments similar to collective firms of the Yugoslav type and, we argue next, makes tenure an important feature of academia. The argument is best seen by considering the 'no tenure' situation in which faculty as a group decide on who to hire or fire but have no guarantee on their own job. Each professor would then judge possible new colleagues as competitors who could replace him in the university and as members of the electorate deciding his future. In the absence of profit-and-loss sanctions, the potentiality that collusion among faculty, political bargaining and coalition formation would produce bad appointments is substantial.

Tenure effectively reduces these potentialities and makes the 'partnership' organization viable in the nonprofit market. It is of some interest to note that the historical development of tenure in the U. S. provides some support for this argument, with 'the growing participation of faculty in the recruitment and selection of its own members' and 'the shrinking of presidential competence' in appointments occurring in the same time period as the development of tenure. To test the tenure-appointment power link, the employment practices of institutions lacking tenure could be examined: deans or presidents are predicted to make hiring decisions in such educational enterprises.
There are, of course, costs to the market and individuals from the tenure system. First, and most importantly, tenure (like other seniority systems) places the burden of adjustment to change on the young. When the academic market declines, the probability of tenure will fall or the years needed to attain it rise, with a re-distribution of income from younger to older workers. Declines in the probability of tenure reduce the lifetime income of the young without effecting that of current tenured faculty and conversely for increases in tenure chances when the market gets stronger.

Second, during period of contraction, tenure makes it difficult for institutions to alter the distribution of faculty across disciplines in accord with market demands. Attrition and employment of replacements, rather than closing down department or firing selected specialists, are the tools of adjustment. In addition, even in periods of expansion, tenure make the age distribution of faculty a key parameter in the academic market. An appropriate distribution of older (tenured) to younger faculty is needed for institutions to have a continuous flow of 'young blood'.

Third, since job security is a desirable condition of work which increases costs to employers, it will reduce the earnings of faculty or lower other nonpecuniary components of salaries. In particular, older faculty, the beneficiaries of the system, will receive lower pay, with a resultant flattening in the academic experience or age-earnings profile.
Finally, tenure probably reduces the efficiency of academics by removing the possibility of being fired for nonperformance. Those nearing retirement, in particular, may be so affected, since 'compensatory firing policies' -- failure to grant normal salary increases or salary cuts -- are likely to have a small effect due to the short future work life. The danger of loss of pension rights, which exists in industry, is eliminated by the vesting of academic retirement plans.

3. Capital Goods and Demographic Factors

The dependence of the demand for new faculty on changes in enrollments and the production of new faculty from graduate enrollments suggests application of capital goods accelerator models to the faculty market. These models highlight the dynamic adjustment problems of an industry producing and employing a long-lived capital resource such as faculty and its potential for cyclic fluctuations.

Accelerator Model

Consider a simple accelerator type model, in which demand for faculty depends on numbers of undergraduate (U) and graduate (G) enrollments and on academic salaries (S), and supply of faculty is determined by Ph.D. graduates and last period's supply net of the outflow of workers due to retirement and mobility at depreciation rate δ. For simplicity, only graduate students and Ph.D.'s intending to teach are distinguished in the model; the decision to enroll in graduate
studies is dependent on academic salaries and, once made, is assumed fixed. This eliminates several degrees of flexibility from the market in order to focus on the behavior of interest. The model can be represented as follows:

\[
F^D = aG + bU - cS \quad \text{[faculty demand]}
\]

\[
F^s = \Phi_{h, D, T} \left(1-r\right) F_{-1} \quad \text{[faculty supply]}
\]

\[
F_{hD} = G_{-1} = A + BS_{-1} \quad \text{[new faculty supply]}
\]

where \( a, b \) are incremental faculty student ratios for graduate and other students, and \( c, B \) are the coefficients of response to salaries by institutions and young persons. Alternative salaries are ignored in this formulation.

Equations (14) - (16) yield a second order difference equation which, with plausible assumptions about parameters, has complex roots producing dampened cyclic fluctuation. The cycle will be longer than the classic cobweb cycle in the labor market because demand as well as supply is influenced by the enrollment decisions of students. A typical scenario for the cycle would be: On the demand side, high academic salaries \( \rightarrow \) increased graduate enrollments \( \rightarrow \) greater demand for faculty \( \rightarrow \) higher salaries, a response pattern tending to explosive movements; and on the supply side, high academic salaries \( \rightarrow \) increased graduate enrollments \( \rightarrow \) increased supply of new Ph.Ds \( \rightarrow \) increased supply of faculty \( \rightarrow \) decrease in academic salaries, the usual cobweb adjustment process. The demand-side cycle is attenuated when graduate students are used as teachers, for the demand increasing effect
of graduate enrollments is reduced and possibly reversed. Investigation of this aspect of the market requires analyses of the substitutability between faculty and graduate teaching assistants and consideration of their relative salaries or costs.  

The significance of the endogenous cyclic mechanism in the faculty market will differ across fields, depending on the relative importance of faculty used to produce faculty. When undergraduate enrollment or graduate enrollments independent of the faculty market account for the bulk of academic demand — as in engineering, for example — fluctuations in the faculty market will be proportionally small. When, on the other hand, graduate students loom large in enrollments and tend primarily to become teachers, as in the more arcane subjects, fluctuations could be substantial until equilibrium is attained.

Finally, when cyclic ups-and-downs in academia are initiated by nonacademic market developments, shifting demand for faculty, the amplitude of faculty market cycles is likely to be especially great. In this case, enrollments on the part of students intending to work in industry in government, as well as academia, will vary in the cobweb manner.

**Demographic Fluctuations**

Since colleges and universities enroll persons within a narrow age-band, demand for education is potentially dependent on the age structure of the population. In years past, the proportion of a
cohort attending college was reasonably small so that changes in the number of the young probably had only moderate effects on overall demand for education; more recently, with larger numbers of young persons electing college, however, demographic phenomena have become potentially quite important in determining demand.

The impact and potential impact of changes in the number of 18-21 year old prospective undergraduate enrollees can be examined further with available data. In the 1950's and 1960's, demographic developments - while important - accounted for only a moderate part of the enormous increase in college enrollment. Between '50 and '60, the population of 18-21 year olds was roughly unchanged while enrollments increased by 57 per cent. In this decade all of the growth of demand for college training resulted from changes in the proportion of persons choosing higher education. The 1960's experienced, by contrast, a significant increase in the population of young persons, with a resultant 'scale' effect on college and university enrollments. Even in this period, however, with enrollments doubling, demographic fluctuations were not the entire story of change. Approximately 40 per cent of the growth in enrollments are 'attributable' to increased numbers of persons; another 40 per cent is due to changes in the population of the young going on to college, with the remainder due to 'interactions'.

Projections of future demographic fluctuations suggest especially important population effect in the future. Census projections show a small increase in the number of young persons in
the 1970's and an absolute decline in the 1980's. These demographic fluctuations are the chief input in several forecasts of the faculty labor market. 35
FOOTNOTES

1. Among many studies are Veblen [W], Stigler [H], Harris [H], Cartter [W], Porter [W].

2. To the extent that hospitals behave as workers management cooperatives with doctors making the important decisions, the analysis is not directly relevant to nonprofit hospitals. See B. Ward [W] for the basic workers management model and M. Pau [W], for an application to the medical case.

3. The difficulty is that of forming a group utility function when interests may diverge greatly.

4. See R. Freeman [1973] for a discussion of some interrelations between for-profit and non-profit educational institutions.

5. This assumption is modified in the discussion on pp. 18-20.

6. It is unclear whether or not the normal entrepreneurial return is to be included as a cost of the for-profit firm making its operation more expensive than that of the nonprofit enterprise. If entrepreneurial return is only a reward for risk-holding, and risks average out in an industry, we would not want to include it. If, on the other hand, the entrepreneurial return is a reward for 'founding' an enterprise and/or requires 'monitoring' of employees for future receipts, the 'free' founding of nonprofit institutions by donors and gratis trusteeship behavior reduce the cost of nonprofits. They face a lower price of entrepreneurship in the market as a result of their nonprofit status.

7. Formally, $\varepsilon_A = \varepsilon_M + \varepsilon_N$ so that with $\varepsilon_n < 0$ due to the U-shape of the cost curve, $\varepsilon_A < \varepsilon_N$. 
8. The basic analysis is not affected by non-homotheticity, of course.

9. To prove (c) and (d) and examine the derivative of the coefficients with respect to $c$ in (3c): $\frac{\partial(1+c)}{\partial(1+c)}$ rises, implying greater for-profit responsiveness to $E_0$ while $\frac{1}{\partial(1+c)}$ falls as $c$ rises, implying greater nonprofit responsiveness to $E_A$.

10. The proof follows from examination of the derivatives of the coefficients with respect to $\eta_f$ and $\eta_{1-c}$, as before.

11. Since only $P_t$ changes, balancing the budget requires

$$\alpha_t E P_t = \alpha_f E W_f$$

12. In many cases, subsidy prices are explicit, for instance when a state pays institutions in a per student basis.

13. In terms of the analysis in section I-4, second stage back utility is more important.

14. See [31] for evidence on 'underutilization'.

15. Nonprofit salary policies will, in general, place 'bounds' on possible rewards. The 'equitable' salary goal of colleges and universities is considered on pp. 26 - 28.

16. If the nonprofit utility for function is determined by some latent or actual Wuting procedure, it will depend on preferences. The representative on the other hand, is clearly the mean of the population. For a discussion of another possible difference between nonprofit and preferences, see Nerlove [31].

17. The term is Feldstein's. He argues that philanthropic wage payments have been important in the nonprofit hospital sector [31].
18. See pp. 24-25.

19. When quality has a market value, the receipts function is hyperbolic and universities charge higher tuition per student, the higher their quality.

20. Becker & Lewis consider this effect in great detail [n 23].


22. Precise conditions for this can be easily derived.

23. The reduction in the wage of correct employees might appear at first, to dominate since there are many such workers. Those benefitting from the high-quality professor are, however, likely to be a very limited number.

24. The Dartmouth College statement succinctly sets out many of the problems facing institutions as a result of internal market constraints.

25. See N.E.A. [n 2].

26. Factors not held fixed in our calculations include age and work activity.

27. A typical pattern in 1964 is shown below:

<table>
<thead>
<tr>
<th>Field</th>
<th>Incremental Vacancy Rate* (f)</th>
<th>Ratio of Industrial to Academic Salaries 1964 (2)</th>
<th>Rank of*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td>.177</td>
<td>1.47</td>
<td>1</td>
</tr>
<tr>
<td>Economics</td>
<td>.162</td>
<td>1.72</td>
<td>2</td>
</tr>
<tr>
<td>Mathematics</td>
<td>.143</td>
<td>1.65</td>
<td>3</td>
</tr>
<tr>
<td>Psychology</td>
<td>.123</td>
<td>1.45</td>
<td>4</td>
</tr>
<tr>
<td>Chemistry</td>
<td>.095</td>
<td>1.40</td>
<td>5</td>
</tr>
<tr>
<td>Biology</td>
<td>.069</td>
<td>1.33</td>
<td>6</td>
</tr>
<tr>
<td>Agriculture</td>
<td>.028</td>
<td>1.08</td>
<td>7</td>
</tr>
<tr>
<td>Geology</td>
<td>.017</td>
<td>1.37</td>
<td>8</td>
</tr>
</tbody>
</table>

| Sources: National Education Association, Teacher Supply and Demand (1964); National Science Foundation, National Science Register (1964).
* The incremental vacancy rate is the fraction of new budgeted positions unfilled in a given year.
* The Spearman coefficient is 0.88; 1% level of significance is 0.83.

28. See Wall Street Journal [n 31].

29. Informal tenure, in which faculty 'custom' guarantees rates to continue contracts could, of course, substitute for the formal system.

30. See the fascinating paper by W. Metzger [n 33], pps. 142-143.
31. See Porter [6], Stone [6], Tenbergen [6], for fixed coefficient models.

32. Plausible values would be
   \[ a = b = 1/10 \]
   \[ c = 1/10 \]
   \[ g = 1/10 \]
   \[ B = 1/15 \]

   Note that these coefficients are small due to the units of measurement; elasticities are on the order of 1-2.

33. See Freeman [6] for application of the cobweb cycle to the labor market.

34. R. Strotz has a model focusing on this aspect of the market (personal communication) Freeman [6], chapter 9, examines the effect of graduate students on faculty in engineering and the university as a whole.

35. Note Carttler [6], but also Porter [7].
REFERENCES


Freeman, R., Market for College-Trained Manpower (Harvard University Press, 1971).


National Education Association, Faculty Salary Schedules in College and Universities (Report 1972-p. 10).


