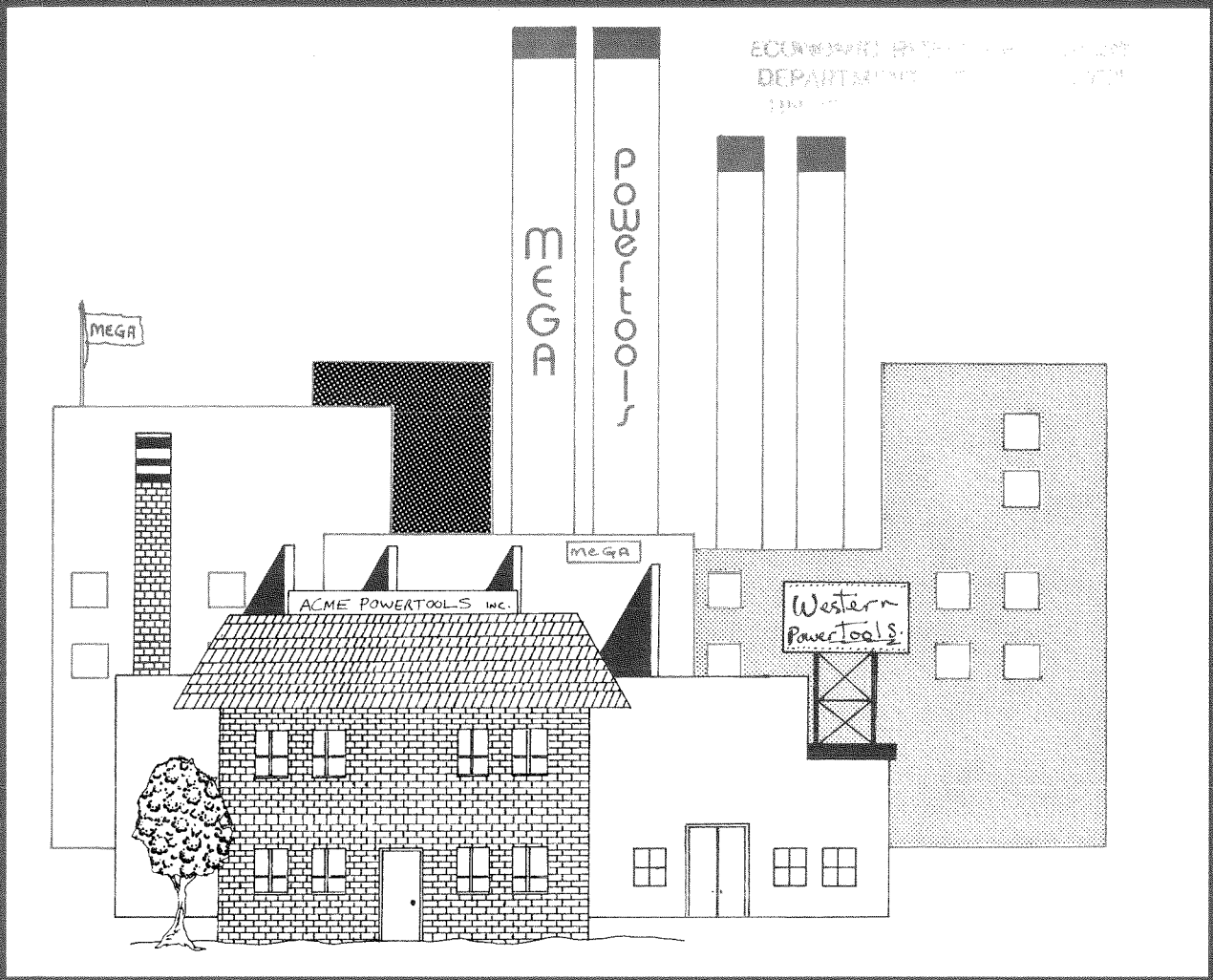
Federal Reserve Bank
of San Francisco

Economic Review
Number 1



Firm Size, Exchange Rates, and Interest Rates

Winter 1984

The Economics of Firm Size: Implications from Labor-Market Studies

Michael C. Keeley*

One hypothesis about why large and small firms coexist in many industries is that entrepreneurial ability determines firm size. More able entrepreneurs manage firms whose sizes vary more than proportionately with their talents. However, because larger firms also face higher costs (per worker) in monitoring worker performance, they have more specialized methods of production, require more specialized training and hire more skilled workers to economize on monitoring. Empirical results tend to confirm this hypothesis. Moreover, the evidence implies that significant economic losses may be associated with public policies that prohibit firms from attaining their optimum size.

Many industries are characterized by the coexistence of firms of widely varying size, often with output concentrated in a few large firms. Understanding why this is so is extremely important for regulatory and antitrust policy.

On the one hand, it is widely believed that a high concentration of output (that is, a positively skewed distribution of firm size) leads to reduced competition.[1] One of the rationales for the regulation of many industries is to reduce concentration, prevent increased concentration, or to restrict how firms in concentrated industries may operate, especially those that are believed to be natural monopolies.[2] Antitrust law also grew out of a concern with concentration and may have had substantial effects on market structure through the prohibition of mergers, and until recently, suits aimed at breaking up successful large businesses.[3] Regulation in industries such as trucking, airlines, rail transportation and banking, may also have had significant effects on the firm-size distribution in these industries. For example, in banking, various restrictions on geographic competition, such as prohibitions against interstate banking, may have resulted in less concentrated market structures.

On the other hand, there is a concern about the potential costs of preventing firms from operating at their most efficient or optimal scales. For example, breaking up a large firm into several smaller ones, or prohibiting the merger of smaller firms, may have substantial costs if there are economies of scale. Thus, possible anti-competitive effects due to concentration should be balanced against possible increases in productive efficiency in formulating regulatory or antitrust policy.

For example, some economists have argued for a repeal of the antitrust laws so that the United States can compete more effectively with Japan.[4] Proposals for the elimination of restrictions on interstate banking are also often based on the notion that a more efficient provision of services would result and benefit consumers. Opponents to this type of deregulation are concerned that the elimination of restrictions would lead to a more concentrated banking industry with less competition.

Until recently, there was no theory of firm-size that was able simultaneously to explain actual firm-size distributions and several empirical regularities in production associated with firm-size. However, new developments in economic theory that focus on entrepreneurial ability as a fixed factor of produc-

*Economist. Helpful comments from Jack Beebe, Fred Furlong, Randall Pozdena, and research assistance from Jennifer Eccles are much appreciated.

tion and on the organization of production are capable of explaining firm-size distributions and differences in production methods among different-sized firms. In this paper, these new theories are reviewed, some of their implications for differences in production are tested indirectly, and the public policy implications are explored. The empirical analysis focuses on differences in the employment practices among different-sized firms, in particular, differences in wage levels, wage growth and turnover. Hopefully, the results provide useful evidence about the determinants of the distribution of firm-size so that public policies aimed at influencing market structure can be better informed.

The organization of this paper is as follows. In Section I, I review the implications of neoclassical theory regarding firm-size distributions and present evidence that contradicts these implications. Next, in Section II, several new developments in economic theory explaining the determinants of firm size are reviewed and their empirical implications regarding differences between various characteristics of the labor forces of large and small firms are discussed. Then, in Section III, empirical evidence is presented that tends to support these hypotheses. Finally, the summary and conclusions are presented along with policy implications.

I. Neoclassical Theory and Facts

To analyze the determinants of the firm-size distribution, it is first necessary to define what a firm is and explain why firms exist. Our current understanding of what firms are and why they exist is due to Coase (1937), who hypothesized that economic activity takes place in firms instead of markets because of the transactions costs involved in organizing economic activities in markets. A firm substitutes a command-and-control system for the allocation of resources that could have been achieved through the market economy. Presumably, an economic activity (production) takes place within a firm if it is less costly than if it took place using the market. Alchian and Demsetz (1972) extended this basic concept by emphasizing the importance of group or team production. Group production implies the need for monitoring workers because the separate contribution of each individual cannot be assessed simply by observing output. Thus, group production might be very difficult to achieve in a market setting.

If entrepreneurs in a given competitive industry have available the same technology of production, face the same relative prices for transactions within the firm and outside, and face identical input prices, all firms in the industry (that is, firms producing the same products) would have identical cost functions. Assuming U-shaped average cost functions, all firms would produce at the minimum point on their average cost curves and the number of firms would equal total market demand (at a price equal to minimum average cost) divided by the output of a typical firm at its minimum average cost. Thus, if such conditions held, all firms in an industry would be the same size.[5]

However, even casual observation contradicts the notion that all firms in an industry are the same size. For example, in banking, the size distribution is positively skewed and the variance in firm-size is very large (with a standard deviation approximately four times the mean), with firms ranging in size from those with less than $5 million in assets to those with over $100 billion. Furthermore, the relative variance of firm-size in many other industries is even larger, and the skewness of the size distribution function in banking is considerably less than that in many other industries.

To analyze the extent to which industry type can explain firm-size, I have estimated the fraction of the overall variance in firm-size that is explained by industry type. The variance in firm-size is analyzed using three regressions of firm size on 1-digit, 2-digit, and 4-digit SIC (Standard Industrial Classification) codes. The regressions are of the following general form:

$$SIZE_i = A + \Sigma_j B_j SIC_{ij} + e_i \qquad (1)$$

where: $SIZE_i$ = the size of firm i, measured at the establishment level, in terms of number of workers,

SIC_{ij} = a set of dummy variables indicating whether firm i is in the Standard Industrial Classification code (SIC) category j,

e_i = a random error term.

The data for these regressions are from an employer survey of over 5000 establishments.[6] (Establishments are defined as places of business regardless of ownership, and thus differ from firms.) Establishment-level data are used (as opposed to firm-level data), and since the overall variance in establishment size is probably less than the variance in firm-size because some firms are comprised of many establishments, the variance in establishment size within an industry is probably less than the variance in firm-size.

The regressions indicate that the SIC code explains 6 percent at the 1-digit level, 14 percent at the 2-digit level, and 47 percent at the 4-digit level of the variance in establishment size. Thus, even at the 4-digit level, over 50 percent of the variance in establishment size is within industries, and this may be an understatement since in some cases the 4-digit SIC code level may be too detailed in disaggregating firms that are really in the same industry.[7]

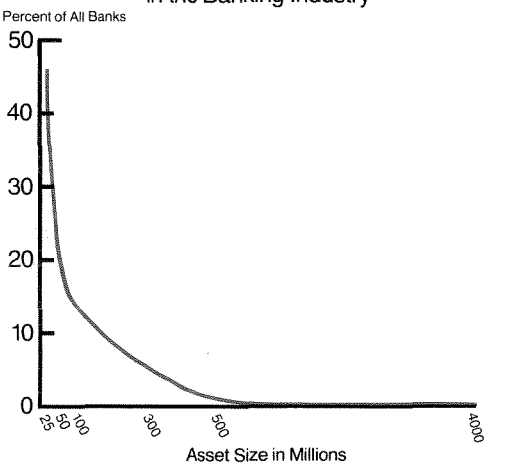
These regression results do support the hypothesis that production technology (and hence, industry) is related to firm-size because firm-size does depend on industry, but they also strongly suggest that other factors must be responsible for the large within-industry variation in firm size. One reason may be that average cost functions are not U-shaped but flat, exhibiting constant returns to scale over a wide range, perhaps with initial economies of scale (and declining average costs) over only a relatively small initial interval.[8] This type of cost function would imply a rectangular distribution of firms within the flat portion of the average cost function, since firms outside this range would be unlikely to survive (because of their higher average costs), and because within the range there is no reason for any particular size to be observed more frequently.

However, this implication of neoclassical theory is also contradicted by the data: the distribution of firm-size within industry is highly skewed, not rectangular. For example, in Chart 1, the distribution of firm-size in the banking industry shows a highly skewed distribution with a long right tail, and distributions in most industries are very similar.[9]

One attempt to reconcile this skewness with neoclassical theory is the application of stochastic models to the growth of individual firms. Much of this analysis is derived from the work of Gibrat (1931), who showed that if all firms have an equal chance of growing (or declining) by a given percentage amount, then a log normal size distribution of firms will result even if all firms are initially the same size. There does seem to be evidence that the growth of firms is independent of size, as well as evidence that, at least for some industries, the observed distribution is log normal. This theory of the firm-size distribution, taken literally, implies that there are no differences in production technologies of firms of different sizes (in the same industry), that average costs are independent of size, and that the existing size distribution at any moment in time is simply due to the cumulative effects of luck (random factors). That is, there should be no systematic differences between large and small firms since they have the same cost functions, and since differences in size are due only to random shocks.

Because this theory implies that the size distribution of firms under competition is due simply to randomness, one very important policy implication is that there would be no losses in economic efficiency with the dissolution of large firms, or opposition to the consolidation of smaller firms through mergers, as long as firms were operating on the flat portion of their average cost curves. For example, interstate banking could be prohibited without any concern for possible losses in output due to an

Chart 1
Distribution of Firm Size
in the Banking Industry



Source: 1981 *Statistics on Banking*, Washington: FDIC, 1982, Table 104.

inefficient scale of operation. Furthermore, since less concentrated industries *may be* more competitive, one need not worry about balancing gains from increased competition against losses due to nonoptimal size when breaking up large firms or prohibiting mergers. Much of the empirical evidence presented in this paper, however, shows that there are many systematic differences between large and small firms that cannot be explained by purely statistical models of firm size.

II. New Explanations of the Firm-Size Distribution

To explain differences in firm size, recent theoretical research has emphasized differences in entrepreneurial ability, which is assumed to be in perfectly inelastic supply. For example, Lucas (1978) developed a model in which individuals are alike as workers but differ in entrepreneurial ability. In his model, the distribution of entrepreneurial ability leads to an equilibrium distribution of firm size, with more able entrepreneurs running larger firms.

Rosen (1981a, b, 1982) also developed a model in which entrepreneurial ability explains the size distribution of firms. His model focuses on the hierarchical structure of production in firms where decisions at each level of the hierarchy affect the efficiency of labor inputs at the next lower level. This production technology implies that there is a multiplicative effect in assigning persons of superior talent to the top ranks because they increase productivity by more than the increments of their talents. A more productive chief executive officer, for example, affects the productivity of everyone below him or her in the organization, and thus even a small increment in his or her talent may have a very large overall effect on productivity. Even if entrepreneurial ability were distributed normally, the firm-size distribution would be skewed because, in equilibrium, this production technology implies that output and labor input rise more than proportionately with talent.

These same characteristics of production imply that managerial compensation rises more than proportionately with ability. This, in turn, implies a skewed distribution of compensation as well, a finding confirmed by the work of Roberts (1956) and Fox (1978), who both find managerial compensation varying with the log of the number of employees. The reason this type of production technology does not lead to an equilibrium in which there is only one firm managed by the most talented individual (at least in each industry) is that the economies due to the hierarchical organization are limited by the increasing costs of monitoring workers. Monitoring workers requires direct worker contact and, therefore, is not subject to the same sorts of scale economies as the coordination and allocation of resources.

Rosen's model has some interesting implications for the structure of firms' cost functions. First, in equilibrium, any given firm will be subject to increasing average costs if it expands output beyond its equilibrium level, holding managerial talent constant. Second, firms of different sizes, in equilibrium, may well have identical *measured* average costs because the economies realized by the larger firm due to its superior management talent will be captured by the management whose talent is assumed to be in perfectly inelastic supply and because managers' compensation is often recorded as a cost, not a profit. Thus, evidence that measured average costs are independent of firm size does not necessarily imply that breaking up large firms would not result in significant economic losses. Rosen's model of firm size implies quite the opposite: there are economic benefits from allowing managers with superior talent to manage larger firms.

Oi (1982a, b) also developed a model that emphasizes entrepreneurial ability, but Oi's model more fully develops the implications of monitoring costs. His model, like Rosen's, assumes entrepreneurs perform two functions: they coordinate production and they monitor the performance of workers, but Oi does not assume a hierarchical production technology and thus Oi's model is unable to explain the skewed distribution of firm size in most industries. In Oi's model, more able entrepreneurs are assumed to be more productive at coordination but all entrepreneurs are assumed to be equally productive at monitoring. Although it might seem somewhat arbitrary to assume more able coordinators are not also more able monitors, Rosen's model of hierarchical production suggests why this might be so.

A more efficient monitor cannot reap the same sort of efficiencies in monitoring that he or she can in making coordinating and allocative decisions because monitoring cannot be delegated in a hierarchical structure.

Since an increase in entrepreneurial talent leads to an increase in the number of employees, and more employees implies more time spent monitoring and less time spent making coordinating and allocative decisions, the implicit costs of monitoring worker performance should be higher in larger firms. They should be higher because the alternative use of time is coordination (or allocation of resources), for which there are economies of scale implicit in hierarchical organizations and because of the lack of such scale economies in monitoring. These scale economies make coordination more valuable in large firms, and, as Rosen points out, this strengthens the implication that firm size will be skewed because superior managerial talent can be economized by "subordinating" monitoring through a more hierarchical structure.

The dependence of monitoring costs on firm size means that firms of different sizes will have different types of workers, different types of managers, different types of capital, and different sorts of production methods. Thus, this new theory stands in sharp contrast to the stochastic explanations of the firm-size distribution that predict no systematic structural differences among firms of different sizes. For example, the monitoring-cost hypothesis predicts that large firms should have more hierarchical structures, less flexible production methods (which are presumably associated with less monitoring), more reliable workers (who require less monitoring), and more reliable capital equipment (which requires fewer repairs and therefore less monitoring of workers who perform the repairs).

The monitoring-cost hypothesis has several empirical implications. First, it implies that larger firms invest in more specific human capital (that is, skills specific to the firm) than small firms because larger firms have higher costs per worker in monitoring worker performance. These higher monitoring costs lead larger firms to have more rigid and specialized methods of production, which in turn require more firm-specific training (that is, specific human capital). Since large firms find it optimal to invest in more specific human capital than small firms, turnover rates (both quit and fire/layoff rates) should be lower in large firms.

Second, this theory implies that large firms will hire more productive employees—that is, employees with higher levels of human capital (which depends on commonly measured variables such as education as well as traits such as intelligence or reliability that are more difficult to measure). This is the case because more productive workers allow firms to lower monitoring costs per unit of output and thus to economize on those costs, assuming that they depend on the number of workers and not total output.

Below, we present some indirect tests of these hypotheses by estimating differences in wage levels, wage growth, and turnover among firms of different sizes and types.

III. Empirical Evidence on the Monitoring-Cost Hypothesis

The monitoring-cost hypothesis implies that large firms invest more in specific human capital than small firms because large firms have higher costs (per worker) of monitoring worker performance. These higher monitoring costs lead large firms to institute rigid and specialized methods of production, which, in turn, require more specialized training. This hypothesis also implies that large firms hire workers with more general human capital in order to reduce the costs (per unit of output) of monitoring, assuming that monitoring costs depend on the number of workers and not total output. Although specific and general human capital are not directly observable, wage rates, wage growth and turnover are. Thus, one can test the monitoring-cost hypothesis indirectly by analyzing these observable variables. Below, I first discuss the implications for wage levels.

According to human capital theory, (see Becker (1964)), wage rates depend on general and specific human capital. General human capital is a set of skills and knowledge that can be transferred from one employer to another, while specific human capital is a set of skills and knowledge that are

useful only in a specific firm. Since this theory predicts that wage levels differ among firms of different sizes because of differences in human capital, to analyze the implications of the monitoring-cost hypothesis for differences in wage rates one needs to assess its implications for human capital.

General human capital is, by definition, equally valuable in any firm. Workers are therefore expected to bear the full costs of acquiring general human capital since they take their general human capital with them when they leave the firm. If such general human capital is acquired on the job, then observed earnings would be net of investment costs (that is, observed earnings would equal the potential marginal product minus the costs to the employer of providing general training). Since such general human capital is equally valuable at all firms, workers must be paid the full return on any investments in such capital (or they will leave and find employment in a new firm).

The allocation of costs and returns between employer and employee of specific and general human capital is quite different. Since specific human capital is only valuable in the firm where it is acquired, this type of capital completely depreciates when the worker leaves the firm. Thus, if the firm had entirely borne the costs and received the benefits of such investments, the firm would lose its investment if a worker quit. Similarly, if the worker paid the entire cost of the investment and received the full benefit and then was fired, the worker would lose his capital. Becker shows that such considerations lead workers and firms to share in the costs and benefits of investments in specific human capital to ensure that both decisions to fire and to quit take into account the loss of specific human capital that would result.[10]

To summarize, human capital theory implies that observed wages depend on (opportunity) marginal products,[11] the amount of training currently being undertaken, and the share of the training costs being paid implicitly by the worker. Higher marginal products lead to higher wages as do lower workers' shares of training costs (because workers pay for their training implicitly with lower wages) and greater amounts of on-the-job general or specific training (holding constant the share of costs that are borne by the worker) lead to lower wages. Thus, all other things being equal, a given amount of specific training will lead to higher observed current wages than the same amount of general training because only a fraction of specific training costs are borne by the worker. Marginal products, of course, depend on the accumulation of human capital, and the share of the marginal product being paid to the worker depends on the share of the training costs that are borne by the worker. Wage levels thus may differ among firms of different sizes and types because of differences in the levels of their workers' general and specific human capital and differences in the provision of current general and specific training.[12]

Workers with more general human capital require less monitoring per unit of output if monitoring costs depend on the number of workers and not total output, or if there are other aspects of production in which managers' and workers' skill levels complement each other. Large firms thus should be more likely to hire highly skilled workers than small firms; that is, there should be a positive matching of more able entrepreneurs with more able workers. This consideration alone implies that larger firms would pay higher wages. However, if large firms provided sufficiently more training and this training were paid for by employees, such a training effect could conceivably offset the higher wages in large firms due to the greater skill levels of their employees.

Whether large firms would provide more on-the-job general training than small firms depends on whether training activities require more monitoring than production activities because large firms face higher monitoring costs. It seems likely that such training does require much individual attention (monitoring). If so, large firms would simply hire workers with more general training that had been acquired elsewhere. This lower rate of general human capital accumulation would lead to even greater wage differences between large and small firms. Although large firms are expected to offer more specific training (which would depress observed wages somewhat), it is unlikely this would dominate the higher wages large firms pay due to higher skill levels and their practice of providing less general training. Thus, on balance, large firms are expected to pay higher wages. Below, this hypothesis is tested.

Data and Samples

The data analyzed come from the Employment Opportunity Pilot Projects (EOPP) baseline household and employer surveys. These surveys were designed to obtain pre-program measures of a variety of variables, such as wage rates, earnings, employment, and unemployment as part of the evaluation of EOPP.[13] The household survey covered the period January 1, 1979 through the date of the interview (most interviews occurred between May and September 1980).[14]

The household survey was conducted in 10 pilot and 10 matching control sites throughout the U.S.; and the employer survey was conducted in 10 pilot sites and 19 control sites. The employer and household surveys have in common 7 pilot and 7 matching control sites where the two surveys are linked. The linked surveys are used when analyzing the household data since firm size comes from the employer survey.[15]

When analyzing differences among firms of different types and sizes in wage levels, wage growth, and turnover, all firms are classified into one of five types:

Large private business (an establishment with 500 or more employees)
Small private business (an establishment with less than 500 employees)
Government—federal, state or local
Self employed
Special government—(CETA, WIN, EOPP, Manpower or youth program)

Analysis of Firm Size on Wage Levels

To test the hypothesis that wage rates are higher in large firms, the following sorts of models were estimated:

$$\ln w = A_0 + A_1 C + B_1 D_1 + B_2 D_2 + B_3 D_3 + B_4 D_4 + e \qquad (2)$$

where: lnw is the natural log of an employee's wage rate, C is a vector of control variables, $D_i = 1$ if the job is of the ith type ($i = 1, \ldots, 4$), and the As and Bs are parameters to be estimated. In this analysis, wage rates are defined as earnings divided by hours of work, and include tips, bonuses and commissions but not fringe benefits. (There were no measures of fringe benefits in the EOPP household survey.) Three different specifications of this model, with different control sets, were estimated: one with no control variables, one with a set of 2-digit SIC industry dummies, and one with the same industry dummies and other control variables.

In the model with no control variables, B_i measures the mean difference in the natural log of the wage rate between category i and small private businesses (the excluded category). The natural-log specification is used since it fits somewhat better than a linear model, and because the coefficients can be interpreted as percentage effects (if they are small).[16] Industry control variables are included to control for possible differences in wages that might be correlated with firm size across industries. It should be noted that the coefficient estimates of the government category, when industry dummies are included, cannot be easily interpreted since government employment is largely but not entirely captured in SIC codes 91 through 97.

Finally, the complete set of control variables are added to hold observable differences in the characteristics of the individuals and their employers constant. These control variables are described in Appendix A: they include not only the usual human capital variables (education, experience, demographic characteristics) but also dummies for occupation of the worker and whether the worker was a union member. Finally, there are a number of site characteristics (unemployment rate and SMSA size). This control set is far more comprehensive than those normally available.[17]

In Table 1, the estimated coefficients of these models are presented for four demographic groups. The results from the specification with no control variables indicate that for all groups, workers in large private businesses receive considerably higher wage rates than workers in small private businesses. The effects are large and statistically significant for all groups, indicating that employees of large firms earn between 17 and 40 percent (exp. .16 = 1.17 and exp. .34 = 1.40) more than workers in small private businesses. This table also shows some statistically significant differences for other types of employers, with government workers earning less than workers in small private businesses for married men and youth, but earning more in the case of married women and single female heads. (F Tests of the joint significance of the four firm-size-and-type

variables presented in Table 1 indicate they are jointly significant at the 1% level or better.) Likewise, special government workers earn less—probably an indication of the low-paying nature of these special jobs. Self-employed married men and women earn significantly less than their counterparts in small private businesses, but there are no statistically significant differences for self-employed single female heads and youth.

These results strongly confirm the hypothesis that workers in large firms are paid more than workers in small firms.[18] These results affirm those of other researchers [see Schiller (1982), Mellow (1981), and Oi (1982)].

When industry-control variables are included, the results show similar, although generally somewhat smaller, effects. F tests indicate one can reject the hypothesis that industry has no effect on wages, holding firm size constant. This is not surprising since different industries probably have workers with different skill levels and, hence, different wages.

The results with the complete set of control variables are generally similar except that estimated wage differences are smaller, ranging from 10 to 15 percent depending on the demographic group. However, all estimated differences between large and small private businesses are statistically significant at the 1 percent level or better, except for youth for whom the effects are significant at the 5% level.

These results show that large firms do hire workers with higher levels of general human capital (since the inclusion of the human-capital control variables leads to smaller differences) than do small firms, but they also show that, even controlling for industry type and a large number of observable differences between the employees of large and small businesses, large businesses pay significantly higher wages. These results are consistent with the monitoring-cost hypothesis that large firms hire more productive workers, both in terms of higher levels of measurable characteristics and factors such as intelligence that are not observed. This would explain the smaller wage differences when

Table 1
Natural Log of Wage Rates as a Function of Employer Type
(Compared to Small Private Businesses)
(Standard Errors in Parentheses)

	Married Men			Married Women		
Sample Size	9,369			4,683		
Dependent Variable Mean (ln wage rate)	1.87			$ 1.37		
Wage Rate Mean	$ 7.33/hr			$ 4.41/hr		
	No Control Variables	**Industry Control Variables**	**All Control Variables**	**No Control Variables**	**Industry Control Variables**	**All Control Variables**
R^2	.04	.16	.38	.05	.16	.32
Large Private Business	.24*** (.018)	.19*** (.018)	.098*** (.016)	.30*** (.027)	.22*** (.027)	.14*** (.025)
Self Employed	−.16*** (.019)	−.10*** (.019)	−.21*** (.017)	−.11*** (.034)	−.07** (.034)	−.15*** (.032)
Government	−.072*** (.016)	−.005 (.019)	−.08*** (.017)	.15*** (.017)	.08*** (.022)	.02 (.020)
Special Government	−.56*** (.05)	−.44*** (.05)	−.33*** (.04)	−.15*** (.048)	−.12*** (.048)	−.05 (.044)
F Test for inclusion of additional variables	107.07***	15.66***	95.84***	55.45***	7.87***	29.21***

* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

all control variables are included, as well as the persistence of significant wage differences even after controlling for many factors.

However, the results also would be consistent with the idea that lower levels of specific or general training are being provided by large firms (whose costs are partially or fully borne by workers), although our theory predicts the opposite: that large firms provide more specific and less general training than small firms. Since training leads to more rapid wage growth, we can test this alternative theory by analyzing wage growth.

Firm Size and Type and Wage Growth on the Job

Real wage growth on a particular job, according to human capital theory, is due to the accumulation of human capital. More rapid human capital accumulation that is paid for by the employee leads to more rapid wage growth. Although we expect large firms to provide more specific training, they would provide less general training if providing general training requires relatively more monitoring than other activities. Thus, there is no strong prior reason to expect differences in wage growth between small and large firms since the more rapid wage growth in large firms due to the higher rate of specific human capital accumulation may be fully or partially offset by less rapid general human capital accumulation.

Starting and ending wage rates for hourly workers are used to analyze wage growth on a particular job. (For salaried employees, however, no measure of wage growth on the job is available, so such workers are excluded.) The empirical models employed to analyze wage growth are very similar to those used to analyze wage levels. They are of the general form:

$$\ln (w_e/w_s)/\text{length} = A_o + A_1 C + B_1 D_1 + B_2 D_2 + B_3 D_3 + B_4 D_4 + e \quad (3)$$

where: w_s = starting wage rate

w_e = ending wage rate

Table 1, continued
Natural Log of Wage Rates as a Function of Employer Type
(Compared to Small Private Businesses)
(Standard Errors in Parentheses)

Single Female Heads			Youth		
2,900			2,228		
1.37 $ 4.41/hr			1.14 $ 3.43/hr		
No Control Variables	**Industry Control Variables**	**All Control Variables**	**No Control Variables**	**Industry Control Variables**	**All Control Variables**
.08	.19	.35	.01	.16	.24
.34***	.23***	.15***	.16***	.16***	.12**
(.032)	(.034)	(.031)	(.050)	(.048)	(.047)
.0063	.03	−.01	−.07	−.06	−.04
(.052)	(.051)	(.047)	(.072)	(.070)	(.068)
.26***	.21***	.14***	−.09**	−.04	−.07***
(.021)	(.025)	(.024)	(.041)	(.042)	(.041)
−.052	−.065	−.014	−.11***	−.06*	−.02
(.043)	(.044)	(.040)	(.032)	(.035)	(.035)
61.70***	4.81***	18.32***	7.31***	5.14***	6.02***

length = length of the period (in years) over which the starting and ending wages are measured, and the D_is, A_is, B_is and C are defined as before.

The model therefore measures the relative wage growth of various sizes and types of employers compared to small private businesses. The same three specifications of the control set that were used in the wage-level regressions also are used here.

The estimates of this wage-growth model are presented in Table 2. When no control variables are included, there are no statistically significant differences in the rate of wage growth between small and large firms, with the exception of the youth demographic group. For youth, wage growth on the job is greater in large businesses. The only pattern that is consistent across demographic groups is a lower rate of growth for special government jobs.

Estimates using industry control variables only and estimates using industry, human capital and additional control variables for the reason the job spell ended, if it ended (quit, laid off, or fired) were not significantly different from those using no control variables. The one difference was that they showed no significant differences between large and small private businesses for youth.

Since wage growth does not appear to differ significantly between large and small firms, to the extent that large firms provide more specific training (which is paid for by employees) than small firms (which would lead to more rapid wage growth in large firms), it must be offset by less general training being provided by large firms. These results, along with the existence of higher wage levels in large firms, suggest that such firms are hiring more highly skilled workers (in terms of both measurable and unmeasurable characteristics), and that observed wage differences are due to differences in skill levels and not differences in on-the-job human capital accumulation. Also, if large firms do provide more specific human capital (as both theory and the empirical work on turnover presented below suggest), then these results imply that small firms provide more general training.[19] The monitoring-

Table 2
Annual Wage Growth as a Function of Employer Type
(Compared to Small Private Businesses)
(Standard Errors in Parentheses)

	Married Men			Married Women		
Sample Size	5,968			3,104		
Dependent Variable Mean (annual wage growth)	.085			.077		
	No Control Variables	**Industry Control Variables**	**All Control Variables**	**No Control Variables**	**Industry Control Variables**	**All Control Variables**
R^2	.003	.022	.06	.006	.048	.079
Large Private Business	−.0007 (.005)	−.0017 (.006)	−.0052 (.006)	.0127 (.008)	.010 (.009)	.005 (.009)
Self Employed	−.038*** (.012)	−.034*** (.012)	−.034*** (.012)	.0008 (.021)	.007 (.021)	.007 (.021)
Government	.0028 (.0061)	.0008 (.007)	−.0079 (.007)	−.02*** (.006)	−.016** (.008)	−.016** (.008)
Special Government	−.039** (.016)	−.033* (.017)	−.036** (.017)	−.0217 (.015)	−.0127 (.015)	−.015 (.015)
F Test for inclusion of additional variables	4.21***	1.42***	6.43***	4.29***	1.68***	2.71***

* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

cost hypothesis predicts higher skill levels, more specific training and less general training in large firms. Thus, these results confirm the predictions of the monitoring-cost hypothesis.

Analysis of Turnover Rates

Since the monitoring-cost hypothesis predicts more specific human capital in large firms, turnover rates should be smaller. To determine if turnover rates depend on firm size and type, models determining the (instantaneous) transition rates between employment and leaving that employment (either finding new employment or not working) are estimated.

The instantaneous rate of an event occurring, r(t), is the limit, as Δt approaches zero, of the probability of the event occurring between t and $t+\Delta t$ $[P(t, t+\Delta t)]$ per unit of time:

$$r(t) = \lim_{\Delta t \to o} \frac{P(t,t+\Delta t)}{\Delta t} \cdot \qquad (4)$$

If r(t) were constant over time, then the expected duration until the event occurs would be 1/r and the duration until the event occurs would be distributed exponentially.

This framework can be used to model various discrete events. For example, to model job turnover, let the rate of leaving employment for the *jth* person be given by r_{jk}, where k is the destination state, and k=1 indicates being fired or laid off and k=2 indicates quitting. We assume that the turnover rate depends on the type and size of the employer and various control variables:

$$\ln r_{jk} = A_{ok} + A_k C_j + B_{1k} D_{1j} + B_{2k} D_{2j} + B_{3k} D_{3j} + B_{4k} D_{4j} \qquad (5)$$

where,

D_{ij} = a dummy variable indicating a firm of size and type i.

C_j = a vector of control variables including those described in Appendix A and, in addition, 1-digit SIC industry dummies.[20]

The As and Bs are parameters to be estimated.

In this model, the rate of leaving employment depends on whether the person quits or was fired, the characteristics of the individual, and the size and type of the person's employer.[21]

The vector of parameters in equation (5) can be

Table 2, continued

Single Female Heads			Youth		
1,923			2,163		
.071			.048		
No Control Variables	**Industry Control Variables**	**All Control Variables**	**No Control Variables**	**Industry Control Variables**	**All Control Variables**
.003	.08	.13	.011	.064	.13
.011	.004	−.004	.025*	.015	.010
(.010)	(.010)	(.011)	(.013)	(.013)	(.013)
−.002	.016	.013	−.037	−.032	−.022
(.022)	(.022)	(.022)	(.025)	(.026)	(.025)
−.0006	.009	.003	−.0046	−.0035	.0019
(.007)	(.009)	(.009)	(.011)	(.012)	(.012)
−.03**	−.010	−.011	−.034***	−.021**	−.012
(.014)	(.014)	(.014)	(.008)	(.009)	(.010)
1.56	2.063***	2.51***	6.06***	1.64***	4.40***

Table 3
Turnover Rates as a Function of Employer Type
(Compared to Small Private Businesses)
(In Percentage Terms)
(Standard Errors of the Antilog of the Parameters in Parentheses)[a]

	Married Men	Married Women	Single Female Heads	Youth
Sample Size	11,197	5,637	3,319	2,867
Fraction Leaving Employment	.28	.35	.34	.54
Mean Rate (per year)	.39	.53	.53	1.51
X_2	2,556.93***	1,361.32***	855.09***	419.94***
Pseudo R_2	.05	.05	.05	.02
Large Private Business	−44.1***	−34.5***	−57.8***	−41.5***
	(4.5)	(7.7)	(7.4)	(10.9)
Self-Employed	−42.1***	−46.1***	−46.9***	−53.2***
	(4.1)	(5.7)	(9.8)	(10.2)
Government	−48.7***	−29.5***	−36.9***	−14.1
	(4.1)	(5.4)	(6.4)	(11.1)
Special Government	6.4	6.3	−32.0***	18.4
	(16.9)	(15.4)	(10.5)	(12.7)

[a] The coefficients in this table are percentage effects calculated as $((e^b - 1)100)$, where b is the maximum likelihood estimate of the coefficient of a log-linear rate model, similar to that described by equation (5).

* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

Table 4
Voluntary and Involuntary Turnover as a Function of Employer Type
(Compared to Small Private Businesses) — (In Percentage Terms)
(Standard Errors in Parentheses)

	Married Men		Married Women	
	Fired/Laid off	Quit	Fired/Laid off	Quit
Sample size	11,019		5,466	
Fraction Leaving Employment	.11	.16	.08	.25
Mean Rate (per year)	.15	.22	.12	.38
x^2	1555.06***	1338.44***	543.73***	1098.89***
Pseudo R^2	.07	.04	.07	.05
Large Private Business	−29.8***	−54.4***	−4.9	−40.4***
	(7.9)	(5.6)	(21.9)	(8.5)
Self Employed	−31.3***	−49.8***	−35.3	−52.2***
	(8.00)	(4.8)	(14.9)	(6.1)
Government	−64.2***	−43.8***	49.2**	−54.4***
	(5.7)	(5.7)	(21.0)	(4.8)
Special Government	−12.4	16.0	32.8	−5.4
	(23.4)	(24.3)	(39.1)	(17.3)

* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

estimated by the method of maximum likelihood using individual data on observed lengths of employment spells.[22] The observed length of employment (in a particular job) equals the last time the person is employed (either when the person leaves his or her job or when the observation period ends) minus the time the person is first employed in that job (or July 1, 1979, depending on which is later).

In Table 3, we present the results of a simplified version of the model described by equation (5) in which there is only one destination state—leaving the current job. Mean annual turnover rates (from a rate model with only a constant term) show that turnover rates are relatively high in our sample, ranging from .39 per year for men to 1.51 per year for youth. Since the inverse of the turnover rate gives the expected duration at that particular job, these numbers imply lengths of employment at a particular job ranging from 2.56 years for married men to .66 years for youth.[23]

The results in this table strongly suggest that small businesses have much higher turnover rates than large businesses, government, or the self-employed. For example, for married men, turnover rates are 44 percent less in large businesses than small businesses, and for single female heads they are 58 percent less. The only type of employer that has higher turnover rates than small private firms is special government programs, which is not surprising given that the intention of these programs is to provide short-term employment. These results also suggest that turnover rates are not, in general, significantly different among the government, the self-employed, and large private businesses.

In Table 4, we present the coefficients of the turnover model described by equation (5), which is identical to the model in Table 3 except that quits are distinguished from lay-offs. Sample sizes are somewhat lower because some observations lacked information on why a job ended. The results suggest that for all demographic groups, quit rates are considerably higher than fire/lay-off rates, with the smallest differences for married men and the largest differences for youth. These results also suggest that large private businesses have lower quit rates and lower fire/lay-off rates than small businesses, with somewhat larger differences for quit rates. Both the self-employed and large private businesses generally have lower quit and fire/lay-off rates than small businesses. Not unexpectedly, the

Table 4, continued

Single Female Heads		Youth	
Fired/Laid off	Quit	Fired/Laid off	Quit
3,250		2,814	
.09	.24	.15	.38
.14	.37	.42	1.06
363.27***	604.33***	286.57***	308.47***
.07	.05	.04	.02
−47.8***	−61.9***	−21.5***	−50.1***
(16.8)	(8.33)	(26.6)	(11.7)
−50.3***	−43.1***	−78.4***	−60.00***
(19.5)	(12.2)	(7.3)	(10.6)
−18.2	−48.7***	34.2	−33.7***
(16.1)	(6.6)	(27.8)	(11.4)
8.6	−47.6***	98.0***	−22.2*
(27.6)	(10.7)	(32.4)	(12.0)

government has lower fire/lay-off rates than large private businesses.

The results in Tables 3 and 4 are consistent with the hypothesis that large private firms provide more specific training than small businesses. Since specific human capital is fully depreciated when a worker leaves, both the firm and the worker have an incentive to avoid this potential loss of wealth. Much smaller turnover rates for large firms are consistent with the notion that large firms provide more specific on-the-job training than small firms. Also, we find that small firms generally have the highest turnover rates of all five categories of firms analyzed. This suggests that very little specific human capital is accumulated by workers in small firms.

However, the fact that the self-employed have significantly lower turnover rates than employees of small businesses indicates that owners of small businesses are much less likely to quit and close their businesses than the employees of small businesses are likely to leave. This is consistent with the notion that many owners of small businesses have substantial specific capital, both human and physical, invested in their businesses.

IV. Summary and Conclusions

After controlling for industry type and a large number of individual characteristics, we find striking differences in wage levels and turnover among different-sized firms. Large private businesses pay significantly higher wages than small private businesses. However, no significant differences are found between the *rates* of wage growth of large and small businesses. This suggests that large private firms are hiring more highly skilled workers, both in terms of measurable and unmeasurable characteristics, than small private firms, and that the observed wage differences are due to differences in levels of human capital, not differences in the rate of accumulation. This is consistent with the hypothesis that large firms hire more highly skilled workers because such workers have lower monitoring costs (per unit of output). The finding that large firms also have significantly lower turnover than small firms supports the hypothesis that large firms have more rigid and specialized methods of production and therefore provide more on-the-job training. These results taken together provide strong support for the hypothesis that, even holding constant industry, occupation and various individual characteristics, employment practices depend strongly on firm size.

To summarize, large firms hire more highly skilled workers and consequently pay higher wages, provide more specific on-the-job training, provide less general on-the-job training, and retain their workers much longer than small firms. Stochastic models of firm size (taken at face value) are not consistent with these systematic differences among firms of different sizes. Thus, the results in this paper support the monitoring-cost hypothesis.

The evidence supports the notion that firm size does matter—that firm size is the result of a deterministic process depending on the distribution of managerial or entrepreneurial talents, the economics of a hierarchical organization of production within firms and the costs of monitoring workers' performance. This model of the firm also explains the skewed distributions of firm size within industries, why large and small firms coexist, and suggests that there may be economic losses associated with public policies that prohibit firms from attaining their optimum size.

Appendix A
Control Variables Employed in the Wage-Level Regression

Site Characteristics

Large SMSA dummy (population over 1 million)
Small SMSA dummy (population under 1 million)
Not SMSA dummy—excluded category
Site unemployment rate

Spell Characteristics

Dummy for spell being truncated by the end of the period
Duration of the spell
Dummy for spell being truncated at 7-1-79
Dummy for job coming from 2-job file
Dummy for job being continued from prior spell

Demographic Characteristics

Race dummy for Black
Race dummy for Hispanic
Low-income strata dummy (from EOPP survey)
Age in years
Number of persons in the family

Human Capital Variables

Disability dummy for disability that limits the amount of work
Number of years of school
Number of years worked since age 17
Number of years worked squared

Occupation Characteristics

Dummy for union member
Dummy for occupation executive/administration
Dummy for occupation engineer/scientist/doctor
Dummy for occupation teacher/librarian
Dummy for occupation health technician/ nurse/pharmacist
Dummy for occupation marketing/sales
Dummy for occupation clerical
Dummy for occupation service
Dummy for occupation transportation
Dummy for occupation mechanical
Dummy for occupation production
Dummy for occupation not known because person was not working when occupation question was asked (excluded occupations include material handler, technologists, writer/artist, and any unknown occupations)

Income and Labor Force Characteristics

Dummy for not working first half of 1979
Dummy for receiving AFDC first half of 1979
Dummy for receiving UI first half of 1979
Dummy for receiving Food Stamps first half of 1979
Non-Labor income first half of 1979

FOOTNOTES

1. There is also concern about the concentration of political power as well as the distribution of income that would result from such concentration.

2. For example, it is widely believed that public utilities represent natural monopolies, which, if unregulated, would restrict output and charge higher prices to consumers.

3. For example, the government's IBM case was brought primarily because of IBM's large market share in mainframe computers.

4. See Lester Thurow, "Abolish the Antitrust Laws," **Dun's Review** (February 1981, p. 72.)

5. See Baumol (1982) for a recent discussion of industry structure that emphasizes the technology of production. Viner (1932) originally developed this theory of market structure.

6. Data are from the first wave of the employer survey that was performed as part of the evaluation of the Employment Opportunity Pilot Projects (EOPP). See Section IV for a description of the data.

7. In the data set analyzed, the 4-digit SIC code resulted in 548 different categories of firms (i.e., industries) out of a sample of 5271 observations.

8. See Stigler (1958), Simon and Bonini (1958), Hoit and Prais (1956), and Ijiri and Simon (1964).

9. Studies by Hart and Prais (1956), Simon and Bonini (1958), Quandt (1966) and Ijiri and Simon (1964) all show that the distribution of firm-size within specific industries is skewed. Analysis of the EOPP data indicates that the firm-size skewness in banking is less than most, but not all, other industries defined at the 2-digit SIC level.

10. This framework has been used by Pencavel (1972) to explain differences in turnover rates.

11. That is the marginal product that could be achieved if no time were devoted to training. Opportunity marginal products themselves depend, of course, on the accumulation of both general and specific human capital.

12. Another reason why observed wages may differ among firms is because of differences in the nonpecuniary

conditions of work. For example, Masters (1969) has argued that large firms have to pay higher wages because of their more rigid and inflexible working schedules. However, one can think of many cases where the working environment is superior in large firms.

13. EOPP was designed to test a structured job-search program combined with a work and training program that was a key part of President Carter's welfare reform proposal. The program began in some sites on a very limited basis in the summer of 1979 but was not into full operation until the summer of 1980. The program never reached the scale of operation originally intended and was soon phased out during 1981 under the Reagan Administration. However, the operations and purpose of this program are not pertinent to this study in which only preprogram data are analyzed.

14. An important characteristic of the sample is that the period covered by the interview (January 1, 1979 through June 1, 1980, on average) is artificially divided into a six-month "control" period from January 1, 1979 through June 30, 1979, and an analysis period from July 1, 1979 through the end of the interview. This is done because the statistical models employed in this paper are based on the assumption that variables measured during the first six-month period are exogenous with respect to the dependent variables that are analyzed during the second period. If such variables were calculated during the analysis period it might be difficult to infer the direction of causality.

15. In this study, firm size is from the employer survey. Since all firms with 500 or more employees were included in the sample frame of the employer survey, it is possible to determine firm size for the employers of all individuals in the household survey by inference. Thus, samples are many times larger than they would have been were we to restrict the analysis to only matching cases. Only 6,788 jobs in the household survey were matched to the employer survey out of approximately 35,000 jobs. For all matching cases, firm size is taken directly from the employer survey and for all non-matches firm size can be inferred to be less than 500, assuming that the matching was done accurately. For matching cases, firm size is taken from the employer survey sample records, which contain information on the entire sample frame of employers in the sites common to both the household and employer surveys regardless of whether the employer survey was actually completed.

16. Since $\ln w_{Di=1} - \ln w_{Di=0} = Bi$, the exponential of the coefficient is the ratio of the wage when Di = 1 to the wage when Di = 0. That is,

$$\ln\left[\frac{{}^{w}Di = 1}{{}^{w}Di = 0}\right] = B_i, \text{ or } \frac{{}^{w}Di = 1}{{}^{w}Di = 0} = \exp B_i \quad .$$

17. In addition to these sorts of control variables there are also variables that hold constant various ways in which the observations were created. There is control for left- and right-censoring of the spell whether the job was continued from a previous spell, whether the job was from the 2-job spell file (indicating that the person held 2 jobs at least part of the time during which the job in question is being analyzed), and whether this job was a second job (indicating that two jobs were held and that the job being analyzed is less important in terms of hours worked).

18. Workers in large private firms also earn more than government workers or self-employed workers.

19. Schiller (1982) finds that workers in small firms have more rapid rates of wage growth than workers in large firms for new entrants to the labor force. This evidence is also consistent with the notion that small firms provide more general training.

20. Two digit SIC industry dummies were not used in the analysis of turnover because of computational cost.

21. This equation is based on a number of assumptions. For example, it assumes that the explanatory variables and their coefficients do not vary over time, that the rate of leaving employment does not depend on the length of time of employment, that the rate of leaving one spell is independent of characteristics of previous spells and that unobserved variables do not affect the rate (heterogeneity). By including a large number of variables in C, we hope to account for some of these effects.

22. If we define e_j to equal one if individual j is observed leaving his or her job due to being fired or laid off and zero otherwise, o_j to equal one if individual j is observed leaving his or her job due to quitting, and zero otherwise and then the likelihood function, assuming independence among length of spells, may be written as:

$$L = \prod_{J=1}^{n} \left[r_{1j}\, H(t_j)\right]^{ej} \left[r_{2j}\, H(t_j)\right]^{oj} \left[H(t_j)\right]^{1-ej-oj}$$

where $$H(t_j) = \exp\left[-r_{1j}t_j - r_{2j}t_j\right]$$

is the probability the individual is still employed at the same job at time t_j is the length of the observed spell. Maximization of L with respect to the Bs from the above equation gives the maximum likelihood estimates of the Bs. For further details on the structure of this model, see Tuma (1976), Tuma and Robins (1980), or Tuma, Hannan, and Groeneveld (1979).

23. Very high turnover rates for youth are one reason why youth have such high observed unemployment rates.

REFERENCES

Alchian, Armen A., and Harold M. B. Demsetz, "Production, Information Cost and Economic Organization," **American Economic Review**, Vol. 62, Dec. 1972, pp. 777-795.

Baumol, W. J., "Contestable Markets: An Uprising in the Theory of Industry Structure," **American Economic Review**, Vol. 72, No. 1, 1982.

Becker, Gary S., **Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education**, New York: National Bureau of Economic Research, 1964.

Coase, Ronald, "The Nature of the Firm," **Economica**, Vol. 4, 1937, pp. 386–405.

Federal Deposit Insurance Corporation, **1981 Statistics on Banking**, Office of Public Information, FDIC, Washington, D.C., 1982.

Feller, William, **An Introduction to Probability Theory and its Applications**, 3rd Edition, New York: John Wiley and Sons, 1968.

Fox, H., **Top Executive Compensation**, (1978 Edition), New York: National Conference Board, 1978.

Gibrat, R., **Les Inegalites Economiques**, Paris: Recueil Sirey, 1931.

Hart, P.E., and S.J. Prais, "An Analysis of Business Concentration," **Journal of the Royal Statistical Society**, Ser. A, Vol. 119, Pt. 2. 1956, pp. 150–181.

Hymer, Stephen and Peter Pashigian, "Firm Size and Rates of Growth," **Journal of Political Economy**, Vol. LXX, No. 6, December 1962, pp. 556–569.

Ijiri, Y. and H. A. Simon, "Business Firm Growth and Size," **The American Economic Review**, Vol. 54, No. 2, March 1964, pp. 77–89.

Keeley, Michael C., and Philip K. Robins, "Job Search and the Duration of Unemployment," SRI International, November 1982.

Lewellen, W. G., and B. Huntsman, "Managerial Pay and Corporate Performance," **American Economic Review**, Vol. 60, No. 4, 1970.

Lucas, Robert E., Jr., "On the Size Distribution of Business Firms," **The Bell Journal of Economics**, Vol. 9, pp. 508–523, Autumn 1978.

Lester, R.A., "Pay Differentials by Size of Establishment," **Industrial and Labor Relations Review**, Vol. 7, No. 167, pp. 57–67.

Masters, Stanley H., "An Inter-Industry Analysis of Wage and Plant Size," **Review of Economics and Statistics**, Vol. 51, August 1969, pp. 341–345.

Mellow, Wesley, "Employer Size and Wages," Washington, DC: Bureau of Labor Statistics, draft, 1981.

Oi, Walter, "The Fixed Employment Costs of Specialized Labor," Working Paper No. E-82-16, The Hoover Institution, Stanford, California, June 1982b.

Oi, Walter, "Heterogeneous Firms and the Organization of Production," Working Paper No. E-82-10, The Hoover Institution, Stanford, California, April 1982a, and **Economic Inquiry**, Vol. XXI, No. 2, April 1983.

Pencavel, John H., "Wages, Specific Training, and Labor Turnover in U.S. Manufacturing Industries," **International Economic Review**, Vol 13, No. 1, February 1972.

Quandt, Richard E., "On the Size Distribution of Firms," **American Economic Review**, Vol. LVI, No. 3, June 1966.

Roberts, D.R., "A General Theory of Executive Compensation Based on Statistically Tested Propositions," **Quarterly Journal of Economics**, Vol 20, 1956, pp. 270–294.

Rosen, Sherwin, "Output, Income and Rank in Hierarchical Firms," Working Paper No. E-81-10, The Hoover Institution, Stanford, California, August 1981a.

Rosen, Sherwin, "The Economics of Superstars," **American Economic Review**, Vol. 71, No. 5, December 1981b.

Rosen, Sherwin, "Authority, Control and the Distribution of Earnings," **The Bell Journal of Economics**, Vol. 13, No. 2, Autumn 1982, pp. 311–323.

Schiller, Bradley R., "Human Capital Transfers from Small to Large Businesses," research report prepared for the Office of Economic Research, U.S. Small Business Administration, June 1982.

Simon, Herbert A., and Charles P. Bonini, "The Size Distribution of Business Firms," **American Economic Review**, Vol. XLVIII, No. 4, September 1958, pp. 607–617.

Stigler, George J., "The Economics of Scale," **Journal of Law and Economics**, Vol. 1, Oct. 1958.

Stigler, George, **The Organization of Industry**, Richard D. Irwin: Homewood Ill., 1968.

Stoikov, Vladimir and Robert L. Raiman, "Determinants of Differences in the Quit Rate Among Industries," **American Economic Review**, Vol. LVIII, No. 5, Part 1, December 1968.

Tuma, Nancy B., "Rewards, Resources, and the Rate of Mobility," **American Sociological Review**, Vol. 41, April 1976.

Tuma, Nancy B., Michael Hannan, and Lyle Groeneveld, "Dynamic Analysis of Event Histories," **American Journal of Sociology**, Vol. 84, No. 4, 1979.

Tuma, Nancy B., and Philip K. Robins, "A Dynamic Model of Employment Behavior: Evidence from the Seattle and Denver Income Maintenance Experiments," **Econometrica**, 1980.

Viner, J., "Cost Curves and Supply Curves," **Zeitschrift für Nationalokonomie**, Vol. 3, 1932, pp. 23–46.

Williamson, O.E. "Hierarchical Control and Optimum Firm Size," **Journal of Political Economy**, Vol. 75, 1967, pp. 123–138.