BLS WORKING PAPERS

U.S. DEPARTMENT OF LABOR
Bureau of Labor Statistics

OFFICE OF EMPLOYMENT AND UNEMPLOYMENT STATISTICS

Occupation-Specific Human Capital and Local Labor Markets

Jeffrey A. Groen, U.S. Bureau of Labor Statistics

Working Paper 376
February 2005

Occupation-Specific Human Capital and Local Labor Markets

Jeffrey A. Groen*

Bureau of Labor Statistics
2 Massachusetts Ave. NE, Room 4945
Washington, DC 20212
E-mail: Groen.Jeffrey@bls.gov

January 25, 2005

Abstract

Most skills acquired through on-the-job training may be specific to an occupation and therefore transferable to some but not all firms. This paper explores the relationship between the size of the local market for an occupation-specific skill and job-training outcomes. The Stevens (1994) model of training predicts that as market size increases, job turnover increases and training becomes more general. I test these predictions using data on blue-collar workers and variation in market size across U.S. metropolitan areas. The empirical results support the theoretical predictions and the impacts are most relevant at low levels of market size.

JEL Categories: J24, J63, J61. Keywords: on-the-job training, occupation, human capital, local labor markets, market size.

* I have benefited from comments by seminar participants at the University of Michigan, Syracuse University, Cornell University, Indiana University, SUNY-Binghamton, the Bureau of Labor Statistics, the Federal Reserve Bank of Cleveland, and the Society of Labor Economists meetings. I am grateful for conversations and detailed comments from Dan Black, John Bishop, John Bound, Charles Brown, Julie Cullen, Jed DeVaro, Keenan Dworak-Fisher, George Jakubson, Anne Polivka, Stephen Salant, Lucie Schmidt, and Michelle White. I thank the Population Studies Center of the University of Michigan and the Cornell Higher Education Research Institute for financial support. The views expressed in this paper do not necessarily reflect the policies of the Bureau of Labor Statistics or the views of other BLS staff members.

1. Introduction

Previous research on the economics of job training has been guided by Becker's (1964) distinction between skills that are specific to a given firm and skills that are completely general. While this distinction has been valuable at a conceptual level, it fails to describe the full range of training empirically. Most skills learned on the job may be somewhere between the extremes of firm-specific and general; that is, the skills are transferable to some but not all firms. In particular, some skills are specific to the type of work one does. I show that when workers are imperfectly mobile across geographic areas, the nature of such occupation-specific skills depends on the local economic environment. This paper explores the relationship between the size of the local market for an occupation-specific skill and job-training outcomes.

Becker's (1964) model of job training predicts sharp differences in training outcomes between general and firm-specific skills. For example, the model predicts that workers bear the entire costs of general skills training but share with their employer the costs of firm-specific skills. These differences suggest that the size of the local labor market might have fundamental effects on training decisions for occupation-specific skills. Recent theoretical work by Stevens (1994) provides a framework for investigating these effects. She generalizes the Becker model to encompass the case of "transferable" training, which "is of some value to at least one firm in addition to the training firm" (p. 540). Consideration of transferable training, Stevens shows, leads naturally to issues of imperfect competition in the labor market.

Two other areas of research provide motivation for this paper. Recent empirical studies on wage determination provide evidence that occupation- and industry-specific skills play a significant role in earnings. It is well-known that wages rise during a worker's tenure with an employer (e.g., Topel 1991). However, recent evidence indicates that much of the apparent return to employer tenure is in fact due to the accumulation of industry- and/or occupation-specific experience. Evidence from Neal (1995) and Parent (2000) on wage growth with industry experience suggests the importance of industry-specific human capital. On the other hand, Kambourov and Manovskii (2002) document substantial wage returns to occupational experience and emphasize occupation-specific human capital.[1]

A second area of research maintains Becker's distinction between firm-specific and general skills, but challenges the assumption of perfect competition. In Becker's model, firms do not pay for general skills training because workers receive the benefits of training in the form of higher wages from other firms. However, in practice firms seem to pay for some general skills training. As a result, several authors have constructed theoretical models to explain firm-sponsored general training (Acemoglu and Pischke 1998, 1999; Autor 2001). As Acemoglu and Pischke (1998, p. 80) explain, "in order to explain firms' investments in general skills, some labor market imperfection must exist so that the mobility of workers is restricted and that employers earn rents on trained workers." In the present paper, the relevant imperfection is limited geographic mobility of workers. This force, together with the specialization that comes with training in occupation-specific skills, provides firms some market power and thus an incentive to invest in transferable

[1] Neal (1995) looks at displaced workers and finds that the wage cost of switching industries is strongly correlated with pre-displacement measures of both work experience and tenure. Parent (2000) adds a measure of experience in the current industry to a wage-tenure regression and finds that the return to tenure with the current employer is reduced markedly. Kambourov and Manovskii (2002) find that when occupational experience is also taken into account, it is occupational experience rather than industry experience that is of primary importance in explaining wages.

skills. More generally, this is one example of recent interest within labor economics in issues of imperfect competition and market power (Bhaskar, Manning, and To 2002).

The next section outlines Stevens' (1994) model of on-the-job training. The model predicts that as market size increases, job turnover among trained workers increases and training becomes more general. Section 3 describes my empirical strategy for testing these predictions using data on blue-collar workers and variation in market size across U.S. metropolitan areas. Section 4 relates market size to job turnover using data from the Current Population Survey. Section 5 relates market size to the generality of training using data from the National Longitudinal Survey of Youth and the Employment Opportunity Pilot Project survey of firms.

The empirical results support the theoretical predictions: in thicker markets, job turnover is greater and training is more general. In each case, the effects of market size are most important at low levels of market size. This suggests that the Stevens model is most relevant to cases where occupation-specific skills are transferable to a relatively small number of firms.

2. Theory

2.1 Description

In this section, I summarize the Stevens (1994) model of job training. For the present purpose, consider the labor market as a metropolitan area in which the workers are limited to working in that area. In this metropolitan economy, there are many workers and firms, and we assume constant returns to labor within a firm. This allows us to focus on the training decisions at a single firm, called firm 0. Initially, all workers are untrained and have constant productivity, initialized to zero, in all firms. A random group of these workers is attached to firm 0.

The timing of the model is as follows. There are two periods: a training period and a work period. In the first period, each worker and firm 0 decide whether or not to train and, if so, choose the level of training. The level of training is chosen to maximize the joint return of the worker and firm, net of training costs. At the start of the second period, the worker enters the labor market and then works for the training firm or some other firm.

The firm offers a type of training that is potentially useful in *n* other firms in the metropolitan area. The post-training productivity of the worker is given by the vector

$$v = (v_0, v_1, v_2, ..., v_n, 0, 0, ...) , \tag{1}$$

where $i = 1, ..., n$ indexes the other firms that employ the skill in the area. The size of the external market, *n*, is taken to be exogenous. To generate the possibility of labor turnover, the model makes the productivity components v_i uncertain during training. This reflects uncertainty about either the worker's productivity within a firm or the future demand for a firm's output. Productivity is realized at the start of the second period.

The training consists of two elements: a transferable element and a specific element. The transferable element $m \geq 0$ is equally useful in the training firm and the n other firms, while the specific element $a \geq 0$ is useful only in the training firm. As a result, the expected value of the training is equal in all external firms, but may be greater in the training firm:

$$E(v) = (m + a, m, m, ..., m, 0, 0, ...) . \tag{2}$$

The random shocks are represented by independent and identically distributed random variables ε_i, $i = 0,1,...,n$, with mean zero and support $[-1,1]$.[2] Therefore, the complete productivity vector is:

$$v = (m + a + \varepsilon_0, m + \varepsilon_1, m + \varepsilon_2, ..., m + \varepsilon_n, 0, 0, ...) . \tag{3}$$

The cost of providing a level of training (m, a) is given by the function $C(m, a)$, which is increasing and convex in m and a. This cost represents both the direct financial cost of the training and the foregone output of the worker during training.

After becoming trained, the worker enters the labor market and can work for the training firm or any of the n external firms. At this stage, the worker's true productivity in each firm is revealed and becomes public knowledge. Each of the $n+1$ firms makes simultaneous wage offers to the worker and the worker chooses to work for the firm offering the highest wage. Since the worker's true productivity varies across firms, firms have some market power over trained workers. As the outcome of the bidding, the worker works at the firm at which he has the highest productivity, at a wage equal to the next-highest productivity among the other firms.

Since firms have market power over trained workers, each of the external firms shares in the expected returns to the training. Even though it doesn't pay for the training, an external firm benefits from it if the worker's realized productivity is highest in the firm. This feature distinguishes the model from the Becker model of investment in general and

---

[2] The independence assumption is convenient, but it is only necessary that the shocks are not perfectly correlated across firms. For instance, the shocks might be industry-specific and arise from variation in product demand. Since most occupations are employed in more than one industry, this would produce a pattern where the shocks are not perfectly correlated across the set of firms that are relevant for a given trained worker.

firm-specific skills, in which the training firm and the worker share the full amount of the return.

2.2 Predictions

This paper tests two predictions of the Stevens model. The first prediction is that job turnover increases with market size. The second prediction is that training becomes more general as market size increases. This section highlights the mechanisms behind these predictions; for a more formal treatment, see Stevens (1994) and Appendix A of the present paper.[3]

The first prediction of interest concerns job turnover – the movement of the worker from the training firm to one of the external firms in the second period. In the model, turnover depends on the number of external firms (i.e., market size) and the training levels chosen, and these training levels may also depend on market size. As market size increases, the model predicts that turnover increases. This prediction operates through two channels: a direct effect and an indirect effect.

The direct effect is the impact of market size on turnover for a given level of training. As market size increases, there are more competitors for workers from the training firm. Therefore, it is more likely that the worker's highest realized productivity will be in one of the external firms. The indirect effect of market size on turnover reflects the impact of market size on the choice of training levels. In a larger market, turnover is greater (via the direct effect) and therefore there is a smaller incentive to invest in the specific element. Reducing the specific element increases turnover even further and thus

[3] In Appendix A, I analyze a special case of the model in which there is no specific element and the random shocks are uniformly distributed.

the indirect effect reinforces the direct effect. The combined effect is that job turnover increases with market size.

In contrast to the specific element, the choice of the transferable element m does not depend directly on market size. Due to the separability of the shocks and m in the production function, the marginal benefit of an increase in m is independent of market size n. An increase in m increases the worker's expected productivity in each of the $n+1$ firms, raising the worker's wage in proportion to the increase in m without affecting the returns to any of the firms (i.e., the marginal benefit of m is equal to 1). As a result, market size can affect the choice of m only via interactions with the specific element a in the cost function $C(m,a)$. If, for example, m and a were separable in the cost function, then the equilibrium level of m would be independent of market size.

The second prediction of interest in the model concerns the relationship between market size and training levels. As I have explained, the primary impact of market size is on the specific element rather than the transferable element. In the empirical work, I base my test on the share of total training that is transferable as opposed to specific, i.e., $m/(m+a)$. The model clearly predicts that the specific element a decreases with n, while the relationship between n and the transferable element m depends somewhat on the cost function. Assume that the cross-partial of the cost function is non-negative: $\partial^2 C / \partial a \partial m \geq 0$. Then the equilibrium level of m is either independent of n or increasing in n. As a result, the model predicts that $m/(m+a)$, which I call the "generality of training," is increasing in n.[4]

The impact of market size on the wages of trained workers is perhaps surprising. When market size increases, wages do not necessarily increase due to the combination of two opposing effects. First, an increase in market size creates more competition for trained workers and increases wages. Second, the specific element is smaller with a larger market, leading to lower productivity in the training firm and thus lower wages. The same ambiguity would likely translate to the wage-tenure profile, which further depends on how training costs are divided between the worker and the training firm.

2.3 Comparison to Other Models

In preparation for testing the predictions of the Stevens model, it is useful to compare the predictions to those of other models. My primary goal in this section is to discuss alternative explanations for the predictions of the Stevens model on turnover and type of training. These explanations come from two sources: other models of training and models of labor-market search.

Becker's (1964) model of training doesn't explicitly consider the role of market size, but he made some conjectures that turn out to be consistent with Stevens' predictions on turnover and the generality of training. Becker assumed a perfectly competitive labor market and considered the polar cases of general and firm-specific training. With general training, firms would not care about turnover of trained workers, since workers would bear the full costs of their training. With firm-specific training, on the other hand, firms would

[4] In general, the relationship between m and n depends on the sign of $\partial^2 C/\partial a \partial m$. My assumption that $\partial^2 C/\partial a \partial m \geq 0$ is sufficient but not necessary for generality to be increasing in n. If $\partial^2 C/\partial a \partial m < 0$, m is

lose their investments if trained workers left the firm. Therefore, he suggested that firms would share with workers some of the returns to firm-specific training (and, hence, some of the costs) in order to reduce the chances of turnover.[5]

Becker acknowledged that much on-the-job training is neither firm-specific nor completely general, but he argued that such training can be considered as "the sum of two components, one completely general, the other completely specific" (p. 44).[6] In the case where training is transferable to a small number of firms, Becker said that the effect on training is "difficult to assess," but conjectured that such training would be more like specific training than general training because of the monopsony power held by firms (pp. 50-51). Combining these conjectures, Becker's model would predict that as market size increases, the role of general training becomes more important and, as a result, turnover increases.[7]

In addition to models of training,[8] models of search and matching within an urban context might generate predictions similar to the Stevens model for the relationship between turnover and market size. Since search costs are presumably lower in larger markets, static models of search (e.g., Wheeler 2001) predict that workers and firms are

---

decreasing in n but generality would still be increasing in n if the change in a dominates the change in m.

[5] Hashimoto (1981) arrives at the same conclusion, but argues that sharing results from concerns about transactions costs rather than turnover.

[6] While Becker's claim provides good intuition in many cases, it is not generally true. Stevens (1994) shows that some transferable training cannot be considered strictly a sum of general and firm-specific components.

[7] In terms of wages, Becker's model is not consistent with the prediction of the Stevens model on wages. Working through the intuition of the Becker model, one would expect that the wage-tenure profile becomes steeper with a larger market, since training becomes more general and the wage-tenure profile is steeper for general skills. However, the impact of market size on wages in the Stevens model is ambiguous, as explained above.

[8] Acemoglu and Pischke (1998, 1999) develop models to explain firm-sponsored general training. However, their models involve perfect competition among employers, so the models don't have any implications about

more suitably matched in larger areas.[9] In a dynamic setting, lower search costs might also lead to greater turnover in larger markets, but this would seem to depend on how agents learn over time about the quality of their matches. In particular, one would expect search considerations to be important for young workers, since they are actively learning about their abilities and interests.

3. Empirical Strategy

My empirical work tests two predictions of the Stevens model: as market size increases, (1) job turnover among trained workers increases and (2) the generality of training increases. My empirical strategy relies on variation in market size across metropolitan areas. This approach treats the worker's current area as the relevant labor market. To support this, I limit my analysis to blue-collar workers, who are less geographically mobile than are other workers. The working assumption is that these workers are perfectly mobile *within* their local labor market but immobile *across* markets. Mobility across areas is limited by costs involved in changing residences and searching for jobs in a different area.

Some evidence on the limited mobility of blue-collar workers is presented in Table 1. Over both the 1-year and 5-year periods ending in 1990, blue-collar workers had lower rates of mobility across states than did workers in other occupations. Between 1985 and 1990, for example, data from the 1990 Census of Population indicate that 7 percent of blue-collar workers moved between states, compared to 13 percent among white-collar workers and 10 percent among workers in clerical, sales, or service occupations.

---

the role of market size on training. In addition, all training is perfectly general in their models and therefore they do not address the balance of general and specific training.

3.1 Defining Local Labor Markets

I define local labor markets using metropolitan areas. The general concept of a metropolitan area (MA) is "that of a core area containing a large population nucleus, together with adjacent communities that have a high degree of economic and social integration with that core" (U.S. Bureau of the Census 1994, p. 13-1). More concretely, MAs contain one or more central counties and may include outlying counties with a close connection to the central counties, based on commuting patterns and population density. MAs are a suitable construct for local labor markets because workers generally can change jobs within an MA without changing their residence. MAs range in total population from around 50,000 to 1 million or more.

The federal government distinguishes between three types of MAs: metropolitan statistical areas (MSAs), primary metropolitan statistical areas (PMSAs), and consolidated metropolitan statistical areas (CMSAs). The MSAs represent relatively free-standing metropolitan areas, while the CMSAs represent large metropolitan regions that contain two or more PMSAs. For example, the Washington-Baltimore CMSA contains the Washington, DC PMSA; the Baltimore, MD PMSA; and the Hagerstown, MD PMSA. I use a combination of MSAs and PMSAs in this analysis. In combining data from various sources, I use consistent definitions of metropolitan areas as of June 30, 1997. At this time, there were 328 MAs in the 50 states and the District of Columbia, including 255 MSAs and 73 PMSAs.

I classify blue-collar workers into detailed occupations using the occupational classification system developed for the 1990 census. I start with 3-digit occupations within

---

[9] Another benefit of pooling workers and firms in cities is to reduce risk associated with industry-specific

the broad categories of "Precision Production, Craft, and Repair Occupations" and "Operators, Fabricators, and Laborers." In line with the theory, I drop occupations that don't require much in the way of training – for example, helpers and laborers. I also drop codes for supervisors of blue-collar workers and non-specific codes such as "not elsewhere classified." I combine some closely related occupations into a single category in order to avoid small cells and to make the data comparable with the OES classification system (described below). Finally, I drop occupations for which the market definition is problematic.[10] This leaves 103 occupations; examples are aircraft engine mechanics, carpenters, tool and die makers, and printing press operators.

3.2 Measuring Market Size

I construct measures of market size for each occupation in each MA using 1998 data from the Occupational Employment Statistics (OES) survey. The OES survey is an annual mail survey from the Bureau of Labor Statistics measuring occupational employment and wages for wage and salary workers in non-farm establishments, by industry.[11] The OES survey samples and contacts approximately 400,000 establishments each year and, over 3 years, contacts approximately 1.2 million establishments. The 1998 data are therefore based on survey results from 1996, 1997, and 1998.

---

shocks (Simon 1988; Diamond and Simon 1990).

[10] That is, workers in those occupations are likely to switch to a different occupation or move to a different area. These judgments are based on tabulations from the March CPS (see Section 4.1). Occupational mobility is judged by comparing occupation at the time of the survey to occupation in the longest job in the previous year. Geographic mobility is judged by comparing state of residence at the time of the survey to state of residence in the previous year.

[11] An establishment is defined as an economic unit that processes goods or provides services, such as a factory, store, or mine. The establishment is generally at a single physical location and is engaged primarily in one type of economic activity. The OES survey includes establishments in most industries, but excludes those in agricultural production, forestry, fishing, the postal service, and the federal government. For the micro-level data sets used in connection with the OES data, I exclude workers in those industries from the analysis.

The OES data provide a measure of market size that is consistent with the theoretical model presented in Section 2. That measure is the number of establishments that employ workers of a given occupation in a given metropolitan area. The OES survey defines occupations using 5-digit codes from the OES classification system. I developed a crosswalk between the OES and Census systems and use it to convert the OES data to Census occupation groups.[12] The OES data cover every MA but, due to confidentiality and data quality criteria, they do not cover every occupation within a given MA. In particular, occupation-MA cells are not reported if there are fewer than 3 establishments for a given cell or if one establishment contains 80 percent or more of the employment in a given cell.

Summary statistics on the number of establishments in an occupation-MA are presented in the first row of Table 2. This measure of market size is right-skewed, reflecting the concentration of economic activity in relatively few geographic areas. The mean number of establishments in an occupation-MA is 43 and the median is 17. There exists a fair amount of variation across cells: from 6 establishments at the 10th percentile to 93 establishments at the 90th percentile.

[12] In cases where Census occupations are composed of multiple OES occupations (about half of the Census occupations), it is challenging to construct my measure of market size. I want to measure the number of establishments employing any of the component OES occupations. The appropriate method for aggregation depends on the degree of overlap between the sets of establishments employing each OES occupation; however, this overlap is not observable in my OES data set. In the case of perfect overlap, the maximum among the component OES occupations is appropriate. At the other extreme of no overlap, the sum of establishment counts is appropriate. Since the OES occupations for a given Census occupation are necessarily closely related, I use the maximum.

4. Job Turnover and Market Size

4.1 Data

I test the prediction on job turnover using data from the March Current Population Surveys (CPS) for 1990-2002. The CPS is a monthly survey of 60,000 households conducted by the Census Bureau for the Bureau of Labor Statistics. The Annual Income Supplement to the March CPS collects information on employment and income in the previous calendar year. It contains a question on the number of employers each individual had during the year; specifically, the question reads: "For how many employers did you work in [year]? If more than one at the same time, only count it as one employer." The response is coded as zero, one, two, or three-or-more employers. Since those who had more than one employer must have changed employers at some point, I use this question to construct a measure of job turnover. This measure is simply an indicator for having more than one employer in the previous year. This captures all employer-to-employer transitions but does not capture all separations, since individuals who separated from their employer but were unemployed for the remainder of the year would be counted as having only one employer.

Although this question from the March CPS was not designed to measure turnover, measures of turnover based on it are consistent with turnover data collected in other CPS surveys. Farber (1999) computed aggregate rates of job change based on this measure and compared them to those based on the Tenure Supplements to the CPS. Over the 1975-1995 period, the average rate of job change in the March data is 15.3%. Considering the downward bias noted above, this corresponds well to the fraction of workers who have been in their job less than one year. This latter measure averaged 18.6% over the 1979-

1996 period. Stewart (2003) matched the March 1987 Income Supplement to the January 1987 Tenure Supplement, providing two reports of employment transitions for the same period for each individual. He found that the transitions were identical in both reports for nearly 80 percent of the cases and were consistent with each other for 90 percent of the cases.

I restrict the sample to blue-collar workers between the ages of 18 and 64 who had at least one employer in the previous year, live in an MA, and are not self-employed.[13] In my sample period, the CPS recorded occupations using the classification system developed for the 1990 census. As described in Section 3.1, I use 103 occupation categories for blue-collar workers. For a given year of the March CPS, these procedures yield a sample of about 7,000 workers. A sample of this size is too small to support my empirical strategy, which relies on detail within occupations and MAs. Therefore, I pool the data over 13 years of the March CPS from 1990 to 2002 and control for year effects in the analysis.

My empirical strategy exploits variation in market size across MAs. In order to protect respondent confidentiality, the public-use CPS files do not identify the particular MA for workers in the smallest MAs. This prevents me from linking their records to the OES data on market size. As a result, my CPS sample is limited to workers from 262 of the 328 MAs. Excluding the smallest MAs tends to reduce the variation in market size at the lower end of the distribution within the OES data, as shown in the second row of Table

---

[13] Since the turnover measure is based on employment in the previous year, I identify the worker's occupation and other job-related variables based on the longest job held in the previous year. (The March CPS does not collect this information about any other jobs held in the previous year.) The only exception to this rule is union status, which is based on the worker's current job since that information is not reported for the longest job held in the previous year. I also exclude workers who had less than one year of potential experience as of March of the previous year.

2. In the CPS sample, the median number of establishments for an occupation-MA is 27, compared to 17 in the overall OES data.

Table 3 presents sample means for the individual-level data from the CPS sample. The share of workers who had multiple employers in the previous year is 15 percent. As one might expect in a sample of blue-collar workers, the typical worker is a male with a high-school education. The sample covers a range of ages: half of the sample is between 30 and 45 years of age, with about one quarter less than 30 and one quarter greater than 45.

4.2 Specification

I estimate the effect of market size on job turnover using the specification:

$$turnover_{om} = \alpha_o + \beta\, size_{om} + \gamma' Z_{om} + \varepsilon_{om}, \qquad (4)$$

where o refers to occupation and m refers to MA. The dependent variable is the share of workers with occupation o in MA m who had multiple employers in the previous year. The key independent variable is the measure of market size from the OES data: the number of establishments in MA m that employ workers in occupation o. The theory predicts that job turnover increases with market size: $\beta > 0$. Since equation (4) includes occupation fixed effects (α_o), β is identified from variation in market size across MAs within occupations.

The vector Z_{om} includes a variety of other variables that might affect turnover. It includes firm size since it is well known that turnover is lower in larger firms (Idson 1996; Oi and Idson 1999).[14] It includes variables for other job characteristics: industry, union status, part-time work, and public-sector employment. It also includes standard demographic variables and indicators for each year of the CPS sample. Finally, to control for effects at the aggregate level, Z_{om} includes the population of the MA in 1999 and population growth in the MA between 1990 and 1999, based on Census Bureau population estimates.

To estimate equation (4) with the CPS sample, I group workers into occupation-MA cells and average the individual information within each cell, leaving a dataset of 10,004 observations. For each occupation-MA in the CPS data, the OES data give the number of establishments. Even with 13 years of CPS data, there are relatively few workers in each cell: the group sizes range from 1 to 785, with a median of 3. To account for the heteroskedasticity induced by variation in group size, I use a two-step GLS estimator (Dickens 1990). In the first step, I estimate the extent to which the error in a cell varies with group size. Estimates of error-components variances from the first stage are then used to construct a weight for a weighted least squares estimator.[15]

In addition to the simple linear specification in equation (4), I also estimate a piecewise linear specification that allows the effect of market size to vary with the level of market size. The Stevens model suggests that the effect of market size on job turnover is greatest at low levels of market size. In the example analyzed in Appendix A, for instance, the probability of job turnover as a function of the number of establishments displays the

---

[14] Several reasons have been given for why turnover is lower in larger firms, including: (1) larger firms are less likely to go out of business, (2) monitoring costs are greater in larger firms, and (3) larger firms are more likely to use incentive contracts.

[15] The qualitative results are robust to limiting the sample to cells with 3 or more workers, or to cells with 5 or more workers.

nonlinear relationship shown in Figure 1. As market size increases, job turnover increases rapidly at low levels of market size and increases only marginally beyond that.[16]

4.3 Results

In the simple linear specification, increases in market size are not associated with greater job turnover (Table 4). The estimate of β is positive, as expected, but its magnitude is quite small. An increase in market size from the 10th percentile to the 90th percentile would, according to the estimate, increase job turnover by less than 1 percentage point. This is perhaps not surprising, since much of the variation in the data is at the high end of the market-size distribution, where the model suggests the effect of market size is negligible.

In contrast, the piecewise linear specification offers some support for the prediction of the model. When market size is 10 establishments or less, increases in market size are associated with greater job turnover and the effect is statistically significant. In contrast, the estimated effects for the other two ranges are negligible. Taking the point estimates at face value, an increase of market size by 5 establishments in the first range (≤10 establishments) increases turnover by 2.0 percentage points, in the second range (10-30) decreases turnover by 0.02 percentage points, and in the third range (30+) increases turnover by 0.01 percentage points. This empirical relationship is shown in Figure 2. As the figure demonstrates, the important variation in market size appears to be at the lowest levels.

---

[16] For simplicity, the example in Appendix A ignores the specific element a. However, including it in the model doesn't change the main point of Figure 1. In particular, for a given value of a, the relationship between turnover and market size follows the nonlinear pattern in Figure 1. Changing the value of a merely shifts the entire curve up or down.

Turning to the other variables in the model, the effects of the control variables on turnover are generally in the expected direction. Notably, turnover is higher for younger workers and part-time workers. Turnover is lower for workers in large firms and workers in the public sector. In addition, workers in larger cities (in terms of population) have lower turnover, all else equal, although the effect is small. This is consistent with evidence that larger cities have lower unemployment rates (Gan and Zhang 2003).

While the empirical results are consistent with the Stevens model, there might be other explanations for the results. In particular, turnover might be higher in larger markets because of lower search costs (see Section 3.2). Therefore, I provide a further test of the Stevens model based on differences in training requirements among blue-collar occupations. If the turnover effect reflects training, then it should be greater for occupations involving more training. In contrast, if the turnover effect reflects search costs, then the effect of market size on turnover shouldn't vary with training requirements.

I measure training time in an occupation using Specific Vocational Preparation (SVP) scores from the Dictionary of Occupational Titles. SVP is the "amount of lapsed time required by a typical worker to learn the techniques, acquire the information, and develop the facility needed for average performance in a specific job-worker situation" (U.S. Department of Labor 1993, p. B-1). SVP includes formal vocational education as well as on-the-job training. SVP is measured on a nine-point scale, with each level corresponding to a range of training times. I use the measures of training time for Census occupations from England and Kilbourne (1988). For the occupations in my data, training time ranges from 6 months at the 10^{th} percentile to 44 months at the 90^{th} percentile, with a median of 25 months.

I implement this test by adding interaction terms between market size and training time in the turnover equation. The Stevens model predicts that the coefficients on the interaction terms are positive, while the search story predicts that the coefficients are zero. Since the effect of market size on turnover is positive only in the lowest range of market size, the coefficient of interest here is on the training-time interaction for this range. The estimate of this coefficient is positive, as predicted by the Stevens model (Table 5, column 2). However, it is not statistically significant and the magnitude of the effect is rather small. For instance, the estimates imply that the effect on turnover of increasing market size by 5 establishments in the lowest range, which is 2.0 percentage points overall, is only 0.2 percentage points higher for an occupation with 2 years longer training time.[17] Therefore, this second test does not provide additional support for the Stevens model.

5. Generality of Training and Market Size

In this section, I test the theoretical prediction that on-the-job training is more general the larger is the size of the local market for an occupation. Ideally, a test would involve the empirical counterparts of the training components in the model: the specific component a and transferable component m. However, I am not aware of any data sources that include such measures.[18] Therefore, I base my test on responses to unique survey questions on how much of the skills workers learn during training are transferable to other firms. The evidence in this section is based on worker responses in the National Longitudinal Survey of Youth 1979 and employer responses in the Employment

[17] For instance, the implied effect is 1.86 percentage points for an occupation with 1 year of training time and 2.04 percentage points for an occupation with 3 years of training time.

[18] For a critical review of available data on training, see Loewenstein and Spletzer (1999a).

Opportunity Pilot Project survey. The second survey allows a further test of the model based on the wage returns to relevant experience.

5.1 Evidence from the NLSY

The National Longitudinal Survey of Youth 1979 (NLSY) is an ongoing study of labor market and other experiences of a cohort that was age 14-21 in 1979. For the first and only time in 1993, when respondents were age 28-36, the NLSY included a series of questions on the generality of skills learned at the start of the worker's current job. [19] First, the survey asked workers: "When you started doing this kind of work for [employer], about what percentage of the duties you currently do were you able to perform adequately?" For those who initially performed less than 100 percent of their current duties adequately, the survey then asked whether they received any of the following kinds of training when they were learning to perform their job duties: classes or seminars, time with supervisor, time with co-workers, and self-study materials.[20] For each kind reported, the survey then asked: "How many of the skills that you learned in [training kind] do you think would be useful in doing the SAME kind of work you are doing for an employer other than [current employer]?" There are five possible responses: all or almost all, more than half, about half, less than half, and none or almost none.

I construct a sample of blue-collar workers in the 1993 NLSY data who live in MAs and are not self-employed. As shown in Table 6, 251 workers in the sample reported at least one kind of training at the start of their job. The most common kinds are guidance

---

[19] The survey also asked workers to report the generality of (formal and informal) training in the previous year. I base my analysis on the questions regarding training at the start of the job because the theory outlined in Section 2 refers to training at the start of the job. For more discussion of the 1993 training data, see Loewenstein and Spletzer (1999a, 1999b).

from supervisors and guidance from co-workers. The last column of the table shows the share of those reporting each kind of training who said that "all or almost all" of the skills are transferable. Overall, 64 percent of training is considered to be fully general. Across kinds of training, this measure ranges from 58 percent for self-study materials to 83 percent for classes and seminars.

In order to determine whether workers in larger markets are more likely to report their training to be general, I estimate a regression of the form:

$$general_i = occ_i + \beta\, size_{om} + kind_i + \gamma' Z_i + \varepsilon_i \,. \qquad (5)$$

The dependent variable equals 1 if worker i reported that "all or almost all" of the skills learned in training are transferable, and equals 0 otherwise. Equation (5) follows the same structure as the turnover equation (4), with the key independent variable representing market size for the occupation in the MA. However, due to the smaller sample in the NLSY, equation (5) is more parsimonious in certain respects than the turnover equation.

First, instead of including a full set of occupation fixed effects, I group the 103 blue-collar occupations into six categories and include indicators for these groups (occ_i) in the regression. Second, I parameterize market size into three groups: 30 or less, 31-100, and more-than-100 establishments in the occupation-MA (from the OES data). The regression includes indicators for the second and third groups, with the effects measured relative to the first group. The specification also includes indicators for the kind of training $(kind_i)$ and a set of control variables Z_i similar to that in the turnover model.[21]

---

[20] Self-study materials are described in the questionnaire as: "any self-study material or self-instructional packages, such as manuals, workbooks, or computer-assisted teaching programs."

[21] The standard errors are adjusted for the non-independence of observations within occupation/MA cells. This accounts for clustering on two levels. First, there is clustering at the occupation/MA level since the

The estimated impacts of market size on the generality of training are in the direction predicted by the Stevens model (Table 7). Compared to workers in markets with 30 or fewer establishments that employ their occupation, workers in markets with 31-or-more establishments are 10-11 percentage points more likely to report their training to be general. These impacts cannot be explained by overall MA size, since MA population is also included in the model and has a positive estimated impact on generality. While effects of this magnitude are definitely important, they are not statistically significant for this sample because the associated standard errors are large.

5.2 Evidence from the EOPP

Another source of data for relating generality and market size is the Employment Opportunity Pilot Project (EOPP) survey of firms in 1982. This survey was administered in 28 local areas that were sites for the EOPP labor market experiments in the late 1970s. The sites are concentrated in the South and Midwest, and about half are MAs. The 1982 survey was the second wave of a two-wave longitudinal survey of employers in these areas. The first wave, conducted in 1979 to evaluate the EOPP experiments, oversampled firms with a relatively high proportion of low-wage workers. The second wave attempted to interview all respondents to the first wave and obtained a response rate of about 70 percent.

In the 1982 survey, each employer provided information on the last worker hired prior to August 1981. I restrict the analysis to workers in the same set of blue-collar occupations used in the CPS and NLSY samples. Employers report the generality of on-

---

measure of market size is measured at this level. (However, there are nearly as many individuals in my NLSY sample as there are occupation/MA groups.) Second, there is clustering at the individual level since individuals reporting multiple types of training contribute multiple observations to the regression.

the-job training for the last worker hired by answering the question, "How many of the skills learned by new employees in this job are useful outside the company?" The majority of employers in my sample (63 percent) responded that "almost all" of the skills were useful in other firms, while the rest responded that "most," "some," or "almost none" of the skills were useful in other firms. In the next question, employers assessed the local market size for the occupation: "Focusing on the skills that are useful outside your company, how many other companies in the local labor market have jobs that require these skills?" The responses were spread fairly evenly over the four ranges provided in the survey: less than 5, 5-15, 16-100, and more than 100.

Following my analysis of the NLSY data, I compare the generality of training to the size of the local market for occupation-specific skills. I estimate a specification similar to equation (5), with the dependent variable equal to 1 if the employer reported that "almost all" of the skills were useful in other companies; and 0 otherwise. As in the NLSY, the results indicate that training is more likely to be general in areas with more companies having jobs using the skills (Table 8). Compared to markets with fewer than 5 companies using the skills, employers in markets with 5-15 companies are 21 percentage points more likely to report their training to be general; for the other two ranges, 16-100 and more-than-100, the estimated effects are 34-36 percentage points. Unlike in the NLSY data, these effects are statistically significant at conventional levels. Furthermore, the pattern of effects across size categories suggests that the effect of market size becomes negligible beyond a certain point, as in the analysis of turnover. Increases in market size from less-than-5 to 5-15 and from 5-15 to 16-100 both increase generality, but increases in market size beyond 100 firms do not increase generality.

While these results are consistent with the predictions of the Stevens model, they are also consistent with another explanation. Suppose, for instance, that training and equipment in a given occupation is the same in all firms in all areas. For example, suppose that all printing firms use the same type of printing press, so that printing press operators learn the same skills regardless of where they work. In this case, training would be perfectly general in all areas, at least in a technological sense. However, the size of the local market might influence the perceived generality of the training. In areas with few printing firms, knowing how to operate the common press may not appear to be a general skill in the context of the local labor market because the skills are applicable at only a few local firms. In areas with many printing firms, by contrast, the same skills would appear to be quite general. This pattern of perceptions would generate a positive relationship between generality (as reported in surveys) and local market size.

The Stevens model predicts, on the other hand, that training requirements and equipment truly vary (in a technological sense) across local markets of different sizes. For example, in small markets the model predicts that each printing firm would use a specific (different) type of press. In large markets, by contrast, all printing firms would use the same (common) type of press. In terms of the observed relationship between market size and generality, the "perception" explanation is presumably present in any event. At issue is whether the mechanism emphasized in the Stevens model is also present.

One way to distinguish between the effects of market size on the perceived versus technological generality of training is by examining the value to a worker's current employer of the worker's previous experience in related jobs. Employers in the EOPP survey were asked how many months of the worker's previous work experience had some application to the current job. The answers to this question provide a rough indicator of occupation-specific experience. In my sample, workers have an average of 3.7 years of "relevant" experience, compared to an average of 9.6 years of potential labor-market experience (age minus years of education minus 6).

If training in a given occupation were the same in every firm in every area, then a given amount of relevant experience would have the same value to the current employer in every area. If, on the other hand, the generality of training truly varies across areas of different size, relevant experience is more valuable in larger markets because the training is more general. The value of relevant experience to employers in the EOPP data can be judged using the starting hourly wage of the last worker hired. I estimate a wage regression in which the log wage is a function of potential experience, relevant experience, education, and market size. In one specification I also include a set of control variables to account for such factors as industry, occupation, and union status. The overall return to relevant experience is 4.3 percent per year in the specification without controls and 2.9 percent in the specification with controls (Table 9, columns 1 and 3).

I allow the returns to relevant experience to vary with market size by adding interaction terms between relevant experience and the indicators for the three highest market-size categories. The Stevens model predicts that these coefficients are positive, whereas the "perceptions only" view implies that these coefficients are zero. In the specification without controls, these coefficients are all positive and statistically significant (Table 9, column 2). Furthermore, the estimated effects are economically significant in magnitude: the implied returns to relevant experience are 2.4 percent for the smallest market-size category (less than 5 companies) and 4.6-5.2 percent for the other categories.

As in the case of reported generality, increases in market size do not matter beyond a certain point. However, the threshold is much lower in this case: 5 companies compared to 100 companies in the case of reported generality.

Adding the control variables reduces the overall return to relevant experience, but the pattern of returns by market size is similar to the specification without controls. The implied returns are 1.5 percent for the smallest category and 3.2-3.7 percent for the other categories. Compared to the specification without controls, the coefficient on the 16-100 interaction term is of similar magnitude, while the coefficients on the 5-15 and more-than-100 interaction terms are smaller.

Taken together, these results generally support the prediction of the Stevens model that the true generality of training increases with market size. Since the returns to relevant experience are larger in larger markets, the relationship between generality and market size reflects more than simply perceptions. Furthermore, the results indicate that the effects of market size on the generality of training exist primarily at the lowest levels of market size.

The positive impact of market size on generality can be interpreted as an external economy of scale from a concentration of firms employing workers in a given occupation. Since on-the-job training is more general the greater is the market size, when workers move between employers in the same area, their relevant experience is more valuable. This increases productivity and wages. This finding is consistent with Glaeser and Mare's (2001) argument that cities speed the accumulation of human capital.

6. Conclusion

The Stevens (1994) model extends the Becker (1964) model of job training to allow for explicit consideration of market size. The model highlights the link between labor-market size and the incentive to invest in firm-specific capital. With smaller markets, firms face less competition for their trained workers and thus experience less turnover in their workforces. As a result, firms have a greater incentive to invest in firm-specific skills. Thus, the model predicts that as market size increases, turnover increases and training becomes more general.

The empirical evidence in this analysis generally supports the theoretical predictions. In the case of both turnover and type of training, variation in occupation-specific market size is important primarily at low levels of market size. This suggests that the Stevens model is most relevant to cases where occupation-specific skills are transferable to a relatively small number of firms. Specifically for the blue-collar occupations considered here, the relevant range is less than 10 firms. Straightforward calculations indicate that roughly 15-20 percent of blue-collar workers in the United States fall in this range.[22]

[22] This estimate includes workers in both metropolitan and non-metropolitan areas. For workers in metropolitan areas, the OES data indicate that 3.27% of blue-collar workers have 10 or fewer local establishments that employ their occupation. Workers outside metropolitan areas are not covered by the OES data, but the relevant percentage for them can be approximated based on OES data for workers in the smallest metropolitan areas. In areas with total population between 50,000 and 100,000, 17% of blue-collar workers have 10 or fewer local establishments that employ their occupation. It is therefore plausible that the relevant percentage for workers in non-metropolitan areas is 45-65%. Given that metropolitan areas contain 72.6% of the blue-collar workers in the nation (based on my CPS sample), those numbers imply that 15-20% of blue-collar workers nationwide face small local markets for their skills.

Appendix A. Derivation of Theoretical Model for Special Case

This appendix analyzes a special case of the model of job training developed by Stevens (1994). Compared to the discussion of the general case in the text, restricting attention to a special case allows me to derive closed-form solutions for the training outcomes. This special case involves two restrictions on the general case: (1) no specific element in the training and (2) a uniform distribution for the random shocks.

A.1 Setup

The post-training productivity of the worker is given by:

$$v = (m+\varepsilon_o, m+\varepsilon_1, m+\varepsilon_2, ..., m+\varepsilon_n, 0, 0, ...)\ , \tag{A.1}$$

where $m \geq 0$ is the transferable element and ε_i, $i = 0,1,...,n$ are independent and identically distributed random variables with mean zero and support $[-1,1]$. For this special case, further assume that the shocks ε_i are uniformly distributed, with p.d.f. $f(.)$ and c.d.f. $F(.)$:

$$f(x) = \begin{cases} 1/2 & \text{for } x \in [-1,1], \\ 0 & \text{otherwise;} \end{cases} \qquad F(x) = \begin{cases} 0 & \text{for } x \leq -1, \\ (1/2)(x+1) & \text{for } x \in [-1,1], \\ 1 & \text{for } x \geq 1. \end{cases} \tag{A.2}$$

A.2 Expected Returns

I solve the model by starting at the labor-market stage, where the $n+1$ firms observe v and make simultaneous wage offers. Let v^1 and v^2 be the highest and second highest of the values v_i, $i = 0,1,...,n$. The outcome of this competition is that the worker works at the firm for which he has the highest value, v^1, at a wage equal to the second highest value v^2. Ex-post, the total value of the training is v^1, which is shared between the worker, who receives v^2, and the firm that has the highest value, which receives $v^1 - v^2$. The next step involves calculating the expected returns to the training for the worker and each firm.

Under the assumptions of this special case, I derive the expected returns following the integrals presented by Stevens (1994) for the general case. (The following formulas hold for $n \geq 1$.) The total expected return to the training is:

$$R = E[v^1] = m + \frac{n}{n+2}\,. \tag{A.3}$$

The total expected return is divided between the worker, the training firm, and the external firms, whose expected returns, respectively, are:

$$R_w = E[v^2] = m + \frac{(n-2)}{(n+2)}\,, \tag{A.4}$$

$$R_0 = E[v^1 - v^2 \mid v_0 = v^1]\Pr[v_0 = v^1] = \frac{2}{(n+1)(n+2)}\,, \tag{A.5}$$

$$X = \sum_{i=1}^{n} E[v^1 - v^2 \mid v_i = v^1]\Pr[v_i = v^1] = \frac{2n}{(n+1)(n+2)}. \quad (A.6)$$

The probability that the worker moves to another firm in the second period is:

$$P = \frac{n}{n+1}. \quad (A.7)$$

A.3 Effect of Market Size on Expected Returns

With these formulas, we can investigate how the outcomes of the training problem (for a given level of training) are affected by a change in the size of the external market, n. (This exercise treats n as a continuous variable.) The total return increases with n because the maximum value of the ε_i is larger with more draws:

$$\frac{\partial R}{\partial n} = \frac{2}{(n+2)^2} > 0. \quad (A.8)$$

Notice that the expected return to each external firm is the same as the expected return to the training firm: $X / n = R_0$. This follows from the lack of a specific element in the productivity vector v. Therefore,

$$\frac{\partial (X/n)}{\partial n} = \frac{\partial R_0}{\partial n} = -2\left[\frac{2n+3}{(n+1)^2 (n+2)^2}\right] < 0. \quad (A.9)$$

The return to each firm, including the training firm, decreases with n: with a larger market, it is more likely that another firm has the highest value. For the same reason, it is more likely that the worker will switch firms after training:

$$\frac{\partial P}{\partial n} = \frac{1}{(n+1)^2} > 0. \quad (A.10)$$

The worker's wage in the second period increases with n because the gap between v^1 and v^2 decreases with n:

$$\frac{\partial R_w}{\partial n} = \frac{4}{(n+2)^2} > 0. \quad (A.11)$$

Note that, in expected terms, workers are paid less than their productivity: $R_w < R$ for any $n < \infty$. This has the flavor of the specific-capital model, even though training is transferable. However, as n increases, the wage increases and the gap between pay and productivity falls. Also, as $n \to \infty$, $R_w \to (m+1)$, which is the expected productivity (m) plus the maximum productivity shock (1).[23]

A.4 The Training Decision

---

[23] Stevens (1994) shows that for *any* distribution of ε_i, (A.8)-(A.11) hold with weak inequalities. A caveat is that $\partial R_w / \partial n \geq 0$ may not hold for some distributions. However, Stevens argues that a sufficient condition for it to hold is that F be log-concave, which is true for a wide class of distributions including the uniform distribution considered here.

The training firm and the worker choose the level of training that maximizes their joint private return less the cost of training. The joint expected private return is the sum of the return to the training firm and the worker's wage:

$$R_p \equiv R_0 + R_w = m + \frac{n(n-1)}{(n+1)(n+2)}\,. \tag{A.12}$$

Assume that the cost of training $C(m)$ is increasing and convex in m: $C'(m) > 0$, $C''(m) > 0$. The equilibrium level of training m^* satisfies the first order condition:

$$\frac{\partial R_p(m^*, n)}{\partial m} = C'(m^*)\,. \tag{A.13}$$

It follows from (A.12) that the marginal private benefit of m is 1: an increase in m raises the worker's productivity in each of the $n+1$ firms and thus increases his wage in direct proportion to the increase in m. Therefore, the equilibrium level m^* is independent of n and determined by the cost function:

$$C'(m^*) = 1 \qquad \frac{dm^*}{dn} = 0\,. \tag{A.14}$$

Given this result and the fact that I am ignoring the specific component, the effect of market size on training outcomes, in equilibrium, is given by the direct effects in (A.8)-(A.11) above. The firm returns and the probability of turnover do not depend on m. The worker return and the total return depend on m, but since m^* is independent of n, there is no indirect effect of n through m^*. As described in the text, the general case is more interesting in this regard.

References

Acemoglu, Daron and Jorn-Steffen Pischke. 1998. "Why Do Firms Train? Theory and Evidence." *Quarterly Journal of Economics* 113 (February): 79-119.

________. 1999. "The Structure of Wages and Investment in General Training." *Journal of Political Economy* 17 (June): 539-572.

Autor, David H. 2001. "Why Do Temporary Help Firms Provide Free General Skills Training?" *Quarterly Journal of Economics* 116 (October): 1409-1448.

Becker, Gary S. [1964] 1993. *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*. 3d ed. Chicago: University of Chicago Press.

Bhaskar, V., Alan Manning, and Ted To. 2002. "Oligopsony and Monopsonistic Competition in Labor Markets." *Journal of Economic Perspectives* 16 (Spring): 155-174.

Diamond, C.A. and C.J. Simon. 1990. "Industrial Specialization and the Returns to Labor." *Journal of Labor Economics* 8 (April): 175-201.

Dickens, William T. 1990. "Error Components in Grouped Data: Is it Ever Worth Weighting?" *Review of Economics and Statistics* (May) 72: 328-333.

England, Paula and Barbara Kilbourne. 1988. *Occupational Measures from the Dictionary of Occupational Titles for 1980 Census Detailed Occupations* [computer file]. Ann Arbor, Mich.: Inter-university Consortium for Political and Social Research [distributor].

Farber, Henry S. 1999. "Mobility and Stability: The Dynamics of Job Change in Labor Markets." In: *Handbook of Labor Economics*, vol. 3B, edited by Orley Ashenfelter and David Card. Amsterdam: Elsevier Science, pp. 2439-2483.

Gallup Organization and the National Center for Research in Vocational Education. 1984. *National Survey of Employers, 1982* [computer file]. Princeton, N.J.: The Gallup Organization [producer].

Gan, Li and Quinghua Zhang. 2003. "The Thick Market Effect on Local Unemployment Rate Fluctuations." Working Paper, University of Texas. Forthcoming, *Journal of Econometrics*.

Glaeser, Edward L. and David C. Mare. 2001. "Cities and Skills." *Journal of Labor Economics* 19: 316-342.

Hashimoto, Masanori. 1981. "Firm-Specific Human Capital as a Shared Investment." *American Economic Review* 71 (June): 475-482.

Idson, Todd L. 1996. “Employer Size and Labor Turnover,” *Research in Labor Economics* 15: 273-304.

Kambourov, Gueorgui and Iourii Manovskii. 2002. “Occupational Specificity of Human Capital.” Working Paper, University of Toronto.

Loewenstein, Mark A. and James R. Spletzer. 1999a. “Formal and Informal Training: Evidence from the NLSY.” *Research in Labor Economics* 18: 403-438.

________. 1999b. “General and Specific Training: Evidence and Implications.” *Journal of Human Resources* 34 (Fall): 710-733.

Neal, Derek. 1995. “Industry-Specific Human Capital: Evidence from Displaced Workers.” *Journal of Labor Economics* 13 (October): 663-677.

Oi, Walter Y. and Todd L. Idson. 1999. “Firm Size and Wages.” In: *Handbook of Labor Economics*, vol. 3B, edited by Orley Ashenfelter and David Card. Amsterdam: Elsevier Science, pp. 2165-2214.

Parent, Daniel. 2000. “Industry-Specific Human Capital and the Wage Profile: Evidence from the National Longitudinal Survey of Youth and the Panel Study of Income Dynamics.” *Journal of Labor Economics* 18 (April): 306-323.

Simon, C.J. 1988. “Frictional Unemployment and the Role of Industrial Diversity.” *Quarterly Journal of Economics* 103 (November): 715-728.

Stevens, Margaret. 1994. “A Theoretical Model of On-The-Job Training with Imperfect Competition.” *Oxford Economic Papers* 46 (October): 537-562.

Stewart, Jay. 2003. “Recent Trends in Job Stability and Job Security: Evidence from the March CPS.” Working Paper, Bureau of Labor Statistics.

Topel, Robert. 1991. “Specific Capital, Mobility, and Wages: Wages Rise with Job Seniority.” *Journal of Political Economy* 99 (February): 145-176.

U.S. Bureau of the Census. 1990. *Census of Population and Housing*. Public-Use Microdata (‘A’ Sample): 5-Percent Sample [computer file].

________. 1990-2002. *Current Population Survey: Annual Demographic File* [computer files].

________. 1994. *Geographic Areas Reference Manual*. Washington, D.C.: U.S. Government Printing Office.

U.S. Bureau of Labor Statistics. 1998. *Occupational Employment Statistics Survey*. Occupational Employment and Wage Estimates by Metropolitan Area [computer file].

________. 2000. *National Longitudinal Survey of Youth 1979* [computer file].

U.S. Department of Labor. 1993. *Selected Characteristics of Occupations Defined in the Revised Dictionary of Occupational Titles*. Lanham, Md.: Bernan Press.

Wheeler, Christopher H. 2001. "Search, Sorting, and Urban Agglomeration." *Journal of Labor Economics* 19 (October): 879-899.

Table 1. Differences in Geographic Mobility across Occupation Groups

Occupation Group	Percent Moving between States		Occupation Share (%)
	1989 to 1990	1985 to 1990	
White-Collar	4.5	12.9	33
Clerical/Sales/Service	3.7	9.6	37
Blue-Collar	3.1	7.1	30
Total	3.7	10.0	100

Sources: March 1990 CPS [for 1989 to 1990]; 1990 Census of Population [for 1985 to 1990].

Notes: Sample is full-time workers in civilian labor force, age 18-64. Sample excludes those who were living abroad in 1985 or 1989 and those in farming, forestry, or fishing occupations. Occupation group is based on occupation in 1990. All data are weighted by sampling weights. White-collar occupations include managerial, professional specialty, and technical occupations. Clerical/Sales/Service occupations include sales, service, clerical, and administrative support occupations. Blue-collar occupations include precision production, craft, and repair occupations; and operators, fabricators, and laborers.

Table 2. Market-Size Summary Statistics

		Number of Establishments				
				Percentile		
Sample of Occupation-MA Cells	N	Mean	Std. Dev.	10^{th}	50^{th}	90^{th}
All Observations	17,231	43	95	6	17	93
Observations in CPS Sample	10,004	62	120	8	27	137

Sources: Occupational Employment Statistics survey, 1998; March 1990-2002 CPS.

Table 3. Sample Means, CPS Sample

	Individual Level [Workers]	Group Level [Occupation-MAs]
Number of Observations	90,945	10,004
Multiple Employers	0.15	0.16
Female	0.20	0.19
Education:		
Less than High School	0.25	0.22
High School / Some College	0.70	0.74
College Graduate or More	0.05	0.05
Age:		
Less than 30	0.27	0.28
30 to 45	0.47	0.47
Greater than 45	0.26	0.25
Race / Ethnicity:		
White	0.62	0.72
Black	0.10	0.10
Hispanic	0.24	0.14
Other	0.04	0.04
Population of MA (1999)	2,638,621	1,263,913
Population Growth of MA (1990-1999)	10.52%	10.69%
Union	0.06	0.06
Part Time	0.06	0.06
Public Sector	0.04	0.05
Firm Size:		
Less than 25 Employees	0.25	0.27
25-99 Employees	0.19	0.18
100-499 Employees	0.18	0.18
500-999 Employees	0.06	0.06
1000+ Employees	0.32	0.31
Industry:		
Construction	0.18	0.21
Manufacturing – Nondurable Goods	0.16	0.15
Manufacturing – Durable Goods	0.25	0.25
Transportation/Public Utilities	0.14	0.10
Wholesale/Retail Trade	0.12	0.11
Services	0.13	0.16
Other	0.01	0.02

Source: March 1990-2002 CPS.

Note: In the group-level sample, variables represent averages over workers in the occupation/metropolitan area (MA).

Table 4. Job Turnover and Market Size: Main Results

Independent Variable	Specification (1)	(2)
Market Size: Establishments	7.59×10^{-6}	
	(8.70×10^{-6})	
Market Size: Establishments (≤10)		4.00×10^{-3}
		(1.99×10^{-3})
Market Size: Establishments (10-30)		-3.82×10^{-5}
		(4.19×10^{-4})
Market Size: Establishments (30+)		1.10×10^{-5}
		(1.00×10^{-5})
Female	-0.023	-0.023
	(0.010)	(0.010)
Education: Less than High School	-0.026	-0.026
	(0.008)	(0.008)
Age: Less than 30	0.117	0.117
	(0.010)	(0.010)
Age: 30 to 45	0.036	0.036
	(0.007)	(0.007)
Race: Nonwhite	-0.035	-0.035
	(0.007)	(0.007)
Log (Population of MA)	-0.008	-0.009
	(0.002)	(0.003)
Population Growth of MA	1.79×10^{-3}	1.79×10^{-3}
	(2.63×10^{-4})	(2.64×10^{-4})
Union	-0.010	-0.009
	(0.014)	(0.015)
Part Time	0.058	0.058
	(0.018)	(0.018)
Public Sector	-0.041	-0.041
	(0.017)	(0.017)
Firm Size: 25-99 Employees	-0.009	-0.010
	(0.012)	(0.012)
Firm Size: 100-499 Employees	-0.019	-0.020
	(0.012)	(0.012)
Firm Size: 500-999 Employees	-0.018	-0.018
	(0.015)	(0.015)
Firm Size: 1000+ Employees	-0.031	-0.032
	(0.011)	(0.010)
Industry Controls (7 categories)	Yes	Yes
Year Controls (13 years)	Yes	Yes
Occupation Fixed Effects (100 occupations)	Yes	Yes
R^2	0.53	0.53

Source: March 1990-2002 CPS.

Notes: Sample size is 10,004. By range of establishments, sample sizes are: 1,834 (≤10), 3,568 (11-30), and 4,602 (31+). The dependent variable is the share of workers with multiple employers; mean is 0.16. In specification (2), the coefficients on the market-size variables represent the effect of market size in the indicated range of establishments. Standard errors, in parentheses, are calculated using the method of Huber-White and allow for arbitrary clustering at the metropolitan-area (MA) level. The omitted categories are: for age, Greater than 45; for firm size, Less than 25 Employees.

Table 5. Job Turnover and Market Size: Variation with Training Time

Independent Variable	*Specification* (1)	(2)
Market Size: Establishments	3.40×10^{-7}	
	(1.36×10^{-5})	
Market Size: Establishments (≤10)		3.54×10^{-3}
		(4.45×10^{-3})
Market Size: Establishments (10-30)		-1.88×10^{-4}
		(6.72×10^{-4})
Market Size: Establishments (30+)		4.24×10^{-6}
		(1.47×10^{-5})
Establishments × Training Time	4.23×10^{-7}	
	(4.48×10^{-7})	
Establishments (≤10) × Training Time		1.49×10^{-5}
		(1.38×10^{-4})
Establishments (10-30) × Training Time		7.29×10^{-6}
		(2.17×10^{-5})
Establishments (30+) × Training Time		4.10×10^{-7}
		(4.52×10^{-7})

Source: March 1990-2002 CPS.

Notes: Training time is measured in months. Regressions also include the control variables listed in Table 4. Sample size is 10,004. By range of establishments, sample sizes are: 1,834 (≤10), 3,568 (11-30), and 4,602 (31+). The dependent variable is the share of workers with multiple employers; mean is 0.16. In specification (2), the coefficients on the market-size variables represent the effect of market size in the indicated range of establishments. Standard errors, in parentheses, are calculated using the method of Huber-White and allow for arbitrary clustering at the metropolitan-area level.

Table 6. Incidence and Generality of Training at Start of Job, NLSY Sample

Kind of Training	# Reporting	Incidence [a] (%)	Incidence [b] (%)	Generality [c]
Classes and Seminars	46	6	18	0.83
Supervisor Show You	167	23	65	0.63
Co-Workers Show You	188	25	74	0.63
Self-Study Materials	86	12	34	0.58
Total	251	34	98	0.64

Source: National Longitudinal Survey of Youth 1979, survey year 1993.

Notes: Generality is calculated using 1993 sample weights. In the last row, 251 is the number of workers reporting at least one kind of training and 0.64 is the average generality over all kinds reported.
[a] Sample size = 739 (Those who initially performed 100% of duties are assumed to have not received training.)
[b] Sample size = 255 (Those who initially performed less than 100% of their current duties adequately)
[c] Generality: Share of those reporting who say that "all or almost all" of the skills learned in the training program would be useful in doing the same kind of work for a different employer.

Table 7. Generality of Training and Market Size, NLSY Sample

Independent Variable	
Market Size: 31 to 100 Establishments	0.114
	(0.080)
Market Size: More than 100 Establishments	0.105
	(0.082)
Training Kind: Classes and Seminars	0.219
	(0.071)
Training Kind: Supervisor Show You	0.042
	(0.057)
Training Kind: Co-Workers Show You	0.062
	(0.054)
Female	-0.039
	(0.089)
Years of Education	-0.002
	(0.015)
Age	-0.011
	(0.013)
Race: Nonwhite	-0.074
	(0.058)
Log (Population of MA)	0.053
	(0.028)
Union	0.011
	(0.070)
Part Time	0.012
	(0.135)
Public Sector	-0.231
	(0.147)
Log (Firm Size)	-0.010
	(0.016)
Industry Controls (6 categories)	Yes
Occupation Controls (6 categories)	Yes
R^2	0.69

Source: National Longitudinal Survey of Youth 1979, survey year 1993.

Notes: Sample size is 474. The dependent variable equals 1 if "all or almost all of the skills" learned in training would be useful in doing the same kind of work for a different employer; and equals 0 otherwise. The mean of the dependent variable is 0.63. Standard errors, in parentheses, account for clustering of observations by occupation/metropolitan area (MA). The omitted categories are: for market size, 30 or Less Establishments; for training kind: Self-Study Materials.

Table 8. Generality of Training and Market Size, EOPP Sample

Independent Variable	
Market Size: 5 to 15 Companies	0.212
	(0.075)
Market Size: 16 to 100 Companies	0.362
	(0.068)
Market Size: More than 100 Companies	0.343
	(0.082)
Female	0.018
	(0.070)
Years of Education	0.015
	(0.014)
Age	0.006
	(0.003)
Log (Total Private Employment in Area)	-0.015
	(0.025)
Union (Percent Unionized in Firm)	0.000
	(0.001)
Part Time	0.111
	(0.079)
Log (Firm Size)	-0.007
	(0.014)
Industry Controls (7 categories)	Yes
Occupation Controls (5 categories)	Yes
R^2	0.70

Source: Employment Opportunity Pilot Project, 1982 employer survey.

Notes: Sample size is 421. The dependent variable equals 1 if "almost all" of the skills learned by new employees would be useful outside the company; and equals 0 otherwise. The mean of the dependent variable is 0.63. Standard errors, in parentheses, account for the clustering and stratification in the survey design. The omitted category for market size is Less than 5 Companies.

Table 9. Market Size and the Returns to Relevant Experience

	Specification			
Independent Variable	(1)	(2)	(3)	(4)
Potential Experience (Years)	0.022	0.023	0.018	0.018
	(0.008)	(0.008)	(0.007)	(0.007)
(Potential Experience)^2	-0.0005	-0.0006	-0.0003	-0.0003
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Relevant Experience (Years)	0.043	0.024	0.029	0.015
	(0.010)	(0.009)	(0.009)	(0.009)
(Relevant Experience)^2	-0.0013	-0.0015	-0.0009	-0.0012
	(0.0004)	(0.0005)	(0.0004)	(0.0004)
Relevant Experience × 5-15 Companies		0.026		0.017
		(0.010)		(0.012)
Relevant Experience × 16-100 Companies		0.022		0.022
		(0.010)		(0.011)
Relevant Experience × More than 100 Companies		0.028		0.019
		(0.010)		(0.012)
Years of Education	0.013	0.011	0.027	0.027
	(0.010)	(0.010)	(0.010)	(0.010)
Previous Vocational Training (1=yes)	0.118	0.118	0.053	0.055
	(0.040)	(0.040)	(0.034)	(0.034)
Log (Total Private Employment in Area)	-0.049	-0.050	-0.020	-0.019
	(0.018)	(0.018)	(0.018)	(0.018)
Market Size: 5-15 Companies	0.017	-0.045	-0.020	-0.053
	(0.047)	(0.053)	(0.046)	(0.056)
Market Size: 16-100 Companies	0.092	0.047	0.051	-0.000
	(0.048)	(0.056)	(0.046)	(0.053)
Market Size: More than 100 Companies	0.113	0.037	0.009	-0.034
	(0.054)	(0.063)	(0.052)	(0.064)
Constant	1.825	1.899	1.305	1.340
	(0.242)	(0.244)	(0.255)	(0.252)
Other Controls	No	No	Yes	Yes
Observations	408	408	362	362
R^2	0.19	0.20	0.45	0.45

Source: Employment Opportunity Pilot Project, 1982 employer survey.

Notes: The dependent variable is the natural log of the starting hourly wage. The mean wage is $6.20 and the mean of the log wage is $1.74. Other Controls are gender, union, firm size, part-time employment, temporary or seasonal employment, industry (7 categories), and occupation (5 categories). Standard errors, in parentheses, account for the clustering and stratification in the survey design. The omitted categories are: for relevant experience × market size, relevant experience × Less than 5 Companies; for market size, Less than 5 Companies.

Figure 1. Job Turnover and Market Size: Example from Theory

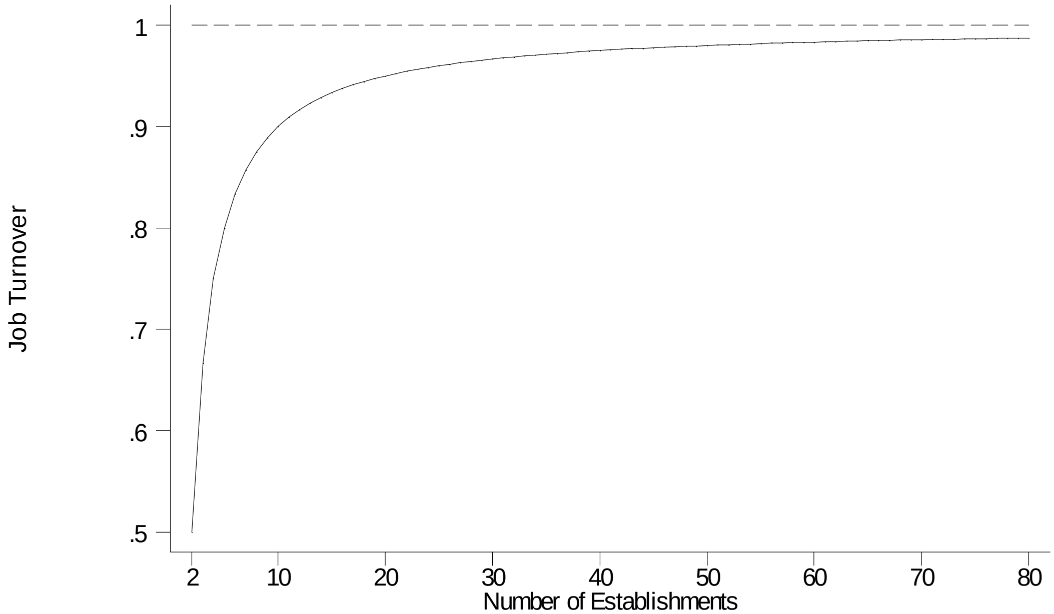

Figure 2. Job Turnover and Market Size: Empirical Relationship