# Firm Specific Human Capital vs. Job Matching: A New Test.

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**Abstract**

We use a unique data set on employee turnover by industry in Arizona to test competing theories of turnover. We find that industries with lower establishment survival rates have more employee turnover, even after controlling for differences in the distribution of employee tenure. This result is consistent with a model of turnover where employees choose how much firm specific human capital to accumulate, but it is inconsistent with job matching models.

*Keywords:* Firm survival; Employee turnover; Firm specific human capital.

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# 1 Introduction

The negative correlation between a worker's tenure and the likelihood that the worker quits or is laid off (see Anderson and Meyer, 1995, for a review) motivates two competing theories of turnover. In job matching models (e.g. Jovanovic, 1979a, or Mortensen and Pissarides, 1994), workers well-matched with their employers are less likely to quit or lose their job, and tend to have more seniority. In a second class of models (e.g. Oi, 1962, Becker, 1962, or Jovanovic, 1979b), workers endogenously decide how much firm specific human capital to accumulate. Separation rates fall with tenure because workers with more tenure tend to have more specific human capital.[1]

A large literature is devoted to separating these competing views. Most tests are centered on two predictions of the endogenous, human capital view: 1) earnings should rise with tenure, 2) involuntary separations should be associated with higher earnings losses for workers with more tenure, even after controlling for initial employer-employee match quality. Those tests yield mixed results. For example, Altonji and Shakotko (1987) and Abraham and Farber (1987) find that earnings rise little with job tenure, while Topel (1991) finds strong support for both predictions of the firm specific human capital model.

In this paper, we adopt a new strategy. If firm specific capital is in part endogenous, then workers employed in firms that are less likely to survive should choose to accumulate less firm specific capital than their counterparts with more secure jobs. In turn, those workers should be more likely to quit their jobs or be laid off than other workers, even at equal tenure. We begin by establishing those claims formally in the context of a dynamic general equilibrium model. Then we implement the corresponding test with a unique data set on turnover by industry in Arizona. We find strong evidence that industries where survival rates are higher have less turnover in Arizona, even after controlling for differences in the distribution of tenure and the size distribution of establishments across industries. This evidence, we conclude, provides new support for the view that endogenously accumulated firm specific human capital accounts for part of the variance of earnings and turnover across

[1]The endogenous view includes models with contractual frictions (Lazear, 1981) where workers choose to forego a fraction of the value of their current marginal product in return for an actuarially fair repayment promise. Employers use this promise to induce more effort over the duration of the employment relationship. Over time the value of the promise rises, and so separations become less likely.

firms and industries.

## 2 Firm survivor and employee turnover

We consider a model with an infinite number of periods. Each period, constant measures of firms and workers are born. Firms belong either to industry $H$ or to industry $L$. The fraction of firms born in each industry does not vary over time, and firms remain in the industry to which they are born until they die. In industry $H$, firms survive from one period to the next with likelihood $p_H$ while in industry $L$ they survive with likelihood $p_L < p_H$.[2] Industries are otherwise identical. Firms in both industries can transform a quantity $n$ of labor into $f(n)$ units of the consumption good, where $f$ is strictly concave, strictly increasing, and $\lim_{n \mapsto 0} f'(n) = +\infty$.

Workers are risk neutral and endowed with the same ownership share of all firms. They die with likelihood $1 - \beta \in (0, 1)$ at the end of each period. In each period, workers are employed by exactly one employer. The maximum quantity $x$ of labor a worker can deliver to their employer is drawn from the set $\{0, 1, 2\}$. We refer to $x$ as a worker's *productivity*.

In the first period of employment with a given firm, $x = 1$ with probability 1. The evolution of a worker's productivity in subsequent periods depends on the time $s$ she devotes to training. With probability $h(s)$, $x$ moves up to 2 while with probability $\delta(s)$, $x$ falls to 0, where $h$ and $-\delta$ are increasing, $h$ is strictly concave, $h(0) > 0$ and $h'(1) = 0$. States $x = 0$ and $x = 2$ are absorbing. At the beginning of any period, workers can choose to quit and begin providing labor to a new employer.

The process governing the evolution of $x$ may be correlated across workers in a given subset of firms, but we assume no aggregate uncertainty. Specifically, in each industry, a fraction $h(s)$ of the workers who devote time $s$ to training see their productivity rise, while a fraction $\delta(s)$ of these workers see their productivity fall.

We only consider steady state equilibria, i.e. equilibria in which the price $w_i$ of labor (the

[2]Dunne et al. (1987) show that exit rates differ markedly across industries and that those differences tend to persist over time. The data we present below for Arizona illustrates these empirical regularities. Our assumption that exit rates are exogenously fixed is strong, but can be relaxed without altering our main result.

wage rate) in industry $i \in \{H, L\}$ is constant. A steady state equilibrium is a pair of wage rates such that labor markets clear in both industries in all periods. To simplify the proof of existence we assume that $\beta h(1) < \delta(1)$. Under this assumption, all firms must hire new workers in every period in steady state.[3] Therefore, wages adjust so that new workers are indifferent between the two industries. As a result, incumbent workers at productivity level $x = 1$ are indifferent between quitting and staying. We assume, for concreteness, that they do not quit. With this convention, workers quit if, and only if, their productivity level falls to $x = 0$.

Let $V_i(x)$ denote the expected income of a worker of productivity level $x$ in industry $i \in \{H, L\}$. From the previous discussion we know that in steady state new workers are indifferent between working in the two industries, so $V_H(1) = V_L(1)$. Therefore, the expected income of a worker of productivity $x$ in industry $i \in \{H, L\}$ can be written as

$$V_i(x) = \max_{s \in [0,1]} (1 - s)xw_i + \beta \{V_i(1) + p_i[(1 - h(s))V_i(x) + h(s)V_i(2)]\} \tag{2.1}$$

where $(1 - s)xw_i$ is current period earnings if a fraction $s$ of time is devoted to training. Because the worker can change employers if necessary, her productivity is at least 1 in the next period. If her employer survives, which occurs with likelihood $p_i$, and if her training efforts pays off, which occurs with likelihood $h(s)$, she moves up to productivity $x = 2$.

Workers with $x = 2$ devote no time to training. Denote by $s^i$ be the fraction of time workers with $x = 1$ devote to training in industry $i \in \{H, L\}$. Let $Q^i(t)$ denote the fraction of workers of tenure $t$ who quit in industry $i$ in any given period. By tenure we mean the number of periods a worker has worked for their current employer at the beginning of a given period. In particular, all workers have tenure 0 in their first period of employment, and workers of tenure 0 do not quit by construction. We can now state:

**Proposition 1.** *A unique steady state equilibrium exists. Furthermore, in steady state,*

1. $w_H < w_L$,

2. $s^L \leq s^H$ *with a strict inequality if and only if* $s^H > 0$,

[3] See Quintin and Stevens, 2003, for a complete argument. That paper also relaxes many of the simplifying assumptions made in this section and introduces unemployment.

3. $Q^i(t) < Q^i(t+1)$ *for all* $t \geq 0$ *and* $i \in \{H, L\}$,

4. $Q^H(t) \leq Q^L(t)$ *for all* $t > 0$, *with a strict inequality if and only if* $s^H > 0$.

*Proof.* Existence and uniqueness can be established with standard arguments (see Quintin and Stevens, 2003). Assume by way of contradiction that $w_H > w_L$ in steady state. Then, since the return to any training policy is higher in industry $H$, we have $V_H(1) > V_L(1)$, which can't be in steady state. Now consider the second item in the proposition. Given (2.1), workers in industry $i \in \{1, 2\}$ choose an $s^i$ that satisfies

$$w_i \leq h'(s^i)\beta p_i[V_i(2) - V_i(1)]$$

with a strict equality if and only if $s^i > 0$. (Recall that $h'(1) = 0$.) To establish the second item of the proposition, we only need to argue that $p_H[V_H(2) - V_H(1)] > p_L[V_L(2) - V_L(1)]$. Assume that this inequality does not hold. Then, because $w_L > w_H$, inspection of (2.1) shows that $V_H(1) > V_L(1)$, an inequality which cannot hold in equilibrium as no worker would join firms of industry $H$. This result yields the second item of the proposition. In both industries the evolution of a worker's productivity with tenure follows a Markov chain with states $\{1, 2\}$. Because $h(0) > 0$ the chain's expected value rises strictly with tenure, which is item 3 of the proposition. In addition, $s^H \geq s^L$ implies that the Markov process governing a worker's productivity in industry $H$ first order stochastically dominates the process governing the evolution of a worker's productivity in industry $L$. This yields the last item of the proposition, and completes the proof. □

On average, workers in industries with high survival rates have more tenure, quit less often, and are more productive. This result is true even if there is no training ($s^H = s^L = 0$) because $h(0) > 0$. The no-training outcome prevails, for instance, when $h(s) = h(0)$ for all $s$, in which case the model has the same predictions for turnover as exogenous, job matching models.

When $s^H > 0$, which occurs for instance when $\lim_{s \mapsto 0} h'(s) = +\infty$ , workers in the high survival industry choose to accumulate more firm specific capital than workers in low survival industries. Therefore, if we interpret $s$ as the time devoted to training, we can, in principle,

separate the exogenous view ($s^H = 0$) from the endogenous view ($s^H > 0$) by comparing training intensity across industries. However, as Barron et al. (1997) point out, the state of existing evidence on training, particularly informal training, does not allow for a convincing test along those lines.

The last item of proposition 1 suggests another approach. If the endogenous view of firm specific capital is empirically relevant, then turnover rates should be lower in high survival industries, *even after controlling for differences in the distribution of tenure across industries*. If, on the other hand, the evolution of worker productivity is mostly exogenous, then controlling for tenure should suffice to account for differences in turnover rates across industries. We implement this test after describing our dataset.

# 3 The data

Our test requires industry level information on turnover rates, firm or establishment death rates, and the distribution of tenure. We use separation rates computed from state unemployment records by Arizona's Department of Economic Security (DES) as our measure of turnover for 1994, 1996, and 1998. A separation is said to have occurred when an individual received earnings from a specific employer in a given quarter, but did not receive any earnings from that employer in the subsequent quarter. For 1994 and 1996, the reported separation rates equal annual separations divided by annual employment; for 1998, the ratio of annual separations to average quarterly employment was reported.[4] In each of the three years, the separation rates were published for 2-digit Standard Industry Classification (SIC) industries. DES also reports average quarterly employment by industry in Arizona.

Annual exit rates for establishments by industry are calculated by the U.S. Census Bureau using consecutive years of the data underlying the U.S. County Business Patterns (CBP) data. The Census exit rate tabulations are for the nation as a whole, and while Arizona-specific rates would be preferable, we do not expect that it would have a substantively

[4]If the quarterly separation rates were constant over the year, then the two measures would be equal. If the separation rate are seasonal, then the measures are not equivalent. Likewise, if total employment is seasonal then the measures will not be equal even if the separation rates just exhibit random noise (due to weighting differences between the two measures).

different effect, as industry survival rates in Arizona will be correlated with their nationwide counterparts. A weak correlation would only weaken the significance of our exit rate variables. If anything therefore, using nationwide data for exit rates biases our test against the endogenous view.

Our data on the distribution of tenure come from the February 1996 and 1998 Job Mobility and Tenure Supplements of the Current Population Survey.[5] We also make use of these CPS data to compute the average age of employees as well as the fraction of men and white workers in all industries. In all our calculations, we include all employees between the ages of 16 and 65, and rely on CPS weights.

Finally, we added to our set of variables various statistics that describe the organization of production in Arizona using CBP data. Large establishments have less turnover, a phenomenon for which a variety of reasons have been advanced (see Even and Macpherson, 1996, for a review). We want to make sure that it is not simply because high survival industries have larger firms (due for instance to learning by doing) that they have less turnover.

Table 1 provides summary statistics for the major industry group with the largest employment in each of the 9 industry division for which we have data. Our entire data set is available upon request. Table 1 reveals that exit rates and employee turnover rates vary greatly across industries, and that those differences are very persistent over time.

# 4 The test

The test is simple. Do industry exit rates for establishments help account for the variation in industry separation rates? The literature has ignored the role of exit, instead focusing on the somewhat mechanical relationship between tenure and separation rates. Given this relationship, we should expect industries where average tenure is high to have low separation rates.[6] A regression of separation rates on tenure and other demographic and industry variables, shown in Table 2 under the Model I column, confirms that separation rates decline

[5]The amount of time spent working for one's current employer is not available in 1994.

[6]Note however that even though employees with more tenure are less likely to quit or be laid off, it is conceivable for industries with high average tenure to also have high separation rates. This would be the case for instance in an industry where 50 percent of employees quit after 1 year and the other 50 percent have 20 years of tenure on average.

as tenure rises. For example, in 1994, an industry whose employees have one more year of tenure than the average industry will, everything else equal, have a quit rate that is 3 percentage points lower.

The results for 1994 and 1996 are quite similar in all three models; the results for 1998 are similar in sign but often vary in magnitude and degree of statistical significance due to the different method for calculating separation rates. Nonetheless, some general patterns emerge. Industries with higher shares of women and whites exhibit lower separation rates (although the significance of these results varies across years and specifications).[7] The dummy for agricultural industries is always significant and may reflect fundamental differences in the nature of the employer-employee relationship in this sector. In contrast, the dummy for manufacturing is never significant, despite what seems to be a common belief that separation rates for manufacturing differ systematically from those in the trade and service industries.

In Model II we extend the mechanical, tenure-only explanation by including industry exit rates and an interaction term between tenure and exit rates. Our test hinges upon the sign and significance of these variables. We find that exit rates help account for separation rates: An industry with an exit rate that is one percentage point higher than average will, everything else equal, have a separation rate that is nearly 3-1/2 percentage points higher. The interaction term enters negatively, which suggests that as average tenure rises, the exit rate plays a diminishing role. We were particularly concerned that the behavior of tenure was not adequately captured by a simple average tenure measure, so we also included the level of tenure for the employee at the 25th percentile. This measure, when statistically significant, tends to lower separation rates. We were also concerned that our results could be affected by the share of employees with less than one year of tenure, as quits tend to be concentrated in the first year, but including this share did not alter our results.[8]

While this test favors the endogenous view of firm specific capital, exit rates could be proxying for other industry characteristics such as the distribution of establishment size

[7]It is important to note that our unit of analysis is *industries* and not *individuals*. If we had individual-level data, we would expect to find that women have higher separation rates than men *after controlling for industry fixed effects*. In our industry-level regression, the share of men is likely proxying for other industry characteristics, such as poor working conditions, that tend to reduce the share of women and increase separation rates.

[8]Results from this specification, and from specifications that use a variety of tenure statistics in each industry are available upon request.

and age (two characteristics that are empirically correlated). To test the robustness of our result to this possibility, we included in Model III the share of Arizona employment that is in establishments with 9 or fewer employees.[9] Depending upon the year, this variable was marginally significant to insignificant, and the exit rate results were not substantively changed either qualitatively or quantitatively.

All of the results reported in Table 2 are from weighted regressions using industry employment in Arizona as the weights. We also ran unweighted regressions, but our conclusions, with one exception, were unchanged. The exception is that in 1998 the exit rate is not significant in Models II and III, however, we think that these results give too much weight to very small industries. To check this possibility we reran the unweighted regressions excluding industries with fewer than 10,000 employees—for Arizona this roughly corresponds to the 25 percentile of industries. The results of these regressions were not substantively different from the weighted regressions with all industries included. Finally, we might expect that, everything else equal, unionized industries should have lower separation rates. However, the share of unionized employees by industry (from the CPS) did not have any explanatory power after controlling for tenure.

# 5 Conclusion

Using a unique data set on employee turnover, this paper provides new evidence that employee turnover is higher in industries where firms or establishments are more likely to exit the industry. We show that tenure alone cannot explain the higher separation rates in low survival industries. The evidence we report favors endogenous, specific human capital models of employee turnover rather than job matching models. This result also has implications for the literature on industry rents. Specifically, our results suggest that industry rents may reflect differences in job security across industries. Workers may receive higher wages in low survival industries, because they face a greater risk of unemployment, and the corresponding loss of firm-specific human capital, than their counterparts in industries where jobs are more secure.

[9]This share is calculated from the CBP data as in Holmes and Stevens (2002).

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Table 1: Selected statistics for the largest major industry group in each industry division

| | Average quarterly employment | Separation rate (%) | Establishment exit rate (%)† | Establishments with 9 employees or fewer (%) | Average tenure in years |
|---|---|---|---|---|---|
| *Agricultural Services* | | | | | |
| 1994 | 49,782 | 48.8 | 10.4 | 82.6 | n.a. |
| 1996 | 51,517 | 44.2 | 10.2 | 80.0 | 5.3 |
| 1998⋆ | 45,952 | 74.0 | 12.7 | 77.2 | 5.4 |
| *Metal Mining* | | | | | |
| 1994 | 11,260 | 6.2 | 18.0 | 50.8 | n.a. |
| 1996 | 13,355 | 8.2 | 19.7 | 54.5 | 12.2 |
| 1998 | 9,163 | 19.2 | 17.5 | 58.6 | 11.8 |
| *Special Trade Contractors* | | | | | |
| 1994 | 128,985 | 31.9 | 12.5 | 75.8 | n.a. |
| 1996 | 147,321 | 31.4 | 12.1 | 72.4 | n.a. |
| 1998 | 153,491 | 59.8 | 12.1 | 72.6 | n.a. |
| *Electronics and Other Electrical Equipment* | | | | | |
| 1994 | 53,844 | 6.0 | 8.2 | 42.2 | n.a. |
| 1996 | 59,903 | 7.5 | 8.0 | 41.9 | 7.5 |
| 1998 | 48,232 | 59.4 | 8.5 | 43.9 | 8.4 |
| *Trucking and Warehousing* | | | | | |
| 1994 | 28,943 | 23.4 | 13.0 | 74.3 | n.a. |
| 1996 | 28,708 | 23.9 | 13.6 | 75.1 | 6.2 |
| 1998 | 33,947 | 54.0 | 13.4 | 76.2 | 5.9 |
| *Wholesale Trade, Durables* | | | | | |
| 1994 | 78,340 | 16.0 | 9.1 | 73.6 | n.a. |
| 1996 | 90,776 | 16.4 | 9.0 | 72.4 | 6.6 |
| 1998 | 93,154 | 40.1 | 9.3 | 72.6 | 7.1 |
| *Eating and Drinking Places* | | | | | |
| 1994 | 206,411 | 34.3 | 12.1 | 49.9 | n.a. |
| 1996 | 227,014 | 35.0 | 11.9 | 48.6 | 3.0 |
| 1998 | 219,122 | 69.8 | 12.7 | 47.1 | 3.1 |
| *Depository Institutions* | | | | | |
| 1994 | 42,567 | 12.8 | 7.0 | 52.3 | n.a. |
| 1996 | 44,680 | 15.9 | 5.9 | 41.4 | 7.0 |
| 1998 | 93,154 | 37.1 | 9.3 | 55.2 | 7.0 |
| *Health Services* | | | | | |
| 1994 | 169,035 | 13.7 | 7.0 | 82.8 | n.a. |
| 1996 | 179,783 | 16.0 | 8.0 | 81.0 | 6.5 |
| 1998 | 192,484 | 50.4 | 7.9 | 80.0 | 6.8 |

*Sources*: Average quarterly employment and Separation rates (for Arizona): Arizona Departement of Economic Security. Establishment exit rates (for the U.S.): Census tabulations based on County Business Pattern (CBP) data. Establishments with 9 employees or fewer (for Arizona): Authors' calculations based on CBP data. Average tenure (for the U.S.): February Current Population Survey.

⋆ In 1998, separation rates were computed using a different formulae.

† Exit rates for year $t$ are establishment deaths between year $t-1$ and $t$ divided by initial number of establishments.

Table 2: Explaining Separation Rates

| | Model I | | | Model II | | | Model III | | |
|---|---|---|---|---|---|---|---|---|---|
| Variable | 1994 | 1996 | 1998 | 1994 | 1996 | 1998 | 1994 | 1996 | 1998 |
| Constant | 47.98 | 47.70 | 118.16 | 5.27 | 7.71 | 42.81 | 24.98 | 17.70 | 40.64 |
| | (12.89) | (12.25) | (29.33) | (14.62) | (13.87) | (25.25) | (14.61) | (13.44) | (25.96) |
| Fraction of men | 13.55 | 9.77 | 14.65 | 8.20 | 5.30 | 8.76 | 9.12 | 5.92 | 8.54 |
| | (3.85) | (3.84) | (7.51) | (3.35) | (3.45) | (6.81) | (3.39) | (3.58) | (6.95) |
| Fraction of whites | -15.20 | -13.17 | -51.90 | -8.58 | -9.31 | -39.99 | -21.22 | -16.24 | -37.20 |
| | (14.33) | (13.53) | (34.75) | (14.43) | (13.22) | (25.04) | (13.96) | (12.81) | (25.42) |
| Average tenure | -3.17 | -2.74 | -6.20 | 2.17 | 2.70 | 4.66 | 0.68 | 2.00 | 4.60 |
| | (0.92) | (0.85) | (1.24) | (1.67) | (1.25) | (3.98) | (1.16) | (1.19) | (4.02) |
| Tenure, 25th-percentile | -1.79 | -2.49 | 8.51 | -2.42 | -3.81 | 1.81 | -1.20 | -2.98 | 1.84 |
| | (2.14) | (1.76) | (5.87) | (1.23) | (1.11) | (5.80) | (1.25) | (1.10) | (5.83) |
| Agriculture dummy | 21.86 | 17.63 | 14.70 | 25.14 | 20.22 | 19.33 | 25.21 | 20.32 | 19.09 |
| | (3.52) | (2.56) | (5.32) | (1.59) | (1.60) | (3.58) | (1.64) | (1.64) | (3.65) |
| Manufacturing dummy | -1.40 | -2.25 | 0.58 | -2.41 | -3.82 | -1.98 | 0.24 | -2.05 | -2.35 |
| | (3.10) | (2.81) | (4.73) | (2.72) | (2.64) | (4.72) | (1.72) | (1.99) | (4.34) |
| Exit rate | | | | 3.42 | 3.34 | 5.57 | 2.64 | 2.99 | 5.57 |
| | | | | (0.73) | (0.72) | (1.90) | (0.78) | (0.73) | (1.93) |
| Exit rate × avg. tenure | | | | -0.44 | -0.43 | -0.79 | -0.32 | -0.38 | -0.79 |
| | | | | (0.084) | (0.095) | (0.28) | (0.093) | (0.093) | (0.29) |
| Average size | | | | | | | -0.063 | -0.036 | 0.012 |
| | | | | | | | (0.030) | (0.020) | (0.042) |
| $R^2$ | 0.77 | 0.78 | 0.53 | 0.83 | 0.84 | 0.61 | 0.85 | 0.91 | 0.61 |
| Number of obs. | 56 | 56 | 65 | 56 | 56 | 65 | 56 | 56 | 65 |

Note. The dependent variable in all models is the separation rate. All regressions are weighted by industry employment in Arizona. Unweighted regression results (available from the authors) are similar for 1994 and 1996; the exit rates are not significant in 1998 for the unweighted regressions. Heteroskedasticity-consistent standard errors are in parentheses.