July 2004 Draft

Firm Performance, Workforce Quality and Workforce Churning

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Disclaimer and Acknowledgment: This research is a part of the U.S. Census Bureau's LEHD Program, which is partially supported by the National Science Foundation Grant SES-9978093 to Cornell University (Cornell Institute for Social and Economic Research), the National Institute on Aging, and the Alfred P. Sloan Foundation. The analysis presented here has undergone a much more limited review than an official Census Bureau publication. The views expressed are attributable only to the author(s) and do not represent the views of the U.S. Census Bureau, its program sponsors or data providers. This chapter is a draft chapter from "Economic Turbulence: The Impact on Workers, Firms and Economic Growth" by Clair Brown, John Haltiwanger and Julia Lane. It is a preliminary version and should not be cited without permission.

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1. Introduction

What factors contribute to the success and survival of a business? Underlying this important question are even more basic questions: what constitutes a business, how has this changed over time, and have the factors contributing to success changed? In the old economy (or at least the common view of the old economy) a business is typically characterized by economists as a production location that combines inputs like capital, labor and materials to produce goods. The benchmark old economy model permits little role for differences across businesses in how they organize themselves especially within industries.[1]

For the new economy (or perhaps even a new view of the old economy) there is a perspective that a business is more difficult to define in terms of just the standard measures of outputs and inputs. This new view emphasizes that the mix and scale of these inputs may differ substantially across businesses even if they are producing similar products and services. Moreover, the key inputs for a new economy business (or with this new view) that are often emphasized are human capital and high tech physical capital, and recent evidence suggests that even businesses in narrowly defined sectors combine these two key inputs in a myriad of ways. In a related fashion, the increasing emphasis on producing services as opposed to goods has raised questions about what constitutes the boundary of a firm and the role of location as a defining characteristic of a firm. For a bricks and mortar business that produces or sells physical goods, it is clear that the physical location of a business is a fundamental characteristic of the business. For a producer of services or even high tech goods like software, the information revolution has changed the importance of physical proximity in the organization of the production of the service or the good.

The development of longitudinal business databases for the U.S. and other countries has provided a rich new perspective on how to think about what constitutes a business. These databases permit the measurement of firms and establishments and include measures of productivity along with the underlying measures of outputs and inputs. The

[1] To be more precise, the industrial organization has a long tradition of studying the organization of firms in terms of the mix of establishments that constitute a firm. While the issues of horizontal and vertical integration of firms is closely related to the issues emphasized in this study, our focus is more on the heterogeneity across establishments and firms inside narrowly defined industries which has only recently become the focus of the literature on industry evolution. The neglect of within industry heterogeneity is a common limitation of the statistics on businesses produced by the statistical agencies. Indeed, the definition of a specific industry is often based in part on the presumption that the production process for the businesses classified in the same industries is similar. Interestingly, the recently developed NAICS emphasizes this basis for defining industries relative to the earlier SIC basis. In some ways, the findings and the perspectives from this and related studies that emphasize the heterogeneity in firm performance within narrowly defined industries raises fundamental questions about this conceptual basis for defining industries.

dominant empirical finding is the overwhelming importance of idiosyncratic factors in terms of firm performance measured in a variety of ways. Within narrowly defined industries, some businesses are growing while others are shrinking, some businesses are entering while others are exiting, some businesses are increasing the skill mix of their workforce while others are decreasing the skill mix, some are adopting advanced technologies and some are not, some are increasing their capital intensities while others are decreasing their capital intensities, and some are exhibiting increases in productivity while others are exhibiting decreases in productivity. Moreover, the heterogeneity in key firm performance outcomes like growth, survival and productivity are linked to enormous heterogeneity in how firms are organizing themselves.

The recent literature has shown that all of this heterogeneity is important not only for understanding micro business dynamics but also fundamental for understanding aggregate dynamics. In particular, the recent literature has shown that aggregate productivity growth depends critically on the efficiency of the ongoing churning of jobs and firms. That is, a large fraction of aggregate productivity growth is accounted for by reallocation of outputs and inputs from less productive to more productive businesses. In this context, a key part of the productivity enhancing churn is generated by the entry and exit of businesses as entering businesses tend to be much more productive than the exiting businesses they displace. These entry and exit dynamics are intimately connected since for each wave of entrants there are selection and learning dynamics that shape the evolution of young businesses. That is, in the first several years for each cohort, we observe many young businesses fail with those that fail being the least productive and those that survive exhibit rapid growth in both activity and productivity suggesting a form of learning-by-doing.

A key theme of this study is to explore these issues for five selected industries: financial services, retail food, semiconductors, software and trucking. These industries span services and goods producing industries as well as traditional and high-tech industries. Our objective is to combine the case study contextual information about the detailed workings of the industry with the insights from the new longitudinal matched employer-employee datasets that are at the core of this analysis.[2] Relative to the findings of the recent literature discussed above, an additional contribution is that much of the above referenced literature exploits longitudinal business databases that did not have much information about the characteristics of workers and in turn the human resource practices of businesses. In the analysis of this study, we focus our attention on the connection between firm performance and measures of workforce churning and workforce quality.

At first glance the role of workforce quality in firm performance appears to be straightforward. That is, a higher quality workforce should result in higher productivity. Part of our analysis is to explore whether this straightforward relationship holds. However, another aspect of the relationship between workforce quality and firm performance is not so straightforward. That is, it is not clear that a higher quality

[2] This paper is part of a collaborative project between the Sloan industry centers for these selected industries and the LEHD project at the U.S. Bureau of the Census.

workforce should lead to greater survival. The reason is that a higher quality workforce may lead to higher productivity but not necessarily higher profitability. Simply put, a higher quality workforce will yield higher value-added output but also, in principle, a higher wage bill. However, there may be a number of factors that imply that a higher quality workforce is positively correlated with profitability and survivability. For one, there may be some wage compression so that wages do not fully reflect worker quality. As such, businesses that attract and retain the best workers will in turn have higher profits as well. In a related fashion, a higher quality workforce may be correlated with key unobserved factors that are related to the success of a business. Suppose for example that high quality owners/managers are even more productive if they surround themselves with a high quality workforce. This type of complementarity between managerial ability and worker ability would lead to a positive correlation between workforce quality and survival. [3]

In terms of the relationship between worker churning and firm performance, it is important to recognize that some worker churning is undoubtedly part of a healthy firm. Both life cycle factors and turnover associated with efficient matching (referred to as life cycle turnover and match turnover in what follows) may be fully efficient. Life cycle factors inducing worker turnover include workers entering and exiting the labor market for a variety of reasons (new entrants, exits for schooling/children/retirement, re-entry after schooling/children). Efficient matching turnover results when workers and firms make a match that they are uncertain initially about whether the quality of the match (i.e., is the worker well-suited for the job hired relative to outside options? is the worker happy with the job hired relative to outside options?)

Beyond life cycle and efficient match turnover, there may be inefficient turnover related, for example, to workforce practices and/or managerial practices and abilities. Evidence from existing studies suggests firm performance varies dramatically within industries and it often speculated that such variance reflects managerial ability or deliberate choices on the part of management regarding managerial or workforce practices (see, e.g., Haltiwanger, Lane and Spletzer (2003)). Along these lines, one potentially important characteristic of a good manager often emphasized in the literature is the ability to attract and retain good workers (Ichinowski and Shaw (1997), Black and Lynch (2001)). Workforce practices that contribute to an attractive work environment and loyalty to the firm likely include wage and benefit practices that reward loyalty (e.g., upward sloping wage-firm specific tenure profiles), the provision of training that benefits the worker and the firm, the use of effective teams for production so that workers have a voice in and are rewarded for the productivity of their teams. All of these practices should reduce worker turnover but as noted above should not eliminate worker turnover. As such, in what follows we explore the relationship between our measure of churning and firm performance.

This paper is organized as follows: The next section discusses how we define and measure key variables. Of particular importance is our ability to make significant

[3] Some evidence in favor of this idea using LEHD data is provided in Abowd et. al. (2003). In the latter paper, firms with high quality workforce are found to have higher market value.

improvements to past measures through use of a linked employer-employee database. At the same time, we also identify those economic factors that still pose measurement challenges to researchers. Section III uses these measures to generate a set of basic empirical facts about each of the five Sloan industries. Section IV takes a closer look at the more complex relationship between traits if a business workforce (such as worker skill and turnover) and productivity. In this section, we also explore whether patterns that are true for the sector as a whole are also true for various sub-groupings of businesses within the industry. In this context, we explore some of the key idiosyncratic features of the characteristics of the businesses in each of our five industries. The final section summarizes and highlights the significance of our empirical findings

II. Measurement Challenges

Two main types of data we use in this study are the 1992 and 1997 Economic Censuses and the Longitudinal Employer Household Dynamics (LEHD) databases. Variables available from Economic Censuses are revenue, employment, payroll, establishment identifier, and firm identifier. Given that we have two Economic Censuses we can identify establishments' entry and exit behavior. For 1992 establishments, we can identify whether they survive or exit until 1997. For 1997 establishments, we can identify whether they are new entrants or existed in 1992 (incumbents). It is possible to identify not only entry/exit in establishment level but also entry/exit of parent firms so that mergers/acquisitions and firm entry/exit can be quantified and analyzed. From LEHD, we can get measures of worker turnover and workforce quality at the business level.

The longitudinal employer-employee data that we use in this study permits an unprecedented look inside businesses. In what follows, we provide some exploratory analysis of the relationship between measures of firm performance (measured here by proxies for productivity and by survival) and measures of workforce churning and workforce quality. For the latter we use indirect measures in some cases as well so while we offer a rich new perspective, we also must recognize the measurement challenges and limitations of this analysis.

What do we measure well? We measure the entry and exit of establishments and the organization of establishments into firms well. We measure revenue, employment, job flows, workers flows, earnings, and workforce composition well. For firm performance, the measurement of entry and exit dynamics is important as a key indicator of performance is survival.

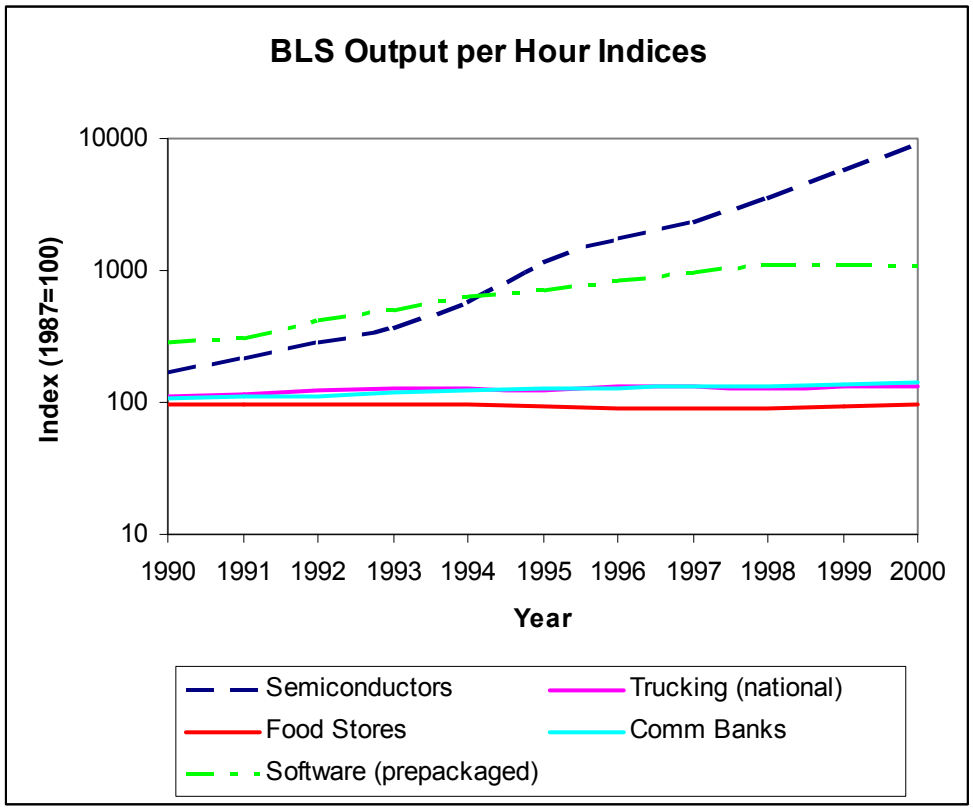
What do we measure less well? To start, our measures of productivity (like much of the micro and aggregate literature) are crude at best. For what we denote productivity in what follows, we measure gross output per worker where gross output is measured as gross revenue deflated with a detailed industry deflator. This is a crude measure of labor productivity. This crude measure is closely related to the measures of gross output per unit of labor that are published by the BLS (BLS typically uses gross revenue data from Census as the primary source data for gross output) and are used extensively in the

literature. For some industries, gross output per worker is not a bad proxy for productivity. For example for the manufacturing sector, a variety of studies have shown that at the establishment-level, labor productivity measured in this manner is highly correlated with value-added per worker and even carefully measured multi-factor productivity (with careful treatment of the measurement of output and inputs including physical capital, labor and materials). However, for the non-goods producing industries, gross output per worker measures of productivity are often problematic. Recent studies have shown that in many service industries, measures of labor productivity based upon gross output per worker at the aggregate level have yielded implausible negative productivity growth in the 1990s (see, e.g., Corrado and Slifman (1999) and Gullickson and Harper (2002)). The problems with gross output per worker are especially severe in those industries where the product or service is difficult to measure. A related problem is that in some sectors it is especially difficult to allocate the output of a firm to individual establishments. In our case, these problems are particularly severe in the financial services sector and in what follows we explore the limitations of our measures for this industry.

To gain some perspective on the measurement challenges for our industries in terms of measuring productivity, Figure 1 depicts the BLS output per hour index for key 4-digit industries that are part of the five somewhat broader sectors that are the focus of this study. A log scale for the vertical axis is used because of the dramatic increases in the productivity index for the semiconductor industry. The latter is largely driven by the tremendous decreases in the price index of semiconductors measures that take into account the enormous efficiency/quality improvements in semiconductors (via hedonic price indices). At the other end of the scale, the official BLS indices suggest little or even declining productivity for food stores, commercial banks and trucking. As noted above, it is not uncommon to find modest or even declining productivity for many non-goods producing industries in the 1990s. An open question is the extent to which this poor productivity performance is real or reflects measurement difficulties especially in difficult to measure sectors like the financial services sector.[4]

[4] As will become apparent below, our biggest problem with productivity measurement is also with financial services. We should note in this regard that BLS uses the gross revenue measures that we use for all of our sectors *except* for financial services (for the latter they attempt to measure the service flow from financial service providers). Even with their alternative approach, there are anomalous results for the financial services sector.

Figure 1: BLS Output Per Hour Indices



Another related problem is that our revenue measure is gross revenue. While for some industries, we can measure value-added at the firm-level for a sample of firms (especially for manufacturing industries) we focus our attention on gross revenues since this measure is readily available for all businesses. Given our focus on the impact of the entry and exit of firms and establishments this is important as value-added measures are often not available for small and young businesses. Value-added per worker would be the preferred concept but a number of studies have shown that value-added per worker is highly correlated with gross output per worker across firms *within* the same industry (see, e.g., Foster, Haltiwanger and Krizan (2001)). An obvious limitation is that gross output per worker measures in levels (not growth rates) are not comparable across industries. In what follows, this limitation will be self-evident for the retail food industry. In retail food, we measure gross revenue per worker not taking into account the cost of the goods sold (as we do not measure gross margins at the micro level). Much of the gross revenue in retail food (and in retail more generally) is accounted for by the cost of goods sold. As such, we find that gross revenue per worker is very high relative to gross revenue per worker in the software and semiconductor industries which is quite misleading. For the most part, we focus on the growth of revenue per worker or we only consider variation within industries so that this problem with measurement levels across industries is not relevant.

In what follows, our primary focus is on the relationship between firm performance (measured as revenue per worker and survival) and measures of workforce quality and

workforce churning. For workforce quality, we take advantage of the measures of human capital developed by Abowd, Lengermann and McKinney (2003). These measures are based upon a statistical decomposition of the wage for a worker into a person effect, a firm effect and time varying person characteristics including general labor market experience. The person effect is the portable component of a worker's wage and as such is a good summary measure of the general skills of a worker (and indeed studies have shown that it is highly correlated with direct measures of skills such as education). In what follows, we use two measures of workforce quality: overall human capital measured as the person effect plus the labor market experience component and the person effect by itself. It may be that the contribution of these different components of human capital interacts with firm performance differently across businesses and industries.

Our measures of human capital are available at the individual worker level but the focus here is on measures of workforce quality at the business level. We construct summary measures of these measures at the business level by estimating kernel densities for every business in the LEHD dataset. Using such kernel densities a wide range of summary measures of the distribution of workforce quality are available. Here we use two simple measures based upon the fraction of workers at a business that are above the economy-wide median human capital measure (using 1997 as the reference year for the economy-wide median). We compute this fraction for both the overall human capital measure and the person effect human capital measure.

We are also interested in exploring the role of workforce churning. For this purpose, we focus on a measure of excess worker reallocation which is likely to be related to internal labor markets and workforce practices. This measure at the business level is given by:

$$\frac{\left(Accessions + Separations - \left|\Delta Employment\right|\right)}{Average\_Employment(t, t-1)}$$

This measure captures the component of worker turnover or reallocation that is in excess of that needed to accommodate any net changes in the number of workers in the business. Whether it represents any excess in an efficiency sense is an open theoretical question and part of our investigation. This is a topic we take up in detail below

Before proceeding, it is important to discuss the unit of observation for this analysis. In this chapter, the unit of observation is typically the establishment. That is, for performance we measure the productivity and survival of establishments. However, our data permit linking the establishments to the parent firms and many of our exercises exploit this information. For example, we distinguish between entering establishments that are new firms and entering establishments for existing firms. In terms of basic measures like revenue, employment, payroll, firm linkages, and survival the primary source of information are the Economic Censuses. Our workforce quality and workforce churning measures are developed from the matched employer-employee datasets from the LEHD project. We integrate these measures at the establishment-level with our Census based measures by matching LEHD data to Census data at the EIN, County, 2-digit SIC

level of aggregation. For most businesses, this match is at the establishment-level. When the match is at higher level of aggregation (e.g., for a firm that has multiple establishments in the same county and same industry), we assume that the workforce quality and workforce churning are the same across establishments in the EIN, County, 2-digit industry cell.

III. Basic Facts

TABLE 1: Means of Core Variables[5]

Sector	Year	Revenue /worker ($)	Churning Rate (%)	Human Capital (%)	Person Effect (%)	Employment (Number)	Payroll /worker ($)
Financial	1992	143,814	16.8	48.3	57.1	18.9	24,433
Services	1997	117,857	15.9	61.6	63.1	18.2	23,397
Retail	1992	138,176	28.7	31.2	46.7	16.1	9,343
Food	1997	140,355	24.3	40.6	50.3	16.6	9,068
Semiconductors	1992	141,306	13.2	56.6	48.4	82.4	26,873
	1997	555,483	13.2	65.7	53.9	84.5	28,188
Software	1992	116,952	20.2	72.3	74.1	19.0	35,220
	1997	139,924	17.1	79.0	77.0	23.0	38,671
Trucking	1992	97,891	26.9	54.5	39.3	13.9	17,547
	1997	99,313	21.3	67.4	46.0	14.1	17,307

We begin by reporting basic facts about firm performance and measures of workforce quality and churning across time and across industries. Table 1 reports mean values of core variables for the five industries under consideration by year. In terms of labor productivity (measured again as real gross revenue per worker), one can see a huge increase in measured productivity for semiconductors, a significant increase in software, modest increases in trucking and retail food but a significant decrease for financial services. However, the results for financial services may be due to poor measurement of productivity. High revenue per worker in terms of levels in retail food reflects use of gross revenue not gross margins. The huge increase in revenue per worker for semiconductors is driven substantially by a dramatically decreasing price index for semiconductors reflecting the use of hedonic price indexes for this industry. Hedonics are used for only a handful of industries in the price deflators produced by the statistical agencies and for our sectors semiconductors is one in which hedonics are used. As has been noted elsewhere in the literature, the enormous changes in the characteristics of semiconductors (and other key IT products) over this period of time have led to rapid rises in measured productivity in key IT industries.[6]

Churning rates are high in retail food and trucking and lower in semiconductors and financial services. The average variation across industries is substantial with

[5] In all the succeeding tables, we refer to our measure of gross output per worker as revenue/worker. As noted in the text, the measure is gross revenue deflated with an industry deflator per worker. For earnings per worker, we measure this in real terms by deflating payroll with the CPI and dividing by the number of workers at the business.

[6] There has been some recent work at BEA exploring hedonics for software but this research has not been incorporated into the official statistics.

churning in retail food and trucking almost twice the rate in semiconductors. Churning rates are somewhat lower in 1997 than in 1992 which might reflect both trend and cyclical effects.

Businesses in software and semiconductors have, on average, a high fraction of high human capital workers whether the overall human capital or person effect measure is used. In contrast, retail food has low human capital. Trucking has surprisingly high overall human capital but low person effect human capital. The implication is that the surprisingly high human capital of trucking is being driven by high experience component as opposed to high general skills. In contrast, financial services has very high person effect human capital but relatively low overall human capital suggesting that general labor market experience is low in financial services. All of the industries exhibit substantial increases in human capital over the 1992-97 period for both overall and person effect human capital.

The average size of establishments is much larger in semiconductors than in the other industries and especially small for trucking and retail food establishments. Average size has been relatively stable over time with modest increases in establishment size between 1992 and 1997 in software.

Earnings are highest in software and semiconductors followed by financial services, trucking and retail food. Workers in software have on average earnings that are about four times larger than the earnings in retail food. The low earnings per worker in retail food is not surprising but also helps remind us that the revenue per worker are highly misleading in a level sense for value-added per worker. If workers are roughly paid their marginal products, we would have expected that the rank ordering of revenue per worker to be roughly the same as the rank ordering of payroll per worker but this is far from the case.[7]

[7] Of course, it is an open empirical question whether productivity per worker and payroll per worker are similarly ranked as many factors may impact their relationship.

TABLE 2: Entry/Exit (Establishments)

Sector	1992		1997	
	Type	Share	Type	Share
Financial	Exiter	39.5	Continuer	65.4
Services	Continuer	60.5	Entrants	34.6
Retail	Exiter	38.6	Continuer	66.7
Food	Continuer	61.4	Entrants	33.3
Semiconductors	Exiter	25.2	Continuer	70.0
	Continuer	74.8	Entrants	30.0
Software	Exiter	38.7	Continuer	47.4
	Continuer	61.3	Entrants	52.6
Trucking	Exiter	40.1	Continuer	63.3
	Continuer	59.9	Entrants	36.7

Table 2 reports shares of continuers, exiters and entrants amongst establishments in 1992 and 1997 respectively. By exit of an establishment in this context, we mean that the establishment truly exited – i.e., is no longer in operation. Similarly, by entry of an establishment we mean that the establishment did not previously exist. The 1992 continuer rates can be interpreted as survival rates since they reflect the fraction of establishments in 1992 that survived until 1997. Survival rates are around 60% for all sectors but semiconductors where 75% of establishments survived until 1997. The 1997 continuer rates can be quite different from the 1992 rates depending on the pace of entry and exit. For example, in 1997, only 52.6 percent of software establishments are continuers even though 61.3 percent of establishments survived from 1992 to 1997. This difference reflects the enormous entry rate in software over this period – the entry rate is so large that there are more "new" than "old" establishments in software in 1997. The entry rate in software is much higher than those of other sectors which are in 30~37%. The high entry rate in software is obviously associated with the IT boom in late 1990s.

Table 3 shows more detailed results on entry/exit incorporating parent firms' entry/exit and merger/acquisition. Entry and exit of firms is conceptually different than the entry and exit of establishments and reflects administrative, organizational and ownership changes. Formally, entry and exit of firms here reflects changes in the firm identification number. A firm obtains a firm identification number if it is truly a new firm (starts up with all new establishments) or has undergone an administrative or organizational change requiring a new firm identification number. Similarly, a firm identification exit occurs when all establishments of the firm cease operations, the firm is sold in its entirety, and/or it undergoes an organizational change (e.g., changes legal form of organization or changes from a single-unit firm to a multi-unit firm).

Caution must be used in combining the establishment entry and exit concepts with the firm entry and exit concepts used here. An establishment may exit since its parent firm closes or it might exit since its parent firm closes some of its establishments

(downsizing, restructuring, etc.). In both cases, the establishment exits – the open question is whether the parent firm is also ceasing operations or changing structure. In addition, surviving establishments may change ownership. New establishment entrants might be associated with an existing firm or represent a totally new firm. Again, in both cases, new establishments are true establishment entry but they may be part of a new firm or a new establishment of an existing firm. In Table 3, we denote exiter/exiter as cases where the establishment exited and the firm identification exited as well and we denote entry/entry as cases where the establishment entered and the firm id entered as well. In contrast, for example, the exiter establishment/continuing firm case represents an establishment that exits for a multi-unit firm that continues (i.e., the firm id survives and some of the establishments for that firm id survive).

Based on Table 3, it is clear that most entry and exit of establishments is associated with the entry and exit of firms. This reflects the fact that most firms have only one establishment and the distinctions between establishment and firm entry and exit are not important. However, in the financial services sector there is very high entry and exit of establishments from continuing firms. In terms of ownership changes of establishments, the pace is relatively modest but with the highest rates in financial services and in semiconductors. The high entry and exit rates of establishments for continuing firms and the high ownership changes for establishments in financial services reflects the rapid restructuring process and M&A in this sector during 1990s.

TABLE 3: Entry/Exit (Establishments and Firms)

Sector	1992			1997		
	Type		Share	Type		Share
	Estab	Firm		Estab	Firm	
Financial Services	Exiter	Exiter	20.6	Entrants	Entrants	18.0
		Continuer	18.9		Continuer	16.6
	Continuer	Different	7.8	Continuer	Different	8.1
		Same	52.7		Same	57.4
Retail Food	Exiter	Exiter	34.0	Entrants	Entrants	27.4
		Continuer	4.6		Continuer	6.0
	Continuer	Different	4.8	Continuer	Different	4.4
		Same	56.6		Same	62.3
Semiconductors	Exiter	Exiter	22.4	Entrants	Entrants	28.6
		Continuer	2.7		Continuer	1.4
	Continuer	Different	6.1	Continuer	Different	5.5
		Same	68.8		Same	64.5
Software	Exiter	Exiter	34.9	Entrants	Entrants	48.4
		Continuer	3.8		Continuer	4.2
	Continuer	Different	4.1	Continuer	Different	3.2
		Same	57.3		Same	44.2
Trucking	Exiter	Exiter	37.9	Entrants	Entrants	34.6
		Continuer	2.2		Continuer	2.1
	Continuer	Different	2.5	Continuer	Different	2.0
		Same	57.4		Same	61.2

Table 4 reports correlation coefficients among core variables for each of the industries. All values in this table are calculated after deviating about mean values of four-digit SIC level. A bold item in the table indicates that the correlation is statistically different from zero. The patterns in the table make sense for the most part but also help highlight some of the measurement challenges. For most sectors, we observe that labor productivity is positively correlated with human capital (both overall and person effect) as well as with payroll per worker and is negatively correlated with churning. In a related fashion, in most sectors we observe that earnings per worker is positively correlated with human capital (both overall and person effect) as well as with employer size but is negatively correlated with churning. We also find that employer size is positively correlated with human capital (both overall and person effect). In terms of the relationship between human capital and churning rates, there is some tendency for overall human capital to be inversely correlated with churning but some weaker evidence that the person effect is positively correlated with churning. Putting these results suggests that the negative relationship for the overall measure presumably reflects the fact that businesses that are dominated by experienced workers are less likely to exhibit churning.

There are some exceptions to these patterns. For example, in financial services measured labor productivity is inversely correlated with size. Moreover, the magnitudes of the correlations vary substantially. For example, the correlation between labor productivity and human capital is very high in semiconductors and software and close to zero in financial services. The generally weaker correlations of measured productivity with other variables in financial services are presumably related to the difficult measurement challenges in measuring productivity in this sector. The finding that at least the sign of the cross sectional correlations between productivity and the other variables is consistent with other industries suggests that there is some information content in the revenue data collected for the financial services sector. In what follows, we will see that there are some sub-industries within the financial services sector where the results on productivity are more sensible.

The main focus of this chapter is on the relationship between productivity, human capital and churning where we find clear and striking patterns. Businesses with higher human capital are also more productive as expected. The finding that businesses with higher churning rates are less productive suggests that the high churning businesses within an industry may be experiencing inefficiently high churning. That is, even if there is, as suggested in the introduction, a more complex nonlinear relationship between churning and efficiency, these results suggest that the overall relationship is negative.[8] Note that even if the relationship between efficiency and churning is negative, there may not be a negative relationship between churning and profitability. For example, it may be to reduce churning, firms must pay higher wages so there is a tradeoff between efficiency and costs. We cannot address this issue directly but since we examine the relationship between survival and churning this provides an indirect means of investigating the impact on profitability.

[8] In future drafts, we will investigate whether we can find a nonlinear relationship.

TABLE 4: Correlations (Financial Services)[9]

	Revenue /Worker	Churning Rate	Human Capital	Person Effect	Size	Payroll /Worker
Revenue /Worker	1.000	**-0.048**	**0.045**	**0.049**	0.005	**0.571**
Churning Rate		1.000	**-0.096**	**0.097**	**-0.033**	**-0.116**
Human Capital			1.000	**0.499**	**-0.047**	**0.179**
Person Effect				1.000	0.009	**0.126**
Size					1.000	**0.206**
Payroll /Worker						1.000

TABLE 4.2: Correlations (Retail Food)

	Revenue /Worker	Churning Rate	Human Capital	Person Effect	Size	Payroll /Worker
Revenue /Worker	1.000	**-0.053**	**0.118**	**0.039**	**-0.081**	**0.452**
Churning Rate		1.000	**-0.235**	**0.070**	-0.004	**-0.115**
Human Capital			1.000	**0.416**	**0.223**	**0.337**
Person Effect				1.000	**0.260**	**0.150**
Size					1.000	**0.288**
Payroll /Worker						1.000

TABLE 4.3: Correlations (Semiconductors)

	Revenue /Worker	Churning Rate	Human Capital	Person Effect	Size	Payroll /Worker
Revenue /Worker	1.000	**-0.092**	**0.380**	**0.302**	**0.133**	**0.547**
Churning Rate		1.000	**-0.135**	0.041	**-0.116**	**-0.156**
Human Capital			1.000	**0.642**	**0.097**	**0.516**
Person Effect				1.000	0.027	**0.371**
Size					1.000	**0.283**
Payroll /Worker						1.000

[9] In all tables, coefficients in bold indicate statistical significance at the five percent level.

TABLE 4.4: Correlations (Software)

	Revenue /Worker	Churning Rate	Human Capital	Person Effect	Size	Payroll /Worker
Revenue /Worker	1.000	**-0.081**	**0.313**	**0.222**	**0.062**	**0.671**
Churning Rate		1.000	**-0.121**	0.015	-0.008	**-0.122**
Human Capital			1.000	**0.530**	**0.099**	**0.497**
Person Effect				1.000	**0.114**	**0.340**
Size					1.000	**0.174**
Payroll /Worker						1.000

TABLE 4.5: Correlations (Trucking)

	Revenue /Worker	Churning Rate	Human Capital	Person Effect	Size	Payroll /Worker
Revenue /Worker	1.000	**-0.072**	**0.282**	**0.086**	**-0.077**	**0.594**
Churning Rate		1.000	**-0.223**	0.012	**-0.063**	**-0.131**
Human Capital			1.000	**0.344**	**0.137**	**0.431**
Person Effect				1.000	**0.072**	**0.127**
Size					1.000	**0.248**
Payroll /Worker						1.000

IV. Market Selection, Workforce Quality and Worker Churning

A. Basic Patterns Across Entering, Exiting and Continuing Establishments

In this section, we explore the role of entry and exit more fully with a focus on the connection between survival, workforce quality and workforce churning. We begin this analysis with some basic facts about the differences in the core variables we have been exploring across entering, exiting and incumbent establishments. In all cases, exit of an establishment here means that the establishment has ceased operations and entry of an establishment is a new establishment that had not previously operated at that location.

TABLE 5: Productivity Difference (Continuing/Entry/Exit Establishments)

	Financial Services	Retail Food	Semiconductors	Software	Trucking
Exiter (1992)	**0.171**	**-0.133**	**-0.918**	**-0.251**	**-0.158**
	(0.007)	(0.008)	(0.063)	(0.020)	(0.015)
Continuer (1992)	**0.118**	**0.060**	**-0.773**	**-0.091**	**0.026**
	(0.006)	(0.007)	(0.045)	(0.018)	(0.013)
Entrants (1997)	**-0.124**	**-0.020**	**0.220**	-0.004	**-0.058**
	(0.008)	(0.009)	(0.059)	(0.017)	(0.015)
Continuers (1997)	0.000	0.000	0.000	0.000	0.000
	(-)	(-)	(-)	(-)	(-)
R-squared	0.335	0.347	0.616	0.042	0.028
N	80,308	60,125	1,277	11,674	19,767

* Dependent variable is revenue/worker and standard errors are in parenthesis.

** Controls: Four digit SIC

Table 5 shows the differences in means of productivity across exiting, entering and continuing establishments in 1992 and 1997 for the five industries. These differences in means are generated from a simple linear regression of measured labor productivity on entry, exit and continuer dummies with the omitted group the continuers in 1997. Calculating the differences in means in this fashion provides a transparent way of identifying whether differences in means are statistically significant.

In semiconductors and software, we observe that the large increases in overall productivity are associated with both dramatic productivity increases for continuing businesses and entrants with much higher productivity than the exiting establishments they are replacing. Even in these sectors with rapid within business growth (as evidenced by the growth rate in productivity for continuers), it is striking that the productivity gap between entering and exiting businesses for both of these sectors is greater than the productivity gap between incumbents in 1992 and 1997. For example, the productivity gap between entering and exiting businesses is about 140 log points in semiconductors while the productivity gap between continuers in 1992 and 1997 is 77 log points. This finding indicates that the contribution of net entry is disproportionate in semiconductors.

For retail food and trucking, entrants are less productive than incumbents but still substantially more productive than exiting businesses. In both of these sectors the net entry gap substantially exceeds the growth rate in productivity for continuers so net entry's contribution is again disproportionate in these sectors. Indeed, in retail food the continuing establishments exhibited negative measured productivity growth. While the latter might reflect measurement difficulties with the gross revenue per worker measure of productivity, it is still striking that the net entry effect is so large and positive.

For financial services, the results imply that continuing businesses exhibited substantial negative productivity growth and that entering businesses are less productive than the exiting businesses they are displacing. Further, the exiting businesses seem to be more productive than incumbents. While these results are consistent with the overall drop in revenue per worker documented in Table 2, as an account of industry dynamics, the

findings are implausible. It is more likely that measured revenue per worker in the sector is not representative of establishment-level productivity. Even in the cross section (i.e., same year), the results are puzzling, which suggests that the difficulties are not simply a matter of having the wrong price deflator or some other factor that is mismeasured over time. Rather, comparisons of revenue per worker across businesses within the same year do not provide accurate representations of productivity differences across the financial services sector.

Table 6 depicts the differences in mean productivity across businesses taking into account entry and exit of establishments, entry and exit of firms and ownership changes. For most sectors, exiting establishments of exiting firms are typically the least productive and entering establishments of continuing firms are more productive than entering establishments of new firms. In terms of ownership change, continuing establishments that change ownership are more productive both before and after the ownership change than establishments that did not change ownership.

The productivity differences between those that changed ownership and those that did not are especially large in the trucking industry. These findings taken together with earlier results suggest ownership changes are important in productivity dynamics and also that the productivity dynamics for entering and exiting establishments are closely linked to firm structure. In general, we find that the positive net entry effect associated with establishments is driven disproportionately by the exit of very low productivity establishments that are single-unit firms and the high productivity of entering establishments of existing firms.

TABLE 6: Productivity Difference and Ownership Change

Estab/Firm (Year)	Financial Services	Retail Food	Semiconductors	Software	Trucking
Exiter/Exiter	-0.002	**-0.142**	**-0.923**	**-0.289**	**-0.174**
(1992)	(0.009)	(0.008)	(0.067)	(0.021)	(0.015)
Exiter/Continuer	**0.410**	0.017	**-0.703**	**0.177**	**0.301**
(1992)	(0.010)	(0.019)	(0.169)	(0.050)	(0.050)
Continuer/Different	**0.063**	**0.220**	**-0.646**	0.086	**0.383**
(1992)	(0.014)	(0.018)	(0.116)	(0.048)	(0.047)
Continuer/Same	**0.135**	**0.058**	**-0.765**	**-0.095**	0.021
(1992)	(0.007)	(0.007)	(0.047)	(0.018)	(0.013)
Entrants/Entrants	**-0.102**	**-0.029**	**0.235**	-0.019	**-0.065**
(1997)	(0.010)	(0.009)	(0.060)	(0.018)	(0.016)
Entrants/Continuer	**-0.105**	**0.077**		**0.275**	**0.219**
(1997)	(0.011)	(0.017)		(0.044)	(0.052)
Continuer/Different	**0.062**	**0.149**	0.220	**0.129**	**0.301**
(1997)	(0.014)	(0.020)	(0.118)	(0.050)	(0.052)
Continuer/Same	0.000	0.000	0.000	0.000	0.000
(1997)	(-)	(-)	(-)	(-)	(-)
R-squared	0.344	0.349	0.617	0.054	0.038
N	80,308	60,125	1,277	11,674	19,767

* Dependent variable is revenue/worker and standard errors are in parenthesis

** Controls: Four digit SIC

Table 7 reports differences in the mean churning rates across entering, exiting and continuing establishments. The overall decrease in the churning rate over time is driven by a fall in the churning rate for continuing establishments. Entering establishments have higher turnover than incumbents and exiting businesses have higher turnover than continuers. The differences in churning rates between entering and exiting establishments on the one hand and continuers on the other hand are especially large in the software and trucking industries.

TABLE 7: Churning Differences (Continuing/Entry/Exit Establishments)

	Financial Services	Retail Food	Semiconductors	Software	Trucking
Exiter (1992)	**0.043**	**0.083**	**0.049**	**0.108**	**0.148**
	(0.003)	(0.004)	(0.022)	(0.011)	(0.008)
Continuer (1992)	**0.024**	**0.053**	0.003	**0.049**	**0.058**
	(0.003)	(0.003)	(0.015)	(0.010)	(0.007)
Entrants (1997)	**0.062**	**0.061**	**0.048**	**0.078**	**0.098**
	(0.003)	(0.004)	(0.020)	(0.009)	(0.008)
Continuers (1997)	0.000	0.000	0.000	0.000	0.000
	(-)	(-)	(-)	(-)	(-)
R-squared	0.021	0.013	0.008	0.011	0.020
N	77,464	57,056	1,242	11,031	18,769

* Dependent variable is churning rate and standard errors are in parenthesis

** Controls: Four digit SIC

In Table 8, differences in means of workforce quality measured using the overall human capital by entering, exiting and continuing establishments are reported. Exiting businesses have lower human capital than survivors except for semiconductors and entrants have lower quality than incumbents except for semiconductors. The semiconductors sector shows a very different pattern on workforce quality in that the entering establishments have much higher workforce quality than incumbents. In all sectors, continuing establishments exhibited substantial increases in human capital. The analogous differences for the person effects are reported in Table 9. For the most part, the results mimic the results in Table 8. One notable exception is that entering establishments have higher person effects than incumbents suggesting that the human capital advantage of incumbents is primarily through experience. In a related fashion, observe that the gap between the human capital of the entering and continuing establishments in semiconductors is even larger when human capital is measured in terms of the person effect, suggesting that entering establishments may have lower worker experience (or younger workers) on average.

One data limitation present in Tables 8 and 9 relative to earlier tabulations is that the number of establishments for which we can measure the human capital variables is smaller than the overall sample. For example, in semiconductors there are 1242 establishments in 1992 and 1997 used in Table 7 to depict churning differences across establishments but only 886 establishments in 1992 and 1997 in Tables 8 and 9 for which we can measure human capital. Both as a cross check and for independent interest, Table 9 shows the differences across continuing, entering and exiting establishments for payroll per worker which we can measure for the full sample of establishments. One pattern that is similar is that exiting establishments have lower payroll per worker than incumbents.

We also find that entrants have lower payroll per worker than incumbents. This latter pattern is consistent with the findings of overall human capital differences between incumbents and entrants.

TABLE 8: Human Capital Differences (Continuing/Entry/Exit Establishments)

	Financial Services	Retail Food	Semiconductors	Software	Trucking
Exiter (1992)	**-0.137**	**-0.132**	-0.038	**-0.068**	**-0.185**
	(0.002)	(0.003)	(0.024)	(0.007)	(0.006)
Continuer (1992)	**-0.131**	**-0.092**	**-0.089**	**-0.072**	**-0.133**
	(0.002)	(0.002)	(0.015)	(0.006)	(0.005)
Entrants (1997)	0.001	**-0.039**	**0.057**	-0.006	**-0.071**
	(0.002)	(0.003)	(0.022)	(0.006)	(0.007)
Continuers (1997)	0.000	0.000	0.000	0.000	0.000
	(-)	(-)	(-)	(-)	(-)
R-squared	0.383	0.092	0.073	0.055	0.143
N	43,661	32,163	886	4,784	8,664

* Dependent variable is human capital and standard errors are in parenthesis

** Controls: Four digit SIC

TABLE 9: Person Effect Differences (Continuing/Entry/Exit Establishments)

	Financial Services	Retail Food	Semiconductors	Software	Trucking
Exiter (1992)	**-0.061**	**-0.052**	-0.013	**-0.014**	**-0.083**
	(0.002)	(0.003)	(0.021)	(0.007)	(0.006)
Continuers (1992)	**-0.043**	**-0.027**	**-0.030**	-0.010	**-0.051**
	(0.002)	(0.002)	(0.013)	(0.006)	(0.005)
Entrants (1997)	**0.030**	0.002	**0.125**	**0.046**	**0.029**
	(0.002)	(0.003)	(0.020)	(0.006)	(0.007)
Continuers (1997)	0.000	0.000	0.000	0.000	0.000
	(-)	(-)	(-)	(-)	(-)
R-squared	0.142	0.031	0.097	0.034	0.048
N	43,741	32,316	886	4,787	8,658

* Dependent variable is person effect and standard errors are in parenthesis

** Controls: Four digit SIC

TABLE 10: Payroll Per Worker Effect Differences (Continuing/Entry/Exit Establishments)

	Financial Services	Retail Food	Semiconductors	Software	Trucking
Exiter (1992)	**-0.057**	**-0.196**	-0.085	**-0.331**	**-0.291**
	(0.007)	(0.006)	(0.043)	(0.021)	(0.013)
Survivor (1992)	0.005	**0.063**	-0.001	-0.029	**0.043**
	(0.006)	(0.005)	(0.030)	(0.018)	(0.012)
Entrants (1997)	**-0.169**	**-0.157**	0.001	**-0.089**	**-0.224**
	(0.007)	(0.007)	(0.040)	(0.018)	(0.014)
Continuers (1997)	0.000	0.000	0.000	0.000	0.000
	(-)	(-)	(-)	(-)	(-)
R-squared	0.141	0.071	0.010	0.030	0.061
N	80,299	60,013	1,276	11,673	19,762

* Dependent variable is log of real payroll per worker and standard errors are in parenthesis

** Controls: Four digit SIC

B. Market Selection: The Role of Productivity, Workforce Quality and Worker Churning

Economic models of industry evolution (e.g., Jovanovic (1982), Ericson and Pakes (1996), and Hopenhayn (1992), Melitz (2003)) suggest that market selection will be an ongoing process in industries given the myriad of changing economic conditions and the role of idiosyncratic factors determining business success. Idiosyncratic shocks to demand, costs and efficiency generate idiosyncratic profitability outcomes across establishments. Differences in managerial ability yield idiosyncratic profitability outcomes in addition to the impact of idiosyncratic shocks through a variety of channels – good managers make good choices in their responses to shocks, in their choices of goods and services to produce, in their choices of business location, in their choices of the mix of inputs including the mix of workers and in their managerial practices including human resource practices.

The recent literature using longitudinal business databases has provided substantial empirical support for these models of industry evolution as a number of authors have found that businesses with low measured efficiency (via measures of productivity) and that are young and/or small are more likely to exit (see, e.g., Bartelsman and Doms (2001) and Caves (1998) for recent surveys of these findings).

Our value-added to this literature is that we measure workforce quality and workforce churning as well at the business level and as discussed in the introduction of this chapter, these are factors that are also potentially related to business survival. In Table 11a-11c, we present results from estimating the determinants of exit of establishments (using a probit estimation) based upon the exit and survival of establishments from 1992 to 1997 as a function of initial conditions in 1992. All subsequent probits in this paper are of this general functional form. Table 11a uses the overall human capital measure, Table 11b uses the person effect measure and Table 11c uses the payroll per worker measure to capture workforce quality. The sample size in Table 11c is, as noted above, larger since we can measure payroll per worker for more establishments.

We begin our discussion with Table 11a. Consistent with much of the literature, we find that larger businesses are less likely to fail and, except for financial services, high productivity businesses are less likely to fail. We also control for firm structure with a single-unit dummy. In most sectors, single unit establishments are less likely to fail after controlling for all of the other factors. While this finding might seem surprising, recall that it is after controlling for size, productivity, churning and workforce quality. Moreover, it is consistent with the Holmes and Schmitz (1995) hypothesis that single-unit firms may be, holding other factors constant, less willing to close since closing down the establishment implies closing down the firm while this is not the case for establishments belonging to a multi-unit firm.

Even after controlling for these important factors, we find that workforce quality and worker churning contribute independent explanatory power to accounting for survival. In particular, higher churning businesses are more likely to fail. This result is the most robust finding in Table 11 in that this result holds for all industries and the impact of churning is large in magnitude. For example, a ten percent increase in

churning increases the likelihood of failure by almost five percent in the semiconductor industry. These results are striking because they reflect the independent contribution of churning even after taking into account the impact of productivity (albeit crudely measured) on survival. These results suggest that high churning businesses are low profitability businesses. Appropriate caution on the causal interpretation here (and for all the results for these multivariate probits) is needed of course. It may be that the businesses are low profitability which leads to churning prior to exit.

Human capital yields mixed results on failure with high human capital businesses in financial services, retail food and trucking less likely to fail but in semiconductors high human capital businesses are more likely to fail. In software, the coefficient is also positive but insignificant. However, the measure of human capital here is overall human capital including the contribution of experience and thus it may be that worker experience is less important in semiconductors and software. Alternatively, it is worth emphasizing that these results should be interpreted in the context of already controlling for productivity (and other factors like churning). Of course, one explanation for the independent contribution of human capital is that our measures of productivity are poor so human capital is capturing part of the influence of true (unmeasured) productivity effects.

Turning to Table 11b which uses person effects as an alternative measure of human capital, the results are largely the same as in Table 11a but now the effect of human capital is negative for four of the five sectors and although still positive for semiconductors it is insignificant. Thus, part of the story for software and semiconductors is that the experience component of human capital works differently in those industries. Finally, Table 11c shows the results using a cruder but more widely available measure of human capital – namely payroll per worker. Using this more widely available measure we find that in all sectors, high payroll per worker firms are less likely to fail and this effect is statistically significant in four of the five sectors.

TABLE 11a: Probability of Exit of Establishment (Using Overall Human Capital)

	Financial Services	Retail Food	Semiconductors	Software	Trucking
Single unit dummy	**-0.131**	**0.039**	-0.093	**-0.098**	**-0.112**
	(0.011)	(0.008)	(0.059)	(0.025)	(0.020)
Size	**-0.078**	**-0.072**	-0.019	-0.017	**-0.049**
	(0.003)	(0.005)	(0.016)	(0.010)	(0.008)
Revenue/worker	**0.066**	**-0.110**	-0.015	**-0.038**	**-0.067**
	(0.005)	(0.006)	(0.036)	(0.019)	(0.011)
Churning	**0.100**	**0.069**	**0.494**	**0.219**	**0.206**
	(0.032)	(0.019)	(0.175)	(0.064)	(0.033)
Human Capital	**-0.135**	**-0.151**	**0.261**	0.064	**-0.170**
	(0.027)	(0.023)	(0.105)	(0.066)	(0.036)
N	23160	15682	428	2044	4318

* Estimation is based on Probit with exit/stay as a dependent variable.

** Standard errors are in parenthesis

*** Controls: Four digit SIC

TABLE 11b: Probability of Exit of Establishment (Using Person Effect)

	Financial Services	Retail Food	Semiconductors	Software	Trucking
Single unit dummy	**-0.140**	**0.039**	-0.086	**-0.098**	**-0.103**
	(0.011)	(0.008)	0.060	(0.025)	(0.020)
Size	**-0.077**	**-0.073**	-0.021	-0.017	**-0.050**
	(0.003)	(0.005)	(0.016)	(0.010)	(0.008)
Revenue/worker	**0.065**	**-0.113**	0.013	-0.033	**-0.076**
	(0.005)	(0.006)	(0.036)	(0.019)	(0.011)
Churning	**0.144**	**0.098**	**0.404**	**0.214**	**0.234**
	(0.031)	(0.019)	(0.164)	(0.063)	(0.033)
Person Effect	**-0.219**	**-0.091**	0.051	-0.013	**-0.173**
	(0.025)	(0.022)	(0.115)	(0.063)	(0.038)
N	23160	15682	428	2044	4318

* Estimation is based on Probit with exit/stay as a dependent variable.

** Standard errors are in parenthesis

*** Controls: Four digit SIC

TABLE 11c: Probability of Exit of Establishment (Using Payroll Per Worker)

	Financial Services	Retail Food	Semiconductors	Software	Trucking
Single unit dummy	**-0.136**	**0.039**	-0.1	**-0.12**	**-0.153**
	(0.009)	(0.007)	(0.062)	(0.022)	(0.019)
Size	**-0.076**	**-0.089**	**-0.056**	**-0.033**	**-0.082**
	(0.002)	(0.003)	(0.013)	(0.006)	(0.005)
Revenue/worker	**0.017**	**-0.078**	0.053	0.003	**-0.032**
	(0.004)	(0.005)	(0.043)	(0.014)	(0.009)
Churning	**0.055**	**0.039**	0.085	**0.048**	**0.082**
	(0.008)	(0.008)	(0.069)	(0.017)	(0.012)
Payroll/worker	**-0.038**	**-0.095**	-0.04	**-0.127**	**-0.116**
	(0.005)	(0.006)	(0.059)	(0.013)	(0.011)
N	39474	29170	605	4982	9442

* Estimation is based on Probit with exit/stay as a dependent variable.

** Standard errors are in parenthesis

*** Controls: Four digit SIC

C. A Deeper Look By Sector

The findings in the prior two sections show that firm performance as measured by entry, exit, and growth of continuing establishments is closely connected to workforce quality and workforce churning. The general finding is that businesses that are high productivity businesses are also high worker quality and low churning businesses. Moreover, all three of these factors independently contribute to survival – businesses with high productivity, high worker quality (especially via the person effect) and low worker churning are more likely to survive. While these patterns are reasonably common across the sectors, we know that each of these sectors has its own dynamic idiosyncratic factors. In this section, we explore some of these factors on a sector by sector basis.

C.1 Securities Brokers

In financial services, the structure of the industry has changed dramatically following deregulation and, as we have discussed at some length, measurement of firm performance in financial services is especially problematic. However, the measurement problems in financial services on these grounds differ across specific industries. In the banking industry, revenue numbers are especially problematic (and indeed are not used for official BLS statistics – BLS uses an indirect way to measure value-added in the banking industry). However, revenue numbers are potentially more reliable and sensible indicators of activity in the securities brokers industry. In the latter, brokers are largely providing a transaction service and revenues will reflect the amount of transactions services provided.

To get some sense of the sensitivity of results to more narrowly defined industries in financial services, in Table 12, we repeat the exercises from Tables 5, 6 and 11b respectively for the securities brokers industry (SIC 6211). The first column of Table 12 represents the Table 5 exercise examining productivity differences across entering, exiting and continuing establishments. The second column of Table 12 represents the Table 6 exercise showing related productivity differences taking into account firm entry and exit and ownership changes as well. Recall that it is important here to distinguish conceptually between how entry and exit of establishments are defined vs. the entry and exit of firms. The third column of Table 12 represents the Table 11b exercise where we explore determinants of the probability of exit of establishments.

Overall, we find results that are very different than the remainder of the financial services industry and, in particular, results that now are more consistent with our hypotheses (and other industries). In particular, we find that for securities brokers there is positive overall productivity growth between 1992 and 1997. This finding is driven both by substantial productivity growth of incumbents and by entering establishments being substantially more productive than exiting establishments. Ownership change for securities brokers is associated with higher productivity for continuing establishments both before and after the ownership change. In addition, the exiting establishments of exiting firms have especially low productivity suggesting that the market selection of these establishment/firms is particularly productivity enhancing for the securities broker industry. Larger businesses are less likely to fail in this industry as predicted and also businesses with higher churning are less likely to fail. The remaining effects are mostly statistically insignificant although there is a seemingly anomalous result that high human capital security broker businesses are more likely to fail. This latter result needs more exploration but it might be that this reflects the prevalence in this industry for very small startups with security broker "stars" who quit and then the establishment/firm falls apart.

TABLE 12: Productivity Difference and Probability of Exit of Establishment (Securities Brokers)

Establishment	Revenue/ Worker	Estab/Firm (Year)	Revenue/ Worker		Probability of Exit
Exiter (1992)	**-0.405**	**Exiter/Exiter**	**-0.442**	**Single unit dummy**	0.017
	(0.040)	**(1992)**	(0.052)		(0.039)
		Exiter/Survivor	**-0.294**	**Size**	**-0.092**
		(1992)	(0.052)		(0.011)
Survivor (1992)	**-0.266**	**Survivor/Different**	-0.008	**Revenue/worker**	-0.012
	(0.033)	**(1992)**	(0.071)		(0.023)
		Survivor/Same	**-0.260**	**Churning**	**0.170**
		(1992)	(0.035)		(0.042)
Entrants (1997)	**-0.254**	**Entrants/Entrants**	**-0.139**	**Person Effect**	**0.442**
	(0.034)	**(1997)**	(0.040)		(0.099)
		Entrants/Continuer	**-0.339**		
		(1997)	(0.046)		
Continuers (1997)	0.000	**Continuer/Different**	**0.303**		
	(-)	**(1997)**	(0.071)		
		Continuer/Same	0.000		
		(1997)	(-)		
R-squared	0.030	**R-squared**	0.042		
N	4,097	**N**	4,097	**N**	1,734

* Standard errors are in parenthesis

C.2 Integrated vs. Fabless Semiconductor Establishments

With the growth of foundries in Asia and an ensuing rise of fabless semiconductor companies, the entrants into the domestic semiconductor industry in the 1990s are primarily fabless establishments (semiconductor design establishments without production capability). Fabless establishments employ primarily engineers, as opposed to integrated, or fabbed, establishments which employ engineers, technicians and operators. As a result, employment at entering establishments is skewed towards high-human capital workers. While the fabless startups are high human capital employers, they are also smaller and riskier than their integrated counterparts so the characteristics and dynamics of the young fabless establishments will look quite different from large, established traditional fabbed establishments.

The changes in the composition of the semiconductor industry result in the workforce being more educated as the industry employs a higher proportion of workers with engineering degrees. As a result of this change in industry composition, we would expect the revenue per worker, the payroll per worker, and the human capital all to increase between 1992 and 1997. As a first pass, we can examine the results in earlier sections in light of these composition changes. Observe that revenue per worker in the

semiconductor industry increased fourfold from 1992 to 1997 (Table 1); while payroll per worker increased 5% during this period. Low turnover rates in the industry (churning rates of 13.2%) were unchanged during this period, while mean establishment size increased slightly. The overall level of human capital increased significantly over the period. These findings are consistent with a shift in industry composition away from integrated, fabbed firms towards engineer-dominated fabless firms. Also the revenue based productivity measure may be less reliable for fabless producers since the timing between receipts and inputs may be quite different in this part of the industry.

While it is difficult to identify the fabless and fabbed establishments precisely in our data, we know key characteristics of fabless and fabbed establishments. For one, most entrants in the domestic industry after 1987 are fabless establishments. Second, fabless establishments are much smaller than fabbed establishments. Case study analysis by the Sloan semiconductor industry center suggests that all fabbed establishments have at least 300 employees. As such, we have used this information to classify establishments as "fabbed" and "fabless" based upon vintage and size. That is, any establishment that entered after 1987 and is less than 300 employees is classified as a "fabless" establishment while all others are classified as "fabbed" establishments.

Results using this classification are reported in Tables 13-16. We find that our so-called fabless establishments are indeed much smaller, more human capital intensive and have higher revenue per worker (in spite of the potential timing problems between receipts and inputs). Interestingly, despite these skill and productivity advantages, average payroll per worker is no higher at fabless establishments. Fabless establishments increased dramatically relative to fabbed establishments in terms of the number of establishments. However, they still account for relatively small share in terms of employment and sales but by 1997 account for about 16 percent of employment and 13 percent of sales. Fabless establishments that enter between 1992 and 1997 are especially high productivity and high human capital establishments but the continuing fabless establishments did not exhibit much skill upgrading (they were already high skill in the first place). Fabless establishments that exit between 1992 and 1997 are low productivity but not especially low skill (again reflecting the high human capital of fabless establishments).

In examining the multivariate probit analysis of exit, not much is significant although fabbed establishments that are part of a multiunit and have low churning are less likely to exit with results statistically significant at the 10 percent level. All of the rest of the effects are not statistically significant. The latter may reflect the relatively small sample size for the semiconductor industry so that multivariate analysis that also classifies plants into separate categories is pushing the data very hard. The weak multivariate results may also reflect the changing industry structure in semiconductors that implies amongst other things that factors such as size and human capital play different roles for fabbed and fabless establishments. Put more broadly, the changing industry structure may imply that it has become more difficult to characterize the determinants of survival in this industry.

TABLE 13: Means of Core Variables in Semiconductor Industry by Type

Year	Group	Revenue /worker ($)	Churning Rate (%)	Human Capital (%)	Person Effect (%)	Employment (Number)	Payroll /worker ($)
1992	Fabless	156,657	13.7	59.7	54.2	19.7	26,704
	Fabbed	136,145	13.0	55.8	46.9	103.5	26,931
1997	Fabless	681,979	15.5	67.3	59.6	28.7	28,330
	Fabbed	446,645	11.3	64.7	50.4	132.5	28,065

TABLE 14: Shares of Activity in Semiconductor Industry by Type

Year	Group	Establishments	Employment	Sales
1992	Fabless	25.2	6.0	4.6
	Fabbed	74.8	94.0	95.4
1997	Fabless	46.2	15.7	12.6
	Fabbed	53.8	84.3	87.4

TABLE 15: Differences of Core Variables in Semiconductor Industry by Type

	Year	Group	Revenue/Worker	Churning	Person Effect
Exiter	**1992**	**Fabless**	**-0.925**	0.036	0.014
interacted with:			(0.099)	(0.035)	(0.036)
		Fabbed	**-0.854**	**0.066**	-0.020
			(0.077)	(0.027)	(0.025)
Survivor	**1992**	**Fabless**	**-0.723**	0.022	0.037
interacted with:			(0.077)	(0.026)	(0.024)
		Fabbed	-0.739	0.005	**-0.041**
			(0.051)	(0.017)	(0.015)
Entrants	**1997**	**Fabless**	**0.246**	**0.056**	**0.132**
interacted with:			(0.062)	(0.021)	(0.021)
Continuers	**1997**	**Fabless**	**0.157**	0.025	0.014
interacted with:			(0.075)	(0.026)	(0.022)
		Fabbed	0.000	0.000	0.000
			(-)	(-)	(-)
R-squared			0.618	0.010	0.111
N			1,276	1,241	885

* Estimation is based on measure of interest regressed on interacted dummies.

** Standard errors are in parenthesis

*** Controls: Four digit SIC

**** Small number of fabbed entrants preclude reporting coefficients for this group

TABLE 16: Probability of Exit of Establishment in Semiconductor Industry by Type

	Group	
Single unit dummy		**-0.102**
		(0.061)
Size	**Fabless**	0.015
interacted with:		(0.035)
	Fabbed	-0.024
		(0.018)
Revenue/worker	**Fabless**	0.028
interacted with:		(0.045)
	Fabbed	0.007
		(0.038)
Churning	**Fabless**	0.344
interacted with:		(0.260)
	Fabbed	**0.414**
		(0.214)
Person Effect	**Fabless**	-0.158
interacted with:		(0.224)
	Fabbed	0.090
		(0.135)
N		428

* Estimation is based on Probit with exit/stay as a dependent variable.
** Standard errors are in parenthesis (bold at 10 percent level)
*** Controls: Four digit SIC

C.3 National vs. Regional vs. Local vs. Single-Unit Establishments

In many industries, there are likely quite different characteristics and dynamics depending on whether the establishment is part of a large, national firm (with many establishments across many states) relative to a regional, local or single-unit firm (the firm has only one establishment). For at least two of the sectors that we are examining, these effects are likely to be especially important: retail food and trucking. In retail food, there has been a shift of activity towards large, national chains. In trucking, there is a clear bifurcation between national trucking companies that provide both national and local transportation services vs. smaller locally oriented businesses.

To investigate these differences for these two sectors, we classified establishments into one of four groups: single units, local establishments (establishment part of a multi-unit firm that operates in only one state), regional establishments (establishment part of a multi-unit firm that operates in 2-5 states) and national establishments (establishment part of a multi-unit firm that operates in 6 or more states).[10] Tables 17-20 report empirical results for these two sectors using this more detailed classification. For both sectors, most establishments are single units but large, national establishments account for a disproportionate share of activity. For retail food, the share of activity accounted for by national establishments has grown dramatically. In 1992,

[10] This classification has been used by Foster et al. (2004) to study the selection and learning dynamics in the retail trade sector in the 1990s. They find that this distinction is very important cross the retail trade sector and especially in the department and general merchandise store industries.

national establishments accounted for 35 percent of sales but by 1997 they accounted for 48 percent of sales.

In retail food, national and regional establishments are more productive, are larger, pay higher wages and are more human capital intensive. The productivity ranking between these two types reversed between 1992 and 1997 with regional establishments relatively more productive in 1992 and national establishments more productive in 1997. Observe that although national establishments gained a productivity advantage over regional establishments by 1997, national establishments still pay less than regional establishments in 1997. Both regional and national establishments exhibit greater churning than local and single unit establishments.

Two thirds of retail food stores are single units accounting for one third of employment and a quarter of sales. National firms increased its share of stores by a half and increased employment and payroll shares by around 40% while regional firms' shares fell by about a half in their employment and sales. It may be that part of this reflects some regional firms becoming national over this period of time with an associated change in establishment status along these lines.

In terms of dynamics, skill upgrading occurred in all types of establishments but especially amongst single-units. It may be that this is the only way such establishments could keep up with the large, national chains. In terms of productivity, national establishments increased their productivity advantage both by selection (there is an especially large gap between exiting and entering national establishments) and by smaller productivity losses for continuing establishments. For national establishments, especially high churning establishments exited. In terms of multivariate results, the selection effects on productivity are especially large for national establishments consistent with the above finding of a large gap between exiting establishments and incumbents. Somewhat surprisingly large national establishments that are more human capital intensive are more likely to exit – perhaps this reflects a shift in the composition of large, national establishments over this period of time.

In trucking, national establishments stand out as being larger, more skill intensive, more productive and have less churning of workers. Relative shares of establishments, employment, and sales among these firms remained more or less unchanged (although national establishments lost some market share from 1992 to 1997). In terms of dynamics, national establishments lost some of their productivity advantage over time as selection dynamics (i.e., the gap between entering and exiting establishments is actually negative for national establishments) worked in the wrong direction. All types of establishments exhibited skill increases and decreases in churning. In terms of the multivariate exit probits, single-unit establishments, and local establishments are especially adversely impacted by churning, and national establishments are especially adversely impacted by low human capital. All types of trucking establishments are adversely impacted by low productivity.

TABLE 17: Means of Core Variables by Type

Sector	Year	Group	Revenue /worker ($)	Churning Rate (%)	Human Capital (%)	Person Effect (%)	Employment (Number)	Payroll /worker ($)
Retail Food	1992	Single Unit	132,445	27.7	29.6	44.6	7.9	8,393
		MU local	142,056	28.5	30.8	47.6	18.5	10,555
		MU regional	157,224	30.3	38.4	50.4	48.3	12,704
		MU national	154,871	33.9	31.8	49.5	40.2	11,404
	1997	Single Unit	130,326	24.1	39.2	47.1	8.0	8,241
		MU local	153,723	24.6	41.1	50.9	21.2	10,444
		MU regional	150,421	23.9	45.8	55.5	40.0	10,989
		MU national	166,788	25.1	41.2	54.0	38.8	10,728
Trucking	1992	Single Unit	93,794	28.2	51.5	38.7	9.7	16,491
		MU local	103,611	19.8	56.5	39.0	29.7	21,533
		MU regional	113,856	20.2	61.3	41.8	38.0	24,049
		MU national	149,193	15.3	71.6	42.9	57.3	28,189
	1997	Single Unit	95,595	22.0	65.5	44.7	10.1	16,410
		MU local	112,057	16.0	70.8	48.0	34.6	23,345
		MU regional	130,787	18.5	73.7	51.1	37.6	23,693
		MU national	138,707	14.2	77.1	53.3	59.3	25,818

TABLE 18: Shares of Activity by Type

Sector	Year	Group	Establishments	Employment	Sales
Retail Food	1992	Single Unit	68.5	33.5	27.0
		MU local	11.9	13.7	13.3
		MU regional	7.8	23.3	25.0
		MU national	11.9	29.6	34.7
	1997	Single Unit	66.1	32.0	26.0
		MU local	11.0	14.1	13.1
		MU regional	5.5	13.3	12.9
		MU national	17.4	40.7	48.0
Trucking	1992	Single Unit	88.1	61.3	54.5
		MU local	3.5	7.4	7.9
		MU regional	2.7	7.3	7.4
		MU national	5.8	24.0	30.2
	1997	Single Unit	89.1	63.5	56.8
		MU local	2.9	7.0	7.9
		MU regional	2.7	7.1	8.5
		MU national	5.3	22.4	26.8

TABLE 19: Differences of Core Variables by Type

	Year	Group	Revenue/Worker		Churning		Person Effect	
			RF	TR	RF	TR	RF	TR
Exiter interacted with:	**1992**	**Single Unit**	**-0.440**	**-0.591**	**0.065**	**0.214**	**-0.104**	**-0.175**
			(0.013)	(0.041)	(0.007)	(0.022)	(0.004)	(0.012)
		MU local	**-0.384**	**-0.581**	**0.059**	**0.116**	**-0.094**	**-0.155**
			(0.023)	(0.080)	(0.012)	(0.044)	(0.007)	(0.024)
		MU regional	**-0.220**	**-0.350**	**0.033**	0.063	**-0.057**	**-0.141**
			(0.031)	(0.082)	(0.015)	(0.044)	(0.009)	(0.023)
		MU national	**-0.291**	0.032	**0.164**	0.059	**-0.035**	**-0.147**
			(0.027)	(0.064)	(0.014)	(0.035)	(0.008)	(0.019)
Survivor interacted with:	**1992**	**Single Unit**	**-0.302**	**-0.406**	**0.022**	**0.120**	**-0.087**	**-0.147**
			(0.013)	(0.041)	(0.006)	(0.022)	(0.004)	(0.011)
		MU local	**-0.254**	**-0.280**	**0.042**	0.056	**-0.051**	**-0.149**
			(0.017)	(0.061)	(0.009)	(0.033)	(0.005)	(0.017)
		MU regional	**-0.040**	**-0.204**	**0.084**	**0.086**	**-0.034**	**-0.099**
			(0.019)	(0.068)	(0.010)	(0.037)	(0.005)	(0.019)
		MU national	0.022	0.019	**0.083**	0.015	**-0.043**	**-0.076**
			(0.017)	(0.054)	(0.008)	(0.029)	(0.005)	(0.014)
Entrants interacted with:	**1997**	**Single Unit**	**-0.323**	**-0.487**	**0.046**	**0.159**	**-0.062**	**-0.071**
			(0.013)	(0.042)	(0.007)	(0.022)	(0.005)	(0.013)
		MU local	**-0.286**	-0.174	**0.047**	0.037	**-0.031**	**-0.073**
			(0.027)	(0.114)	(0.014)	(0.062)	(0.008)	(0.032)
		MU regional	**-0.220**	-0.040	**0.059**	**0.104**	0.023	-0.033
			(0.037)	(0.086)	(0.019)	(0.046)	(0.010)	(0.026)
		MU national	**-0.190**	**-0.176**	**0.052**	0.053	0.005	-0.001
			(0.023)	(0.067)	(0.012)	(0.036)	(0.006)	(0.019)
Continuers interacted with:	**1997**	**Single Unit**	**-0.387**	**-0.433**	**-0.021**	**0.056**	**-0.071**	**-0.103**
			(0.013)	(0.041)	(0.006)	(0.022)	(0.004)	(0.011)
		MU local	**-0.262**	**-0.262**	-0.003	0.035	**-0.032**	**-0.059**
			(0.017)	(0.061)	(0.009)	(0.033)	(0.005)	(0.016)
		MU regional	**-0.165**	**-0.213**	-0.011	0.040	0.009	-0.015
			(0.022)	(0.068)	(0.011)	(0.036)	(0.006)	(0.018)
		MU national	0.000	0.000	0.000	0.000	0.000	0.000
			(-)	(-)	(-)	(-)	(-)	(-)
R-squared			0.363	0.050	0.016	0.025	0.056	0.067
N			60,013	19,762	56,960	18,765	32,315	8,657

* Estimation is based on regressing measure of interest on dummies as noted.

** Standard errors are in parenthesis

*** Controls: Four digit SIC

TABLE 20: Probability of Exit of Establishments by Type

	Group	Retail_Food	Trucking
Single unit dummy		**-0.375**	**-0.274**
		(0.030)	(0.086)
Size	**Single Unit**	**-0.056**	**-0.049**
interacted with:		(0.008)	(0.010)
	MU local	**-0.111**	**-0.122**
		(0.009)	(0.027)
	MU regional	**-0.043**	-0.013
		(0.012)	(0.027)
	MU national	**-0.090**	**-0.043**
		(0.009)	(0.017)
Revenue/worker	**Single Unit**	**-0.081**	**-0.074**
interacted with:		(0.007)	(0.011)
	MU local	**-0.122**	**-0.093**
		(0.009)	(0.026)
	MU regional	**-0.150**	**-0.110**
		(0.011)	(0.026)
	MU national	**-0.183**	**-0.079**
		(0.009)	(0.020)
Churning	**Single Unit**	**0.197**	**0.252**
interacted with:		(0.023)	(0.035)
	MU local	0.000	**0.472**
		(0.047)	(0.197)
	MU regional	-0.094	0.009
		(0.079)	(0.172)
	MU national	-0.085	0.082
		(0.053)	(0.145)
Person Effect	**Single Unit**	**-0.084**	**-0.144**
interacted with:		(0.025)	(0.042)
	MU local	**-0.203**	-0.087
		(0.054)	(0.192)
	MU regional	**-0.219**	-0.210
		(0.099)	(0.157)
	MU national	**0.223**	**-0.399**
		(0.074)	(0.111)
N		15,700	4,319

* Estimation is based on Probit with exit/stay as a dependent variable.
** Standard errors are in parenthesis
*** Controls: Four digit SIC

C.4 Small vs. Large Software Establishments

In the software industry, there are both small, custom-designed software producers and also very large pre-packaged software producers. To explore this facet of the industry in a simple manner, we classified establishments into small and large establishments based upon whether or not they are above or below the mean (about 20 workers). Tables 21-24 report the results for the software industry classified on this dimension.

In both 1992 and 1997, large software producers account for only about 20 percent of the establishment but more than 80 percent of the sales. Large software producers have higher revenue per worker, pay higher wages, are more skill intensive and have slightly lower churning. In terms of dynamics, the gap between large and small stayed relatively constant over this time although the productivity gap between large and small widened largely through greater productivity gains for continuing, large establishments. A larger gap between entering and exiting small establishments for small firms worked to offset some of these trends. In terms of multivariate exit probits, productivity has a greater impact for large establishments while churning has an especially large adverse impact for small establishments.

TABLE 21: Means of Core Variables in Software Industry by Type

Year	Size	Revenue /worker ($)	Churning Rate (%)	Human Capital (%)	Person Effect (%)	Employment (Number)	Payroll /worker ($)
1992	Small	114,757	20.3	71.4	72.8	4.9	34,184
	Large	128,584	19.5	73.8	76.3	94.1	40,713
1997	Small	136,875	17.0	77.5	75.4	4.9	37,382
	Large	152,333	17.4	81.1	79.3	96.8	43,913

TABLE 22: Shares of Activity in Software by Type

Year	Size	Establishments	Employment	Sales
1992	Small	84.1	21.5	18.2
	Large	15.9	78.5	81.8
1997	Small	80.3	17.0	13.8
	Large	19.7	83.0	86.2

TABLE 23: Differences of Core Variables in Software Industry by Type

	Year	Size	Revenue/Worker	Churning	Person Effect
Exiter	**1992**	**Small**	**-0.412**	**0.079**	**-0.058**
interacted with			(0.029)	(0.016)	(0.010)
		Large	**-0.203**	0.018	-0.016
			(0.048)	(0.026)	(0.012)
Survivor	**1992**	**Small**	**-0.244**	0.006	**-0.050**
interacted with			(0.027)	(0.015)	(0.008)
		Large	**-0.126**	0.031	**-0.020**
			(0.037)	(0.020)	(0.009)
Entrants	**1997**	**Small**	**-0.157**	**0.043**	0.009
interacted with			(0.027)	(0.015)	(0.008)
		Large	0.003	0.017	**0.035**
			(0.041)	(0.022)	(0.010)
Continuers	**1997**	**Small**	**-0.181**	**-0.053**	**-0.055**
interacted with			(0.028)	(0.015)	(0.008)
		Large	0.000	0.000	0.000
			(-)	(-)	(-)
R-squared			0.050	0.013	0.048
N			11,673	11,030	4,786

* Estimation is based on regressing measure of interest on interacted dummies..
** Standard errors are in parenthesis
*** Controls: Four digit SIC

TABLE 24: Probability of Exit in Software Industry by Type

	Size	
Single unit dummy		**-0.094**
		(0.025)
Size	**Small**	-0.027
interacted with:		(0.025)
	Large	-0.019
		(0.019)
Revenue/worker	**Small**	-0.029
interacted with:		(0.020)
	Large	**-0.052**
		(0.026)
Churning	**Small**	**0.304**
interacted with:		(0.078)
	Large	0.020
		(0.112)
Person Effect	**Small**	-0.065
interacted with:		(0.073)
	Large	0.125
		(0.116)
N		2,045

* Estimation is based on Probit with exit/stay as a dependent variable.
** Standard errors are in parenthesis
*** Controls: Four digit SIC

V. Summary

Firm performance is tightly linked with workforce quality and worker turnover. Measures of productivity, workforce quality and worker turnover are highly correlated across businesses. High productivity businesses have a large share of high human capital workers whether measured in terms of general skills or experience and also have low churning of workers. Survival is a function of all of these factors – businesses with high productivity, low churning and high human capital (especially in terms of general skills) are more likely to survive. The patterns of these results vary substantially across the five industries. For example, worker churning is especially important in semiconductors while human capital is especially important in the trucking industry. Some of the patterns observed are due to inherent measurement problems associated with measuring firm performance. In particular, like others have found, it is difficult to measure output and in turn productivity in the financial services sector. We found that the standard measure of revenue per worker as a measure of labor productivity works reasonably in all sectors but financial services. However, even here, this measure has reasonable properties in selected detailed industries like securities brokers.

While there are some common patterns, we found it helpful to take into account the idiosyncratic factors present in the industries under investigation. Some of the anomalous patterns for the semiconductor industry, for example, are apparently driven by the changing composition to fabless semiconductor establishments. Such establishments are by construction recent entrants but are also small and highly human capital intensive thus changing the dynamics in that industry. In retail food and trucking there are large disparities between the characteristics and dynamics of establishments that are part of national chains vs. small, local establishments. In a related but different way, there are large differences between small and large software producers.

All of these industry-specific idiosyncratic factors make one cautious about drawing general inferences from the analysis. A natural reaction is to say how can we possibly compare the results for high tech semiconductors with the changing composition to fabless establishments with retail food establishments that are facing the wave of entry of new establishments from large, national firms. While this caution is warranted in some respects, at the end of the day we are struck by the common patterns rather than by the idiosyncratic factors. Workforce quality, worker churning and firm performance are related in the most basic and sensible of ways across all the industries studied and virtually all classifications of businesses that we have considered.

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