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# The Effects of Employment Change on Payroll per Employee

*Implications from Size-Wage Premia and Labor Composition*

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## ABSTRACT

Employer size has been linked to higher wages across industries and occupations by a host of studies, but a paradox emerges in the relationship between size and payroll per employee. From multivariate analysis on establishment-level, longitudinal data compiled by the United States Census Bureau, an unexpected, negative relationship exists not only between payroll per employee and size but also with growth. The relationship exists whether employment change is positive or negative, over short and long periods, or measured in fixed or relative terms. The negative effect on average payroll is strongest for the most dynamic change rates and weakest for expanding larger establishments hinting at a diminishing effect across size. The presence of workforce compositional changes within the establishment cannot be directly observed but is nonetheless the most logical explanation; lower wage employees are the primary means by which establishments expand and contract. As to the observed shape of the trends—convergence toward zero and compression of predicted changes in average payroll across size—the available data provides no clear indication of the components at work. Plausible factors stem from size-wage differentials, saturation of lower-wage workers, and/or influences of capital on worker bargaining power. All or none of these may be present but their presence and magnitude are little more than conjecture. Nonetheless, there is certainty in that there is an unquestionable presence of a negative trend across establishment size categories in payroll per employee during growth and a positive trend during downsizing.

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# LABOR MARKET CHANGES IN THE LAST QUARTER OF THE TWENTIETH CENTURY

The establishment-level data used in this paper spans a time when the United States underwent a new socio-economic era beginning in the later part of the 20<sup>th</sup> century following a golden postwar economy. Neologized as either *post-Fordism* or *new capitalism*, new changes in many aspects of the economy such as employment, compensation, firm characteristic, and labor share began to emerge beginning in the 1970s and 1980s. Industries such as agriculture and manufacturing saw sharp declines as the service industry—sourced from high levels of college graduates entering the workforce—expanded the proportion of white collar jobs in the economy (Fisk, 2001). Causes for these changes have been defined as institutional and organizational features: the former is comprised of stiffer international competition, state deregulation, institutional ownership of firms, and rapid technological change—the latter of smaller employer size, structural simplicity, and flexibility (Budros, 1997). However, the widely agreed upon presence of the phenomenon has not brought the nature or the source of these changes any closer to consensus.

## 2.1 UNEMPLOYMENT

The late 1980s was the end of a relatively stable income and job security that had existed since the second world war. Unemployment is believed to be caused by idiosyncratic shocks that businesses cannot respond to quickly enough due to frictions in the market (Davis, Haltiwanger, Jarmin, & Miranda [DHJM], 2006), and in the last quarter of the 20<sup>th</sup> century four recession periods gave way to very dynamic unemployment changes. After the peak of the mid-1975 recession, employment began to drop—the decline is short-lived and as a result of two separate recession periods in 1980 and 1982, unemployment reached heights not seen since the Great Depression. The 1990s saw a similar pattern of an unemployment spike, albeit a less severe one, following a recession and then a long drop until reaching a rate as low as 4 percent (U.S. Bureau of Labor Statistics, n.d.). “While unemployment rates at the end of the century were slightly lower than at the very beginning (Fisk, 2001), the duration of unemployment is markedly longer. Workers in the new capitalist era are less likely to be unemployed over a given period than before but are also much less likely to be find work again

(Goldin, 1994). From the 1970s to the 1990s, the likelihood for a prime age worker to be permanently displaced doubled, and the chances of recovering a job at the firm that laid them off halved; the percentage of employees recalled after the 1990s recession was nearly a third of that of the previous four recessions.

Management was not excluded from this trend either; traditional hierarchical structures were flattening. As the amount of non-managerial positions increased, managerial positions decreased and were more at risk of being dismissed (Cappelli, 1997). Control over the business increasingly shifted from being primarily operated with the interests of the manager to those of the investors, of whom may have the power to dismiss and reinstate managerial teams. The shift in power has put humanistic practices, ones that may have taken married men with large families into consideration when making layoffs (Goldin, 1994), behind a more calculatable shareholder value. Additionally, these shareholder interests have been the motivation behind many mergers and acquisitions following national deregulation of hostile takeovers leaving many administrative positions redundant. These factors have led either directly or indirectly to large and frequent layoffs that have become commonplace in the business sector in this new capitalist era (Budros, 1997). While systematic downsizings practices were generally considered taboo in the mid-century, half of the firms in a 1991 survey stated they had laid off a substantial number of employees in the previous five years, and another reported that only five percent of firms said their layoffs were due to economic reason (Cappelli, 1997).

## 2.2 WAGE INEQUALITY

In the post-war period, internal labor markets came to the fore as unions required management to justify wages and thereby reduce discrimination across jobs. Pay became more closely linked to the job than the individual (Cobb, Lin & Gabriel, 2016), but beginning in the 1980s, internal labor markets began to decline around the same time as the decline in unionization (Hollister, 2004) in the private sector. These changes have also been influenced by minimization of the prominence of the corporate job ladder in which workers would increase their salaries by advancing within the firm. General experience now had a stronger influence on wages than did tenure (DiPrete, Goux, & Maurin, 2002) and during the 1980s and 1990s, the length of tenures at a company began to erode. Evidence that the external labor market became stronger than the internal one is most clear in that employees who changed jobs every other year could expect similar pay increases to employees that had stayed with a company

for a longer tenure (Cappelli, 1997). Starting at the bottom as an unskilled laborer was no longer as important in becoming established within the company. Hourly wages were no longer the primary means for employee compensation, and an increasingly greater number of employers used nonwage benefits as a form of employee compensation. Influencing employee productivity with “carrots”, promotions and bonuses, as part of pay were more common during second part of the century than were “sticks”, or punitive actions. At the turn of the century, benefits made up less than one percent of a worker’s compensation, and by the 1980s the number had jumped to 17 percent (Goldin, 1994) and even further to 27.5 percent by 1999 (Fisk 2001).

In the last quarter of the 20<sup>th</sup> century, the United States was marked by increasing levels of wage inequality within firms. Up until the early 1970s, the increase of all levels of income alongside the expansion of the economy was seen as a period of “growing together”. When growth slowed from the mid-1970s to early 1980s, the wage structure widened leading to a period of “growing apart”, and real family income stagnated in the lowest quintile while the fifth-percentile grew three times as quickly as those in the middle over the latter part of the century (Goldin & Katz, 2007).

The shifts in the wage structure have come about by changes in all wage levels: decreasing lower-wage earners, erosion of the share of middle-wage earners, and accelerated increases of top-wage earners. Mishel, Schmitt, & Shierholz (2014) highlight three major trends that occurred involving the bottom ten percent, the median, the top ten percent and the top one percent:

- 1) Between 1979 and 1986 for men and 1987 for women, the top ten percent pulled away from the median as the median pulled away from the bottom ten percent making wage inequality relatively high at this time. The gap between the median and the bottom did however narrow and remain steady throughout the 1990s.
- 2) While the difference between the median and the bottom has decreased since the 1980s, the top continued to pull away from the median throughout the 1990s.
- 3) Real wages for the top ten percent increased by 34 percent and the top one percent by an astounding 156 percent between 1979 and 2007.

*Prima facie* wage inequality criticism is typically based on abuse of power or other factors within the firm, but much of the evidence gives support to exogenous macroeconomic factors. Over this period, employers have relied on increasing flexibility in wage setting practices in order to navigate shocks in the economy, but this practice has come at the expense of equality (DHJM, 2006). Furthermore, a decrease in productivity in the total economy corresponds with an increasing share of low-wage earners (Bluestone and Harrison, 1988), and similarly Mishel et al. (2014) believe that wage inequality in the 1980s was spurred on by high levels of unemployment and decreased in the 1990s alongside reducing unemployment. Links to macroeconomic events are not enough to understand the composition of these trends which involves more specific sources stemming from legislation, technological changes, market shifts, and pay practices.

#### *Decline of Real Wages for the Lower Percentiles*

The share of wage earners in the lowest percentiles dropped rapidly over the 1960s but began to rise again since the late-1970s; by 1986 those earning less than half of the median wages accounted for 17 percent of all employed (Bluestone and Harrison 1988). Likely causes for such a drop may have come from declining real minimum wages over this period. Minimum wage laws were set forth in 1938 under the Fair Labor Standards Act in order to raise the standard of living for the poorest Americans, and by the 1970s, these laws applied to 80 percent of all nonfarm labor. Minimum wage in the United States is subject to revisions by the federal government which increases the nominal minimum wage from time to time but not necessarily at a rate faster than inflation. During the 1980s, the real federal minimum wage dropped to a fifty year low even though the economy continued to grow. Its distance from median wages fell substantially alongside slowed economic growth (Reich, 2015) and as result contributed to much of the 50-10 gap (Mishel et al., 2014). Despite the falling of real minimum wages, real annual wages overall continued to rise although just at a rate of 0.46 percent, (Goldin, 1994). When all wage levels increased following rapid economic growth in 1990s, the real wages of the 10<sup>th</sup> percentile saw modest gains and slightly narrowed the 50-10 wage gap (Cobb et al., 2016). There may be support then, that low-wage earners are heavily reliant on the real wages closest to the economic floor.



More flexible task allotment such as offshoring and outsourcing have also been instrumental in reducing the bargaining power of lower- and middle- wage earners. Wages of outsourced position for low-skilled tasks tend to be lower than inhouse rates but higher for high-skilled ones (Cobb et al., 2016). A similar mechanism is at play for low-skilled workers whose bargaining power has decreased with increased immigration which tend to gravitate towards lower-wage positions (Mishel et al., 2014). Between 1979 and 1995, immigrants to the US increased the level of unskilled workers and decreased the wages of high school dropouts by 15 percent (Borjas, 2016).

### *Separation between the Middle and Top*

The wage inequality between the top and median since the late 1970s was in large part due to whether or not workers had the necessary skills to advance. This can be seen in that college wage differentials follow the trends of the 90<sup>th</sup> percentile very closely up until the 1990s (Mishel et al., 2014). The rising wages of the college educated is a profound occurrence in neoclassical terms—the supply of college graduates increased in this time as did their wages meaning that the increase in demand must have outstripped increase supply (Borjas, 2016). Yet, college degrees holders have not always fared equally as demand is sharply different for upper- and lower-skilled college graduates. Autor, Levy, and Murnane (2003) find that technological change caused polarization on the wage structure by eroding the bargaining power of middle-wage workers despite their college education. The prominence of computers during the IT revolution replaced the routine tasks done by middle-wage earners but favored those with higher levels of education, as computer-based technologies tend to complement the abstract work of professionals and top-managers. However, these technological changes did not have a significant effect on less-educated, lower-wage earners in the service industry whose nonprogrammable tasks are more difficult to replace. Findings based on occupation show that the share of middle-wage earners such as secretaries have been in decline as high-wage professionals have been in greater demand. As a result, over the last quarter of the 20<sup>th</sup> century the share of middle-wage earners has decreased remarkably, leading to higher compositions of polarized wage structures most present in the service industries (Mouw & Kalleberg, 2010).

Mishel et. al find that thirty to forty percent of the gap between the median and both the top ten and one percents (90-50 and 99-50) is also believed to have occurred because decline of

union power, decreased employee bargaining power from new trade policies, and industry deregulation. The latter two are kith and kin to globalization which emerged about the same period as the IT revolution making pinpointing the exact source difficult. Regardless, there is a clear trend that after the 1980s the 50-10 gap stopped growing and contracted toward low-wage earners as the top continued to pull away from both. This is observable in the fact that during the 1980s, real wages for the lowest percentiles decreased faster than those in the middle, but during the economic expansion of the 1990s when all wages grew, the middle was marginally slower than lower percentiles (Goldin & Katz, 2007).

After the 1980s, middle and lower percentiles seemed to be in the same boat, while the wages of highest percentiles continue to increase leading to wage inequality coming solely from a separation of the top. Unlike anything in the bottom 70<sup>th</sup>, the highest percentiles have seen positive wage growth throughout both the 1980s and 1990s at a rate rising systematically with size (Goldin & Katz, 2007), and as a result the acceleration of both the level and share of top wage earners seems to be the predominate driver behind inequality. Managerial-professional occupations have the highest level of within-occupation pay variation, and whose influence on overall inequality comes from a combination of rising wages and increasing proportion of top wage-earners. The source of which may come from incentivized pay schemes based on performance rather than a particular skill or productivity level<sup>1</sup> (Hanley, 2011; Mouw & Kalleberg, 2010).

Overall, the literature suggests that the rising wage inequality of the latter part of the century was both a matter of imbalanced wage growth as well as compositional changes in the labor force. The declining presence of middle-wage earners destabilized general overall parity and led to increasing shares of workers at either the top or bottom. These compositional changes became the basis for an inequality fueled by a suppression of real wage in lower-percentiles as upper-percentiles continued to grow.

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<sup>1</sup> Oddly enough, Davis & Haltiwanger (1992) find the reverse to be true, that human capital is a primary component of wage differences and incentivized wage theories are un-supportable. The underlying differences may be in that 1) their study only covered the manufacturing industry while Hanely's was multi-industry, and 2) occurred during a recession, which would make incentivized pay harder to detect.

## 2.3 LABOR SHARE

Additional concerns for employee income are derived from the observance of a falling labor share. The labor share is a measure used to capture how expenditures are allocated, and though there are various measures, one of the most common ones is the ratio between aggregate labor compensation and the gross value added measured as price times quantity. Thus, when wages or hours worked decrease relative to total output, labor's proportion decreases, and the remaining non-labor expenditure portion may be allotted as investment in capital or other expenditures. When the ratio of non-labor expenditures increases, the labor share falls as less of the employer's rents are directed towards employee compensation. This does not necessarily imply that salaries would decline, but it does imply that the output-wage ratio would.

The labor share was presumed to be a fixed economic equilibrium, and for a long time remained relatively constant throughout the twentieth century. An assumed static labor share was discredited as in 1987 aggregate labor share in the United States declined noticeably before rebounding briefly in the late 1990s and then declining further. Former misconceptions of the labor share possibly arose from the simultaneous decline in agriculture and the rise of manufacturing whose industry-specific labor shares balanced out uncannily (Alvarez-Cuadrado, Long, & Poschke, 2014).

Explanations include increased globalization, capital-shifts, and unionization decline among others, all of which have a perceived influence on the relative bargaining power of the workforce. Elsby, Hobijn, and Sahin (2013) find that a simple representation of the labor share can be viewed as the product of wages and hours worked divided by output. Output in a constant-returns-to-scale production function can be viewed as:  $Y = F(A_K K, A_L L)$ —where  $F$  is a function of the product of capital  $K$  and capital-augmenting technological improvements  $A_K$ , and likewise the product of labor  $L$  and labor-augmenting technological improvements  $A_L$ .

A conclusion some reach about the changes in labor share is that firms became more reliant on capital than labor in their production process and were capital deepening. Capital deepening may occur when capital-augmenting technology,  $A_K$ , develops at a marginally faster rate than labor-augmenting technology,  $A_L$ , so that capital becomes more efficient than labor in generating output. Labor share would then under these theoretical implications have declined

because technology has favored productivity in capital over productivity in labor (Guscina 2006). Neoclassical arguments by Elsby et al. find that this alone cannot likely be the heart of a declining labor share as an increase in the ratio of  $(A_{KK} / A_{LL})$  would lead to not only higher output-per-hour but also to some degree, high wages by increasing the marginal output of workers<sup>2</sup>. The labor share should therefore under this pretense, balance out, which was exactly what had been perceived throughout much of its known history.

In order to affect labor share, the change in capital-augmenting technology would have to be so extraordinary as to break the economy's ability to maintain equilibrium. Yet the noticeable drop in labor share in the 1980s to mid-1990s show that the labor share is not always self-balancing and forming the basis for Guscina's inference that the IT revolution influenced the disproportionate share of innovations dedicated to augmenting capital. Significant and robust results imply that before 1985, increases in innovation resulted in increases in labor share, until the IT revolution after which point the relationship between innovation and labor share became negative. Technological changes which occurred as a result of the IT revolution decreased the proportion of labor-augmenting technology and thus the labor share decreased with relative decreases in worker productivity.

Capital-based explanations hold a fortified argument, but proximity between the beginnings of the IT revolution and globalization make the two difficult to separate. Using more precise time trends, Elsby et al. find that capital-based theories have trouble explaining the timing of the decline in labor share. Globalization, more specifically import exposure, affords a better basis for explaining the labor share trend as the timing is more in-sync. The conclusion reached is that industries where production costs are largely made up of labor faced the largest competition due to imports and offshoring. Exported goods tend to favor the highly educated persons, but imports create jobs for only the lower wage earners (Borjas, 2016). Guscina finds support for globalization as well in that increased trade does not necessarily have a negative effect on employee compensation; it is only after 1985 that a negative relationship between trade share and employee compensation exists. Alternatively, ADKPR (2017) find that though import exposure is deleterious, it may actually raise labor share of sales because industry payroll declined more slowly than industry sales and value added. However, they concede that

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<sup>2</sup> This relatively simple conclusion only suffices to explain the drop in labor share in the 20<sup>th</sup> century, after which point this theory no longer holds to explain further drops.

the declining labor share from trade across multiple industries found by Elsby et al. are legitimate in their own right.

Sources of labor share decline have been defined on a less macroscale as the labor share can be linked to a few firms with highly concentrated sales within their industries. Sales shifting to “superstars” from others in the market better explain lowering labor shares than a general trend across all firms. These high-performing firms often are often more profitable and have lower labor share in terms of sales and value added, but they do not necessarily have lower mean wages—something that potentially resulted from higher rates of outsourcing (Autor, Dorn, Katz, Patterson, & Reenen [ADKPR], 2017). The study complements the findings related to the IT revolution because superstar firms are more pronounced in industries with higher technological dynamism, and it is presumed that their increased market power is harbored by slowed technological diffusion within the industry. It may be then that the technological changes after the mid-1980s led to market share shifting disproportionately to superstar firms that contributed the least to the labor share.

Whether by shifts in capital-labor ratios, import exposure, or through market concentration the above studies all find, in their own way, that labor share is in large part due to lowered bargaining power of the workforce, especially those in the lower wage percentiles. Changes in labor shares resulting in lower employee compensation from factors dealing with reduced bargaining power of the worker from either increased capital or offshoring bear the marks of the previous discussion on wage inequality, and unsurprisingly, changes in labor share too have been seen to increase inequality. The labor share declined precipitously for the bottom ninetieth percentile group for both self-employed and payroll employees, while the top wage earners’ share increased noticeably. This suggests that the decline in labor share accounted for in headline measures is actually understated and is much more severe for all but the top wage earners (Elsby et al., 2013).

## EMPLOYER SIZE-WAGE DIFFERENTIALS

The employer size-wage effect (ESWE) is an observation in which employees at larger firms tend to earn more than their similarly-skilled peers working at smaller firms. Researchers have almost unanimously agreed upon the existence of ESWE since its discovery more than a century ago, yet there is far less certitude as to the source or magnitude of this phenomenon as it may be a proxy for measurable and unmeasurable factors. It has been difficult to pin down because it persists in spite of numerous controls for occupational, organizational, and personal characteristics.

The following discussion synthesizes the findings of Brown and Medoff (1989), Idson and Oi (1999), Hollister (2004), and Pedace (2010) which each present different approaches and conclusions to the relevance of theoretical factors for size-wage differentials. The collective works not so much give support to any one theory as whittle away at the validities of various theories through empirical studies. Support by one study is likely contradicted by another leaving no degree of certainty to the causal root.

### 3.1 MARKET ENVIRONMENT

#### *Higher Rents*

Factors affecting employers such as industry differences or market power may be deterministic of wage differentials. It is assumed that monopolistic power yields economies of scale and higher rents, but the ability to increase wages alone is an insufficient explanation of why larger firms actually pay higher wages. At best it may serve to compliment other explanations. Higher rents due to industry differences is not supported as size-wage premiums have been found to occur across all industries though to varying degrees by Hollister and also Brown and Medoff, of whom the latter additionally finds that market power, at least for product market power, does not explain much. Pedace finds no support for rent sharing as revenue per employee has no effect, but Idson and Oi state that the source of the rents—productivity—is the real link between rents and wages.

### *Unionization*

Union presence is also widely considered in theory as an external force resting unequally on small and large employers. Unions are more likely to increase wages for unionized firms, but even non-unionized firms may raise wages to avoid potential loss of power due to unionization. Since there is a tendency for larger firms to be targeted by unions, union avoidance would be higher in these firms thereby driving up wages. Hollister finds some support in that size-wage differential's decline in industries with declining union presence, but this decline also was observed, though to a lesser extent, in industries with little unionization changes. The unionization theory loses credibility from persistence of wage premiums for occupations with minimal union threat (less than five percent unionization) such as managerial and high-skilled professionals, and the same applies for industries with minimal union threat (Brown & Medoff, 1989). Furthermore, Pedace finds that controlling for unionization had insignificant influence on levels of firm size-wage premiums.

## 3.2 ENDOGENOUS HETEROGENEITY

### *Working Conditions*

Working conditions may worsen with firm size, and in order to remain competitive, larger firms must offer higher wages. Pedace's conclusion of even minimal influence of poor working conditions is not supported by previous studies by Idson and Oi who state that safe work environments aren't in support of higher wages but lower. Brown and Medoff look at the quit rates of employees when holding wage constant and find that employees stay longer with larger firms; this suggests there may be something more than higher compensation keeping employees at larger firms.

### *Internal Labor Markets*

Internal labor markets were once prominent in many large companies, and employees that stayed with a company for a longer time were rewarded with promotions and bonuses. The rationale behind increased wages in larger firms was to encourage employees to stay with the firm for longer and to foster firm-specific human capital. The decline of the internal labor market has led to a decrease in higher wages associated with larger firms and was replaced by

more competitive labor markets that determined wages by the position rather than the worker. Hollister finds support for this as a source of ESWE under the assumption that older, long-tenured employees with less competitive human capital see wage premiums decline as internal labor markets shift into competitive labor markets. Brown and Medoff find some evidence that when controlling for other possible causes, tenure has a fairly high and significant coefficient for the size variable. However, tenure's explanatory ability is diminished in that new employees also benefit from the size-wage effect.

### 3.3 SORTING AND MATCHING OF HUMAN CAPITAL

#### *Education, Experience, and Tenure*

It is posited that human capital can explain one-third or more of the differences in large and small employer wages which may be linked to themes of demand differences, education, or productivity. Sorting based on education has been found to have a non-existent or inverse impact of the size-wage premium by Hollister, but a positive, although marginal, impact when including work experience and tenure (a proxy for firm-specific skills) by Brown and Medoff. Neither find enough evidence that wage premiums are caused by a simple relationship between firm-size and human capital.

#### *Productivity: Monitoring and Capital-Output Ratios*

Potentially then, sorting and matching of human capital may be an indirect means to increasing efficiency and productivity. Neoclassical theory suggests that if higher rents are gained from higher productivity, employers should be willing and able to increase productivity by offering wage premia above the market price but below marginal increases in profit. Offering somewhat vague support for this notion, employers with more than 2,500 employees were 144 percent more productive and paid twice as much as those with less than fifty employees and observed that "wages and labor productivity...tend to move together across the size spectrum" (105-106, Idson & Oi, 1999). While this statistic makes no allusion to the additional rents gained, one may conjecture that if wages represent a value below the marginal output of labor, then the marginal output of labor increasing at a greater rate than wages yields higher profits, *ceteris paribus*.



The relationship between productivity and employer size is not inherent but may stem from at least two possible sources. The first is that hierarchical inefficiencies in larger firms make monitoring of workers more difficult and additional compensation is required to prevent shirking—a theory that suggests larger firms have a productivity *disadvantage*. The second is that higher levels of production warrant higher level of capital-output ratios and better task allocation—implying larger firms have a productivity *advantage*. Both of these explanations are theoretical grounds for size-wage premiums.

As monitoring becomes more difficult with size, employers may mitigate this difficulty by offering efficiency wages above market reservation wages in order to increase intentionally unproductive workers' costs of being discovered and subsequently fired. Pedace based support for efficiency wages on the notion that even when controlling for numerous variables, wage premiums still existed; this conclusion nevertheless stands weak as it came about by little more than through a process of elimination. Brown and Medoff suggest that if efficiency wages existed, they would be positively correlated with the proportion of lower-level employees and negatively correlated with quit rates because workers receive wages above their reservation wage. They found some support for these proxies, but mixed and contradicting results with other proxies left room for skepticism. Idson and Oi do not pursue this as a possibility in because they had dismissed it already in a previous study of firm size-wage effects.

Support of production theories by Idson and Oi comes from two possibilities: better organization of workers and higher capital-output ratios. The first is that firms with a higher volume of sales have potentially higher employee productivity as employees can be scaled down to minimize downtime. Firms with less employees may be forced to hire on additional employees to cover necessary tasks but at the expense of wasted costs. The second is that larger firms pay less for non-labor inputs associated with economies of scale such as lower interest rates and volume discounts in communications, transportation, and insurance. These lower costs for capital in turn increases the relative quantity and quality available for larger firms. There is therefore higher demand for more skilled workers that can handle increased levels of effort, take more responsibility, bear higher risks, and adhere to higher standards.

Though Idson and Oi make a compelling argument, shortcomings to their findings are that they have not directly analyzed *which* factors cause higher levels of productivity. They find that productivity does increase with firm size, but their support for either organizational ability

or higher level of capital was not causally linked to output. Their assertion that both are influential is, therefore, still only hypothetical. In regard to higher capital-output ratios, contradicting evidence arises from Pedace in that controlling for capital did not offer any major difference in ESWE for either positions based on hierarchy or across firm size. Increased organizational ability may then be a more enduring argument but empirically speaking, needs not be disproved because it has yet to be proven. Abowd, Kramarz, and Margolis (1994) provide support that firms with higher wages are more capital intensive and productive, but overall their conclusion is that firm characteristics explain very little of size-wage differentials compared to employee characteristics.

Taking each of the studies' conclusions at face value leaves no clear support for a predominant source, though the role of tenure seems to be the most resilient. If ILMs are in decline, size-wage differentials could be observed to decline in tandem, yet as Hollister finds, even the much simpler task of determining whether trends of employer size-wage premiums have increased or decreased over this period are inconclusive. Brown and Medoff may have stated it best when they described conclusions about employer size-wage effects as “uncomfortably unclear”, which still holds true even after successive research on the topic.

### 3.4 APPLICABILITY

The size-wage premium is potentially a bit misleading as the “wage” component may be a result both wages and other nonwage benefits more commonly offered by larger firms. Pedace finds that a prominent component of premiums are the fringe benefits offered by large firms, reducing wage differentials 20 to 50 percent when including training and benefits controls find coefficients for firm size plummet. Brown and Medoff also come to a similar conclusion early on but continue to use basic wage measures in subsequent models as does Hollister, adding that total compensation follows the same declining trends as hourly wages and dismisses it from additional models based on this fact. Idson and Oi explicitly dismiss fringe benefits altogether in their analysis based on its non-additive influence of size-wage premiums. One can reasonably surmise then that the magnitude of employer size-*compensation* differentials is even larger, and that aforementioned analyses understate the relationship between total employee compensation and size. Since total payroll available in the dataset used for this study includes all wage and nonwage benefits, it is believed that based on findings from employer size-wage effects that it will have a pronounced impact on increasing payroll.

## DETERMINANTS OF EMPLOYMENT CHANGE

The dynamics of employment levels within the economy cannot be regarded as a macrocosm of the average business as lion's share of firms do not witness much employment change. Coad and Hölzl (2010) find that the distribution of expanding and contracting businesses is observed to be Laplace, or heavy-tailed—upper tails create 75 percent of total jobs created and lower tails 70 percent of job destruction among surviving firms<sup>3</sup>. The determinants of employment change, they find, are not likely linked the economy but on firm idiosyncrasies, yet as to which characteristics remains elusive in that observed variables explain very little.

### 4.1 GROWTH AND SIZE

Employment growth has long been touted to come from small businesses with a view that large firms are stagnant. The notion that smaller firms are the wellspring of job creation was the work of by Birch (1979) but has since been challenged by subsequent studies. Studies upholding Birch's theory have been said to be at fault for use of unsuitable data and misspecification of size categories. Firms at the dividing line between “large” and “small” may temporarily cross over due to shocks, but when these fluctuations reverse themselves, large firms appear to shrink, and small firms appear to grow when returning to their former size category. In sum, while there is general trend that smaller, *surviving* firms have higher job creation rates, net job growth rates hardly relate to firm size as a high number of small firms destroy jobs through exiting the market (Davis, Haltiwanger, & Schuh [DHS], 1996).

Whether or not employment growth rates are dependent on size hinges upon a much-debated theory. The Law of Proportionate Effect, or Gibrat's Law as it is eponymously termed, is a classical theory of firm growth that states that the initial size of a firm does not influence the probability of a given proportionate change in its size. This “law” however is has been repudiated in many studies, and a survey on growth literature found it only held for 7 percent of studies on US employers. Most of the studies concluded that the size-growth rate of firms is negatively correlated—large firms generally grow at a noticeably slower rate than smaller firms (Audretsch et al., 2004). Even controlling for the fact that growth in larger firms is likely

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<sup>3</sup> These findings are based on Austrian firms

to result from autocorrelation, the negative relationship still holds (Coad and Hölzl, 2010). Audretsch et al. does add that Gibrat's law may not be completely void of credibility. Interestingly enough, it does tend to hold in studies focusing only on large firms with a minimum efficiency scale (exhausted economies of scale). The assumption being that Gibrat's Law does not hold whenever growth reduces the likelihood of failure such as increasing efficiency or productivity.

#### 4.2 GROWTH AND AGE

Gibrat's Law uses size as a basis for its predictions but makes no reference to age, something that models presented by Jovanovic (1982) have asserted and became the basis of future studies. There is some evidence that a negative relationship exists between the age and growth, that older firms tend to grow slower than younger ones, but the support is unclear for older firms. Similar to the conclusion that independence between size and growth is likelier to hold when there is a decreased chance of firm failure, so too does the relationship between firm age and size become less certain with decreased risk of failure. The effect of increasing age on the increased probability of survival is much stronger in younger firms and may even turn slightly negative for the oldest firms, and likewise the relationship between age and growth becomes less clear with older firms and may even turn positive (Evans, 1987). Though the study found the negative age-growth relationship occurred at a statistically significant level in less than half of the manufacturing industries studied, the relationship is still present with a greater range of industries (Variyam & Kraybill, 1992).

Whether size or age is the more dominant factor is uncertain or perhaps irrelevant. Small, mature firms tend to see negative net change (Haltiwanger, Jarmin, & Miranda [HJM], 2013) just as large, young firms see high levels of net growth. Net job creation from these high growth firms, or *gazelles*, is nearly evenly split between those with above or below 500 employees. Economic employment growth may therefore be disproportionately sponsored by smaller firms because in order to reach equal magnitude with larger firms because (i) there is a greater number of small gazelles contributing to job creation, and/or (ii) the total job creation of small gazelles is proportionately larger to their starting size than for larger firms. Where this begins to depart from Birch is that while rapidly growing firms may be more likely to be smaller, the first five-years tend to be a more predominant factor (Henerkson & Johansson, 2009), coinciding with evidence that net employment growth within the economy has been

more strongly linked to startups (HJM, 2013; Farrell & Wheat, 2017), which are always young but not necessarily small.

### 4.3 GROWTH AND COMPETITION

There is a correlation between size and age with growth rates, but the relationship is unclear and likely not causal. In a meta-analysis on the sources of firm growth, Coad and Hölzl find after controlling for size and age, growth tends to be stochastic<sup>4</sup> and explore other determinants. Financial performance would theoretically allow the firm to expand operations via employment, but this theory has not been widely supported, but rather growth is more likely to have a causal effect on profits. Similarly, productivity is highly linked with financial performance, and unsurprisingly its relationship with employment growth has not received much support either. The overall conclusion they make is that growth comes from idiosyncrasies that are both heterogenous and temporary within firms—what makes a firm grow is potentially linked to whether or not they can compete.

Firms cannot know the effectiveness of their competitive advantages in real time and must rely on gaining knowledge after decisions and investment have been made. Firms learn passively through the stochastic outcomes of their investments that either improve or worsen their position. As firms learn about their investment outcomes, decisions about reallocation of jobs are likely to be corollary—job reallocation rates are very high in the first year and drop dramatically with age, and employment volatility follows a similar pattern. Moreover, job reallocation occurs independently of sectorial or economic conditions giving support to the notion that employment structural changes are made by heterogeneity between firms (Davis & Haltiwanger, 1992). Jovanovic passive learning theory may explain the rationale of why firms exit even as their industry grows, but it only explains that knowledge of competitiveness is *post hoc*. The reason certain investments and decisions promote growth while others do not remain unanswered.

One suggestion by Lee (2010), is that the path that growth takes is dependent on the initial stock of a firm's technological-competence-enhancing capabilities. Firms that are relatively

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<sup>4</sup> Similarly, HJM (2013) find that when controlling for age, the size-growth relationship flattens or even reverses.

lacking in levels of technological capabilities, or low-cap firms, follow a convergent growth path (increasing with a horizontal asymptote); initially, growth is fast but deteriorates progressively overtime. High-cap firms, or those with high levels of technological capabilities, have a divergent growth pattern (increasing with a vertical asymptote) that either leads to progressively sharper growth or decline. This is consistent with findings that younger firms grow faster than older firms, which Lee finds is especially true in industries that are less technologically progressive. High-cap firms may even see a *positive* growth-age relationship, but this depends on the level of competition which increases how quickly technology become obsolete. While this flies in the face of basic assumptions for a negative age-growth relationship, it in turn, provides interesting support for Evans' findings that much older firms are more likely to have a positive age-growth relationship. For firms following divergent growth path, this would certainly be the case, however as mature firms transition into a convergent growth path, the relationship again becomes negative. Perhaps this is why Evans finds a less clear outcome for older firms.

It is suggested that a pattern of both divergent and convergent growth (S-shaped) is also possible. In a developing industry, many firms enter into the market and accumulate technological capability advances. Over time, only some of the firms have enough initial stock of technological capabilities with favorable characteristics to surpass a threshold, and transition from a divergent growth pattern into a convergent one, reaching a steady state as new technological innovation become more difficult to obtain. The industry-specific threshold is an upward line that represents a border between whether a company's stock of technological-competence-enhancing capabilities is able to generate positive rates of return on R&D expenditures and to be compatible with as well as proliferate newer technologies (Lee, 2010).

Passive learning models tie in well with the divergent and S-shaped growth patterns across thresholds. Firms are unaware which path they will follow or the threshold for their particular setting, which are only learned once comparisons to competition and industry trends are available. Firms who discover that their technological-competence-enhancing capabilities are not conducive to growth contract and exit the market, the remaining firms would likely continue to absorb the market share and grow at a diminishing rate as gains from technology diminish. Eventually the number of firms exiting the market slows as do the new entrants whose initial technological capabilities are less competitive against preexisting firms. As the

industry matures, disturbances to each of the firms do not necessarily dictate their decision of continuance or exit as sunk costs associated with entry and exit into the market still persist; the firms remaining become fixed assuming no other disturbances (Davis & Haltiwanger, 1996).

Passive learning of technological-investment and diminished growth for mature firms dovetails with the observance that industries with similar capital intensities have similar net exit rates and similar shapes in their size-growth relationship (Rossi-Hansberg & Wright, 2007). However, innovation's impact on firm growth is dependent on how each variable is measured. For example, increases in product innovation drives demand which increases sales growth while increases in process innovations make capital more efficient and decrease employment growth (Coad and Hölzl, 2010). Since Lee's measure of growth is based on sales, the relationship between increased capital and increased growth may very well follow a trend where technological capabilities are a driving force behind growth, but the relationship between industry capital intensity and employment growth follows a different pattern. Rossi-Hansberg and Wright find that firms in industries with high capital-labor ratios see relatively stronger rates of declines in employment growth across size, and this connotes that the capital-labor ratio's influence on growth largely is deterministic on how that growth is measured.

Rejecting Gibrat's Law of the independence of size and growth and embracing Jovanovic assertions of growth's dependence on age, holds strong implications for this paper, and their decomposition is well warranted in discovering the relationship between growth and payroll per employee. Yet as it has been shown, size and age may only be indirectly related to growth and the real determinants are unobservable especially in the available dataset used for this paper.

As such, in addition to decomposition by size and age, this paper also explores the role of market competitiveness which hosts a better, though still imperfect, understanding of growth.

#### 4.4 DOWNSIZING

It would be prudent to explore the possibility that employer behavior during contractions are inherently different from employer expansions and that the effect on average payroll are not symmetrically inverse. Growing establishments may do so cautiously as hiring is costly and information about new employees uncertain, and while downsizing ones may have better

information on the productivity levels of their employees, the decisions may be more hastily made in response to crises. Different strategies may be taken in that growth is meant to increase output while contraction reduce costs. If the component of employer learning is unique to employment reductions, then it should not be surprising that in general exiting employees tend to have higher wages than entering one. This may stem from employers learning that certain employees are paid above their marginal product of labor and replacing them with workers that have a lower reservation wages (Daly & Hobijn, 2017).

Between 1979 and 1996, ten million jobs were eliminated due to downsizing measures with corporations being a major contributor to this number. While the motives behind employment reductions are various, corporate downsizing practices are heavily influenced by trends in increased shareholder control. Budros (1997) believes shareholders pressure corporations to raise stock value by virtue of payroll reduction, or management may even enact dramatic employment reductions to simply to reduce the threat of shareholder intervention. Further, corporate layoffs not only occur during economic upswings, peaks may even trigger layoffs, which is in line with the finding that firms are more likely to make employment changes, positive or negative, in upswings rather than downswings (Hölzl and Huber, 2009). Budros finds the only factors to stave off employment reductions are market share gains, shareholder value, and productivity.

Many of these factors point towards layoffs being linked to competition intensity. There may be some continued support for this inference in that regulation may have the same effect as deregulation if it is meant to foster a more competitive environment. A study by Shanefelter (2007) on the US energy sector<sup>5</sup> after the introduction of more-competitive legislation observed restructuring led to a massive decline in employment (350,000 to 250,000 jobs) over the 1990s and early 2000s. Surprisingly, output still increased by 33 percent over the same period, and had there not been restructuring, it is estimated that payroll costs would have been 71 percent higher. There is evidence suggesting that this was not in response to economic or industry crises but rather a competitive strategy. Without digressing into the nature of the industry or its jargon, consider three types of companies: utility (less-competitive, helped by market inefficiencies), merchant (more business-minded, entered after market liberalization),

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<sup>5</sup> This may seem to have come out of left field, but as Shanefelter notes, it warrants a good case to study downsizing effects: changes were obligatory, it did not occur in every state (providing control groups), and generators cannot simply move to cheaper regions (preventing bias).



and divested (former utilities that were forced into competition with merchants). Merchants on average had significantly lower payroll costs and significantly higher payroll per employee than either of the other two. Divested firms, laid somewhere in between, generally represented a blend between utility and merchant.

The overall implication that can be garnered from this study is that firms enacting layoffs may do so in order to minimize the costs of any nonessential tasks, and in turn, decrease total payroll. Anecdotal evidence from the study gives support to this idea: those with higher levels of technological expertise were said to be at minimal risk of losing their position, while cost cutting measures were made through removal of apprenticeships programs, outsourcing nonessential positions, and/or combining job responsibilities. Further Cappelli (1997) finds that there is an increased level in productivity and performance following downsizing. Downsizing then may be concluded to be a strategic measure employed independently of economic conditions, and one that may reduce payroll costs by way of less essential employees.

## DATA AND METHODS

### 5.1 DATASET

The dataset used for conducting research is establishment-level, longitudinal business microdata derived from the Census Bureau’s Synthetic Longitudinal Business Database (SynLBD), which contains information of establishments operating in the United States from the years 1976 to 2000. The data is extracted from the legally-obligated filings of payroll tax, and as a result, it compiles observations of millions of establishments—potentially over the entire lifespan of an establishment—with reduced selection bias. What makes the SynLBD so attractive for research is its “comprehensive coverage over an extended period of time” (1, DHJM, 2006), while providing more accurate industry information than firm-level data (Sadeghi, Talan, & Clayton, 2016).

Released establishment-level variables includes total yearly payroll, total employment at March 12, three-digit Standard Industrial Classification (SIC3), and the year; the latter two are not synthesized and remain as is. Establishments are also given a unique synthetic identification number so that observations can be linked to their corresponding establishment without disclosing sensitive information, but establishments cannot be linked to their proprietary firms. All statistic produced in this paper are derived from these variables with the exception of CPI information used to deflate payroll to the year 2000.

To reduce the immense amount of time and computational resources required in analyzing several complicated models on such voluminous data, a random sample of the population was generated. The sample was created by generating a uniformly-distributed value between 0 and 1 for each establishment and dropping those with values less than 0.85. Duplicate entries and instances of payroll or employment that were either zero or missing were also removed.

### 5.2 DATASET LIMITATIONS

The strengths of using establishment-level data is that it provides more precise industry information. Firms in the United States are capable of operating in multiple industries, while establishments are restricted to a single industry, making controls for industry more powerful.

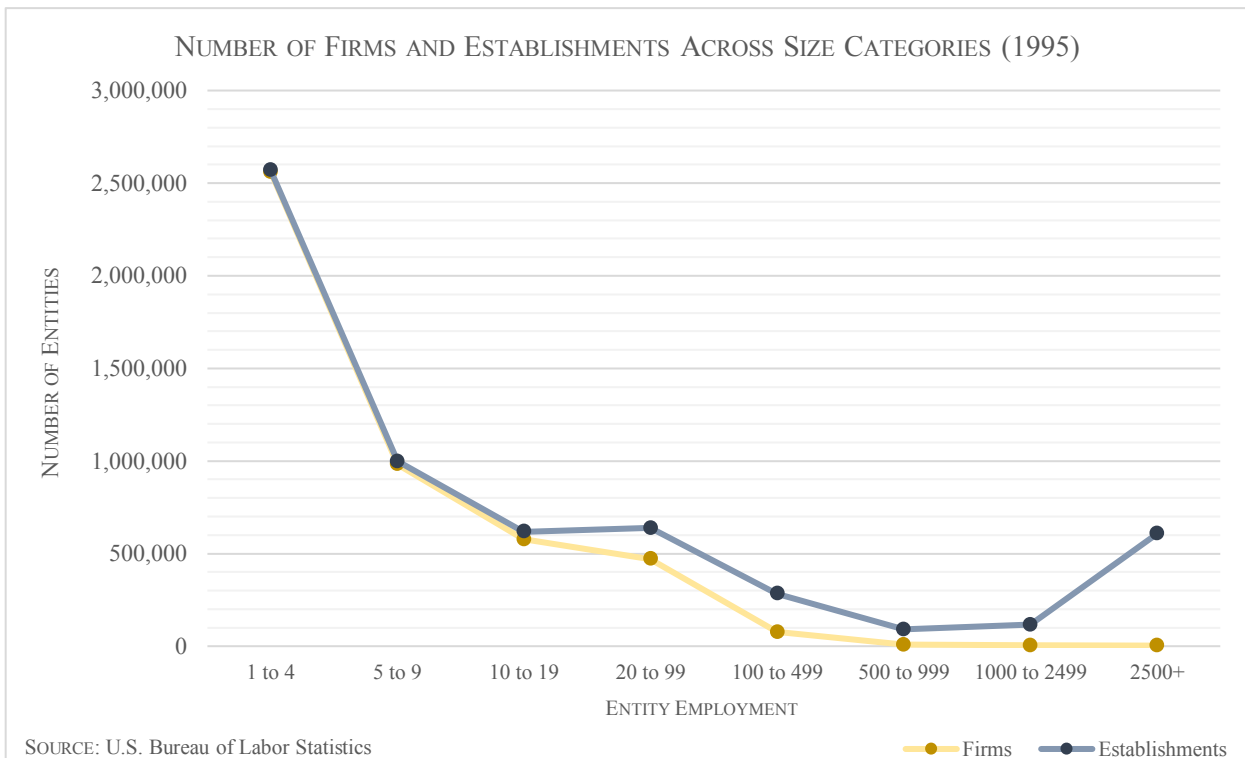
(Sadeghi et al., 2016). Unfortunately, there are inherent limitations to using synthetic establishment-level data that requires a few strong assumptions in order to be able to connect it with literature. These assumptions include, but are not limited to, that synthetic data is statistically comparable to real data, behavior of establishments is similar to firms, employment is a suitable proxy for growth, and the composition in employment remains unchanged across size categories.

### *Use of Synthetic Data*

The synthetic aspect in Synthetic Longitudinal Business Database refers to the fact that the data accessible to the public is not the actual data collected by the Census Bureau, but rather data that has been transformed to maintain its statistical properties while providing discretion of proprietary information. Discrepancies between SynLBD and the actual data for employment and payroll are minor at 1.3 and 8 percent respectively, and analysis provides similar inferences though coefficients may differ (Kinney et al., 2011).

### *Similarities of the Behavior of Establishments and Firms*

Synthetic establishment identification numbers are useful in grouping observations but cannot be used to group establishments to their proprietary firm. The Bureau of Labor Statistics defines an establishment as: “a single physical location where one predominant activity occurs” while firms are a combination of one or more establishments (Sadeghi et al., 2016). For a single-establishment firm, which account for 63 percent of the firms in the United States, using establishment-level data is analogous to firm-level data, yet they employed only 38 percent of the workforce (Dalton, Friesenhahn, Spletzer, & Talan, 2011). The underlying implication is that the differences between establishment-level data and firm-level data increase with employment because large firms are generally comprised of multiple establishments. The figure below shows that the distance between the two gradually increases across entity size until jumping with the largest entities; it is assumed that were the data to continue with high size categories, the gap would continue gradually increasing. This gap necessitates a weakening assumption that *establishment* and *firm* are interchangeable monikers, and as such the terms are used as pedantically as possible.



A review by the Bureau of Labor Statistics found that establishments and firms have many similarities that allow them to be complementary. Comparison of employment changes in response to businesses cycles found near simultaneous turning-points of peaks and troughs in all size categories, and the rates of the changes were strikingly similar in all except the largest size category (more than 1000 employees). For business downturns, establishments in smaller categories had more severe reductions, those in the middle almost identical, and those in the largest less severe. Thus, the correlation between the two business categories were above 95 percent for all categories except the largest which still maintained 83 percent correlation (Dalton et al., 2011). These findings compliment that of Sadeghi et al. (2016) who found that compared to similarly-sized businesses, employment changes were more volatile for establishments with less than 250 employees and were less volatile for those with more than. However, net employment changes for both small and large establishments/firms were relatively similar.

Any general assumptions made about the two primary components of this paper, changes in payroll and employment, are subject to incongruity between establishments and firms. Decisions such as payroll and expansion might be made at the firm level and not the establishment level, and thereby changes in an individual establishment may represent neither

the behavior of the parent firm nor that of similarly-sized, independent establishments (Sadeghi et al., 2016). Additionally, some firms, especially those in retail and franchising, expand through adding establishments while growth within the establishment is minimal (HJM, 2013), and the influence of this trend is not constant. Using surveys from the Census Bureau over roughly the same period as this data, the number of single unit retail stores in the United States decreased from 60 percent to 39 percent, while retail outlets with more than 100 establishments nearly doubled to represent approximately 37 percent of the retail industry by 1997 (Jarmin, Klimek, & Miranda, 2005). Since the data used cannot make the necessary distinctions, establishments in retail trade and hotel/rooming services<sup>6</sup> have been removed in order to reduce biases in the assumption that establishments are suitable proxies for firms.

The assumption this paper makes is that establishments are similar to firms is potentially weakened with the observation that single-unit firms grow a slower than multi-unit firms. Using a binary indicator variable, the difference is 3 to 4 percent (Variyam & Kraybill, 1992), but more specifically using a discrete variable, the effect is much stronger. A 1 percent increase in the number of plants increases ending-period size by 1.18 percent over a ten-year period (Evans, 1987). If growth rates have a significant influence on the relationship between average payroll and employment change, the difference would further weaken the establishment-firm similarity assumption.

### *Employment as a Proxy for Growth*

While measurement for growth and size can be made through output, sales, market share, or assets, numerous studies have relied upon the number of employees<sup>7</sup>. Assets may not take into account intangibles that may be significant for production, and sales may overstate size. Apart from it being more accessible, using employment as a proxy of growth also has the added benefit of not needing to be deflated<sup>8</sup>, is more robust, and is less sporadic than other measures (Coad & Hölzl, 2007). There is a good deal of support in using employment as a measure of

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<sup>6</sup> Having SIC codes 520 to 599 and 701 to 704, respectively

<sup>7</sup> e.g. Belzil (2000), Coad (2007), Evans (1987), Galizzi (2005), Mueller et al, (2017), numerous works coauthored by Davis/Haltiwanger, and a majority of studies in the review by Audretsch et al. (2004) rely solely on employment as a measure of growth.

<sup>8</sup> This is partially true as populations increase overtime and may need to be “deflated” to match previous years in some cases.

growth, but it can only be said with certainty that establishments with the highest employment growth are those adding the most employees. Industries with heavy use of capital may increase output, sales, assets, and market share without adding employment or may even decrease levels of employment.

### *Composition of Employment*

Limitations to use of employer-level data rather than employee-level is that individual employee compensation is not available but must be estimated through dividing total payroll by total employment. For this reason, the terms *average payroll* and *payroll per employee* are used in lieu of *wage* for discussions of analysis based on the SynLBD.

Furthermore, the composition of payroll is nonassessable. This means that the data provides no distinction between year-round, full-time employees and those that work only part-time or part-year. When these employees are included in employment, their contribution to total payroll lowers payroll per employee and introduces parameter bias. If the proportion of part-time employees remained consistent across all size categories, its unobservable influence would not create a strong bias in comparisons between firms. Figures for part-time employment across size are rare, but one source showed that in 1980, part-time workers comprised one-third of the employment for establishments with less than 20 employees. The proportion decreases by more than half with establishment size to those with 51-100 employees, rose slightly and then dropped to 4 percent with the largest categories<sup>9</sup> (Montgomery, 1988). If this composition can be applied throughout the data, payroll per employee should be brought down for smaller establishments which are more composed of part-time workers. This problem is somewhat mitigated by the fact that a large portion of part-time workers are those in industries that have been dropped from the sample and also whose hourly-wage workers are already at the bottom of the wage distribution (Buchmueller, 1999). Nonetheless, the inclusion of unobserved part-time workers biases payroll per employee magnitude and giving growth in establishments' payroll an understated value in smaller sizes.

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<sup>9</sup> Another survey on firms in 1993 found similar results except the labor force at the largest firms was comprised of 18 percent (Snider & Saltford, 1994) rather than 4 percent in the previous study. The difference between the largest categories (those exceeding 500 employees) may be due to a small sample bias, an increased demand for part-time workers over time, and/or differences in establishments versus firms. The proportions for the 1980 study will be taken as the basis for assumptions made on this data because it is based on establishments.

### 5.3 METHODS

The number of unobservable interactions occurring both intra-establishment and inter-establishment make a simple OLS model inappropriate for analysis; namely that autocorrelation and heteroscedasticity are present and can influence the robustness of standard errors. For this reason, a regression model designed for longitudinal data by demeaning the variables is used.

Autocorrelation and heteroscedasticity are most likely present within the data due to the nature of variations of establishments by size. Autocorrelation is suspected for some establishments based on the theory that larger firms are likely to have positive autocorrelation over yearly intervals, while smaller ones are likely to have negative autocorrelation over yearly intervals (Coad, 2007). Heteroscedasticity is assumed in that firms of larger size grow at different rates than smaller ones, and that growth is not normally distributed but is heavy-tailed (Coad & Hözl, 2010). Robust standard errors are still possible in the presence of autocorrelation and heteroscedasticity by relaxing the assumption that residuals are uncorrelated within groups and then clustering observations by their respective establishment when estimating the variance covariance matrix (StataCorp, 2013).

To account for unobserved variations that occur both within establishments and between establishments, random effects were used in the model instead of fixed or between effects. A Hausman test is not possible when clustering observations into groups and additionally may likely provide incorrect estimates for panel data in general (Hoechle, 2007)<sup>10</sup>. Moreover, because fixed effects assume no variance between groups, industry controls cannot be included in the regression model due to collinearity and are automatically omitted. Therefore, the choice of using a random effects model over a fixed effects model is one based more on theoretical implications than empirical tests. Use of random effects over a simple OLS model was confirmed in a Breusch-Pagan Lagrange multiplier test where the null hypothesis of no variance across establishments was emphatically rejected.

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<sup>10</sup> A Hausman test using the *sigmamore* option remedies these problems to some degree; the results failed to reject the null hypothesis (at the 10 percent level) that random effects are suitable.

### The Basic Regression Model

The basic regression model used to analyze the relationship between average payroll and employment is:

$$(1) \quad \log(AVGP_{it}) = \alpha + \gamma SIZE_{it} + \delta AGE_{it} + \theta IND_i + \vartheta YEAR_t + u_{it} + \epsilon_{it}$$

Random effects utilize two error terms:  $u$  for intergroup errors and  $\epsilon$  for intragroup errors that vary by observation and occurrence.

$AVGP$  is the average payroll per employee CPI-W<sup>11</sup> adjusted to the year 2000 for each establishment at each year:

$$(2) \quad \frac{\left(\frac{CPI_{2000}}{CPI_t}\right) * Payroll_{it}}{Employment_{it}}$$

$AGE$  is an ordinal variable (categorical variable based on ordinal progression) that categorizes the age of the establishment for each observation<sup>12</sup>, and  $SIZE$  is also an ordinal variable based on the number of employees<sup>13</sup>.  $IND$  is a categorical variable for the industry divisions used; note that it is time-invariant due to the fact that establishments cannot change industry classifications.  $YEAR$  is a dummy variable controlling for the effect of two economic downturn periods which occurred roughly around 1980-1982 and 1990.

In order to better understand the relationship between changes in average payroll and employment change, four different regression models were created which altered how

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<sup>11</sup> Consumer Price Index for Urban Wage Earners and Clerical Workers

<sup>12</sup> The founding year is not available in the data, and the number of years is calculated by the year of the first observation. For many establishments, the first observation was the first year available in the dataset which understates the actual age for those beginning before 1976. This admittedly introduces biases, and the term *age* is thusly avoided.

<sup>13</sup> The somewhat arbitrary grouping of each size category keeps a range tighter for smaller employment numbers (1-5, 6-10, 11-25...) and wider for larger ones (...501-750, 751-1000, 1000+) under the assumption that incremental changes in employment are more impactful at smaller sizes. Creating a separation at 500 employees was intentional as this is the common division for “small” and “large” firms in the literature.



employment change is measured and the corresponding size category. The previously mentioned theories of the significance that size plays on employment change justifies the creation of an interaction variable between the two.

The general format for each regression is as follows:

$$(3) \quad \Delta \log(AVG P_{it}) = \alpha + \beta_1 [\Delta EMP_{it}] + \beta_2 [SIZE_{it}] + \beta_{12} [\Delta EMP_{it}] * [SIZE_{it}] \\ + \delta AGE_{it} + \theta IND_i + \vartheta YEAR_t + u_{it} + \epsilon_{it}$$

The dependent variable  $\Delta \log(AVG P_{it})$  is the difference of logarithmically transformed payroll per employee for the current and previous year.  $[\Delta EMP]$  is one of four measures for employment change and  $[SIZE]$  is an ordinal variable for size constructed by one of four measures, and their direct interaction  $[\Delta EMP]*[SIZE]$ . The specifications of these two measures are explained hereafter.

#### *Regression Model 1*

This model provides the most basic approach by utilizing a short term, two-period employment change measure:

$$(4) \quad \frac{EMP_{it} - EMP_{i(t-1)}}{(EMP_{it} + EMP_{i(t-1)})/2}$$

where  $EMP$  is total employment of the establishment for observation  $i$  at year  $t$ . While log differences are commonly used in measuring employment growth as the results are less affected by heteroscedasticity (Coad and Hölzl, 2010), this measure has become a standard in studying firm dynamics because in most cases it is identical to log differences, symmetric about zero, and bounded between -2 and 2 (Haltiwanger; DHJM, 2006). This equation also remedies issues noted by Birch (1979) who created an equation, known as the Birch index, that took both relative and absolute changes of growth into account; this was done in order to prevent the large biased relative growth of small entities as well as the large biases in absolute growth by large ones.

For this model the corresponding size category is the same used in equation (3).

## *Regression Model 2*

A short-term change in employment may not fully capture the effects of employment changes on payroll changes. High growth in one year may be followed by strong declines in the next, and yearly autocorrelation differences between establishment are of little use in understand long-term change. To account the effect of employment changes over a longer period, a weighted moving average of employment change was created. The moving average is weighted so that the current observance has the strongest influence while the strength of each weight diminishes along subsequent years. A common four period moving average of:

$$(5) \quad 0.4x_t + 0.3x_{t-1} + 0.2x_{t-2} + 0.1x_{t-3}$$

was set in place to create the moving average variable, however it requires that observations at least in the fifth years of the establishments age. This is the case because  $x$  represents employment change from equation (4) which occurs after the second year. In order to include an additional year into the regression via a three-period moving average, the moving average in equation (5) was deconstructed as:

$$(6) \quad \omega x_{t-0} + \omega x_{t-1} \dots + \omega n_{t-n}$$

where weight  $\omega$  is an expression of total years  $T$  minus the number of lagged years  $n$ <sup>14</sup>:

$$(7) \quad \omega = \frac{(T - n)}{\sum_{n=0}^T (T - n)}$$

This equation is favored because it both allows the weights to sum to 1 while providing each weight to be symmetrically spaced. For example, the weights of  $0.5x_t + 0.3x_{t-1} + 0.2x_{t-2}$  sum to 1 as in the original four-period equation but the weights are asymmetric. A more appropriate three-period moving average based on (5) for would then be:

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<sup>14</sup> Although the author constructed this equation independently, it is not known if the equation is used elsewhere or who first created it.

$$(8) \quad 0.5x_t + 0.333x_{t-1} + 0.166x_{t-2}$$

Therefore, the moving average employment variable was constructed under the condition that observations occurring in the fourth year are calculated under (8) while those in at least the fifth year under (5).

The size category developed under this model is a little more complex than in Model 1. It avoids a problem discussed by DHS (1996) where firms that rapidly change from one category to another can bias results. For example, a firm normally in the size category of 1-5 employees skyrockets in growth to a size category of 26-50 employees would inappropriately credit such growth to the latter category where such levels of growth are less likely. Therefore, the size categories over the three/four periods were averaged with equations (5) and (8)<sup>15</sup>. Averaging size classes is an approach not too dissimilar from the dynamic sizing used by the Bureau of Labor Statistics (Dalton et al., 2011).

### *Regression Model 3*

The influence of industries is controlled for somewhat under the categorical variables included in the model; however, these are bulky and cannot likely capture all of the idiosyncrasies of each industry in any given year. Additionally, there are noticeable difference in the capital-labor ratio for manufacturing and service industries (Alvarez-Cuadrado et al. 2014) which may affect the rate of change in their respective average payrolls especially considering the decline and growth in these two industries over the period of study. For this reason, the employment changes in Model 3 are based on weighted changes in the employment share for each establishment. The calculation of industry employment share is similar to the concept of market share and is the establishment's total employment divided by the total industry employment for each two-digit SIC<sup>16</sup> in each year.

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<sup>15</sup> Instances of values ending in .5 were rounded to the earlier size categories rather than “up”—both to better smooth categorical changes and prevent bias toward larger size categories.

<sup>16</sup> SIC3 data is available but seems to be too narrowly focused. By expanding to SIC2, groups have more observations and better capture more general trends.

$$(9) \quad \left( \frac{EMP_{it}}{IND_{SIC2t}} \right) * (EST_{SIC2t})$$

The measure is weighted by the number of establishments in a particular industry so as to account for larger establishments. For example, an establishment in a relatively small industry holding 25 percent of the industry employment share is less notable than another with the same share in a much larger industry. While simply multiplying the two together may be a bit crude, it does provide at least a somewhat more accurate picture of reality. Doing so does however create a wide range of data and therefore industry employment share were first log transformed and then the difference taken from the previous year.

The size category was created by dividing each establishment industry share into ten quantiles of roughly uniform distribution. These size quantiles have the added benefit of not forcing distributions of size that differ across industries into rigid categories used in the first two regression models. Additionally, employment needs to be “deflated” by the growth in total workforce that occurred over the 25 years of data which is different for each industry, and using quantiles based on relative size amends this issue.

#### *Regression Model 4*

Similar to Model 2, this model seeks to understand the long-term influence of industry employment share changes via a weighted three/four period moving average, except that here the employment change measure  $x$  is the log difference of the industry employment share from Model 3.

In the same vein, the size categories for the model were constructed along the lines of Model 2 but using the ten quantiles of industry employment share from Model 3.

#### *Margins of Responses*

The interaction effect between the four employment measures and their corresponding size categories (i.e. the multiplicative variable in the regression model) makes interpretation of the coefficients difficult and prone to error. By calculating the margins of response for

employment change at four representative growth rates, the coefficients of employment change are much easier to interpret. The four growth rates used to calculate the marginal effect approximately represent the tenth and ninetieth percentiles with two others within the interquartile range: one above and below the median. Margins of responses are calculated by summing the constant, the coefficients of the employment change variable, the size category variable, the interaction variable, and the product of additional factor variables times the lowest category (Williams, 2012).

The calculations of margins of responses are repeated for each of the size categories and for each of the four change rates specified, *C*. The relationship of employment on payroll per employee becomes partitioned vertically into size categories and horizontally into growth rates, and the decomposition makes for a richer understanding of the trends while making interpretation clearer<sup>17</sup>.

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<sup>17</sup> The Stata code used to run the four models is listed in the Appendix.

## RESULTS

Because payroll per employee is the only measure of employee compensation available with the Longitudinal Business Database, using the findings from previous studies involving wages requires that average payroll be deconstructed into hypothetical wage elements. A simplified model of how the average payroll change is constructed in aiding further analytical discussions:

$$\Delta \text{Average Payroll} \equiv \sum_{i=L,M,H} \delta_i \bar{W}_i (\gamma_i P_i)$$

which sums the average wages  $W$  based on the proportion of payroll composition  $P$  of three types of wage earners: low, medium, and high.

$$\begin{array}{ll} \text{As such:} & i) \quad W_L < W_M < W_H \\ & ii) \quad W_L < \text{Average Payroll} < W_H \\ & iii) \quad P_L + P_M + P_H = 1 \end{array}$$

The rate at which the average wage  $W$  increases due to size-wage effects  $\delta$  is positive and is unique for each wage profile as is rate of proportional change  $\gamma$  which may be positive or negative. Medium-wage earners will not be considered in the following discussions as their wages in this model roughly represent average payroll, and changes in  $P_M$  result in changes to  $P_L$  and  $P_H$ .

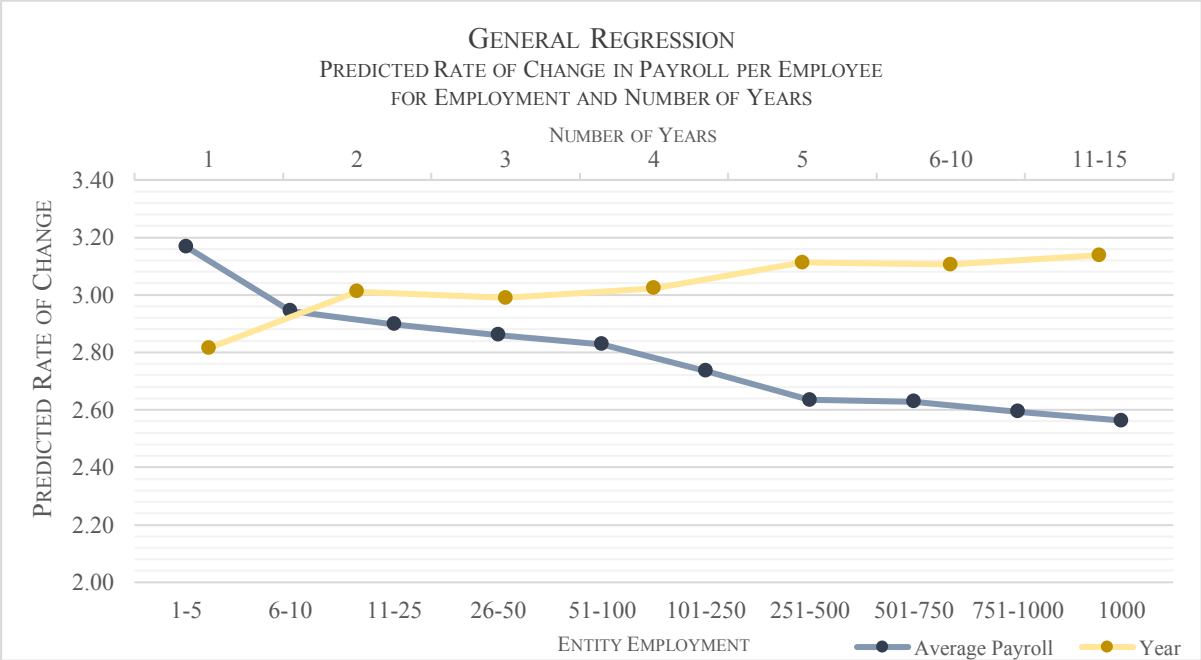
### 6.1 GENERAL PREDICTION BASED ON PRIOR STUDIES

The two most influential payroll determinants are employer size-wage effects and wage inequality, both of which increase with establishment size. Size-wage differentials have been observed to raise wages across all types of wage earners though the proportion of whom they favor varies. If  $W$  for all levels of wage earners increases with establishment size, then a positive relationship between employment growth and average payroll should occur. Wage inequality varying with size and growth (Davis & Haltiwanger, 1992; Mueller, Ouimet, & Simintzi, 2017) means that distributive effects alone would not be capable of reversing the

positive effects that size-wage premiums have across all categories<sup>18</sup>. Increased wage inequality may, at best, reduce the effect of employer size-wage premiums on payroll per employee by concentrating wage premiums towards  $\delta_i$ . Nonetheless, it stands to reason that growing establishments would experience an increased average payroll growth, which would increase with establishment size.

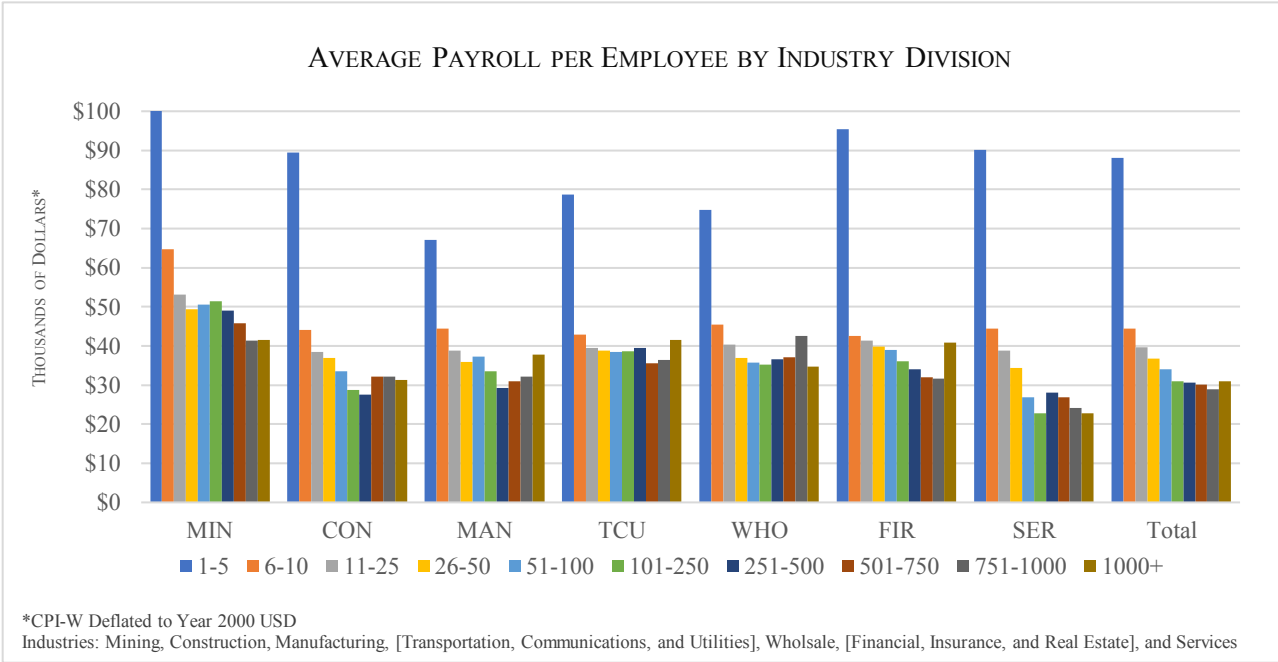
### 6.2 ANALYSIS OF GENERAL TRENDS

Trends from the most basic model regressing the number of employees (as opposed to employment change in later models) on payroll per employee yields striking results. Average payroll per employee does not increase with size as expected by general implications of the employer size-wage differentials, but systematically decreases across size. The number or years since an establishment has been in business is positively correlated with payroll per employee growth, which is less surprising from the effect that longer tenured employees may have.



<sup>18</sup> Mueller et al. (2017) find that for the lowest percentiles, wage growth with firm size is minimal. Furthermore, the data was based on UK firms from 2004-2013 meaning weak associability with the dataset used for results.

All points have undetectably low p-values, but a downward trend in average payroll by size is not consistent across industries. All industries, as seen in table below, exhibit a downward trend, but some are flatter and some increase upwards for the largest categories making it difficult to draw general conclusions. While this is helpful in understanding that the stylized trend of decreasing average payroll across size more or less holds for all industries, understanding the distribution of average payroll between establishments may provide better insight.



\*CPI-W Deflated to Year 2000 USD  
 Industries: Mining, Construction, Manufacturing, [Transportation, Communications, and Utilities], Wholesale, [Financial, Insurance, and Real Estate], and Services

SUMMARY STATISTICS TABLE  
 DISTRIBUTION OF INTRA-ESTABLISHMENT PAYROLL PER EMPLOYEE

SIZE	P10	P25	MEDIAN	P75	P90	SD	SKEWNESS	MEAN
1-5	5.98	11.86	23.86	46.79	88.17	1108.85	57.73	88.45
6-10	6.48	12.64	23.18	39.71	64.84	271.13	65.62	44.51
11-25	7.58	14.09	24.73	40.65	63.88	176.69	93.08	39.67
26-50	8.40	15.35	26.06	41.38	63.64	113.96	89.84	36.79
51-100	8.08	14.96	25.47	41.16	61.55	70.23	76.85	34.10
101-250	7.30	14.19	24.64	38.90	56.65	44.31	41.05	31.12
251-500	6.82	14.24	24.53	38.63	55.93	34.98	29.75	30.38
501-750	7.17	13.90	24.50	38.60	55.71	34.42	20.16	30.12
751-1000	6.58	13.88	24.14	37.92	53.85	27.58	7.48	29.32
1000+	6.58	13.63	24.42	38.36	56.12	27.35	5.46	29.79

\*In thousands of US dollars CPI-deflated to the year 2000



As establishment size increases, standard deviation plummets unequivocally showing that the variation in average payroll lessens with size but not the construction of these changes. Where the median has a minor drop only in the larger categories<sup>19</sup>, the mean drops definitively across all sizes. This reflects that distributional changes come almost entirely from a lessening of the proportion of those with high average payroll per employee rather than average payroll decreasing uniformly across all establishment sizes; were this the case, the median would drop as well. This is best expressed in the measure of skewness which leans strongly positive for smaller establishments but becomes more neutral with larger ones. By taking the various percentiles into account, it becomes apparent that the drop in the mean of average payrolls comes from the very highest percentiles. The 90<sup>th</sup> percentile drop comprises the most dramatic decrease while lower percentiles remain fairly constant across size with only a minor drop.

One suggestion derived from a cross-sectoral study finds that industries with the lowest dispersion in wages are mostly dominated by larger employers and higher union presence, while those with the highest dispersion are exclusively dominated by smaller ones and have lower union presence (Jones, 2003). An intra-industry study of manufacturers also finds some evidence for the role of lessening wage dispersion between plant due to unionization's effect (only for the largest plants), but the primary source of wage dispersion is through unobservable influencers (Davis & Haltiwanger, 1992). Further support for a standardized wage rate is found in a theoretical model by Coles (1998) suggesting that less wage dispersion in larger employers results from an equilibrium between the cost of wages and the costs of quit rates. This alone does not explain why average wages *decrease* across size but may explain the observed steady state in larger establishments. Jovanovic theories of passive learning may also play a role in the composition of larger establishments. For learning models, *new* and *mature* are determinants, not large or small *per se*, but younger businesses tend to be smaller (HJM, 2013). If new establishments are uncertain about initial productivity level, they may adjust the skill

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<sup>19</sup> Why exactly the median peaks for medium-sized employers is unknown. It may come from the bias of smaller firms holding a larger proportion of part-time workers enacting a downward force on average payroll. Without such bias perhaps the peak in the median might occur in smaller size categories; nonetheless, this is a characteristic that has no grounded explanation.

of their labor force to a more efficient composition (Haltiwanger, Lane, & Spletzer, 2000), reallocate jobs within the establishment, or even exit the market upon learning of their inefficiencies (Daly & Hobijn, 2017). These adjustments would weed out establishments with higher payroll costs causing a lower, more homogenous distribution among the surviving ones. Regardless, these results are of little use in making definitive conclusions because of the great deal of unobservable elements and cannot be used to determine employment change those with lower average payroll may happen to be large. Regressing employment change however will be of use in understanding whether or not these effects are really related with size.

### 6.3 POSITIVE EMPLOYMENT GROWTH

Analysis of the results from the regressions are in terms of the rate of change in average payroll by the rate of employment change. Four rates of change that roughly represent the lower percentiles, upper percentiles, and two interquartile rates on either end of the median provide valuable insight into the relationship by adding another dimension. Results are not important in terms of any given value but in relation to the magnitude and sign of other values in different size categories, change rates, or both. The analysis will first consider employment change and employment change over a moving average, and then in industry employment share change and industry employment share change over a moving average. Following this, the same will be done for negative employment change and finally in the largest employer size for positive and then negative changes.

REGRESSION TABLE IA<sup>20</sup>  
 PREDICTED RATE OF CHANGE IN PAYROLL PER EMPLOYEE  
 FOR POSITIVE EMPLOYMENT CHANGE BY SIZE

CHANGE RATE	ESTABLISHMENT EMPLOYMENT									
	1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-750	751-1000	1000+
0.05	0.00•	0.05	0.04	0.04	0.04	0.05	0.07	0.07‡	0.01•	0.07†
0.25	-0.19	-0.11	-0.10	-0.09	-0.09	-0.09	-0.07	-0.06†	-0.10	-0.05‡
0.50	-0.43	-0.32	-0.27	-0.26	-0.26	-0.26	-0.24	-0.22	-0.24	-0.19
1.00	-0.92	-0.73	-0.62	-0.58	-0.58	-0.59	-0.60	-0.55	-0.52	-0.49

NOTE.- Regression Model 1: change rates are based on equation (4)  
 All coefficients are p<.001 unless otherwise noted.  
 † p<.01 ‡ p<.05 • p≥.05

<sup>20</sup> The title of each regression table is a clickable link to the corresponding graph in the Appendix.

Immediately, one notices that payroll per employee is predominantly marked negatively by increases in employment. Furthermore, while the relationship is somewhat sporadic, it is far from stochastic. Four important trends emerge:

- 1) Comparisons across size show clear trends that changes in payroll per employee in larger establishments are higher or more acutely, are less low in that most values are negative.
- 2) Comparisons by change rate provides the clearest, irrefutable trend—as the rate of change increases, the faster payroll per employee drops. This holds without exception for positive employment change in all four models.
- 3) Comparisons by change rates across size show a slight convergence of the four change rates as the number of employees increase. Another way of observing it is that differences between rates of change decreases with size.
- 4) Comparisons of the sign of the coefficients shows that though other growth rates tend to follow a pattern towards becoming positive, only the slowest growth rate exhibit positive influence on payroll per employee.

Results from this short-run model may not accurately reflect the true relationship as employment change from one year to the next is quite volatile, and yearly autocorrelation is significantly different for small and large employers (Coad, 2007). Furthermore, size categories have not been averaged in this model so rapid change from one category to the other could prevent biased results (DHS, 1996). By looking at a moving average, differences in yearly fluctuation will be smoothed to better understand the relationship over long run growth, and here, growth is deemed as positive net growth over a three/four-year period. The number of years in and of itself is not a strong factor but is monotonic for all models, and only the graphs for these will be included in the Appendix.

REGRESSION TABLE IIA<sup>21</sup>  
 PREDICTED RATE OF CHANGE IN PAYROLL PER EMPLOYEE  
 FOR POSITIVE EMPLOYMENT MOVING AVERAGE BY SIZE

CHANGE RATE	ESTABLISHMENT EMPLOYMENT									
	1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-750	751-1000	1000+
0.05	-0.17	-0.03	-0.01	0.01†	0.01•	0.02	0.03 ‡	0.04•	-0.01•	-0.01•
0.10	-0.21	-0.06	-0.04	-0.02	-0.02	-0.01•	0.01•	0.01•	-0.02•	-0.02•
0.25	-0.35	-0.14	-0.11	-0.10	-0.11	-0.09	-0.07	-0.09	-0.07†	-0.07†
0.50	-0.57	-0.29	-0.23	-0.25	-0.25	-0.23	-0.20	-0.25	-0.15†	-0.15 ‡

NOTE.- Regression Model 2: change rates are based on moving average of equation (4)  
 All coefficients are p<.001 unless otherwise noted.  
 † p<.01 ‡ p<.05 • p≥.05

Stylized trends from the first model persist with the moving average model. The most notable differences though are that the smallest employers do not start out with positive changes in payroll per employee but arrive there somewhere in the neighborhood of 25 employees. Secondly, the four change rates stay relatively parallel to one another, but this is hard to be sure of because the largest establishments suffer from insignificance. This occurs possibly because those averaging low growth over four years include fluctuations between positive and negative growth, while those in the higher growth rates maintain a constant growth trend. This cannot explain why the smallest establishments are significant because these are more volatile, but perhaps these are buffered by higher observation counts. The fluctuation differences vertically and the robustness differences horizontally may explain why significance differs diagonally in the matrix.

Nonetheless, results from the summary statistics as well as the first and second models abandon the proposition that payroll per employee increases with size either through idiosyncrasy of large establishments or through growth over time. Though there is an upward trend across size, values are still negative, and the relationship is far from being deemed *positive*. The findings contrary to predictions do not allow for forays against size-wage premiums, but requires the consideration of other, stronger forces at work.

<sup>21</sup> The last two columns appear to have the same values, but this is only due to rounding. The 751-1000 employee category is slightly greater than the 1000+ employee category for all change rates showing a slight downward trend.

### *Employment Composition and the Wage Structure*

A decreasing average payroll across size occurs by either a decrease in  $W_L$  or  $W_H$ , and/or a higher  $P_L$  relative to  $P_H$ . As discussed earlier, support for size-wage premia in all wage groups strongly suggests that the former is not the case for either new or preexisting employee. The best argument against decreasing payroll for incumbent workers is that tenure has been shown to have an increased effect on wages (Krueger and Summers, Cobb et al., 2016). Though, at least in Danish firms, new job creation may decrease the effect of tenure, overall tenure remains a positive force on wages (Belzil, 2000). It therefore seems unlikely that growing establishments decrease wages of current employees as it would lead to higher quit rates in larger firms of which the opposite has been shown (Brown & Medoff, 1989). Additional evidence finds size-wage premia not only hold for entry wages of new workers in larger employers (Cappelli, 1997; Brown & Medoff, 1989) and growing ones (Belzil, 2000) but also that the effect is at least as strong as for current employees.

If it is then the proportion of  $P_L$  to  $P_H$  that causes average payroll to decline, this change can result from either an increase in low-wage employees or a decrease in high-wage ones. Since average payroll decreases with additional employees, decreasing high-wage employees alone would, by nature, not be considered growth. In fact, any decreases in high-wage employees would have to be compensated by even more low-wage ones to count as net growth. Reconsidering the middle-wage earner, in some cases larger establishments may lessen the number of middle-wage employees and thereby increase  $P_L$  and  $P_H$ . If the change increased the proportion of low-wage earners relative to high-wage ones, then growth's erosion of the middle could explain how payroll averages could be lowered over time because shifting wage compositions are in themselves not growth. If new employees came from a range of wage profiles as the middle eroded, then it could register as both growth and decreasing payroll without necessarily coming from exclusively hiring of low-wage employees. The problem still persists however that any additions to the portion of workers above the average payroll must be offset by an even greater amount by additions to the portion of those below in order for average payroll to decrease. Therefore, the proportion of those below the average payroll rate must increase at a rate faster than increases in wage from all profiles and additional workers whose wages are above the average payroll. Thus, decreasing average payroll exists when:

$$\sum_{i=L,M,H} \delta_i \bar{W}_i < \gamma_L P_L$$

When the downward effects of increases proportions of  $\gamma_L$  are most prevalent, positive influences on payroll  $\delta$  such as size-wage premia have only a secondary role. The lowest change rate categories, i.e. those with the lowest  $\gamma_L$ , may then see increased average payroll per employee when the left-hand side is greater. Positive values for the lowest change rate category show this, but larger categories decrease again. If contributions to payroll by size-wage premia begin to lessen with the largest establishments then predominance would shift, and the left-hand side may again switch to becoming the lesser.

Consider that establishments are comprised of core personnel (high-wage earners) and production workers (low-wage earners), and that the output elasticities for managerial-professional tasks of the core personnel are higher than that of lower-wage workers. Capital complements and scaling of abstract work for those with higher-skills (Autor et al., 2003) would make this fair assumption. If increases in output lead to greater increases in the proportion of low-wage earners due to their lower returns to scale, then larger establishments would be more proportionately comprised of workers in the lower earnings percentiles. Higher proportions of managers and professionals whose occupation has markedly high levels of within-occupation wage dispersion (Mouw & Kalleberg, 2010) would lead to larger differences in average payroll. As the level of low-wage employees increases, the relative homogeneity between establishments increases from these more homogeneously-paid workers. While this may coincide with the decreasing variation in inter-establishment wages and explain falling average payroll, the theory stands on shaky ground.

When  $P_L$  increases, average payroll per employee would decrease, and the effect would result a stronger positive skew as the proportion of those below the median increases. Analysis on restricted-access data from firms in US in 1999 shows that as median wages falls, skewness noticeably increases and flattens at the lower median wages. For higher median wage firms, skewness even becomes slightly negative (Cunningham & Mohr, 2017). Granted, median wage is different from average payroll, but if the two are positively correlation then those with the lowest average payroll, or the largest establishments, have the most positively skewed wage structure. Since the 90-10 relationship is lowest in the lowest quantiles, the skewness likely results from high proportions of low wage workers. Furthermore, towards the lowest

median wage the positive skewness stops increasing and flattens. If average payroll per employee decreases with lower-wage employees that are lower bound in their wages, then the result would be that each additional low-wage employee has a diminishing effect on average payroll. The flattening skewness may be picking this effect up, but also it would suggest that declines in payroll per employee would diminish as the gap between low-wage workers and average payroll decreases.

Outside support for structural changes are difficult to come by as there is fairly sparse literature exploring the relationship between employee compensation and changes in employment, as most size-wage differential studies do not take growth or employment composition into account. With access to both firm-level and employee-level data from Italy over 1981 to 1983, Galizzi (2005) found that while employment growth had a negative relationship for both aggregate and disaggregate measures of payroll per employee<sup>22</sup>, a positive relationship exists for employment growth and wages. The distinction here is that individuals' unique wages increased as the firm's payroll per employee decreased. This paradox is evidence as Galizzi surmises, for a composition bias that occurs because firms have a higher proportion of low wage employees as they grow. These new entrants may have lower levels of education, experience, and/or motivation whereby they are more willing to accept lower wages. As a result, firm growth based on these individuals would dilute aggregate payroll per employee values and introduce a bias based on the composition of workers within the company. The theory does have its merits, but establishments need not always hire from the chronically unemployed or the least-skilled as higher wages could attract more productive workers.

In a study of the manufacturing industry, the marginal change of the proportion of production workers, whose wages were roughly two-thirds of that of non-production workers, increased slightly until the 500-999 category after which it flattened and even declined (Dunne & Schmitz, 1995). This alone has weak implications for a composition effect, but the workers' wage premia were more responsive to the degree that average payroll increased with size<sup>23</sup>.

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<sup>22</sup> The former is change in wage bill (similar to that employed in this thesis) and the latter the difference in payroll as the total sum of all individuals' wages. That average payroll decreases even when actual wage statistics are available is support that average payroll is a relevant, though imperfect, proxy for wages.

<sup>23</sup> Using the mean log wage of production workers (2.28) and the non-production worker (3.50) at the mean production worker share (0.68) yields an average log payroll of 2.67. Following a .022 percent increase in the share of production workers for plants with 500-999 employees with wage premiums of .084 and .028 percent for production and non-production workers, respectively, yields an average log payroll of 2.80—an increase of about 5 percent. Applying the same methods to the next smallest category, 250-499 employees, resulted in an increase of about 1 percent.

This may have resulted from other influencers on the proportion of production workers were included, and as in the previous study disaggregated summations of wages differ from payroll per employee. To note, the increase in the proportion of production workers exists in spite of controls for technology, suggesting that larger establishments need a higher proportion of low wage workers even in the presence of higher capital-labor substitutes; establishments with lower capital-labor ratios may have even stronger increases in the proportion of low-wage employees. Additionally, perhaps there are composition biases even within the two types of workers where the proportion of the very lowest-wage production workers causes distortions to average payroll<sup>24</sup>. Nonetheless, much stronger support for changes in employee composition is provided by Abowd et al. (1994) from rich, employer-employee linked data France. Multiple-industry data confirms that the proportion of managers and professionals is negatively correlated with the number of employees and is all the stronger for the proportion of skilled workers. The findings also reflect that of Galizzi in that a worker's unique wages are positively correlated with the number of employees, but the implications on payroll per employee remain uncertain.

#### 6.4 POSITIVE ESTABLISHMENT INDUSTRY SHARE CHANGE

Changes in industry share are much more difficult to decompose because size is no longer solely defined by the number of employees as the industry employment share is weighted by the number of establishments within a given industry. This employment measure does not require that establishments add more employees because in declining industries, employment share can be gained simply by losing the least number of employees. Though increasing employment has been shown to decrease payroll per employee, it is still uncertain if this effect carries to changes in industry employment share as the implications that low-wage employees dilute average payroll does not necessarily apply here nor do size-wage premia.

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<sup>24</sup> This supposition cannot gain much traction in that six-years prior to the above study in the same industry, the standard deviation of production worker wages did not necessarily increase with size and even halved in the aforementioned size category, but also production workers were more homogenously paid than non-production workers within the plant (Davis & Haltiwanger, 1992). Again, the relevance of the study to the overall data may or may not provide applicable connections.



REGRESSION TABLE IIIA  
 PREDICTED RATE OF CHANGE IN PAYROLL PER EMPLOYEE  
 FOR POSITIVE INDUSTRY EMPLOYMENT SHARE CHANGE BY SIZE

CHANGE RATE	INDUSTRY EMPLOYMENT SHARE QUANTILE									
	1	2	3	4	5	6	7	8	9	10
0.10	-0.27	-0.23	-0.18	-0.16	-0.08	-0.07	-0.04	-0.02	-0.01	-0.01‡
0.50	-0.52	-0.49	-0.46	-0.43	-0.38	-0.36	-0.32	-0.28	-0.25	-0.23
1.00	-0.83	-0.82	-0.81	-0.78	-0.76	-0.73	-0.67	-0.61	-0.54	-0.51
2.00	-1.46	-1.48	-1.52	-1.46	-1.51	-1.45	-1.36	-1.26	-1.13	-1.08

NOTE.- Regression Model 3: change rates are based on the log difference of equation (9)  
 All coefficients are p<.001 unless otherwise noted.  
 † p<.01 ‡ p<.05 • p≥.05

REGRESSION TABLE IVA  
 PREDICTED RATE OF CHANGE IN PAYROLL PER EMPLOYEE  
 FOR POSITIVE AVERAGE INDUSTRY EMPLOYMENT SHARE CHANGE BY SIZE

CHANGE RATE	INDUSTRY EMPLOYMENT SHARE QUANTILE									
	1	2	3	4	5	6	7	8	9	10
0.05	-0.30	-0.23	-0.15	-0.14	-0.11	-0.04	-0.05	-0.03	-0.01	0.02
0.25	-0.46	-0.40	-0.33	-0.29	-0.26	-0.18	-0.14	-0.12	-0.11	-0.09
0.50	-0.67	-0.62	-0.54	-0.48	-0.45	-0.35	-0.26	-0.23	-0.23	-0.23
0.10	-1.08	-1.04	-0.97	-0.86	-0.83	-0.69	-0.51	-0.45	-0.47	-0.50

NOTE.- Regression Model 4: change rates are based on the moving average log difference of equation (9)  
 All coefficients are p<.001

The values in Tables III and IV represent the relative changes of payroll per employee by industry employment share growth and follow the same negative relationship as the previous models based on employment. It is worth noting that these models have remarkably low p-values, which may have benefitted from the robustness of using narrowly defined industries. The major difference is in that the relationship is more dynamic for smaller establishments and nears zero with larger ones—something especially true for the establishments with averaged positive growth. An interesting theme emerges as industry share growth is incapable, for the most part, of breaking the barrier separating negative and positive changes in employment growth. Only in Table IV did the largest quantile for the slowest growth amount to positive payroll per employee change. Though it is certainly significant, it may or may not be anything more than a statistical artifact.

These values marked by strong initial changes that near zero across size suggest that the shape of the relationship is a downward sloping curve converging towards a horizontal asymptote: ↵ (backwards-J-shaped). The horizontal asymptote then may represent a sort of steady state where an establishment's average payroll is less influenced by the wages of additional employees but persists to decrease. The reason higher change rates intensify the decline of average payroll may be that employers with higher growth travel down the curve at an accelerated rate, or in other words, the negative effect of growth on average payroll is being compressed into a shorter interval. The differences between higher and lower change rates decreases for larger establishments already at the asymptote experiencing because the asymptote inhibits downward effects of additional employees. Supposing that a weakening of the decline in average payroll stems from additional low-wage labor may not suffice in explaining the sharper convergence in industry employment share models.

Capital-labor substitutions<sup>25</sup> may be used to continue the theoretical presence of a growing proportion of low-wage earners within the establishment and attempt to explain the observed diminishing changes across size without relying on the number of employees as a basis. In these models, the comparison by establishments in industries with similar capital-labor ratios controls to some degree the unobserved capital component. Strictly speaking, the results in these tables only express the rate at which establishments add labor rather than growth or output. A case can be made that the establishments in the highest quantiles are the most productive; Haltiwanger, Hyatt, and McEntarfer (2017) find that while the relationship between the number of employees and productivity varies widely across industries, most industries exhibit a positive relationship<sup>26</sup>, and productivity is likely to lead to employment growth. Therefore, though varying in strength between industries, a positive relationship between size and productivity can be presumed. Furthermore, the wage-productivity relationship is much stronger and is positive across all industries, likely from workers migrating to more productive companies. Similarly, recall that superstar firms are those with the lowest respective contributions to labor share, but they are not necessarily those with the

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<sup>25</sup> Outsourcing also has a substitutive effect on inhouse labor, but in order to maintain a clear discussion, outsourcing will not be mentioned explicitly. The term "capital" in the following discussion can be considered to encompass outsourcing aspects as well as these two mechanisms have the same basic influence on reducing the bargaining power of potential and incumbent employees. Furthermore, outsourcing can be considered a type of capital because capital is needed to bridge the productivity of outsourced work and the establishment, and the marginal cost of production may be wholly rest upon the capital portion.

<sup>26</sup> Those that with a negative relationship—industries dealing with food, accommodation, or retail—are not included in the regressed sample used in this paper.

lowest average wages. If superstar firms are the most productive within their industry as suggested by ADKPR (2017), they would exist in the upper quantiles of the industry employment share. The paradox of the largest firms paying the highest wages yet having the lowest average payroll continues in measurement of growth defined in terms of industry, and that industry employment share quantiles are likely also affected by composition bias. It also remains within the scope of reasonable judgement to assume that those in the higher quantiles, have higher productivity and even market share.

Yet as previously discussed, output levels are likely associated with industry employment quantiles. In this light, observed employment growth occurs because the marginal product of labor for these employees is cheaper than that of labor substitutes; otherwise, increased output would come by way of capital. Since larger employers make better use of capital through economies of scale, then the marginal costs of labor they are willing to accept would be lower as well. The relationship between size and the capital-labor substitution rate is likely non-linear and is subject to diminishing returns. Under Cobb-Douglas production function theory, the marginal product of capital and technology reaches a steady state at which returns to capital decrease infinitesimally in absence of shocks. Therefore, the ceiling at which employers are willing to create or continue employment is determined by the cost of capital-labor substitution which decreases along a saddle-shaped asymptote.

If employers merely hired from the labor-substitute-defined ceiling, the trend from the results would suggest the opposite—that average payroll decline accelerates with larger establishments. Yet the wage rate is not determined by the ceiling and employers only need to hire from a floor coming from at least two sources. The first somewhat weaker argument is that minimum wage rates create a lower bound. Technically it does create a floor, but it would only be in effect if employer were willing and able to pay a lower rate. The second is that employers not only seek to minimize costs but also to increase productivity, and workers that meet higher standards of productivity command higher wages through higher bargaining power. While both may be applicable, the second is a more practical assumption in that: (i) it is more expansive as it covers any range of occupations, (ii) takes into account that the largest employers pay the highest wages, (iii) that there is a noticeably higher level of human capital at larger employers even amongst low-wage earners (Davis & Haltiwanger, 1992), and (iv) larger firms have more productive employees (Idson & Oi, 1999).

The floor for larger establishments would be upward sloping under the increased scarcity of more productive workers. Combined with a downward sloped ceiling from lower marginal capital costs afforded by economies of scale would mean that the gap between the two narrows across size. A steady state is presumed to occur when establishments hire employees that meet their specific productivity requirements for the lowest wage possible after achieving a technological steady state. Establishments with inefficiently paid employment would have higher labor-output costs than competitors with more efficiently paid workers and presumably have lower industry employment share. Establishments with lower capital-output costs would decrease lower-wage labor by switching to more capital-intensive production and thereby giving additional industry employment share to establishments that are capable of lowering employee-output costs. It has not only been shown that as the rate of capital increases the proportion of non-production workers increases (Abowd et al., 1994), but also that market share tends to transfer to those with lower labor share (ADKPR, 2017). An efficiently paid employee theory rather than simply low-wage dilution may better suffice to explain the lessening change in payroll per employee into a steady state without relying on the assumption that establishments source from the least qualified new entrants into the workforce. The added benefit of this explanation is that though capital-labor ratios between establishments in narrowly defined industries are more homogenous, productivity between them is heterogenous.

The monopsonistic characteristics of establishments with high employment share could not be taken into account with the first two models and may have a unique influence on lowering payroll per employee. Lower average payroll could come by way of reducing the relative bargaining power of workers with industry specific skills. Where this theory wanes in applicability is in that the location of the establishments are not accounted for in these regression models and therefore the costs of worker mobility cannot be assessed. The ceiling of labor substitution and the minimum wage floor from the previous discussion would still hold under a monopsony, but the productivity requirements only hold under the assumption that workers with higher levels of human capital have higher bargaining power. Establishments with high levels of employment share may be able to create more low-wage positions that new workers must settle for. Workers whose skills warrant a better paying position elsewhere, may be required to take a lower-wage position because these are the only positions created. Since size is not necessarily applicable here, size-wage premium theory is of limited use. If it did apply, it could be that these employees at larger establishments are

being paid more for the position they hold compared to similar positions but less than a counterfactual position in a free market that better matches the worker's human capital. The floor then would be upheld by efficiency wages instated to reduce shirking within the workplace but also simultaneously weakened by the increased costs of being caught and fired. Nonetheless, a steady state should still persist at the equilibrium of the worker's bargaining power. The presence of monopsonies in the highest industry share quantiles may be useful in explaining why the 9<sup>th</sup> and 10<sup>th</sup> quantiles of the highest growth rate shows further decreasing of payroll per employee.

Nevertheless, lowering of payroll per employee is much more significant and clear in industry employment share models giving indications that perhaps competition is linked to the decline in average payroll per employee. Causally, it could be that lower output costs are the drivers behind growth just as easily as it could be that larger employers have a more favorable ratio  $P_H$  and  $P_L$  by nature of their size. There is probably truth to both in that tasks of higher-wage core personnel can be scaled more widely in larger establishments, and establishments with lower cost grow from having competitive prices in the market.

#### 6.5 NEGATIVE EMPLOYMENT CHANGES

Analysis of growth was deeply based under the presumption of compositions coming from changes in new employees, but declines in employment can come from any level within the industry. Furthermore, the assessments made for positive employment change cannot be merely reversed as some elements of progress over time such as increased capital-output ratio and wage increases are not likely reversible. Removal of the least efficiently paid employees could vary widely upon the reasoning of the employer, and as employers learn of the efficiency of each employee over time, the wage level of inefficiently paid employees may be more stochastic in nature. Predictions based on stylized facts are that if layoffs were made solely by lower-wage employees there would be an increase in payroll per employee. If downsizing efforts were made through removal of higher wage earners, the trend would result in lowering of payroll per employee.

REGRESSION TABLE VA  
 PREDICTED RATE OF CHANGE IN PAYROLL PER EMPLOYEE  
 FOR NEGATIVE EMPLOYMENT CHANGE BY SIZE

CHANGE RATE	ESTABLISHMENT EMPLOYMENT									
	1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-750	751-1000	1000+
-0.05	-0.06	0.04	0.05	0.05	0.07	0.09	0.10	0.12	0.06•	0.04•
-0.25	0.09	0.16	0.18	0.19	0.21	0.22	0.22	0.23	0.22	0.15
-0.50	0.26	0.31	0.33	0.36	0.38	0.38	0.37	0.37	0.42	0.30
-1.00	0.62	0.60	0.64	0.70	0.72	0.70	0.66	0.64	0.81	0.58

NOTE.- Regression Model 1: change rates are based on equation (4)  
 All coefficients are  $p < .001$  unless otherwise noted.  
 †  $p < .01$  ‡  $p < .05$  •  $p \geq .05$

REGRESSION TABLE VIA  
 PREDICTED RATE OF CHANGE IN PAYROLL PER EMPLOYEE  
 FOR NEGATIVE AVERAGE EMPLOYMENT CHANGE BY SIZE

CHANGE RATE	ESTABLISHMENT EMPLOYMENT									
	1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-750	751-1000	1000+
-0.05	-0.08	0.05	0.06	0.08	0.10	0.11	0.15	0.15	0.18	0.10†
-0.10	-0.04	0.09	0.09	0.12	0.14	0.15	0.18	0.20	0.19	0.13
-0.25	0.07	0.21	0.18	0.22	0.25	0.29	0.26	0.33	0.23	0.21
-0.50	0.25	0.41	0.34	0.39	0.45	0.51	0.41	0.56	0.31	0.35†

NOTE.- Regression Model 2: change rates are based on the moving average of equation (4)  
 All coefficients are  $p < .001$  unless otherwise noted.  
 †  $p < .01$  ‡  $p < .05$  •  $p \geq .05$

The most basic assumption applied is that establishments experiencing difficulties should use employment reduction measures to lower average payroll per employee by removing inefficiently paid employees at any level. The fact that change rates are unequivocally negatively correlated with changes in payroll per employee suggests that the predominant source of change is in a lowering of  $P_L$ . Downsizing by way of wage earners below average payroll employees is then presumed to be the predominant source of reductions for the largest change rates. High rates of downsizing cannot come solely from high-wage employees as their proportion is likely smaller and may represent the core personnel that cannot be scaled with output or replaced by capital.

Reduction by low-wage earners has been observed by Solon, Barsky, and Parker (1992) in that unemployment is more comprised of low-wage workers that understates the decline of real

wages. Looking at individual average wages over roughly this period Daly & Hobijn (2017) affirm this notion as higher proportions of low-wage earners exited the labor force in economic downturns. These studies provide credence for the assumption of layoff by way of low-wage workers at the establishment level. The positive effect on the average payroll within an establishment rises during times of unemployment and would generate slightly higher totals in data aggregated at the economy level. As to why this may occur, Shanefelter's (2007) findings from the electricity generation study that payroll costs decreased while average payroll increased as a result of downsizing provides the most telling support from outside literature. If reductions are made to remove employment outside of the core personnel, then the tasks of lower percentiles could be outsourced elsewhere, and their removal would result in higher payroll per employee.

Employer size-wage premiums still have not been account for but may be instrumental in explaining an upward trend even in downsizing. Although not significant at the 95 percent level, Galizzi (2005) finds that in fact even in contraction periods there is still an increase in actual wages albeit slightly lower than that during periods of expansion. All else equal, size-wage premiums should still exhibit an increase in payroll per employee for the largest establishments. The results do not provide clear support or dismissal for this conjecture, but increasing payroll per employee occurs steadily across size categories which may be a result of size-wage effect finally being observable. If premia favor more strongly those with better education, tenure, firm-specific skills, and other human capital elements, then removal of lower-skilled workers could illuminate the employer size-wage effect masked during growth. Here ESWE theories of higher rents per employee would be most applicable assuming reductions occur as cost reduction measures rather than declining performance. The theory loses much of its credence when considering that for the largest employers, average payroll tends to decrease<sup>27</sup>.

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<sup>27</sup> It should be noted the high confidence intervals in the largest size categories do not allow for any conclusions as to whether larger establishments follow the upwards trend of smaller categories or not. Theories of shareholder influence may apply in the assumption that public entities are more likely to be in larger categories, and whose layoff tactics may not follow any particular mean other than to increase shareholder value. The assertion that layoffs occur sporadically or even when a corporation is not inefficiently size (Budros, 1997) may or may not hold any weight in explaining why the largest employers do not follow the same trend as smaller sizes. The differences in the layoff tactics of private and public entities may be the reason that the results are significant but, contrary to coefficients for positive employment share change, have high confidence intervals. The lower bounds are nonetheless still positive for all change rates except for the two largest categories with the least change in the non-averaged measure.

REGRESSION TABLE VIIA  
 PREDICTED RATE OF CHANGE IN PAYROLL PER EMPLOYEE  
 FOR NEGATIVE INDUSTRY EMPLOYMENT SHARE CHANGE BY SIZE

CHANGE RATE	INDUSTRY EMPLOYMENT SHARE QUANTILE									
	1	2	3	4	5	6	7	8	9	10
-0.10	-0.16	-0.07	-0.10	-0.01	0.04	0.05	0.07	0.09	0.11	0.11
-0.50	0.15	0.21	0.20	0.26	0.28	0.29	0.30	0.31	0.32	0.37
-1.00	0.53	0.55	0.57	0.59	0.59	0.57	0.58	0.58	0.60	0.68
-2.00	1.29	1.24	1.30	1.26	1.20	1.15	1.14	1.12	1.14	1.32

NOTE.- Regression Model 3: change rates are based on the log difference of equation (9)  
 All coefficients are  $p < .001$ .

REGRESSION TABLE VIIIA  
 PREDICTED RATE OF CHANGE IN PAYROLL PER EMPLOYEE  
 FOR NEGATIVE AVERAGE INDUSTRY EMPLOYMENT SHARE CHANGE BY SIZE

CHANGE RATE	INDUSTRY EMPLOYMENT SHARE QUANTILE									
	1	2	3	4	5	6	7	8	9	10
-0.05	-0.14	-0.11	-0.11	-0.09	0.00•	-0.02	0.01•	0.02	0.04	0.08
-0.25	-0.06	0.01†	0.05	0.06	0.14	0.15	0.16	0.17	0.16	0.21
-0.50	0.05	0.16	0.24	0.25	0.31	0.36	0.35	0.35	0.31	0.37
-1.00	0.27	0.46	0.62	0.62	0.65	0.78	0.73	0.72	0.62	0.69

NOTE.- Regression Model 4: change rates are based on the moving average log difference of equation (9)  
 All coefficients are  $p < .001$  unless otherwise noted.  
 †  $p < .01$  ‡  $p < .05$  •  $p \geq .05$

Under the assumption that smaller establishments grow to take on the characteristics of larger ones, positive growth models were read left to right. If the reverse also applies, that larger establishments decrease to take on the characteristics of smaller establishments, then the results should be viewed right to left. If the same mechanisms of increased output by way of lower-wage employees apply here, then those with decreasing output would remove lower wage employee initial and eventually  $P_L$  would diminish. Applying the asymptotic theory based on proportions would imply that average payroll changes should be closest to zero at the largest establishments that begin by reducing  $P_L$ , which would not have a pronounced effect as the payroll is already lower. As the payroll per employee rises, the marginal removal of low wage employees would have an increased effect—that is the trend would be flipped on



a vertical axis. The results emphatically reject this notion as the opposite occurs. The only evidence for such a trend is in Table VII at the highest rates of decline. If output could be linked to average payroll changes by lower-wage earners, it would suggest that establishments facing massive downsizing over one period, potentially in a panic, would do so by way of primarily lower wage employees. The shape of the trends more closely resembles that of positive growth being flipped on a horizontal axis. This can be observed in that from right to left the values decrease just as in positive models the values increased from left to right. Compositions of higher low-wage workers in larger establishments mean that those dismissed are predominantly from these groups, while smaller establishments may need to remove higher-skilled workers.

If downsizing came by way of capital-labor substitution, then those with lower capital ceilings could replace the largest number of low-wage workers and create the largest increase in average payroll. Capital deepening's effect hits the lower-skilled workers the hardest and the effect heightens with the number of employees. The relative wages of routine jobs diminish most strongly for medium-skilled workers, but the proportion of routine jobs is highest with lower skilled workers (Mueller et al., 2017). When these routine jobs are replaced by capital, the effect will remove those in the lower wage-earning percentiles. As for those in the upper percentiles, increased amounts of capital within an establishment leads to larger shares of higher-wage professional that receive heightened size-wage premiums (Abowd et al., 1994; Dunne & Schmitz, 1995; Idson & Oi, 1999). The same could be said for outsourcing and offshoring in that the task of less-skilled workers are affected the most. If suppressed output in declining establishment was the reason for these measures, then removal of production workers would follow the same trend as employment growth. The only clear picture is that payroll per employee increases with change rates and is slightly flatter than for growth, and the lack of compression in change rates suggests that there is not a steady state. Combined with removal of inefficiently paid employees across the entire wage spectrum following employer learning may explain why larger establishments are not widely different from smaller ones in periods of downsizing.

## 6.6 LARGE ESTABLISHMENT EMPLOYMENT CHANGE

There is clearly a lessening negative influence in payroll per employee for growth across establishment size, that may result from an upward, weaker force exhibited by size-wage premiums. The reason this force may not play an active role in payroll per employee comes from the observance that the largest establishments still do not increase into positive average payroll changes. If all wages increased with establishment size, then it would stand to reason that eventually average payroll growth would occur, which the results cannot support. If anything, the results in Table I suggest that any positive changes in average payroll come from slow growth rather from size.

In an attempt to better understand how growth rates affect the largest employers, a separate sample of only establishments with at least 500 employees was created. The same data preparations were made as in the previous sample<sup>28</sup>, but the number of observations was not reduced because of establishments at or above 500 employees are relatively few. This second sample has the added benefit of bolstering the weakness of fewer observations in larger establishments present in the previous regressions. Statistical analysis was run separately for positive and negative changes in employment, and the results are combined into a single table.

One potential possibly left unexplored is that the shape of the relationship between payroll per employee and employment change may not be backwards-J-shaped but potentially even slightly U-shaped. This possibility exists in that the downward influence of growth on payroll per employee weakens with size as size-wage premiums simultaneously strengthen. If the size-wage premiums for both preexisting and new workers was stronger than the negative effect of additional employees, then the relationship may turn positive in either those with low change in low-wage employees,  $\gamma_L$ , or stronger increases in averages wages,  $\delta_H$ , both of which are characteristic of larger companies. There is indication that some industries do have higher average payroll in larger establishments<sup>29</sup> but if this trend occurs with growth or is applicable in general needs to be discovered.

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<sup>28</sup> Change rates do not have the same values as the corresponding regressions used early but represent roughly the same distributions (i.e. 10<sup>th</sup>, 25<sup>th</sup>-75<sup>th</sup>, and 90<sup>th</sup> percentiles). Change rates are smaller larger establishment's lessening growth.

<sup>29</sup> see Summary Statistic Figure 1 in section 6.2

$$\sum_{i=L,M,H} \delta_i \bar{W}_i > \gamma_L P_L$$

While the four growth rates tend to converge towards zero, a gap between them persists. One possible reason may be establishments having different steady state horizons based on the output elasticities and initial proportion of high-wage earners. Some establishments may have reached a steady state after only a few hundred employees while others may not until a few thousand employees. It is surmised that the largest employers should display a much tighter distribution between change rates because more have exhausted their economies of scale.

REGRESSION TABLE X  
PREDICTED RATE OF CHANGE IN PAYROLL PER EMPLOYEE  
FOR AVERAGE EMPLOYMENT CHANGE OF LARGE ESTABLISHMENTS BY SIZE

CHANGE RATE	ESTABLISHMENT EMPLOYMENT							
	500-750	751-1000	1001-1500	1501-2000	2001-3000	3001-4000	4001-5000	5000+
0.02	-0.02•	-0.02•	0.02•	0.01•	0.04•	0.02•	0.15‡	0.10•
0.05	-0.06†	-0.05†	-0.01•	-0.01•	0.02•	0.03•	0.14‡	0.07•
0.10	-0.12	-0.10	-0.06	-0.04‡	-0.02•	0.03•	0.12‡	0.03•
0.25	-0.32	-0.26	-0.20	-0.14	-0.13†	0.04•	0.05•	-0.11‡
-0.02	0.07†	0.07	0.09	0.04•	0.02•	-0.06•	0.16‡	0.08•
-0.05	0.08	0.08	0.10	0.06‡	0.05‡	-0.02•	0.17†	0.11‡
-0.10	0.11	0.11	0.12	0.09	0.10	0.05•	0.19	0.15
-0.25	0.18	0.18	0.16	0.20	0.23	0.26	0.25	0.27

NOTE.- Regression Model 2: change rates are based on the moving average of equation (4)

All coefficients have  $p < .001$  unless otherwise noted

†  $p < .01$  ‡  $p < .05$  •  $p \geq .05$

Little can be ascertained from the results of average employment change as there is a great deal of insignificant values. The only glimmer of support for a positive change in payroll per employee is in the 4001-5000 category but these are surrounded by completely insignificant values. If positive average payroll growth even for the largest employers is not possible, it may be that new technological developments and outsourcing opportunities would continually lower the labor substitution ceiling. If in actuality they are in fact positive, support for the idea that increases in wages for all profiles is stronger than the negative effects of growth, and that increased bargaining power of highly productive workers recedes the labor substitution ceiling. Convergence of the growth rates does seem to occur from smaller sizes, but not towards a clear zero. Outcomes for non-averaged employment changes are much more

monotonic and equally insignificant in lower change rates. Therefore, there is not enough quality support for or against the presence of a positive relationship with this data. The most likely reason for such degree of insignificance in the largest employers is due to the widely varying trends among industries for the largest size categories.

REGRESSION TABLE XII<sup>30</sup>  
 PREDICTED RATE OF CHANGE IN PAYROLL PER EMPLOYEE  
 FOR AVERAGE INDUSTRY EMPLOYMENT SHARE CHANGE FOR LARGE ESTABLISHMENTS BY SIZE

CHANGE RATE	INDUSTRY EMPLOYMENT SHARE QUANTILE									
	1	2	3	4	5	6	7	8	9	10
0.02	-0.04•	-0.10•	-0.06•	-0.03•	-0.05•	0.00•	0.01•	0.00•	0.00•	0.03•
0.05	-0.07•	-0.06•	-0.09‡	-0.05•	-0.07†	-0.03•	-0.02•	-0.01•	-0.02•	0.02•
0.15	-0.17‡	0.06•	-0.19	-0.14	-0.17	-0.12	-0.08	-0.06	-0.05†	-0.01•
0.30	-0.31•	0.24•	-0.35	-0.27	-0.30	-0.26	-0.19	-0.14	-0.11†	-0.06•
-0.02	0.09•	0.09•	0.09‡	0.12	0.09	0.13	0.02•	0.05•	0.01•	0.07†
-0.05	0.08•	0.09‡	0.10†	0.12	0.11	0.13	0.04•	0.08	0.04•	0.09
-0.15	0.07•	0.06•	0.14	0.12	0.14	0.15	0.13	0.18	0.17	0.15
-0.30	0.05•	0.01•	0.20	0.11‡	0.19	0.18	0.25	0.32	0.35	0.25

NOTE - Regression Model 4: change rates are based on the moving average log difference of equation (9)  
 All coefficients have p<.001 unless otherwise noted  
 † p<.01 ‡ p<.05 • p≥.05

Average and non-averaged industry employment share changes also show that the negative influence of growth for the largest establishments continues to lessen across size but unlike in the previous sample, are plagued with insignificant results. The two largest positive change rates do in fact show that there is a strong converging trend and that the values are much closer to zero than for smaller establishment sizes. Were it not for their insignificance, the slowest growth rates would be even greater evidence for a steady state.

It may be worth noting that the flat, parallel lines of the short-term, non-averaged employment change and industry employment share change for large establishments<sup>31</sup> may in themselves be signs of a steady state. If short-term fluctuations manifest no differently across sizes, then

<sup>30</sup> The positive value “0.24” at Change Rate 0.30 - Quantile 2 creates a strange spike, and though completely insignificant, is not a mistype.

<sup>31</sup> (Regression [Tables IX](#) and [XI](#), Appendix: Large Establishments).

potentially they are moving along the horizontal asymptote. Granted there is still a gap between the highest and lowest growth rates, but the difference is considerably smaller than in smaller categories. Very large establishments still capable of high levels of growth may likely not be in a steady state due to temporary exogenous shocks, and complete convergence of lines may not be possible in the short-term.

Negative growth also preserves the same general trends as for smaller establishments. Though it is hard to be certain with such large confidence interval, positive employment changes tend to compress for the largest establishment, yet negative employment changes tend to remain flatter and more parallel across all sizes. Decreasing average payroll per employee does not occur during downsizing for any size categories giving increased buttressing to the idea that proportions of lower- and higher-wage employees are at work. Altogether, there is strong support for the notion that while the size of establishments has a noticeable impact on average payroll changes in times of expansion, its influence during bouts of contraction are more homogenous. If employment increases are mainly linked to increased output, then labor substitutes and the bargaining power of workers would be deterministic of workers' wages. If employment downsizing is linked to decreases in output, introductions of labor substitutes, employer learning, and shareholder influence then the eventuating changes to payroll per employee are presumably less systematic and likely void of any steady state. The proportion of those above and below average payroll may then form the structural differences of size's affect for both periods of expansion and contractions, but asymmetric motivations behind the two create noticeably different trends.

## CONCLUDING REMARKS

Applying Occam's razor, all that can be said of these results is that in non-franchising establishments for the last quarter of the twentieth century, employment change and payroll per employee were negatively correlated and that the effect is stronger for more dynamic change. This relationship was observed in four measures for employment change and occurred across size, employment change measures, for expansions and for downsizing. Conclusions drawn from logical inferences and previous studies using richer data suggest that employment change comes predominantly by way of employees below the average wage rate, and similarly, lower wage employees are the first to be laid off during downsizing. The most solid conclusion is in dispelling the assumption that size-wage differentials result in larger employers having lower average payroll per employee, and literature, for the most part, seems to be oblivious to the paradox. For example, Brown and Medoff (1989) assume that larger firms have higher labor costs and wonder how these firms retain competitiveness amidst higher wages. The supposition of the existence of compositional changes asserts that payroll for larger employers *enhances* their competitiveness rather than compromises it.

A particular trend observed is that positive change rate's influence on average payroll diminishes across size, yet the relationship never turns positive and effects of various growth rates compress. Several more suppositions regarding steady states of employment composition were needed to buffer the uncertainty persisting from limited data and were possibly that: (i) the gap between average payroll and lower wage narrows with lower wage dilution, (ii) size-wage differentials evoke upward trends in payroll per employee but lose their potency, (iii) establishments continually hire at wages below marginal product of labor and fire those above until eventually most payroll employees are efficiently paid, and (iv) labor substitute ceilings curtail the rising bargaining power floor of workers. The first two possibilities were most applicable when size was measured by absolute employment but were less applicable with the relative employment categories based on industry employment share change. The third holds better in explaining converging trends but cannot account for lowering average payroll.

Capital-labor substitution allows for a more fluid explanation across industries and occupations and may account for the much more defined convergence and compression found in long-run size categories based on industry employment share. Whether or not the size-wage effects become more dominant than compositional changes in the largest establishments and create a positive relationship continues to be uncertain as many of the coefficients are

insignificant, though to note there were some significant positive values. The narrowing of the trends between change rates for those with the most industry employment share shows much more clearly the possibility of a steady state based on the assumption that there are similar capital-labor ratios. Those with the most employees relative to those in their industry are presumed to have the most capital, which creates a ceiling that prevents the effects of size-wage premia from increasing further. Not so much based on findings as predictions, average payroll may not necessarily decrease with size as it does with competitiveness, and establishments with lower labor output costs are those capable of growth.

Downsizing may be linked to decreases in output or increasing of capital intensity, but the effect on lower wage employees is still the most prominent. Outside literature suggests that tasks of low-wage employees are more likely to be outsourced or substitute with capital. The increases in average payroll in times of downsizing do not follow the same patterns as in times of growth leading to implications that dismissed workers may not be only linked to output but can come from any noncompetitively-paid employee. As to which employees seems to be associated with the proportion of high- and low-wage earners as smaller establishments have an unexpected decreasing average payroll change.

## 7.1 IMPLICATIONS AND FUTURE STUDY

The period over which this paper covers underwent a time of radical change in the relationship between employer and employee. Transformational shifts between and within industries saw a decline in labor share in ways that were unimaginable to those before and led to growth in the economy being reinvested in the company rather than in the worker. Though larger employers do in fact have lower payroll per employee, without additional information it is difficult to say for sure if they contribute less to labor share. If firms that have the highest market share in concentrating industries are drivers behind the falling labor share (ADKRP, 2017) then establishments in the higher industry employment share quantiles with the lowest payroll per employee could potentially find accord. Yet the role of larger employers in national income inequality, rising share of lower-wage positions, and increased unemployment rates is far from being supported or dismissed from the findings presented here.

Presumptions about employment change coming by way of lower wage employees cannot aptly be linked to lowering labor share as it is uncertain if larger employers force job seekers

into settling for a lower-wage positions or if more lower-skilled employers find work at larger establishments. If larger establishments do not influence the job workers can expect to receive given their skill-level, then the behavior and characteristics of larger establishments are irrelevant to labor share. On the other hand, large establishments—either in absolute or relative term—partially dictate the income workers are capable of receiving, then establishment growth could have implied connections with growing lower-wage positions and labor share inequality. There is some discrepancy, however, in the simultaneous decline in labor share and decreasing proportion of the workforce employed by large companies during the latter part of the twentieth century (McCall, 2004) that distance labor share from establishment size. Perhaps then the discussion is best moved to consider not size in terms of absolute measures but relative to other establishments within an industry; support for size's influences on labor share are better aligned considering arguments based on capital-labor ratios.

Using the Longitudinal Business Database to continue researching this topic could explore the possibilities raised in this paper by further analysis of average payroll change within industries. While the four regression models controlled for industry effects in their own way, none isolated a specific industry to determine if the trends maintain the same characteristics cross-sectionally. Moreover, understanding the different capital-labor ratios in each industry may comment on assumptions of labor substitution ceilings, and moreover, defining observations by the periods in which they occur, such as before the era of globalization and the IT revolution, could integrate the historical strengths of worker's bargaining power and the results. The paper has also not empirically addressed causality of average payroll and employment change rates; the possibility that establishments with lower labor costs are capable of expansion is as likely as the possibility that lower-wage employee are primarily what an establishment needs to expand without further analysis. Nevertheless, employer-employee linked data is first and foremost essential in assessing changes in employee composition with establishment growth, and only then can any certainty be afforded as to the mechanisms that make average payroll per employee decrease with size, causes the trend to flatten, and what prevents it—if anything—from becoming positive. The primary contributions of this paper have been to decompose a generality that larger employer pay more by illuminating a paradox arising through labor force composition within the establishment, but in doing so, was subject to its own blindness and relied upon many additional assumptions—some of which still remain unexplored.



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# APPENDIX

## STATA PROGRAM FOR REGRESSION ANALYSIS

### Basic Regression Model

```
xtreg log_avg_pay c.emp i.size_cat i.age, re vce(cluster id)
```

```
margins size_cat
```

```
margins age
```

### Regression Model 1

```
xtreg log_avg_pay_change c.emp_change##i.size_cat i.age ibn.year_dummy  
i.ind_cat if emp_change>0, re vce(cluster)
```

```
margins i.size_cat, at(emp_change=(.05 .25 .5 1))
```

```
margins i.age, at(emp_change=(.05 .25 .5 1))
```

### Regression Model 2

```
xtreg log_avg_pay_change c.moving_average_emp_change##i.avg_size_cat  
i.age ibn.year_dummy i.ind_cat if moving_average_emp_change>0, re  
vce(cluster)
```

```
margins i.avg_size_cat, at(moving_average_emp_change=(.05 .10 .25 .5))
```

```
margins i.age, at(moving_average_emp_change=(.05 .10 .25 .5))
```

### Regression Model 3

```
xtreg log_avg_pay_change c.log_ind_emp_share_change##i.log_ind_share_cat  
i.age ibn.year_dummy i.ind_cat if ind_emp_share_change>0, re  
vce(cluster)
```

```
margins i.ind_share_cat, at(log_ind_emp_share_change=(.1 .5 1 2))
```

```
margins i.age, at(log_ind_emp_share_change=(.1 .5 1 2))
```

### Regression Model 4

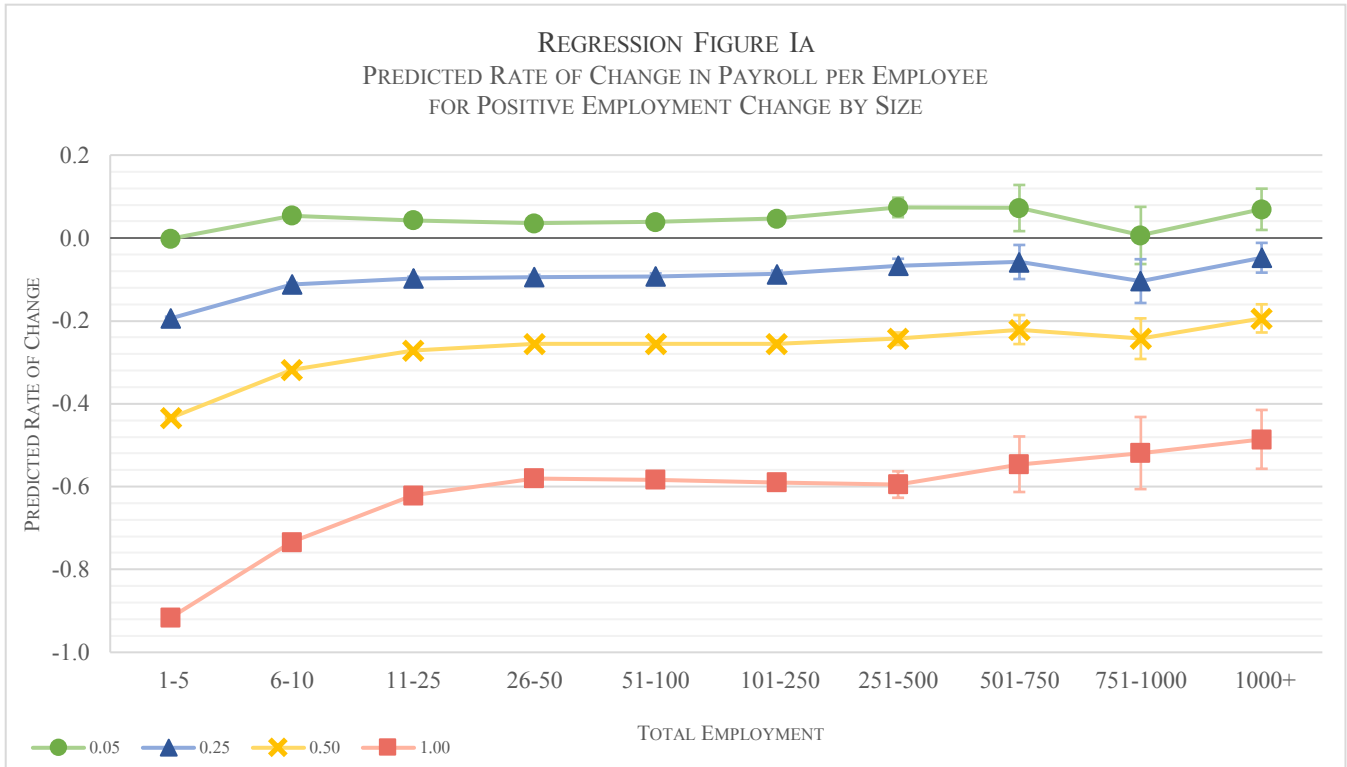
```
xtreg log_avg_pay_change c.moving_average_ind##i.avg_ind_share_cat i.age  
ibn.year_dummy i.ind_cat if moving_average_ind>0, re vce(cluster)
```

```
margins i.avg_ind_share_cat, at(moving_average_ind=(.05 .25 .5 1))
```

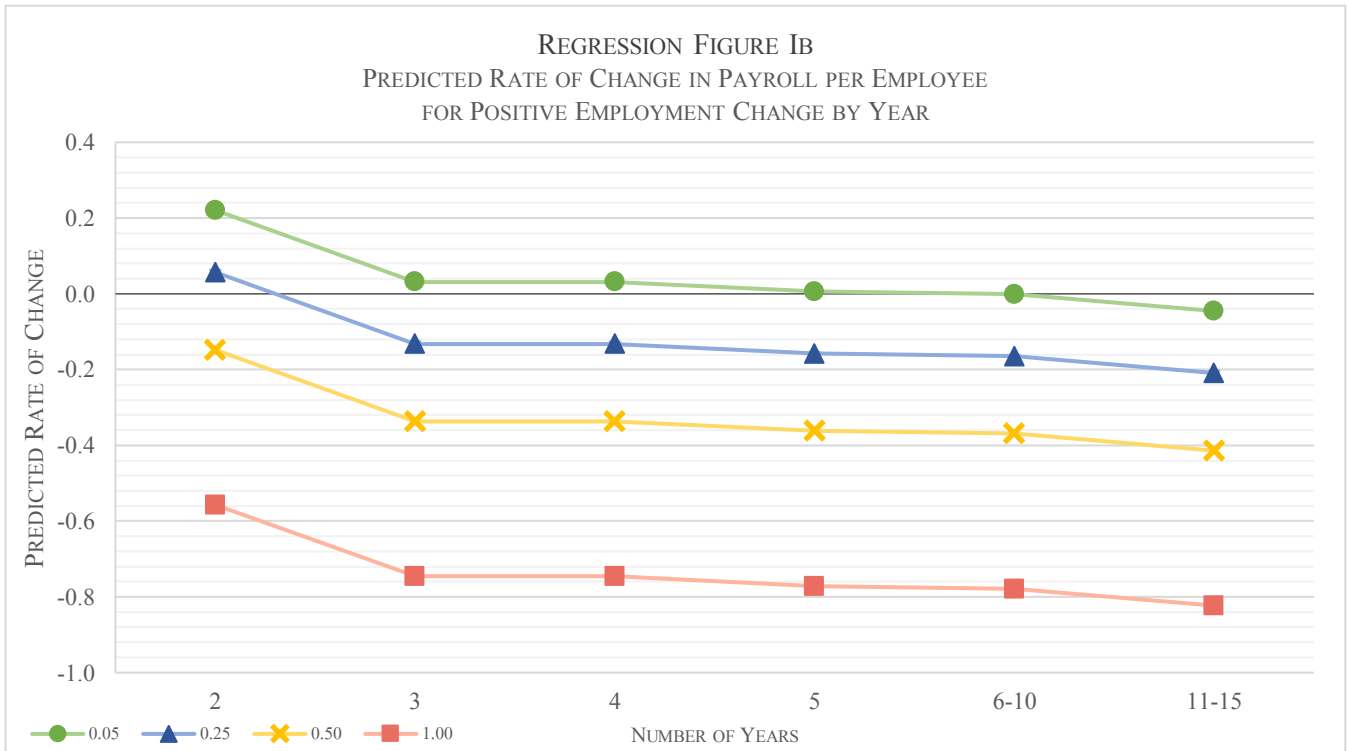
```
margins i.age, at(moving_average_ind=(.05 .25 .5 1))
```

\*The same code for the regression models was run for negative employment change by reversing the “>0” to “<0”.

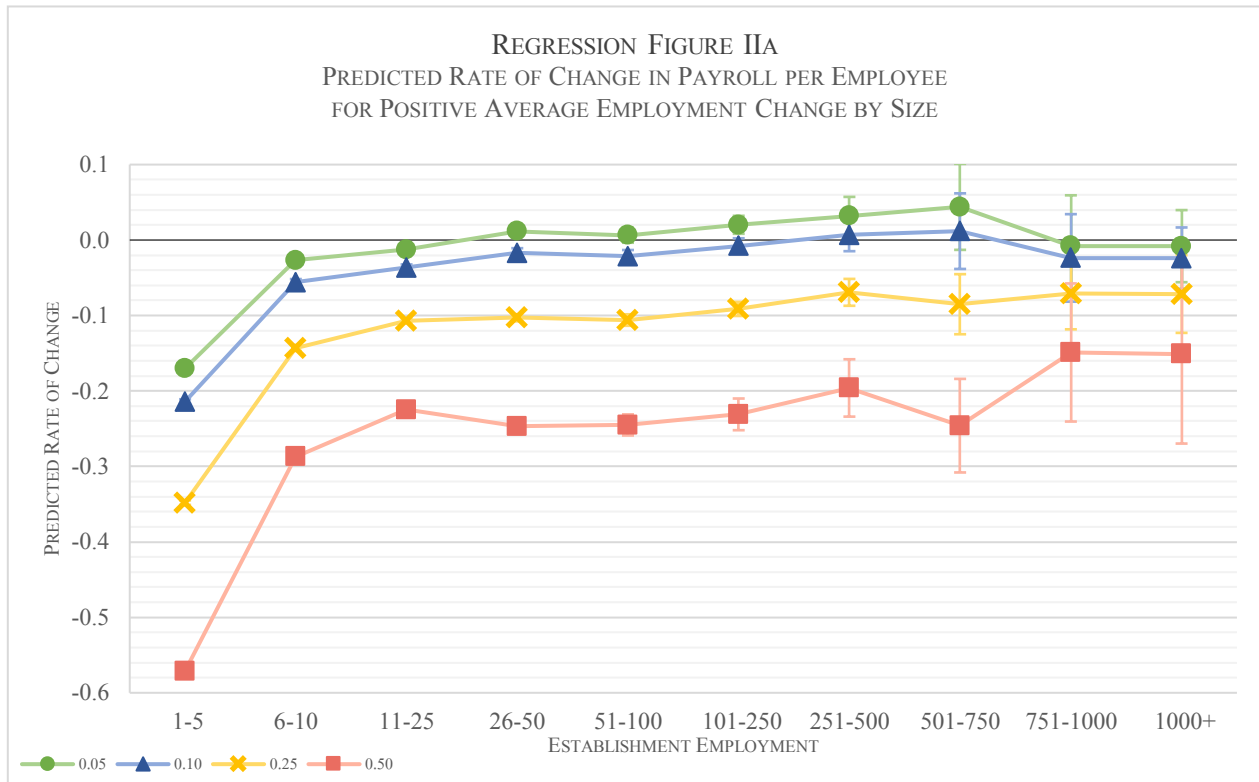
## POSITIVE EMPLOYMENT CHANGE



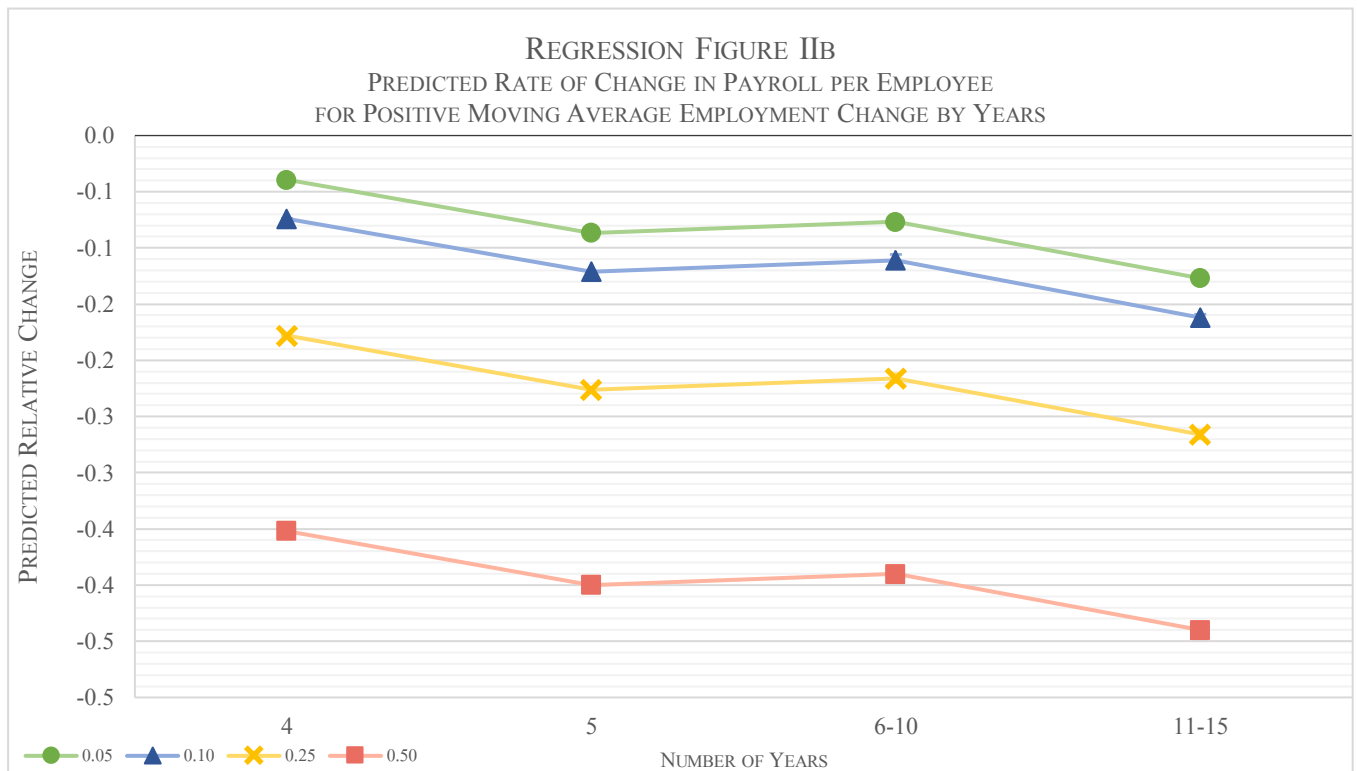
[\[Return to Table Ia\]](#)





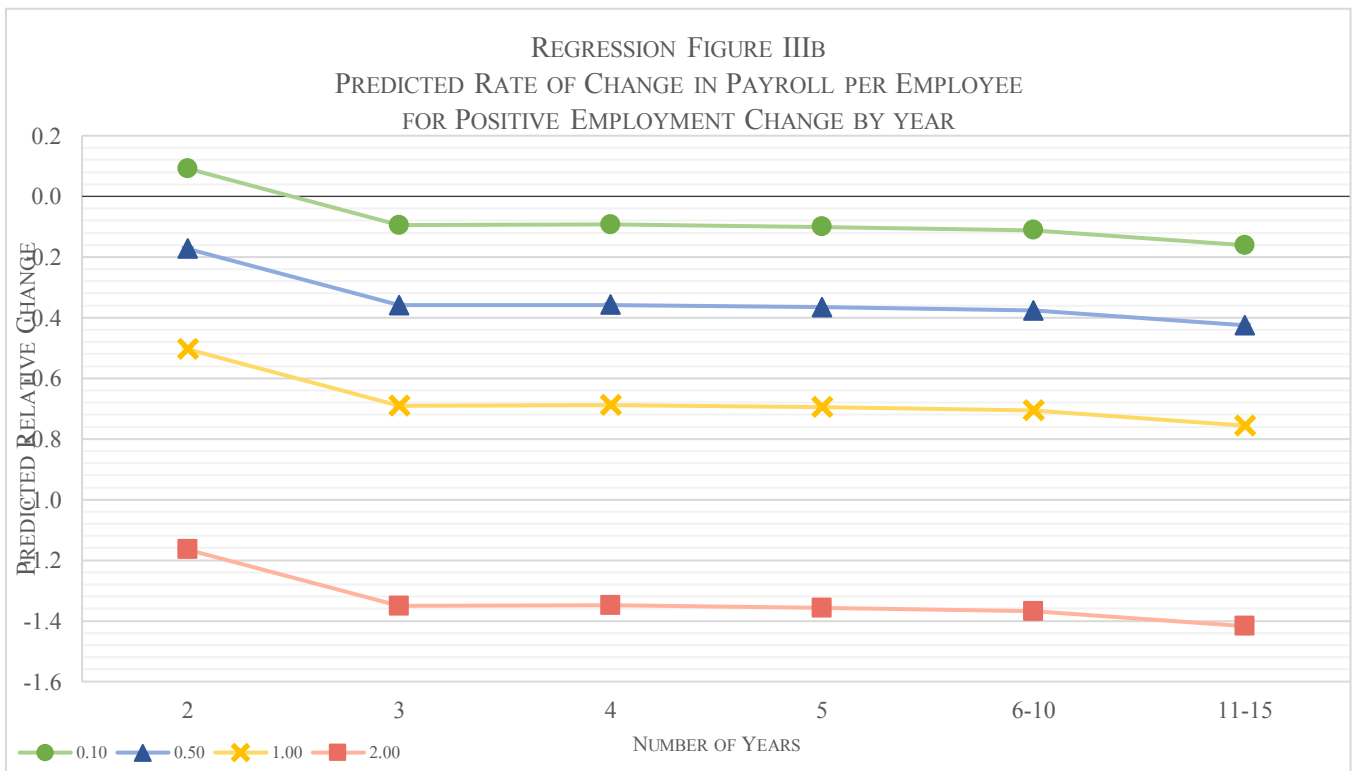


[\[Return to Table Iia\]](#)





[\[Return to Table IIIa\]](#)

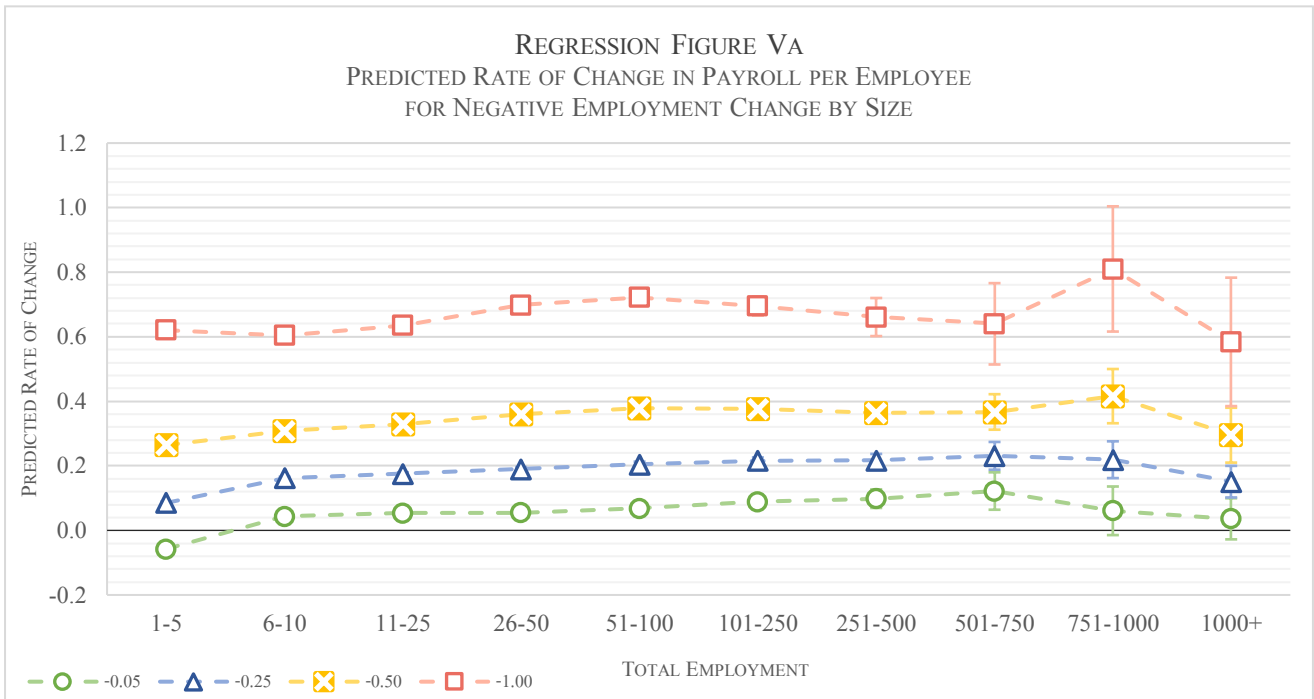




[\[Return to Table IVa\]](#)

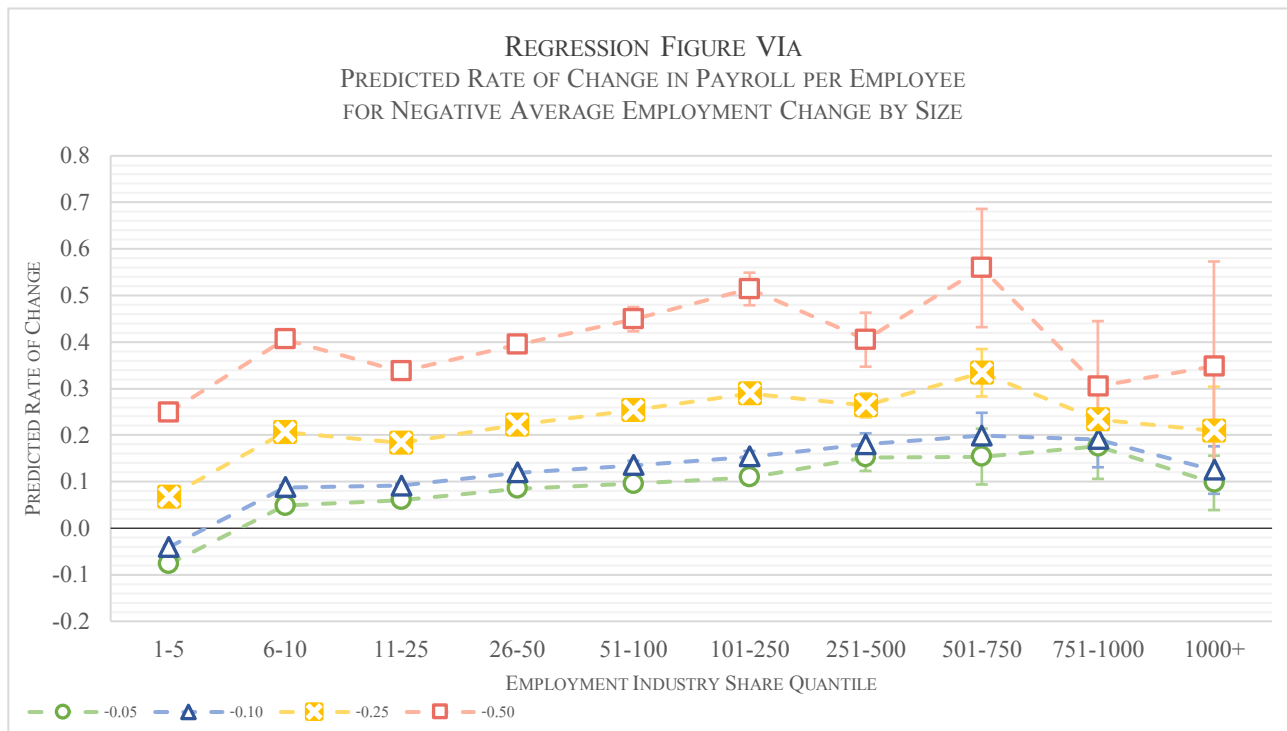


## NEGATIVE EMPLOYMENT CHANGE

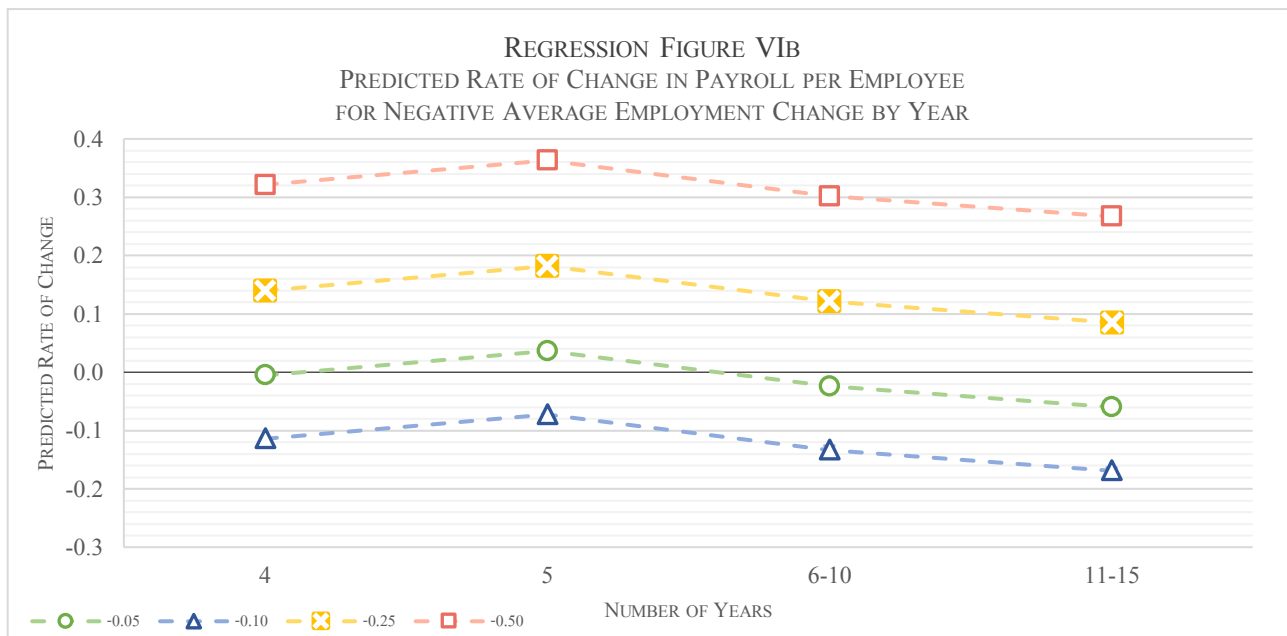


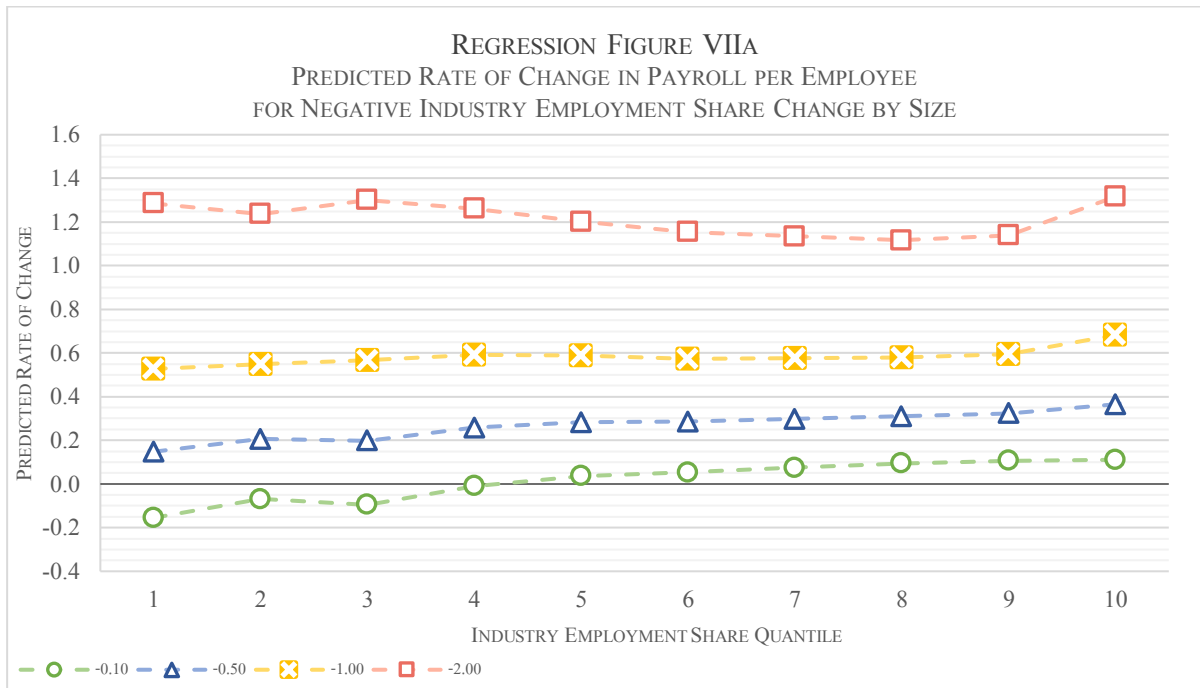
[\[Return to Table Va\]](#)



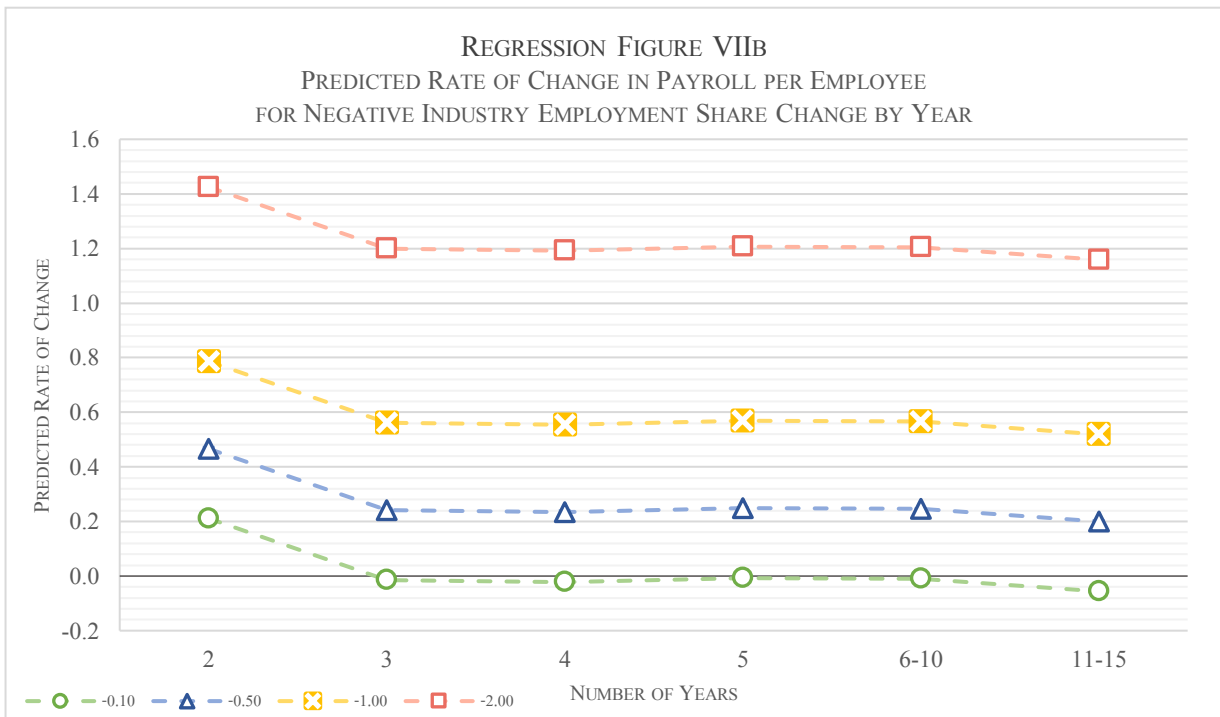


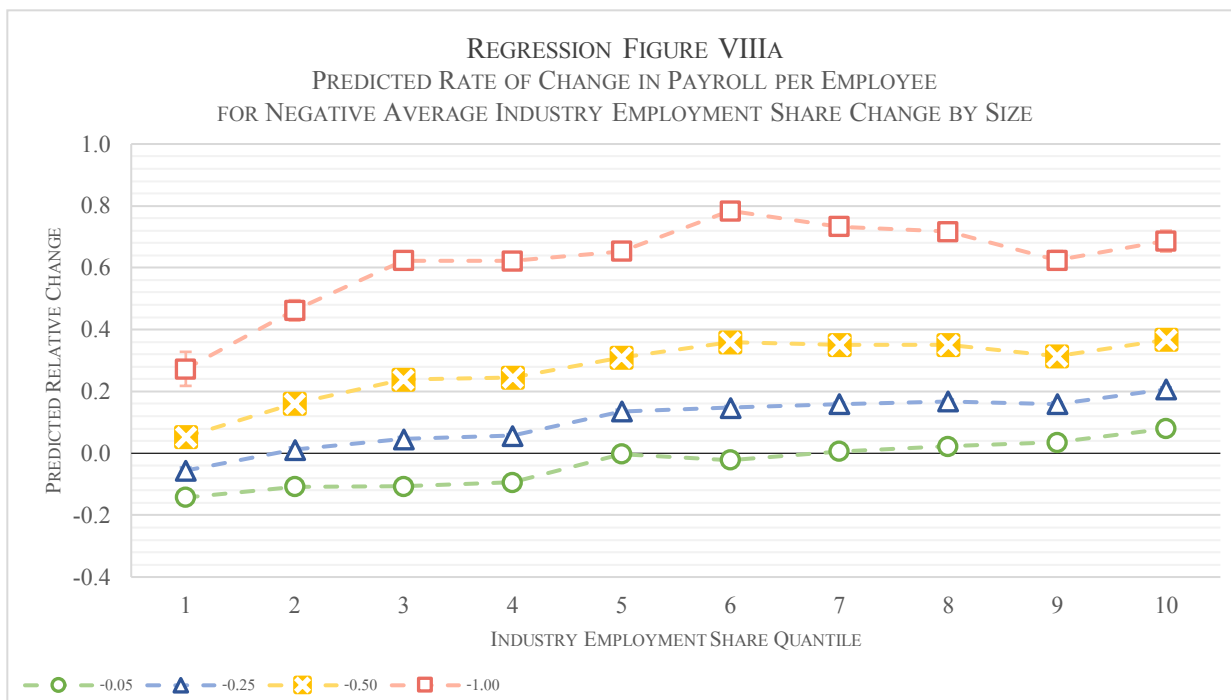
[\[Return to Table VIa\]](#)



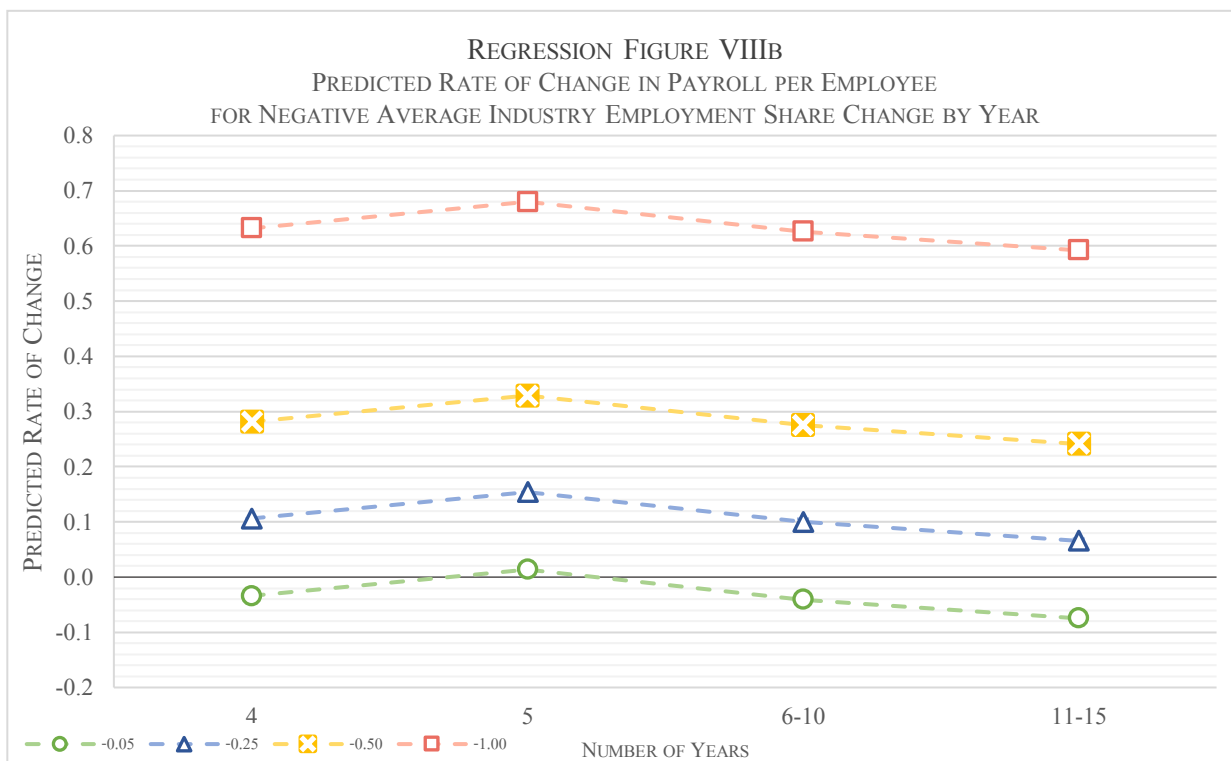


[\[Return to Table VIIa\]](#)





[\[Return to Table VIIIa\]](#)



## LARGE ESTABLISHMENTS



[\[Return to Table IXa\]](#)

**REGRESSION FIGURE IX**  
**PREDICTED RATE OF CHANGE IN PAYROLL PER EMPLOYEE**  
**FOR EMPLOYMENT CHANGE IN LARGE EMPLOYERS BY SIZE**

CHANGE RATE	ESTABLISHMENT EMPLOYMENT							
	500-750	751-1000	1001-1500	1501-2000	2001-3000	3001-4000	4001-5000	5000+
0.04	0.05†	0.02•	0.03‡	0.03•	-0.02•	0.00•	0.02•	0.10‡
0.10	0.02•	-0.01•	0.00•	0.00•	-0.04‡	-0.02•	-0.01•	0.07•
0.40	-0.13†	-0.18	-0.16	-0.19	-0.17	-0.13	-0.18	-0.07‡
0.75	-0.31	-0.37	-0.35	-0.40	-0.31	-0.25	-0.38	-0.24
-0.05	0.08	0.06	0.04‡	0.07‡	0.07†	0.06•	0.02•	0.11•
-0.25	0.12	0.10	0.08	0.09	0.10	0.09†	0.06•	0.16†
-0.50	0.28	0.28	0.28	0.22	0.26	0.23	0.24	0.39
-0.75	0.47	0.48	0.52	0.37	0.45	0.39	0.46	0.67‡

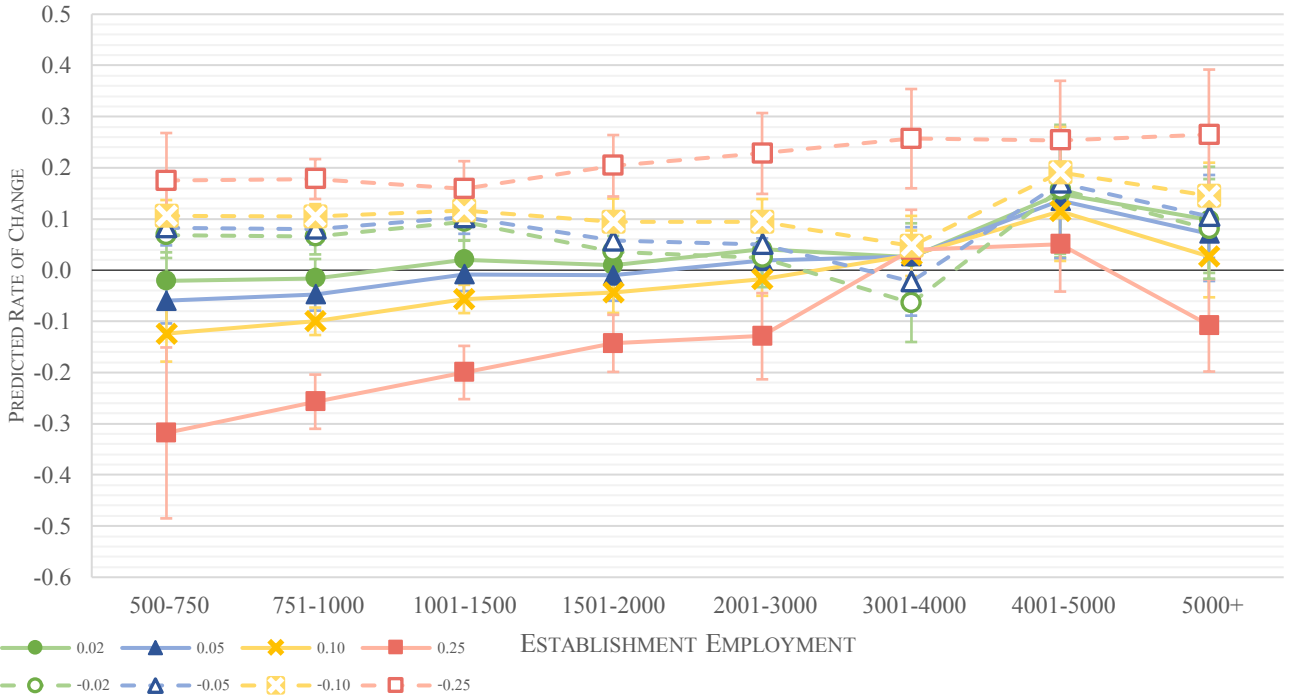
NOTE.- Regression Model 1: change rates are based on equation (4)

All coefficients have p<.001 unless otherwise noted

† p<.01    ‡ p<.05    • p≥.05



**REGRESSION FIGURE X**  
**PREDICTED RATE OF CHANGE IN PAYROLL PER EMPLOYEE**  
**FOR AVERAGE EMPLOYMENT CHANGE OF LARGE ESTABLISHMENTS BY SIZE**



[\[Return to Table Xa\]](#)

**REGRESSION FIGURE XI**  
**PREDICTED RATE OF CHANGE IN PAYROLL PER EMPLOYEE**  
**FOR INDUSTRY EMPLOYMENT SHARE CHANGE OF LARGE ESTABLISHMENTS BY SIZE**

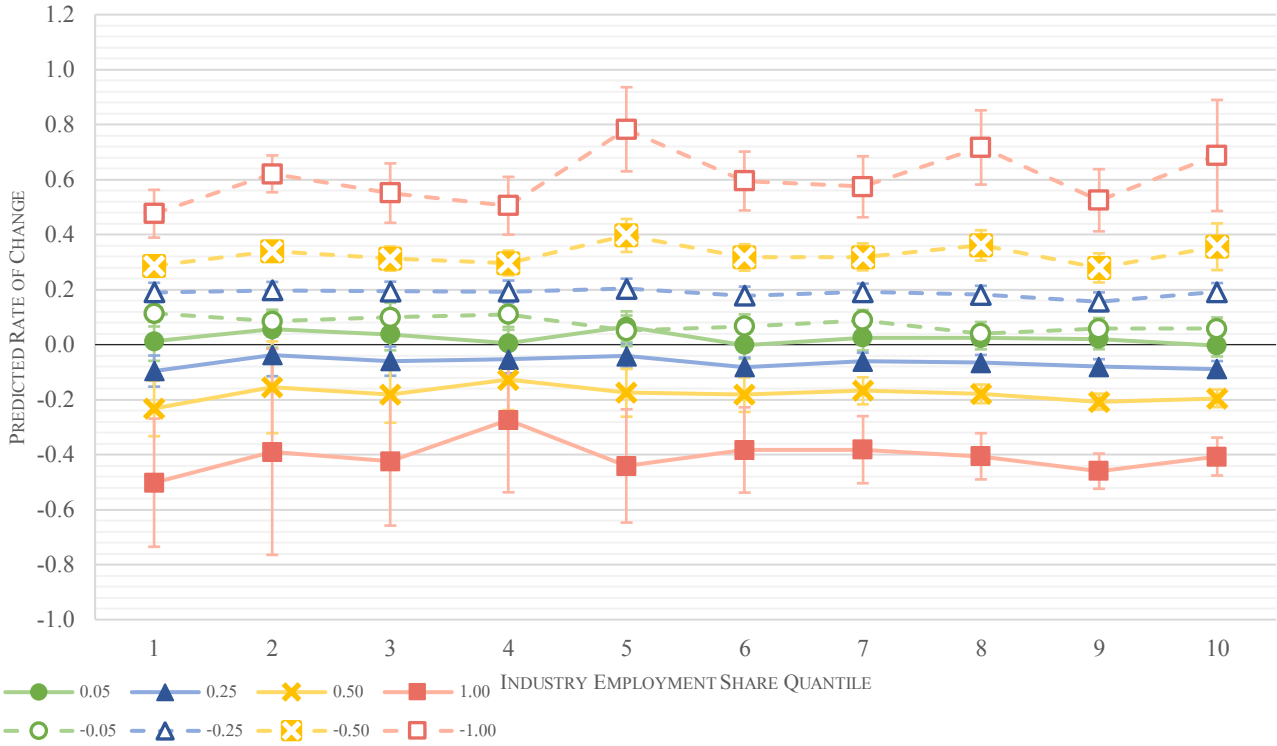
CHANGE RATE	INDUSTRY EMPLOYMENT SHARE QUANTILE									
	1	2	3	4	5	6	7	8	9	10
0.05	0.01•	0.06•	0.04•	0.00•	0.07‡	0.00•	0.03•	0.02•	0.02•	0.00•
0.25	-0.10†	-0.04•	-0.06‡	-0.05‡	-0.04•	-0.08	-0.06	-0.07	-0.08	-0.09
0.50	-0.23	-0.16•	-0.18	-0.13‡	-0.18	-0.18	-0.17	-0.18	-0.21	-0.20
1.00	-0.50	-0.39‡	-0.42	-0.27‡	-0.44	-0.38	-0.38	-0.41	-0.46	-0.41
-0.05	0.11	0.08	0.10	0.11	0.05•	0.07†	0.09	0.04•	0.06†	0.06†
-0.25	0.19	0.20	0.19	0.19	0.20	0.18	0.19	0.18	0.16	0.19
-0.50	0.29	0.34	0.31	0.30	0.40	0.32	0.32	0.36	0.28	0.36
-1.00	0.48	0.62	0.55	0.51	0.78	0.60	0.57	0.72	0.53	0.69

NOTE.- Regression Model 3: change rates are based on the log difference of equation (9)

All coefficients have p<.001 unless otherwise noted

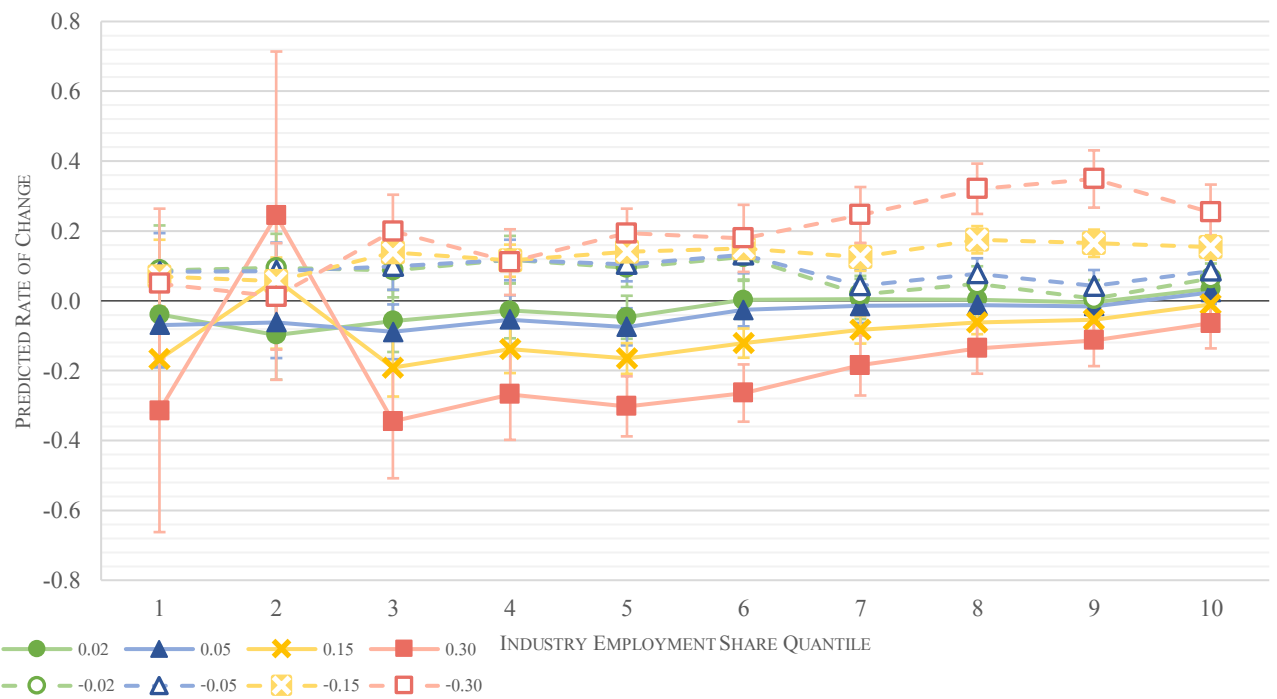
† p<.01 ‡ p<.05 • p≥.05

REGRESSION FIGURE XI  
 PREDICTED RATE OF CHANGE IN PAYROLL PER EMPLOYEE  
 FOR INDUSTRY EMPLOYMENT SHARE CHANGE OF LARGE ESTABLISHMENTS BY SIZE



[\[Return to Table XIa\]](#)

REGRESSION FIGURE XII  
 PREDICTED RATE OF CHANGE IN PAYROLL PER EMPLOYEE  
 FOR AVERAGE INDUSTRY EMPLOYMENT SHARE CHANGE OF LARGE ESTABLISHMENTS BY SIZE



[\[Return to Table XIIa\]](#)