Industry and Firm Dynamics in Early Twentieth-Century America

by

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Table of Contents

List of Figures

List of Tables

List of Appendices

CHAPTER 1

INTRODUCTION

This dissertation explores industry and firm dynamics in early twentieth-century America. Using newly digitized micro data and employing standard analytical techniques, I investigate the determinants of establishment entry, exit, continuation and growth, and their impact on employment. Relatively little research in economic history has investigated plant-level data to study business dynamics in the early twentieth century, particularly the Great Depression. This dissertation narrows the gap by showing how firms and establishments grew and created jobs during this period.

There are common themes across all three chapters. First of all, they analyze establishment behavior because it is the unit in which production and employment decisions are implemented. I find substantial establishment heterogeneity in survival and growth across all industries. The differences are not fully captured by aggregated measures. For example, a reduction in productivity dispersion can be brought about by different factors, such as the exit of low productivity establishments or their productivity growth.

To account for such heterogeneity, all three chapters investigate new or improved establishment-level data. I compiled the micro-level information from the Census of Manufactures for Chapters 2 and 3 and from the North Carolina state reports for Chapter 4. Using the constructed data, all chapters test the role of establishment size, productivity and firm structure in survival and growth. In particular, I demonstrate the importance of size in establishment survival during the Great Depression. I suggest that it may have been due to the credit constraints caused by the Great Depression. I also highlight that resource reallocation within a firm is often different from market reallocation through the framework of single- versus multi-plant firms. I find that multi-plant firms tend to protect member units from external shocks, which contrasts with market selection.

Chapters 2 and 3 investigate this question in the context of the Great Depression. Chapter 2 reexamines the cleansing hypothesis raised by Bresnahan and Raff (1991) for the motor vehicle industry. I find that the Depression was not cleansing in the passenger car market, the most important segment. Establishment size rather than productivity before the Great Depression predicts the survival of establishments. I draw further implications by breaking the sample into single-plant and multi-plant firms. I find that they show contrasting behaviors. For single-plant firms, establishment size was particularly important in establishment survival. In line with the evidence on the Great Recession, this result suggests that credit constraints potentially impeded the cleansing by the market. The analysis for multi-plant firms finds no significant explanatory variables. This result implies that within-firm resource reallocation can be different from market reallocation because managerial considerations may dominate other economic factors in making a shutdown decision. Both would have contributed to the lack of cleansing effects in the motor vehicle industry.

Chapter 3 examines employment dynamics from the job perspective. Extending the scope to a large and diverse set of manufacturing industries, I confirm the finding of Chapter 2 that the Great Depression was not cleansing. Within each industry, establishment size is a strong predictor while labor productivity is not. However, job destruction rates were higher at large establishments conditional on survival, indicating that large employers contributed more to overall job destruction. Chapter 3 also examines the quality of jobs destroyed. I find that the employment change rates were high at low-paying establishments both in downturn and recovery. The Great Depression was not cleansing also in the job aspect.

In Chapter 4, I use the frames of earlier chapters to analyze industry evolution over the long term. Taking the rise of the North Carolina cotton textile industry as the context, I examine how firm structure affects mill survival and productivity. As previous literature suggests (Braguinsky et al. 2014; Foster, Haltiwanger, and Syverson 2008, 2012), I find that marketing and distribution was a powerful factor of mill productivity. The multi-mill structure of several leading business groups was likely to be an outcome of investment constraints that existed among mills with many small owners. However, new mills of these groups benefited from the parent firm's marketing and distribution assets. The business groups also adopted new technology, such as electricity, faster than individual mills and quickly diffused to member mills. Based on these findings, I emphasize the role of local managers in overall industry growth. Although cheap labor is still an important factor for the fast growth of Southern textiles, the importance of marketing and technology adoption demonstrates the importance of managerial abilities. Old firms could maintain their market leadership thanks to better management, and it brings out the indigenous nature of Southern textile industry's growth.

CHAPTER 2

Was the Great Depression Cleansing?

Evidence from the U.S. Automotive Industry

2.1. Introduction

Are recessions times of creative destruction and accelerated reallocation of resources towards more productive business units? Since the classical work of Schumpeter (1942), great attention has focused on this question. A canonical model, such as one by Caballero and Hammour (1994), suggests that a fall in demand facilitates the exit of unproductive and outdated units and creates space for newcomers. Empirical evidence on the postwar U.S. manufacturing sector confirms this prediction in general. For example, Davis and Haltiwanger (1996) find that job destruction is more responsive to recessions than is job creation throughout the postwar period. Foster, Haltiwanger and Krizan (2001) find that "productivity-enhancing" reallocation, measured by employment changes, is greater during recessions. These findings have important implications; there are silver linings to recessions because successful restructuring through selection and reallocation will lead to faster recovery and growth. Foster et al. (2001) also demonstrate that there is substantial heterogeneity in firms' responses to recessions which vary systematically with firm characteristics.

However, economists also recognize that not all recessions are the same. Researchers report several cases where recessions are not cleansing. The Great Recession of 2007 in the United States (Foster, Grim, and Haltiwanger 2013), during the 1990s in Japan (Caballero, Hoshi, and Kashyap 2008) and recessions in Colombia (Eslava et al. 2010) did not weed out less productive business units. These studies commonly indicate that distortions in the financial sector, such as zombie lending or credit constraints, inhibit the process of creative destruction. The effect of credit constraints, the "credit crunch" channel, has particularly attracted research attention because of its real effects on reduced investment and employment as shown in recent studies (Campello, Graham, and Harvey 2010; Chodorow-Reich 2014).

While the Great Depression serves as a touch point to study the effects of the Great Recession because of its severity and the failures in the financial sector, little is known about whether the Great Depression had cleansing effects. Data limitations have been a primary reason for this knowledge gap. Bresnahan and Raff (1991)'s groundbreaking work is one of the few studies on this subject. It is the first to code establishment-level micro data for the motor vehicle industry from the Census of Manufactures. They showed that exiting establishments were smaller and had lower labor productivity than continuing establishments on average. Although this chapter provided a number of novel findings, their group average comparison does not directly answer the creative destruction question, because exit and employment decisions are made at the firm or plant level. After two decades with little follow-up research, several researchers now have begun to address this issue using the Census of Manufactures microdata for other industries (Scott and Ziebarth 2014; Ziebarth 2014b). However, more evidence is needed to characterize the Great Depression generally.[1]

[1] Ziebarth (2014b) collected information for the following industries: manufactured ice, cement, macaroni, sugar refining, bone black, automobiles, radios, cane sugar, and agricultural implements, but he did most of his analysis for the concrete industry only. He finds that the dispersion in revenue productivity increased between 1929 and 1933, which he interprets as the evidence of resource misallocation by financial institutions. This method is popular in macroeconomics, but it reveals little about the characteristics of exiting

This chapter examines whether the Great Depression was cleansing in the U.S. automotive industry (final assembly), an industry accounted for 2.5 percent of employment and 5.3 percent of output in 1929. I re-examine and extend Bresnahan and Raff (1991)'s analysis using a more systematic method at the establishment level. For the analysis, I construct a completed and improved dataset for this industry. My dataset builds on what Bresnahan and Raff (1991) had compiled, adding records of 31 establishments in 1931 (mostly Ohio, Pennsylvania and Wisconsin) missing in the earlier digitization as well as missing information for several key variables.

Using the improved dataset, I test how well productivity and establishment size *before* the Great Depression predict the survival and reallocation during the Depression. In other words, I ask whether the Great Depression weeded out less productive establishments.

From the analysis, I find no evidence of cleansing effects in the passenger car segment that account for most of output and employment of the industry. Revenue-based total factor productivity (TFP) does not predict survival of passenger car producers. When I include producers of other vehicle types as Bresnahan and Raff (1991) did, I find that revenue-based TFP predicts survival. Therefore, Bresnahan and Raff's observation was correct, but it was driven by the behavior of many but small establishments that produced other types of vehicles. It will be a misleading conclusion if one argues that the Great Depression was cleansing based on their observation.

I find the reasons why the Depression was not cleansing from the following two factors. First, within-firm reallocation differed from selection and reallocation by the market. While market selection was based on revenue productivity and size, the managers of multi-plant firms did not always reallocate their resources towards more productive units. Their different behavior had a large effect enough to affect the aggregate industry pattern. Second,

and entering establishments as noted by Hsieh and Klenow (2009) who proposed the methodology. Scott and Ziebarth (2014) analyze the radio industry, claiming that brand ownership was more important than technical efficiency in the radio industry. Their conclusion is in accord with this paper's findings.

smaller single-plant firms faced a credit crunch. Drawing on existing empirical evidence about corporate finance during the Great Depression, I argue that it is reasonable to think that smaller firms suffered from financial distress and credit constraints, and therefore were more likely to exit without regard to their productivity level.

I also relate the plant dynamics to production technology, offering an alternative explanation about why small, craft producers exited suddenly in the wake of the Great Depression. This topic has attracted many historians' attention (Bresnahan and Raff 1996; Hounshell 1985; Nye 2013). Previous studies have argued that craft plants could have coexisted with mass production firms if not for the Depression. Some even argue that they were profitable on the eve of the Great Depression. I provide quantitative evidence that mass production increased both revenue and physical productivity, primarily because of standardization and better management. However, many of mass production plants survived not because they were efficient but because they were large. Moreover, standardizing models rather than increasing production volume was essential to increasing productivity. These two factors contributed to the diffusion of mass production.

This chapter brings new insights to our understanding of the Great Depression and relationship between firms, financial markets, and industry dynamics. First of all, it rejects the old view that the Great Depression was cleansing. By making this argument, I suggest that the Depression would have caused credit crunch and inefficient reallocation of resources. Second, I show that resource reallocation can differ by firm structure and the difference can affect the overall pattern in an industry like the auto industry. My results raise the need to understand heterogeneity in firm response to aggregate changes. Third, I demonstrate the importance of firm size in survival during the Great Depression. I suggest that firm size would have related to the ability to obtain credit for operation. I also connect producer dynamics to employment. I explain how jobs are destroyed at establishments with different characteristics. To my knowledge, this is the first study that addresses employment changes during the Great Depression in terms of plant dynamics.

The remainder of this chapter is organized as follows. Section 2 describes the main data source, biennial Censuses of Manufactures between 1929 and 1935. Section 3 overviews the changes in the auto industry during the Great Depression and suggest important questions to be tested. Section 4 performs the main analysis. Section 5 discusses why no cleansing pattern is found in passenger car markets. Section 6 connects productivity and production technology and explains the diffusion of mass production in this period.

2.2. Data: Biennial Census of Manufactures, 1929-1935

The Census Bureau creates longitudinal microdata on U.S. manufacturing establishments by compiling information from the Census of Manufactures (CoM) and the Annual Survey of Manufactures (ASM) and by linking the establishments over time. The availability of these data has opened new opportunities of analysis beyond what is possible with more aggregate data. Since Dunne et al. (1988) and Dunne et al. (1989), numerous empirical papers have measured the survival and growth of establishments and analyzed firm and industry dynamics. The currently available data start in 1963. Recently, the Census Bureau located earlier microdata from the ASMs in the 1950s and 1960s and the CoM in 1958 and they were partially recovered (Becker et al., 2011). However, only a few such sources are available for the first half of the century.

The Census of Manufactures for the years 1929, 1931, 1933 and 1935 have survived. These four census years are the only period before World War II for which the original schedules of the census still exist at the National Archives. The information available varies by year. The censuses of 1929 and 1935 have the most detailed information, including the capacity of power equipment, chief materials used and fuel, and the number of nonproduction workers. These questions were not asked in the 1931 and 1933 censuses.[2]

[2] This is because the 1929 census was conducted as a part of the decennial Census of Population and Housing and the 1935 census along with the Census of Business, which allowed the Census Bureau to use more resources for the survey. In the intervening years, 1931 and 1933, tight budgetary situation allowed them to

The 1933 and 1935 censuses added questions about man-hours because improving the employment situation was one of the main interests of policymakers after the enactment of the National Industrial Recovery Act (NIRA).

From those schedules, Bresnahan and Raff collected information for final assembly establishments in the US motor vehicle industry and deposited their data at the ICPSR (The Interuniversity Consortium for Political and Social Research, data number 31761). Although the Standard Industrial Classification (SIC) system was not employed until the 1947 census, they effectively separated final assembly establishments and bodies and parts establishments using the industry code (1407: bodies and parts, 1408: final assembly).[3]

The scope is all final assembly establishments (plants) with annual product of $5,000 and more for which the Census Bureau collected information. The Census defines a manufacturing establishment as "a plant, mill, factory, shop or works at a single location and engaged in one line of manufacture" and note that: "A company or business unit often includes more than one establishment." Because "establishment" and "plant" carry the same meaning in the context of the auto industry, I use these two terms interchangeably. Establishments in which main activities are the production of parts, bodies, and accessories (i.e., not final assembly) belong to a separate Census category and are not the subject of this chapter, although some final assembly establishments also engage in these activities.

The Bresnahan and Raff data were missing a number of plant records and variables, including 31 establishments in 1931.[4] It is particularly problematic that the missing establishments are concentrated in a few states: 11 from Wisconsin, 6 from Pennsylvania, and 6 from Ohio. Most were relatively small establishments; among the missing records,

ask only a limited set of questions.

[3] Since trailer producers were grouped into motor vehicle only in 1929 but not afterward, I excluded them in this study. A sample schedule can be seen in Appendix Figure 1.

[4] I found that 31 establishments were omitted from the data in 1931. Bresnahan and Raff (1991) relied on secondary sources to determine if omitted establishments were open in 1931, but even from the outside source they could identify opening in 1931 for only about ten establishments.

there are also two Chevrolet establishments. This could have led to a biased conclusion that many old technology-type establishments were scrapped in the first two years.

I made other improvements in data quality. First, I added missing variables such as the quantities and values of products in each category and in total. This was important because firms and establishments had different product mixes. Making meaningful productivity comparisons in an industry with heterogeneous products requires accounting carefully for the establishments' product mix. I also corrected the linkage across time of some establishments that had been given different identification codes. The new dataset is now available at the ICPSR (data number 35604).

2.3. The Automotive Industry during the Great Depression

The Great Depression fundamentally transformed the U.S. automobile industry. Rae (1965) offers a concise and cogent narrative of the change, particularly the varying patterns by firm size and structure. The Depression "accelerated the extinction of the independent producers" while "the middle group of automobile manufacturers survived the depression, along with one of the smaller producers… and the stronger of the truck manufactures." On the other hand, "General Motors, Ford, and Chrysler all shared in the agonies of the period… nevertheless there was a fundamental difference between the experience of the Big Three and that of their smaller competitors." However, he never forgets to mention that managerial quality made a difference in performance between the big firms.

This narrative provides a good starting point for this chapter's economic analysis of the determinants of establishment survival and reallocation. Table 2.1 presents a summary of the auto industry between 1929 and 1935 using the information in the Census of Manufactures. Panel A shows that the Great Depression was a harsh period. About half of establishments shut down between 1929 and 1933. The magnitude of this shakeout is second only to the one in 1920-21. Note that the NBER identifies a downswing in the aggregate economy from August 1929 to March 1933.[5]

Panel B demonstrates the importance of multi-plant firms in the industry. About 40 percent of all establishments belonged to multi-plant firms, accounting for more than three quarters of output and employment. The importance of multi-plant firms suggests the need to understand how managerial decisions on plant closure and intra-firm reallocation of resources differ from the selection by market.

Panel C and D raise the need to focus on the passenger car product segment. They show that passenger car producers account for only a third of the number of establishments, but three quarters of total output. In contrast, heavy truck producers, the largest in number, account for only about 10 percent of total output. In addition, Panel C shows that heavy truck producers underwent a more severe selection process. This suggests that treating these two product segments with equal weights may result in a misleading conclusion. Bresnahan and Raff (1991) conclude that the Great Depression was cleansing from comparing simple averages of exiting and continuing establishments. They did not consider differences between products. I will show that the Great Depression was not cleansing in the passenger car segment, the most important segment.

Panel E translates plant dynamics into employment dynamics. Between 1929 and 1931, plant closure (extensive margin) and declining employment in continuing establishments (intensive margin) contributed about equally to job destruction. In contrast, plant closures explain most of job destruction between 1931 and 1933. Surviving establishments were already supplying jobs between 1931 and 1933, before aggregate employment started recovering. The different behaviors of the two margins suggest that establishment closure and layoff may have different determinants, and therefore need to be examined separately.

[5] See http://www.nber.org/cycles.html.

2.4. Empirical Analysis: the Determinants of Survival and Reallocation

A large economics literature has been devoted to the search for the determinants of establishment survival and growth. Empirical studies have commonly found that productivity and size are positively correlated with survival. For example, Foster, Haltiwanger and Syverson (2008) argue that most of these findings confound the effect of demand-side factors , such as price and customer base, and technical efficiency. By estimating physical and revenue productivity separately, they find that technical efficiency and demand-side factors are both equally important in homogeneous good industries. Their discussion has an important implication for this chapter because the auto industry has very different characteristics from commodity-like products. Automobiles are highly differentiated and producers strategically choose their places in the product space. Other demand-side factors such as brand and dealer networks are also important in promoting sales. Price reflects the combination of technical efficiency and market choice rather than simply pricing power. Comparing the effects of revenue and physical productivity separately will be helpful identifying the drivers of survival and reallocation.

Historical narratives of the auto industry during the Great Depression, such as Rae (1965), call attention to the importance of establishment and firm size. Economists have paid attention to firm size for different reasons, because a robust estimation of the production function has to be conditioned on selection. Firm size, measured by capital stock in the methods of Olley and Pakes (1996), is often used as a predictor of continuation. The logic is that successful firms would invest and increase their size while unsuccessful would stop investing or exit. Because this chapter analyzes the survival and reallocation pattern in a short window between 1929 and 1935, how selection biases productivity is less a concern. The main concern is what establishment or firm size means about survival. Does it reflect the competitiveness of firms or other factors such as the ability to get credit? Answering this question becomes even more important when considering the argument by Bresnahan and Raff (1996) that smaller firms were never uncompetitive. My analysis starts by addressing this question, which in turn requires proper measurement of productivity and size.

2.4.1. Measuring Productivity

For empirical analysis, I measure total factor productivity, in both revenue and quantity. The earlier work of Bresnahan and Raff (1991) used labor productivity, measured by revenue divided by total wage-months and number of vehicles divided by total wage-earner months for group comparisons. This is problematic for two reasons: it uses not net but gross products, and it does not take into account the productivity differences caused by different product mix. I address both problems by using multifactor productivity, including materials as a factor, and adjusting physical productivity for product mix.

In measuring productivity, I follow the conventional index method, taking a cost-share based approach that assumes constant returns to scale. This method is easy to use and convenient in the sense that one can circumvent problems stemming from small sample size. It is employed in the NBER productivity database construction (Bartelsman and Gray 1996) and many productivity studies (Foster, Grim, and Haltiwanger 2013; Foster, Haltiwanger, and Syverson 2008). The literature also has shown that results are quite robust to productivity metrics (Syverson 2011). Following the method in these papers, a TFP index can be computed using the following formula:

$$tfp_{i,t} = y_{i,t} - \alpha_L l_{i,t} - \alpha_H h_{i,t} - \alpha_K k_{i,t} - \alpha_M m_{i,t} \quad (1)$$

where lower-case letters represent the variables in logs $y_{i,t}$, is the log output of establishment *i* in year *t*, (for revenue-based TFP) or the number of vehicles and chassis *i* in year *t* (for quantity-based TFP). $\{l_{i,t}, h_{i,t}, k_{i,t}, m_{i,t}\}$ are the man-hour of production labor, the number of non-production workers, the horsepower capacity of power equipment, and materials/ fuels/ electricity used. $\{\alpha_L, \alpha_H, \alpha_K, \alpha_M\}$ are the cost shares of respective input in the value of product. Given that the Census reports labor, material and fuel costs but not capital rent, the constant returns to scale assumption assigns $(1 - \alpha_L - \alpha_H - \alpha_M)$ to capital.

A well-known problem in the index method is that it ignores adjustment costs. A remedy to this problem is to average shares over time or over establishments. Given this chapter's research goal which focuses on cross-sectional difference, a reasonable approach it to use the average cost shares of establishments in each product group. What matters is to group establishments having similar main products. The standard 6-digit SIC provides a reference (passenger cars and specialty vehicles 371101, truck and tractor trucks 371102, and bus and other large specialty vehicles 3171104). Corresponding with the SIC system, I defined groups by the highest-share product as follows: 1) passenger cars 2) trucks 3) public conveyance and others. More detail in categorizing products is explained in the Appendix.

Table 2.2 reports the average cost shares by category in 1929. I use the average shares of broadly defined categories in computing the TFP of establishments in each category. The table also shows that there exists technological heterogeneity even within each category. While expensive passenger cars require more labor to produce than cheap passenger cars do, light trucks use more non-production labor than heavy trucks. Specialty vehicles use less materials but more labor. The last row reports the cost shares of highly diversified establishments that have two or more products, each accounting for more than 30 percent of their revenue. Most of these establishments have a combination of either passenger cars and trucks or trucks, parts and accessories as their main products. It seems that they are not very different from average cheap passenger car producers and heavy truck producers, so multi-product characteristics would not matter much in productivity estimation.

For factor input, I use the best possible input measures. For example, for labor I use the average work week (wage-earner months times average working hours per week of an individual worker) and for capital I use the horsepower capacity of power equipment times the number of days in operation to reflect different utilization ratio. See the Appendix for details of measuring inputs.

One of the toughest challenges in estimating plant-level productivity using Census data from this period is that the Censuses between 1919 and 1937 did not record capital stock or investment. Using horsepower capacity as a proxy for capital input is a reasonable choice given that physical input, rather than the value of capital stock estimated from the investments made each year, would be an ideal measure of capital service. Previous studies have used similar approaches. Bresnahan and Raff (1996) use installed horsepower per wage-earner month as a proxy for the capital intensity of mass production system. An industry-level study by Inklaar et al. (2011) used the same measure as a proxy for capital input.

Once the TFP of establishments is computed, I take the deviation from the average of each product category (so passenger cars, trucks and others) to make them comparable across establishments. Figure 2.1 presents the kernel density of revenue-based and quantity-based TFP of each main product category in 1929. The distributions center around zero, because productivity is reported in log terms and demeaned. It is noteworthy that the distribution of passenger car producers is somewhat bimodal and physical productivity has large dispersion, as it implies heterogeneity in business model and production technology.

2.4.2. Was Establishment Size in 1929 Correlated with Productivity?

The first empirical question is about the correlation between productivity and size in 1929. Figure 2.2 illustrates the relationship in 1929, a year less affected by the Great Depression. I consider two measures of size: employment and by capital stock, and both revenue and physical productivity. Strikingly, no meaningful relationship is found between size and productivity, though crude correlation coefficients indicate a weak positive relationship between productivity and employment and a weak negative relationship between productivity and capital stock.

This pattern is in line with previous findings. The capital stock reflects the accumulated effects of past productivity, while TFPR (revenue-base total factor productivity) and TFPQ (quantity-base total factor productivity) reflect current productivity. Figure 2.2 shows that they were “orthogonal” on the eve of the Great Depression, as found in other industry studies.[6] It also suggests that both higher revenue productivity and a larger capital stock had positive effects on survival, though capital stock seems to be more important. Interestingly, these patterns almost vanish when establishment size is measured by 1929 employment. As standard economic models assume, employment may be more variable than other inputs such as capital stock and materials. While the difference in the implied relationship between size and survival may reflect differences in capital intensity, it also suggests that employment and capital stock carry different meanings for establishment size.

2.4.3. Determinants of Survival: Revenue, Physical Productivity or Size?

To examine the determinants of survival systematically, I use a standard econometric specification to regress the outcome in year *t* on the characteristics in year *t-1* (Foster, Grim, and Haltiwanger 2013; Foster, Haltiwanger, and Syverson 2008). I modify the specification to test how well productivity and other factors in 1929 predict the survival through the Depression, to 1933, the trough year. Specifically, I estimate the following equation for $t = 1933$.

$$\boldsymbol{Y_{i,t} = \alpha + \beta A_{i,1929} + \gamma K_{i,1929} + X'_{i,1929}\Theta + \varepsilon_{i,t}} \qquad (2)$$

$$\boldsymbol{Y_{i,t}} = \begin{cases} \mathbf{0}, & \text{if establishment } i \text{ closes before year } t \\ \mathbf{1}, & \text{if establishment } i \text{ survives to year } t \end{cases}$$

$A_{i,1929}$ is productivity in 1929, normalized as the deviation from the industry-wide or product-wide average in that year. $K_{i,1929}$ is the capital stock of establishment *i* in 1929. $X_{i,1929}$ is a set of control variables in 1929, such as the main product and location that are supposed to capture product-wide or regional shocks. The coefficients of interest are β and γ.

[6] Foster, Haltiwanger and Syverson (2008) explains that “the TFP, price, and demand coefficients in the specifications that include capital, capture the shorter-run survival effects that are orthogonal to those embodied in the plant's capital stock.”

I conduct a pair-wise analysis between 1929 and other years rather than pool all years and exploit the changes between every two years. I do this for several reasons. Most of all, it is conceptually the best specification to test the cleansing effect of recessions. Because the industry hit the bottom in 1933 among the census years, 1931 is too early and 1935 is too late to observe the effect. Using indicators in 1931 and 1933 is also problematic. Suppose that there were two establishments in 1929 and one of them closed in 1932 because of its low profitability. A pair-wise analysis of 1929 and 1933 will conclude that the Great Depression was cleansing. However, a pooled analysis may not reach the same conclusion because both establishments with high and low profitability survived between 1929 and 1931.Table 2.1 shows that most of passenger car producers exited between 1931 and 1933. Moreover, the mid-Depression indicators are not free from possible distortions such as labor hoarding and later interventions, such as the National Recovery Administration (NRA).[7] These can mask the true productivity of auto establishments, and 1929 is the least contaminated year. Finally, using 1929 productivity allows to connect the production technology to establishment dynamics. As productivity and technological choice are basically unobservable, they must be inferred from observed characteristics. 1929 is the best year to observe these characteristics, because establishments operated during the Great Depression under the legacy of long-term strategic decisions made in normal times.

A possible concern in using characteristics in a single year as predictors is that the 1929 outcomes could have been just a result of a productivity “surprise” or transient errors. Empirical studies have found that productivity rankings are highly persistent (Syverson 2011), so if an establishment is above the average in one year, it is very likely to be above the average again in the next year. Moreover, even if transient errors caused some reversal of productivity, it would not change the general pattern observed in Figure 2.2 and the empirical analysis below.

[7] Economists have long been concerned about the distortion. See Bernanke and Parkinson (1991), who offer the labor hoarding as an explanation of pro-cyclical productivity during the Great Depression.

For the estimation of equation 2, I employ a linear probability model because the interpretation is straightforward - the coefficients are close to the average marginal effects. Moreover, adding fixed effects does not bias estimates while doing so in the probit or logit model does. For these reasons, Angrist and Pischke (2008) defend the use of the linear probability model in most uses unless the estimated parameters are of a structural probit or logit model. I have also estimated a logit model, and the results are qualitatively the same. Because I use the linear probability model, I report heteroskedasticity-robust errors.

Table 2.3 presents summary statistics. It can be seen that logged productivities, ln(TFPR) and ln(TFPQ) are normalized to zero, and Davis, Haltiwanger and Schuh (1996)'s measure of employment change has the lower bound of negative two.

Table 2.4 presents the empirical results of survival analysis. Columns 1 to 6 report the results for all establishments. The results suggest that the Great Depression was cleansing in the automotive industry, because column 1 and 4 show that revenue-based TFP predicts survival to 1933. Because the standard deviation of ln(TFPR) is 0.345, increasing revenue TFP by one standard deviation increases the probability of survival to 1933 by 11.2 percentage points in the fullest specification in column 4. Foster, Haltiwanger and Syverson (2008) consider ln(TFPR) as a combination of ln(TFPQ) and demand-side factors, such as price and idiosyncratic demand shocks. They isolate the effects of the two variables by including both on the right-hand side of the equation. I replicate their analysis in a modified way, because price and demand shocks have different meanings in the auto industry, where products are differentiated strategically. Therefore, I include the main product dummies in columns 3, 6, 9 and 12. Quantity-based physical productivity also predicts survival when product-specific shocks are controlled by including main product dummies (columns 3 and 6). Yet the coefficients for ln(TFPQ) are much smaller than those for ln(TFPR). This is expected result, because market selection rewards high profitability that is reflected in high ln(TFPR). Technical efficiency, reflected in ln(TFPQ), maybe a necessary condition for survival but not a sufficient condition.[8]

Columns 1 to 6 seem to confirm Bresnahan and Raff (1991)'s claim that the Great Depression was cleansing in the automotive industry. However, columns 7 to 12 find no evidence that the Great Depression was cleansing in the passenger car market, the most important segment. Recall that the passenger car producers account for only a third in number but three quarters in output. The results show that not ln(TFPR) but capital stock in 1929 is a powerful predictor of survival in the passenger car segment. A one-standard-deviation increase in the 1929 capital stock increases the probability of survival by 33 to 39 percentage points. Considering that about 39 percent of passenger car producers exited between 1929 and 1933, capital stock explains most of survival in the passenger car market. This strongly suggests that the Great Depression was not cleansing.

The importance of capital stock in all establishments also strengthens the argument that the Great Depression was not cleansing. Even when all establishments are considered, capital stock has much greater explanatory power. In column 4, One-standard-deviation increase in ln(TFPR) increased the probability of survival by about 11 percentage points but an increase of the same magnitude increases the probability by 16.5 percentage points. It is surprising that most of passenger car producers' survival and more than half of all producers' survival is explained by capital stock or establishment size.

Economic literature usually interprets capital stock embodying the establishment's accumulated profits and success. An establishment with larger size would not have made an exit decision even if it had lower revenue productivity if it believed that it was only transitory. However, the auto industry suffered not only from an unusual demand shock but also from a unusual financial distress. It is reasonable to consider establishment size a good indicator of

[8] It is noteworthy that expensive car producers had better chance to survive. Compared to establishments making primarily cheap cars under $1,000 in 1929. This looks somewhat surprising, but there are observations that during serious recessions, like the recent recession in 2007, the decline in consumption is deeper in lower income classes than in upper classes as shown in Cynamon and Fazzari (2014). This may be a reason why luxury car producers were more likely to survive, with everything else equal.

credit access. The next section is devoted to explaining this puzzle. Before moving to the next section, I conduct another test of the cleansing hypothesis in the next subsection.

2.4.4. Reallocation Patterns and Implications for Employment Dynamics

Another way to test the cleansing effect of recessions is examining input allocations. The pace and degree of reallocation is usually measured by net employment growth, the sum of job creation and destruction defined by Davis, Haltiwanger and Schuh (1996, DHS henceforth). Their measures have been widely used to study the characteristics of labor demand, that is, what kind of establishments create or destroy jobs. For reallocation analysis, I use DHS's measure for establishment-level employment change as defined below.

$$g_{i,t} = \frac{(E_{i,t} - E_{i,1929})}{(E_{i,t} + E_{i,1929})/2} = \frac{2(E_{i,t} - E_{i,1929})}{(E_{i,t} + E_{i,1929})} \quad (3)$$

$E_{i,t}$ denotes wage earner-months, the size of employment, at establishment *i* in year *t*. Note that the measure is the job growth rate normalized by the average employment between year *t* and 1929, $(E_{i,t} + E_{i,1929})/2$. An advantage of this measure is that one can assign values to exiting and entering establishments, making it possible to address both margins. If an establishment entered between 1929 and year *t*, the value of $g_{i,t}$ is equal to 2 because $E_{i,1929} = 0$. If an establishment closes between 1929 and year *t*, $g_{i,t}$ is equal to -2 because $E_{i,t} = 0$.

The reallocation pattern can be examined by estimating the equation below.

$$g_{i,t} = \alpha + \beta A_{i,1929} + \gamma E_{i,1929} + X'_{i,1929}\Theta + \varepsilon_{i,1929} \quad (4)$$

Here, note that the change between 1929 and year *t* is regressed on establishment characteristics in year *t*. For establishment size, I use employment instead of capital stock because I look at reallocation of labor and need to control for the baseline effect.

Panel A of Table 2.5 reports regression results parallel to the results Table 2.4, testing the cleansing effect of the Great Depression. The results confirm the conclusion from Panel A that the Depression was not cleansing in the passenger car segment. A positive and significant coefficient for productivity indicates that establishments that were more productive in 1929 destroyed fewer jobs in the contraction period, 1929 to 1933.[9] Columns 1 to 6 indicate that revenue-based TFP in 1929 predicts employment changes, even after controlling for employment size in the baseline year. However, columns 7 to 12 show that it was not the case for passenger car producers. The results in Table 2.5 demonstrates the close link between employment and industry dynamics. Factors of establishment exit also affected employment changes. In the passenger car market, establishment size determined survival and job destruction. In other market segments, revenue-based productivity determined both.

I found no evidence of reallocation towards more productive establishments in the passenger car segment from a reallocation analysis that incorporates both channels of employment change, plant closure (extensive margin) and employment adjustment within continuing plants (intensive margin). However, it is possible that some low-productivity establishments chose to continue with minimizing excess employment. If the number of such establishments was large, the extensive margin may dominate the intensive margin. To test if this was the case, I conduct a reallocation analysis only for establishments in 1929 continuing to 1933. However, Panel B of Table 2.5 presents no evidence for cleansing effects. Foster, Grim and Haltiwanger (2013) suggest that most postwar recessions were cleansing except the Great Recession. My results suggest that the lack of cleansing effects in both recessions is driven by problems in the financial sector.

2.5. Explaining the Puzzle

2.5.1. Managerial Decisions of Multi-plant Firms

[9] Of course, some establishments actually increased employment in this period. 13 and 7 establishments increased employment in 1929-31 and 1929-33, respectively.

One of the keys to the puzzle that TFP does not predict survival in the passenger car market is the different behavior of multi-plant and single-plant firms. It has long been acknowledged that multi-plant firms may have different decision-making criteria from single-plant firms. Financial economists would understand this as a difference in the operation of "internal capital markets." There are opposing views on what might explain such a difference. On the one hand, firms may reallocate resources to increase overall productivity. Stein (1997) constructs a model in which corporate headquarters allocate resources across branches in a "winner-picking" way. A number of empirical studies, such as Maksimovic et al. (2002) and Giroud and Mueller (2012), provide supporting evidence that firms take resources from less productive or less important divisions rather than subsidize them. On the other hand, firm headquarters often work to insulate the branches' financial distress by pooling financial resources of firms. Shin and Stulz (1998) and Ziebarth (2014a) find that investment and employment of diversified or multi-plant firms are less sensitive to financial conditions. Likewise, Matvos and Seru (2014) find that weaker divisions receive too much capital, as if they are more productive than they are, suggesting a firm-level distortion of what Caballero and Hammour (2000) suggest at the macro level.

I test whether single-plant firms behaved differently from multi-plant firms, and Ford behaved differently from other multi-plant firms. I analyze the Ford observations separately because it was different from any other multi-plant firms. They had 33 plants and closed half of them. GM, Chrysler, and others had a smaller number of plants in 1929 but kept most of them. This fact suggests that survival analysis alone does not capture the way multi-plant firms reallocate resources when they do so by adjusting employment rather than closing plants. Therefore, I do both survival and reallocation analyses.

Analysis results in Table 2.6 support the view that multi-plant firms differ from the market in selecting establishments to close (Panel A) and reallocating resources between establishments (Panel B). In Panel A, Columns 1 to 3 show that the market selected single-plant firms based on revenue-based productivity, demand-side factors and establishment size, indicating cleansing effect among them. Establishment size, a proxy for firm size, has a significant and positive effect on survival, indicating a credit crunch among smaller firms. In contrast, columns 4 to 9 find no meaningful determinants of plant closure among multi-plant firms. Extending the analysis to all passenger car and truck producers does not change the results, because most multi-plant firms were passenger car makers.

Panel B reports the results of reallocation analysis, incorporating both extensive (survival) and intensive (employment adjustment) margins. Reported standard errors clustered at the firm level. Columns 1 to 3 show that revenue productivity in 1929 does not predict the employment changes of small firms between 1929 and 1933. While many of less productive establishments destroyed jobs by closing (so employment change = -2), surviving high-productivity establishments also destroyed as many jobs. This explains why productivity in 1929 does not predict the employment change in overall. In contrast, firm size, represented by establishment size for single-plant firms, is again a powerful predictor of employment change. Columns 4 to 9 confirm that multi-plant firms' reallocation did not depend on revenue productivity. These results support the hypothesis that firms insulate weak units from external shocks rather than weed out the weaker units as market competition does. Ford's behavior is different again from other multi-plant firms because their decision to close or continue a plant depended on establishment size.

A natural question is why multi-plant firms behaved differently. It is possible to say that these large, multi-plant firms may have reallocated resources by long-term strategic factors that cannot be measured by TFP. This may explain the cases of GM and Chrysler because each plant of these firms specialized in different types of vehicles, such as the Buick-only plant and the Cadillac-only plant of GM. When the product allocation was made according to their broader business plan, productivity alone would not have been a powerful factor of closing or layoff decision. But this explanation does not explain the case of Ford, because all but one plants produced the same vehicle – either Model A or the V8, Ford's cheap car models. Hence there was little variation in the strategic value of plants to consider in closing decision.[10] What is more, columns 4 to 9 of Panel B show that Ford adjusted employment according to plant size rather than productivity.

There are a few possible explanations for the different behavior of Ford. Business historians have suggested that Ford had a tradition of "anti-planning," which clearly contrasts to GM's systematic management based on carefully formulated strategy (Kuhn 1986). Ford eliminated the central office in the 1920s and had no systems of coordination and control. Henry Ford "persisted in trying to control the company, although his efforts increasingly became mere capricious interference" (Rae 1965). Most research on Ford Motor Company and biographies about Ford discuss the issue of management style in terms of product strategy. However, it is not hard to imagine that Ford had similar problems in planning and operating production. Another possible explanation is that the family ownership prevented the management of Ford from being checked by market discipline. Ford remained a family firm until 1956, when it became public. In contrast, the two other notable multi-plant firms, GM and Chrysler, had been public for long and separated ownership and management from the early years of their histories. It would have caused them to be sensitive to profitability and productivity. At the same time, Ford suffered from internal power struggles between Ford's sons and managers that plagued firm operation. Ford's plant closing behavior might also have been related to geography. Appendix Table A1 shows that plants in Southern states and Western states were more likely to close.

My results suggest that the lack of cleansing effect is largely driven by the different behavior of multi-plant firms. While the market selected more productive establishments, firm management, at least those at Ford, did not necessarily do so. It is perhaps because firm management allocate resources in the way of better serving long-term strategic goals, and such capability may not be captured by productivity or size. Therefore, one needs to separate out resource reallocation by the market and the firm. It is also necessary to understand better

[10] One may consider the distance from the firm headquarter as an indicator of strategic value. But the distance variable was not statistically significant when included in the regressions for Ford plants as an explanatory variable.

how firms with more complex organizational structure respond to aggregate changes.

2.5.2. Credit Constraints of Small Single-plant Firms

The results in Table 2.6 also indicate that the survival of single-plant firms was strongly affected by their firm size in 1929, represented by the establishment size. There exists a vast literature showing that small firms are financially constrained that the constraint often limits the survival and growth possibility of able firms. Mach and Wolken (2012) find that credit constraints and credit access are the most important factors predicting the exit of the small enterprises from 2004 to 2008. The disproportionate effect on small firms is more pronounced during the serious downturn from 2007 to 2009. Şahin, Kitao, Cororaton and Laiu (2011) argue that while credit constraints are an important factor, weak demand, poor sales, and uncertainty were more important reasons for exit (based on the self-reports of business owners).[11] However, they do find that small businesses find it hard to borrow and invest. Although they do not find that credit standards were even tighter for smaller firms (from their survey of loan officers), their results do not contradict the previous finding that smaller firms suffer from financial constraints. As explained in Section 4, firm size is considered a measure of accumulated productivity and profit. When financial institutions become more risk-averse, it is reasonable to make decisions based on the past success.

Proving the link between size and credit access directly during the Great Depression period is difficult with available data. While there exist information sources of auto firms' financial status, they also have selection problems; only large and surviving firms report their operating and financial statements. Given this limitation, I review recent findings and provide some descriptive evidence for why the financial constraint hypothesis seems plausible for the auto industry.

[11] They analyze the Business Employment Dynamics (BED) data, covering all private sector industries.

By 1926 investments of automobile firms depended largely on the retained earnings (Seltzer 1928). According to the estimates of Mercer and Morgan (1972), retained earnings explain about 11-21 percent of new investment during the five years before the Great Depression. This changed dramatically during the Great Depression, with declines in retained earnings reducing investment in 1931 and 1932 and funding about 5-14 percent in the rest of 1930s (Figure 2.3).[12] The abrupt decline in this ratio reflects both overall tight credit and the exit of auto firms with heavy reliance on retained earnings.

Hunter (1982) analyzes the statistics of Internal Revenue Service to find that the largest one percent firms were raising liquidity ratio (cash-to-receipts ratio) in the 1930s while smaller firms saw the ratio falling, indicating that they were in a credit crunch.[13] She attributes this phenomenon to selective credit rationing in the banking system. Combining these two findings, it is reasonable to think that small firms faced exceptionally intense credit constraints in the auto industry.

Recent studies using firm-level information, such as Graham, Hazarika and Narasimhan (2011), also support this view. They collect balance-sheet information for several industrial firms from *Moody's Investment Manual* and *Capital Changes Reporter* series and analyze, finding that firms with high leverage ratio, low operating profit, low credit rating and high investment in 1928 were more likely to be "distressed" during 1930-1938.[14] They also report that firm size is correlated positively with operating profit and negatively with leverage (total debt to total assets) for the 1928 data. Therefore, it is not a stretch to suggest a negative relationship between firm size and financial constraints.[15]

[12] She emphasizes that the ratio represents the lower bound.

[13] Her study covers all non-financial corporations that reported to the IRS.

[14] They define a firm is distressed "if the firm files for bankruptcy, liquidates, undertakes a court-ordered reorganization, recapitalizes… or is taken over".

[15] However, a study on the experience of the 2008 recession claim that survey response is a better measure of financial constraints than traditional measures including firm size (Campello, Graham, and Harvey 2010). Although it is possible that the link has changed throughout time, numerous empirical studies still find meaningful differences

To summarize, the lack of a cleansing effect in the passenger car market can be well explained by two factors: the difference of multi-plant firms, particularly Ford, in resource allocation and credit constraints of single-plant firms as implied by the firm size effect.

2.6. How Mass Production Techniques "Diffused" during the Great Depression

Auto establishments in 1929 differed not only in size and productivity but also in production technology. The historical literature including Piore and Sabel (1984), Scranton (2000), and Nye (2013) has pointed that mass production did not dominate auto establishments before the Great Depression. Craft production, a production mode employed by producers who pursued specialty and customization to satisfy specific consumer tastes, was not a "sideshow" (Nye 2013). Economists Bresnahan and Raff (1996) agree with this view, claiming that small producers would have maintained their position in the industry had the Great Depression not hit them unexpectedly. Their characterization suggests a clearly different interpretation of the phenomenon from the creative destruction thesis that establishments with outdated technology exit because they are less competitive. Why did small producers disappear from the scene? Given the historical significance of mass production techniques, there exists surprisingly too few quantitative studies on its efficiency. In this section, I offer a rough sketch of technological changes.

2.6.1. Defining Characters of Mass Production Techniques

An ideal approach to assess the effect of a certain production technology is to identify the choice of business units and estimate cross-sectional productivity differences. However, this is extremely difficult because production technology is essentially unobservable. For this

in credit access and constraints between small and large firms.

reason, economists employ various strategies to classify technology. Sometimes survey questions allow them to identify technological choices (Collard-Wexler and De Loecker 2014).[16] Identifying technology for the auto industry is even harder because production technology choice is closely related to the strategic choice of products. Van Biesebroeck (2003) is one of the few papers analyzing the transition from mass production to lean production in the postwar period American automobile industry. He "estimates" the choice of production technology by setting up a structural model and using the maximum-likelihood method.[17] This requires a proper parametrization of underlying technology class, but there is troublesome to find historically relevant identifiers of technology.[18] Given this imperfection in identifying production technology, I choose to verify historical observations quantitatively instead of estimating the choice econometrically.

Panel A of Table 2.7 summarizes the main features of the two production techniques based on the observations of Womack et al. (1990) and Nye (2013).[19] Mass production techniques were employed to produce and sell cheap cars. To produce cars at lower cost, scale economies were required.[20] To realize scale economies, car designs had to be standardized and frozen, and production tasks had to be divided and assigned to special-

[16] They use a questionnaire in the census asking production method to study the emergence of minimills in the steel industry. However, because the information is available only for the most recent three census years, they rely on material use to identify production technology.

[17] In other words, he tries to jointly infer the underlying distribution of labor productivity generated by each technology and technology choice which is parametrized with relevant variables.

[18] He uses only car dummy, truck dummy, Japanese dummy, and time.

[19] Nye provides an excellent summary of the main features of the assembly line. To him, Ford's ingenuity is how he integrated several factors of early assembly line into an efficient production system. He lists what defined Ford's assembly line: 1) subdivision of labor 2) interchangeable parts 3) single-function machines 4) machines grouped by the sequence of work 5) automatic movement of parts and sub-assemblies 6) electrification that improved precision and the predictability of parts (individual motors were necessary to run machines at a uniform speed) 7) standardization and freezing of car design.

[20] Nye finds the revolutionary feature of mass production from this "linking production and consumption". Ford's five dollars a day was not only the result of high productivity, but also a mean to broaden the set of potential buyers. With this statement, he makes it clear that the choice of production technology is closely tied to business strategy.

purpose machines to make the work flow continuous. In contrast, traditional craft production techniques are employed to produce high-quality cars or cars with various designs, but at the expense of physical labor productivity. Because the production process requires flexibility, plants employing these techniques rely on skilled blue collar workers and general-purpose machines. Top management communicated directly with the workers on the production line, unlike at GM and Ford.

How well do data confirm these qualitative characterizations? Panel B lists some representative plants and their characteristics. I use the plants of Ford, GM, and Chrysler as a reference group here for the illustrative purpose, because they were leaders in employing mass production techniques. In general, mass production plants engaged primarily in cheap car (under $1,000) production, but this alone does not represent the business goal that leads to choosing mass production. Note that Studebaker is often described at the other end of mass production, though it produced cheap cars (1995), and the production of Cadillac and Lincoln was under the mass production philosophy though they were luxury brands of GM and Ford. Therefore, it is a useful but noisy indicator. The number of vehicles (quantity) and the number of models (variety) produced seem to be promising indicators of mass production, but still they do not explain the Studebaker case well.[21] Looking for indicators of technology, I turn my eyes to average monthly earnings of production workers as a measure of skill content and nonproduction-production worker ratio as a measure of managerial intensity. I find a pattern that workers of luxury car makers get paid more in

[21] While most information is obtained from the census, this is from the dataset compiled by Raff and Trajtenberg (1997) and matched to each assembly plant using outside sources. The dataset is publicly available at the ICPSR, No. 31762, "Hedonic Quality-Adjusted Price Indices for the American Automobile Industry, 1906-1941". Their dataset contains the technical specifications of most passenger car models produced from 1906 to 1940 from the periodicals *Automotive Industries* and *Motor*. They checked the data against the 1985 edition of Kimes and Clark (1996) and found that they cover most of makes and models produced in the country. The variables in the dataset include wheelbase, body type, the type of engine and horsepower for each make, which differentiates models of the same make.

It should be noted that while auto *firms* such as Ford and GM had various brands and models, their establishments usually produced only one make and limited number of models, two at the maximum. For example, Chevrolet establishments did not produce Pontiacs or Cadillacs but different models of Chevrolet.

general but there is too much variation (Stutz and Gardner makes expensive cars but pay less) to confirm this as a uniform pattern. Similarly, it is hard to draw a general pattern regarding the nonproduction-production worker ratio from the Panel B of Table 2.7. Packard, an obvious craft firm, is low in the ratio while Duesenberg and Gardner are high. GM, Ford, and Chrysler also show much difference within the group. In sum, actual figures in the pre-Depression period do not fit in the stylized facts of Panel A. The only consistent indicators of mass production seem to be the number of models and the number of vehicles. Based on these observations, I perform a simple test to determine what components of mass production actually increased productivity.

2.6.2. What Components Mattered

I regress log of TFPR and TFPQ on the identified components of mass production techniques to find the source of productivity advantage. Table 2.8 reports the results. Columns 1 to 6 show that all the components, so reduced variety, larger production volume (large batch), low wage (supposedly low human capital) production labor and higher management intensity, affect productivity in expected ways. Higher coefficients in the TFPQ than TFPR equations mean that these components of mass production contribute to physical productivity, but also revenue productivity via the economies of scale.

Not all the results hold once the sample is narrowed to cheap car producers (average passenger car price under $1,000), leaving the number of models and management intensity the only significant variables (Columns 7-12). This implies that the low productivity of expensive car producers can be partly attributed to the lack of scale economies and low skill labor. To gain such productivity, the firm needs to increase capacity and substitute low-skilled for high-skilled labor. This would mean shifting the focus of production from expensive cars to cheap cars, which requires related switching costs. Standardization and management intensity had positive effects on productivity in any case. Product variety increased not only physical productivity but also revenue productivity in this period.[22]

Mass production was a better technology in terms of revenue-based productivity. While large size is often considered a crucial part of mass production method and may be a necessary condition, it was not the sufficient condition for higher productivity; standardization and more intense management were required. Combined with the empirical results in Section 4, one can reason that mass production establishments were likely to more survive mainly because they were large rather than because they were more productive. But continuing large craft establishments also made efforts to increase productivity by reducing the number of models offered. For example, Hudson Motor produced two models in 1935. Studebaker and Stutz produced three and two respectively. At the same time, they also implemented required investment by modernizing equipment, increasing capital intensity and improving management. Of course, financial constraints would have limited such investment. This is how mass production techniques "diffused."[23]

2.7. Conclusion

This chapter has examined the automotive industry during the Great Depression to determine how the downturn of 1929-33 accelerated the process of creative destruction. An

[22] It is interesting to see the comeback of flexibility about half a century later. When the American automakers dwindled in face of the challenges from the Japanese side equipped with lean production or "just-in-time" in the 1970s, economists found the strength of the Japanese carmakers from the flexibility and human capital of workers who can achieve flexible production. However, the lean production system in the 1970s was not the extreme opposite of the Ford system like the craft production techniques that we discuss here. It was built on the mass production system.

[23] This contrasts with long-run technological shift to a better technology and its effects on aggregate productivity growth, which have been relatively well studied: Van Biesebroeck (2003) on the shift to lean production in the automobile industry and Collard-Wexler and De Loecker (2014) on the emergence of minimills in the steel industry, are good examples. Both papers study three to four decades since the 1960s. Although both papers did not look at the role of credit constraint in the transition to a better technology, this problem should be more pronounced in the times of financial distress.

analysis of the whole sample gives an impression that the Depression was cleansing in this industry, as Bresnahan and Raff (1991) observed. However, an analysis focused on passenger car producers that account for most of output and employment, provides no evidence of cleansing effects of the Depression. I find that revenue-based TFP does not predict survival of passenger car producers. At the same time, establishment size has greater explanatory power even in the full sample.

I find the reasons from two factors. First, the selection and reallocation behavior of multi-plant firms differed from the market process. While the survival of single-plant firms is explained by revenue-based TFP and establishment size, neither explain the survival of multi-plant firms. The management of multi-plant firms would have made the decisions based on firm-wide strategic goals rather than currently observed productivity. Second, the importance of firm size of single-plant firms in their survival indicates that limited credit would have constrained their survival and employment, which is in line with contemporary evidence.

This chapter leaves room for improvement and development. My argument about the impact of credit constraint on small firms relies on the findings of other studies rather than causal evidence. I collected financial statements of auto firms collected by the National Recovery Administration and housed at the National Archives, but the data do not record any information on closed firms. I will need to refer to other sources, such as *Moody's Investment Manual* and *Capital Changes Reporter* series. The Ford case also invites further research. Surprisingly, I found no previous research or records explaining how the Ford management changed their production organization. Archival work may help finding the economic or managerial motives behind Ford's decisions. Finally, there are various aspects of how the Great Depression affected firms and the industry yet to be examined. For example, financial distress would have constrained the ability to pay sunk costs required to launch new models. In the auto industry, product is another important margin of reallocation. It is possible that large firms could have afforded the cost, running ahead of other competitors in the race towards more efficient and attractive cars. Revealing these underlying mechanisms will broaden our understanding of how a large aggregate shock changes the microstructure of industries.

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Figures

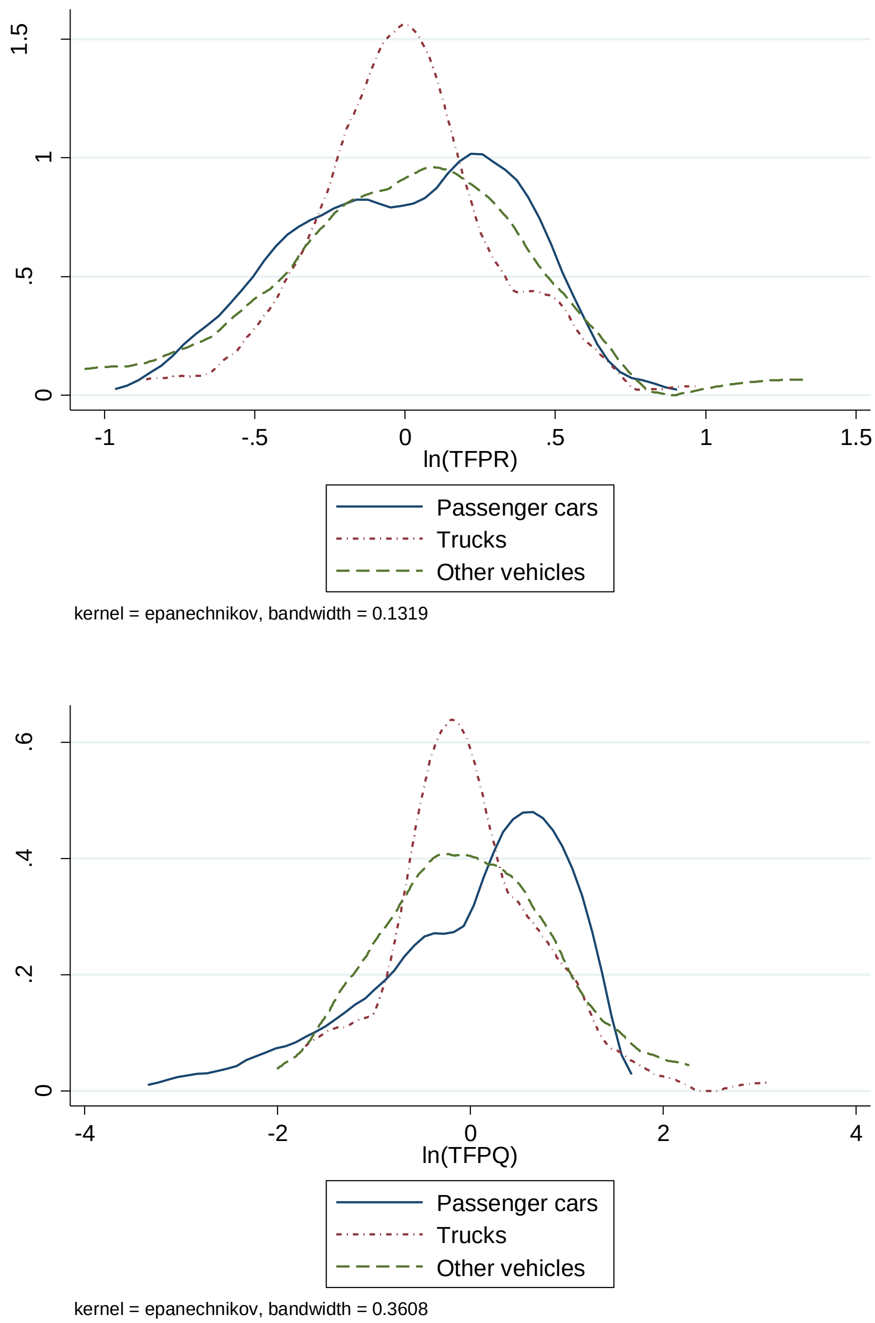


Figure 2.1. – Distribution of Revenue-based and Quantity-based TFP in 1929

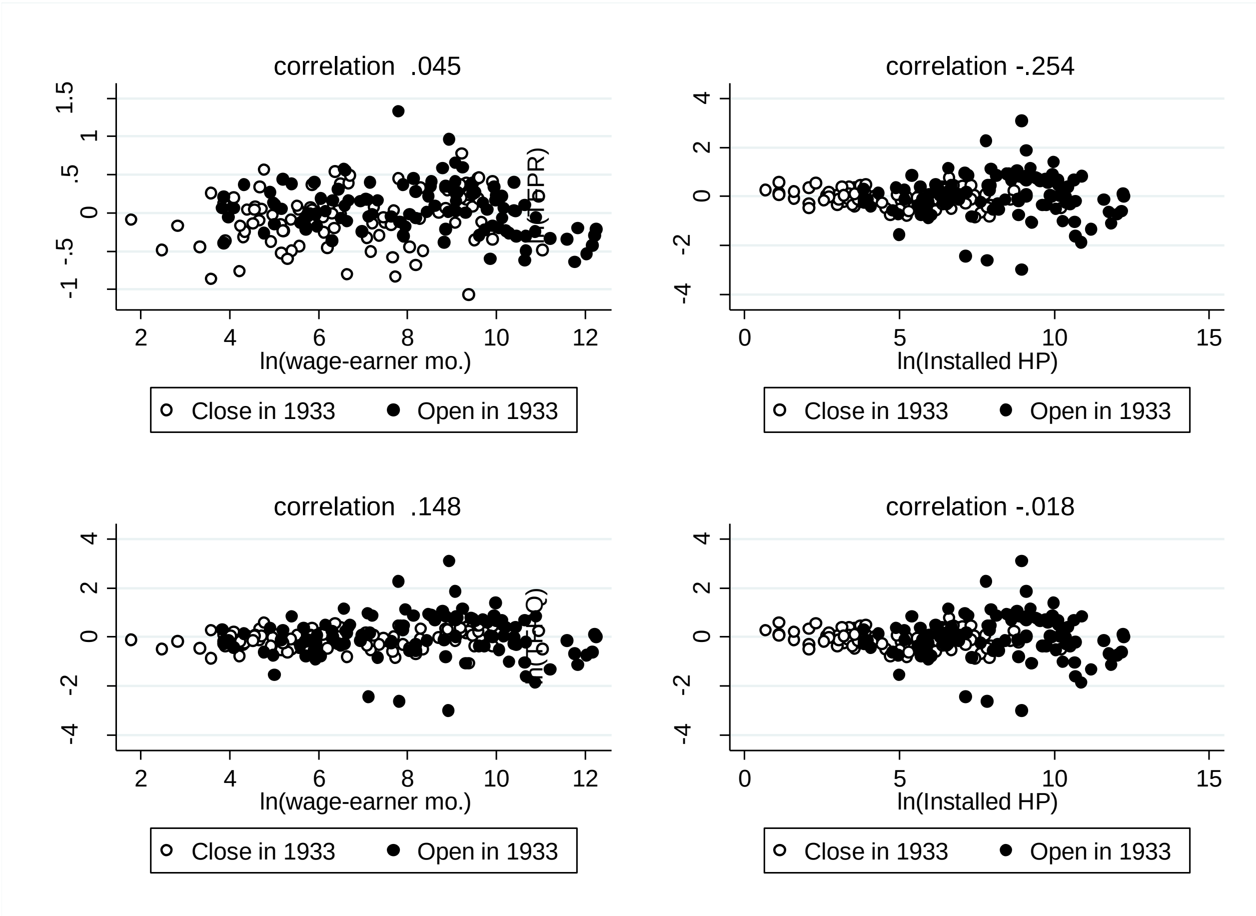
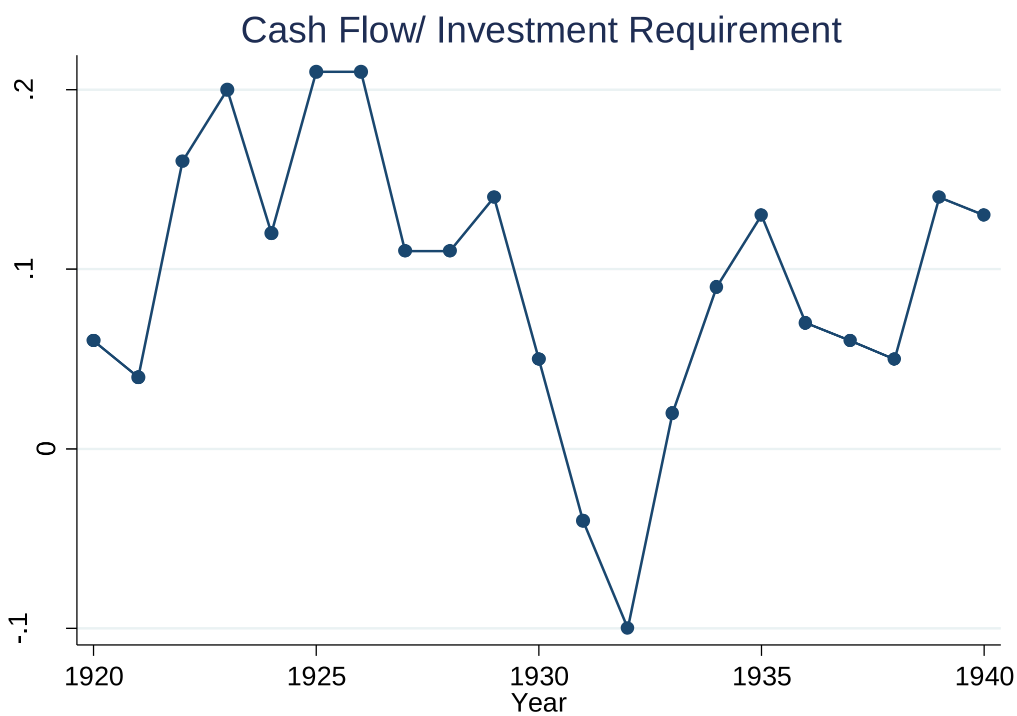


Figure 2.2 – Relationship between Productivity and Size in 1929 and Survival



Source: Mercer and Morgan (1972)

Figure 2.3 – Cash Flow-Investment Requirement Ratio

Tables

Table 2.1 – Overview of the Motor Vehicle Industry, 1929 to 1935

Year	1929	1931	1933	1935
A. Industry Aggregates				
Number of firms	145	118	84	79
Number of establishments	211	180	122	121
Entry, between year t-2 and year t	11**	14	6	18
Exit, between year t-2 and year t		45	64	19
Value of Products ($ mil)**	3,710	1,570	1,160	2,380
Wage-earner months (thousands)**	2,695.8	1,615.8	1,174.5	1,764.8
B. Share of Multi-plant Firms				
Number of establishments	38.4%	41.7%	38.5%	42.1%
Value of Products	80.2%	86.9%	89.7%	90.3%
Wage-earner months	74.1%	77.5%	78.7%	79.7%
C. Number of Establishments by Main Product* **				
Passenger cars	83	76	51	52
Cheap car makers (average price < $1,000)	63	64	42	47
Expensive car makers (average price >=$1,000)	20	12	9	5
Light trucks (< 1t)	8	3	5	0
Heavy trucks (>= 1t)	93	73	41	40
Public conveyance	10	10	6	7
Other vehicles	17	18	19	21
D. Percentage Distribution of Industry Total Revenue by Products				
Passenger cars	76	71	69	74
Cheap car makers (average price < $1,000)	63	64	65	72
Expensive car makers (average price >=$1,000)	13	7	4	2
Light trucks (< 1t)	2	2	3	4
Heavy trucks (>= 1t)	13	12	10	11
Public conveyance	2	2	2	2
Other vehicles	0	1	0	0
Parts and Accessories	8	12	15	10
E. Percentage change in Employment				
Aggrege change in wage-earner months bewteen year t-2 and year t		-40.0	-27.3	50.2
Decomposition				
New esetablishments (including re-opening)		9.1	1.5	11.7
Establishment closure		-20.4	-44.9	-2.5
Continuing estblishments		-28.7	16.1	41.0

Sources: Computed from the Census of Manufactures, 1929, 31, 33 and 35.

* Value of products and value added in nominal value.

** The 1929 census asked if the establishment is new. 11 establishments answered "yes".

*** Product having the largest share in an establishment.

Table 2.2 - Average Cost Shares by Category in 1929

	Obs.	Production Labor	Non-production Labor	Materials/ fuels/ energy	Capital (residual)
All	**211**	**0.098**	**0.022**	**0.646**	**0.235**
Group by the highest-share product					
Passenger Cars	**83**	**0.099**	**0.019**	**0.646**	**0.236**
Cheap Passenger Cars	63	0.091	0.016	0.655	0.238
Expensive Passenger Cars	18	0.141	0.033	0.599	0.227
Trucks	**111**	**0.092**	**0.039**	**0.645**	**0.223**
Heavy Trucks	93	0.091	0.039	0.655	0.216
Light Trucks	8	0.108	0.083	0.607	0.202
Others	**27**	**0.132**	**0.060**	**0.514**	**0.294**
Public Conveyances	10	0.111	0.037	0.543	0.309
Other Specialty Vehicles	17	0.186	0.118	0.440	0.256
Diversified establishments (two ore more products having +30% revenue share)	44	0.092	0.029	0.610	0.270

Table 2.3 - Summary Statistics

Variable	Obs	Mean	St. Dev	Min	Max
ln(TFPR) in 1929	208	0.000	0.345	-1.067	1.327
ln(TFPQ) in 1929	208	0.000	0.877	-2.986	3.079
ln(wage earner-months)	210	7.493	2.270	1.792	12.249
ln(installed horsepower)	209	5.835	2.409	0.693	11.493
Part of multi-establishment firm in 1929	211	0.289	0.454	0	1
Open in 1931	211	0.787	0.411	0	1
Open in 1933	211	0.507	0.501	0	1
Open in 1935	211	0.464	0.500	0	1
Employmeng change of continuing establishments*					
1929-31	211	-0.803	0.743	-2.000	1.823
1929-33	211	-1.359	0.748	-2.000	0.731
1929-35	211	-1.227	0.942	-2.000	1.052
Total Obsevations	634				

* Davis, Haltiwanger and Schuh (1996)'s measure

Table 2.4 - Determinants of Survival: Linear Probability Model

Dependent variable: =1 if survive to 1933, =0 otherwise

	All establishments						Passenger car producers					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ln(TFPR)	0.204*			0.325**			-0.163			0.224		
	(0.0924)			(0.0884)			(0.160)			(0.144)		
ln(TFPQ)		0.0199	0.0772+		0.0226	0.0876*		-0.0879+	-0.0850		-0.0644	0.0390
		(0.0397)	(0.0447)		(0.0376)	(0.0421)		(0.0524)	(0.0857)		(0.0525)	(0.0850)
Expensive car			0.294+			0.350**			0.00833			0.292+
			(0.149)			(0.125)			(0.204)			(0.151)
Heavy truck			0.0384			0.319**						
			(0.0858)			(0.0919)						
Light truck			-0.371*			0.0237						
			(0.147)			(0.164)						
Other specialty vehicles			0.285*			0.575**						
			(0.133)			(0.126)						
Public Conveyance			0.0505			0.278						
			(0.158)			(0.197)						
ln(Installed HP)				0.0684**	0.0567**	0.0884**				0.166**	0.139**	0.153**
				(0.0127)	(0.0125)	(0.0162)				(0.0269)	(0.0229)	(0.0231)
Constant	0.514**	0.514**	0.459**	0.114	0.182*	-0.235+	0.530**	0.530**	0.528**	-0.747**	-0.543**	-0.720**
	(0.0345)	(0.0348)	(0.0677)	(0.0823)	(0.0826)	(0.139)	(0.0551)	(0.0546)	(0.0736)	(0.215)	(0.186)	(0.199)
Observations	208	208	208	208	208	208	83	83	83	83	83	83

All explanatory variables are of 1929. Excluded main product category is cheap passenger cars. Constants are not reported.

Heteroskedasticity-robust standard errors in parentheses

+ p<0.1 * p<0.05 ** p<0.01

Table 2.5 -Patterns of Job Reallocation

Dependent Variable: Net Employment Change between 1929 and 1933

A. Both Exiting and Continuing Establishments

	All establishments						Passenger car producers					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ln(TFPR)	0.377*		0.355*		0.391**		-0.0177		0.0873		0.240	
	(0.149)		(0.145)		(0.144)		(0.244)		(0.231)		(0.253)	
ln(TFPQ)		0.0827		0.0539		0.0861		-0.00479		-0.0449		0.0748
		(0.0593)		(0.0585)		(0.0686)		(0.0892)		(0.0844)		(0.134)
ln(wage earner-mo.s)			0.0760**	0.0754**	0.149**	0.144**			0.214**	0.215**	0.240**	0.228**
			(0.0222)	(0.0227)	(0.0306)	(0.0317)			(0.0617)	(0.0617)	(0.0641)	(0.0626)
Constant	-1.350**	-1.350**	-1.922**	-1.917**	-2.836**	-2.796**	-1.359**	-1.359**	-3.376**	-3.389**	-3.702**	-3.596**
	(0.0513)	(0.0519)	(0.174)	(0.178)	(0.306)	(0.312)	(0.0860)	(0.0860)	(0.588)	(0.588)	(0.627)	(0.614)
Main Product Dummies	No	No	No	No	Yes	Yes	No	No	No	No	Yes	Yes
Observations	208	208	208	208	208	208	83	83	83	83	83	83

B. Continuing Establishments Only

	All establishments						Passenger car producers					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ln(TFPR)	0.262		0.250		0.219		0.389		0.584		0.527	
	(0.166)		(0.172)		(0.185)		(0.307)		(0.379)		(0.410)	
ln(TFPQ)		0.107+		0.108+		0.0973		0.170+		0.170+		0.253
		(0.0601)		(0.0603)		(0.0799)		(0.0969)		(0.0982)		(0.158)
ln(wage earner-mo.s)			-0.00765	-0.0171	0.000828	-0.0146			0.0950	0.00592	0.0824	0.0178
			(0.0257)	(0.0249)	(0.0366)	(0.0371)			(0.108)	(0.0869)	(0.113)	(0.0892)
Constant	-0.749**	-0.740**	-0.686**	-0.600**	-0.742+	-0.618	-0.776**	-0.764**	-1.720	-0.824	-1.568	-1.000
	(0.0545)	(0.0538)	(0.219)	(0.211)	(0.383)	(0.383)	(0.102)	(0.100)	(1.075)	(0.875)	(1.154)	(0.919)
Main Product Dummies	No	No	No	No	Yes	Yes	No	No	No	No	Yes	Yes
Observations	107	107	107	107	107	107	44	44	44	44	44	44

All explanatory variables are of 1929. Excluded main product category is cheap passenger cars. Constants are not reported.

Standard errors in parentheses

+ p<0.1 * p<0.05 ** p<0.01

Table 2.6 - Did Multi-Plant Firms Reallocate Resources in a Different Way from the Market?

A. Survival Analysis

	Dependent variable: =1 if survive to 1933, =0 otherwise								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Single-plant			Non-Ford Multi-plant			Ford only		
ln(TFPR)	0.784**			0.136			0.0760		
	(0.208)			(0.523)			(0.764)		
ln(TFPQ)		-0.164+	0.190		0.0354	0.526		-0.143	-0.240
		(0.0924)	(0.130)		(0.125)	(0.395)		(0.0893)	(0.775)
Avg. price \$1,001~\$2,000			0.263			0.483			
			(0.184)			(0.320)			
Avg. price \$2,001~\$3,000			1.205**			0.835			-0.236
			(0.315)			(0.587)			(1.817)
ln(Installed HP)	0.179**	0.160**	0.211**	0.0532	0.0345	0.215	0.199	0.151+	0.137
	(0.0264)	(0.0301)	(0.0275)	(0.107)	(0.0662)	(0.136)	(0.161)	(0.0888)	(0.129)
Observations	28	28	28	22	22	22	33	33	33

B. Reallocation Patterns (Exit + Continuing Establishments)

	Dependent Variable: Net Employment Change between 1929 and 1933								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Single-plant			Non-Ford Multi-plant			Ford only		
ln(TFPR)	0.326			0.448			-0.574		
	(0.301)			(1.145)			(0.444)		
ln(TFPQ)		-0.234*	-0.0567		0.296	0.707		0.0176	-0.774
		(0.0872)	(0.143)		(0.352)	(1.001)		(0.224)	(0.492)
Avg. price \$1,001~\$2,000			0.231			1.140			
			(0.202)			(0.709)			
Avg. price \$2,001~\$3,000			0.535			0.580			-2.387+
			(0.348)			(1.231)			(1.332)
ln(wage earner-mo.s)	0.123*	0.172**	0.172**	0.0138	0.0425	0.232	0.450*	0.553**	0.526**
	(0.0484)	(0.0466)	(0.0462)	(0.468)	(0.285)	(0.601)	(0.178)	(0.190)	(0.184)
Observations	28	28	28	22	22	22	33	33	33

All explanatory variables are of 1929. Excluded main product category is cheap passenger cars. Constants are not reported.

Heteroskedasticity-robust standard errors, in parentheses, , are clustered at the firm level in columns 4-6 and 13-15.

+ p<0.1 * p<0.05 ** p<0.01

Table 2.7 - Mass and Craft Production Techniques

A. Historical Observations

Production Techniques	**Type of Vehicle**	**Specific Factors**	**Organizational structure**
Mass Production	Cheap, standardized cars	Specialized machines	Centralized administrative structure
	Moderate-quality cars	Unskilled workforce	Continuous process
	High volume		
Craft Production	Various designs	General-purpose machines	Decentralized
	High-quality cars	Skilled workforce	
	Low volume (< 1,000) and small batches		

Source: Womack et al. (1990), Nye (2013)

B. Examples: "Big Three" and other notable plants in 1929

Firm	Establishment	Avg. Passenger Car Price	No. of Models Produced	No. Vehicles Produced	Avg. Monthly Earnings of production workers($)	Avg. Nonproduction -production worker ratio
"Big Three"						
GM	Chevrolet Motor Company of California	468	1	90,010	1597.12	0.34
	Chevrolet Motor Co. of Michigan - Assembly Plant	463	1	92,291	1465.63	0.42
	Buick Motor Company	928	3	195,990	1812.05	0.12
	Cadillac Motor Car Company, Division of General M	2,062	2	36,616	1793.78	0.15
Ford	Ford Motor Company - Rouge	437	1	116,465	1578.00	0.01
	Ford Motor Company - Charlotte, North Carolina	484	1	40,947	1423.98	0.05
	Lincoln Motor Company	3,718	1	7,665	1773.45	0.02
Chrysler	Plymouth - Mt. Elliot Plant	512	2	94,429	1475.30	0.07
	Dodge Main	839	2	124,681	1819.52	0.09
	Auburn Automobile Company	1,200	3	23,297	1175.99	0.36
	Cleveland Peerless	963	4	10,370	1653.35	0.18
	Duesenberg Inc of Indiana	8,875	1	162	1747.21	0.34
	Durant Motor Company of California	659	4	15,117	1373.84	0.25
	Elcar Motor Company	966	4	1,194	1282.61	0.13
	F.B. Stearns Co.	1,904	4	1,310	1940.14	0.17
	The Gardner Motor Co Inc	1,064	3	2,203	1227.52	0.32
	Graham-Paige Motors Corporation	792	5	76,905	1904.39	0.20
	Hudson Motor Car Company	634	3	300,783	1807.70	0.07
	Hupp Motor Car Corporation	1,073	2	34,307	1770.64	0.22
	The Nash Motors Company	949	3	31,597	1509.20	0.10
	Packard Motor Car Company	1,994	4	47,827	1731.17	0.08
	Rolls-Royce of America, Inc.	13,386	2	338	1546.54	0.06
	The Studebaker Corporation	938	4	91,922	1518.29	0.07
	Stutz Motor Car Co of America, Inc.	2,407	3	4,060	1355.73	0.10
	Willys-Overland Pacific Company, Assembly Plant	626	2	8,038	1301.44	0.14

Table 2.8 - Sources of Productivity Advantage

All Passenger Car Producers	ln(TFPR)			ln(TFPQ)		
	(1)	(2)	(3)	(4)	(5)	(6)
ln(No. models)	-0.380**	-0.388**	-0.407**	-0.664**	-0.702**	-0.715**
	(0.0578)	(0.0567)	(0.0571)	(0.125)	(0.109)	(0.124)
ln(No. vehicles)	0.0332+	0.0393*	0.0406*	0.293**	0.322**	0.307**
	(0.0173)	(0.0172)	(0.0171)	(0.0374)	(0.0331)	(0.0371)
ln(monthly earnings)		-0.252*			-1.167**	
		(0.119)			(0.229)	
Nonproduction/ production workers			0.437*			0.838*
			(0.177)			(0.385)
Constant	-0.164	1.613+	-0.293	-2.648**	5.586**	-2.894**
	(0.188)	(0.862)	(0.189)	(0.405)	(1.657)	(0.412)
Observations	82	82	82	82	82	82
R-squared	0.425	0.456	0.467	0.607	0.705	0.630
Average price under $1,000 only	ln(TFPR)			ln(TFPQ)		
	(7)	(8)	(9)	(10)	(11)	(12)
ln(No. models)	-0.443**	-0.444**	-0.477**	-0.782**	-0.782**	-0.823**
	(0.0654)	(0.0660)	(0.0644)	(0.0876)	(0.0885)	(0.0871)
ln(No. vehicles)	-0.0186	-0.0215	-0.00952	0.00906	0.0120	0.0200
	(0.0311)	(0.0431)	(0.0302)	(0.0417)	(0.0578)	(0.0409)
ln(monthly earnings)		0.0171			-0.0172	
		(0.174)			(0.234)	
Nonproduction/ production workers			0.423*			0.510*
			(0.175)			(0.237)
Constant	0.426	0.333	0.281	0.592	0.685	0.418
	(0.345)	(1.009)	(0.337)	(0.462)	(1.352)	(0.456)
Observations	63	63	63	63	63	63
R-squared	0.449	0.449	0.498	0.601	0.601	0.630

Standard errors in parentheses
+ p<0.1 * p<0.05 ** p<0.01

Appendix

A.1. Categorizing Products

The automotive industry consists of various types of vehicles, from passenger cars to street-cleaning cars, and a number of establishments produced multiple products, which makes it necessary to adjust product mix. This task requires a proper categorization. The census recorded the quantity and value for several vehicle types, as can be seen in "9. Products" of the 1929 census (Appendix Figure 1) for example. Categorization differs by census year. For example, ambulances, fire-department apparatus, patrol wagons and street-cleaning cars constituted the "government vehicles" category in 1929 but became part of the "commercial-type vehicles" category in 1935. To deal with this consistency issue, I regroup census product categories as below[1]:

1. Passenger cars (including chassis)
2. Light trucks (less than one tonnage; including chassis)
3. Heavy truck (one ton and higher tonnage; including chassis)
4. Public conveyances: buses and taxis
5. All other vehicles: street cleaning cars, ambulances, hearses, tractors and fire engines
6. Parts, bodies and accessories

I do further segmentation for the passenger car category, incorporating Bresnahan and Raff

[1] An ideal categorization will have each group consisting of relatively homogeneous products. A standard categorization uses the SIC code system, as Bernard and Schott (2010) use five-digit SIC categories as "products" to analyze product switching of all manufacturing firms. However, applying their method will result in just one category and using six-digit SIC categories will end up with three broad categories. "Automobile assembly, including specialty automobiles (371101)" which includes passenger cars, hearses, patrol wagons and taxicabs and all trucks, "truck and tractor truck assembly (371102)" and "bus and other large specialty vehicle assembly (37110)." My categorization is close to using eight-digit SIC categories, each category represents a technically different type of vehicles. For the SIC categories, see http://www.naics.com/standard-industrial-code-divisions/?code=37.

(1996)'s observation that these two ends of passenger cars were different in many aspects: targeted consumers, price-cost margin, the degree of competition and so on. Using their line of demarcation, I classify every establishment producing passenger cars as either a cheap car producer, if the average price of passenger cars is below $1,000, or an expensive car producer if it is $1,000 or above.[2]. This is consistent with how trade journal *Automotive Industry* grouped passenger cars.

A.2.Measurement of Output and Inputs

Output. I use two different variables for y_i to differentiate revenue and physical productivity. For revenue productivity, I use the total revenue. For physical productivity, I use total number of vehicles and passenger car/ truck chassis produced.

Labor. I use directly observed physical inputs of wage earners (production workers) and the average weekly working hours. Labor input is measured by (wage-earner months X 4 X average working hours per week of an individual worker) for all observation years, with the exception of 1933 when we observe total man-hour directly but no average working hours per week).Using the hours of operation per week can lead to miscalculation, because a few establishments ran night shift. If an establishment runs two shifts and the average working hours per week is 80 hours, an employed worker actually works 40 hours on average.

Capital. Many researchers have lamented the absence of capital measures in the census around this time, both in quantity and value, and have tried to find a proxy for capital. Individual industry forms report relevant information on equipment (but not structures), installed horsepower of prime movers and electric motors. This information can be found in

[2] In 1929 dollars. Prices are deflated by the year-around average CPI index. Alternatively, one may use the distribution of the price of passenger cars in intervals at each establishment, which can be found in the Inquiry 9-o in the Appendix Figure 1. This way might be better in dealing with establishments that were committed to both product types, producing both cheap and expensive passenger cars. Willys-Overland was one of the examples. However, such cases were rare and most establishments mostly engaged in either product type; simplifying the setting using the average passenger car price balances well between complexity and parsimony.

the "power equipment" section of the censuses of 1929 and 1935.[3] I measure capital input by (installed horsepower X (% days in operation)).

I find corroborating evidence in a booklet from the Ford archive records, which lists the values of capital investments by category in selected establishments.[4] They are in general proportional to the installed horsepower in 1929 and 1935, as can be seen in Appendix Table 2.

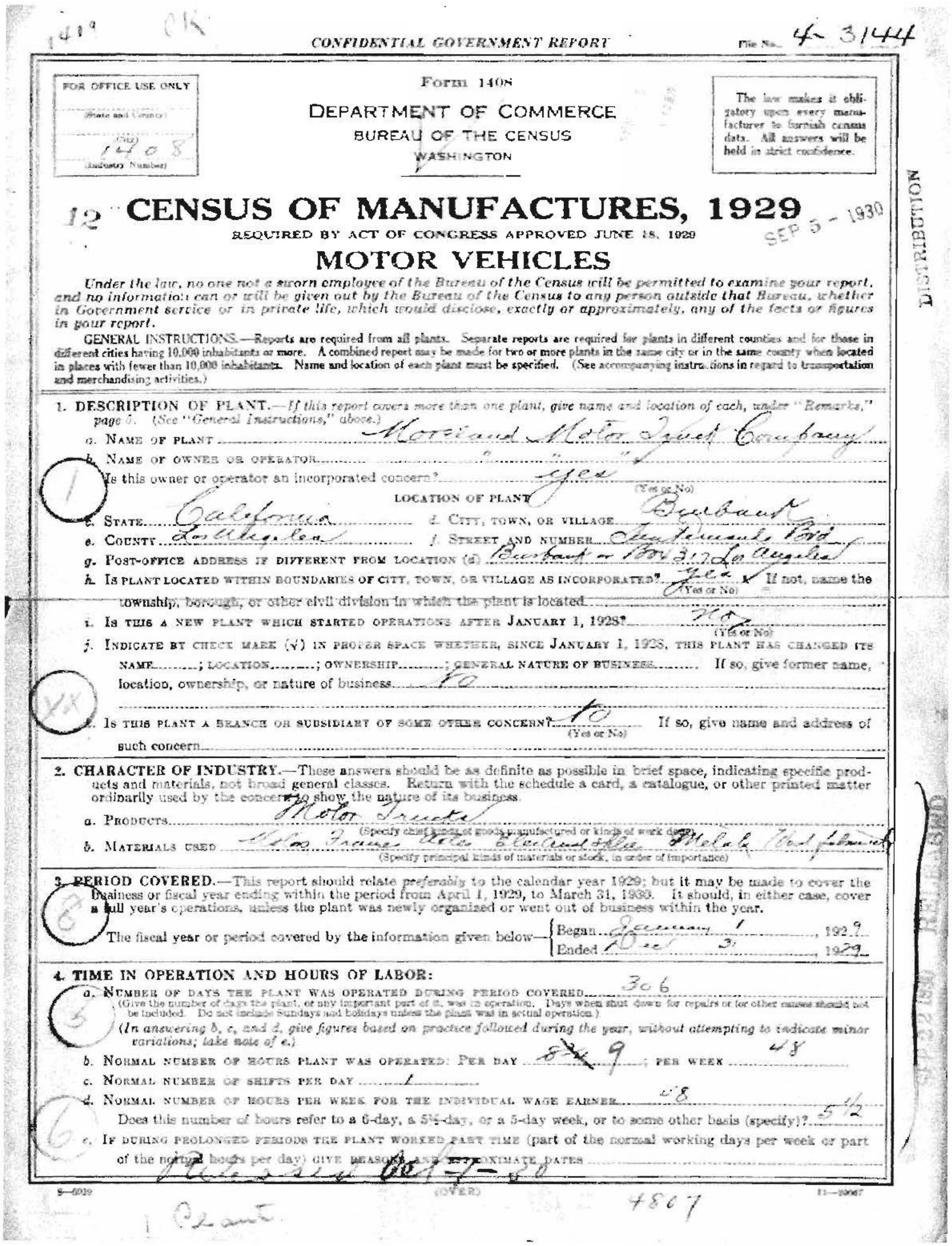
Intermediate Input An issue in measuring intermediate input is how to reflect the differences in input mix across establishments. There are three broad categories in intermediate input: materials, fuel, and electricity. The 1929 and 1935 censuses asked the quantity and cost of each input while 1931 and 1933 censuses simply asked the total costs of all. Appendix Table 3 shows that there is little variation in the shares across establishments and most of costs come from materials in both 1929 and 1935 – so input mix was stable. Moreover, fuel and electricity accounts for less than two percent of the total cost of intermediate inputs.[5]

[3] For prime movers, total horsepower of standby equipment is available. In a number of establishments the rated capacity of prime movers was not fully utilized, so there is a possibility that varying utilization rates cause mismeasurement. For example, the Minneapolis establishment of Ford Motors had 14,000 of 32,340 horsepower from prime movers idle. However for most establishments horsepower from electric motors exceeded that from prime movers, and the utilization rate was over 90 percent both in 1929 and 1935. Any possible correction for utilization rate is left for future work.

[4] Ford Archives, Accession No. 696 Box 11. This is a collection of photographs of selected domestic and foreign establishments, taken in 1934 or 1935. Statistics on the back of pictures.

[5] One might consider even different materials mix between establishments. From more detailed information on the use of chief materials available in 1929 and 1935, it appears that establishment had different material mix - while some establishments used iron and steel heavily, other establishments used more coppers. However, this information is too inconsistent to address heterogeneous material use, as many establishments did not report. I find that "iron and steel bars, sheets, plates, and shapes" and "rubber tires" are the most important inputs, and expect this fact justifies using the sheets price as a representative price indicator.

Appendix Figures



CONFIDENTIAL GOVERNMENT REPORT — File No. 4-3144

FOR OFFICE USE ONLY
(State and County)
(City)
1408
(Industry Number)

Form 1408

DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS
WASHINGTON

The law makes it obligatory upon every manufacturer to furnish census data. All answers will be held in strict confidence.

12 **CENSUS OF MANUFACTURES, 1929** SEP 5 - 1930

REQUIRED BY ACT OF CONGRESS APPROVED JUNE 18, 1929

MOTOR VEHICLES

DISTRIBUTION

Under the law, no one not a sworn employee of the Bureau of the Census will be permitted to examine your report, and no information can or will be given out by the Bureau of the Census to any person outside that Bureau, whether in Government service or in private life, which would disclose, exactly or approximately, any of the facts or figures in your report.

GENERAL INSTRUCTIONS.—Reports are required from all plants. Separate reports are required for plants in different counties and for those in different cities having 10,000 inhabitants or more. A combined report may be made for two or more plants in the same city or in the same county when located in places with fewer than 10,000 inhabitants. Name and location of each plant must be specified. (See accompanying instructions in regard to transportation and merchandising activities.)

1. DESCRIPTION OF PLANT.—*If this report covers more than one plant, give name and location of each, under "Remarks," page 5. (See "General Instructions," above.)*
   - a. NAME OF PLANT: Moreland Motor Truck Company
   - b. NAME OF OWNER OR OPERATOR: " " "
   - Is this owner or operator an incorporated concern? Yes (Yes or No)

   LOCATION OF PLANT
   - c. STATE: California
   - d. CITY, TOWN, OR VILLAGE: Burbank
   - e. COUNTY: Los Angeles
   - f. STREET AND NUMBER
   - g. POST-OFFICE ADDRESS IF DIFFERENT FROM LOCATION (d)
   - h. IS PLANT LOCATED WITHIN BOUNDARIES OF CITY, TOWN, OR VILLAGE AS INCORPORATED? Yes (Yes or No) If not, name the township, borough, or other civil division in which the plant is located
   - i. IS THIS A NEW PLANT WHICH STARTED OPERATIONS AFTER JANUARY 1, 1928? No (Yes or No)
   - j. INDICATE BY CHECK MARK (√) IN PROPER SPACE WHETHER, SINCE JANUARY 1, 1928, THIS PLANT HAS CHANGED ITS NAME ......; LOCATION ......; OWNERSHIP ......; GENERAL NATURE OF BUSINESS ...... If so, give former name, location, ownership, or nature of business: No
   - k. IS THIS PLANT A BRANCH OR SUBSIDIARY OF SOME OTHER CONCERN? No (Yes or No) If so, give name and address of such concern

2. CHARACTER OF INDUSTRY.—These answers should be as definite as possible in brief space, indicating specific products and materials, not broad general classes. Return with the schedule a card, a catalogue, or other printed matter ordinarily used by the concern to show the nature of its business.
   - a. PRODUCTS: Motor Trucks (Specify chief kinds of goods manufactured or kinds of work done)
   - b. MATERIALS USED (Specify principal kinds of materials or stock, in order of importance)

3. PERIOD COVERED.—This report should relate *preferably* to the calendar year 1929; but it may be made to cover the business or fiscal year ending within the period from April 1, 1929, to March 31, 1930. It should, in either case, cover a full year's operations, unless the plant was newly organized or went out of business within the year.

   The fiscal year or period covered by the information given below— Began January 1, 1929 / Ended Dec 31, 1929

4. TIME IN OPERATION AND HOURS OF LABOR:
   - a. NUMBER OF DAYS THE PLANT WAS OPERATED DURING PERIOD COVERED: 306
     (Give the number of days the plant, or any important part of it, was in operation. Days when shut down for repairs or for other causes should not be included. Do not include Sundays and holidays unless the plant was in actual operation.)

     (In answering b, c, and d, give figures based on practice followed during the year, without attempting to indicate minor variations; take note of e.)
   - b. NORMAL NUMBER OF HOURS PLANT WAS OPERATED: PER DAY 9; PER WEEK 48
   - c. NORMAL NUMBER OF SHIFTS PER DAY: 1
   - d. NORMAL NUMBER OF HOURS PER WEEK FOR THE INDIVIDUAL WAGE EARNER: 48
     Does this number of hours refer to a 6-day, a 5½-day, or a 5-day week, or to some other basis (specify)? 5½
   - e. IF DURING PROLONGED PERIODS THE PLANT WORKED PART TIME (part of the normal working days per week or part of the normal hours per day) GIVE REASONS AND APPROXIMATE DATES

9—6019 (OVER) 11—10067

4807

Figure A.1 - Sample Census Schedule (continued in next pages)

5. **PERSONS ENGAGED.**—Number December 14, 1929, as per pay roll. If this was not a representative day, give data for the nearest representative or normal day, stating here what date is used. **Do not count the same person twice under different headings.**

	Male	Female
a. Proprietor or firm members (not applicable to incorporated companies)		
Salaried employees as follows:		
b. Principal officers of corporations (Do not include directors unless holding other offices on salary)	2	
c. Managers, superintendents, and other responsible administrative employees; foremen and overseers who devote all or the greater part of their time to supervisory duties; clerks, stenographers, bookkeepers, and other clerical employees on salary (Do not include foremen and overseers in minor positions; see 5-*d*)	45	17
Total salaried employees (sum of *b* and *c*) 64	47	17
d. Wage earners—Report skilled and unskilled workers of all classes, including engineers, firemen, watchmen, packers, etc.; also foremen and overseers in minor positions who perform work similar to that done by the employees under their supervision. Include pieceworkers employed in the plant covered by this report, but do not include persons working in other plants on materials furnished by your establishment	130	

6. **WAGE EARNERS EMPLOYED, BY MONTHS.**—Give number on pay roll for week which included 15th day of month, if this was a normal week. If not, give number for a normal week. (Follow instructions under Inquiry 5-*d* as to who are to be included.) Figures given in this inquiry should relate to *calendar year 1929*. If remainder of report refers to some other period, give under "Remarks" (p. 5) figures for those months in 1928 or 1930 which fall within that period. (See Inquiry 3.) 2055

Jan. 177	Feb. 170	Mar. 180	Apr. 179	May 186	June 195
July 190	Aug. 178	Sept. 165	Oct. 158	Nov. 157	Dec. 130

7. **SALARIES AND WAGES.**—Amounts paid during the period covered by this report. Include bonuses or percentages of profits when paid either to officers and salaried employees or to wage earners.

a. Total amount of salaries of principal officers of corporations (see Inquiry 5-*b*) $ 24000.

b. Total amount of salaries of managers, superintendents, and other responsible administrative employees; foremen and overseers; clerks, stenographers, bookkeepers, and other clerical employees on salary (see Inquiry 5-*c*) $ 156547

c. Total amount paid to wage earners, as defined under Inquiry 5-*d* 180547 $ 275296.

Aggregate of salaries and wages (sum of items *a*, *b*, and *c*) $455843

8. **MATERIALS, FUEL, AND ELECTRIC CURRENT.**—The items entered below should relate *preferably* to the amounts of materials, fuel, and electric current *actually used* during the period covered; but if it is impracticable to report materials and fuel on this basis, enter the costs of the amounts purchased during the period. Include freight and haulage costs, but not the cost of haulage performed by the plant's own employees and equipment if practicable to segregate it. Place a check mark (✓) after the word "used" or "purchased," as the case may be, in the space below.

The entries for materials and fuel, as given for this inquiry, refer to the costs of the amounts— Used ____ Purchased ✓

a. Cost of all materials and raw stock actually used (including those transferred from other plants under the same ownership) during the period covered by this report, which entered into the products manufactured. *Do not include cost of mill or shop supplies* $ 1542900 ~~1547899~~

b. Cost of fuel actually used (including that transferred from mines, wells, or plants under the same ownership) during the period covered by this report (total of items in Inquiry 11-*a*) $ 3116.78

c. Cost of purchased electric current (see Inquiry 11-*b*) 17281 $ 14165.74

Total cost of materials, fuel, and electric current (sum of *a*, *b*, and *c*) $1560181.78

9. **PRODUCTS.**—Report the numbers and the net wholesale values **at the factory** of all factory sales to dealers, distributors, branch agencies, and other customers during the period covered, according to the classification below. Do not include products **made** by this establishment and **used** by it in further manufacture.

Kind	Number	Value
a. Passenger vehicles, not including public conveyances:		
1. Open—		
2. Roadsters and runabouts		$
3. Other		$
4. Closed—		
5. Coupes (including convertible)		$
6. 2-door sedans and coaches		$
7. 4-door sedans		$
8. Other closed (landau, broughams, etc.)		$

(Continued on next page)

9. PRODUCTS—Continued.

KIND	NUMBER	VALUE
b. Public conveyances:		
1. Motor busses (including school, sightseeing, and public-utility, etc.)		
2. Under 21 passengers		$
3. 21 to 32 passengers		$
4. 33 passengers and over		$
5. Taxicabs		$
6. Other public conveyances (specify)		$
c. Government (Federal, State, and municipal), etc:		
1. Ambulances		$
2. Fire-department apparatus (specify)		$
		$
3. Patrol wagons		$
4. Street-cleaning apparatus—sprinklers, sweepers, etc. (specify)		
		$
5. All other (specify)		$
		$
d. Commercial vehicles:		
1. Light delivery (less than 1 ton)		$
2. Trucks (1 ton and over)	(659) ~~659~~ [illegible]	$ 1,723,745.00
3. Truck tractors (semi-tractors)		$
4. Hearses and undertakers' wagons		$
5. All other commercial vehicles (specify)		$
		$
e. Trailers and semi-trailers		$
f. Tractors (specify kind):		
1. Road, not including truck tractors (total belt horsepower)		$
2. Farm (total belt horsepower)		$
3. Industrial (total belt horsepower)		$
g. Chassis:		
1. Passenger		$
2. Commercial		$
3. Bus		$
h. Bodies	220	$ 86,335.00
i. Tops		$
j. Speedometers		$
k. Piston rings (for sale)		$
l. Parts and accessories		$ 583,570.00
m. All other products (specify)		$
		$
		$
n. Amount received for custom work and repairing		$
Total value of products		$ 2,393,650.00

o. SUMMARY BY VALUES (use wholesale values)	NUMBER	*p.* SUMMARY BY TONNAGE	NUMBER
Passenger vehicles (Inquiry 9, group *a*):		Delivery wagons and trucks (Inquiry 9, groups *d*-1, *d*-2, *d*-3, and *g*-2):	
Value up to $500		Complete cars and chasses—	
$501 to $750		¾ ton or less	
$751 to $1,000	~~706~~	1 ton	100 ~~400~~
$1,001 to $1,500	~~212~~	Over 1 to 2½ tons, inclusive	267 ~~[illegible]~~
$1,501 to $2,000	~~155~~	3 to 4½ tons, inclusive	136 ~~135~~
$2,001 to $2,500	~~48~~	5 tons	79 ~~44~~
$2,501 to $3,000	~~58~~	Over 5 tons	83 ~~100~~
$3,001 and up	~~478~~		

(Continued on next page)

(6) [illegible]. $ 533,749

9. PRODUCTS—Continued

	Number
g. Summary by body types of commercial vehicles (Inquiry 9, groups *d*-1 and *d*-2):	
Platform (including stake)	349 ~~116~~
Panel (including van)	6 ~~4~~
Express (including screen)	3
Dump	25
Other (specify) *Wrecker, ..., ...*	296 ~~38~~
	720

If the value of the products actually ***manufactured*** during the period covered by this report ***differed by more than 10 per cent*** from that of the products ***shipped or delivered***, give also, in the space indicated, the exact or estimated value, ***based on selling prices f. o. b. factory***, of the products ***manufactured*** (including receipts for contract work and repairing).

Value of products manufactured, $ ....

10. POWER EQUIPMENT.—Give figures for equipment as of the end of the period covered by this report.

Important Note.—The form of this inquiry is different from that previously used, the purpose being to distinguish between active and inactive prime movers and generators. It is desired, at the same time, to obtain a total which shall be comparable with that reported at the 1927 census, when the inquiry called simply for a combined total of "all power equipment in the plant, active and emergency." By "emergency" equipment is meant that which is capable of being put into operation promptly but which is used only in case of breakdown of the active equipment or at rather rare intervals when an exceptional load occurs. Equipment which is regularly used, but not usually on full time, should be classed as active.

	Number	Horsepower
a. Prime movers—total, active and emergency:		
Steam engines		
Steam turbines		
Internal-combustion engines (oil, gas, gasoline, etc.)		
Water wheels and turbines		
Total of above		
Rated horsepower of above equipment which is not ordinarily active (included in "Total of above") Horsepower	x x x x x	x x x x x x x
b. Electric motors driven by purchased current—total, active and emergency	56	595
c. Electric motors driven by current generated in plant—total, active and emergency		
		Kilowatts
d. Electric generators driven by prime movers in the plant (do not include rotary converters or motor-generator sets)—total, active and emergency		
Rated capacity of generators which are not ordinarily active (included in "total, active and emergency") Kilowatts	x x x x x	x x x x x x x

11. FUEL AND ELECTRIC CURRENT:

a. Fuel used (including that transferred from mines, wells, or plants under the same ownership) during the period covered by this report. Include fuel used for all purposes—for power, heat, and light—but do not include oil or gas if none is used except for lighting.

	Unit of quantity	Quantity	Cost delivered at factory
Coal, anthracite	Long ton		$
Coal, bituminous	Short ton		$
Coke	Short ton		$
Fuel oils (including crude oil and gas oils)	Gallon		$
Gasoline and kerosene	Gallon		$
Natural gas	M cu. ft.		$
Manufactured gas	M cu. ft.	[illegible]	$ 3116.85
Total cost			$ 3,116.85

b. Electric current.—(Report current generated or purchased during the year for all uses; but a plant which buys current for lighting *only* should not report it.)

	Kilowatt hours	Cost
Generated in the plant		x x x x x x x
Purchased	1105130	$ 14165.81

TABULATED

12. CONSUMPTION OF CHIEF MATERIALS.—Report the total quantities and the total costs of the specified materials consumed (or purchased; see instructions for Inquiry 8) during the period covered by this report (cost to be included in Inquiry 8-a).

KIND	UNIT OF MEASURE	QUANTITY	COST
Pig iron	Tons	16	$ 463.
Iron and steel scrap, purchased as such	Tons	38	$ 6100.
Iron castings, purchased as such	Tons		$
Iron and steel forgings, purchased as such	Tons	10	$ 2619.
Iron and steel bars, sheets, plates, and shapes	Tons		$
Copper pigs, bars, and tubing, and brass and bronze, all forms, purchased as such	Pounds	28691	$ 5192
Aluminum pigs, bars, sheets, tubings, and castings, purchased as such	Pounds	11348	$ 7607
Hardwoods	M ft. b. m.	77000	$ 6010
Softwoods	M ft. b. m.	18100	$ 879
Glass	Sq. ft.	14239	$ 7831
Paint, varnish, and lacquer	Gallons	3600	$ 7750
Rubber tires and tubes		x x x x x x x x x	$ 201057
Leather and artificial leather	Sq. yd.	4675	$ 17012
Textile fabrics	Sq. yd.	3767	$ 502

13. DISTRIBUTION OF SALES.—Report below, in the proper spaces, the values (at f. o. b. factory prices) of goods shipped or delivered to customers (or to warehouses on customers' accounts) during the period covered. If exact figures are not available, give the best possible approximations.

	AMOUNT
a. SALES INVOICED TO WHOLESALE ESTABLISHMENTS OF ALL KINDS *not* OWNED OR CONTROLLED BY OR AFFILIATED WITH THIS PLANT	$
b. SALES INVOICED TO BRANCH OR OTHER WHOLESALE ESTABLISHMENTS OWNED OR CONTROLLED BY OR AFFILIATED WITH THIS PLANT	$ 2,164,700.00 ✓
c. SALES INVOICED TO RETAIL ESTABLISHMENTS OF ALL KINDS *not* OWNED OR CONTROLLED BY OR AFFILIATED WITH THIS PLANT	$ 229,250.00 ✓
d. SALES INVOICED TO BRANCH OR OTHER RETAIL ESTABLISHMENTS OWNED OR CONTROLLED BY OR AFFILIATED WITH THIS PLANT	$
e. SALES DIRECT TO INDUSTRIAL AND OTHER LARGE CONSUMERS WHO BUY AT WHOLESALE	$
f. SALES DIRECT TO HOME CONSUMERS (THROUGH FIELD AGENTS OR OTHERWISE)	$
g. Total sales	$ 2,393,950.00 ✓
h. VOLUME OF ABOVE SALES MADE THROUGH MANUFACTURERS' AGENTS, SELLING AGENTS, BROKERS, AND COMMISSION HOUSES	$

THIS IS TO CERTIFY that the information contained in this report is correct and complete to the best of my knowledge and belief, and covers the period from Jany 1 1929, to Dec. 31 1929

E. L. Kostka
(Signature of enumerator)

O. W. Creighton Secy
(Signature and official title of person furnishing the information)

Berkeley California
(Address)

REMARKS:

Appendix Table

Table A.1 Number of Ford Plants Open by State and Year

State	1929	1933	Note
California	2	0	New plant in 1935
Colorado	1	1	
Florida	1	0	
Georgia	1	0	
Iowa	1	0	
Illinois	1	1	
Indiana	1	0	
Kentucky	1	1	
Louisiana	1	0	
Massachusetts	1	1	
Michigan	2	2	
Minnesota	1	0	Reopen in 1935
Missouri	2	1	Reopen in 1935
North Carolina	1	0	
Nebraska	1	0	
New Jersey	1	0	New plant in 1935
New York	1	0	New plant in 1935
Ohio	3	1	
Oklahoma	1	0	
Oregon	1	0	
Pennsylvania	2	1	
Tennessee	1	1	
Texas	2	1	
Virginia	1	1	
Washington	1	0	
Wisconsin	1	0	

CHAPTER 3

Employment Dynamics during the Great Depression:

A Job-Perspective Analysis

3.1. Introduction

Unemployment during the Great Depression is a much studied topic. Scholars have tried to understand what caused unemployment to be so deep and prolonged. Their research has taken the macroeconomic approach, setting a model and fitting aggregate time-series data. Particular attention has been paid to the role of wage rigidity and public policies in delaying adjustment (Bernanke and Carey 1996; Bernanke and Parkinson 1991; Bhattarai, Eggertsson, and Schoenle 2014; Bordo, Erceg, and Evans 2000; Cole and Ohanian 2004; Ohanian, Cole, and Ohanian 2004; Taylor 2011).

In contrast to the development in macro-perspective research, little advance has been made in the micro foundation. Margo (1993) called for more research using disaggregated data two decades ago, yet there is still a dearth of micro-level evidence on unemployment in the early 1930s. Little is known about the source of job destruction, the quality of jobs destroyed, and the source of wage rigidity.

There are a few studies that use micro data to document the characteristics of unemployment in the 1930s. Margo himself (1988, 1991) examines the 1940 census individual sample. He finds that the unemployed workers in 1940 were less educated and had fewer skills on average. He also finds that unemployment was more severe and prolonged among low-wage occupations. However, 1940 is eleven years after the Great Depression broke out. He could not assess the immediate impact of the Depression on employment by analyzing cross-section data for that year, without linking them to earlier censuses. Another line of research that address firm and plant heterogeneity during the Great Depression covers the early 1930s (Bertin, Bresnahan, and Raff 1996; Bresnahan and Raff 1991). These two industry case studies certainly give some implications for how jobs disappeared, because both studies suggest that the Great Depression was cleansing. However, their main interest was to explain industry dynamics rather than to use it to explain the employment changes. Moreover, it is possible that their findings are driven by specific industry effects rather than systematic forces that are common across industries.

This paper conducts exploratory research to fill the knowledge gap. I analyze employment and wage dynamics from the employer's (labor demand) side by taking the *job* perspective of Davis, Haltiwanger and Schuh (1996, DHS henceforth). Their definition of a job is "an employment position filled by a worker." Following this definition, I measure only the number of filled positions, no matter how many positions are unfilled and remain vacant. I do not distinguish jobs by their skill content. They are considered the same job as long as the position is filled by a production worker (or wage earner in census terminology).[1]

The basic observation unit is the plant (or establishment), "a physical location where production takes place." The job flow measure, net employment change, is defined as the rate of change in the number of filled positions (employment) within a plant between two time periods. The DHS framework interprets measured changes as "changes in desired employment levels rather than changes in the stock of unfilled positions," therefore

[1] Like most labor economics literature, DHS distinguish production workers and nonproduction workers (salaried workers) and count these two different types of jobs separately. This is the only distinction in DHS's job approach. In this paper, I focus on production workers only.

employment changes of a plant reflect the changes in the plant's economic condition. This conceptual framework makes it possible to associate measured employment changes with various plant characteristics such as size, wages, and productivity.

For the job flow analysis, I constructed establishment-level longitudinal data for six industries: aircraft, motor vehicles, sugar refining, blast furnace products, and petroleum refining. These data were collected from the original returns of the biennial Census of Manufactures 1929-1935 by Bresnahan and Raff (1990). However, because publicly available datasets were missing several variables and records, I conducted an archival investigation to complete and correct the data. The manuscript records contain rich information enabling me to investigate how employment changes differed by employer characteristics.

This paper provides a number of stylized facts about how employment and wage dynamics are associated with establishment characteristics. First of all, I demonstrate the association of employer size and the margin of job destruction. Smaller establishments were more likely to close, but their job destruction rates were lower conditional on survival. I find this effect across sample industries, suggesting that the Great Depression was not cleansing. Second, large employers account for most of aggregate job destruction and creation. I reach this conclusion by using the 1929 size to avoid the problem caused by the fact that establishments can move up or down size categories. Third, I find that jobs between 1929 and 1933 were destroyed disproportionately among low-paying establishments. However, from 1933 to 1935, job creation was much faster at low-paying establishments. Such higher cyclicality of low-wage jobs contrasts with the findings of contemporary studies. Finally, I find that high-paying establishments cut monthly earnings to greater extents. Because high-paying establishments were less likely to survive than low-paying establishments, I suggest that such compositional changes would have driven observed wage rigidity, if any. In contrast to this finding, I find no evidence of any associations between employer size and the change in earnings.

My paper highlights the importance of establishment heterogeneity in wage and employment behavior across industries, which aggregate data do not show. My findings would help explain "who fared worse" in the face of an aggregate shock and why, from the labor demand side. I begin the paper with a short commentary on the data source and the measurement of employment, hours, and wages. The analysis of employment and wage dynamics follows.

3.2. Data and Measurement

This paper draws on establishment-level information from the original returns of the Census of Manufactures for 1929, 1931, 1933, and 1935. These are the only years for which original records exist and establishment-level information is available.[2] Bresnahan and Raff (1990) digitized part of the data to investigate firm and plant heterogeneity during the Great Depression. One of their goals was to demonstrate that there is considerable within-industry heterogeneity in technology and market power, therefore the "representative firm" paradigm often leads to a wrong interpretation of data. This motivation led them to collect data for a diverse set of industries, in terms of market structure, technology, durability and end users. Industries in their final data include cotton textiles, linoleum, rubber tires, blast furnace products, motor vehicles, and cigarettes.[3]

However, currently, datasets for only two industries (cotton goods and motor vehicles)

[2] Ziebarth (2014) offers an excellent introduction to the Census of Manufactures manuscripts for these years and discusses data quality. He also collected data for a few industries by himself.

[3] NSF Award #9023021. In the proposal report submitted to the NSF, they explain their selection criteria:

"We wanted a group that spanned the range of competitive conditions from roughly perfectly competitive through loose oligopolies through tight ones and dominant firms to the other extreme of virtual monopoly. We wanted a range of technology types represented, from capital-intensive and tightly integrated through labor-intensive and fragmentary. We sought a mix of producer and consumer goods and durables and non-durables. We wanted semi-manufactures and finished goods, and industries that drew their raw materials from a variety of sources. (p.14)" are publicly available, and even these suffer from missing records and variables. I corrected and completed them after some archival work and re-deposited them.[4] The data for this paper include those two and four additional industries: sugar refining, petroleum refining, blast furnace products and aircraft. I obtained spreadsheets containing Bresnahan and Raff's data for sugar, petroleum and blast furnace and digitize part of them to use for the analysis in this paper.[5] On top of this, I added another dataset for the aircraft industry.[6] Table 3.1 gives a summary of these six industries.

Motor vehicle has the largest establishment size and a concentrated market structure, whereas cotton goods has many small producers and a more competitive structure. While cotton goods and sugar refining take agricultural materials and produce relatively homogeneous-goods, motor vehicles and aircraft take industrial materials and make differentiated products. The dataset also encompasses old, low-tech (such as sugar and cotton) and new or high-tech industries (such as motor vehicles and aircraft). The dataset also includes two of the ten largest manufacturing industries in terms of employment (cotton goods and motor vehicles) and represents about 9 percent of all manufacturing employment.

Employment Changes

Key employment and wage variables are measured at the establishment level. For employment changes, Davis, Haltiwanger and Schuh (1996)'s job flow measures are employed. The establishment-level employment growth rate over the two-year interval is

[4] The code for old data is 31761. New data were given codes separately for the cotton textiles (35604) and the auto (35605)

[5] I am very grateful to Margaret Levenstein. She has preserved the original spreadsheets and allowed me to use them. Nicolas Ziebarth gave help entering missing information. Peteroleum refining was not included in the project to the NSF report (Bresnahan and Raff 1990), but the data exist in an incomplete form along with glass, soap, matches and steel works and rolling mills.

[6] I added 1931 and 1933 to Paul Rhode's data for 1929 and 1935. I thank him for sharing his data.

defined as

$$g_{i,t} = \frac{(E_{i,t} - E_{i,t-2})}{(E_{i,t} + E_{i,t-2})/2} = \frac{2(E_{i,t} - E_{i,t-2})}{(E_{i,t} + E_{i,t-2})} \quad (1)$$

where $E_{i,t}$ denotes employment, at establishment *i* in year *t*. This definition assigns two (2) or minus two (-2) to the employment change due to plant opening and closure, instead of the infinity and zero. Job creation is defined as the sum of positive employment changes from all new and expanding establishments and destruction is defined as the sum of negative employment changes from all closing and shrinking establishments.

For employment, I measure the number of salaried workers and wage earners separately. The census counted the number of salaried workers for the whole year and the number of wage earners by month. For the employment of production workers, I sum wage-earner months over the year.

Productivity

To find the relationship between productivity and establishment continuation, I compute labor productivity. Although total factor productivity would be an ideal measure, census schedules in the 1920s and the 1930s did not ask information about capital stock or investment. Because negative value added was common in this period, I calculate gross labor productivity instead. Log of labor productivity is estimated using a Cobb-Douglas production function of total wage earner-months and material and fuel costs for each industry and year. Then I take the deviation for labor productivity. In this way, labor productivity is normalized to zero in each year and industry cell. This allows focusing on within-industry heterogeneity. This research design implies that productivity growth over time is not the main focus of this paper. My interest is to see whether more productive establishments in each industry and each year were more likely to survive and keep jobs.

Wages and Hours

For wages, I calculate the average monthly earnings as below, because the Census of Manufactures asked wage payment for the whole year only, not hourly wages.

$$\text{Average monthly earnings} = \frac{\text{total wage payment}}{\text{(total wage earner months)}} \qquad (2)$$

Average monthly earnings (AME) is an imperfect measure in many ways. It is difficulto to identify whether a change in AME is due to a reduction in working hours or a reduction in hourly wage rates. To obtain wage rate-equivalent earnings measure, it should be divided again by the number of working hours per month.

$$\text{Average hourly earnings} = \frac{\text{average monthly earnings}}{\text{average working hours per month}} \qquad (3)$$

But finding the average working hours per month is challenging because information availability varies with year and respondents often misunderstood or miscoded answers. Appendix Table A1 summarizes census questions asked regarding hours of work. Given the information availability, the most accurate measure of the average working hours per month can be obtained by dividing total man-hours by total wage-earner months. However, man-hours were asked only in 1933 and 1935 and many establishments did not answer this question submitting the simpler "Form B." Another possible measure would be "the number of hours worked by an individual worker per week" multiplied by four and a half. But this question was asked only in 1929 and 1931. The only information that provides good comparability is "normal hours of plant operation per week." But it is not equal to the number of hours an individual worker work on average when the establishment runs multiple shifts, and the number of shifts was asked only in 1929 and 1935. Considering these problems, I use average monthly earnings in my analysis.

The choice of price index affects the calculated level of real wages and thus judgement about wage rigidity during the Great Depression.[7] Past studies have used various deflators. For example, a macro time-series analysis by Bordo, Erceg and Evans (2000) uses GNP deflator, while industry-level studies such as Bernanke and Carey (1996) and Hanes and James (2012) use wholesale price indices. Hanes (2000) looks at the cyclical behavior of consumer price index (CPI)-deflated wages, so-called "real consumption wages." However, the choice of deflator among all these seems to make little difference in conclusion. In serious downturns the absolute level of both the wholesale price index (WPI) and the CPI fall considerably, which makes only the degree of nominal wage rigidity important.[8]

With all this in mind, I use both the CPI and industry-specific WPIs as deflators and compare the results. NBER Macrohistory database provides necessary price series. Table 3.2 summarizes CPI and WPIs for the selected industries, showing that WPIs fell more than CPIs, which would inflate measured real wages.

My wage measure, average monthly earnings, is the mean pay to worker at an establishment. DHS's definition of a job does not consider within-establishment wage differences between skilled and unskilled workers. Therefore, my measure does not capture within-establishment wage differentials across occupations such as foremen, machinists and assembly line workers. Borrowing the terms of Hanes (2012), I use "job-wages" rather than "person-wages."

3.3. Sources of Job Destruction and Creation

7 Between 1929 and 1933, the producer price index fell by 30.6 percent (Bureau of Labor Statistics) and CPI by 18.7 percent (NBER macrohistory database m04128).

8 Hanes (2000) focuses on nominal wage rigidity for this reason, though he acknowledges that CPI-deflated real wages are relevant for explaining labor supply rather than producer behaviors. In another paper, he argues that consumption goods were "less finished" than they are nowadays and that would have affected higher real wage rigidity compared to the postwar period (Hanes 1996).

In this section, I analyze the sources of job destruction and creation between 1929 and 1935. By running diagnostic regressions, I demonstrate differences between small and large establishments in the way they destroy jobs and its magnitude. While smaller establishments in 1929 were more likely to close, their job destruction rates were significantly lower conditional on survival. I find this pattern consistently across industries. Unlike establishment size, labor productivity in 1929 explains neither subsequent survival nor employment changes in most industries. This suggests that the Great Depression was not cleansing. Lower job destruction rates at smaller establishments also help explain why large employers account for most of job destruction in the downturn.

Economists have investigated the role of firm size and age in the ability to keep and create jobs. They have identified a number of empirical regularities from the analysis of postwar data, which are summarized as follows. First, there is a negative relationship between firm size and job creation. This view was suggested initially by Birch (1987) who emphasized the role of small businesses in creating jobs. Davis et al. (1996) raise the possibility that Birch's conclusion may be driven by transitory errors and the regression to the mean,[9] but Neumark, Wall and Zhang (2011) confirm Birch's hypothesis using a different dataset, the National Establishment Time Series data from 1992 to 2004. However, they find the negative relationship is not clear for the manufacturing sector. Second, younger businesses tend to be small and more likely to exit. Haltiwanger, Jarmin and Miranda (2013) find that the negative size-job creation relationship is largely driven by the positive age-size relationship and the "up-or-out" growth pattern of young firms; many of starting and young firms fail, but those that survive grow very fast. Their analysis indicates that extensive and intensive margins have to be analyzed separately when considering the firm life cycle.[10] My

[9] If a firm that is large in year t contracts in t+1 due to a temporary shock, it will expand by t+2. Although the fundamentals of this firm never changed, a researcher using the current year size may lead to a wrong conclusion that small employers exhibit a faster employment change.

[10] Moscarini and Postel-Vinay (2012) obtain a contradicting result that large firms are more responsive, even

analysis in this section yields results that square with the modern evidence. Job destruction during the Great Depression was closely related to size and age. My results confirm the usefulness of linking employment issues to business dynamics.

3.3.1. Margins of Job Destruction and Establishment Size

Figure 3.1 illustrates the overall relationship between employment change and establishment size with different size definitions. Panel A uses employment size in the starting year, which is why new establishments (growth rate = 2) do not appear. A weak negative relationship is observed among continuing establishments with having non-extreme values (neither 2 nor -2). However, using the current year size causes a regression-to-the-mean bias that overstates the employment growth of smaller establishments. Panel B and C correct the bias by using the average employment size of two observation years and employment size in the base year, 1929, respectively. Note that Panel B show all entering and exiting establishments while Panel C shows only closing (growth rate = -2) and re-opening establishments (growth rate = 2). Panel B and C also show that the size distribution of closing establishment (growth rate = -2) lies on the left of continuing establishments' size distribution. This indicates that the closing of small establishments, due to tightened credit or weak demand, was a main cause of job destruction.

I conduct a formal test of the hypothesis that small establishments were more likely to close with the specification below.

$$Y_{i,j,t+2} = \alpha + \beta A_{i,j,t} + \gamma \tilde{E}_{i,j,t} + \Gamma_t + \Theta_j + \varepsilon_{i,j,t+2} \qquad (4)$$

$$\boldsymbol{Y_{i,j,t+2}} = \begin{cases} \mathbf{0}, & \text{if establishment } i \text{ closes before year } t+2 \\ \mathbf{1}, & \text{if establishment } i \text{ survives to year } t+2 \end{cases}$$

after accounting for the role of entry and exit. However, because they hypothesize that a countercyclical monetary policy may cause the pattern, their explanation is ruled out for the Great Depression.

$$\tilde{E}_{\boldsymbol{i,j,t}} = (E_{\boldsymbol{i,j,t+2}} + E_{\boldsymbol{i,j,t}})/2$$

For each industry, I regress a binary variable indicating establishment *i* in industry *j*'s survival to the next observation year on the labor productivity $(\boldsymbol{A_{i,t}})$ and the average employment size $(\tilde{E}_{\boldsymbol{i,t}})$ of the establishment. I add year dummies (Γ_t) and industry dummies (Θ_j) on the right-hand side if necessary. If the Great Depression was cleansing, weeding out establishments having weak demand or low efficiency, labor productivity should predict survival. Otherwise, if establishment size predicts survival, the credit crunch story gains support.

The results are reported in Panel A of Table 3.3. It gives an impression that the Great Depression was cleansing in some industries (petroleum refining, blast furnace and motor vehicle) where log labor productivity has a positive and significant coefficient. However, as in previous analyses, using current year indicators can cause the bias from transitory changes in establishment size. Suppose an establishment in 1929 continued to 1931 laying off many workers. This will make labor productivity look higher in 1931 than in 1929. By pooling two observations (1929-31 and 1931-33), one may conclude that smaller size and higher labor productivity lead to plant closing. To correct this type of bias, I re-do the analysis limiting the scope to the establishments that were open in 1929 and using that year's indicators, because they are the least contaminated measures of productivity and size.

$$Y_{i,j,t} = \alpha + \beta A_{i,j,1929} + \gamma E_{i,j,1929} + \Theta_j + \varepsilon_{i,j,t} \quad (5)$$

$$Y_{i,j,t} = \begin{cases} 0, & \text{if establishment } i \text{ closes before year } t \\ 1, & \text{if establishment } i \text{ survives to year } t \end{cases}$$

Panel B of Table 3.3 reports the results. With the exception of the motor vehicle industry, labor productivity does not predict survival. In contrast, establishment size remains as a strong predictor in all industries but the sugar industry. In Chapter 2, I employ similar specifications to demonstrate that the Great Depression was not cleansing in the passenger car market, contrary to the argument of Bresnahan and Raff (1991). The results in Panel B suggest that many other industries also present no evidence of cleansing effects. The Depression weeded out smaller rather than less productive establishments. Jobs at those small plants disappeared when they went out of business.[11]

Table 3.4 shows the importance of separating this extensive margin in explaining employment dynamics. The odd number columns include all establishments and the even number columns include continuing establishments only. Comparing the two columns suggests that the "up-or-out" pattern of smaller establishments also explains job destruction during the Great Depression, at least partially. When both extensive and intensive margins are considered in odd-number columns, the estimated coefficient for the base year size is positive in all industries except sugar. This leads to the conclusion that larger establishments have a greater tendency to keep jobs. However, when the scope is limited to continuing establishments, the estimated coefficient turns negative or insignificant. In the cotton and petroleum refining industry continuing smaller establishments have a greater tendency to keep jobs in the downturn and supply jobs in the recovery. In other industries there was no difference between small and large employers.

The results in Table 3.4 highlight the effect of establishment size on job destruction via plant closing is a commonly found across industries. Related studies suggest that small businesses suffer from credit crunch in recessions. Ziebarth (2014b) argues that there was a considerable misallocation of capital in manufacturing industries and it explains much of the decline in TFP. The exit of smaller but more productive establishments would have caused the increase in measured misallocation. Similar patterns are reported for the Great Recession.

[11] In Chapter 2, I find that a few establishments shut down temporarily and reopened later in 1935, but they were predominantly large establishments and part of multi-plant firms in many cases.

For example, Mach and Wolken (2012) find that smaller businesses were more likely to become credit-constrained and exit. Table 3.4 also shows that the effect of labor productivity varies with industry, even among continuing establishments. In the cotton industry more productive continuing establishments laid off a relatively share of workers, whereas the opposite is found in the aircraft and the motor vehicle industry.

3.3.2. Establishment Age, Ownership Structure and Other Factors

My results suggest that within-industry heterogeneity across establishments is more important than between-industry effects in employment dynamics during the Great Depression. I highlighted different channels of job destruction pattern across establishment size. However, establishment size may represent some other factors, such as establishment age and firm structure. Haltiwanger, Jarmin and Miranda (2013) argue that the size effect is largely driven by the age effect, because young establishments tend to be small. They argue that the true relationship exists between age and jobs rather than between size and jobs. Firm structure is another factor to be considered. There is ample evidence that resource reallocation by internal capital markets of multi-plant firms is different from market reallocation. In particular, firm management tend to protect production units from demand and financial fluctuations in the bad times (Matvos and Seru 2014; Shin and Stulz 1998; Nicolas L. Ziebarth 2014a). Establishments being part of multi-plant firms are likely to be larger than individual establishments.

Using available information, I examine the effect of establishment age and firm structure on employment. Although the Census of Manufactures this time did not ask firm age or the year of establishment, the 1929 census schedule asked whether an establishment opened between 1927 and 1929. I use this information to identify young establishments. But in industry dynamics literature firm age and establishment age have different meanings. While establishment age is considered a measure of vintage, firm age is considered an indicator of experience and customer base. One would expect firm age to have a positive effect on survival and establishment age to have a negative effect. Using firm ownership information addresses this problem partially. The census also asked whether an establishment was a subsidiary of another establishment. Using the firm ownership information, I test whether having a parent firm had more likelihood of surviving the Depression thus keeping jobs.

Table 3.5 reports the results of the survival analysis. The first columns for each industry are comparable to columns 4, 10, 16, 22, 28 and 34 in Panel B of Table 3.3. I add a new establishment dummy and a multi-plant firm dummy to this baseline specification. Overall, being new or part of a multi-plant firm did not give particular advantages or disadvantages in survival, though the pattern varied with industry. In the petroleum refining and blast furnace industry new establishments were more likely to survive to 1933, probably because newer vintage gave them competitive advantage. In the motor vehicle industry having a parent firm had negative effect on survival.[12] However, Table 3.6 shows that conditional on survival, new establishments had greater tendency to keep jobs. The first columns for each industry are comparable to columns 2, 4, 6, 8, 10, 12 and 14 in Table 3.4. Having a parent firm has a positive effect only for cotton goods establishments. While my analysis results confirm the "up-or-out" pattern, size effect still persists. It may be because I could not compute establishment and firm age for all establishments that started before 1927. But it is not likely that age effect replaces size effect, from the fact that age effect is the largest among new firms in their results and the coefficients changed little.

3.3.3. Who Destroyed More Jobs?

I demonstrated the difference in employment *behavior* between small and large employers during the Great Depression. In all regressions I did not weight by employment size for this reason. But what about their *contribution* to overall employment changes in the

[12] This is because of Ford. The Ford Motor Company had 33 establishments in 1929 and closed 16 of them by 1933.

absolute term? How much of job destruction is explained by plant closing of small employers and the adjustment of continuing establishments? Haltiwanger, Jarmin and Miranda (2013)'s analysis of contemporary data also differentiates growth patterns and contribution of small and large employers. Although young and small firms exhibit high employment change rates, old and large employers account for a larger part of employment. I find the same pattern for the manufacturing industries in the Great Depression period.

Table 3.7 tabulates net employment changes by employment size. Size categorization follows the convention in census publications. Size is defined as the average annual employment, total wage earner-months divided by twelve. The first three columns report the net employment changes by size. The next three columns show job destruction due to establishments closing only and the last three columns adjustments by continuing plants. The last three columns compute job creation from new openings or re-openings. Panel A shows that using current year size leads to an overestimation of small- and medium-sized employers' contribution, as David, Haltiwanger and Schuh (1996) point out. I correct this problem in Panel B by using establishment size in 1929, the base year, and limiting the scope to establishments that were operating in 1929.

After correcting the potential bias, Panel B demonstrates the importance of large employers in the aggregate job destruction and creation. Table 3.4 shows that conditional on survival, job destruction rates were high at large employers between 1929 and 1933. It is natural that large employers account for most of job destruction in the four years. However, it is noteworthy that large employers also account for most of the job creation between 1933 and 1935. This is driven not by high job creation rates but by their large size. It is also confirmed that small and large employers differ in the way they destroy and create jobs. Small employers destroyed jobs by closing down and exiting. In contrast, large establishments did so by adjusting employment rather than closing plants.

The contribution of entrants and re-opening is worth mentioning. While Table 3.7 illustrates the role of continuing large employers, it also shows significant contribution of de novo entrants (Panel A, "jobs created by new plants") throughout the period. Even in 1929-31, the early downturn years, new plants opened and added about sixteen thousand new jobs. They become more important in the early recovery phase between 1933 and 1935, accounting for 28 percent of all jobs created. Panel B shows that part of jobs destroyed by plant closing came back after re-opening, and these jobs are concentrated in establishments between 100-249 and 1,000-2,499 categories.

3.4. Wage Dynamics

3.4.1. Wage Profiles of Jobs Created and Destroyed

This subsection investigates the quality of jobs destroyed and created using average monthly earnings. Earlier I showed that smaller establishments were more likely to close and labor productivity was associated with employment growth in some industries such as aircraft and auto (Table 3.6). If large size and high productivity lead to high wages, one might expect that the Great Depression destroyed mainly low-wage jobs. I test this conjecture by observing the actual earnings.

This analysis addresses two empirical issues regarding employment during the Great Depression. First, I examine wage profiles of job destruction in the Depression period. Based on the public use sample of the 1940 census, Margo (1991) claims that "the unemployed of the 1930s were disproportionately low-wage workers" who had long unemployment spells and they were the main target of the Works Progress Administration. My approach, observing job destruction across wage distribution, complements his supply-side analysis. Second, I address differential cyclicality of employment and wages. Kahn and McEntarfer (2014) find that employment of high-paying firms is more sensitive to the business cycle from an analysis of Longitudinal Employer Household Dynamics (LEHD) data from 1998 to 2011. Applying their findings to manufacturing industries during the Great Depression, one expects high-paying establishments to have low employment growth rates in the downturn (1929-1933) and high employment growth rates in the recovery phase (1933-1935). The difference in employment and wage cyclicality also has a macroeconomic implication. Solon, Barsky and Parker (1994) find that hours cyclicality varies with demographic characteristics and claim that it causes a composition bias in aggregate data that are not properly weighted.

Figure 3.2 presents wage profiles of jobs destroyed and created over the years. Panel A charts the overall relationship between real average monthly earnings in year t (deflated by the CPI) and employment growth rates between year t and t+2. On top of the scatter plot, I overlay lowess-smoothed lines to see the relationship non-parametrically. Note that new establishments are not included because they do not have comparable monthly earnings in year t. Panel B includes these new establishments but excludes closing establishments by using earnings in the ending year (year t+2). Both panels show that employment growth rates are lower among low-paying establishments in 1929-31 and 1933-35. The exit of low-paying establishments in 1929-31 may explain relatively high growth rates in later years. In contrast, employment changes at high-paying establishments are relatively stable over time. This pattern lines up with the supply-side evidence that the majority of unemployment in this period came from low wage workers.

Panel C and D goes into further detail by observing establishments that destroyed jobs and created jobs separately. Panel C shows that the initial downturn destroyed low-paying establishments destroyed jobs disproportionately but more high-wage jobs were destroyed in the following years. Panel D exhibits a similar pattern that job creation was low among low-paying establishments and high among high-paying establishments in early years. It also shows that between 1933 and 1935, most of the jobs created were low-wage. Summarizing all the findings, I find supporting evidence for Margo (1991)'s argument that low-wage workers fared worse. However, once recovery began, job creation rates were higher in the lower tail of the wage distribution. In terms of cyclicality, my evidence contrasts with Kahn and McEntarfer (2014). High-paying establishments were less sensitive and low-paying establishments were more sensitive to the business cycle.

One concern is that these results are driven by industry-specific effects. Many of lowest-paying establishment in the petroleum refining and motor vehicles industry, representative high-paying industries, paid more than highest-paying establishments in the cotton goods industry. The exit of lowest-paying establishments in the motor vehicles industry may be read as the exit of high-paying establishments in an aggregate analysis. To control for industry effects, I run a descriptive regression of employment growth rate on monthly earnings quantile dummies for each industry and year cell, permitting to focus on within-industry effects.

Regression results in Table 8 replicates the patterns observed in Figure 3.2 overall. Column 1 of Panel A shows that overall the middle quintiles had higher employment growth rates than the first quintile and the last quintile. Columns 2 to 4 exhibit different cyclicality across earnings quintiles. Job destruction was the highest in the first quintile in the first two years and then in the fifth quintile in 1931-33. Employment growth was faster in the second and third quintiles. Panel B and C examine job destruction and creation separately. I obtain similar results in Panel C and D of Figure 3.2, but with slight differences. In the first two years, job destruction rate is the highest in the first quintile while job creation rate is the highest in the fifth quintile. Some of the highest-paying establishments were still employing additional workers while the others were destroying jobs. But in subsequent years the fifth quintile destroyed disproportionately more jobs than other quintiles. Job creation was concentrated in the lowest-paying establishments. These patterns are confirmed by unreported industry-by-industry regression results.

Differential exit rates across earnings quintiles explain part of the reason why employment situation worsened at the fifth quintile but improved at the lowest quintile over time. Panel D shows that the second and the third 1929 earnings quintiles had consistently higher survival rates than the lowest quintile. This improves the quality of the first quintile while diminishing the quality of the fifth quintile in the next census year.

Summarizing the results, I find that job destruction was concentrated among low-paying establishments. But creation rate was also very high in the low-paying establishments. I also find high cyclicality among low-paying establishments, which contrasts with the postwar evidence. But it is possible that the degree of wage cuts varied across earnings quintiles and it would have caused a composition bias in the lowest and the highest quintiles.

3.4.2. Changes of Wage Distribution

This subsection examines the question of "where wages were cut more in recessions." This question pertains to the wage rigidity argument that regards the propagation of the initial monetary shock. It has been argued that nominal wages did not fall enough and the wage rigidity delayed the adjustment process to increase productivity (Bernanke and Carey 1996; Bordo et al. 2000; Ohanian 2004). There also has been an opposing view that price flexibility can be destabilizing and excessive deflation rather than wage rigidity is what characterizes the Great Depression (Bhattarai et al. 2014; De Long and Summers 1986). There is a disagreement not only on how wage rigidity affected the economy but also on whether wages were rigid indeed. Dighe (1997) argues that wage rigidity in the Great Depression was "far less extraordinary than many have believed." Hanes and James (2012) claim that wages were not unusually rigid over 1929-32 when compared to other recessions.

My analysis add more micro-level evidence by showing how overall wage distribution changed over time in each industry in Figure 3.3. Panel A shows a general pattern that nominal earnings fell considerably between 1929 and 1933 and rebounded in the next two years. But the timing of wage reduction varied with industries. Plants in the cotton goods, blast furnace and motor vehicle industries exhibit substantial wage reductions between 1929 and 1933. Plants in the sugar refining, petroleum refining and aircraft industries cut wages later in 1931-33. However, the wage rigidity argument would focus on the extent of wage adjustment compared to the decrease in prices rather than the reduction in nominal wages itself. Panel B and C present the changes of real earnings distribution with different deflators. In Panel B, monthly earnings are deflated by the consumer price index, while in Panel C they are deflated by the wholesale price index of each good.[13] Panel B shows that nominal wages fell at least as much as consumer prices in most industries between 1929 and 1933. But Panel C shows that the reduction in nominal wages was not as large as the decrease in wholesale price indices in the cotton (1929-31) and petroleum (1929-33) industries. Interestingly, employment decreased the most in the auto industry, where wages fell quickly, than the cotton and petroleum industry. There may be industry-specific factors that can explain the differences in the timing and extent of wage reductions, from industrial organization, technology to labor relations. Explaining the reasons, however, is beyond the scope of this paper.

Within-industry differences between establishments may be at least an equally interesting issue to economists. I explore how the extent of wage cuts was associated with establishment characteristics, controlling for industry fixed effects and analyzing individual industries. I first examine the difference across earnings by regressing the percentage changes in monthly earnings on monthly earnings in the previous census year. Panel A of Table 3.9 reports the results. While different size of constants across industries reflects industry-specific effects, I find a consistent pattern that higher quintiles cut earnings to greater extent. On average, from 1929 to 1931 the fifth quintile reduced earnings by 30.8 percentage point more than the first quintile. Between 1933 and 1935, the first and second quintiles increased earnings while the higher quintiles still reduced earnings on average. Industry-by-industry analysis mostly reproduces this pattern. This result suggests that wages were more downward rigid in low-paying, presumably less productive, establishments. In contrast, during the recovery monthly earnings increased faster in lower quintiles. Therefore, low-paying establishments contributed to aggregate wage rigidity, if any, by both higher survival rates and smaller wage reduction.

The relationship of wage cuts and employer size is another interesting topic.

[13] Deflators are from the NBER macrohistory database (Auto: m04180b, Cotton: m04100a and Petroleum: m04091).

Maintaining wages and the purchasing power of workers was one of major policy goals of the Hoover Administration. In particular, the government actively engaged in urging large firms to delay wage cuts. However, it is questionable whether this policy initiative was successful. For example, Rose (2010) find no evidence that the conference in 1929 affected the duration until wage cut. I find supporting evidence by analyzing employer size-earnings change patterns across size quintiles and industries. Panel B of Table 3.9 reports regression results of monthly earnings changes on size quintiles. It shows that large employers were not different from the others in cutting earnings except in the cotton textile industry. In the auto industry, the highest quintile even reduced wages more than lower quintiles. Therefore, there is little empirical ground that wage rigidity in this period is attributable to large employers.

3.4. Concluding Remarks

In this paper, I have explored employment and wage dynamics during the Great Depression from the job perspective. The impact of the Great Depression was uneven. I found a number of patterns and relationships that are consistent across industries by conducting diagnostic regression. Establishment size is a powerful factor that explains employment dynamics. Smaller establishments were more likely to keep jobs when they continued, but they were more likely to close. Financial distress would have caused the exit of small but productive employers. Jobs at the lowest-paying establishments were destroyed and created faster, in the downturn and recovery respectively. These patterns between establishments were consistent after controlling for industry effects.

With these novel findings of establishment behavior, this paper broadens our understanding of the employment impact of the Great Depression. It provides preliminary answers to the question of “who fared worse” without relying on limited case studies. This paper also sets the basis for future research. Suggested stylized facts can be used to test predictions of standard economic models of firm and plant behavior. It will contribute to validating existing macroeconomic explanations for the cause of deep, prolonged unemployment. Another promising avenue of research is to analyze the effect of public policies, such as the National Recovery Administration's work sharing policy, on wages, hours and employment at different establishments. It will explain how the business cycle and the government policy affected employment growth in the early recovery years, between 1933 and 1935.

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Figures

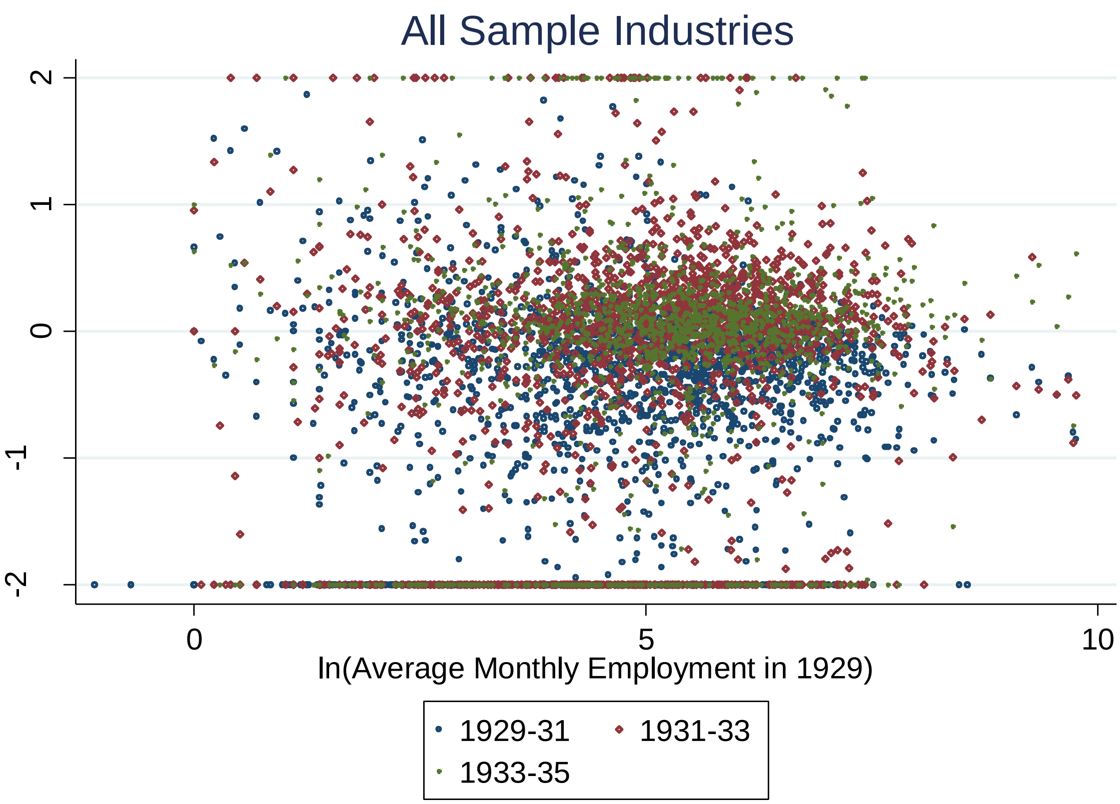
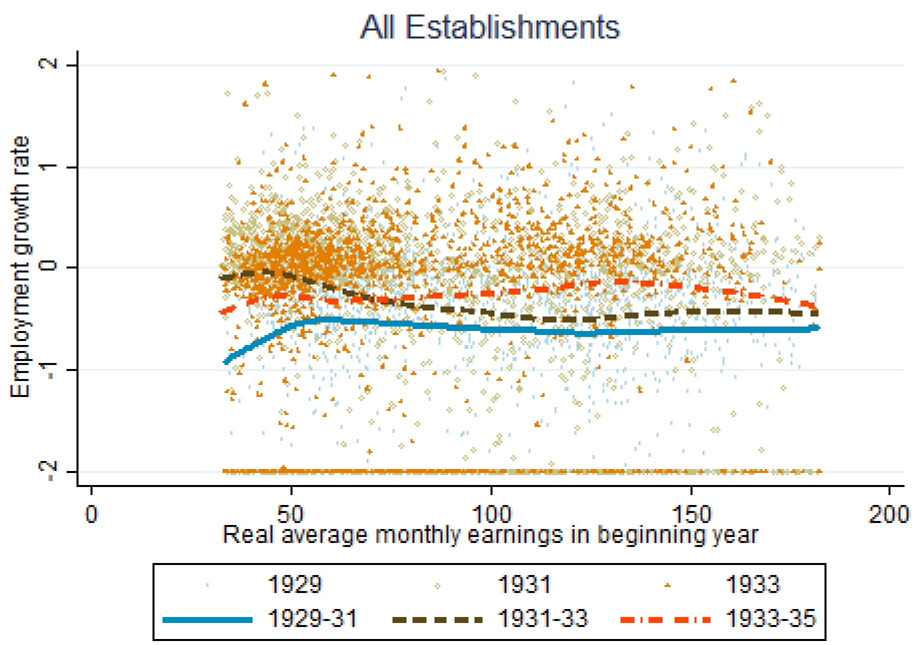
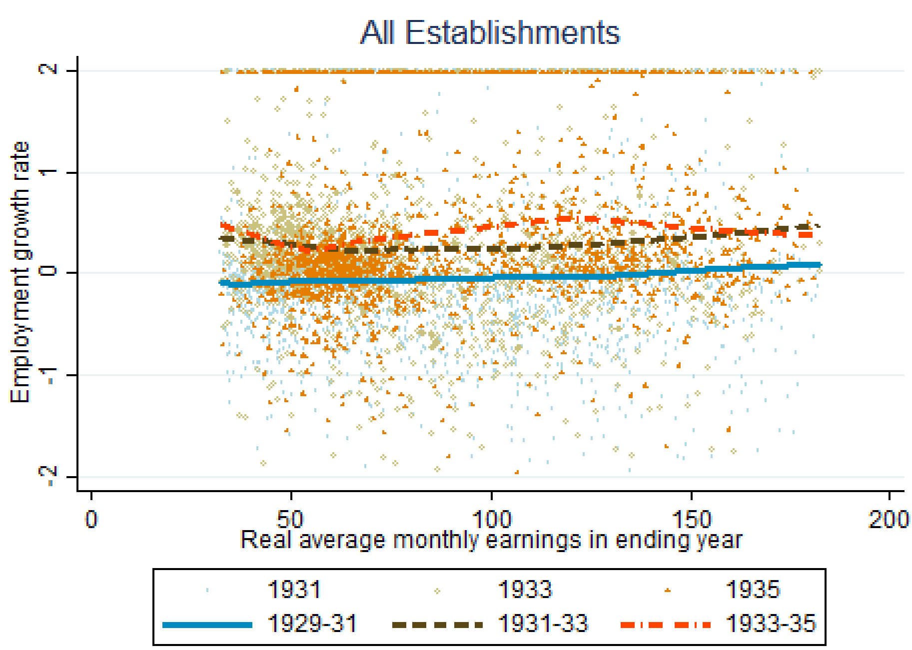


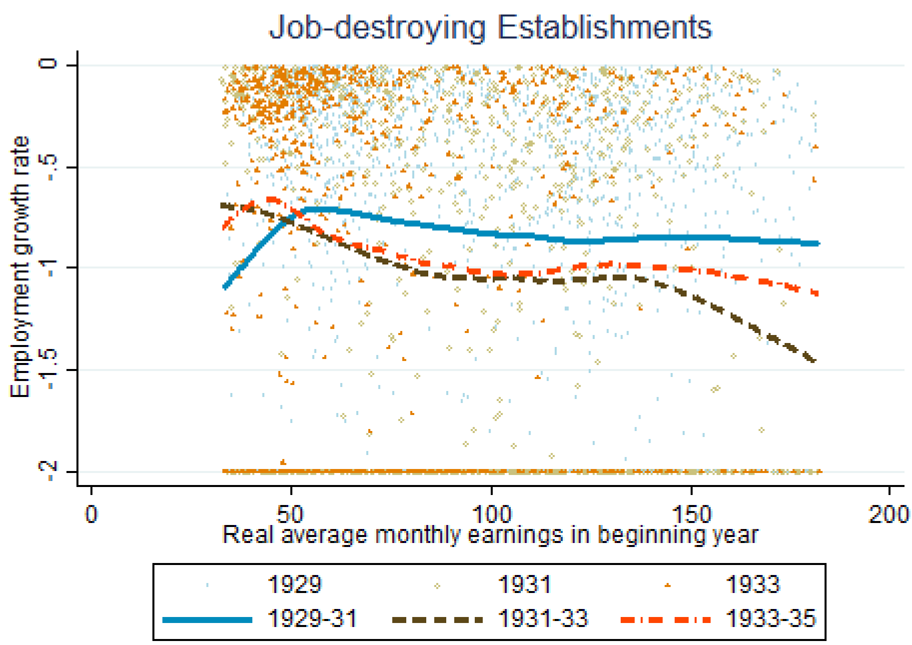
Figure 3.1 – Establishment Size and Employment Changes



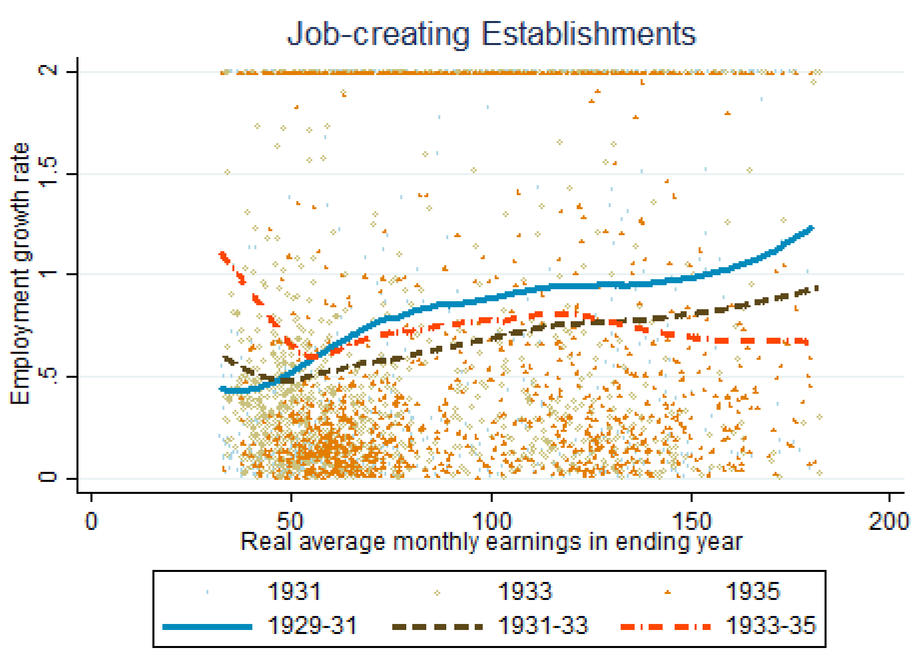
A. Net Employment Changes across Beginning Year Monthly Earnings, All Establishments



B. Net Employment Changes across Ending Year Monthly Earnings, All Establishments

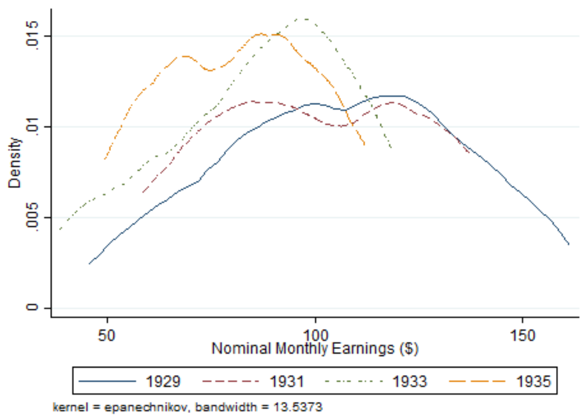


C. Job Destruction Rates across Beginning Year Monthly Earnings

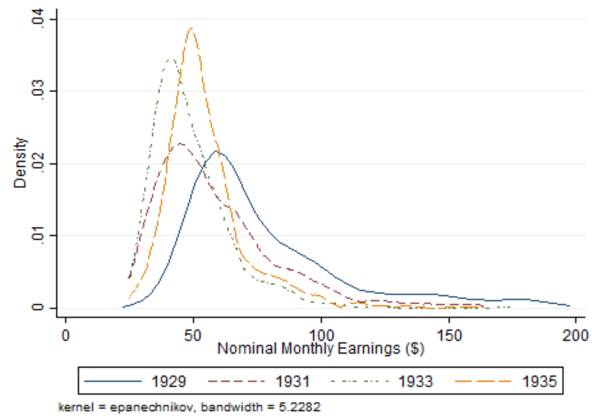


D. **Job Creation Rates across Ending Year Monthly Earnings**

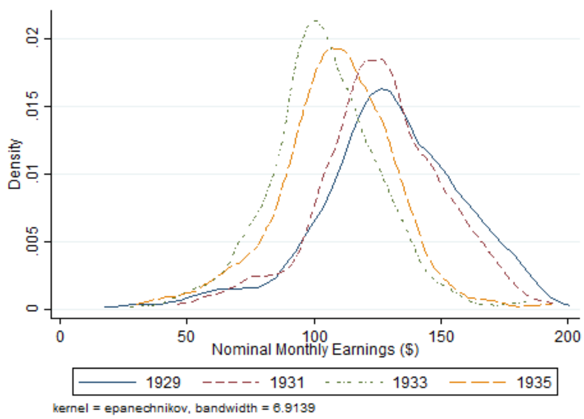
Figure 3.2 – Real Monthly Earnings and Employment Changes



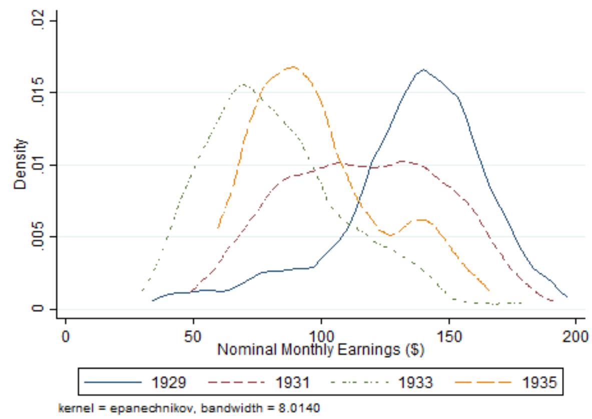
Sugar Refining



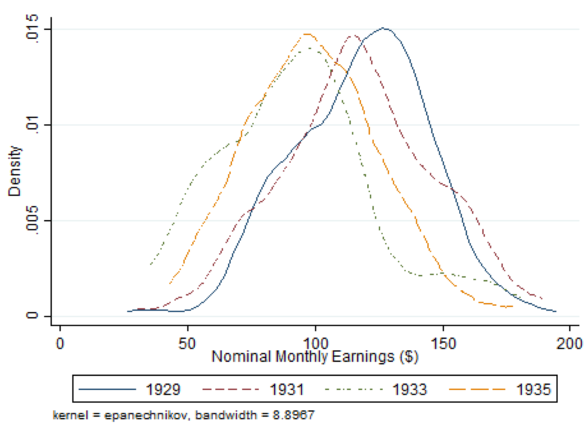
Cotton goods



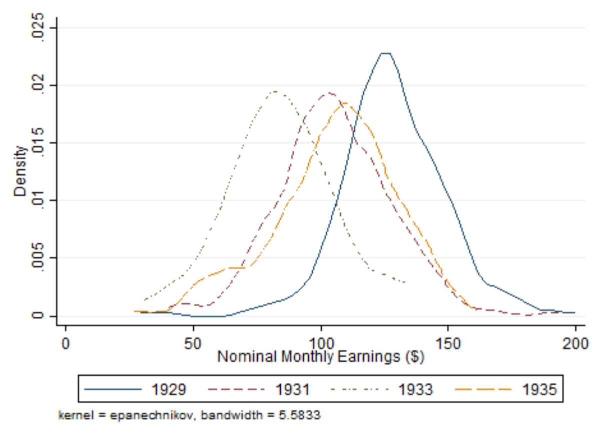
Petroleum Refining



Blast Furnace Products

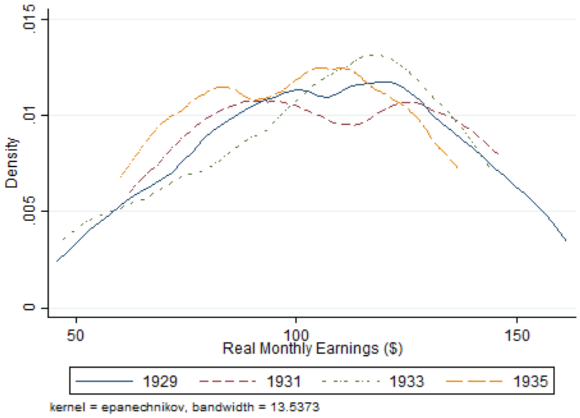


Aircraft



Motor Vehicles

A. Distribution of Nominal Wages



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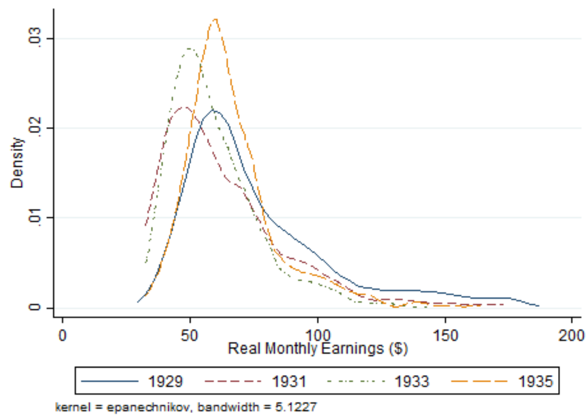
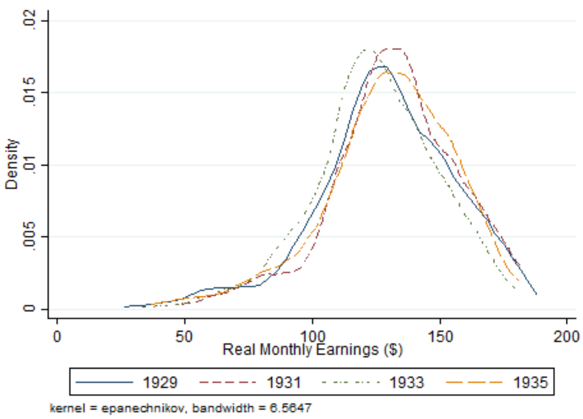
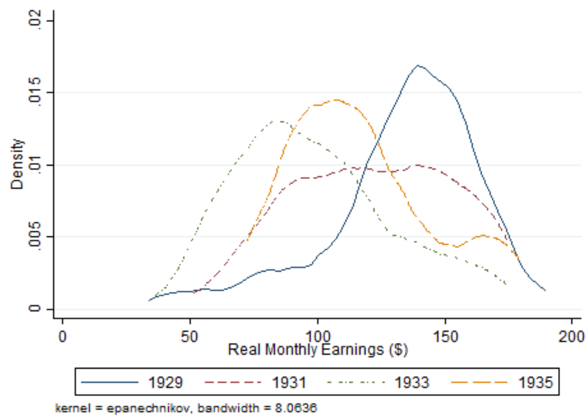


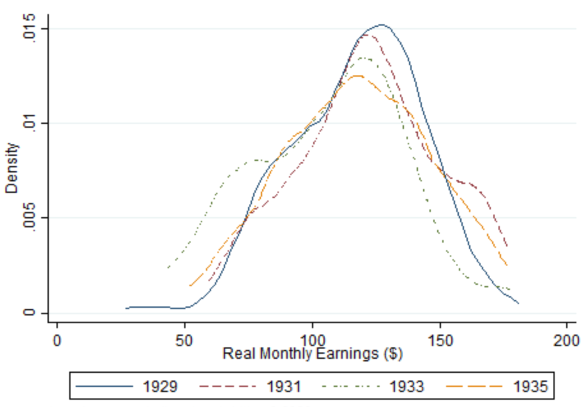
Cotton goods



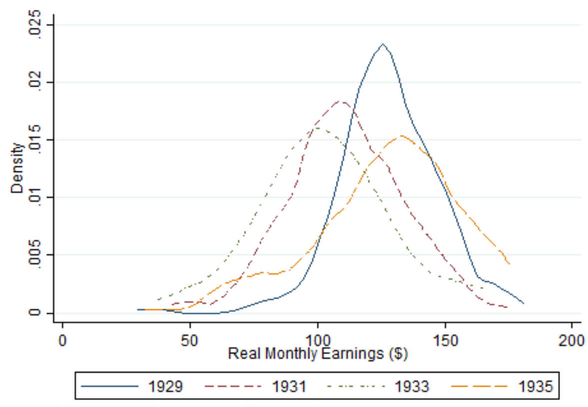
Petroleum Refining



Blast Furnace Products

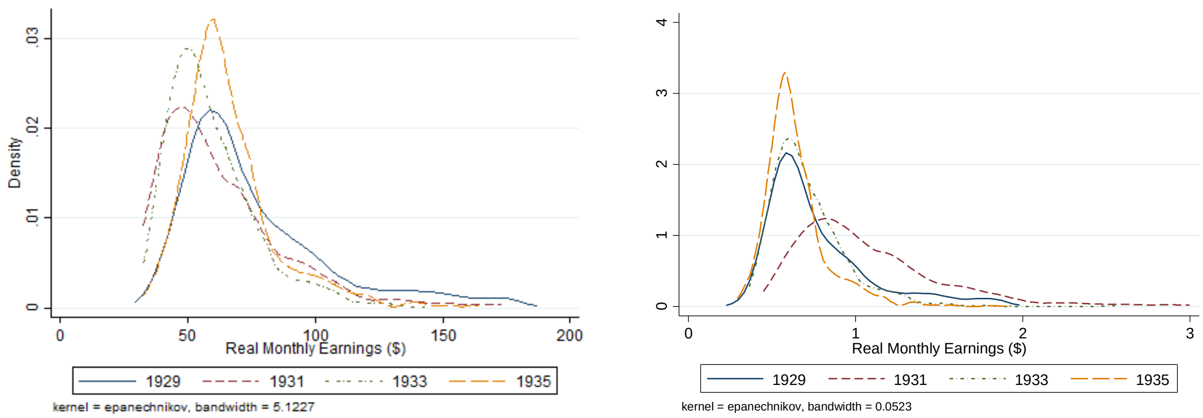


Aircraft

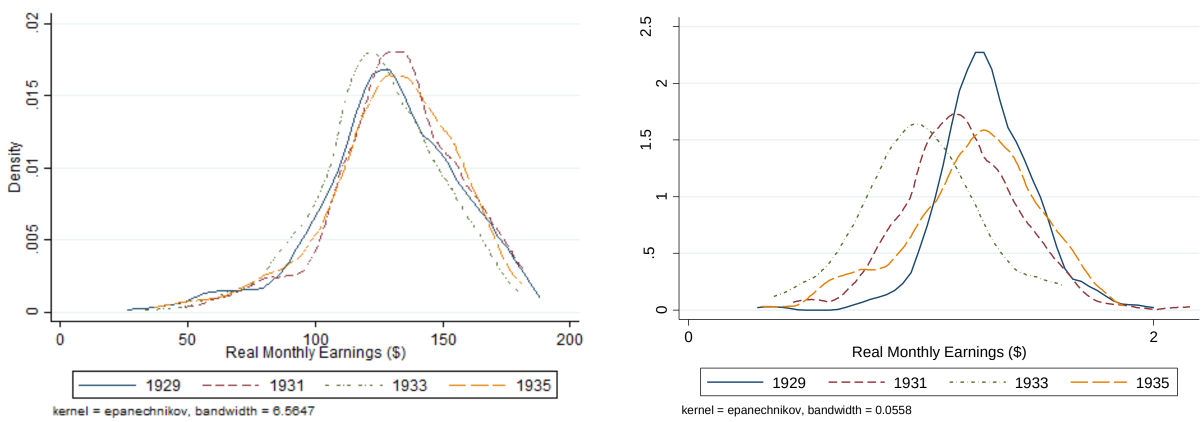


Motor Vehicles

B. Distribution of Real Earnings (deflator = CPI)



Cotton goods



Petroleum Refining

Motor Vehicles

C. Comparison of CPI-deflated and WPI-deflated Real Earnings Distribution

Figure 3.3 –Change of Earnings Distribution over Time

Tables

Table 3.1- Overview of Selected Manufacturing Industries

Census Code	Industry	Number of Establishments				Number of Production Workers				Share in Manufacturing Total			
		1929	1931	1933	1935	1929	1931	1933	1935	1929	1931	1933	1935
216	Cotton goods	1,281	1,140	1,057	1,042	424,916	329,962	379,445	369,062	4.8%	5.1%	6.3%	4.8%
1408	Motor Vehicles	210	178	122	121	224,688	134,866	97,869	147,044	2.5%	2.1%	1.6%	1.9%
705	Petroleum Refining	390	376	389	393	80,596	68,824	69,047	77,402	0.9%	1.1%	1.1%	1.0%
1110	Blast Furnace Produc	105	80	72	72	24,960	13,572	12,098	15,178	0.3%	0.2%	0.2%	0.2%
1401	Aircraft	132	101	64	79	14,710	9,870	7,816	11,384	0.2%	0.2%	0.1%	0.1%
131	Sugar refining	21	19	19	18	13,912	11,855	11,495	13,832	0.2%	0.2%	0.2%	0.2%
	Sum	2,139	1,894	1,723	1,725	783,782	568,949	577,770	633,902	8.9%	8.7%	9.5%	8.2%
	Manufacturing Total	209,862	174,255	141,769	169,111	8,821,757	6,506,701	6,055,736	7,738,845				

Table 3.2 - CPI and WPI of Sample Industries

Source	CPI except food m04052	PPI all BLS	WPI Auto m04180b	Cotton m04100a	Petroleum m04091	Blast Furnace m04010c	Sugar Refining m04030a
1929 (base year)	100	100	100	100	100	100	100
1931	94.5	76.7	89.8	54.6	60.1	87.7	88.1
1933	82.3	69.4	84.4	68.3	64.7	85.5	85.8
1935	82.4	84.0	86.1	85.1	66.8	100.2	97.0

Table 3.3 - Determinants of Establishment Survival, Linear Probability Model

A. Using Current year indicators

Dependent variable: = 1 if establishment in t survives to year t+2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Sugar		Cotton goods		Petroleum Refining		Blast Furnace		Aircraft		Auto	
ln(labor productivity in year t)		0.186		-0.0699**		0.100*		0.207+		0.0496		0.212*
		(0.263)		(0.0268)		(0.0486)		(0.122)		(0.0855)		(0.0876)
ln(Average monthly employment of year t and t+2)	0.143**	0.195**	0.135**	0.107**	0.137**	0.102**	0.193**	0.227**	0.167**	0.135**	0.107**	0.0707**
	(0.0203)	(0.0365)	(0.00269)	(0.00386)	(0.00482)	(0.00592)	(0.0104)	(0.0212)	(0.00942)	(0.0143)	(0.00574)	(0.00780)
Dummy for 1931-33	0.0731	0.0454	0.00766	0.0313*	-0.0627**	-0.0346	0.177**	0.165**	0.0556	0.0650	-0.153**	-0.130**
	(0.0701)	(0.0668)	(0.0127)	(0.0135)	(0.0236)	(0.0245)	(0.0434)	(0.0471)	(0.0446)	(0.0579)	(0.0366)	(0.0398)
Dummy for 1933-35	0.0484	0.0543	-0.0221+	-0.00928	-0.0693**	-0.0294	0.178**	0.140**	0.156**	0.265**	-0.0531	0.0501
	(0.0706)	(0.0669)	(0.0130)	(0.0138)	(0.0233)	(0.0242)	(0.0442)	(0.0486)	(0.0484)	(0.0663)	(0.0386)	(0.0447)
Constant	0.00559	-0.322	0.167**	0.308**	0.325**	0.462**	-0.202**	-0.363**	-0.0161	0.0795	0.278**	0.453**
	(0.137)	(0.235)	(0.0160)	(0.0212)	(0.0252)	(0.0287)	(0.0578)	(0.106)	(0.0429)	(0.0580)	(0.0376)	(0.0460)
Number of observations	62	59	3839	3375	1276	1116	300	255	412	276	622	507
R-square	0.459	0.355	0.403	0.187	0.404	0.219	0.550	0.350	0.449	0.292	0.397	0.185

B. Using Base Year Indicators

Dependent variable: = 1 if establishment in 1929 survives to year t

Observation year	1931	1931	1933	1933	1935	1935	1931	1931	1933	1933	1935	1935
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Industry	Sugar						Cotton goods					
ln(labor productivity in 1929)		0.334		0.196		0.502		0.0105		0.00511		-0.155*
		(0.399)		(0.399)		(0.460)		(0.0522)		(0.0599)		(0.0641)
ln(Average monthly employment in 1929)	-0.0573	-0.0573	0.110	0.110	0.153	0.153	0.0659**	0.0637**	0.0859**	0.0815**	0.116**	0.113**
	(0.129)	(0.130)	(0.127)	(0.129)	(0.150)	(0.149)	(0.00737)	(0.00757)	(0.00845)	(0.00869)	(0.00903)	(0.00931)
	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
Industry	Petroleum Refining						Blast Furnace					
ln(labor productivity in 1929)		0.0251		-0.0563		0.0728		0.573*		0.422		0.414
		(0.0839)		(0.105)		(0.111)		(0.257)		(0.274)		(0.282)
ln(Average monthly employment in 1929)	0.0649**	0.0637**	0.0956**	0.0964**	0.117**	0.115**	0.235**	0.234**	0.274**	0.274**	0.245**	0.245**
	(0.0105)	(0.0110)	(0.0131)	(0.0137)	(0.0139)	(0.0145)	(0.0471)	(0.0462)	(0.0495)	(0.0491)	(0.0509)	(0.0506)
	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)
Industry	Aircraft						Auto					
ln(labor productivity in 1929)		0.264+		0.0925		0.215+		0.176		0.344*		0.441**
		(0.142)		(0.135)		(0.129)		(0.140)		(0.170)		(0.164)
ln(Average monthly employment in 1929)	0.132**	0.127**	0.0952**	0.0977**	0.0906**	0.0935**	0.0575**	0.0550**	0.0725**	0.0718**	0.0862**	0.0860**
	(0.0238)	(0.0249)	(0.0222)	(0.0236)	(0.0215)	(0.0226)	(0.0121)	(0.0123)	(0.0148)	(0.0149)	(0.0144)	(0.0144)

+ p<0.1 * p<0.05 ** p<0.01

Standard errors in parentheses. Constants not reported.

Table 3.4 - Establishment Size and Employment Change

Dependent variable: = Employment Growth Rate between year t and t+2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Industry	All Industries		Sugar		Cotton		Peteroleum Refining		Blast Furnace		Aircraft		Auto	
Converage	All	Continuers	All	Continuers	All	Continuers	All	Continuers	All	Continuers	All	Continuers	All	Continuers
ln(labor productivity in 1929)	0.172+	0.0630	0.791	0.138	-0.110	-0.163*	0.148	0.0870	1.317*	0.677	0.987**	1.382**	0.630*	0.514*
	(0.0926)	(0.0664)	(0.802)	(0.436)	(0.120)	(0.0808)	(0.211)	(0.136)	(0.538)	(0.449)	(0.297)	(0.369)	(0.301)	(0.233)
ln(labor productivity in 1929)	-0.254+	-0.133	-0.922	-0.665	-0.0713	0.0133	-0.114	0.174	-1.401	-0.584	-1.350*	-1.841**	0.0213	-0.288
x 1931-33 dummy	(0.141)	(0.0992)	(1.134)	(0.611)	(0.180)	(0.118)	(0.314)	(0.204)	(0.850)	(0.669)	(0.533)	(0.637)	(0.468)	(0.383)
ln(labor productivity in 1929)	-0.106	0.208*	-0.215	-0.319	-0.221	0.395**	0.353	0.0126	-1.820*	-0.560	0.0794	-0.906	0.528	0.00124
x 1933-35 dummy	(0.149)	(0.104)	(1.141)	(0.623)	(0.186)	(0.126)	(0.336)	(0.212)	(0.851)	(0.672)	(0.644)	(0.621)	(0.547)	(0.393)
ln(Average monthly employment in 1929)	0.0875**	-0.0395**	-0.200	-0.0925	0.0885**	-0.0312**	0.0680*	-0.0683**	0.350**	0.000325	0.190**	0.0407	0.0708**	-0.0182
	(0.0121)	(0.00872)	(0.260)	(0.142)	(0.0174)	(0.0119)	(0.0276)	(0.0177)	(0.0967)	(0.0816)	(0.0521)	(0.0648)	(0.0264)	(0.0203)
ln(Average monthly employment in 1929)	0.00551	0.0188	0.519	-0.112	0.00341	0.0257	-0.00199	0.00759	-0.236	-0.151	-0.124	-0.0899	0.0175	0.0295
x 1931-33 dummy	(0.0180)	(0.0128)	(0.374)	(0.219)	(0.0262)	(0.0177)	(0.0409)	(0.0259)	(0.153)	(0.121)	(0.0932)	(0.102)	(0.0408)	(0.0322)
ln(Average monthly employment in 1929)	0.0126	0.00709	0.359	0.0688	0.0187	-0.0428*	0.0109	0.0506+	-0.427**	-0.247*	-0.207+	-0.0928	0.0564	0.0612+
x 1933-35 dummy	(0.0193)	(0.0136)	(0.409)	(0.221)	(0.0276)	(0.0194)	(0.0426)	(0.0269)	(0.157)	(0.120)	(0.109)	(0.104)	(0.0462)	(0.0340)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No
Observations	5296	4408	60	56	3293	2812	971	826	256	210	228	133	488	371

+ p<0.1 * p<0.05 ** p<0.01

Standard errors in parentheses. Constants not reported.

Table 3.5 - Effect of Establishment Age and Ownership Structure on Survival, Linear Probability Model

Dependent variable: = 1 if establishment in 1929 survives to year 1933

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Industry	Sugar^				Cotton goods			
ln(labor productivity in 1929)	0.196		0.326		0.00511	0.00819	0.00506	0.00817
	(0.399)		(0.428)		(0.0599)	(0.0600)	(0.0599)	(0.0601)
ln(Average monthly employment in 1929)	0.110		0.106		0.0815**	0.0828**	0.0819**	0.0833**
	(0.129)		(0.130)		(0.00869)	(0.00884)	(0.00880)	(0.00894)
New in 1929						0.0577		0.0584
						(0.0651)		(0.0651)
Having a parent firm			0.162				-0.0102	-0.0110
			(0.184)				(0.0311)	(0.0311)

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Industry	Petroleum Refining				Blast Furnace			
ln(labor productivity in 1929)	-0.0563	-0.0107	-0.0558	-0.0111	0.422	0.522+	0.436	0.532+
	(0.105)	(0.106)	(0.105)	(0.106)	(0.274)	(0.274)	(0.278)	(0.278)
ln(Average monthly employment in 1929)	0.0964**	0.112**	0.0954**	0.110**	0.274**	0.277**	0.277**	0.279**
	(0.0137)	(0.0143)	(0.0137)	(0.0143)	(0.0491)	(0.0494)	(0.0502)	(0.0506)
New in 1929		0.189*		0.173*		0.509+		0.512+
		(0.0840)		(0.0851)		(0.301)		(0.302)
Having a parent firm			0.0669	0.0550			-0.0265	-0.0203
			(0.0477)	(0.0483)			(0.0858)	(0.0880)

	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
Industry	Aircraft				Auto			
ln(labor productivity in 1929)	0.0925	0.0839	0.0864	0.0769	0.344*	0.338*	0.491**	0.502**
	(0.135)	(0.136)	(0.135)	(0.136)	(0.170)	(0.171)	(0.169)	(0.170)
ln(Average monthly employment in 1929)	0.0977**	0.0969**	0.0898**	0.0887**	0.0718**	0.0721**	0.105**	0.106**
	(0.0236)	(0.0238)	(0.0250)	(0.0252)	(0.0149)	(0.0149)	(0.0167)	(0.0169)
New in 1929		-0.0392		-0.0425		-0.0670		0.0727
		(0.0779)		(0.0780)		(0.147)		(0.147)
Having a parent firm			0.122	0.125			-0.316**	-0.326**
			(0.126)	(0.126)			(0.0811)	(0.0838)

+ p<0.1 * p<0.05 ** p<0.01

^ No new establishments in the sugar refining industry between 1927 and 1929

Standard errors in parentheses. Constants not reported.

Table 3.6 - Effect of Establishment Age and Ownership Structure on Employment Changes of Continuing Establishments

Dependent variable: = Employment Growth Rate between year t and t+2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Industry		All Industries			Sugar^			Cotton			Peteroleum Refining	
ln(labor productivity in 1929)	0.0630	0.0921	0.0930	0.138		0.0559	-0.163*	-0.150+	-0.148+	0.0870	0.170	0.176
	(0.0664)	(0.0667)	(0.0667)	(0.436)		(0.447)	(0.0808)	(0.0808)	(0.0807)	(0.136)	(0.140)	(0.140)
ln(Average monthly employment in 1929)	-0.0395**	-0.0339**	-0.0370**	-0.0925		-0.0939	-0.0312**	-0.0265*	-0.0289*	-0.0683**	-0.0553**	-0.0562**
	(0.00872)	(0.00882)	(0.00890)	(0.142)		(0.143)	(0.0119)	(0.0120)	(0.0121)	(0.0177)	(0.0184)	(0.0184)
New in 1929		0.170**	0.165**					0.177**	0.177**		0.160*	0.153*
		(0.0375)	(0.0375)					(0.0531)	(0.0530)		(0.0670)	(0.0674)
Having a parent firm			0.0488*			-0.104			0.0443+			0.0356
			(0.0194)			(0.119)			(0.0241)			(0.0385)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No
Observations	4408	4340	4340	56	56	56	2812	2812	2812	826	773	773

	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
Industry		Blast Furnace			Aircraft			Auto	
ln(labor productivity in 1929)	0.677	0.771+	0.758+	1.382**	1.390**	1.312**	0.514*	0.545*	0.521*
	(0.449)	(0.451)	(0.452)	(0.369)	(0.370)	(0.375)	(0.233)	(0.233)	(0.233)
ln(Average monthly employment in 1929)	0.000325	0.000404	-0.0115	0.0407	0.0418	-0.00612	-0.0182	-0.0204	-0.0299
	(0.0816)	(0.0823)	(0.0841)	(0.0648)	(0.0649)	(0.0753)	(0.0203)	(0.0202)	(0.0215)
New in 1929		-0.133	-0.142		0.0895	0.0954		0.311*	0.266+
		(0.235)	(0.236)		(0.138)	(0.137)		(0.140)	(0.145)
Having a parent firm			0.0599			0.253			0.0893
			(0.0844)			(0.202)			(0.0711)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	No	No	No	No	No	No	No	No
Observations	210	195	195	133	133	133	371	371	371

+ p<0.1 * p<0.05 ** p<0.01

^ No new establishments in the sugar refining industry between 1927 and 1929

All specifications include "ln(labor productivity in 1929) x year dummies" and "ln(Average monthly employment in 1929) x year dummies"

Standard errors in parentheses. Constants not reported.

Table 3.7. Employment Changes by Establishment Size

A. Current year size

Establishment size	Net employment changes			Jobs destroyed by plant closing			Jobs created by new plants			Adjustment by continuing plants		
	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35
1-19	-826	3,616	1,074	1,074	1,135	1,036	715	718	1,149	-467	4,033	960
20-49	-1,350	2,704	1,908	1,908	1,927	1,613	923	813	1,243	-364	3,819	2,277
50-99	-5,009	17	4,601	4,601	3,007	2,303	1,224	1,463	2,101	-1,632	1,560	4,804
100-249	-22,874	7,948	14,146	14,146	8,056	7,002	1,564	3,826	4,448	-10,292	12,179	16,700
250-499	-31,175	8,074	12,698	12,698	4,730	5,980	1,285	2,348	4,559	-19,763	10,456	14,118
500-999	-40,017	-1,478	10,107	10,107	19,167	9,940	2,316	1,073	4,914	-32,226	16,615	15,132
1,000-2,499	-61,018	1,720	14,274	14,274	7,458	12,249	4,863		7,591	-51,607	9,177	18,931
2,500-4,999	-21,415	-7,143	4,774	4,774	3,143		3,713		4,860	-20,354	-4,001	
5,000-9,999	-12,693	-8,876	5,200	5,200						-7,493	-8,876	
10,000+	-36,824	-3,585	3,888							-36,824	-3,585	3,888
Total	-233,200	2,997	72,669	68,781	48,622	40,122	16,601	10,240	30,867	-181,021	41,379	76,810

B. 1929 size

Establishment size	Net employment changes			Jobs destroyed by plant closing			Jobs created by re-opening			Adjustment by continuing plants		
	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35
1-19	-826	-66	-181	1,074	460	585		62	36	248	332	369
20-49	-1,350	-1,424	-133	1,908	2,295	628		71	159	558	800	336
50-99	-5,009	-276	-6	4,601	2,373	1,998		634	745	-407	1,462	1,247
100-249	-22,874	2,134	2,908	14,146	5,832	5,192		984	3,265	-8,728	6,981	4,835
250-499	-31,175	13,997	1,154	12,698	7,449	9,508		1,044	4,084	-18,478	20,403	6,578
500-999	-40,017	625	1,470	10,107	13,676	8,722		571	1,339	-29,910	13,731	8,853
1,000-2,499	-61,018	6,696	12,562	14,274	9,886	9,825			3,799	-46,744	16,582	18,588
2,500-4,999	-21,415	-1,927	7,840	4,774	3,143					-16,641	1,216	
5,000-9,999	-12,693	-3,058	2,498	5,200						-7,493	-3,058	
10,000+	-36,824	-10,361	12,124							-36,824	-10,361	12,124
Total	-233,200	6,341	40,235	68,781	45,113	36,459		3,366	13,427	-164,420	48,089	52,929

Table 3.8 - Employment Growth across Earnings Quintiles

Dependent variable: = Employment Growth Rate between year t and t+2

	A. Net Employment Growth				B. Job Destruction			C. Job Creation		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Year	All	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35
Second earnings quntile in year t	0.144**	0.204**	0.0915	0.128+	0.258**	-0.00365	0.0753	-0.182+	-0.0957	-0.346**
	(0.0365)	(0.0549)	(0.0654)	(0.0672)	(0.0554)	(0.0880)	(0.0895)	(0.108)	(0.0595)	(0.0703)
Third earnings quntile in year t	0.185**	0.269**	0.127+	0.148*	0.306**	0.0159	0.0813	0.00313	-0.136*	-0.352**
	(0.0364)	(0.0548)	(0.0653)	(0.0671)	(0.0556)	(0.0884)	(0.0921)	(0.101)	(0.0594)	(0.0697)
Fourth earnings quntile in year t	0.107**	0.192**	0.00257	0.115+	0.170**	-0.0492	-0.143	0.00728	-0.239**	-0.268**
	(0.0365)	(0.0549)	(0.0654)	(0.0672)	(0.0559)	(0.0858)	(0.0929)	(0.100)	(0.0598)	(0.0705)
Fifth earnings quntile in year t	-0.0353	0.141*	-0.172**	-0.106	0.115*	-0.296**	-0.365**	0.398**	0.0709	-0.0616
	(0.0365)	(0.0550)	(0.0655)	(0.0673)	(0.0557)	(0.0832)	(0.0871)	(0.103)	(0.0633)	(0.0702)
Constant	-0.346**	-0.375*	-0.142	0.0167	-0.516**	-0.257	-0.664	-0.0243	0.421+	0.445*
	(0.114)	(0.175)	(0.204)	(0.203)	(0.193)	(0.243)	(0.488)	(0.296)	(0.226)	(0.189)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	No	No	No	No	No	No	No	No
Observations	5472	2041	1774	1657	1633	881	811	538	1087	1116

D. Continuing Rates

Linear Probability Model

Dependent variable: = 1 if establishment in 1929 survives to year t

	(1)	(2)	(3)
Year	1931	1933	1935
Second earnings quntile in 1929	0.122**	0.114**	0.104**
	(0.0265)	(0.0306)	(0.0327)
Third earnings quntile in 1929	0.148**	0.129**	0.139**
	(0.0265)	(0.0306)	(0.0326)
Fourth earnings quntile in 1929	0.0827**	0.0450	0.0324
	(0.0265)	(0.0306)	(0.0327)
Fifth earnings quntile in 1929	0.0798**	0.0443	-0.0398
	(0.0265)	(0.0307)	(0.0327)
Constant	0.822**	0.842**	0.812**
	(0.0843)	(0.0974)	(0.104)
Industry FE	Yes	Yes	Yes
Observations	538	1087	1116

+ p<0.1 * p<0.05 ** p<0.01

Standard errors in parentheses. Constants not reported.

Table 3.9 - Wage Rigidity across Earnings and Size Quintiles

Dependent variable: = Employment Growth Rate between year t and t+2

A. Monthly Earnings

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Industry	All			Cotton			Petroleum			Blast Furnace			Aircraft			Motor Vehicle		
Year	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35
Second earnings quntile in year t	-0.171**	-0.176**	-0.151**	-0.126**	-0.162**	-0.126**	-0.323**	-0.235**	-0.181**	-0.0886	-0.164	0.0601	-0.448*	-0.194	-0.257	-0.0623	-0.188*	-0.380**
	(0.0191)	(0.0167)	(0.0194)	(0.0236)	(0.0183)	(0.0222)	(0.0462)	(0.0396)	(0.0388)	(0.0736)	(0.106)	(0.0895)	(0.171)	(0.128)	(0.199)	(0.0430)	(0.0870)	(0.111)
Third earnings quntile in year t	-0.219**	-0.234**	-0.228**	-0.175**	-0.236**	-0.221**	-0.406**	-0.260**	-0.229**	-0.120	-0.223*	-0.128	-0.404*	-0.179	-0.315	-0.0772+	-0.254**	-0.356**
	(0.0188)	(0.0166)	(0.0194)	(0.0232)	(0.0183)	(0.0221)	(0.0456)	(0.0406)	(0.0402)	(0.0747)	(0.0994)	(0.0878)	(0.156)	(0.120)	(0.193)	(0.0433)	(0.0812)	(0.105)
Fourth earnings quntile in year t	-0.200**	-0.301**	-0.294**	-0.132**	-0.304**	-0.276**	-0.435**	-0.317**	-0.290**	-0.0437	-0.283**	-0.279**	-0.444**	-0.267*	-0.444*	-0.108*	-0.334**	-0.450**
	(0.0192)	(0.0168)	(0.0197)	(0.0238)	(0.0186)	(0.0228)	(0.0460)	(0.0402)	(0.0392)	(0.0759)	(0.101)	(0.0895)	(0.160)	(0.128)	(0.205)	(0.0425)	(0.0805)	(0.105)
Fifth earnings quntile in year t	-0.308**	-0.379**	-0.349**	-0.264**	-0.402**	-0.305**	-0.493**	-0.361**	-0.347**	-0.148+	-0.330**	-0.364**	-0.566**	-0.462**	-0.540**	-0.163**	-0.312**	-0.643**
	(0.0193)	(0.0174)	(0.0205)	(0.0237)	(0.0192)	(0.0238)	(0.0471)	(0.0412)	(0.0411)	(0.0759)	(0.104)	(0.0915)	(0.157)	(0.133)	(0.193)	(0.0446)	(0.0870)	(0.109)
Constant	0.231**	0.144**	0.171**	-0.0403*	0.230**	0.335**	0.396**	0.215**	0.296**	-0.0326	0.0407	0.403**	0.444**	0.171+	0.486**	-0.0521	0.183**	0.691**
	(0.0534)	(0.0483)	(0.0554)	(0.0179)	(0.0131)	(0.0159)	(0.0340)	(0.0297)	(0.0289)	(0.0557)	(0.0691)	(0.0633)	(0.133)	(0.0851)	(0.145)	(0.0324)	(0.0592)	(0.0763)
Industry FE	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Observations	1565	1412	1355	948	890	833	310	285	303	71	65	60	59	43	40	158	111	101

B. Size

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Industry	All			Cotton			Petroleum			Blast Furnace			Aircraft			Motor Vehicle		
Year	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35	1929-31	1931-33	1933-35
Second earnings quntile in year t	0.00991	0.0172	0.0575*	0.0316	0.0356	0.0660*	-0.0636	0.0433	0.00427	0.0135	-0.117	0.0132	-0.0308	-0.101	0.447+	-0.00316	-0.0866	0.0255
	(0.0220)	(0.0219)	(0.0249)	(0.0261)	(0.0249)	(0.0290)	(0.0602)	(0.0531)	(0.0508)	(0.0849)	(0.117)	(0.111)	(0.192)	(0.176)	(0.232)	(0.0466)	(0.102)	(0.126)
Third earnings quntile in year t	0.0376+	0.0613**	0.0647**	0.0873**	0.121**	0.0566*	-0.0567	0.0348	0.0285	-0.0344	-0.285*	0.162	-0.0988	-0.207	0.126	-0.0386	-0.0294	0.166
	(0.0214)	(0.0212)	(0.0242)	(0.0252)	(0.0246)	(0.0283)	(0.0583)	(0.0486)	(0.0485)	(0.0815)	(0.110)	(0.103)	(0.186)	(0.168)	(0.229)	(0.0466)	(0.100)	(0.126)
Fourth earnings quntile in year t	0.0319	0.0493*	0.0664**	0.0866**	0.0948**	0.0567*	-0.0917	0.0208	0.0131	0.0191	-0.201+	0.0949	0.0449	-0.205	0.150	-0.0724	-0.0162	0.280*
	(0.0209)	(0.0208)	(0.0239)	(0.0249)	(0.0238)	(0.0280)	(0.0572)	(0.0486)	(0.0468)	(0.0779)	(0.110)	(0.104)	(0.181)	(0.163)	(0.237)	(0.0442)	(0.102)	(0.125)
Fifth earnings quntile in year t	0.0537**	0.0726**	0.0664**	0.120**	0.110**	0.0286	-0.105+	0.0203	0.0526	-0.00867	-0.0394	0.269*	0.187	-0.0913	-0.0404	-0.146**	0.0207	0.353**
	(0.0207)	(0.0207)	(0.0239)	(0.0245)	(0.0238)	(0.0281)	(0.0570)	(0.0485)	(0.0469)	(0.0747)	(0.109)	(0.106)	(0.171)	(0.163)	(0.232)	(0.0448)	(0.0949)	(0.121)
Constant	0.0438	-0.107+	-0.0709	-0.260**	-0.0624**	0.111**	0.125**	-0.0493	0.0621+	-0.113+	-0.0190	0.150+	-0.0288	0.104	0.0112	-0.0755*	-0.0178	0.146
	(0.0578)	(0.0574)	(0.0631)	(0.0194)	(0.0184)	(0.0223)	(0.0451)	(0.0387)	(0.0375)	(0.0600)	(0.0825)	(0.0768)	(0.154)	(0.135)	(0.193)	(0.0358)	(0.0779)	(0.0939)
Industry FE	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Observations	1565	1412	1355	948	890	833	310	285	303	71	65	60	59	43	40	158	111	101

+ p<0.1 * p<0.05 ** p<0.01

Standard errors in parentheses. Constants not reported.

Appendix Tables

Table B.1 - Census Questions Regarding Hours of Work

Census Question	asked in 1929	asked in 1931	asked in 1933	asked in 1935
Normal hours of plant operation per day	O			O
Normal hours of plant operation per week	O	O	O	O
Number of days per week		O		O
Number of shifts per day	O			
Number of hours per week for the individual wage earner	O			
Number of hours per day for the individual wage earner	O			
Man-hours by month			O	O

CHAPTER 4

The Role of Management in the Growth of North Carolina Cotton Textile Industry in the Early Twentieth Century

4.1. Introduction

Cotton textiles is one of the most studied industries in economic history. It was a pioneering sector in the British Industrial Revolution. It also played a central role in late industrialization of developing economies around the world, including Germany, the United States, Japan, and India. Historians have put much effort into searching for the mechanism of catch-up in this industry. Popular explanations are that cheap factor prices and factor accumulation led the catch-up process. Saxonhouse (1977) emphasizes the role of increased worker experience and education in the productivity growth of Japanese spinning firms between 1891 and 1935. Wright (1981, 1986) also highlights increased worker experience, reflected in increased worker ages, and capital accumulation as the main driver of the US Southern textiles' rise.

Previous work has paid relatively little attention to the progress within and across mills, the units in which actual economic decisions were made. It is only recent that a number of studies brought attention to the role of firm strategy and industry dynamics in the historic takeoff of this industry (Braguinsky and Hounshell 2015a; Braguinsky et al. 2014; Ohyama, Braguinsky, and Murphy 2004). They demonstrate that industry leaders have superior management skills, which give them an edge in market competition that helps them increase their shares in output and inputs. Often times, acquisitions of younger production units by older firms also led to such productivity-enhancing relocation. Both market selection and acquisitions increase aggregate productivity.

This paper revisits the historic growth of the Southern textile industry in the early twentieth century in light of firm and industry dynamics. Specifically, I highlight the role of management and firm structure in the persistence of industry leadership. For this analysis, I construct a longitudinal dataset from North Carolina state government reports between 1900 and 1926. Although new mills entered the industry with newer machines throughout the period, my analysis shows that mills owned by business groups that were established before 1900 account for most of industry spindleage. Since they were more likely to survive, they were the main source of labor force "maturation" and capital accumulation, the main catch-up factors suggested by Wright (1981).

Understanding the unique firm structure of these business groups is essential to this conclusion. The managers of these groups continuously open new mills that produce the same or similar products in neighboring areas. Those mills often existed as separate companies, but were under the same management. Among several explanations, I find supportive evidence of the hypothesis of Carlton and Coclanis (1989). They argue that the underdevelopment of financial institutions caused the mill ownership to consist of many shareholders with small stakes. Such ownership structure constrained expanding production capacity. Although the firm structure was a product of such constraints, the management of the business groups was well coordinated. Member mills could benefit from the parent firm's management assets. They could adopt new technology, such as electricity, earlier than the independent mills. They could also use marketing channels built by the parent firm. Thanks to these spillovers effects, new mills opened by these business groups were more productive than new independent mills.

The case of cotton textiles in North Carolina shows the usefulness of firm strategy and industry dynamics in explaining an industry's growth. The historical literature on this topic has mainly examines the role of labor.[1] There exist an immense sum of historical

[1] For example, Galenson (1985) and Wood (1986) focus on cheap labor in the South as a driver of the North-

narratives about the lives of prominent entrepreneurs (Andrews 1994; Beatty 1999; Vandenberg 2013). However, focusing on their personal lives does not reveal the economic mechanism that made their firms successful. To find the systematic factors of firm performance and industry growth, I utilize the theoretical and empirical findings in managerial and industrial economics. Accumulated evidence shows that industry leaders and followers have different strengths and strategic considerations. Young firms usually come with newest technologies embodied, exhibiting higher technical efficiency, whereas firms with long history have better management skills and stronger customer base.[2] I show that the southern textile case fits this story well. Leading firms with long history performed better than younger firms despite their machines being and getting older, mainly because they had better access to finance, technology and marketing channels. By opening new mills they took advantage of newer machine vintage and better management. Although many of the business groups were family-based, it never means that their management was behind.

This story naturally highlights the role of managers and the indigenous nature of the industry's development. They understood local constraints. They used local knowledge, experience and human network to find ways to address them. Founders of the groups started building their own mills after gaining experience as bankers, engineers and industrialists in other sectors of the same region. Their experience helped them financing their ventures, adopting new technologies, managing operation, and finding sales channels. The business groups also had a system to nurture future managers within the firms. It was not rare to see a son or younger brother of a firm's president serving as the treasurer or secretary. Many engineers and middle managers spun off after gaining experience in these large business groups.

I choose to study a specific state in a specific time period because the context has

South convergence, drawing largely on state-level macro statistics. Hall et al. (1987) and McHugh (1988) explain how labor was mobilized in the South by analyzing the mill village system.

[2] Among many research papers, Foster, Haltiwanger and Syverson (2008, 2012) demonstrate this point well. They explore the mechanism further by separating out revenue- and quantity-based productivity.

two distinct advantages. First, North Carolina was a leading state in the rise of Southern textiles, becoming near top cotton goods producing state in America by the mid-1920s. Therefore it is a useful case study of the entire Southern industrialization. Second, the existence of unusually rich detailed mill-level information makes this investigation possible. The North Carolina state government collected information about all mills in the state annually or biennially between 1900 and 1926, which enables the investigation of each business group's and mill's performance over time.

4.2. Mill-level Data from State Government Reports

In order to investigate the role of firm evolution in industry growth, I collect mill-level information from the reports of the Bureau of Labor and Printing of North Carolina from 1900 to 1926. This report series was published annually from 1887 to 1916 and biennially from 1918 to 1926.[3] It contains various mill-level information from every cotton mill in the state: location, year established, capital stock, number of spindles, power source, labor inputs and wages, the quantity of raw materials consumed, the value of production and sales channel. From these reports, I construct a dataset of four-year intervals from 1900 to 1920, and 1926.

Information availability varies by year. While basic information, such as location, incorporation status, capital stock and power source, has been asked every year since 1900, input and output information was included in the survey later (employment and wages in 1905, raw materials in pounds and the value of products in 1910). See Appendix for details about the availability.

Identifying mill ownership is the most critical part in this paper, because explaining the effect of firm management on mill performance is one of the main goals of this study. At the same time, it is the most difficult part because the state report did not ask owning firms directly. Instead, it asked the name of a mill's "secretary, treasurer or owner" before 1912

[3] The 1927-28 volume was not published, and the last report of 1929/30 was not issued due to insufficient funds as the Commissioner states in the letter of transmittal.

and the name of president and secretary after that. In several cases, the names listed were designated managers rather than the actual owners. They still clue one in personal ties each mill has, but I had to consult various external resources to identify ownership correctly.[4]

After identifying mill ownership, I compute mill age and business group age separately. Business group age is defined as the age of the oldest mill in the same business group, following the convention of firm-level studies using establishment-level data, such as in Haltiwanger, Jarmin and Miranda (2013). But I had to deal with several complications. State reports often mingled business group and mill age. For example, several mills of the Holt family were reported to be established in 1837, when the first Holt mill started operation, but in fact they were established much later. There are even cases where different years of establishment were recorded for the same mill. With the help of external resources listed in Appendix, I identified years of establishment as accurately as possible. Some mills underwent near complete renovations and reported the year of renovation as the year of establishment. In this case, I used the year of renovation instead of the year of establishment. Even all these efforts leave about 6.5 percent of all mills missing the established year of establishment.

4.3. Historical Background

When the Civil War ended in 1865, North Carolina was not comparable in any aspects to Massachusetts, the leading textile state in the United States. Out of 39 mills that were operating in North Carolina in 1860, many were destroyed by the Union Army's raids. The others barely survived with little operating capital and collapsed local market. In this

[4] References include: 1) books including Hall et al. (1987), Escott (1988), Tullos (1989), Glass (1992), Andrews (1994) and Vandenberg (2013). 2) business directories including the *Business Directory of North Carolina* series, *Davison's Textile Blue Book* of 1901 and 1910, and *Lamb's textile industry of the United States*, 3) the National Register of Historic Places Inventory records 4) *The Dictionary of North Carolina Biography* (online version: http://ncpedia.org/), and 5) online resources such as the Textile Industry History (http://www.textilehistory.org/), ancestry.com and various local history websites of North Carolina counties.

situation, northern capital did not flow into the southern states just looking for cheap labor when they lacked everything; from financial institutions which could provide a stable income stream to engineers who can plan and operate production sites. Industrial development of the state required the organization to carry it out and the building of such an organization required versatile entrepreneurs who can raise capital, mobilize labor, and devise a plan for mill establishment and production.

It was a group of home-grown industrialists who undertook the task. A number of historical narratives describe the efforts of the entrepreneurs, so-called "mill men". It is not a coincidence that those local elites had close ties to agriculture and local politics, including at least three governors of the state.[5] This indicates that they understood the economic and cultural conditions they faced and implemented feasible strategies. Although they had great vision seeing cotton textile manufacturing as the road to a "New South," they were practical in realizing the vision (Escott 1988; Glass 1992; Thompson 1906). For example, Glass (1992) shows that they built mills in the countryside near rivers not only to utilize cheap power sources but also to accommodate the conservative political sentiment and isolate workers from urban environment, imposing the southern paternalistic order on them. Mill villages, the unique southern institutions, were the outcome of the efforts to pursue industrialization in the local cultural settings.

Extensive growth characterizes the first phase of the industry's historic take-off. The "Cotton Mills Campaign," a wave of mill establishments, which started in the middle of 1880s and continued until around 1915. Backed by region-wide enthusiasm for building new mills, the number of mills more than tripling by 1900 (Hearden 1982).[6] The establishment of new mills also increased capital and labor inputs. As Table 4.1

[5] John M. Morehead (in office 1841-45), Jonathan Worth (in office 1865-68) and Thomas M. Holt (in office 1891-93).

[6] Unlike historians who put emphasis on the economic aspect of the movement between 1885 and 1915, Hearden (1982) focuses on its political implications, arguing that the Mill Campaign was an effort to gain economic independence and return to the export-oriented economy, For this reason, he considers the Mill Campaign as a long-term process from 1865 to 1901.

summarizes, the number of spindles and workers and the value of products increased at faster rates, to more than ten times the 1879 levels. But the table also shows the limitation of this extensive growth. In 1899, North Carolina had the same number of mills as Massachusetts, but the average mill size was much smaller both in the number of spindles and employment. North Carolina mills also had much lower capital intensity level than Massachusetts. While the spindle-per-worker ratio increased from 68.5 to 84.5 in Massachusetts between 1880 and 1900, it increased from 27.6 only to 37.4 in North Carolina. Although early entrepreneurs made achievements in building new mills, the industry remained labor-intensive.

The 1900s and 1910s was a period of qualitative upgrading. More new mills were established, and existing mills made big advances in capital accumulation. As a result, North Carolina overtook Massachusetts in both capital intensity and labor productivity by this period. The historical literature describes important changes during this period, such as the World War I boom and capital deepening as a reaction to the post-war increase in labor costs (so-called "stretch-outs"). But the literature hardly addresses an important question: who made the progress and how?

Wright (1981) points out that capital accumulation and the "maturation" of the labor force were the main factors of the catch-up, His argument is based on the "rational representative firm" paradigm. He does not explain where the progress was made. But it is the firm that materializes any economy- and industry-wide changes and firms are heterogeneous. Studying why some business groups could lead industry changes while others leads to a better understanding of how decision-making of individual agents interact with industry outcome. There is another reason why looking at the source of progress is important. If old leaders who played a role in the Cotton Mill Campaign also led the step-up in 1900-29, it strengthens the indigenous development story than "migration of northern cotton textiles". Data confirms the importance of old business groups in both aspects.

4.4. Old Industry Leaders: Their Importance and Origin

4.4.1. Persistence of Industry Leadership

North Carolina's cotton textile industry in first two decades of the twentieth century is marked with vivid business dynamism. Panel A of Table 4.2 shows that the industry's low entry cost attracted continuous mill entry. The wartime boon between 1916 and 1920 saw the largest number of new mill establishments, but it continued in the following depression between 1920 and 1926. While Massachusetts was closing mills, scrapping machines, and laying off workers, North Carolina was adding new mills, spindles, jobs and products.

As newly built mills install significant amount of new capital, the share of old mills established before 1900 decrease over time. Panel B shows that mills opened before 1900 account for 85 percent of all installed spindles in the state in 1904, but only one-half by 1920. This may seem to support the view that new businesses, probably from the north being allured by the profitability of the southern textiles, were the main force of the industry growth. But this is a misleading conclusion. Panel C recounts the number of spindles using business group rather than mill establishment year. For example, spindles of a mill opened in 1912 by a business group that started in 1898 count toward spindles in pre-1900 cohort. Recounted numbers reveal that mills of pre-1900 business groups account for most of spindle`s in the industry. Even in 1926, after the entry of numerous new mills, they still account for 66 percent of all spindles in 1926.

Old businesses maintained their position by continuously opening new mills and forming multi-mill business groups. Panel D shows that of all new mills, 17.5-41.4 percent were opened by existing business groups. The new mills opened by existing business groups tended to have more spindles than the new independent mills, indicating that new branch mills benefited from internal capital of the owner business group.

Table 4.3 provides supporting evidence that the new mills opened by existing business groups were more successful in terms of survival than independent new mills. The table reports the result of a duration analysis based on the Weibull distribution. I define exit in the next observation year as failure, and exclude the observations in the last year, 1926 rather than censor in that year. Note that the reported coefficients are exponentiated, so being greater than one means that the variable decreases exit probability. The mill age variable has a coefficient less than one in every specification, meaning that old mills have higher survival probability. But including the mills opened in the nineteenth century may cause a survivorship bias. If I limit the analysis to mills opened after 1904 in columns 2 and 3, it does not change the results. Older mills still have much even lower hazard of exit. This may reflect the fact that many young businesses exit early after learning its productivity draw. Column (3) shows that when a new mill is opened by an existing business group, its probability of exit declines significantly. All results confirm that old businesses were the main source of capital investment.

The analysis results also demonstrates the advantage of being a part of a multi-mill business group, which will be discussed in the next section. This multi-mill structure also has an important historical meaning, because it is commonly found among leading business groups in this period. It was the outcome of efforts to overcome the local conditions they faced. The leading business groups show well-coordinated management of this complex structure. Elucidating its origin and workings of this business group will be helpful in understanding how a latecomer industry utilizes given environments to gain capability to take off.

4.4.2. Emergence of Multi-mill Business Groups

The history of North Carolina cotton textiles is full of influential entrepreneurs' stories. Their impact is demonstrated by contemporary journals and the list of board members of national trade associations. *Commerce and Finance*, a national journal of industry, six nominated national cotton leaders in its 1921 volume, three of which were from North Carolina: James W. Cannon, Caesar Cone, and D. A. Tompkins. Of eleven nominated but not elected members, four were from North Carolina. [7] Their names are found again from the chairman list of the American Cotton Manufacturers Association, along with other North Carolina businessmen.[8]

Table 4.4 overviews the growth of major business groups formed between 1880 and 1926. The list includes not all but most important multi-mill business groups. Listed major groups account for about 30 percent of all mills and 35-40 percent of spindles in the state throughout the time.

The founder of early multi-mill business groups used the experience that they gained in plantation, gristmills and retail stores in building their own mills. Edwin M. Holt was one of the pioneering business leaders. His first mill was established in 1837 in Alamance County in partnership with a brother-in-law. It turned into the sole ownership of the Holt family. He was very active in acquiring and rebuilding cotton mills in the 1870s, transferring the management of several mills to his sons. Several separate companies were established, including E. M. Holt's Sons, the L. Banks Holt Manufacturing Company and Holt, White and Williamson. But they operated in close connection and coordination. Although professional managers were sometimes hired, in most cases family members engaged deeply in the operation of mills. Different names of the Holt family appear as the president, secretary, and treasurer of their mills in the state reports.[9]

[7] William A. Erwin, Stuart W. Cramer, Edwin M. Holt and D. Y. Cooper.

[8] The association was later consolidated with and changed name to American Textile Manufacturers Institute. North Carolina businessmen who served as presidents include Cooper, Erwin, Cramer, Tompkins, A. J. Draper and C. E. Hutchinson, *Textile World* website provides a full list of president since 1910 (http://www.textileworld.com/Textile_Resources/History/1900-1910/ATMI_Presidents). For the earlier period, the proceedings of the Southern Cotton Spinners Association, its predecessor, records the name of chairmen and the Board of Governors members.

[9] An article of the *Dictionary of North Carolina Biography* about Lawrence S. Holt exemplifies their belief and attitude towards their family business: "like his father, he firmly believed in a family-owned-and-operated business, and in 1896 he included his sons in the mill's management by forming the firm of Lawrence S. Holt and Sons."

There are other important business groups that grew out of family businesses, such as the Cannons, the Cone brothers, the Erwins, and the Mauney and Neisler's concerns. These families are often connected through marriages and participated in joint ventures. For example, William A. Erwin was a brother-in-law of Lawrence S. Holt, the youngest son of Edwin M. Holt, and John Q. Gant, who was the founder of the Glen Raven Company. Both Erwin and Gant worked for Edwin before starting their own mills. The Margrace Mill Village in Kings Mountain, Cleveland County, is another good example where such connection turned into a thriving enterprise. Charles Eugene Neisler, from Cabarrus County, joined the Kings Mountain Manufacturing Company of brothers William A. and Jacob S. Mauney. After he married a daughter of William and eventually took control of all Mauney family mills and expanded the business.

These early enterprises thrived for a long time. The Holt dynasty came to an end in the late 1920s. The Cannon Mills Company and the Cone Mills operated until 2003 and 2004 respectively until they filed for bankruptcy, and Glen Raven is still operating under the leadership of John Q. Gant's grandson.

Many of business groups that emerged later in the 1910s and 1920s were based on partnership between two or three families. Participating families had equal status, preventing a family from abusing it power over the mill management. For example, the Lineberger-Stowe Corporation that showed remarkable growth was based on two families' long-lasting friendship and partnership. The Separk-Gray interest, the Armstrong Company of C. B. Armstrongs and A. K. Winget and the paternstship between John C. Rankin and C. F. Craig are other examples.[10]

Although some business groups were family-oriented and family members took management positions, most of business groups consisted of many stakeholders, limiting a particular family's influence over the group. The John C. Rankin, sharing the same family

[10] W. T. Rankin, not related to J. C. Rankin, and his family mills were known for their "progressiveness," because they believed in the need of cooperation between employers and employees. Their mills were more like traditional family mills.

name as the leaders of W. T. Rankin's, but not directly related to this family, invested and was listed as president in 24 mills by 1926. He often partnered with C. F. Craig. Mills of other business groups also had similar ownership structures.

The 1910s and 1920s were a time of change. Northern capital started southward "migration" by acquiring southern mills. In 1912, Marshall Field and Company of Chicago purchased several mills in the Leaksville-Spray-Draper, once owned by the Moorhead family. A contemporary writer argued that this acquisition led to the replacement of old-time production system and the improvement of work environment (Ditchett 1922). In 1922, four mills in North Carolina as well as mills in other southern states were acquired and merged into the Consolidated Textile Corporation, a Delaware-based corporation. During this time, some old family-based mills also went through organizational changes. Neisler's three mills were consolidated into the Neisler Mills, Inc. in 1927 and the Cannon mills consolidated nine mills that existed as separate companies into the Cannon Mills Company in 1928. Erwin prepared a bigger merger with other out-of-state firms but did not proceed with the plan. This movement was to overcome the inefficiencies that the multi-mill structure caused. Opening new mills was a way to overcome an obstacle of the day, financing new investment, but it caused new problems in coordination.

These later consolidation movements indicate that the North Carolina's multi-mill structure caused considerable information coordination problems. So a natural question emerges: why did the multi-mill structure emerged from the first place, when they could have expanded existing mills and pursue the economies of scale?

4.4.3. Why New Mills Instead of Expansion of Old Mills?

What can explain the "new mills instead of expansion of old mills" behavior? A conceivable explanation is that the multi-mill structure reflects the strategic movement of North Carolina entrepreneurs to have more diversified product portfolio, as the modern business enterprises (MBEs) did. According to Alfred Chandler (1990), multi-divisional organization emerged and became increasingly widespread as the large-scale MBEs pursued product diversification and globalization efforts. To avoid information overload and bureaucratic inefficiencies, each unit was assigned main products or regional markets and took charge of everyday operations. The top management of the firm made important strategic decisions such as how to allocate resources within the firm and coordinated different divisions and branches. If the multi-mill structure of the North Carolina business groups had followed the logic of MBEs' multi-division, a new mill should have brought a new strategic value to the owner firm, having some modularity but not adding complexity at the same time.

However, the North Carolina case does not fit the Chandlerian framework. Table 4.5 shows that leading business groups opened another mills to produce cotton yarn, which was already produced by most others and their own mills. Some leading business groups opened new mills to produce yarns that could have been complementary to existing products, such as towels of the Cannon Mills, gingham and plaid of the Holt family, and denim of the Cone brothers.[11] But they are not so different products from yarns. Product diversification alone does not explain opening a new mill and opening the same type of mills again. Moreover, no comparable modularity is found, as all or most mills were under the same managers. While some family business groups like the Holt let the family members run different mills, it is hard to say that those mills are under different managers.[12]

Therefore, the multi-mill structure of those business groups seems to be an evolutionary outcome of efforts to overcome constraining factors that existed locally, rather than a carefully designed one. A plausible explanation is that the underdevelopment of financial institutions in the South constrained expansion and new investment of existing businesses and led to opening new mills. Capital scarcity was a chronic problem of the

[11] All these products can be categorized as the same family of "coarse yarn goods" with low profitability. Therefore, adding similar type of goods would not have added much value to the mill's operation while it adds monitoring costs.

[12] Such cases suggests a possibility that family business groups opened new branch to offer business opportunities to sons and grandsons, though this motivation is hard to prove and generalize.

southern economy. It is not only why Wright (1981) sees capital accumulation at this fast pace to be a main driver of catch-up, but also why Carlton and Coclanis (1989) think that the southern industrial growth could have been faster and intense. They argue that although the southern economy provided higher rates of return and savings were relatively high, southern financial institutions could not mediate northern investors and southern businessmen. For this reason, newly established mills often relied on many subscribers to small amount of stocks or loans from northern machinery producers or commission houses. Daniel A. Tompkins formulated a model to facilitate the opening of small mills. There were only few exceptions like the mills of the Erwin brothers. They could finance their investment using the close relationship with the Duke family, which already built an industrial empire encompassing tobacco, electricity, and cotton textiles. However, most mills started operation with funds from many local investors and this seriously constrained later expansion which needed further investment after gaining some success. Carlton and Coclanis find a good example from the Cone brothers' Chronicle Mills in Belmont County. Their plan to invest in additional spindles were denied by shareholders because they did not want to forgo dividends. The Cone brothers had to choose to organize another corporation and build a new plant nearby: the Proximity Mill. This helps explain why the number of spindle did not increase as fast as the number of mills as shown in Table 4.1.

I find supporting evidence for this hypothesis from inputs allocation patterns of the multi-mill business groups. First, the firm headquarter allocated more input to newer mills. Panel A of Table 4.6 shows that within a business group, newer mills experienced a faster growth of spindles and workers but not of output.[13] While it may be expected that new mills are equipped with spindles of newer vintage in a more efficient building layout, I find that the expectation has no empirical support. This indicates that if multi-mill business groups had not been constrained by the ownership structure, they would have chosen to expand existing mills rather than open new mills. Because making incremental investment was difficult, new mills had to be larger than in the case of no constraints in making investment

[13] Observations having top and bottom 1% value in each dependent variable are trimmed.

decision. Panel B of Table 4.6 supports this conjecture. It shows that there was an increasing time trend in spindles and workers of starting mills, but the time effect was much stronger for new mills of multi-mill business group.

I consider two other possible explanations for the multi-mill structure. First, it is possible that the cotton textile industry did not have the economies of scale. If it was the case, multi-mill structure would be a rational behavior given the technological constraints. Examining the evolution of size distribution can be a quick test. With scale economies, market force would cause the distribution towards higher concentration among larger mills. Panel A of Table 4.7 shows the distribution of mill size (measured by the number of spindles) over time. Although small-scale mills persist, the mode increases over time. Very large mills with more than 100,000 spindles also appear in 1920.[14] Panel A indicates that even if there is no scale economies in the industry beyond a certain size, most mills did not hit the upper limits. The second possible explanation is that the use of water power by early mills constrained their expansion. Panel B suggests that this hypothesis is partly true. Of all mills that used water power in 1904, the mills that still used water as a power source in later years had significantly less spindleage than the mills that switched to other power sources, either steam or electricity. But at the same time, Panel B shows that switching power source in the same location was possible. Such a change of power source would have been subject to the investment constraints.

4.5. Advantages of Being Part of a Business Group

I have suggested that opening a new mill was not the best alternative for existing firms when they could expand existing production facilities. But having new mills as a part of the business group, managers could apply their management practices to the new mills and increase the new mills' productivity quickly. By comparing new mills owned by existing groups and independent mills, I examine the advantages the existing business group provided their new mills.

[14] Only two mills in North Carolina had more than 100,000 spindles; Cannon Mills and Loray Mill.

4.5.1. Effect of Multi-mill Status on Productivity

I estimate productivity to conduct this analysis. Specifically, I measure total factor productivity (TFP) of cotton mill *i* at time *t* as the difference between actual output and the predicted output:

$$tfp_{it} = y_{it} - \hat{\alpha}_l l_{it} - \hat{\alpha}_k k_{it} - \sum_t \hat{\delta}_t I_t \tag{1}$$

In this equation, tfp_{it} is the logged TFP, l_{it} is labor input and k_{it} is capital input. Labor input is measures by the weighted sum of workers. Past literature has found that the cotton textile industry has used female and child labor extensively at its early stage. Goldin and Sokoloff (1982) studies the importance of women and children's role in the textile industry in New England and the evolution of female wages. Wright (1981) suggests that age and gender composition accounts for the South's productivity improvement. In this spirit, I define total labor input in the following manner, assuming that the average wage rate of a group reflect the group's productivity and adjusting female labor accordingly.

$$L_{it} = Male_{it} + 0.6Female_{it} \tag{2}$$

Capital input is measured by the number of spindles. For simplicity, I ignore the number of looms and cards. For output, I use the value of products and the quantity of raw materials used to estimate revenue-based and quantity-based productivity separately. The value of products is deflated by the cotton yarn price index of NBER Macrodatabse (series m04100a).[15] Although materials used is often considered intermediate input, I use the fact

[15] Using the yarn price makes sense also because yarns had the highest share in North Carolina cotton mills' production. Of 1,335 observations that report the main type of goods among producing either denim, gingham or sheet, 81.6 percent reported that yarns were the main type of products and 11.2 percent report sheets. Therefore, yarn is representative of products produced by North Carolina mills.

Price series of other products are also available: cotton sheet from the *Historical Statistics* (series Cc233), and gingham (Series m04075, NBER Macro History). Special reports attached to the Census of Manufactures series offers another piece of important information regarding this choice. In 1919, 43 percent of total output of that conversation ratio from materials to products was stable in the cotton textile manufacturing to use materials as a proxy for physical production. The state report asked about the quantity of materials used since 1910. Therefore, quantity-based productivity is calculated from 1912, the earliest year when this information is available. Finally, I added year fixed effects. By including year fixed effects on the right-hand side, measured productivity indicates the deviation from the industry average in each year, as shown in Figure 4.1.[16]

This estimation method does not correct for survivorship bias and endogeneity. While several estimation techniques, including Olley-Pakes and Levinsohn-Petrin, address those problems to decompose productivity growth into extensive and intensive margins, my interest is to determine the relative position of mills in the industry each year and where the competitive edge, if any, comes from. I do not think using these alternative methods would make a significant difference.

Table 4.8 reports the analysis result of multi-mill status on productivity. Columns 1 to 6 are report results for all mills and columns 6 to 12 report results only for mills opened after 1904. Columns 1 to 3 and 7 to 9 use logged revenue-based TFP as the dependent variable, while columns 4 to 6 and 10 to 12 use logged physical TFP. The results show that the benefit from the owner business group's management on a mill appears in profitability rather than technical efficiency. The multi-mill coefficient is positive and significant only in the specifications for revenue-based TFP (columns 1 to 3 and 7 to 9), whether or not I include age or entry cohort fixed effects. Note that TFPs are centered around the year's industry average, so I do not need to include year dummies. Columns 1 to 6 report the results for all mills, so it is possible that the multi-mill status actually captures the effect of age, because the leading business groups opened many mills much before 1912, when productivity estimation becomes available (See Table 4.4). Limiting the scope to new mills since 1912 produces more precise estimates, which are reported in columns 7 to 12. On

North Carolina came from cotton yarns. Cotton sheeting accounted for about 12 percent, and denim and gingham for about 15 percent. Cotton flannel accounted for another 8 percent.

16 Again, observations having top and bottom 1 percent value in each dependent variable are trimmed.

average, being a part of an existing business group increases revenue productivity by about 11-14 percent. However, it did not mean higher technical efficiency. The coefficients for year dummies in column 12 suggest that mills opened later were predicted to have higher TFPQ, which suggests that machines of newer vintage would have been a factor of technical efficiency.

These results are consistent with previous findings from the Japanese spinning industry that newer mills had higher technical efficiency but experienced improvement in their inventory and demand management, and thus profitability, after being acquired by old leading firms (Braguinsky and Hounshell 2015a, 2015b). My results also indicate that the strength of old business groups lies in better management in industries like cotton textiles. Among many ways that management affect mill productivity, I consider technology and marketing channels the most important channels.

4.5.2. Potential Source I: Early Electrification

In the late nineteenth and early twentieth century manufacturing, electrification was one of the most important innovations that brought huge productivity increase. A crude regression of revenue-based TFP on the use electricity estimates that mills using electricity were about 6.5 percent more productive on average. A similar regression estimates that mills using water were 11.4 percent less productive. Table 4.7 showed that the choice of power source constrains the number of spindles, because it would restrain mill location and layout.

It is natural to think that new entrants come with the most recent technology. One may imagine that many of leading business groups would have been slow in adopting electricity because their mills were built in the late nineteenth century, when water was the main power source. However, contrary to this expectation, they made the transition to electricity even before those new mills entered with electricity. Historians of the cotton textile industry indicated that the 1920s was when textile mills were electrified and experienced a productivity boost. New data suggest that it was much earlier for old leading business groups.

Early electrification of those business groups may be because the business groups can spread fixed costs over more output and more plants. Transition to electricity incurred considerable costs, which varied by the type of products and type of drive. Clapp and Standard (1929) provided estimates of the cost per spindle, indicating that \$1.5 ~ \$2.25 were required per spindle when install in group drive. If a cotton mill chooses individual drives, the average would be doubled. An average mill having 15,000 spindles would need at least \$22,500, not even including "generative equipment, mill lighting system or low-tension feeders between the substation and the switchboard." Costs would have been much higher in the early stage. Although the cost is not prohibitively large, financially constrained mills would have considered cheap but still economic power source as a viable option.

Another interesting fact from Table 4.9 is that many business groups had all or most mills electrified at once, rather than experimenting electricity in one mill and gradually adopting it in other mills. They probably did not need experiment because they knew the advantage of electricity well. Many managers had engineering background and participated in technical institutes that promoted exchange of the state-of-the-art technology. This would also help explain the coordinated action.

4.5.3. Potential Source II: Marketing and Pricing Power

I explained that difficulties in mobilizing capital was one of the most important problems to southern cotton textile manufacturers. Many mills chose to rely on a large number of local small shareholders. These shareholders placed constraints on starting and expanding textile mills.

The other alternative was to use the northern funding sources: textile machinery firms and commission houses. Machinery firms set the standards for spindles, looms and other machinery and supplied loans and credit. Commission houses also provided capital required to start mills and install new spindles. But the choice of a mill to rely on these external sources had its costs, because it meant that the mill was under the control of the northern commission houses in determining prices and product, which undermined its profitability.[17] For this reason, many mill managers complained about the strong bargaining power of the Northern commission houses and sales agents. Thompson (1906) pointed out this problem very acutely.

> The unsuccessful mills are often so because of slavery to the commission houses through which they sell their product. Too many Southern mills have been built with insufficient working capital or with none at all. The commission houses charge 4 per cent on unbleached cloth, and 5 per cent on yarns and fancy cloths, and sell when and to whom they please. Goods are sold upon sixty days' time, with 2 per cent discount for cash within ten days.
>
> The commission house to which the mill is indebted may demand entire control of its output, and the manufacturer may not receive in every case a price as high as might be realized in a market entirely free.

Data confirm that many mills had these problems. The state reports asked mill managers what kind of sales channel they used and the names of agents if they sold their output through an agent. Many mills are found to have relied on sales agents who were based in either New York or Philadelphia. But most business groups that relied on local financiers had their own marketing agencies: the Cannons (Cannon Mills, NY), the Cones (Cone Export and Com. Co., NY and Philadelphia, PA), and the Erwins (Erwin Yarn Agency) are the examples. Some groups chose to maintain long-term relationships with their northern agents: the Lineberger-Stowes (Gastonia Cotton Yarn Co. Philadelphia, PA), the Rankins (Lowell Yarn Co. Philadelphia, PA), the Erwins (J.L. Bailey & Co., NY), and the Holts (Farish Co, NY and W. Iselin & Co. NY). Business groups who did not rely on external financing sources could invest in sales channels, thus increasing their bargaining power

[17] There were cases where the relationship between producers and sales agents ended up with a good result, such as Spencer Love who built an empire after he took his agent's advice and went into rayon. But this was rather an exception.

and their profitability. Old industry leaders had the strength in marketing abilities from early on, and that was a crucial factor of continued success.

4.6. Concluding Remarks

The historical growth of North Carolina textiles has been commonly explained as the process of capital accumulation, utilization of cheap labor, and learning by doing. However, little attention has been paid to the role of old industry leaders and new entrants. By introducing notable business groups and their firm structure and management, I explained how the entrepreneurs with local background dealt with challenges they faced, and the multi-mill structure represent such efforts. It emerged to expand business under constraints from the ownership structure of many small local investors. But the managers effectively used the firm resources to grow new units. They could use the firm-wide financial resources to start with large capacity and the firm's marketing channels to gain better pricing power. These advantages are reflected in higher revenue productivity of their new mills compared to new independent mills, whereas no significant difference is found in technical efficiency.

All the evidence presented in this paper emphasizes the role of old industry leaders in the historic growth of North Carolina textiles even in the 1910s and later. It also contributes to illuminating the indigenousness of the growth. Table 4.10 shows the geographic background of the founders of the business groups and their fathers. It shows that the industrial growth was driven by indigenous entrepreneurs who understood and solved the local problems they faced.

Potential future work includes formalizing the analysis in Section 4.5 and linking the data to the Census of Manufactures from 1929 to 1935. Using more detailed data and econometric models will provide more credible evidence for the advantage of multi-mill business groups in electrification and pricing power and the effect on productivity. Linking the data to the Census will not only extend the time coverage, but also demonstrate the role of firm structure in mill survival and employment changes during the Great Depression.

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Figures

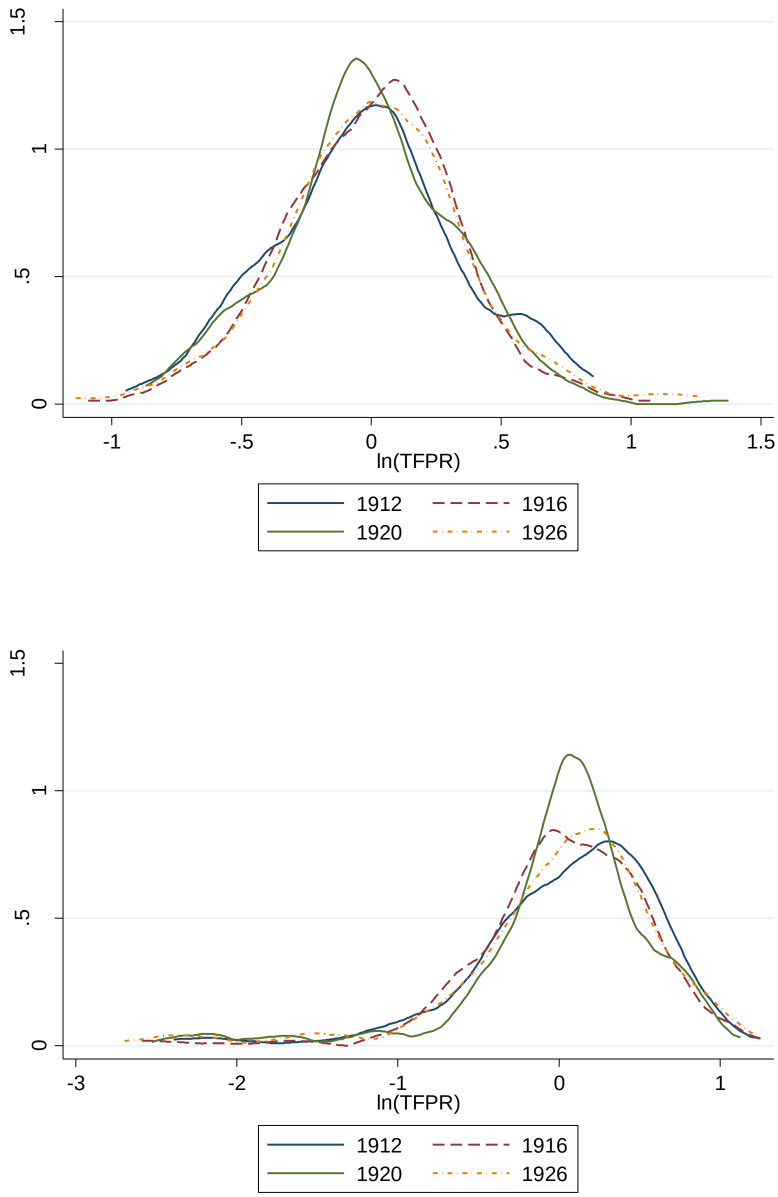

Figure 4.1 – Distribution of Mill TFP

Tables

Table 4.1 - Growth of North Carolina Cotton Textiles, 1900-1926

	1879	1899	1919	1929
Number of establishments (mills)				
US	756	973	1288	1281
Massachusetts	175	177	191	135
North Carolina	49	177	311	351
Number of spindles				
US	10,653,435	19,008,352	34,350,509	31,583,588
Massachusetts	4,236,084	7,784,687	11,206,855	7,750,404
North Carolina	92,385	1,133,432	4,662,714	6,117,858
Number of workers				
US	174,659	297,292	430,986	424,916
Massachusetts	61,844	92,085	122,499	70,788
North Carolina	3,343	30,273	67,297	91,844
Spindles per worker				
US	61.0	63.9	79.7	74.3
Massachusetts	68.5	84.5	91.5	109.5
North Carolina	27.6	37.4	69.3	66.6
Value of products (current $, 'thousands)				
US	192,090	339,200	2,125,272	1,524,177
Massachusetts	72,290	111,125	596,687	233,618
North Carolina	2,554	28,373	318,368	317,005
Value of products per worker (US = 100)				
US	100	100	100	100
Massachusetts	106.28	105.77	98.78	92.01
North Carolina	65.37	77.66	97.12	104.58

Source: Special reports for cotton textile industry in the Census of Manufactures

Table 4.2 - Source of Capital Accumulation

A. Number of Mills, and Entry and Exit by Year

Year	Number of Mills	Entry between year t-4 and t	Exit between year t and t+4
1900	261		
1904	230	45	15
1908	270	65	33
1912	284	40	16
1916	297	32	22
1920	366	87	57
1926	390	78	86

B. Number of Spindles ('thousands) by Mill Establishment Year

Year	Total	Distribution of spindles by mill establishment year						
		-1900	1901-04	1905-08	1909-12	1913-16	1917-20	1921-26
1904	2,162	1,835	327					
1908	2,964	2,214	355	395				
1912	3,399	2,220	370	459	350			
1916	3,943	2,378	397	508	398	262		
1920	5,269	2,674	427	604	426	344	794	
1926	5,914	2,725	377	702	464	328	718	600

C. Number of Spindles ('thousands) by Business Group Establishment Year

Year	Total	Distribution of spindles by business group establishment year						
		-1900	1901-04	1905-08	1909-12	1913-16	1917-20	1921-26
1904	2,162	2,001	161					
1908	2,964	2,522	172	271				
1912	3,399	2,763	147	221	269			
1916	3,943	2,973	176	250	315	229		
1920	5,269	3,648	306	337	364	310	303	
1926	5,914	4,009	236	257	395	289	303	425

D. Importance of Mills Opened by Existing Business Groups

Year	Of all new mills…		Opened by existing groups	
	Number	Spindles	Number	Spindles
1904	45	161,072	11	49.2%
1908	65	270,654	15	31.4%
1912	40	268,568	7	26.1%
1916	32	228,564	7	12.7%
1920	87	303,341	36	61.8%
1926	78	425,503	19	29.1%

Note: the counts of mills and spindles by the state reports exceed those of federal censuses, because the federal census

Table 4.3- Estimation Results of Weibull Duration Model

Dependent Variable: Exit in the next survey year

Exponentiated coefficients are reported

	(1)	(2)	(3)
Mill age	0.724**	0.597**	0.598**
	(0.0204)	(0.0432)	(0.0434)
Part of multi-mill business gr			0.361**
			(0.136)
Year FE		Yes	Yes
Observations	1191	416	416

Standard errors in parentheses

+ p<0.1 * p<0.05 ** p<0.01

Table 4.4 - Overview of Major Multi-plant Business Groups

Business group	Year of first mill establishment	Base city, county	Number of mills					
			1904	1908	1912	1916	1920	1926
Holt	1837	Burlingotn, Alamance	15	17	17	16	16	15
Steele	1874	Rockingham, Richmond	4	4	5	5	6	6
Gant	1881	Glen Raven, Alamance	3	3	3	3	3	2
Rhyne	1883	Mount Holly, Gaston	4	3	6	8	9	10
Cannon	1887	Kannapolis, Cabarrus	10	12	14	13	15	18
Mauney-Neisler	1888	Kings Mountain, Cleveland	3	3	3	3	4	5
Hutchinson	1891	Mount Holly, Gaston	2	3	4	4	3	2
Tompkins	1892	High Shoals, Gaston	2	2	2	2	2	2
Erwin	1892	Durham, Durham	6	7	7	7	8	8
Morehead	1893	Spray, Rockingham	6	6	6	6	2	2
Cone	1893	Greensboro, Guilford	3	3	3	4	4	5
Cooper	1895	Henderson, Vance	2	2	2	2	2	2
J.C. Rankin	1896	Lowell/Gastonia, Gaston	5	7	7	7	13	17
W.T. Rankin	1899	Gastonia, Gaston	1	1	1	1	6	7
Chadwick-Hoskins	1900	Charlotte, Mecklenburg	5	5	5	5	5	
Lineberger-Stowe	1901	Belmont, Gaston	1	3	2	4	8	15
Gray-Separk	1901	Gastonia, Gaston	1	3	3	3	8	8
Armstrong	1907	Gastonia, Gaston		3	3	4	8	10
Total			73	87	93	97	122	134
Industry Totals			230	270	284	297	366	390

Business group	Year of first mill establishment	Base city, county	Number of spindles ('thousands)					
			1904	1908	1912	1916	1920	1926
Holt	1837	Burlingotn, Alamance	137	171	169	170	166	176
Steele	1874	Rockingham, Richmond	60	63	83	92	115	188
Gant	1881	Glen Raven, Alamance	14	14	15	16	13	11
Rhyne	1883	Mount Holly, Gaston	19	14	37	43	61	61
Cannon	1887	Kannapolis, Cabarrus	164	299	398	385	514	621
Mauney-Neisler	1888	Kings Mountain, Cleveland	24	32	29	15	24	25
Hutchinson	1891	Mount Holly, Gaston	15	21	37	57	48	71
Tompkins	1892	High Shoals, Gaston	19	21	26	26	29	
Erwin	1892	Durham, Durham	89	136	184	184	184	225
Morehead	1893	Spray, Rockingham	50	66	71	21	18	18
Cone	1893	Greensboro, Guilford	89	110	115	123	158	189
Cooper	1895	Henderson, Vance	34	52	85	95	101	103
J.C. Rankin	1896	Lowell/Gastonia, Gaston	37	64	78	94	166	186
W.T. Rankin	1899	Gastonia, Gaston	10	10	10	20	61	69
Chadwick-Hoskins	1900	Charlotte, Mecklenburg	77	90	98	102	113	0
Lineberger-Stowe	1901	Belmont, Gaston	5	22	23	39	100	206
Gray-Separk	1901	Gastonia, Gaston	10	25	35	57	175	145
Armstrong	1907	Gastonia, Gaston		16	21	33	110	107
Total			852	1,227	1,514	1,571	2,156	2,402
Industry Totals			2,162	2,964	3,399	3,943	5,269	5,948

Table 4.5 - Main Product of Mills by Order of Opening, 1920

Order of opening	Business Group								
	Holt	Canon	Cone	Erwin	Rankin	Rhyne	Lineberger	Gray-Separk	Armstrong
1	Gingham	Sheeting	Yarn	Sheeting	Yarn	Yarn	Yarn	Yarn	Yarn
2	Cloth	Sheeting, yarns	Denim	Denims	Yarn	Yarn	Yarn	Yarn	Yarn
3	Cloth	Sheeting, yarns	Denim	Coarse Yarns	Yarn	Yarn	Yarn	Yarn	Yarn
4	Gingham	Yarn	Sheet	Cloth	Yarn	Yarn	Yarn	Yarn	Yarn
5	Gingham	Yarn		Coarse Yarns	Yarn	Yarn	Yarn	Yarn	Yarn
6	Sheeting	Gingham, shirtings, yarns		Indigo Blue Denim	Yarn	Yarn	Yarn	Yarn	Yarn
7	Sheeting	Hosiery Yarns		Seetings	Yarn	Yarn	Yarn	Yarn	Yarn
8	Shirt	Flanels		Sheeting	Yarn	Yarn	Yarn	Yarn	Yarn
9	Yarn	Yarns			Yarn	Yarn	Yarn		
10	Gingham	Yarn			Yarn				
11	Yarn	Cotton Yarn			Yarn				
12	Cloth	Yarn			Yarn				
13	Yarn	Yarn			Yarn				
14	Hosiery	Towels, Crashes, Sheeting							
15	Gingham	Yarn							

Table 4.6. Patterns of Within-Group Resource Allocation

A. Allocation within Multi-mill Business Group

Dependent variable: growth rate of each variable

	(1)	(2)	(3)	(4)	(5)	(6)
	Spindles		Workers		Output	
Mill age	-0.00534*	-0.00409+	-0.00582*	-0.00608+	0.00182	-0.00101
	(0.00222)	(0.00215)	(0.00271)	(0.00292)	(0.00914)	(0.00950)
Constant	0.114**	0.251**	0.127**	0.151*	0.196*	0.373*
	(0.0139)	(0.0742)	(0.0188)	(0.0587)	(0.0781)	(0.139)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	No	Yes
Observations	423	423	341	341	163	163

+ p<0.1 * p<0.05 ** p<0.01

Standard errors are in parentheses. They are clustered at the firm level.

Observations having top and bottom 1% value in each dependent variable are trimmed.

B. Starting Mill Size

Dependent variable: natural log of each variable

	(7)	(8)	(9)
	Capitalization	Spindles	Workers
Year of establishment	0.0491**	0.0173*	0.00348
	(0.0104)	(0.00771)	(0.00751)
Year of establishment	0.0493**	0.0175*	0.00363
x multi-mill business group	(0.0104)	(0.00771)	(0.00751)
Constant	-82.12**	-24.36	-2.129
	(19.86)	(14.76)	(14.38)
Observations	245	246	226

+ p<0.1 * p<0.05 ** p<0.01

Standard errors are in parentheses.

Table 4.7. Test of Other Possibile Reasons for Multi-mill Structure

A. Distribution of Spindles over Time

Year	1904	1908	1912	1916	1920	1926
Less than 5,000	77	88	70	67	55	50
5,001-10,000	79	88	97	83	115	95
10,001-20,000	42	61	73	86	108	136
20,001-50,000	19	29	34	46	59	64
50,001-100,000	2	4	6	8	9	13
100,001+					2	2

B. Mean Number of Spindles, Mills that Used Water Power in 1904

Year	1904	1908	1912	1916	1920	1926
Water	10,424	10,647	11,637	12,188	15,718	14,569
Other Power		15,797	16,664	19,602	19,969	24,809

Table 4.8. Productivity Effect of Business Group on Member Mills

	(1)	(2)	(3)	(4)	(5)	(6)
Scope	All Mills					
Dependent variable	ln(TFPR)			ln(TFPQ)		
Multi-mill business group	0.0701**	0.0768**	0.0774**	-0.0290	-0.0301	-0.00769
	(0.0245)	(0.0245)	(0.0250)	(0.0401)	(0.0404)	(0.0406)
Mill age		-0.00170+			0.00174	
		(0.000996)			(0.00166)	
Entry cohort						
1901-04			-0.0775+			-0.169*
			(0.0417)			(0.0700)
1905-08			0.0184			-0.0536
			(0.0351)			(0.0585)
1909-12			0.0233			0.0264
			(0.0375)			(0.0632)
1913-16			0.105+			0.228*
			(0.0544)			(0.0918)
1917-20			-0.00303			-0.165*
			(0.0401)			(0.0686)
1921-26			0.104+			-0.00158
			(0.0561)			(0.0928)
Constant	-0.0250+	0.00205	-0.0350+	0.0357	0.00232	0.0513+
	(0.0137)	(0.0219)	(0.0184)	(0.0232)	(0.0371)	(0.0303)
Observations	940	936	940	962	956	962

	(7)	(8)	(9)	(10)	(11)	(12)
Scope	New Mills since 1912					
Dependent variable	ln(TFPR)			ln(TFPQ)		
Multi-mill business group	0.114*	0.120*	0.141*	-0.0736	-0.0610	0.000429
	(0.0503)	(0.0496)	(0.0542)	(0.0794)	(0.0793)	(0.0837)
Age		-0.00182			0.0181*	
		(0.00452)			(0.00714)	
Entry cohort						
1901-04						
1905-08						
1909-12			0.0759			0.201+
			(0.0665)			(0.106)
1913-16			-0.0513			-0.195*
			(0.0573)			(0.0916)
1917-20			0.0746			-0.0288
			(0.0683)			(0.107)
1921-26			0.0887			0.0535
			(0.0639)			(0.103)
Constant	-0.00505	0.00172	-0.0187	0.0650	-0.0792	0.0767
	(0.0259)	(0.0414)	(0.0364)	(0.0425)	(0.0684)	(0.0583)
Observations	287	283	287	279	273	279

+ p<0.1 * p<0.05 ** p<0.01

Standard errors are in parentheses.

Observations having top and bottom 1% value in each dependent variable are trimmed.

Table 4.9. Diffusion of Electricity

Share of Mills that Adopted Electricity

Business Group	1904	1908	1912	1916	1920	1926
Holt	0%	18%	29%	35%	94%	80%
Steele	0%	0%	0%	80%	83%	100%
Gant	0%	0%	0%	0%	0%	0%
Rhyne	0%	0%	17%	50%	78%	70%
Cannon	0%	75%	57%	85%	100%	100%
Mauney-Neisler	0%	0%	100%	100%	100%	80%
Hutchinson	0%	100%	75%	75%	100%	100%
Tompkins	0%	0%	50%	100%	100%	
Erwin	0%	0%	57%	71%	75%	86%
Morehead	0%	0%	0%	0%	50%	0%
Cone	0%	100%	100%	100%	100%	100%
Cooper	0%	0%	100%	50%	100%	100%
J.C. Rankin	0%	43%	71%	71%	77%	76%
W.T. Rankin	0%	0%	0%	100%	83%	86%
Chadwick-Hoskins	0%	100%	100%	100%	100%	
Lineberger-Stowe	0%	67%	100%	50%	75%	93%
Gray-Separk	0%	67%	100%	100%	75%	88%
Armstrong		100%	100%	100%	88%	100%
All	3%	27%	44%	58%	73%	85%
New mills	7%	51%	45%	72%	77%	90%

Table 4.10. The Geographic Background of Major Business Groups' Founders

Founder of Business Group	State of birth	
	...of self	...of father
Edwin M. Holt	North Carolina	North Carolina
Robert L. Steel	North Carolina	South Carolina
Gant	North Carolina	South Carolina
Daniel E. Rhyne	North Carolina	North Carolina
John W. Cannon	North Carolina	North Carolina
William A. Mauney	North Carolina	North Carolina
C. E. Niesler	North Carolina	North Carolina
C. E. Hutchinson	North Carolina	North Carolina
Daniel A. Tompkins	South Carolina	South Carolina
William A. Erwin	North Carolina	North Carolina
Moses H./ Cesar Cone	Tennessee	Germany
J.C. Rankin	North Carolina	North Carolina
Wiiey T. Rankin	North Carolina	North Carolina
Robert L. Stowe	North Carolina	North Carolina
A.C. Lineberger	North Carolina	North Carolina
George A. Gray	North Carolina	North Carolina
Joseph H. Separk	North Carolina	Virginia
C. B. Armstrong	North Carolina	North Carolina

Appendix C.1. Mill Information Sources

A. Library Archives

UNC the Southern Historical Collection

ID	Title	Related mills
4712	Robert Bruce Cooke Papers, 1926-1972	Pearl Cotton Mills (Durham), Virginia Cotton Mills (Swepsonville), and the Mooresville Cotton Mills (Mooresville)
4488	Pickett Cotton Mill Records, 1899-1933	

Duke

ID	Title	Related mills
	Guide to the Cannon Mills Records, 1836-1983	Bloomfield Manufacturing Co. (Statesville), Brown Manufacturing Co. (Concord), Roberta Manufacturing Co. (Cabarrus ct), Swink Manufacturing Company (Rowan ct), Travora Textiles (Graham and Haw River), Windemere Knitting Mills (Albemarle), Wiscassett Mills (Albemarle) Amazon Cotton Mills (Thomasville), Durham Hosiery Mills, Efird Manufacturing Co (Albemarle), Tuscarora Cotton Mill (Mt. Pleasant) and Paola Cotton Mills (Statesville).
	Guide to the Erwin Cotton Mills Records, 1832-1976	Pearl Cotton Mills, Cooleemee Cotton Mills, Erwin Yarn Co., Alpine Cotton Mills, Durham Cotton Manufacturing Co., Locke Cotton Mills, Oxford Cotton Mills, Flint and Co

B. National Register of Historic Places Inventory records

Information for each mill can be fetched by adding the code to the address "http://www.hpo.ncdcr.gov/nr/"

Code	County	Item	Mentioned mills
WA0189	Wake	Falls of the Neuse Manufacturing Company	River Mill, Neuse River Cotton Mill
PR0219	Person	Roxboro Cotton Mill	Longhurst Mill
UN0833	Union	Piedmont Buggy Factory	Bearskin Cotton Mills,Monroe Cotton Mills
DH0011	Durham	Durham Hosiery Mill	
CA0611	Cabarrus	North Union Street Historic District	Odell-Locke-Randolph Mill
RH0002	Richmond	The Manufacturers Building	Rockingham mills: Pee Dee, Steel's Roberdel, Midway (Leak, Wall & McRae) and Hannah Pickett
CL0350	Cleveland	Margrace Mill Village Historic District	William Andrew Mauney's mills: Bonnie, Cora, Dilling, Lula, Pauline
CL0784	Cleveland	Double Shoals Cotton Mill	Celevland Mills: Minnette, Margrace, Mason, Park Yarn, Patricia, Phoenix, Sadie, Catherine, Consolidated Textiles, Dover, Eastside Mfg, and others
CA0147	Cabarrus	Mount Pleasant Historic District	Kindley Cotton Mill, Tuscarora Cotton Mill
CL0784	Cleveland	King Street Overhead Bridge	Enterprise, Diling, Cora, Lula, Mauney family's mills
GS0007	Gaston	Mount Holly Cotton Mill	American Yarn and Processing Co., Efird Mills Co.
RK0281	Rockingham	Spray Industrial Historic District	Morehead Cotton Mill, Spray Cotton Mill, Leaksville Cotton Mill, Fieldcrest Mills, Nantucket Mills, Lily Mills

C. Local History Websites

County	Mainly related mills	Other information	Address
Orange County Textile Mills	High Falls Mill, Granite Mills, Durham Hosiery Mills No.4/7, Old Alamance Mill, Saxapahaw Cotton Mill, Eno Mill, Bellevue Mill		http://freepages.history.rootsweb.ancestry.com/~orangecountync/places/txmills/txmills.html
Gaston county mills	Loray Mills	Describes group membership:	http://lcweb2.loc.gov/master/pnp/habshaer/nc/nc0400/nc0499/data/nc0499data.pdf
		Lineberger group (all in Belmont): Chronicle Mills, Imperial Yarn Mills, Majestic Manufacturing Co., Climax Spinning Co., Sterling Spinning Co., Crescent Spinning Co., Acme Spinning Co., Perfection Spinning Co., Linford Mills, and National Yarn Mills. Armstrong group: Armstrong Cotton Mills, Clara Manufacturing Co., Winget Yarn Mills, Victory Yam Mills, Dunn Manufacturing Co., Mutual Cotton Mills, Seminole Cotton Mills, Piedmont Spinning Co., and Monarch Cotton Mills. Gray-Separk group (all in Gastonia): Arrow Mills, Flint Manufacturing Co., Arlington Cotton Mills, Gray Manufacturing Co., Myrtle Mills, Parkdale Mills, and Arkray Mills	
Charlotte and Mecklenburg County			http://www.cmhpf.org/S&Rs%20Alphabetical%20Order/surveys&rjohnstonmill.htm
Rockingham area	Leak, Steele, Cole families		http://www.livingplaces.com/NC/Richmond_County/Rockingham_City/Rockingham_Historic_District.html http://www.ncgenweb.us/richmond/rockmills.html

Rowan	Salisbury Cottn Mill		https://www.rowancountync.gov/GOVERNMENT/Departments/RowanPublicLibrary/HistoryRoom/TheoBuerbaumsSalisbury/CottonMills.aspx
Leaksville-Spray-Draper			http://www.leaksville.com/History.html
Cherryville	Cherryville, Gaston Mfg, Vivian, Melville, Howell Mfg, Rhyne Houser Mfg, Carlton Yarn		http://www.cherryville.com/history/new_textile/
Rutherford	Henrietta, Caroleen		http://remembercliffside.com/history/the_county/hca_1.html

Appendix C.2. Available Information from the North Carolina Annual Reports

Basic Information	Name of the mill, year established, president, secretary or treasurer, type of goods manufactured
Geography	County, post office (city).
Capital	Capital stock
Machinery	Number of spindles, looms and cards.
Power	Type of power source, number of horsepower.
Labor	Days in operation, number of hours worked, number of employees (men, women, children), wages (highest and lowest), frequency of wage payment, percentage of workers who can read and write, number of dependents.
Raw Material	The amount of raw materials used in pounds (no value).
Products	The value of production (no quantity).
Sales channel	Direct or through agent, and agents' name if they sell products through them.
Miscellaneous	Opinion of mill president about compulsory schooling, child labor prohibition, situation of workers.