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# The increasing presence of large firms and its consequences for US startup rates\*

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**VERY PRELIMINARY - DO NOT CITE**

## **Abstract**

While the significant decline in US startup rates over the past 30 years has raised concern about the health of the US economy its causes have not yet been fully understood. I document the concurrent increase in the size and presence of large firms in the US economy and link it to the decline in firm creation rates. I construct a simple model that rationalizes this channel by increases in the span of control of managers. Importantly, while generating a decrease in startup rates and an increase in the size of large firms, average productivity improves. These findings thus counter the popular conception that declining startup rates are necessarily a “bad sign”.

**Keywords:** Industry Structure, Firm Size Distribution, Firm Creation, Entrepreneurship

**JEL Codes:** E24, L25, L26

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# 1 Introduction

The strong entrepreneurial spirit embedded in American culture is regularly regarded as a crucial element of the United States economic success. At least since Schumpeter (1942) entrepreneurs are seen as an important driver of productivity growth through the process of creative destruction. The reallocation of economic activity from old unproductive firms to new more productive firms has been shown to be a major cause of productivity growth (Foster et al., 2006). Furthermore, young firms have been shown to be important for job creation. However, starting with Davis et al. (2006), research over the past ten years has shown that entrepreneurship as measured by the number of newly started firms relative to all firms in the economy has been in decline since the 1980s. This finding, surprising as it is considering the prominence of startups in popular culture, has led researchers, policymakers and the media to worry about the long run vitality of the US economy. The reasons for these concerns are twofold: First, the declining firm creation rate and its consequence, the shift of economic activity to older firms, can account for up to 30% of the decline in job reallocation rates over the past 30 years. Second, the declining firm creation rate is regarded as a symptom of more fundamental changes in the economy which might have negative consequences for aggregate productivity. Whether this latter point actually is a reason to worry, crucially depends on which fundamental shifts are found to be underlying the declining startup rate. One prominent explanation behind falling startup rates is that stricter regulations such as occupational licensing or zoning laws increased the costs of starting a firm (Davis and Haltiwanger, 2014). In the classic Hopenhayn (1992) framework of firm dynamics increasing startup costs would lead to a decrease in firm creation rates and a worsening of the productivity distribution.

In this paper I will explore an alternative explanation of the startup rate decline. I show that concurrent with declining startup rates, the importance of large firms in the US has increased and in particular that in almost all sectors large firms have become much larger. Furthermore, I show that the regions which saw the largest increase in the share of large firms also experienced the largest drop in startup rates. These stylized facts suggest that new establishments created due to the expansion of already existing large firms substituted for establishment entry by new firms. I propose a simple mechanism consistent with these

facts. Beginning in the 1980s reliance of firms on IT became more widespread, reducing organizational costs. For example, Rajan and Wulf (2006) show that managerial span of control increased and firm hierarchies became flatter between the end of the 1980s and 2000. In an organizational model close to Williamson (1967) this change in organizational constraints translates into higher returns to scale. Embedding an increase in returns to scale into the classic Hopenhayn (1992) framework leads to an increase in the size of large firms and along the transition path to a reduction in the firm creation rate. In contrast to the mechanism relying on an increase in startup costs, an increase in the return to scales under which firms operate leads to an improvement in the productivity distribution of active firms.

These findings suggest that the decreasing startup rate should not necessarily be seen as a symptom of shift in fundamentals which leads to a deteriorating productivity distribution. It is thus important to understand which fundamental shifts are consistent with the observed patterns in the data. I will show the implications of an improvement in organizational technology, leading to higher returns to scale, are broadly consistent with the empirical patterns. On the other hand, the implications of an increase in startup costs are not consistent with the observed changes in the firm size distribution.

## 1.1 Related Literature

This paper is related to a growing literature documenting the decline in US startup rates and the concurrent decline in business dynamism. Davis et al. (2006) was to my knowledge the first paper to mention the decline in business formation rates. They note that the declining dispersion in business growth rates between the 1970s and the 2000s can be partially explained by the contemporaneous decline in business entry and exit rates. The connection between declining startup rates and declining dynamism of firm growth and declines in labor market fluidity is a recurring theme in the literature. Decker et al. (2014) show that up to 30% of the decline in job reallocation rates can be explained by a shifting age structure of US businesses towards more mature <sup>1</sup> firms. Pugsley and Sahin (2015) show that this shift to-

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<sup>1</sup>Hathaway and Litan (2014c) show how dramatic that shift is

wards older firms is primarily caused by the reduction in startup rates over the same period. Adding to the decline in pure numbers, Decker et al. (2016) find that not only the dispersion in firm growth rates but also the skewness of growth rates declined. In particular, there have been less high growth (young) firms in the past years. Furthermore, the decline in startup rates is not confined to some part of the economy. To the contrary, business formation rates decline throughout all states and most metros (Hathaway and Litan, 2014b) and across all broad sectors (Decker et al., 2014).

New firms are an important factor for economic growth, especially for job growth. Haltiwanger et al. (2013) investigate the role young firms in job creation. New firms contribute up to 20% to gross job creation even though their share in overall employment is only 3%. Furthermore, as Decker et al. (2014) show almost all net job creation is due to new firms as incumbent firms in the aggregate destroy as many jobs as they create. Even though many young firms fail the long term impact of new firm cohorts is sizable. Due to the rapid growth of surviving firms, firm cohorts still contribute 80% of their initial employment five years after birth. The direct effect of young firms on productivity growth is not as clear cut. Foster et al. (2008) find that net entry contributes about 26% to overall productivity growth in a sample of manufacturing industries. Foster et al. (2006) analyze the retail sector and find that almost all of the productivity growth during the 1990s is caused by net entry effects. However, entry of new establishments of incumbent firms is much more important than entry of new firms in explaining productivity growth. Entry by new firms only accounted for 17% of productivity growth in their sample. While these studies used firm level data, Casares et al. (2016) using aggregate state level data on entry rates and per-capita GDP find no significant relationship between entry and per capita GDP growth. Nonetheless the literature overall suggests that entry, exit and reallocation are important for job and productivity growth.

Even though the startup rate decline has been shown to be pervasive across the industries and geographies and potentially troubling for the health of the US economy there is not yet a large literature exploring the sources of this decline. Hathaway and Litan (2014a) use

variation in startup rate declines across MSAs and investigate several potential sources of the decline in business formation with OLS regressions. They find a strong regression to the mean effect i.e. MSAs with large initial startup rates experienced the strongest declines. Furthermore, metros with higher population growth experienced weaker declines. They also look at the correlation with business consolidation and find only a very weak correlation. Note however that these regressions are potentially problematic as for example the initial startup rate and the change in business consolidation are highly correlated. Davis and Haltiwanger (2014) find significant negative effects of stricter labor regulations on labor market fluidity. They suggest that another effect could be that stricter regulation increases startup costs and thus decreases entry. On the other hand, Goldschlag and Tabarrok (2014) find that stricter regulation cannot be blamed for the decline in entrepreneurship. They run a battery of regressions using cross industry variation in federal regulation and startup rates and find no significant effect of regulation on firm creation. Furthermore stricter regulation should also negatively affect establishment creation by incumbents which we don't observe in the data (Hathaway et al., 2014).

A recent contribution by Karahan et al. (2016) explores the role of demographic change and in particular of a reduction in the labor force growth rate in explaining the decline in firm creation. Instrumenting state level changes in labor force growth by changes in state level fertility 20 years earlier they find that higher labor force growth causes higher firm creation rates. On the other hand, the effects on firm characteristics such as survival rates, firm growth or firm size are negligible. These findings are consistent with dynamics along the BGP in a variant of the Hopenhayn (1992) framework where a decrease in the labor force growth rate results in a decrease of the startup rate while leaving the distribution of active firm types unaffected. The analysis in Karahan et al. (2016) offers an interesting explanation of the decline in firm creation. However, the seeming time invariance of the firm size distribution is a result of aggregation. Within most sectors the firm size distribution changed dramatically over the last 35 years. While the largest manufacturing firms shrank, large firms in services or retail increased in size. As I will argue in this paper, these shifts in the firm size distribution might be the result of changes in the way firms operate which in turn could have important implications for industry dynamics and the startup rate.

One important development since the 1980s has been the increased use of information technology. For example Dunne et al. (2004) find that the percentage of manufacturing plants investing in IT increased from 10% in 1977 to 60% in 1992. Investment in information technology has also been closely linked to organizational change. Brynjolfsson et al. (2002) find that every dollar invested in IT increases the market value of a firm by ten dollars. Furthermore, firms that invest a lot in IT also change their work practices by e.g. distributing decision rights. They interpret their findings as suggestive for IT investment requiring (costly) organizational change in order to be productive. In turn the change in organizational structure creates value above the pure cost of IT investment. Bresnahan et al. (2002) also find that firms with the right organizational structure are particularly likely to invest in IT.

Several studies show that large firms disproportionately adopt and benefit from IT. The analysis of Doms et al. (2003) showed that introduction of IT in retail was a major driver of productivity growth during the 1990s in particular benefitting larger firms. Brynjolfsson and McElheran (2016) find that large manufacturing firms disproportionately adopt data-driven decision-making. Burke (2005) finds also finds a positive relationship between firm size and IT usage among smaller firms up to 250 employees.

Starting with Garicano (2000), a growing literature in macroeconomics has examined the effects of information and communications technology on firm organization. Garicano (2000) frames the production process as requiring the solution of different problems. Organizations are modelled as knowledge hierarchies, lower level workers try to solve the problems they encounter and direct problems they are unable to solve upwards in the hierarchy. Communications and information technology act as constraints on the ability to hand over problems and to acquire the relevant knowledge. Improvements in technology relax these constraints and lead to organizational change. In particular lowering communication or knowledge acquisition costs leads to increases in the span of control of managers and reductions in organizational costs. Garicano and Rossi-Hansberg (2006) put this basic notion of organizations into an equilibrium model and similarly find that decreases in communications cost or costs of knowledge acquisition translate into increasing span of control of managers. These models

are consistent with empirical evidence from Rajan and Wulf (2006). In a sample of over 300 large US firms they find that firm hierarchies became flatter between 1986 and 1999. In particular the span of control of managers has gone up significantly while the number of layers in management has decreased.

My model incorporates changes in organizational structure into a model of firm dynamics. I use a variant of the Hopenhayn (1992) model to investigate the implications of changes in span of control or delegation costs for industry dynamics. Using the particularly simple formulation of hierarchy costs in Williamson (1967), changes in the span of control directly translate into changes in the returns to scale under which firms operate. I show that the implications of a decrease in returns to scale, plausibly caused by changes in IT and communications technology, are consistent with changes in the firm size distribution and declines in the entry rate found in the data.

The rest of this paper is structured as follows. In section 2 I present the stylized facts on startup rates and the increasing importance of large firms. In section 3 I use a simple variant of the Hopenhayn (1992) model to compare different mechanisms consistent with decreasing startup rates along other dimensions that are observable in the data. Section 4 concludes the paper.

## **2 Empirical Analysis**

In this section I present evidence for the pervasive decline in business formation and the simultaneous change in the firm size distribution. I then analyse the relationship between declining business formation rates and changes in firm size using variation across 350 MSAs. But first let me describe the data I will be using.

### **2.1 Data description**

In order to analyze business formation rates and the firm size distribution I use the publicly available Business Dynamics Statistics (BDS) data product of the US Census. The BDS



is based on the US Census' Longitudinal Business Database (LBD) which is a yearly panel containing establishment level information on employment of nearly all private US establishments with at least one payroll employee in the week of March 12th each year. The Census is also able to aggregate individual establishments into firms, where a firm is a collection of all establishments under common ownership. The public use BDS data contains yearly data on e.g. the number of firms, the number of establishments or employment aggregated along different strata as e.g. sectors, MSAs, firm size groups or firm age groups. The data run from 1976 to 2014<sup>2</sup>.

In this data set, firm age is assigned according to the age of the oldest establishment in a firm. Establishments age naturally one year at a time and are assigned age 0 in the year when they first report positive payroll employment. I will denote age 0 firms as startups, thus a startup is a firm which is responsible for truly new business activity at a new location. M&A activity or legal reorganization of firms thus will not be classified as a startup.

## 2.2 Declining firm formation - stable firm exit

Figure 1 plots the time series of the aggregate firm creation rate between 1980 and 2013. I define the firm creation rate in year  $t$  as the number of new (age 0) firms in year  $t$  divided by the total number of firms in the previous year  $t - 1$ . The firm creation rate declined in steps, from about 13% in the 1980s to 11% in the 1990s, gradually going down to 10% in the 2000s and dropping to about 8% after the great recession. The blue trendline in figure 1 is a loess smoothed trend. This decline was not confined to a specific sector but occurred across the economy as can be seen in figure 2. Figure 2 plots for each broad sector<sup>3</sup> of the economy, the firm creation rate in each year relative to the firm creation rate in 1980. The sectoral firm creation rate is counted as the number of new firms in the sector in year divided by the total number of firms in that sector in the previous year. The firm creation rate did not decline at the same time in all sectors. However, by 2012, as the US recovered from the great recession, the firm creation rate of every broad sector was at least 25% below the level

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<sup>2</sup>I will be using data starting in 1979, due to data problems in 1977 and 1978 as noted by Moscarini and Postel-Vinay (2012). Furthermore when using MSA data I will start in 1981 due to data problems for Texas MSAs in 1979 and 1980.

<sup>3</sup>The sectors are agriculture; construction; finance, insurance and real estate; manufacturing; mining; retail; service; transportation, communication and utilities; wholesale.

of 1980. The broad based decline in firm creation suggests that a common factor is at work.

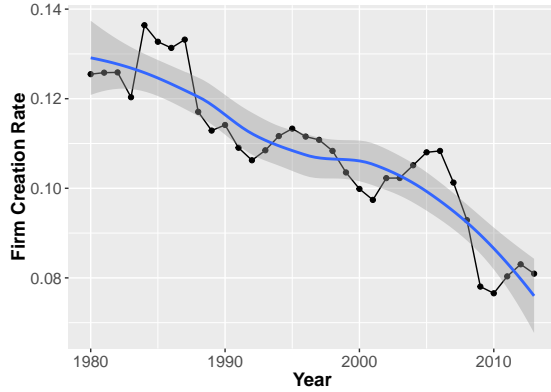


Figure 1: Firm creation rate

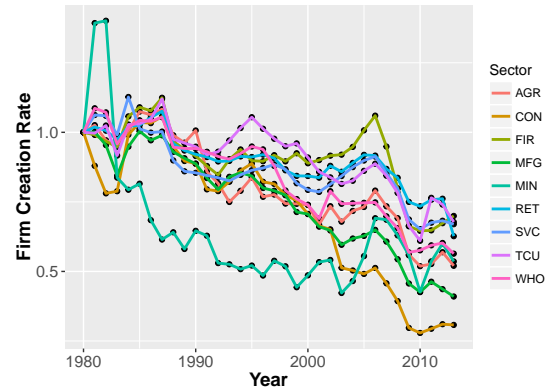


Figure 2: Firm creation rates by sector

The decline in firm formation was not countervailed by an increase in the size of firms. The employment weighted firm formation rate, i.e. the number of new jobs created by new firms in year  $t$  divided by the total number of jobs in the US economy in the previous year, shows a very similar time series behavior as the unweighted firm formation rate. The weighted firm creation rate drops from 3.75% in the early 1980s to 3% in the 1990s and early 2000s to 2% in the aftermath of the great recession. The sectoral picture shows more differences in the individual time series than for the unweighted firm formation rate. While the employment weighted firm creation rate is essentially flat until before the great recession in finance, manufacturing and transportation, communications and utilities, there is a notable decline since the end of the 1980s in services, retail and wholesale as well as construction. Notwithstanding these differences, by 2012 all sectors had an employment weighted firm creation rate of at least 25% below the level in 1980.

In contrast to the firm creation rate, the firm exit rate has remained considerably stable between 1980 and 2013. In figure 5 I plot the time series of the firm exit rate. The firm exit rate is defined as the number of firms that had positive employment in year  $t - 1$  but have no positive employment in year  $t$ , divided by the number of firms in year  $t - 1$ . Firm exit rates have been stable at an average around 8.5% to 8.75% since the mid 1980s with at most a very slight downward trend. Looking at the different sectors we see a similar picture. After a drop in firm exit rates in the early 1980s, sectoral firm exit rates have also remained relatively stable in most sectors. Retail and manufacturing have experienced a

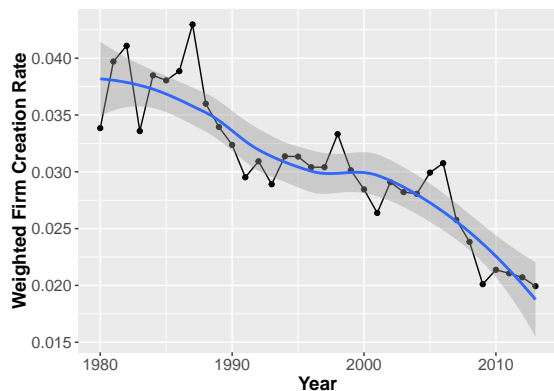


Figure 3: Employment weighted firm creation rate

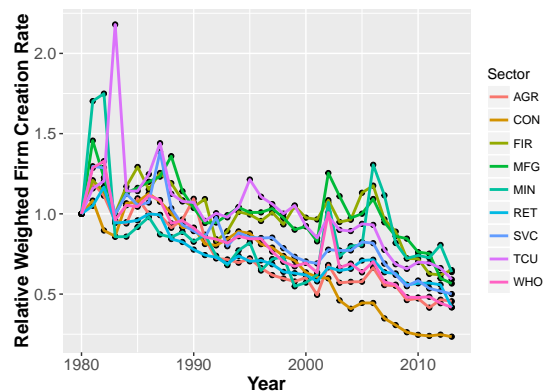


Figure 4: Employment weighted firm creation rates by sector

slight downward trend.

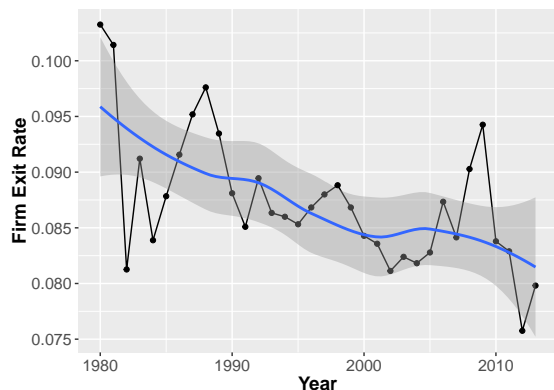


Figure 5: Firm exit rate

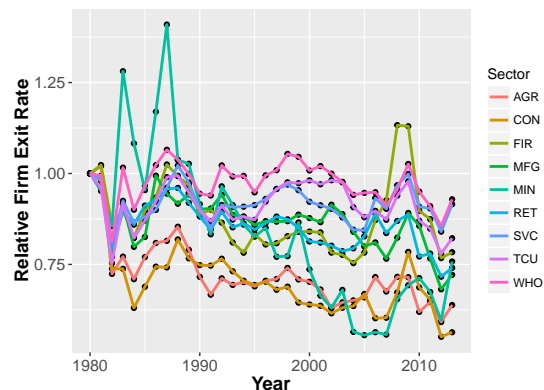


Figure 6: Firm exit rates by sector

The weighted firm exit rate shows a slightly different picture. The weighted firm exit rate is measured as the number of jobs destroyed by exiting firms divided by the total number of jobs in the previous year. The aggregate weighted firm exit rate declined from around 3% in the 1980s to 2.5% in the late 1990s and 2000s and declined slightly more after the great recession. This decline is stronger than for the unweighted firm exit rate which suggests that the size of exiting firms relative to the size of continuing firms declined between 1980 and 2010. The sectoral picture is not clear, while for example the weighted exit rate in service and retail have remained relatively stable, the weighted exit rate in manufacturing and construction declined significantly by about 30% to 40%.

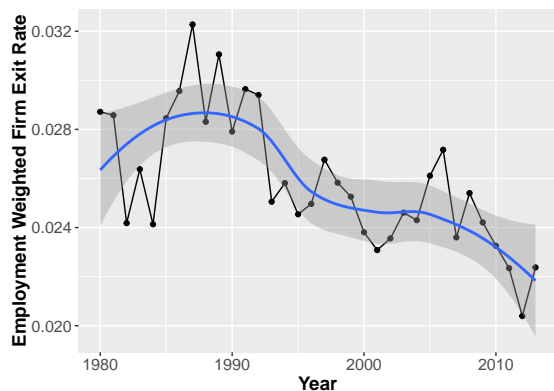


Figure 7: Employment weighted firm exit rate

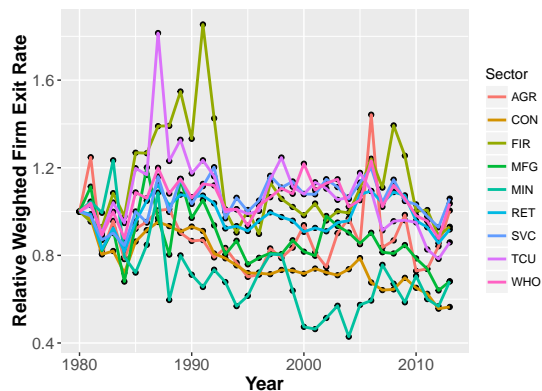


Figure 8: Employment weighted firm exit rates by sector

## 2.3 Changes in the firm size distribution

Over the same period during which the US economy experienced a decline in firm formation, the firm size distribution shifted significantly. Figure 9 displays the average size of firms in the US economy in terms of employment. While the average firm employed about 20 employees in 1980, that number increased by ca. 15% to an average of 23 employees per firm by the 2000s. This development is all the more notable as the reallocation of economic activity from manufacturing to services should have led to a decrease in the number of employees<sup>4</sup>. Within sector changes in average firm size however, more than compensated for this reallocational effect. Figure 10 displays the average employment per firm in each sector relative to the level in 1980. While the average firm size increased dramatically in retail and services, average firm size in manufacturing declined.

The change in average firm size is caused both by a in increase of the share of large firms and an increase in the size of large firms. In the 1980s the major driver of increasing firm size was a compositional shift towards larger firms, while the average firm size of large firms decreased. The decrease of the large firms' firm size was caused by the shift from manufacturing towards services. Starting at the end of the 1980s however, the increase in the size of large service and retail firms shown in figure 12 countered this sectoral shift and the average size of large firms started to increase dramatically. Note furthermore that especially the very largest firms increased in size. For example in the service sector, firms with more

<sup>4</sup>In 1980 manufacturing firms had an average of 75 employees while service firms employed on average 15 workers.

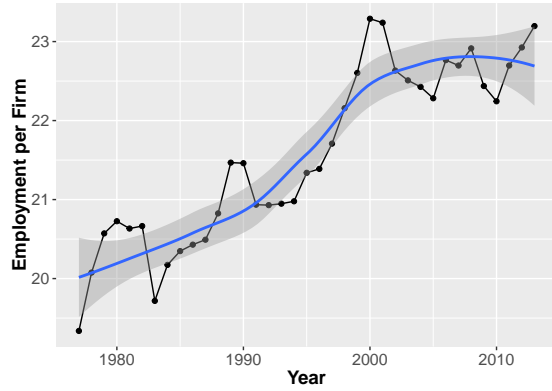


Figure 9: Average number of jobs per firm

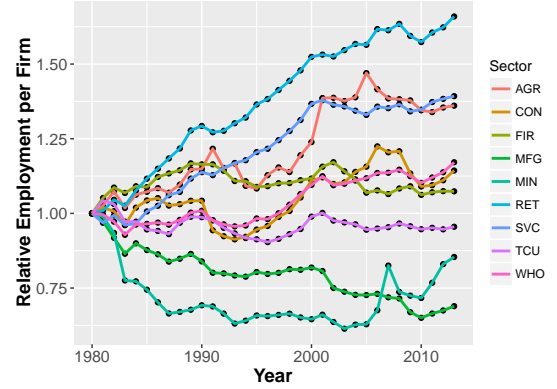


Figure 10: Average number of jobs per firm by sector

than 10000 employees increased their average number of employees by 150% between 1980 and 2010.

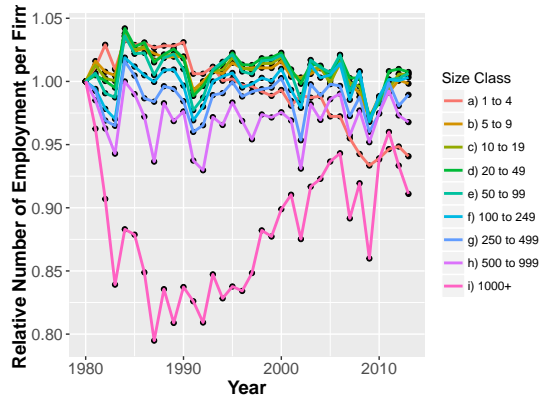


Figure 11: Number of jobs per firm relative to 1980, stratified by size class.

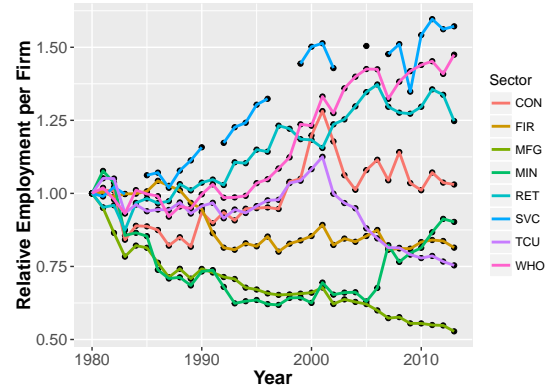


Figure 12: Number of jobs per firm, for firms with more than 1000 employees, relative to 1980, stratified by sector

The change in the average number of establishments run by each firm is similarly pronounced as the increase in employment per firm. Between 1980 and 2010 the average number of establishments per firm increased by about 10% from 1.22 to 1.33 establishments per firm. This development is plotted in figure 13. The increase in the number of establishments per firm is almost entirely due to within sector increases, as the differences between the service and manufacturing sector are much smaller than for employment. Figure 14 displays these within sector changes. The number of establishments per firm increases in almost all non-tradable sectors with strongest increases in finance, insurance and real estate, trans-

portation, communications and utilities and retail. Establishments per firm in the retail sector also increase consistent with the expansion of national retail chains in the 1990s.

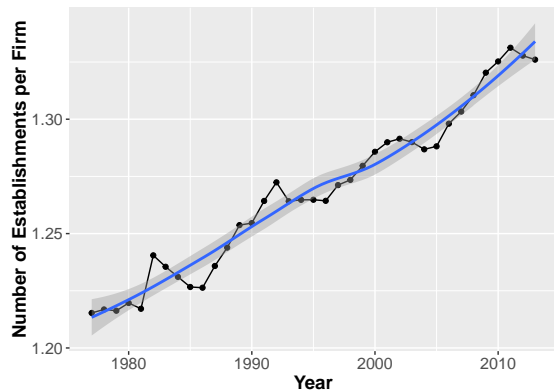


Figure 13: Average number of establishments per firm

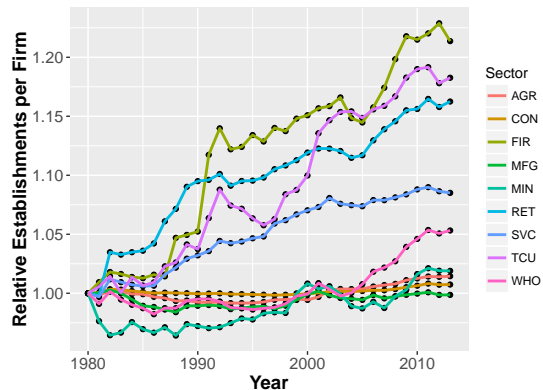


Figure 14: Average number of establishments per firm relative to 1980 by sector

The increasing number of establishments per firm is especially driven by the largest firms. Furthermore the main reason for the increase in the number of establishments per firm was not a shift towards larger firms but a within size group increase in the number of establishments per firm. Figure 15 plots the number of establishments per firm relative to the level in 1980 in 9 different firm size classes between 1980 and 2013. After an initial drop in establishments per firm for the largest firm size class in the 1980s, the number of establishments of firms with more than 1000 employees increased by about 40% between the late 80s and the 2000s. In figure 16 we can investigate how this within group change in the number of establishments per firm came about. Figure 16 displays the number of establishments per firm relative to the level in 1980, for firm with more than 1000 employees, subdivided by sectors. The drop in the early 1980s was caused by a drop in the number of establishments per large firm in manufacturing. The large increase after the late 1980s was due to a massive increase in the number of establishments per large firm in services and TCU. Between 1986 and 2006, the number of establishments operated by each large firm in services doubled.

Overall, large firms increased average employment and the average number of establishments per firm between the 1980s and the 2000s. The increase in firm size was especially pronounced in non-tradable sectors, while tradable sectors like mining and manufacturing show a different pattern. The increasing role of large firms in the economy can also be seen

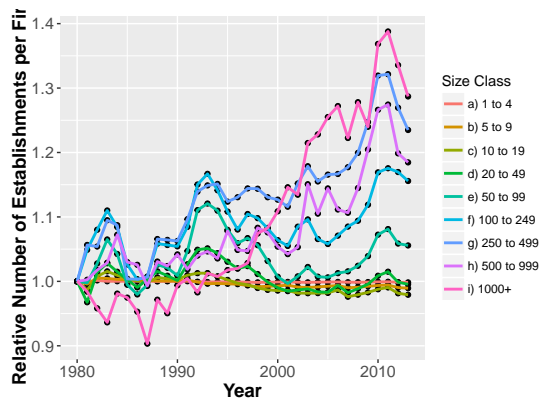


Figure 15: Average number of establishments per firm relative to 1980 by size class

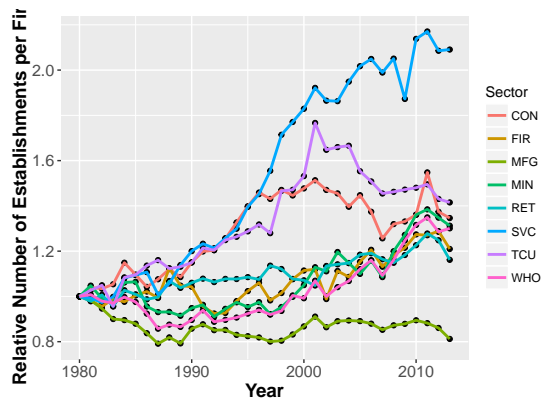


Figure 16: Average number of establishments per firm, for firms with more than 1000 employees, relative to 1980 by sector

geographically. For example, we can look at the presence of firms with overall more than 1000 employees across the metropolitan areas in the US. One measure of the presence of these firms is the percentage of firms that have an establishment in an MSA, which employ more than 1000 workers nationally. Alternatively we could look at the percentage of establishments in an MSA that belong to such firms. To get a feeling for these measures consider the following example: Assume that e.g. WalMart is not yet present in the New York metro area but is about to open a new store there. Then both the percentage of large firms active in the New York metro and the percentage of establishments operated by large firms in the New York metro would increase. If WalMart opens a second store in New York, only the percentage of establishments operated by large firms would increase, the percent of active firms that are large would not increase. In figures 17 and 18 I plot the median of both measures across all MSAs over time. In 1980, in the median MSA, firms with nationally more than 1000 employees made up 5.7% of all active firms. This number increased to over 8.3% by 2013. At the same time these firms also operated a larger fraction of establishments in the median MSA. The fraction of establishments operated by large firms increased from about 10% in 1980 to more than 17% in 2013. Overall, large firm increased their presence across the country.

The data on the firm size distribution show that large firms in the US increased in size, both in the average number of employees and in the average number of establishments. The size of large firms increased within almost all sectors and the presence of large firms increased

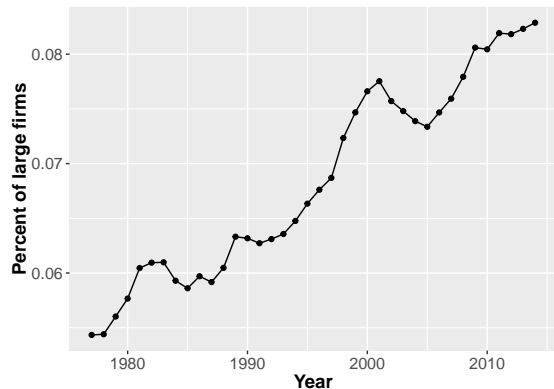


Figure 17: Percent of firms that are large, for the median MSA

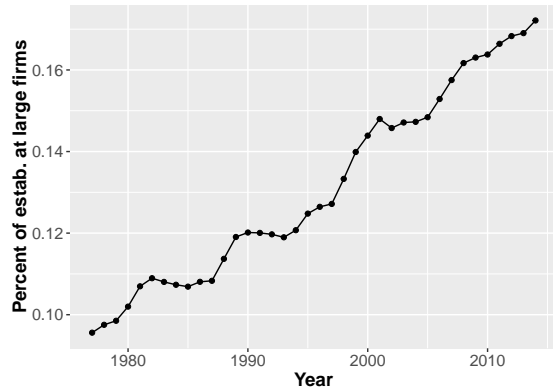


Figure 18: Percent of establishments operated by firms that are large, for the median MSA

throughout the whole country. These findings suggest that the optimal organization of large firms changed since 1980. A possible explanation is the wider use of IT over this period which reduces the cost of coordinating a larger number of establishments.

## 2.4 Cross sectional analysis

The increasing presence of large firms across MSAs might have reduced the entry of truly new firms. If instead of a new establishment of a new firm, a new establishment of an already existing firm is opening up, this is not recorded as a firm startup. Thus the substitution of new establishment of multi-establishment firms for entirely new firms has a direct negative effect on the startup rate. Furthermore there might be an indirect effect: establishments run by large multi-establishment firms exit much less frequently than establishments run by single establishment firms<sup>5</sup>. When less establishments exit, there is also less room for new entrants. In addition, new establishments of large firms are usually bigger than the average establishment by a new firm, further taking up demand from potential new entrants.<sup>6</sup>. Thus an increase in the presence of larger firms could also have an indirect negative effect on the startup rate. In figure 19 I plot the correlation between the fraction of firms in an MSA that are large and the firm creation rate in that MSA for the beginning of the 1980s and the years

<sup>5</sup>Note that the establishment exit rate by size class has an inverse U relationship. However, exit rates of firms with less than 5 employees are extremely high, more than double the exit rates of establishments at firms with more than 1000 employees.

<sup>6</sup>For example, Jia (2008) finds that the entry of one Wal-Mart store displaces 2-3 smaller stores.



just preceding the great recession. The correlation is clearly negative in both periods, as is the shift towards both lower startup rates and increasing presence of large firms in MSAs over between the time periods. Furthermore, the correlation between the presence of large firms and startup rates is not a result of differences in the sectoral composition of MSAs. Controlling for the fraction of employment in services, manufacturing and retail, increasing the fraction of of large firms in an MSA by 1 percentage point is associated with a 0.47 percentage point decrease in the startup rate. Now a natural question to ask is whether

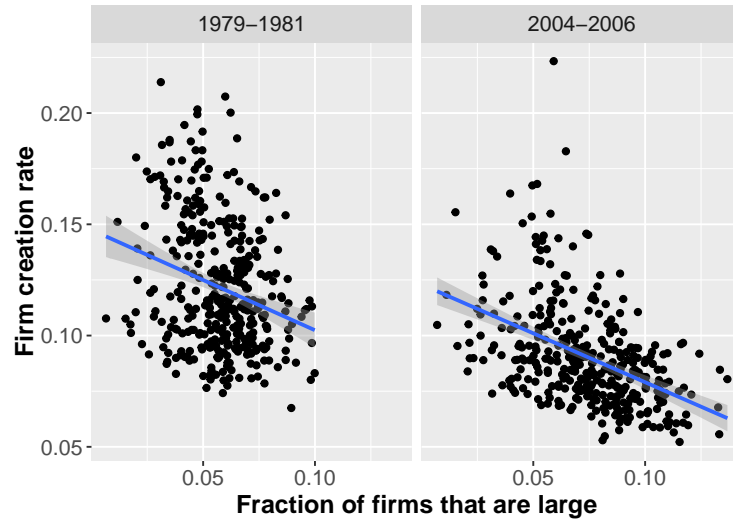


Figure 19: Correlation between presence of large firms and the firm creation rate

MSAs that saw a larger increase in the fraction of large firms also saw a larger decrease in the startup rate. I compare changes between the early 1980s (averages over 1979-1981) and the mid 2000s (averages over 2004-2006) just before the great recession. Figure 20 plots the raw correlation which is slightly negative but neither strong nor statistically significant. The change in the fraction of large firms is however, negatively correlated with the initial startup rate. A 1 percentage point increase in the startup rate is associated with a 1.14 percentage point lower decrease in the fraction of large firms. From Hathaway and Litan (2014a), we know that the startup rate exhibited a strong mean reversion between the 1980s and the 2000s. The correlation between initial startup rates and the change in startup rates is displayed in figure 21.

Not accounting for the mean reversion effect results in an upward bias of the correlation between the change in startup rates and the change in the fraction of large firms. Figure

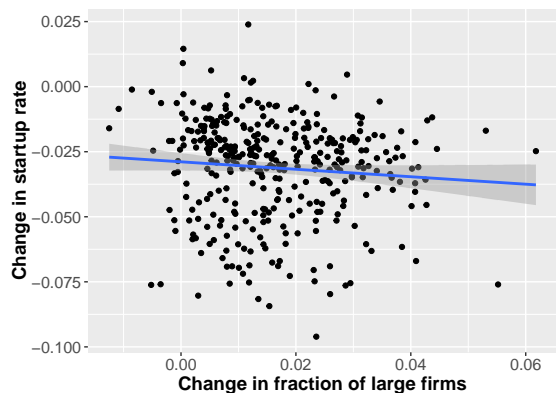


Figure 20: Correlation between changes in the presence of large firms and changes in the startup rate between 1979-81 and 2004-06

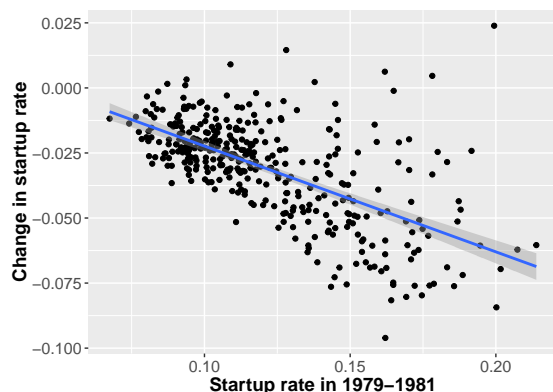


Figure 21: Correlation between the startup rate in 1979-81 and changes in the startup rate between 1979-81 and 2004-06

22 thus displays the correlation between residual change in startup rates, after accounting for mean reversion, and the change in the fraction of large firms. The correlation is clearly negative, a one percentage point increase in the fraction of large firms in an MSA is associated with a 0.75 percentage point decrease in the firm creation rate. Importantly, accounting for changes in total employment or industry composition of the MSAs does not significantly affect this conclusion.

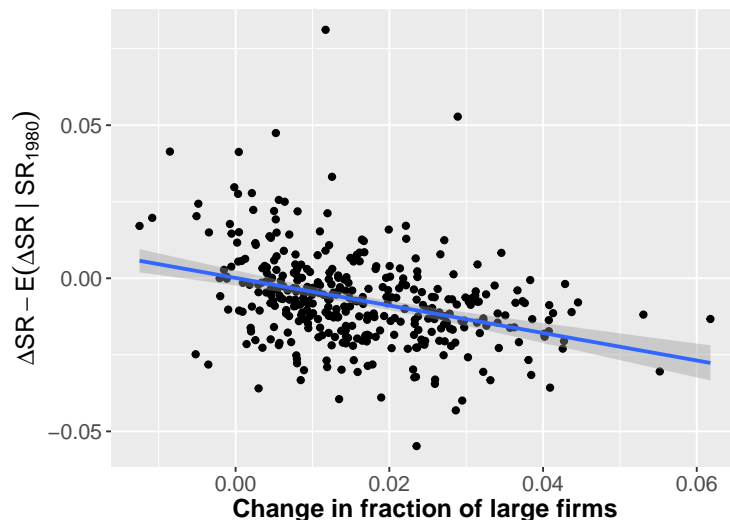


Figure 22: Correlation between changes in the presence of large firms and changes in the startup rate, purged of mean reversion, between 1979-81 and 2004-06

### 3 A Model of Firm Dynamics and Organizational Change

The empirical analysis showed that simultaneous with the decrease in startup rates, firms in the US became bigger. In particular large firms increased in size and furthermore increased their presence across metropolitan areas in the US. I finally showed that the metropolitan areas that saw the presence of large firms increase most also experienced the largest declines in firm formation rates after controlling for mean reversion. In this section I present a simple model of industry dynamics which rationalizes these facts.

The model is a variant of the Hopenhayn (1992) model. The economy is populated by a continuum of firms that produce a homogeneous good. Demand for the homogeneous good is assumed to be exogenous. The output market is assumed to be competitive with price  $p_t$ . Time is discrete.

#### 3.1 Firms

Each firm is indexed by idiosyncratic productivity  $\phi$ , which is fixed over time and equivalent to the output of that firm when it runs a single establishment. If a firm wants to run multiple establishments it has to build up a hierarchy of managers which coordinate these plants. I model this hierarchy along the lines of Williamson (1967). Assume that each manager has span of control  $s > 1$ . For example assume that each manager has span of control 2 and that the firm wants to run 4 establishments (tier 0). Then it has to hire 2 lower level (tier 1) managers, each of which manages 2 establishments. In addition the firm has to hire an upper level (tier 2) manager who coordinates both lower level managers. Overall if the firm has  $n$  management layers it can run  $s^n$  establishments. Furthermore assume that some friction results in a productivity loss  $l \in [0, 1)$  between each layer. This friction could for example be non-alignment of interests. Then the resulting productivity of a single establishment for a firm with  $n$  layers and idiosyncratic productivity  $\phi$  is  $\phi(1 - l)^n$ . Then the maximum output of such a firm is  $F(n) = s^n \phi(1 - l)^n$ . Note that this firm runs  $e = s^n$  establishments, so it holds that  $n = \log(e)/\log(s)$ . For analytical convenience I disregard the integer constraint

on  $n$ . We can thus rewrite the production function in terms of establishments as

$$F(e) = \phi e(1-l)^{\log(e)/\log(s)} = \phi e^{1+\log(1-l)/\log(s)}$$

For notational convenience we define:

$$\alpha = 1 + \log(1-l)/\log(s) < 1$$

The inequality holds due to the assumption that  $l \in (0, 1]$  and  $s > 1$ . The production function thus exhibits decreasing returns to scale in the number of establishments. Now consider the costs of the firm. Assume that running an establishment costs  $\tilde{c}_e$ . The hierarchy of managers however, also entails costs. Assume that conditional on the number of layers of the hierarchy the managerial wage increases, the higher on is in the hierarchy. Furthermore assume that conditional on the layer, a manager in a firm with a smaller hierarchy earns more. The intuition for the second assumption is, that distance to the top layer reduces wages i.e. the CEO of a firm with 2 establishments earns more than the area manager of a firm with 4 establishments even though both are in layer 1 and manage 2 plants. Specifically I assume that conditional on the total number of layers wages increase geometrically per layer with factor  $\beta$  and conditional on the layer, wages decrease inversely to the number of layers. Denote the managerial wage of a tier 1 manager of a firm with only 1 layer by  $w$ . Then a manager in layer  $i$  of a firm with a total of  $n$  layers earns  $\frac{w\beta^{i-1}}{n}$ . Total costs of a firm with  $n$  layers are

$$s^n \frac{w}{n} + s^{n-1} \frac{w\beta}{n} + \dots + s \frac{w\beta^{n-2}}{n} + \frac{w}{\beta^n}$$

Assuming that the wage increase per level is proportional to the span of control i.e.  $\beta = s$  yields total costs of the hierarchy as:

$$C_h(n) = s^{n-1}w = e \frac{w}{s}$$

which is linear in  $e$ . Then the effective costs per establishment, taking into account the costs of the hierarchy are:

$$c_e = \tilde{c}_e + \frac{w}{s}$$

Total per period profit in period  $t$  of a firm with  $e_t$  establishments is then:

$$\pi_t = p_t \phi e_t^\alpha - c_e e_t$$

Assume that firms only exit exogenously with probability  $\delta \in (0, 1)$  and discount the future at rate  $R < 1$ . Furthermore assume that in order to be active, the firm has to run at least one establishment, then the discounted present value of profits is:

$$V_t(\phi) = \max_{e_t \geq 1} p_t \phi e_t^\alpha - c_e e_t + R(1 - \delta) \mathbb{E}[V_{t+1}(\phi)]$$

### 3.2 Industry dynamics

Each period an endogenous measure  $M_t^e$  of potential entrants pay entry costs  $c_0$  to generate a business idea. A business idea is a draw of the idiosyncratic productivity level  $\phi$ , drawn from distribution  $F(\phi)$ . I assume that  $F$  is pareto with shape  $\beta > 1$  and some small scale  $\phi_{min}$ . In order for equilibrium output to remain finite I have to assume that  $\beta(1 - \alpha) > 1$ . Assuming a pareto distribution allows me to derive comparative statics in closed form. After drawing the idiosyncratic productivity, the potential entrants enter if  $V_t(\phi) \geq 0$ , which implicitly defines a cutoff  $\phi_0$  such that potential entrants enter if  $\phi \geq \phi_0$ . The free entry condition requires that the benefit of entering equals the costs i.e.:

$$\int_{\phi_0}^{\infty} V_t(\phi) dF(\phi) = c_0$$

The productivity distribution evolves over time due to entry and exit. Let  $M_t^f$  be the mass of active firms and  $G_t(\phi)$  the productivity distribution. Then the productivity distribution evolves according to:

$$M_t^f G_t(\phi) = \begin{cases} \underbrace{M_{t-1}^f (1 - \delta) G_{t-1}(\phi)}_{\text{Continuers}} + \underbrace{M_t^e [F(\phi) - F(\phi_{0,t})]}_{\text{Entrants}} & \phi \geq \phi_{0,t} \\ \underbrace{M_{t-1}^f (1 - \delta) G_{t-1}(\phi)}_{\text{Continuers}} & \phi < \phi_{0,t} \end{cases}$$

### 3.3 Demand

Demand for the homogeneous good is assumed to be exogenous and downward sloping.

$$Q^d = \frac{D}{p_t}$$

where  $D$  can be thought of as the market size.

### 3.4 Equilibrium

**Definition 1** (Sequential Competitive Equilibrium). *A sequential competitive equilibrium is a sequence of values:*

$$\left\{ p_t, \phi_{0,t}, M_t^e, M_t^f \right\}_{t=1}^{\infty}$$

*and functions*

$$\{V_t(\phi), e_t(\phi), G_t(\phi)\}_{t=1}^{\infty}$$

*given an initial state  $M_0^f, G_0(\phi)$ , such that*

*a) Firms operate at the optimal scale*

$$e_t(\phi) = \max_{e \geq 1} p_t \phi e^\alpha - c_e e$$

*b) The discounted value of profits satisfies:*

$$V_t(\phi) = \sum_{\tau=t}^{\infty} [R(1 - \delta)]^{\tau-t} (p_\tau \phi e_\tau(\phi)^\alpha - c_e e_\tau(\phi))$$

*c) Potential entrants only enter if it is profitable, i.e. the cutoff  $\phi_{0,t}$  satisfies:*

$$V_t(\phi_{0,t}) \geq 0$$

*d) The free entry condition is satisfied*

$$\int_{\phi_{0,t}}^{\infty} V_t(\phi) dF(\phi) = c_0$$

e) *The market clears:*

$$\frac{D}{p_t} = M_t^f \int_{\phi_{min}} \phi e_t(\phi)^\alpha dG_t(\phi)$$

f) *The productivity distribution evolves according to its law of motion*

$$M_t^f G_t(\phi) = \begin{cases} M_{t-1}^f (1 - \delta) G_{t-1}(\phi) + M_t^e [F(\phi) - F(\phi_{0,t})] & \phi \geq \phi_{0,t} \\ M_{t-1}^f (1 - \delta) G_{t-1}(\phi) & \phi < \phi_{0,t} \end{cases}$$

### 3.5 Steady State

The model has two states, the productivity distribution of active firms  $G(\phi)$  and the mass of active firms  $M^f$ . In steady state both states have to be stationary. Stationarity then also implies a constant mass of potential entrants  $M^e$ , price  $p$ , cutoff  $\phi_0$ , establishment number  $e(\phi)$  and value function  $V(\phi)$ . We can derive the stationary distribution  $G$  as well as the firm entry rate in steady state from the law of motion of  $G$ :

$$\lambda M^f G(\phi) = M^e [F(\phi) - F(\phi_0)] \forall \phi$$

which yields an entry rate of  $\lambda$  in steady state and a stationary distribution

$$G(\phi) = \frac{F(\phi) - F(\phi_0)}{1 - F(\phi_0)}$$

Using the market clearing condition we can directly derive the mass of firms in steady state:

$$M^f = \frac{D}{c_e} \frac{1}{\frac{\beta}{1-\beta} (\alpha^{\beta-1} - 1) - \frac{(1-\alpha)\beta}{1-\beta(1-\alpha)} \alpha^{\beta-1}}$$

Note that due to the constant price the discounted present value is positive iff the period profit is positive. The productivity cutoff is then defined by  $\phi_0 = c_e/p$ . Using the free entry condition we can derive the cutoff level  $\phi_0$  as:

$$\phi_0 = \left( \frac{c_e \phi_{min} \left[ \frac{1-\alpha^{\beta-1}}{\beta-1} + \frac{(1-\alpha)^2 \alpha^{\beta-1} \beta}{(\beta-1)(1-\alpha)-\alpha} \right]}{R(1-\lambda)c_0} \right)^{1/\beta}$$

Furthermore we can derive several aspects of the firm size distribution. For example the average number of establishments per firm in steady state is given by:

$$\mathbb{E}(e) = 1 + \frac{\alpha^\beta}{\beta(1-\alpha) - 1} > 1$$

while the average firm size for firms with more than  $\underline{e} > 1$  establishments is given by:

$$\mathbb{E}(e|e \geq \underline{e}) = \underline{e} \frac{\beta(1-\alpha)}{\beta(1-\alpha) - 1}$$

and the fraction of establishments at firms that have more than  $\underline{e} > 1$  establishments is:

$$\frac{\mathbb{E}(e|e \geq \underline{e}) \times \mathbb{P}(e \geq \underline{e})}{\mathbb{E}(e)} = \frac{\underline{e}^{1-\beta(1-\alpha)}}{1 - \frac{\beta(1-\alpha)-1}{\beta(1-\alpha)}(1 - \alpha^{-\beta})}$$

Note that the empirical counterparts to these measures all increased between 1980 and 2013.

### 3.6 Comparative Statics

With the most important steady state measures at hand in terms of model fundamentals: the returns to scale  $\alpha$ , the shape of the productivity distribution  $\beta$ , the entry cost  $c_0$  and the cost of running an establishment  $c_e$ , we can now conduct some comparative statics exercises.

**Proposition 1** (Changes in span of control). *An increase in span of control  $s$  leads to an increase in returns to scale  $\alpha$ . In steady state an increase in returns to scale  $\alpha$  causes:*

- a) The productivity cutoff  $\phi_0$  to increase.*
- b) The number of active firms  $M^f$  to decrease.*
- c) The mean firm size to increase.*
- d) The conditional firm size and the percentage of establishments at firms with more than  $\underline{e} > 1$  establishments to increase for all  $\underline{e} > 1$*

The mechanics behind these results are quite intuitive. Everything else equal, an increase in the returns to scale leads to an increase in the optimal number of establishments  $e(\phi)$  run



by each firm. An increase in the number of establishments yields higher output, which in order to be sold has to be marketed at a lower price. Thus the price decreases. The lowest productivity firms however don't benefit from the increase in returns to scale as they are still constrained to produce with one establishment (actually they would want to produce with less than one establishment). Thus the decrease in price decreases the profits of the lowest productivity firms below zero and they drop out, which increases the cutoff  $\phi_0$ . The increase in the number of establishments given  $\phi$  and the increase in the productivity cutoff directly yield the results on the firm size distribution. The effect on the number of firms is ambiguous as both an increase as well as a decrease in  $M^f$  would be consistent with prices increasing. However, we can show that average firm output increases more than demand per firm and thus the total mass of active firms decreases. Note that due to the assumption of an exogenous exit rate, the entry rate in steady state will be fixed at  $\lambda$ . However along the transition path from a low  $\alpha$  to a high  $\alpha$  steady state, as the number of firms decreases, the entry rate has to decrease as well. Note that I define the entry rate in accordance with the data as the number of newly active firms divided by the total number of firms in the previous period  $M^e[1 - F(\phi_0)]/M^f$ . Other papers have used the number of potential entrants divided by the total number of firms  $M^e/M^f$ .

**Proposition 2** (Changes in entry costs). *An increase in span of control  $s$  leads to an increase in  $\alpha$ . In steady state an increase in  $\alpha$  causes:*

- a) The productivity cutoff  $\phi_0$  to decrease.*
- b) The number of active firms  $M^f$  to remain constant.*
- c) The mean firm size to remain constant.*
- d) The conditional firm size and the percentage of establishments at firms with more than  $\underline{e} > 1$  establishments to remain constant for all  $\underline{e} > 1$*

The mechanics here are also intuitive. An increase in the cost of entering  $c_0$  requires by the free entry condition that the expected benefit of entering has to increase in order to balance the increased costs. Thus the value  $V(\phi)$  has to increase for at least some productivity draws, which is only possible if the price  $p$  increases. Intuitively as the cost of

entering increases, less entrepreneurs decide that they want to take a productivity draw, supply decreases and the price increases. An increase in  $p$  however directly translates into a decrease of the productivity cutoff as productivity draws that were previously marginally unprofitable become profitable. Thus  $\phi_0$  decreases and the productivity distribution of active firms deteriorates. Interestingly the fall in output per firm exactly matches the decrease in demand per firm such that the total mass of active firms remains unchanged in steady state. Furthermore, the firm size distribution is also unchanged, however the same number of establishments now produce a lower output i.e. aggregate productivity of the economy deteriorates.

Comparing the comparative statics of changes in the span of control and changes in the cost of entry we find that an increase in the span of control causes shifts in the firm size distribution which are consistent with the data while an increase in the cost of entry does not. Furthermore along the transition path an increase in the span of control also causes the entry rate to decline. In future work, introducing endogenous exit in the analysis will be a priority. Importantly, while consistent with an increase in several measures of the firm size distribution and a decrease in the startup rate, increases in span of control do not lead to a worse productivity distribution. Thus a decrease in the startup rate is not necessarily the symptom of a “bad” shift in fundamentals.

## 4 Conclusion

In this paper I studied the decline in startup rates and linked it with the concurrent increase of the role and size of large firms in the US economy over the past 30 years. The empirical contribution of this paper is twofold. First I document the massive increase in the size of large firms over the past 30 years both in terms of average employment and even more so in terms of the number of establishments per firm. I show that these trends have been especially pronounced in the expanding sectors of the economy such as services and retail. Furthermore the increase in firm size resulted in a rising the presence of large firms across US metro areas. Second I showed that metro areas which experienced stronger increases in the presence of large firms also experienced stronger decreases in the startup rate after

controlling for mean reversion.

I then used an industry dynamics model to rationalize the empirical findings. Drawing on previous empirical literature changes in firm organization during the 1980s and 1990s, I examined the comparative statics of an increase in the span of control of managers. In the model an increase in the span of control of managers leads both to a decrease in entry rates and an increase in the average size of large firms, consistent with the data. Importantly, while reducing the startup rate, the increase in span of control leads to an improvement of the average productivity in the model economy. Thus lower startup rates are not necessarily a “bad sign”, as suggested by parts of the literature, media and policy makers.

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