The Role of Nonemployers in Business Dynamism and Aggregate Productivity[†]

Pedro Bento
Texas A&M University[*]

Diego Restuccia
University of Toronto
and NBER[**]

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Abstract

A well-documented observation in the U.S. economy in the last few decades has been the steady decline in the net entry rate of employer firms, a decline in business dynamism, suggesting a possible connection with the recent slowdown in aggregate productivity growth. We consider the role of nonemployers, businesses without paid employees, in business dynamism and aggregate productivity. Notwithstanding the decline in the growth of employer firms, we show that the total number of firms, which includes nonemployer businesses, has increased in the U.S. economy since the early 1980s. We interpret this trend, along with the evolution of the employment distribution across firms, through the lens of a standard theory of firm dynamics. The model implies that firm dynamics have contributed to an average annual growth rate of aggregate productivity of at least 0.26% since the early 1980s, over one quarter of the productivity growth of 1% in the data. Further, our implied measure of productivity growth moves closely over time with measured productivity growth in the data.

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JEL codes: O1, O4, O5, E02, E1.

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[*]Department of Economics, Texas A&M University, 3056 Allen Building, 4228 TAMU, College Station, TX 77843, USA. E-mail: pbento@tamu.edu.

[**]Department of Economics, University of Toronto, 150 St. George Street, Toronto, ON M5S 3G7, Canada. E-mail: diego.restuccia@utoronto.ca.

1 Introduction

A number of recent papers have documented a slowdown in business startups and entrepreneurship in the United States over the last several decades. Interpreted through the canonical theories of firm size and firm dynamics, such as Hopenhayn (1992), the slowdown in business startups has been proposed as a potential source of the secular decline in aggregate productivity growth since the Great Recession (Decker et al., 2016; Furman and Orszag, 2018). In standard models of firm heterogeneity, aggregate output depends on aggregate factor inputs and a term that aggregates the productivity of all firms, which also depends on the total number of firms. In this context, measured total factor productivity (TFP)—the aggregate amount of output per unit of composite aggregate inputs—depends on the total number of firms and, hence, a fall in the entry rate generates a fall in measured TFP. Several recent papers however, including Decker et al. (2016) and Li (2017), have noted that commonly used measures of business dynamism appear unrelated to estimates of TFP growth before the Great Recession.

In this paper, we construct a comprehensive measure of U.S. businesses that includes nonemployers, that is businesses that are subject to federal income tax and that have no paid employees, composed solely of owner-managers and unpaid workers such as family members. We show that the startup rate in this measure of firms has not declined, instead it has increased substantially. The literature on business dynamism has thus far focused on employer firms, firms with at least one paid employee, abstracting from nonemployer firms. But since nonemployer businesses account for 82% of all firms in 2014, its evolution over time is an important determinant of changes in the total number of firms. We combine data on employers from the Business Dynamics Statistics (BDS) with data on nonemployers from the Nonemployer Statistics (NES), as well as additional sources of data, to construct a measure of the total number of U.S. businesses from 1981 to 2014. We focus on the number of firms per worker, which according to standard theory, is the relevant measure when drawing implications for aggregate productivity (Hopenhayn, 1992; Karahan et al., 2018). Even though the number of employer firms per worker decreased by 4.5% from 1981 to 2014—consistent with the findings in Karahan et al. (2018)—the total number of firms per worker in our measure increased by 53% over the same period.

We consider a standard model of firm entry in order to study the divergence between the total number of firms and the number of employer firms, and its impact on aggregate productivity. In the baseline model the distribution of firm-level productivities is constant over time but we allow for time variation in aggregate employment as observed in the data. We assume that the cost of entry changes over time in order to match the observed evolution in the total number of firms. We show that even in this simple framework, the model generates a growth rate in the number of employer firms that closely matches that observed in the data. In the model, the increase in the number of firms per worker implies an annualized growth rate in aggregate TFP of 0.26% from 1981 to 2014, about one quarter of the actual growth in measured TFP. In contrast, using the number of employer firms per worker as is standard in the literature, the model implies a slightly negative annualized growth rate of TFP. Over 33 years, these implied differences compound into a cumulative increase in aggregate TFP of 9% when using the total number of firms per worker and −1% when using the number of employer firms per worker.

We extend the baseline model to allow for changes in average productivity over time, which arise from differential exit rates of employers and nonemployers and from differential rates of firm-level productivity growth. We discipline these features using data on exit rates and changes in the employment-size distribution of entrants and incumbents over time. Under relatively weak structural assumptions commonly made in the firm-dynamics literature, we show how this additional data can be combined with data on the total number of firms to derive the change in the average productivity of firms over time, up to a constant, that is, relative to any change in productivity common to all firms. We find that average firm-level productivity has increased from the 1980s to 2014, making the implied cumulative increase in aggregate TFP in the extended model 11.5% or an annualized growth rate of 0.34%, compared to a cumulative 9% or annualized growth rate of 0.26% in the baseline model. Further, TFP growth implied by the model correlates quite well with observed TFP growth over the medium and longer run. This result is in striking contrast to TFP growth implied by a model accounting only for employer firms. When we calculate TFP in the model using employers as our measure of the number of firms, the implied TFP growth is essentially unrelated with observed TFP growth over time.

We emphasize the importance of nonemployers when drawing inferences from firm dynamics. The neoclassical model aggregates the production of all firms and treats aggregate output as equivalent to that produced by a representative firm. As a consequence, to the extent that the smallest firms account for a very small portion of aggregate output, it may be reasonable to abstract from these firms when analyzing aggregate output. But in the neoclassical model, aggregate TFP is left unexplained. Recognizing micro-level production, Hopenhayn (1992) and Melitz (2003) provide frameworks that rationalize production heterogeneity in narrow industries that can be used to assess the implications of firm dynamics on aggregate TFP.[1] An important insight from these models of firm dynamics is that measured aggregate TFP can be expressed as a function of average firm-level productivity and the *total* number of firms. While the relatively low contribution of nonemployers to aggregate output must be taken into account, the number of nonemployers can have important implications for aggregate TFP.

Our paper contributes to the literature by providing a more comprehensive measure of business dynamism than in existing work and by providing a quantitative assessment of this measure of business dynamism to aggregate productivity growth. By providing a comprehensive measure of business dynamism, we complement the important work of Decker et al. (2014) documenting the decline in business dynamism in the U.S. economy since the early 1980s. Decker et al. (2014) emphasize the decline in net entry rates for employer firms, whereas we show that the net entry rate of all firms has not declined. Karahan et al. (2018) and Hopenhayn et al. (2019) document the declining trend in aggregate employment growth and assess the contribution of this factor to changes in the net entry of firms. These papers note that employer firms per worker has declined only marginally, and conclude that changing business dynamism has not been a quantitatively

[1] While our theoretical framework builds on Hopenhayn (1992), Hopenhayn (2011) shows that the monopolistic competition model of Melitz (2003) generates identical implications for aggregate TFP given appropriate values for model parameters.

significant driver of aggregate TFP trends. We show that this conclusion changes dramatically when considering nonemployers in the total number of firms. Li (2017) uses employer data over a similar time period to show that the net entry rate of employer firms is not highly correlated with TFP growth over the medium and long run in the U.S. economy. Our paper complements this literature by considering a comprehensive measure of net entry indicating a substantial increase in business dynamism over time in the U.S. economy and by showing that movements in business dynamism have been an important contributor to the medium and long-run movements of aggregate productivity. Our work is also related to Hsieh and Klenow (2014), Bento and Restuccia (2017), and Bento (2019), who emphasize mechanisms through which a larger number of firms per worker can be associated with *lower* aggregate productivity across countries. We use employment and establishment data to argue that these mechanisms are not important in accounting for the U.S. experience in recent decades.

The paper proceeds as follows. In the next section, we review the evidence on nonemployers and discuss why they may matter for business dynamism. Section 3 describes the data for employers and nonemployers and reports observed trends in the variables of interest. In Section 4, we present our baseline model of firm entry to assess the quantitative impact of changes in firms per worker on aggregate productivity. We use the model to highlight a mechanism through which the number of employer and nonemployer firms can diverge over time. Section 5 extends the analysis to include differential firm exit rates and firm-level productivity growth showing that the implied TFP growth rate from firm dynamics is even larger than in the baseline model. In Section 6, we assess the importance of alternative potential drivers of firm dynamics for the analysis of the U.S. economy over time. We conclude in section 7.

2 Nonemployer U.S. Businesses

We aim to construct a comprehensive measure of the total number of firms in the U.S. economy in order to assess the role of changes in net entry on aggregate productivity. In particular, we focus on a measure of the total number of firms that includes nonemployer businesses. Nonemployer businesses are firms with no paid employees, including self-employed entrepreneurs. A comprehensive measure of firms may be relevant in understanding changes in net entry rates over time, as it is the case when considering very small firms in the context of cross-country differences in establishment size (Bento and Restuccia, 2017, 2018).

There are many economic questions for which abstracting from nonemployers in the analysis is reasonable, as nonemployers contribute little to aggregate output in the U.S. economy. For instance, although nonemployers constitute 82% of all U.S. businesses in 2014, they represent only a small fraction (about 4%) of total revenues. However, standard theories of firm size and firm dynamics suggest that the patterns of firm entry and exit are essential for aggregate productivity implications, and hence, in this context, it is important for the analysis to account for all firms. This is the case even if nonemployers are less productive than employer firms and account for a small proportion of output and employment, although these characteristics obviously need to be taken into account.

Including nonemployers in the total measure of firms raises several questions that need to be addressed. Are nonemployer firms using different technologies than employer firms? Are nonemployers operating in different product markets? Or instead are nonemployers simply the same as employer firms albeit with lower productivity? Recent papers by Acs et al. (2009), Davis et al. (2009), and Fairlie et al. (2018) analyze nonemployers in the U.S. economy in some detail, providing a characterization of nonemployers that can be compared with employer firms.

This literature documents that nonemployers coexist with employers within narrow industries and that nonemployers are a smaller fraction of firms in industries where firms are larger on average (in terms of employment). The survival rate of nonemployer startups is close to that of employer startups. Although data on employment in nonemployers (i.e., owner-managers and unpaid workers) are not available, average growth rates of revenue are similar to that of small employer firms. A small percentage of nonemployers transition into employer status each year, roughly consistent with employment growth rates among small employers. Finally, considering differences in average revenue across different firm-size classes, nonemployers do not appear distinct to small employer firms in terms of relative size. For instance, comparing employer firms with 10 to 20 employees to employer firms with 1 to 5 employees—a 5-fold difference in average employment between these two groups—we find that there is a 6-fold difference in average revenues. Comparing employer firms with 1 to 5 employees to nonemployers, we find approximately the same 5-fold factor difference in average revenues. The main difference between employer and nonemployer firms other than their size appears to be their probability of exit, which again is consistent with a declining hazard exit rate with firm size. While about 8 to 9% of employers exit each year, nonemployers exit at a higher rate of 15% (Davis et al., 2009).

The main takeaway from the discussion of the above facts is that it is reasonable to treat nonemployers as similar to employers, but operating at a lower scale—perhaps because of lower productivity—with implied higher exit rates. Using these facts, in Section 4 we develop a model of firm entry and firm size that classifies nonemployer firms as production units operating with with less than one unit of labor.

3 Data

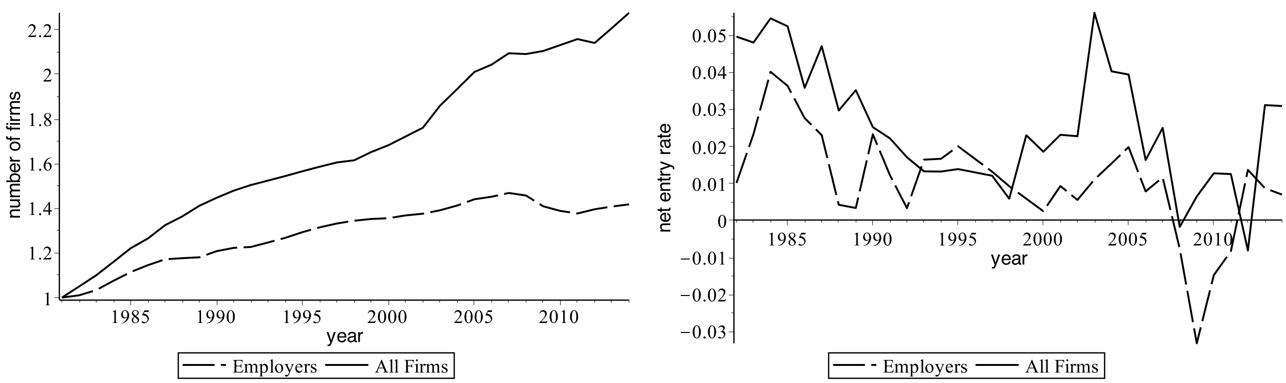
We describe data sources and the procedure we follow to construct our measure of the total number of firms over time in the U.S. economy which includes nonemployer businesses. Data for employer firms is from the U.S. Census Bureau's Business Dynamics Statistics (BDS) and this is the standard data source in the literature of business dynamism (Decker et al., 2014). The employer data contains employer-firm counts, industry classifications, moments of the employment-size distribution, and the age of employer firms from 1977 to 2014. The data comprises all non-farm firms with at least one employer establishment, that is, a minimum of an establishment that formally employs at least one employee.

Data for nonemployers is from the U.S. Census Bureau's Nonemployer Statistics (NES). NES contains economic data for businesses that have no paid employees and are subject to federal income tax, providing nonemployer business counts and industry classification for 1992 and from 1997 onward. The U.S. Internal Revenue Service (IRS) tax return data is used by the Census Bureau to identify the universe of potential nonemployers. IRS counts up to 2008 are reported in U.S. Statistical Abstracts. Care is then taken to identify duplicates (multiple tax numbers belonging to one firm), and reclassify nonemployers when they are properly part of an employer firm.

To construct our measure of the total number of firms, we simply add nonemployer businesses to employer firms. This is done for the years 1992 and 1997 to 2014 for which we have data for both nonemployers and employer firms. We impute nonemployer counts for the years 1981 to 1991 and 1993 to 1996. For the years 1993 to 1996, we simply assume that the number of nonemployers increased smoothly from 1992 to 1997, and add the implied number of nonemployers to the observed number of employers. For the years 1981 to 1991, we impute the number of nonemployers using the growth rate in the total number of firms reported by the IRS which is constructed using tax returns. We work backwards from 1992, imputing the total number of firms using the growth rate in each year from the IRS data, then subtracting the number of employers (from BDS) to obtain the number of nonemployers. In Appendix A, we show that the growth rate in the total number of firms from the IRS and our measure of the total number of firms, for the years in which we have data on employers and nonemployers, track each other very closely, although in general as expected because of a variety of adjustments, the number of firms from the IRS is systematically higher than the counts of employer and nonemployer firms.

Figure 1 documents our measure of the number of firms and the more common measure of the number of employer firms over time (first panel) with the level normalized to one in 1Evolu981 and the net entry rate (the growth in the number of firms) of all firms and employer firms (second panel). Two features of the data stand out. First, the net entry rate of all firms has been consistently higher than that of employer firms. Second, the net entry rate of all firms declined along with that of employer firms from the early 1980s, but have then diverged sharply starting in the late 1990s. From 1981 to 2014, while the number of employer firms increased by 42%, the total number of firms increased by a striking 128%, a 3-fold factor increase in the number of firms relative to only employer firms.

Figure 1: Evolution of All Firms and Employer Firms

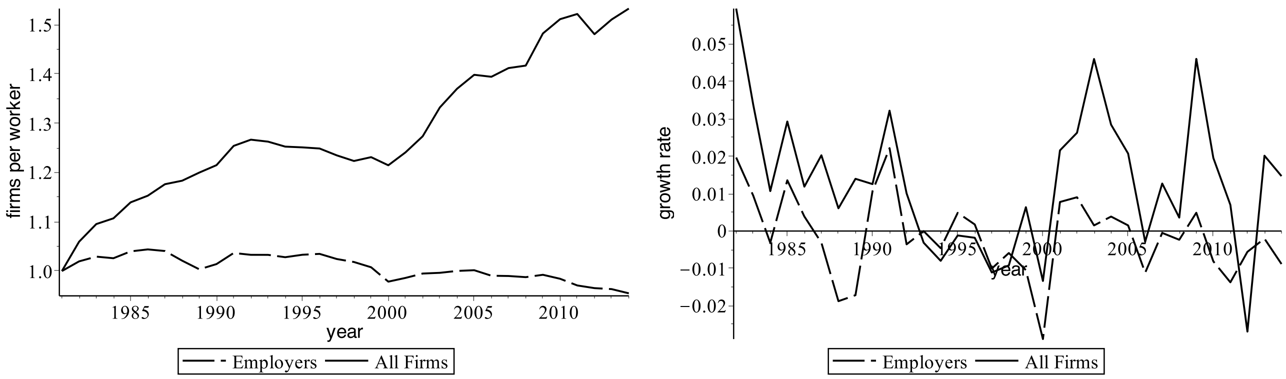


Notes: The first panel reports the number of all firms and the number of employer firms with levels normalized to one in 1981. The second panel reports the net entry rate of all firms and employer firms.

Theories of firm dynamics and aggregate productivity suggest that the more relevant measure of business dynamism when drawing implications for TFP is the number of firms per worker. We collect data for aggregate employment from the U.S. Bureau of Labor Statistics' Current Population Survey (CPS), which provides measures of the total employed civilian non-institutional population. The CPS provides consistent measures of aggregate counts from 1981, and counts by industry from 1983. These measures of employment are fairly consistent with the measures of labor force participants analyzed in Karahan et al. (2018) and Hopenhayn et al. (2019).

Using these measures of CPS employment, Figure 2 documents the number of firms per worker (first panel) for both the measure of all firms and the number of employer firms with both levels normalized to one in 1981, and the net entry rate in these measures (second panel). We note that both the total number of firms per worker and the number of employer firms per worker drop during the 1990s. But whereas the growth rate of employer firms per worker stays negative (on average) after 2000, the total number of firms per worker recovers and grows at a positive rate. From 1981 to 2014, the number of firms per worker increases by 53%, whereas the number of employer firms per worker decreases by -4.5%.

Figure 2: Evolution of All Firms and Employer Firms per Worker



Notes: The first panel reports the number of all firms per worker and the number of employer firms per worker with the level normalized to one in 1981. The second panel reports the net entry rate of all firms and employer firms per worker.

Given the structural transformation in the U.S. economy over the last several decades, it is important to assess whether the large increase in the total number of firms per worker is driven by within-sector changes in net entry or by changes in sectoral employment shares, that is changes from sectors with a low number of firms per worker to sectors with a high number of firms per worker. We analyze how sectoral employment shares have evolved over time between 1983 to 2014 for 9 sectors of the economy: agriculture, forestry, and fishing; mining; construction; manufacturing; wholesale trade; retail trade; transportation, communication, and utilities; finance, insurance, and real estate; and other services. We find that the most significant change is the reallocation of employment away from manufacturing to other services. Within these two sectors, firms per worker in manufacturing rose by 47%, while firms per worker in other services rose by a close 46%, which suggests that the process of structural transformation is not driving the increase in the total number of firms per worker. Indeed, firms per worker rose in seven out of nine sectors. The only sectors that experienced a drop in the number of firms per worker are Mining (-52%) and Retail Trade (-16%).

Nevertheless, to get a more concrete quantitative assessment of the importance of structural transformation to the increase in the number of firms per worker, we compute a counterfactual

Table 1: The Role of Structural Transformation in Total Firms per Worker

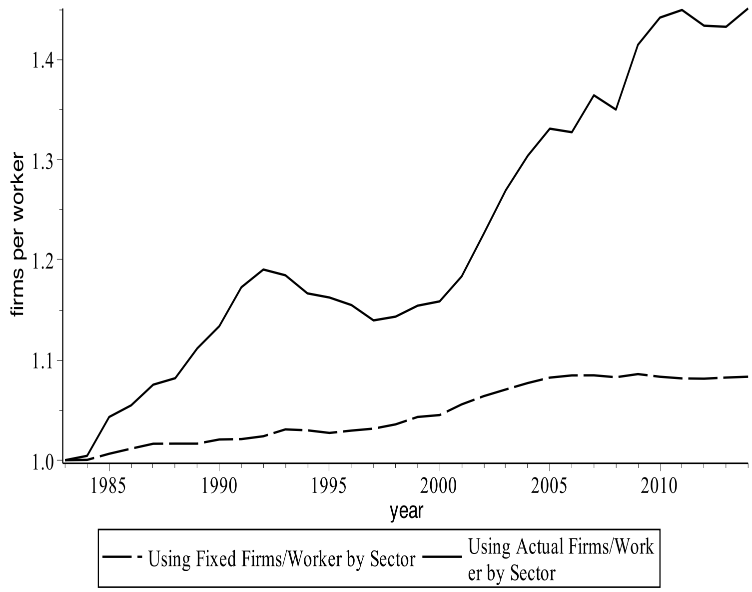
	Employment share (%)		Firms per worker (×100)	
	1983	2014	1983	2014
Sectors				
Agriculture, forestry, and fishing	4	2	9	16
Mining	1	1	25	12
Construction	7	7	21	29
Manufacturing	20	11	3	4
Wholesale trade	4	3	17	20
Retail trade	12	12	21	17
Transportation, communication, and utilities	6	6	11	24
Finance, insurance, and real state	7	7	29	38
Other services	40	52	15	22
Aggregate	100	100	14	20

aggregate number of firms per worker assuming that the number of firms per worker in each sector is fixed at 1983 levels. Changes in this counterfactual measure over time are therefore solely driven by changes in sectoral employment shares. Figure 3 reports this counterfactual measure of the aggregate number of firms per worker, along with the actual number of all firms per worker for comparison. The counterfactual shows that only 20% of the increase in the total number of firms per worker can be accounted for by structural change.

We emphasize that the dramatic difference in the evolution of the number of firms over time between all firms and employer firms is robust to removing sole-proprietors from nonemployer counts. Data on the legal form of nonemployers is available from 1997 onwards. Figure 4 compares the number of all firms per worker, the number of firms without nonemployer sole-proprietors, and the number of employer firms. Although the cumulative increase in the number of firms per worker since 1997 is lower when removing nonemployer sole-proprietors, an 8% increase rather than a 24% increase with all firms, it is still markedly different than the −7% decrease in employer firms per worker.

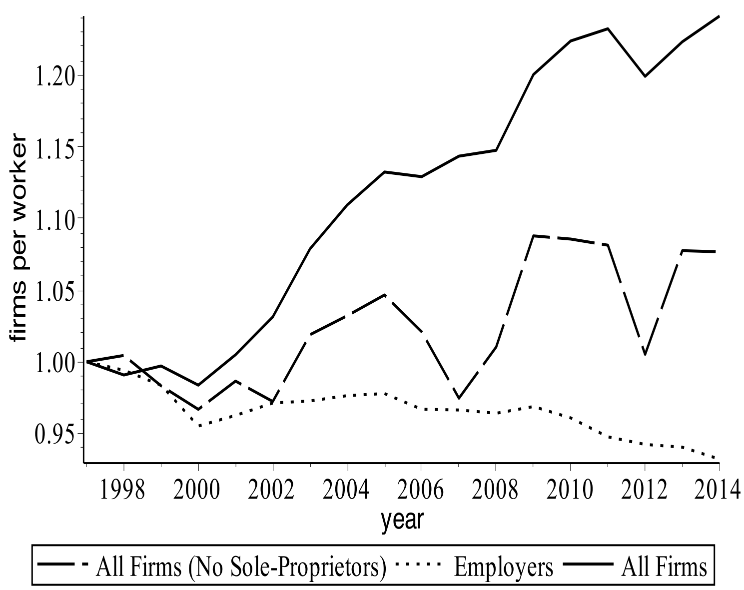
In summary, we find that accounting for nonemployer businesses in firm counts dramatically changes the pattern of net entry over time in the U.S. economy. While the number of employer

Figure 3: Total Number of Firms per Worker, Actual vs. Counterfactual



Notes: The solid line represents the evolution of the total number of firms per worker in the data, whereas the dashed line is the counterfactual evolution of the total number of firms per worker when firms per worker in each sector is kept fixed at 1983 levels.

Figure 4: Number of Firms per Worker with and without Sole-Proprietors



Notes: The solid line represents the total number of firms per worker in the data, the doted line is employer firms per worker, and the dashed line is the total number of firms per worker excluding sole proprietors. In each case, levels are normalized to 1 in 1997.

firms per worker has fallen slightly over the last three decades, the number of all firms per worker has risen substantially by more than 50%.

4 Baseline Model

We consider a simple version of the firm dynamics model in Hopenhayn (1992) in order to provide a mapping from changes in net entry of firms to aggregate TFP. We also use the model to assess the factors leading to the divergence between the number of employer firms and the number of all firms including nonemployers over time in the U.S. economy.

4.1 Environment

We start by describing the model environment. At each date, a single homogeneous good is produced by firms. We use this good as the numéraire. Firms have access to a decreasing returns to scale technology in variable inputs and are heterogeneous with respect to their productivity z:

$$y = (Az)^{1-\alpha}\ell^{\alpha}, \tag{1}$$

where y is output, ℓ is the labor input, and A is an exogenous productivity term common to all firms that can potentially change over time. Decreasing returns to scale in variable inputs implies that $\alpha \in (0,1)$ and hence the optimal scale of the firm depends non-trivially on productivity, that is, absent distortions more productive firms would operate at a larger scale by hiring more inputs, producing more output, and generating higher profits. Firms take the current real wage w as given, and the only cost incurred by incumbents is their wage bill.

There are a large number of potential entrants. Any potential entrant can become a producer by incurring an entry cost equal to $c_e \cdot Y/L$, where Y/L is aggregate output per worker.[2] We allow c_e to change over time. We assume potential entrants draw their productivity z from some

[2] Having the cost of entry scale up with output per capita is consistent with the evidence in Bollard et al. (2016) and Bento and Restuccia (2018).

constant cumulative distribution function $G(z)$, and only realize their productivity draw after entry. There is no fixed operating cost for producers, and firm-level productivity is assumed to stay fixed over the lifetime of a firm. We assume all firms face an exogenous probability of exit equal to λ in each period after production.

We assume a population of workers equal to L, which can change over time. We also assume that firms always believe that the current levels of L, c_e, and A persist forever. At the beginning of each period, they are shocked to learn otherwise, but then again believe current levels of these variables will persist. We discuss below that this assumption about beliefs does not affect our main results, it mainly affects the implied entry costs c_e in the model. Finally, we abstract from household choices by assuming an exogenous and constant real interest rate R.

4.2 Equilibrium

We focus on a competitive equilibrium of the economy in which firms assume that population L, aggregate productivity A, and the entry cost c_e remain at their current levels indefinitely. A *competitive equilibrium* is defined by a wage rate w, firm-level functions labor demand $\ell(z)$ and per-period profits $\pi(z)$, and number of firms N, given exogenous entry cost $c_e \cdot Y/L$, labor supply L, real interest rate R, and firm-level productivity distribution $G(z)$, such that:

(*i*) Given w, firms choose labor demand $\ell(z)$ to maximize per-period profits $\pi(z)$.

(*ii*) Free entry ensures the expected present value of lifetime profits for an entrant is equal to the entry cost, $\int_z \frac{\pi(z)}{1-\rho} dG(z) = c_e \cdot Y/L$, where $\rho = (1-\lambda)/(1+R)$.

(*iii*) The labor market clears: the supply of labor is equal to the quantity of labor demanded by firms, $L = N \int_z \ell(z) dG(z)$.

The equilibrium in each period can be easily solved. Producers choose labor to maximize output minus the wage bill, resulting in the following optimal demand for labor $\ell(z)$, output $y(z)$, and operating profits $\pi(z)$, each expressed as a function of z;

$$\ell = Az\left(\frac{\alpha}{w}\right)^{\frac{1}{1-\alpha}}, \tag{2}$$

$$y = Az\left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\alpha}}, \tag{3}$$

$$\pi = Az\left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\alpha}}(1-\alpha). \tag{4}$$

Labor market clearing implies total labor is equal to aggregate labor demand;

$$L = N \cdot A\left(\frac{\alpha}{w}\right)^{\frac{1}{1-\alpha}}\bar{z},$$

where $\bar{z}$ is equal to average firm-level productivity. This is in turn equal to the expected value of each draw z from $G(z)$, or $\int_z z\, dG(z)$. The wage can therefore be expressed as a function of the number of firms per worker;

$$w = \alpha(A\bar{z})^{1-\alpha}\left(\frac{N}{L}\right)^{1-\alpha}. \tag{5}$$

Using equations (3) and (5), aggregate output per worker as a function of firms per worker is;

$$\frac{Y}{L} = \frac{N}{L}\cdot A\left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\alpha}}\bar{z} = (A\bar{z})^{1-\alpha}\left(\frac{N}{L}\right)^{1-\alpha}. \tag{6}$$

Free entry ensures that N in each period is such that the discounted expected profits of an entrant is exactly equal to the cost of entry:

$$c_e \cdot \frac{Y}{L} = \frac{A(1-\alpha)\bar{z}}{1-\rho}\left(\frac{\alpha}{w}\right)^{\frac{\alpha}{1-\alpha}}. \tag{7}$$

This free entry condition holds as long as c_e is not too high relative to previous periods. If c_e were to increase too much from period $t-1$ to period t, then the number of firms in period t would be $N_t = (1-\lambda)N_{t-1}$. This constraint never binds when we take this model to the data.

Along with equations (5) and (6), the free entry condition implies the following characterization of the number of firms per worker;

$$\frac{N}{L} = \frac{1-\alpha}{c_e(1-\rho)}. \tag{8}$$

Note that the number of firms per worker does not depend on the common productivity term A, on average firm-level productivity $\bar{z}$, or on the size of the workforce L.

Lastly, output per capita, aggregate TFP, and the wage can be expressed as functions of exogenous variables;

$$\frac{Y}{L} = TFP = (A\bar{z})^{1-\alpha}\left(\frac{1-\alpha}{c_e(1-\rho)}\right)^{1-\alpha}, \tag{9}$$

$$w = \alpha \cdot TFP. \tag{10}$$

4.3 Implications

Aggregate TFP In the model described above aggregate labor productivity and aggregate TFP coincide and can be characterized from equation (9) as a function of parameters and exogenous variables, or from equation (6) as a function of exogenous variables and the number of firms per worker. We can link the effect of changes in the number of firms per worker in the data to changes in aggregate TFP using equation (6), noting that average productivity $\bar{z}$ drops out since we have assumed that the distribution of productivity is constant:

$$\frac{TFP_t}{TFP_{1981}} = \left(\frac{A_t}{A_{1981}}\right)^{1-\alpha}\left(\frac{N_t/L_t}{N_{1981}/L_{1981}}\right)^{1-\alpha}. \tag{11}$$

To perform the calculation of the implied TFP change over time (relative to 1981), we use a value for α equal to 0.8, consistent with much of the firm-dynamics literature. This relatively high value can be seen as giving a conservative estimate of implied TFP, as lower values (used occasionally in the literature) imply larger effects on TFP from changes in the number of firms per worker. Figure 5 illustrates our main results on the implied growth in aggregate TFP in equation (11) using the total number of firms per worker (solid line), contrasting it with the

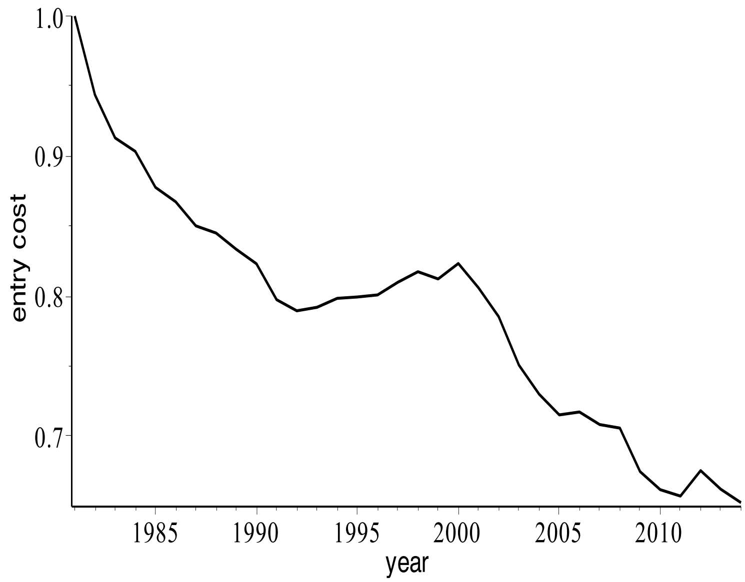
Figure 5: Implied TFP Using Different Measures of Firms in Baseline Model

Notes: Implied aggregate TFP in each year relative to 1981 from equation (11) using the total number of firms per worker (solid line) and the number of employer firms per worker (dashed line).

implied change in TFP in the model if instead we use employer firms per worker (dashed line) as the measure of the number of firms. Through the lens of the model, the increase in the total number of firms per worker from 1981 to 2014 implies a 9% cumulative increase in TFP, or an annualized growth rate of 0.26%. This is substantial relative to the observed 1% growth rate of TFP in the United States over the same time period (Li, 2017). In other words, about a third of the growth in TFP during the period can be attributed to the change in the number of firms per worker. In contrast, using the number of employer firms per worker as is standard in the literature, the implied aggregate TFP decreases by 1% between 1981 and 2014.

Entry Costs In the model, the number of firms responds solely to changes in the size of the labor force L and the entry cost c_e as characterized in equation (8) and the number of firms per worker depends only on the entry cost. We can therefore calculate the implied evolution of the entry cost from 1981 onwards using equation (8). Figure 6 shows the evolution of the entry cost c_e necessary to match the number of firms over time, reported relative to 1981. As

Figure 6: Implied Entry Cost in Baseline Model



Notes: The implied entry cost c_e in equation (8) in order to match the total number of firms per worker in the data, normalized to 1 in 1981.

is clear from equation (8), the evolution of the implied entry cost simply follows the inverse of the number of firms per worker. We note that unlike our calculation of implied TFP, the implied entry cost depends on assumptions about the beliefs held by firms with respect to future aggregate employment growth, future entry costs. But regardless of what we assume about firms' expectations, the overall decline in the implied entry cost still holds. In Appendix B, we show how entry costs change when firms know the future paths of entry costs and aggregate labor supply.

Evolution of Employer and Nonemployer Firms We show that even when the distribution of productivities is constant, the number of employers grows slower, and could even drop, as the total number of firms increases. To gain intuition, note that a firm's optimal demand for labor in equation (2) is increasing in its productivity z and decreasing in the wage. From labor market clearing, the wage is therefore increasing in both the number of firms per worker and average firm-level productivity $\bar{z}$. Combining optimal labor demand in equation (2) with the equilibrium wage (5), we can express a firm's choice of labor as a function of productivity and the number of firms per worker;

$$\ell = \alpha \left(\frac{z}{\bar{z}}\right) \left(\frac{N}{L}\right)^{-1}. \tag{12}$$

A firm's employment size is an increasing log-linear function of both productivity and the inverse of the number of firms per worker. If the number of firms per worker increases, the aggregate demand for labor increases and pushes up the equilibrium wage (equation 5). This results in lower employment for a firm with a given level of productivity, as shown in equation (12).

To explore the implications of equation (12) for the number of nonemployers, we assume that "nonemployers" are firms with less than one unit of labor. Note that this classification is a function of employment and not (directly) productivity. Let z_1 denote the productivity of a firm with exactly one unit of labor. Then we can rearrange equation (12) to solve for z_1;

$$z_1 = \alpha^{-1} \bar{z} \left(\frac{N}{L}\right). \tag{13}$$

The above expression shows that z_1 is increasing in the number of firms per worker. As the number of firms increases, the demand for labor of a firm with a given z drops. As a result, the productivity level associated with a demand for labor equal to one increases, i.e. z_1 increases. What is the implication for the number of employers? The number of employers per worker is the mass of firms above the productivity threshold z_1, that is:

$$\frac{N^{emp}}{L} = \left(\frac{N}{L}\right) \cdot [1 - G(z_1)]. \tag{14}$$

As the number of firms increases, the number of employers increases less as z_1 rises and hence $G(z_1)$ rises. Depending on the shape of the distribution $G(\cdot)$, the number of employers in principle could even drop.

Figure 7: The Number of Employer Firms in the Model and Data

To assess this mechanism quantitatively in the model, we calibrate $G(\cdot)$ to match moments from the employment-size distribution of U.S. firms in 1981. As before, the entry cost is calibrated to match the changes in the number of all firms in the data. To calculate the implied changes in the number of employer firms in the model, we need data on employment in nonemployers, which is not available. We therefore assume owner-managers of nonemployers spend some fraction of their time working, and assume labor is distributed uniformly between 0 and 1 across nonemployers. The BDS data we use reports the number of employer firms falling within 12 different size bins, and the top bin is open-ended. We assume that size is uniformly distributed between the lower and upper bound of each bin, and choose an upper bound for the top bin such that the average size of firms in the top bin implied by a uniform distribution is equal to the average size in the data. Note that equation (2) implies the following productivity ratio between two arbitrary firms i and j with different levels of employment;

$$\frac{z_i}{z_j} = \frac{\ell_i}{\ell_j}. \tag{15}$$

Given the observed employment-size distribution, equation (15) gives the distribution of productivity across firms, up to a constant. With $G(z)$ in hand, we can now calculate the number of employers generated by the model as the number of firms changes each year. Figure 7 reports the number of employer firms in the model and data (first panel) and the growth rate in these two time series (second panel). The model clearly overstates the number of employer firms, for instance by the end of the sample, the number of employer firms in the model is a factor of 2-fold that in the data. This result implies that the mechanism we focus on, namely the effect of the number of firms on the nonemployer threshold, cannot by itself explain the majority of the divergence between the total number of firms and the number of employers over time. What is striking, however, is that while the growth rate of employers implied by the model is consistently higher than in the data, the growth rates move together quite closely.

We conclude that our baseline model emphasizing mainly the evolution of net entry cannot account for the differences in how business dynamism changes over time between employers and nonemployers. This suggests that changes in the productivity distribution across producers, assumed constant in the baseline model, could be quantitatively important. We address this shortcoming of the baseline model in the next section by accounting for changes in the productivity distribution over time.

5 Extended Model

The implied change in aggregate TFP in the baseline model associated with the observed evolution in the number of firms per worker could be biased for two broad reasons. First, an increase in the number of firms implies a larger number of entrants and since entrants are well known to be less productive than incumbents (on average), average productivity may be changing over time, whereas in the baseline model we have assumed $\bar{z}$ to be constant. Second, exit rates and productivity growth rates of incumbents may be changing over time, which would also have implications for average productivity $\bar{z}$ over time, whereas in the baseline model, we have assumed constant exit rates for all firms and constant firm-level productivity. In this section, we extend the baseline model to account for observed changes in the exit rate of employer firms and to allow for arbitrary changes in the productivity distribution of producers over time. We continue to assume that entrants draw from a fixed distribution of productivities

$G(z)$ and allow for changes in aggregate labor supply L as observed in the data. We do not take a stand on why firm entry, firm exit, and firm-level productivity change over time. Instead, we take these moments from the data and draw implications for aggregate productivity.

In each period, optimal firm-level labor, output, and profits are the same functions of productivity z and the wage rate as described in equations (2) through (4). From the labor market clearing condition, the equilibrium wage rate is still a function of average productivity and the number of firms per worker as in equation (5). As a result aggregate TFP, which is equal to aggregate output per worker in our model, is still described by equation (6).

Our goal in this section is to use equation (6) to derive implications from the data for aggregate TFP. Because we use data on firm exit, we now use 1982 as our benchmark year. Relative to 1982, implied TFP in each year can be expressed using equation (6) as:

$$\frac{TFP_t}{TFP_{1982}} = \left(\frac{A_t}{A_{1982}}\right)^{1-\alpha} \left(\frac{\bar{z}_t}{\bar{z}_{1982}}\right)^{1-\alpha} \left(\frac{N_t/L_t}{N_{1982}/L_{1982}}\right)^{1-\alpha}. \tag{16}$$

Changes in aggregate TFP can be decomposed into a term representing the evolution of: (a) the common productivity term A, (b) average productivity across firms, and (c) the number of firms per worker. We again note that our model cannot address changes in firm-level productivity that affect both entrants and incumbents, captured by exogenous changes in A above. When we interpret the data, any observed growth in aggregate productivity not implied by the model will be similarly captured as a residual by A. As in Section 4 we use data on the total number of firms per worker over time as our measure of N/L. Our analysis departs from that in the baseline model in that we now use additional data to infer the evolution of average firm-level productivity $\bar{z}$ over time. We do this using data on the exit rate of employers over time and the evolution of the average size of all firms relative to the average size of entrants, both from the BDS. In what follows, we describe how we do this.

Firm-level productivity is unobserved, but the model provides a mapping from relative productivity to relative size across firms. Imagine we know the average employment size of both entrants and all firms, which we denote by $\bar{\ell}_{ent}$ and $\bar{\ell}_{all}$. Given the direct mapping from size to productivity (up to a constant) in equation (15), the average productivity of all firms relative to entrants in each year is;

$$\frac{\bar{z}_{all,t}}{\bar{z}_{ent,t}} = \frac{\bar{\ell}_{all,t}}{\bar{\ell}_{ent,t}}.$$

If entrants are drawing z from a constant distribution $G(z)$, we can infer average firm-level productivity in each year relative to our 1982 benchmark;

$$\frac{\bar{z}_{all,t}}{\bar{z}_{all,1982}} = \frac{\bar{z}_{ent,t}}{\bar{z}_{ent,1982}} \cdot \left(\frac{\bar{\ell}_{all,t}/\bar{\ell}_{ent,t}}{\bar{\ell}_{all,1982}/\bar{\ell}_{ent,1982}} \right) = \frac{\bar{\ell}_{all,t}/\bar{\ell}_{ent,t}}{\bar{\ell}_{all,1982}/\bar{\ell}_{ent,1982}}. \tag{17}$$

We do not observe the labor input of nonemployers in the data, so we continue to assume a uniform distribution of employment between 0 and 1 for all nonemployers (both entrants and incumbents) in each year. The average size of all firms in a particular year is therefore;

$$\bar{\ell}_{all} = \frac{L_{all}}{N_{all}} = \frac{L_{all}^{emp} + 0.5 \cdot N_{all}^{non}}{N_{all}}, \tag{18}$$

and the average size of entrants is;

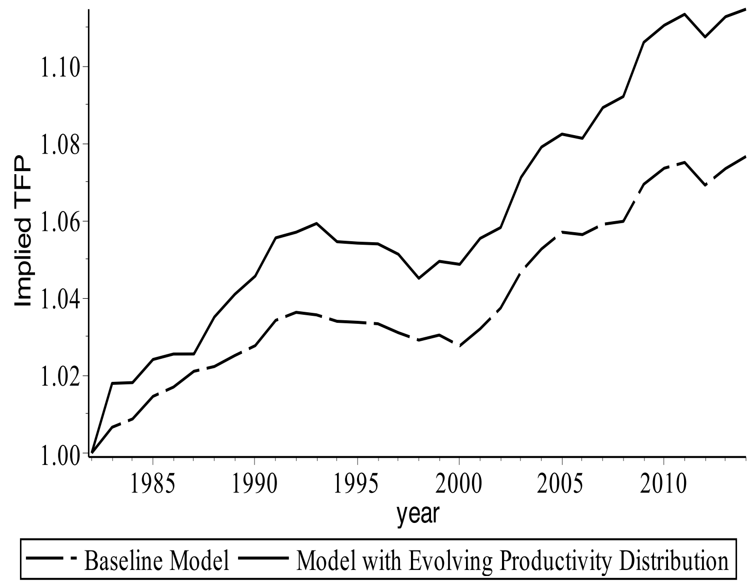
$$\bar{\ell}_{ent} = \frac{L_{ent}}{N_{ent}} = \frac{L_{ent}^{emp} + 0.5 \cdot N_{ent}^{non}}{N_{ent}}, \tag{19}$$

where superscripts identify employers and nonemployers, and subscripts refer to entrants and all firms.

We have data on the numbers of entering and exiting employers, but not the corresponding measures for nonemployers. We therefore assume a constant exit rate λ for nonemployers. We set $\lambda = 0.15$ as reported by Davis et al. (2009) for nonemployers between 1994-1997. With this exit rate, we can infer the number of nonemployer entrants in each year as follows;

$$N_{ent}^{non} = N_{all}^{non} - (1 - \lambda) N_{all,-1}^{non}, \tag{20}$$

Figure 8: Aggregate TFP in Extended Model

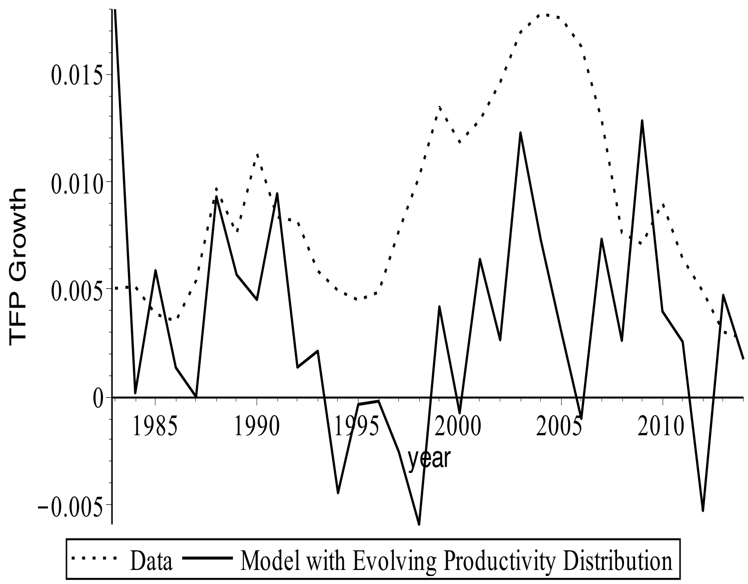


where the subscript '-1' refers to the previous year. Note that in these calculations we are abstracting from any transitions from nonemployer to employer status, because we can not differentiate between truly new employers and transitioning nonemployers. As a result, we slightly overstate the number of employer entrants. Given the very small number of transitioning nonemployers in a given year documented by Davis et al. (2009), this should not be quantitatively important.

We can now calculate average firm-level productivity in each year, relative to 1982, and then use it along with the number of firms per worker to calculate implied TFP from equation (16). We illustrate our results in Figure 8 and compare them to implied TFP from our baseline model. It turns out that implied average firm-level productivity is generally increasing from 1982 to 2014. As a result, the implied cumulative increase in aggregate TFP is even higher than in the baseline model. From 1982 to 2014, the cumulative increase in TFP is 11.5%, whereas the baseline model implies an increase of 7.7% over the same period.

Figure 9 reports the implied growth rate of aggregate TFP over time in the extended model. From 1982 to 2014, annual growth averaged 0.34%. The doted line in Figure 9 is the 8-year

Figure 9: Aggregate TFP Growth in the Extended Model and Data



Notes: Model-implied TFP growth is calculated yearly, while observed TFP growth is calculated as a moving average.

moving average of TFP growth in the U.S. as reported by Li (2017) using data published by the Federal Reserve Bank of San Francisco. The evolution of TFP growth over time implied by the model follows the data quite well over the medium and long term, suggesting that business dynamism in fact plays an important quantitative role in driving trends in aggregate productivity, as suggested by canonical theories of firm dynamics such as Hopenhayn (1992). The cumulative growth in TFP observed in the data between 1982 and 2014 amounts to 37.7%, meaning our implied measure of TFP can account for just over one third of the actual increase. Again, if we instead use the number of employer firms, the baseline model from Section 4 would imply a decline in aggregate TFP. Further, the correlation coefficient between observed TFP growth and growth implied by our extended model is 19%, while growth in TFP from the number of employer firms is essentially uncorrelated with observed TFP growth.

6 Alternative Drivers of Firm Dynamics

A recent literature has emphasized mechanisms through which various policies and institutions can lead to an increase in the number of firms per worker while reducing aggregate productivity in accounting for observed differences across countries (Hsieh and Klenow, 2014; Bento and Restuccia, 2017; Bento, 2019).[3] In this section, we argue that these mechanisms are not quantitatively important for the case of the U.S. economy over time.

We start by considering whether an increase in misallocation may be driving the increase in the number of firms in the U.S. economy over time. Hsieh and Klenow (2014) and Bento and Restuccia (2017) show that cross-country differences in the extent to which firm-level distortions are positively related to firm size can go a long way to rationalizing the large differences in average firm size across countries at differing levels of development. If firms are effectively taxed at higher rates as they grow more productive, then all firms reduce investment in productivity. This effectively reduces non-production costs for all firms, thereby *increasing* profitability and encouraging entry. As a result, the theory predicts more entry and more firms in equilibrium. Both papers document cross-country evidence consistent with this mechanism.

To assess this basic mechanism in the U.S. data over time, we use data from the Economic Census for 74 3-digit NAICS industries for the years 2002 and 2012. Within each industry, we have data on the total number of firms, the number of firms in each size bin, the number of employees per firm within each bin, total payroll, and total revenue.[4] Although we only have data from 2002 to 2012, this period is still characterized by a substantial increase in the number firms by 22%. For each size bin within each industry, we use the ratio of revenue to payroll as our measure of the average distortion faced by each firm within the bin. Hsieh and Klenow (2009) show that under certain structural assumptions, profit maximization implies each firm within an industry should be choosing its labor input such that all firms are left with the same average product of labor. To the extent that the average product is higher for firms in a large

[3]See also Akcigit et al. (2016) for a model emphasizing barriers to managerial delegation for firm dynamics in developing countries.

[4]For manufacturing industries, we use establishments rather than firms, and value added rather than revenue.

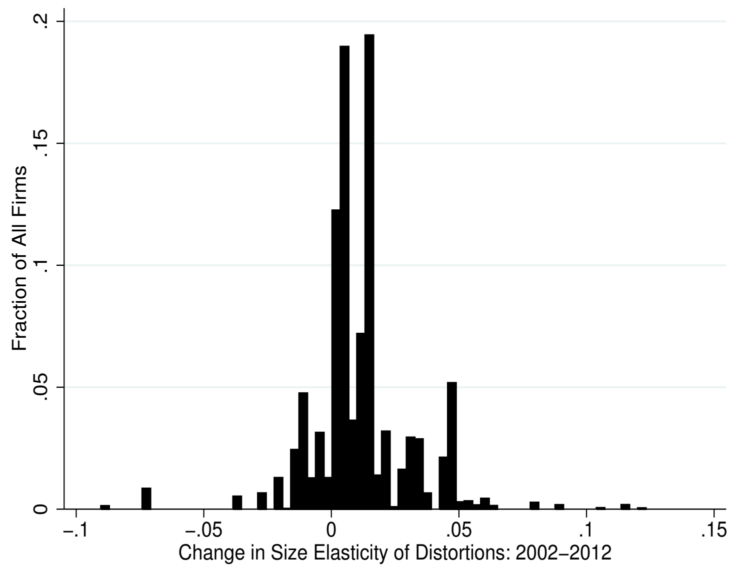
size category relative to a small category, we interpret this as evidence that larger firms face a larger effective tax.

As in Hsieh and Klenow (2014) and Bento and Restuccia (2017), we regress (logged) average products on (logged) employment size within each industry to obtain an estimate of the elasticity of distortions with respect to size.[5] The higher the elasticity, the larger the effective tax rate faced by large firms relative to small firms. For 2002, we find an average elasticity across industries equal to -0.01, with a variance across industries of 0.01. For 2012, we find an average elasticity even closer to zero, with a similar variance. These numbers suggest there is very little systematic misallocation on average, as well as very little change in the extent of systematic misallocation over time. From 2002 to 2012, Figure 10 presents a histogram of the fraction of firms in industries that saw a given change in the size elasticity of distortions, indicating that the vast majority of firms are in industries that saw very little change in this elasticity over time. This suggests that the type of misallocation responsible for cross-country differences in firm dynamics is not driving the increase in the number of firms in the U.S. economy over time.

Another possible explanation for the increase in the number of firms is higher barriers to entering a market, as explored in Bento (2019). Bento (2019) shows that when firms choose how many markets to enter, and the cost of entering is increasing in the number of markets entered, barriers to market entry (distinct from barriers to starting a firm) encourage more firm startups, with each firm competing in fewer markets in equilibrium. As a result, each market is characterized by fewer competing firms, and aggregate productivity drops even as the aggregate number of firms increases. If barriers to market entry have been increasing in the U.S. economy, we should observe fewer firms competing in each local market, even as the aggregate number of firms increases. We do not have data on the number of firms present in each market, and defining a market is difficult. But we can consider how the aggregate number of establishments changes over time. To the extent that firms create multiple establishments to access multiple

[5]For these regressions we exclude all firms with less than 5 employees, to address the problem of unpaid workers not being counted in small firms. For the purposes of this discussion, the 'number of firms' is defined as the number of firms with at least 5 employees.

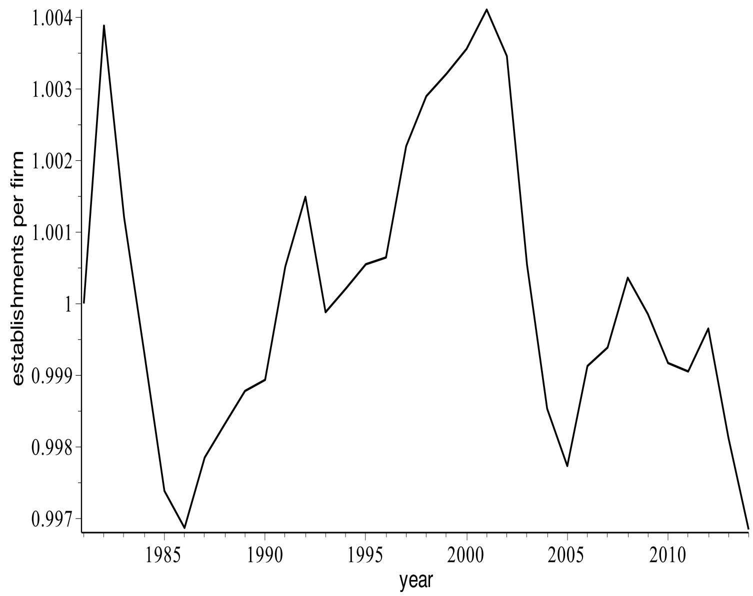
Figure 10: Distribution of Changes in the Size Elasticity of Distortions



markets, the number of establishments per firm can serve as a proxy for the number of markets per firm. Figure 11 reports that the number of establishments per firm essentially remained constant from 1981 to 2014, even as the number of firms per worker grew by 53%. Note that Aghion et al. (2019) and Cao et al. (2019) make a similar observation about establishments per firm over time in the context of employer firms. This suggests that increasing barriers to market entry are not likely driving the increase in the number of firms per worker in the U.S. economy.

In summary, while a recent literature has emphasized various mechanisms that may encourage firm entry while nonetheless lowering aggregate productivity in the context of cross-country differences, the evidence suggests that these mechanisms are not driving the increase in business dynamism in the U.S. economy in recent decades.

Figure 11: The Number of Establishments per Firm (1981=1)



7 Conclusions

An important literature documenting the decline in business dynamism in the U.S. economy over the last several decades has focused solely on employer firms. We consider a broader measure of firms that includes nonemployers, and find that the total number of firms has diverged dramatically from the number of employers over time. We interpret this fact, along with the evolution of the employment distribution across firms, through the lens of a standard model of firm dynamics based on Hopenhayn (1992). We show that accounting for nonemployers drastically changes the implications for aggregate productivity. Although nonemployers are (by definition) small relative to employers, the increase in the number of firms and in firm-level productivity together imply that business dynamism has been responsible for over a quarter of observed aggregate productivity growth from 1981 to 2014. This is in striking contrast to the decrease in TFP implied by a model considering only employer firms.

Several papers have suggested that a decline in business dynamism may be contributing to the recent slowdown in aggregate productivity growth since the Great Recession. Decker et al.

(2016) and Li (2017), however, note that previous measures of business dynamism (focused only on employer firms) do not correlate well with TFP growth before the recession, casting doubt on the quantitative importance of theories of firm dynamics. We show that our broader measure of business dynamism, which accounts for nonemployers and the evolution of the size distribution over time, closely follows TFP growth in the data since the 1980s.

Our results suggest several avenues for future research. It would be useful to relate our comprehensive measure of the number of firms with recently documented trends in market concentration, price-cost markups, and job reallocation rates as documented in Decker et al. (2014), De Loecker et al. (2018), and Rossi-Hansberg et al. (2019). Relatedly, theories developed to explain increasing markups and market concentration, as well as the decline in the labor share of aggregate income, have taken as given a decline in business dynamism arising from the number of employer firms. For instance, Akcigit and Ates (2019) relate these trends to declining business dynamism. As a result, an important direction for future research may be exploring mechanisms that can account for these trends in the context of higher firm entry. Finally, we have abstracted from the underlying causes of changes in exit rates and productivity growth across firms and over time. Understanding these patterns, as explored in Aghion et al. (2019) and Cao et al. (2019), remains an important area for further work.

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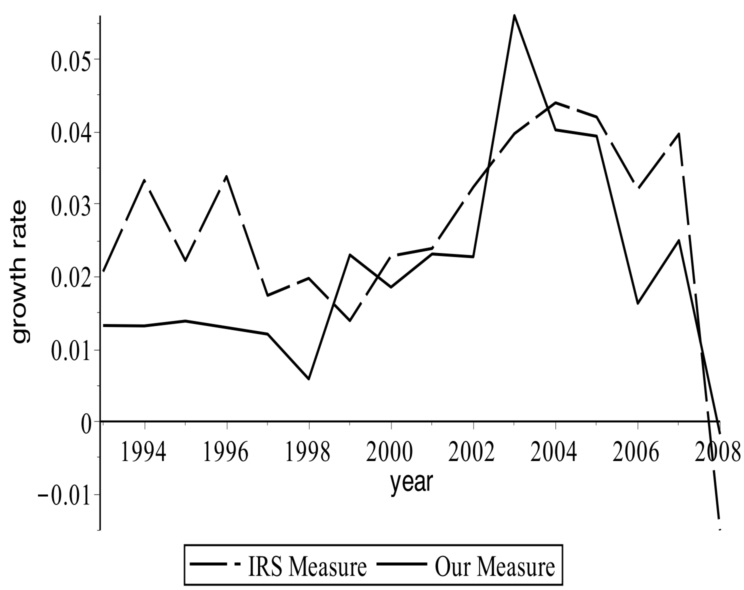
Appendix

A Data Imputation

For the years between 1981 to 1991, we impute the number of nonemployers by using the growth rate in the total number of firms reported by the IRS (constructed using tax returns). We work backwards from 1992, imputing the total number of firms using the growth rate in each year from the IRS data, then subtracting the number of employers (from BDS) to obtain the number of nonemployers. Figure 12 documents the fact that the growth rate in the total number of firms reported by the IRS tracks very closely our measure of the growth rate of the total number of firms over the years for which we have data for nonemployers and employers. Hence, we argue this imputation of the number of nonemployer firms is reasonable.

Figure 12: The Growth Rate in the Number of Firms, IRS and Our Measure



B Alternative Beliefs in the Baseline Model

We show that our assumptions about the beliefs of firms in the baseline model affect the implied evolution of the entry cost over time, but do not affect our calculation of the implied evolution of aggregate productivity. In the baseline model we assume firms always believe the current supply of labor L and entry cost c_e will persist indefinitely, and are subsequently shocked each period. We now assume that firms know the future paths of both L and c_e with certainty. For this exercise we assume that the economy is in a steady state in 1981, such that L and c_e were previously constant at 1981 levels. We further assume these variables stop changing after 2014.

Per-period optimal output, labor demand, and profits, are still described by equations (2) through (4), as functions of firm productivity. The wage is still described by equation (5), as a function of the number of firms per worker. That equation (5) still holds in each period implies that our calculation of implied TFP (11) also holds, given the observed number of firms per worker in each year in the data.

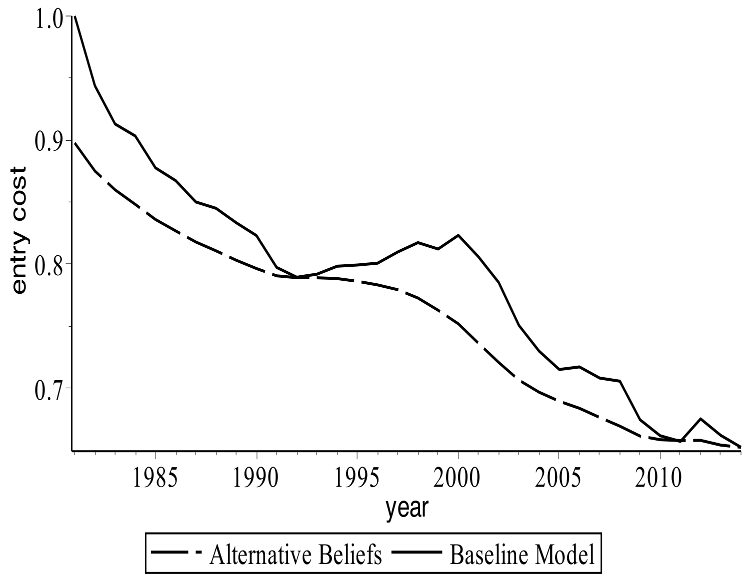
Free entry requires that the expected discounted profits of entrants are exactly equal to the entry cost in the period they enter. This can be expressed recursively as;

$$c_{e,t} = \frac{(1-\alpha)}{(N_t/L_t)} + \rho c_{e,t+1}, \tag{21}$$

$$c_{e,2014} = \frac{(1-\alpha)}{(N_{2014}/L_{2014})(1-\rho)}. \tag{22}$$

Potential entrants now take into account future entry and labor supply growth when making their entry decision. Taking as given the number of firms per worker in the data, the more firms per worker in the future, the lower the current entry cost must be to rationalize a given current number of firms per worker. In Figure 13 we show how the implied entry cost c_e must evolve over time in order to match the observed evolution of the number of firms per worker in the data. Compared to the baseline, this alternative implied entry cost must be lower in 1981, given that firms are now taking into account the future observed increase in the number

Figure 13: Implied Entry Cost with Alternative Beliefs



of firms per worker. By 2014, the two measures converge, as must be the case since the two sets of beliefs also converge. With these alternative beliefs, the implication for the evolution of entry costs is much the same, except here the implied entry cost is less volatile over time.