

Understanding the 30-year Decline in the Startup Rate: a General Equilibrium Approach

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May 2015

PRELIMINARY

Abstract

Recent empirical work has shown that new business formation has declined substantially over the past three decades, while firm growth and survival rates conditional on firm age have remained relatively stable. This paper studies the causes of the declining startup rate. The stability of firms' lifecycle dynamics throughout this period places a strong restriction on potential explanations in standard models of firm dynamics. We show that declines in the growth rate of the labor force, which peaks in the late 1970s, explain an important share of the startup rate decline while leaving incumbent dynamics unaffected. Using cross-sectional demographic variation we estimate a quantitatively and statistically significant labor supply growth elasticity of the startup rate. We show this elasticity is robust to alternative explanations. Finally we show in a model calibrated to the 1980s U.S. economy that the equilibrium response to a permanent demographic shift generates a sizable and gradual decline in the startup rate over the last 30 years. Our findings suggest that the decline in the growth rate of the working age population and its general equilibrium effect on firm dynamics is an important driver of the decline in firm entry.

1 Introduction

Recent empirical work has identified an unmistakable shift in U.S. firm dynamics since the late 1970s. Principally, the startup rate, measured as the share of new employer firms out of all employer firms,

*We thank Rob Dent and Sam Kapon for their superb research assistance. We are also indebted to Felipe Schwartzman for his insightful comments on a previous paper and suggestion to consider the effect of labor supply shocks on firm entry. Any opinions and conclusions expressed herein are those of the author(s) and do not necessarily represent the views of the U.S. Census Bureau, Federal Reserve Bank of New York or the Federal Reserve System. All results have been reviewed to ensure that no confidential information is disclosed.

declined by about 30 percent from 1979 to 2007, before any further impact of the Great Recession. Remarkably, this steady decline occurred relatively uniformly within geographic areas and narrow industry groups and without disturbing the lifecycle dynamics of incumbent firms.

An important question is what explains this apparent decline in the rate of business formation. Startups are both a vital source of job creation and productivity gains. [Bartelsman and Doms \(2000\)](#), for example, find about 25 percent of within industry gains in TFP occurs from new entrants in the manufacturing sector.¹ Understanding the source or sources of the declining startup rate is crucial to understand whether the decline is an efficient response to technological shifts or escalating misallocation that could be eased through policy reforms. For example, fixed costs of starting or running a business may have risen from increased regulations. One difficulty with many potential explanations based on costs or technology is that *ceteris paribus* they impact the value of an incumbent firm and thus its lifecycle dynamics, in contrast with experience in the U.S. over this period. The widespread nature of the startup rate declines poses a similar challenge.

In this paper we propose and evaluate an alternative hypothesis for the declines in the entry rate. Demographic shifts in the growth rate of the labor supply feedback into the pace of business formation. [Figure 1](#) shows that trend labor force growth peaks in the mid 1970s. Its subsequent decline coincides with a gradual reduction in the startup rate, which is plotted against the right axis. We show that the 30-year decline in the startup rate evident in the aggregate time series is primarily the slow convergence to a new balanced growth path for an economy with lower expected labor supply growth. We then test this hypothesis using cross sectional variation in the demographic component of labor supply growth, and we find that this channel explains more than half of the declines in the startup rate.

Our paper is closely related to the emerging literature on the declining dynamism in the U.S. economy. Early work by [Reedy and Strom \(2012\)](#) first called attention to a decline in the aggregate entry rate of new employers. Using more disaggregated data, recent papers by [Pugsley and Şahin \(2014\)](#), [Decker, Haltiwanger, Jarmin, and Miranda \(2014\)](#), [Hathaway and Litan \(2014\)](#), [Gourio, Messer, and Siemer \(2014\)](#) and [Davis and Haltiwanger \(2014\)](#) all document that declines in the entry rate are pervasive within geographic areas and relatively narrow industry aggregations. All of these papers have also drawn attention to the relevance of this decline for the ongoing health in labor market.

[Haltiwanger, Jarmin, and Miranda \(2013\)](#) have shown that new and young businesses are a key input into net employment creation. Taking the trend decline or “startup deficit” as given, [Pugsley and Şahin \(2014\)](#) show that both its direct effect on startup job creation and its indirect cumulative effect through shifts in the employer age distribution partly explain the emergence of slower employment recoveries with each business cycle. Startups are also a source of aggregate productivity gains from the advances in technology embodied in the new firms. A slowdown in business entry may portend an overall slowing of employment and labor productivity growth. Changes in laws and

¹In a structural estimation of an endogenous growth model, [Lentz and Mortensen \(2008\)](#) find a similar share of aggregate TFP growth due to the entry margin.

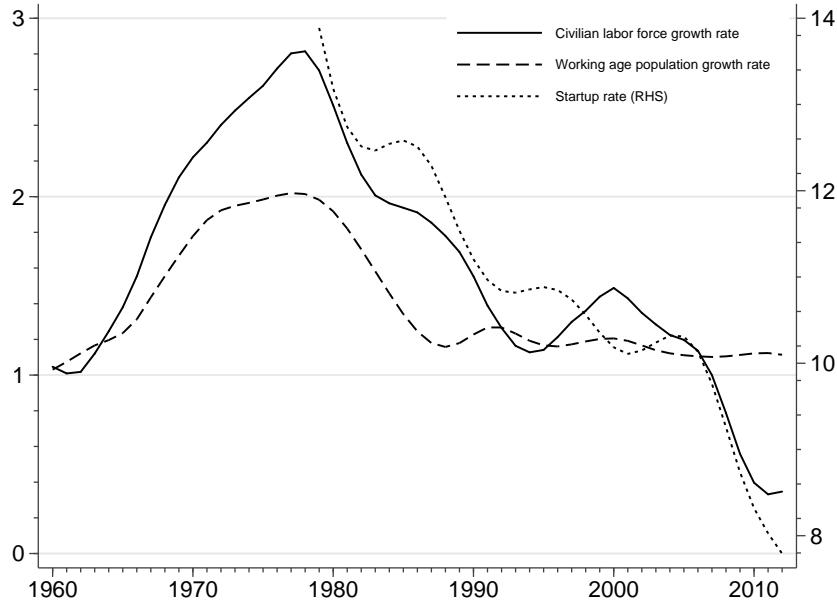


Figure 1: Trend declines of startup rate and labor supply growth coincide

Note: BLS, Annual Census Bureau population estimates, and Business Dynamics Statistics. Annual data, HP filtered with smoothing parameter 6.25. See appendix Figure A1 for unfiltered rates. Working age population is defined here as population ages 20 to 85. Civilian Labor Force is measured by the BLS for the adult (16+) civilian non institutional population. Startup rate is number of age 0 employers as share of the total number of employers within a year.

regulations, market concentration, education and licensing requirements, and shifts in economies of scale might discourage firm entry by creating higher barriers to enter and/or a higher fixed cost of operating. Noting this possibility, [Davis and Haltiwanger \(2014\)](#) among others highlight the introduction of several forms of labor market and occupation regulations in the U.S. that are a potential source of these slowdowns in the entry margin.

Without offsetting effects, these individual changes to the economy are difficult to reconcile with the empirical evidence. We show generically that changes to costs and technology will change the value of an operating firm and by extension its lifecycle dynamics. However, [Pugsley and Sahin \(2014\)](#) show that both in the time series and the cross section that conditional on age, firm dynamics have been unaffected by the net forces causing the decline in the startup rate. This incumbent stationarity along with the widespread nature of the entry declines lead us to consider changes to the supply of labor input as a potential general equilibrium source of the decline.² Specifically we study the role of slow moving demographic shifts in driving the decline in startups.

There are various reasons why population growth rate would affect business formation. Most directly, an older population might be associated with a lower rate of business formation in the economy if younger workers are more likely to engage in entrepreneurial activity. But in fact, the age group with the highest propensity to form businesses, ages 35-54, grows over this period so this is unlikely to explain the decline in startups. We are interested in a different channel.

²We thank Felipe Schwartzman for his insightful suggestion to consider this margin.

Changes in the growth rate of the working age population and also female labor force participation affect the expected expansion in labor supply and could have important effects on business formation through a general equilibrium channel. Positive shocks to the labor supply put downward pressure on wages and create incentives for incumbent firms to expand, but they also create opportunities for potential entrants. Any effect on the entrant share will depend on how the shocks to the labor supply are accommodated by expanding incumbents and new firms. A lesson from models of firm dynamics, starting with [Hopenhayn \(1992\)](#), is that in the long run, the free entry of new firms make labor demand infinitely elastic. Ultimately, shifts in labor supply are absorbed not at the intensive margin by incumbent firms, but at the extensive margin by adjusting the quantity of entrants. Crucially, labor supply changes have no direct effect on the value of an incumbent firm, except indirectly through transient effects on the real wage.

In the U.S. the declines in the the growth rate of the labor force in the 1980s, both through declines in the growth rate of the working age population, and compounded by diminishing increases in female labor force participation, put upward pressure on wages. In response, incumbents may hire fewer workers and the declines in profitability of potential firms reduces the gains from entry. As the flow of entrants eventually adjusts to the smaller labor market growth, any pressure on wages is relieved and incumbent dynamics such as age-specific survival rates, average firm sizes, and employment growth rates are completely unaffected. [Figure 1](#) shows the change in the growth rate of the labor force and the slow transition to a startup share consistent with the long run reduction in labor market growth. While the strong correlation between labor force growth and the startup rate in the aggregate time series makes the demographic channel a compelling explanation, we turn to an alternative source of variation to validate this hypothesis.

We use cross sectional demographic variation in labor supply to measure the effects on firm dynamics. In particular using cross state and industry data pooled over time, we estimate a linear model of the startup rate and several incumbent margins on two measures of labor force growth, controlling for state, time, and industry effects. To generate variation in labor force growth from fully anticipated demographic shifts we instrument with 20-year lags of each state’s fertility rate. The goal is to see whether changes in the growth rate of the working age population and lower frequency component of the civilian labor force growth, our two measures, predicted by purely demographic forces have an effect on firm dynamics.

This strategy relies on two identifying assumptions. The first and most important is the exclusion restriction that conditional on state and time effects, whatever determines the cross sectional variation in the fertility has no other long lasting effects that would still affect business dynamics 20 years later. We argue this is likely to be the case. Second, and less important, is that the mobility costs are large enough to prevent geographic mobility from completely equating the real wage across these segmented markets. To the extent this is not true, our estimates will understate the effect of demographics on startups and incumbent dynamics. One side-effect of the fertility instrument is that it also changes the age composition of the labor force. We further control for compositional differences across states to ensure the effects we estimate follow from changes in the growth rate of

the labor supply and not its composition.

We find that the demographic changes have a large effect on the startup rate. We estimate a startup rate semi-elasticity of labor supply growth of roughly 1 to 1.5. Given these estimates, the declines in the working age population growth and civilian labor force growth over this period in the aggregate time series and plotted in Figure 1, the demographic shifts explain an important share of the decline in the startup rate. Further, we find that the demographic shifts have little effect on incumbent dynamics. A demographically induced increase in the growth rate of labor supply causes a short run increase in incumbent firm size, which diminishes over longer horizons. This is consistent with the transient adjustment of incumbent firms as the entry margin fully adjusts to its long run levels. Although these patterns are consistent with a broader class of models, we show in a calibrated version of the [Hopenhayn \(1992\)](#) model set in general equilibrium with growth, the same gradual adjustment to a fully anticipated shift in the growth rate of the labor supply.

Overall, our results show that a large fraction of the declining startup rate is consistent with the demographic shifts over this same period. At first, this may be a surprising result since changes in the entry costs or other technological explanations would have a more direct effect on entry. However, the stability of the incumbent margins combined with the widespread nature of the declines in entry point to an alternative channel. Generically, shifts in costs and technology affect incumbent dynamics through their effects on the value of a firm, whereas in standard formulations labor supply changes do not.³ In the long run with free entry the labor supply shifts are completely absorbed by the entry margin. In the U.S. the aggregate time series and cross state evidence strongly supports this explanation of the declining startup rate.

The paper is organized as follows. Section 2 presents a simple framework to evaluate potential explanations for the decline in business formation in the spirit of [Hopenhayn \(1992\)](#) and [Hopenhayn and Rogerson \(1993\)](#) and shows that aggregate time series evidence is consistent with our hypothesis that a negative labor supply shock is the main driver of the decline in firm entry. Section 3 exploits cross-state variation in labor supply to evaluate the labor supply channel and finds strong evidence in favor of this explanation. Section 4 presents various robustness experiments. Section 5 concludes.

2 Time series evidence and evaluating potential explanations

In this section we document the widespread decline in business formation and present a simple firm dynamics framework. We then use this framework to evaluate alternative explanations for the decline in firm entry using aggregate time series data on firm dynamics.

2.1 The decline in entry

Our analysis is based on annual data for the period 1979–2012. We use firm-level data from the U.S. Census Bureau Longitudinal Business Database (LBD) and its public use data product the Business

³With a frictional labor market, decreasing returns in the aggregate matching function would be one example where changes in the labor supply would effect the value of the firm through their effects on the match surplus.

Dynamics Statistics (BDS). This dataset covers the vast majority of employers in the U.S. and is based on a longitudinally-linked version of the Census Bureau’s business register that includes all private-sector establishments with paid employees. The data report the total employment of each firm on March 12 of each calendar year from 1977 through 2012.⁴ Further details about the data used in this paper are available in data appendix and in .

Figure 2a shows the startup rate, which is the number of newborn firms as a fraction of the overall stock of firms, for the period 1979 to 2012. The startup rate has declined steadily from an average of roughly 13 percent in the early 1980s to around 10 percent before the Great Recession and eventually to 8 percent by 2012. Moreover, this decline is not concentrated in a particular set of states or industries, but is a widespread phenomenon. To exhibit this across the board decline, we compute the change in startup rates for each state 4-digit industry cell during the sample period, by taking the difference between the average startup rate in the period 1980-1984 and 2003-2007. Figure 2b displays the density of these differences. Startup rates fell in about 85 percent of state-industry pairs. If the differences were computed over a period that includes the Great Recession this share increases to about 95 percent. This across the board decline suggests that it should be a common factor causing a lower pace of business formation in all sectors.

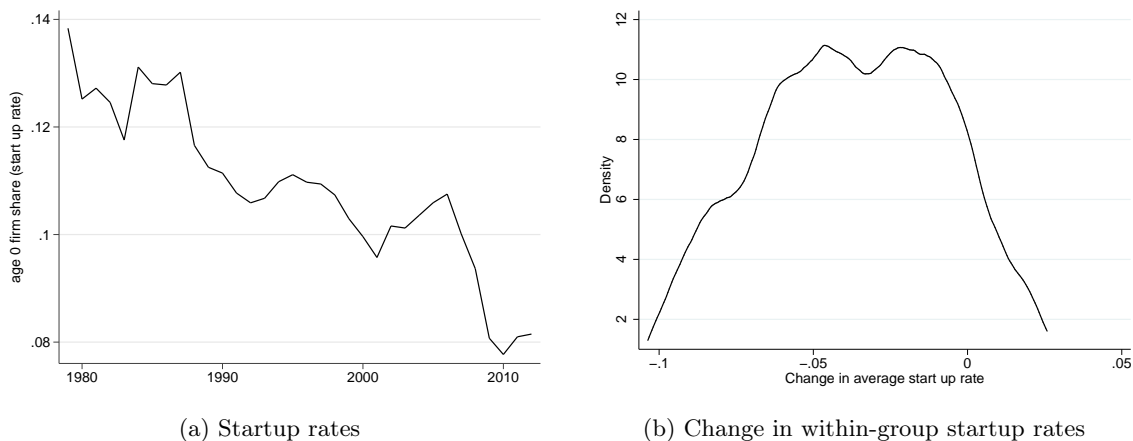


Figure 2: Declines of startup rate in the aggregate and by state-industry pairs

Note: Business Dynamics Statistics and Longitudinal Business Database. Startup rate is number of age 0 employers as share of the total number of employers within a year within BDS. The left panel displays the aggregate startup rate and the right panel shows the density plot of the change in this measure across groups defined by state and 4-digit industry. The change is computed by taking the difference between the average startup rate in the period 1980-1984 and 2003-2007.

⁴Multiple establishments owned by the same firm are linked through their ownership records. This is an important detail, since we are interested in true firm startups rather than new establishments of an existing firm. We do not use years 1977 and 1978 to measure the startup rate because of measurement difficulties in identifying new firms. We thank Rob Shimer for this insight.

2.2 Understanding the decline in entry

There are several potential explanations that might have caused the decline in firm entry. One hypothesis is that the U.S. economy faced serious impediments over this episode, causing a decline in labor market fluidity. Changes in regulations, market concentration, education and licensing requirements, and shifts in economies of scale might discourage firm entry by creating higher barriers to enter and/or a higher fixed cost of operating. A recent literature including [Davis and Haltiwanger \(2014\)](#) emphasize several forms of labor market and occupation regulations as potentially important sources of the slowdowns in the entry margin. Yet another possibility is increased uncertainty about demand or policy that has discouraged entrepreneurial activity ([Davis and Haltiwanger \(2014\)](#)).

A common implication of such factors is a change in the lifecycle dynamics of incumbent firms, which we show to be in contrast with the data. This feature is simply illustrated in the canonical Hopenhayn (1992) equilibrium model of firm entry and exit, but it applies generally wider variety of environments. Changes in the entry or operating costs affect the value of the firm, which in turn alters equilibrium prices, and ultimately the exit and growth behavior of incumbent firms. To see this, consider the simple environment in [Hopenhayn \(1992\)](#) in which firms have to pay a fixed cost pc_e , where p is the price of output (relative to wages), to enter the economy. Upon entry, they draw a random initial productivity, s , from an exogenous distribution G . Staying in business requires the payment of a fixed cost of c_f , so that firms exit when their expected value falls below c_f . Let $V(s, \psi)$ denote the value of a firm with productivity s , where ψ is a vector containing parameters entering the firm's production and exit decisions. The parameter c_f is one example.⁵ The free entry condition in this model is given by:

$$pc_e = \int V(s, \psi) dG(s). \quad (1)$$

This equation equates the cost of entry to the expected value of a new firm. In this framework, one can think of changes in regulations, market concentration, or financial frictions as innovations to entry costs c_e or parameters ψ . Equation (1) implies that such factors affect equilibrium prices, thereby altering the value of a firm at any level of productivity. This change in firm value affects the exit behavior as incumbent firms remain in business only if the value of doing so exceeds fixed operating costs c_f . Consequently, the quality of incumbent firms is different in equilibrium, implying a different growth rate for incumbents. In short, by changing the value of remaining in business, these factors affect the behavior of incumbents.⁶

To study the plausibility of the explanations mentioned above, we look at the survival rates and employment growth rates of incumbent firms for several firm size categories. Figures 3 and 4 plot the survival and growth rates of incumbents by three size categories, respectively: 1–49, 50–249

⁵The contents of ψ depends on the details of the model and may include firm size, the standard deviation of idiosyncratic shocks to firm-level productivity, and so on.

⁶This logic carries forward to more factors than fixed costs and would hold for any factor affecting firm value such as uncertainty shocks or financial frictions. In fact, ? argue that financial frictions hurt the entry margin but improve the quality of incumbents, making them *fewer but better*.

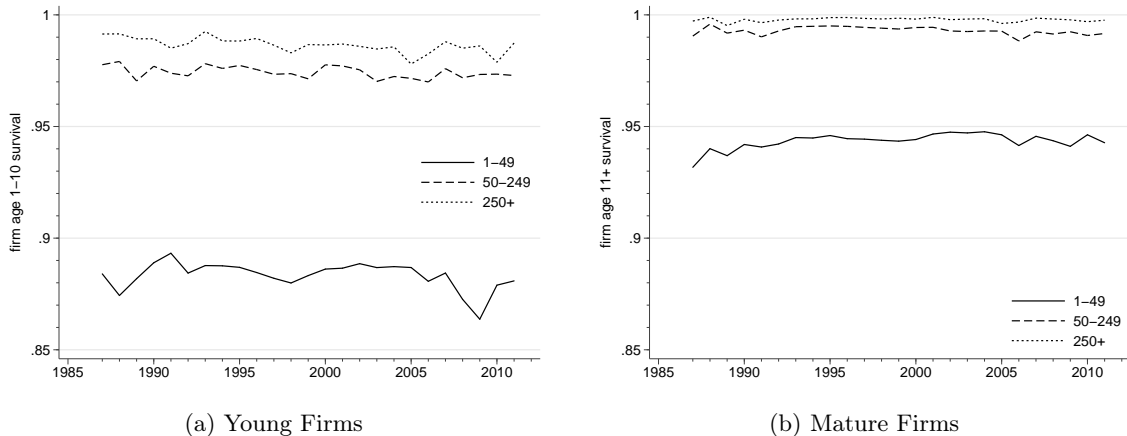


Figure 3: Incumbent survival and conditional growth rates by firm size from 1980 to 2012

Note: Business Dynamics Statistics. Survival rate is the number of incumbent firms within each size group as a fraction of the number of firms in the size group cohort in the previous year. Year 2012 is omitted because of difficulties measuring firm exits in the final year.

and 250+. We present each rate separately for young firms (left panel) ages 1 to 10 and mature firms (right panel) ages 11+ since the declining startup rate has changed the age composition of each size group.⁷ While there are notable business cycle fluctuations in these rates, overall they have remained remarkably stable amid a period of substantial declines in the entry rate. [Pugsley and Şahin \(2014\)](#) show that conditional on firm age, there are no trends in survival or growth of incumbent firms using both aggregate time-series and cross-sectional evidence. Thus, the evidence on incumbent behavior is inconsistent with the explanations that imply changes in the value of incumbent firms, such as increase fixed costs. We should note that it is not possible to rule out these explanations altogether just by the time series evidence, because a combination of various factors may still be consistent with a lower startup rate and a stable incumbent behavior.

This paper emphasizes a different factor—decline in the growth rate of labor supply over this episode—and argues that this factor is quantitatively very important. When adjusted to include population growth, a stationary equilibrium in per-capita terms depends on the population growth rate. Economies with a quickly growing population, but no change in firm lifecycle dynamics, require a larger share of entrants to keep pace with the population growth. Free entry implies that shifts in labor supply are absorbed in the long run by the entry margin and thus have no lasting effects on equilibrium prices or incumbent behavior. This result follows from (1) and holds precisely because labor supply has no direct effect on firm value. Thus, labor supply shifts as a driver of declining entry are also consistent with the time series evidence on stable incumbent behavior. Figure 1 shows that the long-run decline in startups has coincided with a shift in two measures of labor supply. The growth rate of the labor force has declined from around two percent to about 0.8 percent. Similarly, the growth rate of the working age population fell from over two percent to a low of just

⁷[Haltiwanger, Jarmin, and Miranda \(2013\)](#) show that even conditional on size, firm age has a significant effect on firm dynamics.

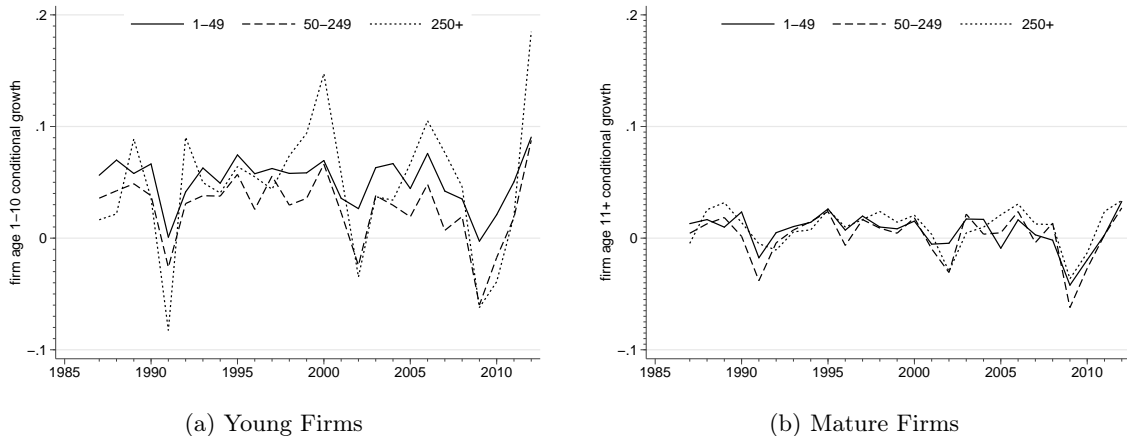


Figure 4: Incumbent conditional growth rates by firm size from 1987 to 2012

Note: Business Dynamics Statistics. Conditional growth rate is the growth rate of average employment size within each size group (excludes all startups) relative to the average employment of the size group cohort in the previous year.

over one percent. These changes in growth rates if permanent have substantial long run effects on the equilibrium share of entrants or startup rate.

3 Exploring the Labor Supply Channel

3.1 Empirical Strategy

As we discussed above, shifts in labor supply may have general equilibrium effects on firm dynamics. Our strategy for measuring these effects exploits cross-sectional demographic variation in labor supply. In particular using cross-state data pooled over time, we estimate a linear model of the startup rate and several incumbent margins on labor supply growth, n_{it} , controlling for state and time fixed effects. We estimate the following baseline specification for various outcomes related to firm dynamics:

$$y_{it} = \mu_i + \lambda_t + \beta n_{it} + \epsilon_{it}. \quad (2)$$

In this specification, the outcome variable, y_{it} , can be state i 's startup rate, average startup size or several incumbent margins, such as average incumbent size and survival- and conditional growth rates. μ_i and λ_t capture state and time fixed effects, respectively, and ϵ_{it} captures other sources of variation in y_{it} . In estimating (2), we use two measures of labor supply growth: the working age population growth and labor force growth.

The key identification problem is that there are possibly unobservable factors that determine firm dynamics and also affect labor supply. Permanent characteristics that affect firm entry and labor supply would not create an identification issue as they would be absorbed by state fixed effects. However, workers might relocate to states that temporarily look better for firms and thus have more firm entry, causing a spurious correlation due to an omitted variable problem. A successful empirical

strategy must deal with such endogeneity issues.

To generate variation in labor force growth that is exogenous to other factors affecting firm dynamics at the state level, we instrument labor supply shifts with 20 year lags of each state’s fertility rate. Lagged birth rates are positively correlated with current labor supply measures at the state level, because of low mobility rates across states. Together with the fixed effects, the first-stage explains 70 and 40 percents of total variation in the growth rates of the working age population and labor force.⁸

This strategy relies on two identifying assumptions. The first and most important is the exclusion restriction that conditional on state and time effects, fertility rates are not correlated with business dynamics 20 years later, except indirectly through labor supply. This exclusion restriction requires fertility decisions not to be driven by long-term expectations. For example, the assumption would be violated if people in a given state had a higher fertility rate 20 years ago in anticipation of, for example, a stronger labor market relative to other states. The restriction also requires that higher fertility or its determinants have no other long lasting (but not permanent) effects that would still affect business dynamics 20 years later. Second, and less importantly, to justify using states as the unit analysis, our empirical strategy requires that the mobility costs should be large enough to prevent geographic mobility from completely equating differences across these segmented markets. To the extent this is not true, our estimates will likely understate the effect of demographics on startups and incumbent dynamics. Drawing on the literature on mobility costs, we argue that this is likely to be the case.⁹

To better understand the cross sectional variation behind our estimation, Figure 5 plots the reduced form for residual startup rates on residual fertility, where both the startup rate and the fertility rate have been purged of state and time fixed effects. Each data point, labeled by its corresponding state is a state year for years 1980 through 2007. The x-axis plots the state’s lagged fertility relative to its state average and the cross state average that year. Similarly the y-axis plots the state’s startup rate relative to both its state average and the cross state average for that year. Although there is no test for our exclusion restriction we can see from the reduced form that the results are not driven by states that we know a-priori to have had unusual shocks to both fertility and the business environment.

4 Results

Tables 1 through 5 report the estimated effects of labor supply shifts on various dimensions of firm dynamics. All the estimates use the growth rate of working age population instrumented with the lagged fertility rate as the proxy for labor supply shifts. Table 1 shows the effect of the growth rate of working age population on the contemporaneous startup rate as well as the startup rates one and

⁸The results of the first stage are reported in the appendix.

⁹In an influential paper, ? find an average moving cost of \$312,000 (in 2010 dollars). This cost encompasses psychic as well as monetary costs. This estimate suggests that labor market differences across states are unlikely to be entirely offset by geographical mobility.

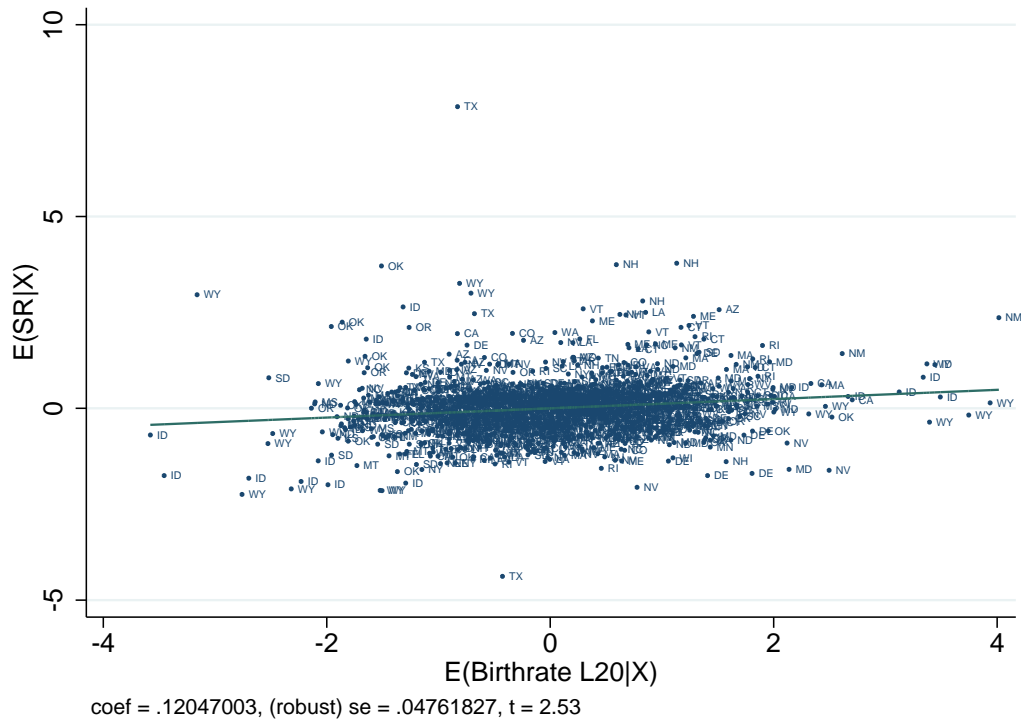


Figure 5: Reduced form partial regression

two year ahead. According to this estimate, a 10 percentage point slow down in the working age population growth rate leads to an almost 9.3 percentage point decline in firm entry. The effect gets stronger when we consider firm entry in subsequent years. Since the working age population growth rate slowed down roughly by a full percentage point in our sample period, the results suggest that this labor supply shift can explain about 1 percentage point decline in startup rates. This effect corresponds to more than 25 percent of the overall decline and is economically significant.

One immediate question is whether the decline in firm entry in response to labor supply shifts is associated with a change in the quality or behavior of entrants. Documenting how other margins are affected by demographic shifts is crucial for understanding the economic forces through which startups are affected. For example, if such shifts affect the relative price of labor, they may also affect the selection margin of entrants and the survival and growth rates of incumbents. Instead, if the only long run impact is on the entry margin, as predicted by workhorse models of firm dynamics with free entry of firms, one would expect all other margins to be unaffected in the long run.

Motivated by these considerations, we turn to the response of other entrant and incumbent margins. Table 2 reports the effect of the growth rate of working age population on the size of startups. The estimated coefficients are negative but economically and statistically insignificant. For example, with a one percentage point decline in the growth rate of working age population over our sample period, these estimates imply a rise in startup size of about 0.3 workers. Given an average startup size around 6, this effect corresponds to an elasticity of -0.08.

Table 1: Working age population and startup rates

VARIABLES	(1) SR _t	(2) SR _{t+1}	(3) SR _{t+2}
WAP GR (20+, %)	0.925*** (0.292)	1.042*** (0.262)	1.152*** (0.263)
Constant	10.76*** (0.550)	10.36*** (0.546)	10.05*** (0.577)
Observations	1,316	1,316	1,316
R-squared	0.887	0.876	0.862
Instrumented	IV	IV	IV
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	State	State	State
State Trend	-	-	-
Years	1980-2007	1980-2007	1980-2007
F-stat	23.53	27.31	27.09

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Business Dynamics Statistics and Current Population Survey. Stand errors clustered by state in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Dep var: startup rate (%). Excludes AK, HI, UT and DC.

Turning to the effects of labor supply shifts on incumbents, tables 3 and 4 show the response of young incumbents' survival and conditional employment growth rates. Between 1980 and 2007, the estimated coefficients imply an increase in the survival rates of young incumbents by less than 0.1 percentage point. With a baseline survival rate of young incumbents about 89 percent, this effect implies a negligible elasticity (-0.001). Similarly, the effects on young incumbent conditional growth rates are economically small, with an elasticity of roughly 0.2. Finally, table 5 shows the effect on incumbent firms' average employment. The effect is positive on impact and in the two years following the shift. However, the estimates are not statistically or economically significant and, interestingly, they get smaller over time.¹⁰ This declining pattern along with the increasing effect for startup rates in table 1 suggests that some of the increase in labor supply might be absorbed by existing firms at least within the first few years. Overall, our results suggest that shocks to labor supply affect firm dynamics mainly along the entry margin changing the startup rate but leaving other margins unaltered.

Changes in the working age population might fail to fully capture labor supply shifts since labor force participation rate also responds to changes in the economy. In fact, our sample period has witnessed important changes in the participation behavior of young and old workers.¹¹ To tackle this issue, Tables 6 through 10 repeat the analysis using the labor force growth rate. All

¹⁰The elasticity associated with the effect on impact is around 0.07.

¹¹See, for example, [Aronson and Davis \(2012\)](#).

Table 2: Working age population and startup size

VARIABLES	(1) N_t^0	(2) N_{t+1}^0	(3) N_{t+2}^0
WAP GR (20+, %)	-0.358 (0.238)	-0.200 (0.195)	-0.164 (0.217)
Constant	6.342*** (0.487)	6.084*** (0.426)	6.022*** (0.481)
Observations	1,316	1,316	1,316
R-squared	0.455	0.496	0.503
Instrumented	IV	IV	IV
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	State	State	State
State Trend	-	-	-
Years	1980-2007	1980-2007	1980-2007
F-stat	23.53	27.31	27.09

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Business Dynamics Statistics and Current Population Survey. Stand errors clustered by state in parentheses.
 *** p<0.01, ** p<0.05, * p<0.1. Dep var: startup rate (%). Excludes AK, HI, UT and DC.

Table 3: Working age population and young incumbent survival rates

VARIABLES	(1) X_t^{1-10}	(2) X_{t+1}^{1-10}	(3) X_{t+2}^{1-10}
WAP GR (20+, %)	-0.0709 (0.288)	-0.0682 (0.222)	-0.0396 (0.194)
Constant	88.40*** (0.280)	88.40*** (0.232)	88.37*** (0.200)
Observations	987	987	987
R-squared	0.681	0.690	0.695
Instrumented	IV	IV	IV
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	State	State	State
State Trend	-	-	-
Years	1987-2007	1987-2007	1987-2007
F-stat	28.92	40.45	53.66

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Business Dynamics Statistics and Current Population Survey. Stand errors clustered by state in parentheses.
 *** p<0.01, ** p<0.05, * p<0.1. Dep var: startup rate (%). Excludes AK, HI, UT and DC.

Table 4: Working age population and young incumbent conditional growth rates

VARIABLES	(1) G_t^{1-10}	(2) G_{t+1}^{1-10}	(3) G_{t+2}^{1-10}
WAP GR (20+, %)	-1.386 (0.852)	-0.845 (0.670)	-0.647 (0.543)
Constant	9.895*** (0.798)	9.428*** (0.627)	9.209*** (0.502)
Observations	987	987	987
R-squared	0.318	0.395	0.416
Instrumented	IV	IV	IV
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	State	State	State
State Trend	-	-	-
Years	1987-2007	1987-2007	1987-2007
F-stat	28.92	40.45	53.66

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Business Dynamics Statistics and Current Population Survey. Stand errors clustered by state in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Dep var: startup rate (%). Excludes AK, HI, UT and DC.

Table 5: Working age population and incumbent size

VARIABLES	(1) N_t^{1+}	(2) N_{t+1}^{1+}	(3) N_{t+2}^{1+}
WAP GR (20+, %)	0.955 (0.608)	0.869 (0.554)	0.864 (0.559)
Constant	20.89*** (1.090)	20.90*** (1.084)	20.85*** (1.142)
Observations	1,316	1,316	1,316
R-squared	0.945	0.944	0.941
Instrumented	IV	IV	IV
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	State	State	State
State Trend	-	-	-
Years	1980-2007	1980-2007	1980-2007
F-stat	23.53	27.31	27.09

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Business Dynamics Statistics and Current Population Survey. Stand errors clustered by state in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Dep var: startup rate (%). Excludes AK, HI, UT and DC.

Table 6: Labor force growth rate and startup rates

VARIABLES	(1) SR _t	(2) SR _{t+1}	(3) SR _{t+2}
CLF GR (20+, %)	0.775*** (0.257)	0.961*** (0.285)	1.082*** (0.284)
Constant	11.12*** (0.444)	10.05*** (0.732)	9.191*** (0.891)
Observations	1,316	1,316	1,316
R-squared	0.773	0.691	0.601
Instrumented	IV	IV	IV
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	State	State	State
State Trend	-	-	-
Years	1980-2007	1980-2007	1980-2007
F-stat	20.05	17.04	18.12

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Business Dynamics Statistics and Current Population Survey. Stand errors clustered by state in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Dep var: startup rate (%). Excludes AK, HI, UT and DC.

the estimates use the growth rate of labor force instrumented with the lagged fertility rate as the proxy for labor supply shifts. Our findings are qualitatively similar: a one percentage point decline in labor force growth rate is associated with roughly one percentage point decline in the startup rate and quantitatively insignificant changes in young firms' post entry performances.

Table 7: Labor force growth rate and startup size

VARIABLES	(1) N_t^0	(2) N_{t+1}^0	(3) N_{t+2}^0
CLF GR (20+, %)	-0.300 (0.193)	-0.184 (0.176)	-0.154 (0.201)
Constant	6.203*** (0.384)	6.142*** (0.475)	6.143*** (0.637)
Observations	1,316	1,316	1,316
R-squared	0.365	0.461	0.473
Instrumented	IV	IV	IV
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	State	State	State
State Trend	-	-	-
Years	1980-2007	1980-2007	1980-2007
F-stat	20.05	17.04	18.12

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Business Dynamics Statistics and Current Population Survey. Stand errors clustered by state in parentheses.
 *** p<0.01, ** p<0.05, * p<0.1. Dep var: startup rate (%). Excludes AK, HI, UT and DC.

Table 8: Labor force growth rate and incumbent survival rates

VARIABLES	(1) X_t^{1-10}	(2) X_{t+1}^{1-10}	(3) X_{t+2}^{1-10}
CLF GR (20+, %)	-0.0520 (0.213)	-0.0591 (0.194)	-0.0340 (0.168)
Constant	88.35*** (0.136)	88.39*** (0.209)	88.36*** (0.174)
Observations	987	987	987
R-squared	0.680	0.685	0.695
Instrumented	IV	IV	IV
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	State	State	State
State Trend	-	-	-
Years	1987-2007	1987-2007	1987-2007
F-stat	17.06	21.20	30.85

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Business Dynamics Statistics and Current Population Survey. Stand errors clustered by state in parentheses.
 *** p<0.01, ** p<0.05, * p<0.1. Dep var: startup rate (%). Excludes AK, HI, UT and DC.

Table 9: Labor force growth rate and incumbent conditional growth rates

VARIABLES	(1) G_t^{1-10}	(2) G_{t+1}^{1-10}	(3) G_{t+2}^{1-10}
CLF GR (20+, %)	-1.015 (0.635)	-0.732 (0.594)	-0.555 (0.470)
Constant	9.090*** (0.450)	9.328*** (0.590)	9.105*** (0.451)
Observations	987	987	987
R-squared	0.254	0.355	0.401
Instrumented	IV	IV	IV
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	State	State	State
State Trend	-	-	-
Years	1987-2007	1987-2007	1987-2007
F-stat	17.06	21.20	30.85

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Business Dynamics Statistics and Current Population Survey. Stand errors clustered by state in parentheses.
 *** p<0.01, ** p<0.05, * p<0.1. Dep var: startup rate (%). Excludes AK, HI, UT and DC.

Table 10: Labor force growth rate and young incumbent average firm size

VARIABLES	(1) N_t^{1+}	(2) N_{t+1}^{1+}	(3) N_{t+2}^{1+}
CLF GR (20+, %)	0.800 (0.521)	0.801 (0.524)	0.812 (0.529)
Constant	21.26*** (0.892)	20.65*** (1.276)	20.20*** (1.545)
Observations	1,316	1,316	1,316
R-squared	0.910	0.906	0.900
Instrumented	IV	IV	IV
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	State	State	State
State Trend	-	-	-
Years	1980-2007	1980-2007	1980-2007
F-stat	20.05	17.04	18.12

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Business Dynamics Statistics and Current Population Survey. Stand errors clustered by state in parentheses.
 *** p<0.01, ** p<0.05, * p<0.1. Dep var: startup rate (%). Excludes AK, HI, UT and DC.

5 Robustness of demographic channel

5.1 Labor Force Composition

[VERY PRELIMINARY]

5.1.1 Age Composition

One side effect of the fertility rate instrument is that by manipulating the future inflows of individuals into the working age population holding outflows constant, it also affects the age composition of the labor supply. In a recent paper, ? show that young firms disproportionately hire young workers. If young workers are a necessary input for new and young firms then changes in the age composition of the labor supply could also affect the startup rate.

We consider two approaches to differentiate the growth rate of the labor supply from this separate composition channel. First we re-estimating equation (2) further controlling for the share of young workers. The idea is if there is a separate composition channel states with a relatively low share of young workers may be more affected by the same lagged fertility shock, which would have a proportionally larger compositional effect. The results in Table (11) show that the effects of the demographic changes to the growth rate of the labor supply are robust to controlling for the state's young worker share. In fact, the estimated semi-elasticities are slightly larger.

A second approach is to use an alternative demographic shocks that affect outflows from the working age population, such as the lagged share of the population that would exit the working age population. [IN PROGRESS]

5.1.2 Immigration Shocks

[IN PROGRESS]

5.2 State Level Trends

A frequent concern with state level fixed effects empirical strategy is the state level fixed effects may not adequately control for differences across states in their trend changes in startup rate or fertility relative to the national averages. We re-estimate equation ((2)) further including linear state trends. Table XXX shows that the results are robust to further controlling for state specific trends.

5.3 Differentiating Supply and Demand Shocks

We argue that the effects on the startup rate work primarily through a labor supply channel. To the extent the fertility shock may also affect labor demand, we want to distinguish these effects.

Table 11: Working age population growth rate and startup rate controlling for age composition

VARIABLES	(1) SR _t	(2) SR _{t+1}	(3) SR _{t+2}
WAP GR (20+, %)	1.389*** (0.297)	1.189*** (0.243)	1.163*** (0.250)
Share of Population 25-34 (%)	0.265*** (0.0605)	0.148*** (0.0567)	0.0275 (0.0654)
Constant	5.348*** (1.318)	7.523*** (1.113)	9.550*** (1.095)
Observations	1,316	1,316	1,316
R-squared	0.852	0.865	0.861
Instrumented	IV	IV	IV
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	State	State	State
State Trend	-	-	-
Years	1980-2007	1980-2007	1980-2007
F-stat	19.86	27.49	28.61

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Business Dynamics Statistics and Current Population Survey. Stand errors clustered by state in parentheses.
 *** p<0.01, ** p<0.05, * p<0.1. Dep var: startup rate (%). Excludes AK, HI, UT and DC.

Table 12: Working age population growth rate and startup rate controlling for state trends

VARIABLES	(1) SR _t	(2) SR _{t+1}	(3) SR _{t+2}
WAP GR (20+, %)	1.434*** (0.302)	1.382*** (0.232)	1.295*** (0.208)
Constant	10.07*** (0.584)	9.918*** (0.516)	9.902*** (0.499)
Observations	1,316	1,316	1,316
R-squared	0.867	0.861	0.864
Instrumented	IV	IV	IV
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Cluster	State	State	State
State Trend	Yes	Yes	Yes
Years	1980-2007	1980-2007	1980-2007
F-stat	25.30	21.59	16.10

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Business Dynamics Statistics and Current Population Survey. Stand errors clustered by state in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Dep var: startup rate (%). Excludes AK, HI, UT and DC.

5.4 Anticipation Effects and Partial Adjustment

The demographic shocks occur well before any effect on the labor supply. Changes in fertility will take 20 plus years to effect the working age population and so the eventual demographic shifts are fully anticipated. We show in more detail below that an intertemporal substitution motive smooths the reduction in the startup rate well in advance of any direct effects on the working age population.

6 Quantifying the Slow Adjustment to the Demographic Shock

[IN PROGRESS]

The effects of a permanent reduction in the population growth rate on the equilibrium startup rate are gradual. We calibrate a Hopenhayn model to mimic features of U.S. firm dynamics in the early 1980s. Figure (6) shows the impulse response of the startup rate to an unexpected fertility shock that will permanently reduce the growth rate of the working age population from 2.1 to 1.25 percent in 25 years. It's apparent that the startup rate adjusts well before the fertility shock affects the labor supply and even after this point, the startup rate continues to decline for an additional 10 years. The gradual adjustment is due to two forces, the first is an intertemporal motive for the households to smooth the changes in the startup rate. In the model this is primarily because changes in the startup rate have significant effects on aggregate profits and thus aggregate

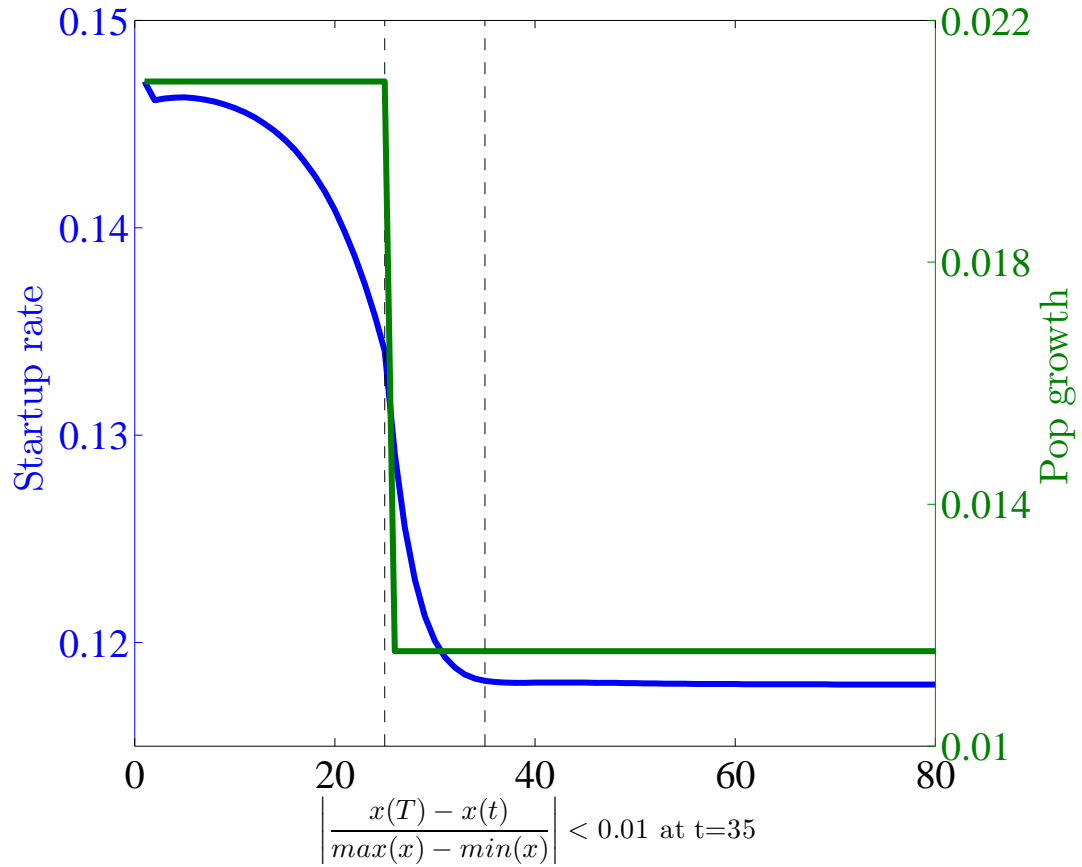


Figure 6: Impulse response of startup rate to an anticipated permanent reduction in labor force growth

consumption, which the household prefers to smooth over time. Second, even absent any smoothing motive, the distribution of firms takes many years to stabilize around the lower startup rate because of the large mass of incumbent firms.

7 Conclusion

To be written.

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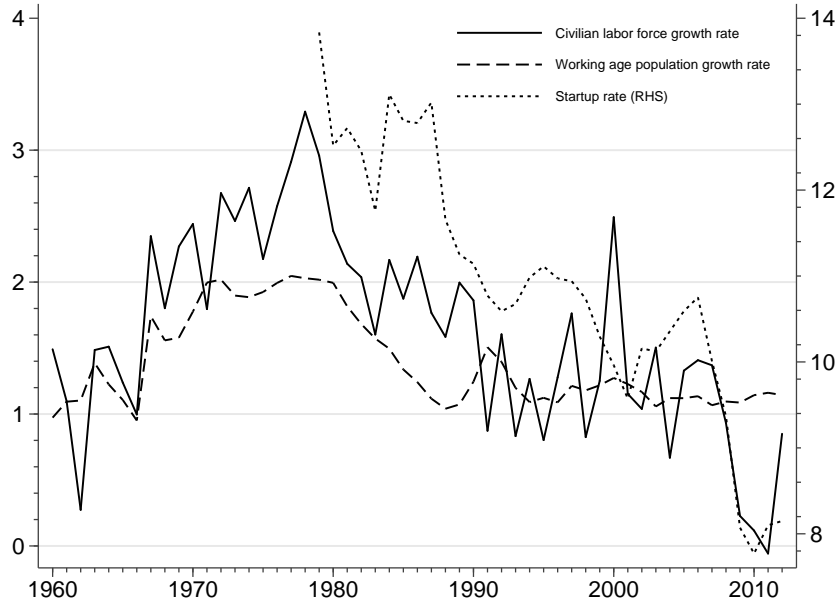


Figure A1: Unfiltered data: declines of startup rate and labor supply growth coincide

Note: BLS, Annual Census Bureau population estimates, and Business Dynamics Statistics. Annual data. Working age population is defined here as population ages 20 to 85. Civilian Labor Force is measured by the BLS for the adult (16+) civilian non institutional population. Startup rate is number of age 0 employers as share of the total number of employers within a year.

A Additional Tables and Figures

B A general equilibrium framework

The cross-state evidence points to a tight link between changes in the growth rate of the working age population and the entry behavior of firms. The link also appears strongest through a labor supply channel rather than a shift in the quantity of potential entrepreneurs or new business. Although the cross-state evidence is weaker, we also see some link between proxies for firm-level costs and declines in the entry rate. To assess these relative contributions quantitatively and in general equilibrium, we turn to an equilibrium model of firm dynamics.

Our starting point is the workhorse [Hopenhayn \(1992\)](#) model set in general equilibrium as in [Hopenhayn and Rogerson \(1993\)](#). In addition to the stationary equilibrium being well-understood, the model's implied behavior of incumbent firms is consistent with the results in [Pugsley and Şahin \(2014\)](#) and further developed in Section 2. Specifically, incumbent firm's conditional life-cycle dynamics appear remarkably stable during over the thirty year period we study.

The key divergence between the predictions of the [Hopenhayn \(1992\)](#) model and its variants is in the behavior along the entry margin. To address this margin, to the standard model we introduce non-stationarity through both population and productivity growth. With an appropriate normalization, we can characterize a balanced growth path in a stationary equilibrium, but the

equilibrium allocation will not be invariant to demographic shifts. The model allows the entry rate and other key indicators of firm dynamism to shift with demographics and various costs to business operation. These predictions are consistent with the reduced-form evidence, and we use the model to identify and quantify the sources of the secular shifts in these measures of firm dynamism.

B.1 Preliminaries

The economy consists of a growing population of identical households and a continuum of firms also of growing size. Time is discrete. The population H_t grows at deterministic rate η_t and has preferences over per-household consumption and leisure ordered by

$$\sum_{t=0}^{\infty} H_t \beta^t \left(\log c_t + \kappa \frac{l_t^{1-\frac{1}{\psi}}}{1-\frac{1}{\psi}} \right). \quad (3)$$

Each household has one unit of time to allocate between leisure l_t and supplying labor to firms. The parameter ψ governs the Frisch elasticity of the labor supply.¹² The consumption good is produced by a continuum of firms, each of which has a decreasing returns technology in labor n_t

$$f_t(s_t, n_t) = A_t s_t n_t^\theta - c_{ft} \quad (4)$$

that further depends on a firm's idiosyncratic productivity s_t and an aggregate productivity frontier A_t , which grows deterministically at rate g_t . The technology requires a fixed cost c_{ft} be incurred each period.¹³ A firm's idiosyncratic productivity evolves as an AR(1) in logs

$$\log s_{t+1} = (1 - \rho) \bar{s} + \rho s_t + \sigma_s \varepsilon_{t+1}. \quad (5)$$

At the end of the period, after production and incurring the fixed cost, firms may exit the market, but only in advance of learning next period's productivity s_{t+1} . Potential firms may freely enter the market by paying a fully sunk entry cost of c_{et} units of output and drawing from an initial productivity distribution G . With a continuum of incumbent and entrant firms, and deterministic rates of population and productivity growth there is no aggregate uncertainty. Households may trade in a one period bond with return r_{t+1} , and markets for output and labor are competitive with prices p_t and w_t respectively. Firms are fully owned by the population and any profits are distributed immediately as an aggregate dividend Π_t . We set $w_t = 1$ by choosing labor as the numeraire.

¹²Hopenhayn and Rogerson (1993) consider household preferences with an infinite Frisch elasticity. Although our only requirement for balanced growth is that income and substitution effects cancel, it will later be important for transitional dynamics that ψ is finite.

¹³Alternatively, we could have introduced an overhead cost in units of labor, i.e., $A_t s_t (n_t - \bar{n})^\theta$, where $w_t \bar{n}$ would be the fixed cost with wage w_t .

B.2 Firm problem

Given relative price p_t and technology (4) the value $V_t(s_t)$ of a firm with idiosyncratic productivity s_t solves the following Bellman equation

$$V_t(s_t) = \max_{n_t \geq 0} \left\{ p_t A_t s_t n_t^\theta - p_t c_{ft} - n_t + \frac{1}{1+r_t} \max_{X_t \in \{0,1\}} \{E_t[V_{t+1}(s_{t+1})], 0\} \right\}.$$

The inner maximization reflects the end of period exit decision. Let $X_t(s)$ be the optimal exit decision, which is 1 if the firm decides to exit and 0 otherwise. Let $n_t(s)$ be the optimal policy for n . With no adjustment costs n solves a static profit maximization problem

$$n_t(s) = \operatorname{argmax}_n \left\{ p_t A_t s n^\theta - p_t c_{ft} - n \right\},$$

with solution

$$n = (\theta p_t A_t s)^{\frac{1}{1-\theta}}.$$

Gross of fixed costs, profit is

$$\pi_t(s) = (\chi p_t A_t s)^{\frac{1}{1-\theta}}$$

where $\chi \equiv \theta^\theta (1-\theta)^{1-\theta}$. Given the optimal choice of n the value of an operating firm simplifies to

$$V_t(s_t) = (\chi p_t A_t s_t)^{\frac{1}{1-\theta}} - p_t c_{ft} + \frac{1}{1+r_t} \max_{X_t \in \{0,1\}} \{E_t V_{t+1}(s_{t+1}), 0\}. \quad (6)$$

B.3 Entrant and incumbent dynamics

Entrants draw an initial productivity from distribution G and are able to operate immediately.¹⁴ The expected value of an entering firm gross of entry costs $p_t c_{et}$ is

$$W_t = \int V_t(s) G(ds).$$

We let M_t be the measure of entrants in period t . We only consider distributions G compatible with entry and exit in equilibrium so that $M_t > 0$ and

$$p_t c_{et} = W_t. \quad (7)$$

As in [Hopenhayn \(1992\)](#), let $\mu_t(S)$ for Borel subsets S be the measure of firms producing in period t with idiosyncratic productivity $s \in S$. This measure of firms includes the new entrants M_t and incumbent firms, which are firms that chose not to exit at the end of the previous year. This

¹⁴Given the fixed operating costs, this timing admits the possibility for initial s sufficiently low that entering firms produce and immediately exit at the end of the period with a loss.

implies that

$$\mu_t(S') = \underbrace{\int (1 - X_{t-1}(s)) F(S'|s) \mu_{t-1}(ds)}_{\text{incumbents}} + \underbrace{M_t G(S')}_{\text{new entrants}}, \quad (8)$$

where F is the conditional distribution for productivity implied by the stochastic process for productivity s_t in equation (5). We define the startup rate as the share of new entrants out of all firms

$$SR_t \equiv \frac{M_t}{\int d\mu_t}.$$

B.4 Households

Households may trade in a one period bond b_{t+1} , which for convenience will be denoted in units of labor. Each household chooses c_t , $n_t = 1 - l_t$, and b_t to maximize (3) subject to its budget constraint

$$p_t c_t + \frac{b_t}{1 + r_t} = n_t + \frac{\Pi_t}{H_t} + \frac{b_{t-1}}{1 + \eta_t}$$

where Π_t/H_t is the per-capita dividend issued by firms.

Optimal choices of c_t , n_t , and b_t require

$$c_t \kappa (1 - n_t)^{\frac{-1}{\psi}} = \frac{1}{p_t} \quad (9)$$

$$\frac{1}{1 + r_t} = \beta \frac{p_t}{p_{t+1}} \frac{c_t}{c_{t+1}} \quad (10)$$

Since bonds are in zero net supply, the MRS between consumption and labor along with the budget constraint require

$$\frac{1}{\kappa} (1 - n_t)^{\frac{1}{\psi}} = n_t + \frac{\Pi_t}{H_t}, \quad (11)$$

which in general have a closed form solution for n_t for $\psi > 0$. If n_t^* solves equation (11), we can define

$$N_t^s \equiv \max \{ \min \{ 1, n_t^* \}, 0 \}.$$

There are at least two special cases where n_t^* can be computed in closed form: $\psi = 1$ and $\psi \rightarrow \infty$.

B.5 Aggregation

We aggregate over households and firms to define several quantities. First, we aggregate over all firms in a period to measure the aggregate dividend total labor demand

$$N_t^d \equiv \int (\theta p_t A_t s)^{\frac{1}{1-\theta}} \mu_t(ds).$$

Total profits include the dividends (possibly negative) summed across all firms net of the total sunk entry costs

$$\Pi_t \equiv \int \left((\chi p_t A_t s_t)^{\frac{1}{1-\theta}} - p_t c_{ft} \right) \mu_t(ds) - M_t p_t c_{et}.$$

Total output is

$$Y_t \equiv \int \left(A_t s (\theta p_t A_t s)^{\frac{\theta}{1-\theta}} - c_{ft} \right) \mu_t(ds)$$

On the household side total labor supplied is

$$N_t^s \equiv H_t \left(\frac{1}{\alpha} - \frac{\Pi_t}{H_t} \right).$$

Market clearing requires

$$\int (\theta p_t A_t s)^{\frac{1}{1-\theta}} \mu_t(ds) = H_t \left(\frac{1}{\alpha} - \frac{\Pi_t}{H_t} \right). \quad (12)$$

B.6 An equilibrium with demographic and productivity shifts

We first define a potentially non-stationary competitive equilibrium that admits shifts in population and productivity growth as well as fixed and entry costs.

Definition 1. Given an initial population of measure H_{-1} , technology A_{-1} , a measure of firms μ_{-1} , sequences of population growth, productivity growth, fixed costs and entry costs $\{\eta_t, g_t, c_{ft}, c_{et}\}$ for $t \geq 0$ an equilibrium is a constant real interest rate $r = \beta^{-1} - 1$, a sequence of prices $\{p_t\}$, sequences of per-capita consumption and leisure $\{c_t, l_t\}$, sequences of individual labor demand and exit rules $\{n_t, X_t\}$ for operating firms, and a sequence of measures $\{\mu_t\}$ such that given prices (i) $\{c_t, l_t\}$ are optimal, (ii) $\{n_t, X_t\}$ are optimal, (iii) $\{\mu_t\}$ satisfies the the law of motion given by equation (8), and (iv) markets clear for all $t \geq 0$.

This definition of an equilibrium allows the number of firms to grow as needed along with the population, as in the data. To compute the comparative statics of a stationary version of this equilibrium we make the necessary assumptions to define a balanced growth path.

B.6.1 Balanced growth path

Assumption 1. *Fixed costs and entry costs are proportional to productivity so that $c_{ft} = c_f A_t$ and $c_{et} = c_e A_t$.*

If fixed costs and entry costs grow at the same rate as productivity, a balanced growth path just requires reformulating the law of motion in equation (8) in terms of a per-capita measure of firms $\bar{\mu}_t = \frac{\mu_t}{H_t}$, then

$$\bar{\mu}_t(S') = \int \mathbf{1}\{X_{t-1}(s) = 0\} F(S'|s) \frac{\bar{\mu}_{t-1}(ds)}{1 + \eta_t} + \bar{M}_t G(S'), \quad (13)$$

where \bar{M}_t is defined the measure of entrants per capita. From this law of motion it is clear with constant η and X that the long run startup rate will depend positively on the population growth rate η . Since

Definition. Given a constant population growth rate η and aggregate productivity growth g a stationary recursive equilibrium with balanced growth is a set of prices r and $p(A)$ a value function $W(s)$ and individual labor demand $n(s)$, allocations $c(A)$ and l for each household, a measure $\bar{\mu}$, and a startup rate \bar{M} such that (i) given relative price $\tilde{p}(A)$, $n(s)$ solves $W(s)$, (ii) $c(A)$ and l are optimal, (iii) $\bar{\mu}$ satisfies equation (13) and (iii) markets clear.

The solution strategy is the same as in Hopenhayn (1992) and Hopenhayn and Rogerson (1993). First note that the solution to an incumbent firm's problem is invariant to shifts in the population growth rate. An incumbent firm's behavior and value are also invariant to changes in aggregate productivity when $p(A) = \frac{\bar{p}}{A}$, which will turn out to be the equilibrium relative price. Since entry costs are proportional to productivity in units of output, with entry and exit this price satisfies the free entry condition in equation (7) for any value of A . Similarly, household consumption must be $c(A) = \bar{c}A$ where $\bar{c} = \frac{1}{\alpha\bar{p}}$. With constant $\bar{\mu}$ and \bar{SR} the total measure of firms and of entrants grow at rate η insuring that profits per household Π/H are constant.

It remains only to determine the equilibrium startup rate \bar{SR} and with it the distribution of firms $\bar{\mu}$. As in Hopenhayn (1992) the right hand side of equation (13) defines a linear operator homogeneous in $\bar{\mu}_{t-1}$ and \bar{SR}_t . With both constant then the constant measure $\bar{\mu}$ that satisfies (13) can be as

$$\bar{\mu} = f\bar{SR},$$

where f satisfies

$$f(S') = \int \mathbf{1}\{X(s) = 0\} F(S'|s) \frac{f(ds)}{1 + \eta} + G(S')$$

Clearing the labor market in equation (12)

$$\bar{SR} = \left(\int \left(s(\theta ps)^{\frac{\theta}{1-\theta}} - c_f \right) f(ds) - c_e \right)^{-1} \frac{1}{\alpha\bar{p}}.$$

determines \bar{SR} and with it $\bar{\mu} = f\bar{SR}$.

C Sources of declines in the startup rate

This section provides a quantitative evaluation of the various sources of variation on the decline in the startup rate. While the ultimate goal of this paper is to provide a structural estimation of the model, this version of the paper focuses on providing comparative statistics to help identify major sources of the decline. In particular, our quantitative strategy is to calibrate our model economy to match features of the U.S. economy in early 1980s and then consider variation along three dimensions: growth rate of working age population; fixed costs of production and entry cost.

In addition, we present preliminary findings from a quantitative exercise where we vary the growth rate the labor force following its evolution from 1980 to 2012.

C.1 Calibrating the early 1980s economy

We calibrate our model at the annual frequency to match various statistics in early 1980s. We calibrate the time discount rate $\beta^{-1} - 1$ and the parameter θ directly to match the real interest rate and labor’s share of total revenue. Population growth rate η is set to 0.023, its level in 1980. The persistence ρ of the productivity shock and its volatility σ are set to 0.95 and 0.262 respectively. The fixed cost c_f , entry cost c_e , average idiosyncratic productivity $a/(1 - \rho)$, and the disutility of labor α , are jointly estimated using the simulated method of moments to match the employment-to-population ratio (0.6), the exit rate of startups (0.73), the startup rate (0.13) and the average firm size (20.7) in 1980. These parameters are summarized in the tables.

Table A1: Fixed Parameters

Parameter	Value
Time discount rate, r	0.064
Elasticity of output relative to labor, θ	0.638
Persistence of productivity shock, ρ	0.970
Population growth rate, η	0.023
Standard deviation of productivity process errors, σ_e	0.262

Note: Table A1 reports the values for parameters fixed outside the model.

Table A1: Parameters Calibrated with MSM

Parameter	Value
Fixed cost, c_f	2.604
Entry cost, c_e	11.00
Average log productivity, a	0.003
Disutility of labor, α	1.146

Note: Table A1 reports the values of parameters calibrated through Simulated Method of Moments (SMM).

Table A1 shows the outcome of the model for the distribution of firms and distribution of employment across different firm sizes and compares them with the average in the data for the 1977-1980 period. The model captures the distributions of firms and employment across firm sizes very well.

Table A1: Firm and employment distributions across firms sizes in the data and the model

	Distribution of Employment		Distribution of Firms	
	<i>Data</i>	<i>Model</i>	<i>Data</i>	<i>Model</i>
1-49	0.32	0.16	0.96	0.96
50-249	0.16	0.15	0.03	0.03
250+	0.52	0.69	0.01	0.01

C.2 Comparative statics

This section considers variation in fixed costs of production, entry costs and the growth rate of working age population and discusses the implications of changes along these dimensions on different aspects of firm dynamics as well as the startup rate.

C.2.1 Changes in the entry cost

A natural candidate to account for the decline in firm entry is a rise in the cost of entry. An increase in the entry cost protects incumbent firms and increases the relative price of output through the free entry condition in 7. The rise in the price increases the profits of incumbents and their optimal employment. Since firm profits are convex in the level of price, incumbents' exit threshold for productivity becomes lower, increasing their survival probability. In addition, the wealth effect of an increase in aggregate profits causes the households to reduce their labor supply. With larger incumbents that are more likely to survive, there is less room for entry in the economy. Even though incumbent firms are on average bigger, aggregate employment demand diminishes from the lower entry. To summarize, the increase in the entry cost discourages firm entry by making incumbents more profitable and and by reducing household's desire to supply labor.

C.2.2 Changes in the fixed cost of production

Another possibility is the rise in fixed operating cost. The increase in overhead expenses and its effects on cash flows makes survival difficult for less productive firms, and reduces the profitability of all firms. As values decline, entry becomes less attractive, which puts some upward pressure on the relative price of output. Again because cash flows are convex in the relative price of output, very productive incumbents ultimately become more profitable at the expense of less productive incumbents that are driven closer to exit by an increase in the exit threshold. Aggregate profits decline increasing labor supply through a household wealth effect. The increase in labor supply is accommodated by expanding incumbents and additional entrants.

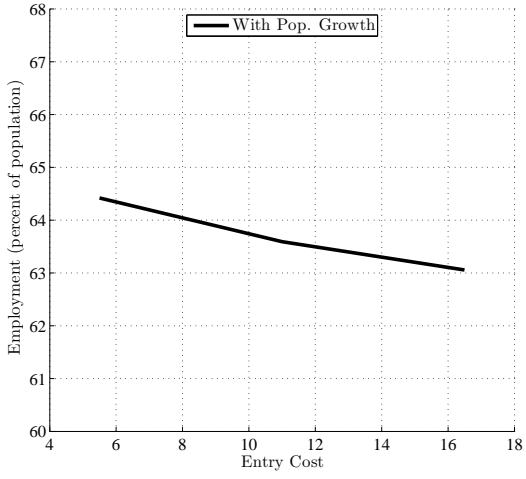
C.2.3 Changes in the growth rate of population

Unlike their response to changes in firm resource costs, equilibrium firm behavior is invariant to changes in the growth rate of the population. This result emerges because of the absence of changes

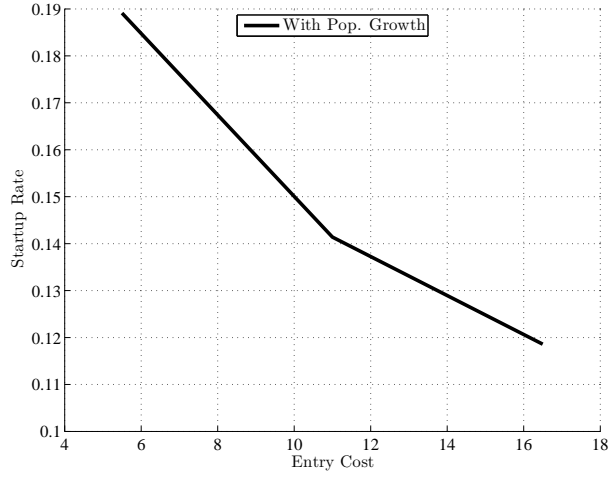
in real wages. Due to free entry, changes in labor supply have no effect on real wages. In the absence of changes in prices, the behavior of incumbents is completely unaffected. The only margin that adjust in response to a labor supply shock is new entry. In particular, a decline in the growth rate of labor supply decreases firm entry.

C.3 The role of labor supply in accounting for the decline in the startup rate

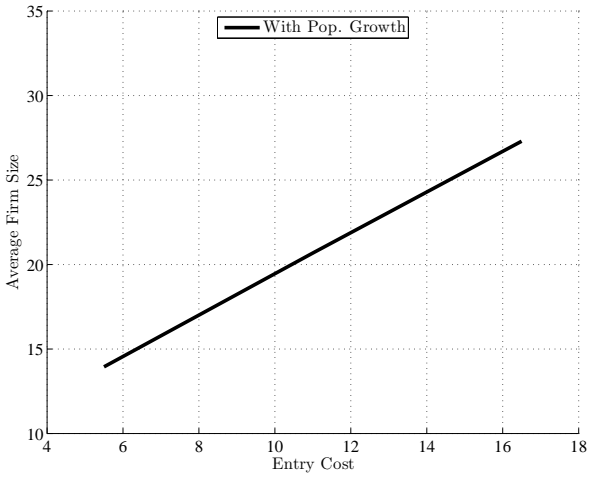
The cross-state empirical analysis and comparative statistics exercises both identified labor supply shifts as a promising source of variation to account for the decline in the startup rate. This subsection presents preliminary findings from a quantitative exercise where we vary the growth rate the labor force following its evolution from 1980 to 2012. Our simulations show that the model captures almost all the decline in the entry rate over timewith only this source of variation. However, it has the counterfactual implication of a drastic increase in the average firm size which suggests that other factors—which might have played offsetting roles on the firm startup rate—might have also played a role in shaping firm dynamics. The goal of our project is to uncover these additional forces and analyze their effects on various features of U.S. firm demographics.



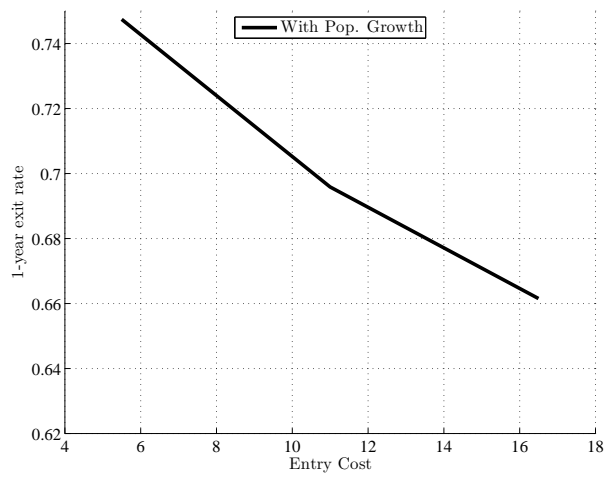
(a) Employment



(b) Startup rate



(c) Average firm size



(d) Conditional exit rate

Figure A2: Changes in entry costs c_e

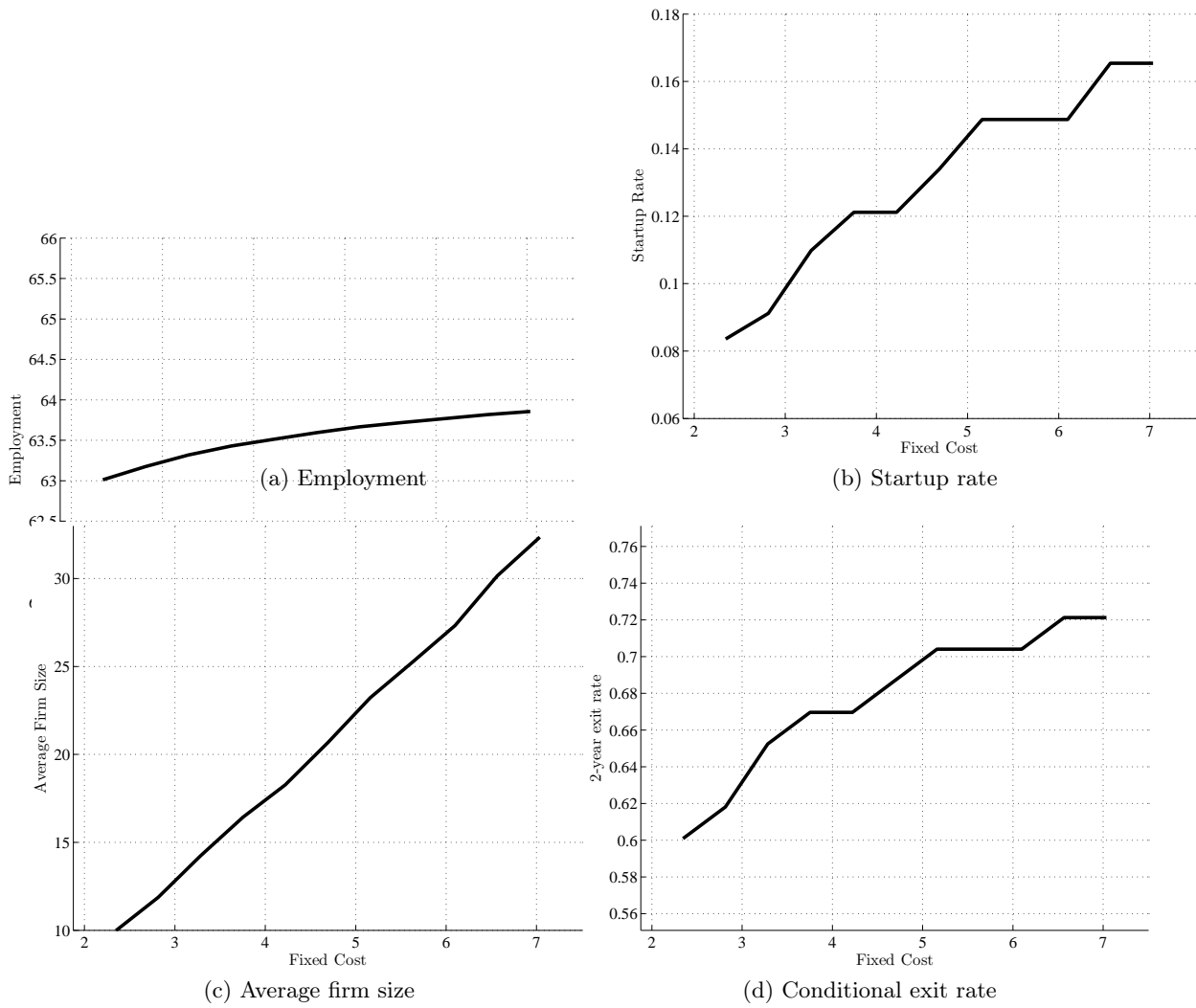
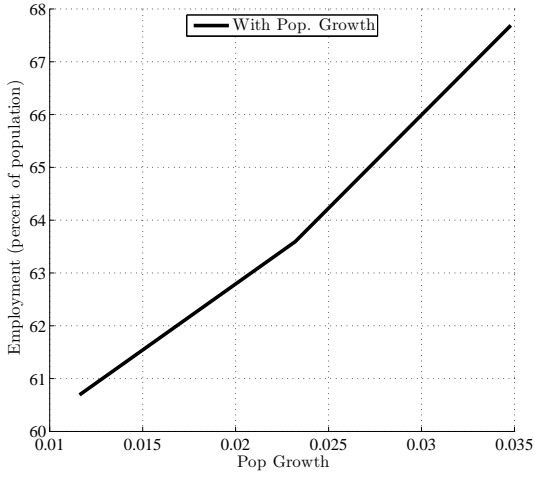
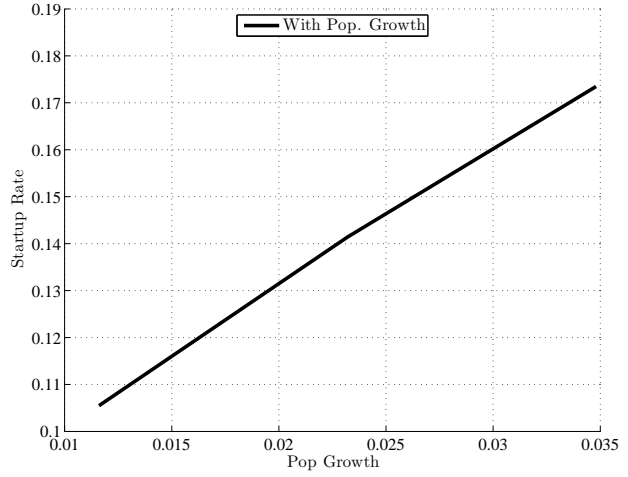


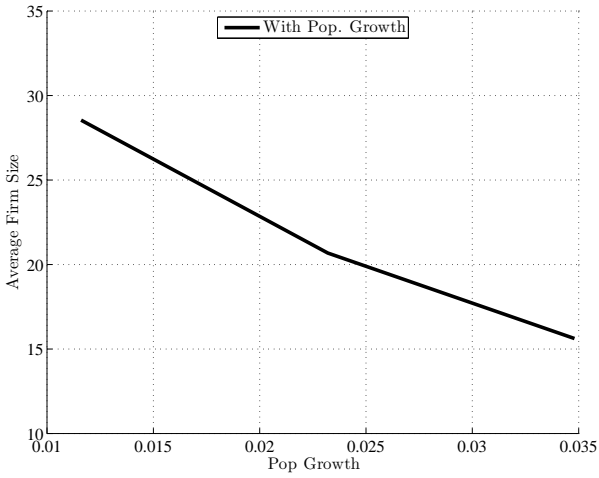
Figure A3: Changes in fixed costs c_f



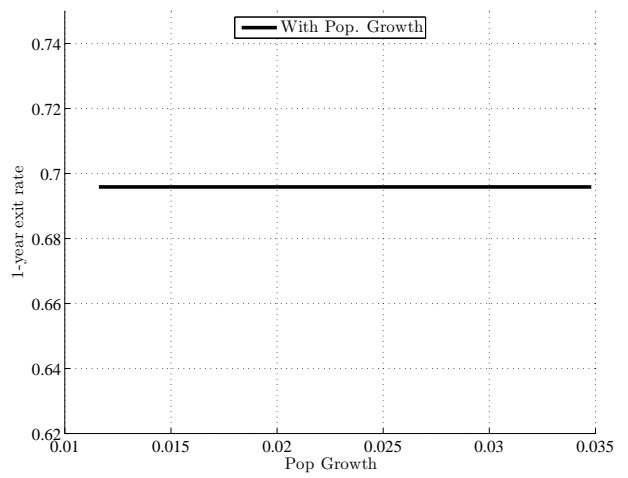
(a) Employment



(b) Startup rate

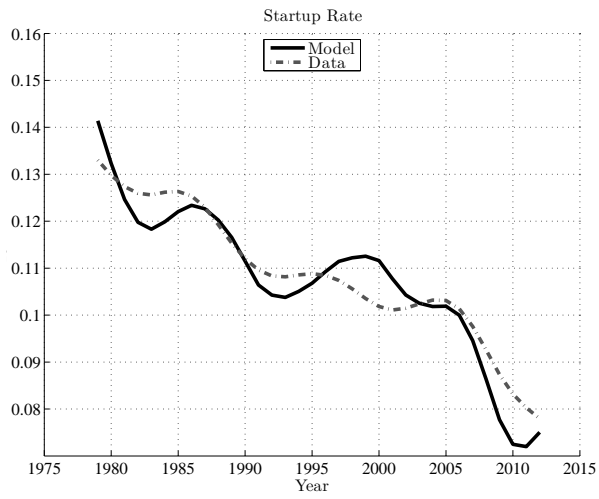


(c) Average firm size

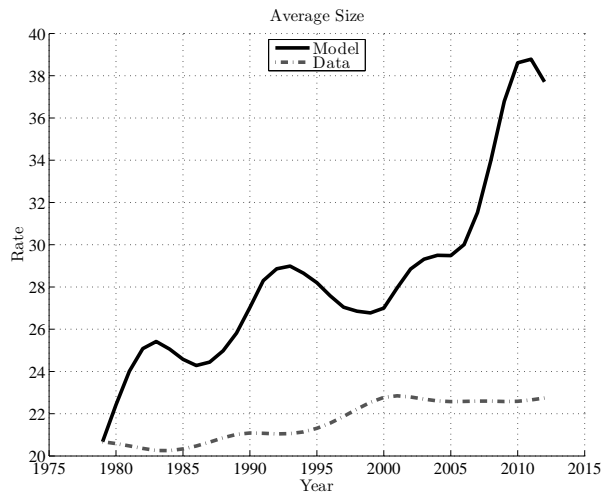


(d) Conditional exit rate

Figure A4: Changes in population growth η



(a) Startup rate



(b) Average firm size

Figure A5: Predicted effects of actual change in population growth rate 1980 to 2012