Why Do Businesses Grow Faster in Urban Areas than in Rural Areas?*

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Abstract

We document that growth of business earnings is mostly observed among young firms in metro areas. Three explanations are considered: metro areas attract more-productive entrepreneurs, and reaching the optimal size takes time due to borrowing constraints; metro areas provide better learning opportunities; and high operating costs in metro areas allow only the productive firms to survive. We use a firm-dynamics model with a location choice to quantify the extent to which the three theories explain the data. We find the first two theories largely explain the high growth among metro, young firms. Our model also suggests the distortion in entrepreneurs’ location choice can induce substantial welfare loss.

Keywords: Firm Dynamics, Firm Sorting, Borrowing Constraint, Firm Learning, Firm Selection, Urban Economy

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1 Introduction

The growth by young firms contributes a significant amount to the local employment growth (Haltiwanger et al. (2013)). Using the Survey of Income and Program Participation, a U.S. representative household-based survey, we document the growth rate among young firms is significantly higher in metro areas than in non-metro areas. We further document that the high growth among metro young firms is the primary driver of the growth difference between metro and non-metro areas.

To understand why the high growth is mainly observed among young firms in metro areas, we consider three possible explanations: (1) entrepreneurs are more productive in metro areas and they can accumulate wealth faster; (2) entrepreneurs in metro areas can improve productivity faster; and (3) only fast growing entrepreneurs in metro areas can survive, due to strong selection effects (Combes et al. (2012)). We quantify the contributions of each theory by developing a firm-dynamics model with a location choice between urban and rural areas. Our results suggest the first two theories largely explain the observed growth-rate difference, whereas the contribution of the selection effect is marginal.

Our model features the above three mechanisms as follows. First, following the literature in urban economics, we assume the location-specific productivity in the urban area is higher than in the rural area, and entrepreneurs’ ability and the location-specific productivity are complements. In the equilibrium, more-productive entrepreneurs sort themselves into the urban area. After choosing their locations, entrepreneurs gradually expand their business under borrowing constraints. Second, young entrepreneurs can gradually learn to improve their productivity, and urban, young entrepreneurs have more opportunities to learn and hence improve their productivity faster. Third, urban entrepreneurs are more likely to be out

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1 The borrowing constraint is assumed to be a collateral constraint (Midrigan and Xu (2014)): the maximum amount of debt is proportional to entrepreneurs’ wealth.

2 The assumption that young entrepreneurs learn faster is common in most “learning by doing” literature.
of the business due to a higher fixed operation cost, which we assume to be proportional to local wages. Surviving urban firms are those that can grow fast.

We characterize the stationary equilibrium of the model and match the model with data. Intuitively, we measure the contributions of each explanation as follows: (1) the growth rate of entrepreneurs with low wealth can be informative to measure the extent of borrowing constraints; (2) given the extent of borrowing constraints, the growth-rate difference between metro and non-metro firms, especially among young firms, can be informative to quantify the learning effect; (3) the observed wage difference across the regions can shed light on the extent of the selection effect. The calibrated model can replicate the growth-rate difference between metro and non-metro, young firms observed in the data.

The calibrated model suggests the sorting under borrowing constraints (explanation 1) explains 66%, and the learning effect (explanation 2) explains 30% of the growth-rate difference across the regions. The contribution of the selection effect (explanation 3) is marginal. Our results show the observed growth-rate difference between metro and non-metro, young firms in large part reflects the innate difference between metro and non-metro firms. Nevertheless, the substantial learning effect indicates being located in metro areas has a treatment effect on the growth rate of young firms.

Our results also suggest that borrowing constraints play an important role in young firms’ location choices and subsequent growth decisions. To further evaluate the role of borrowing constraints on firms’ location decisions and the welfare of the economy, we remove borrowing constraints from the calibrated economy. The aggregate efficiency will increase due to two reasons. First, productive entrepreneurs can get more resources, which is a well-studied channel in the literature (e.g., Moll (2014)). In addition to this conventional channel, our model indicates that the reallocation of firms will also increase the aggregate efficiency. Some entrepreneurs cannot fully enjoy the high location-specific productivity in the urban area because of the bor-
rowing constraint, and rather stay in the rural area. Once the borrowing constraint is removed, these entrepreneurs move to the urban area and enjoy the high location-specific productivity. Other entrepreneurs stay in the urban area because they accumulate wealth faster, and hence get out of the borrowing constraint faster. Once they can fully borrow the optimal amount of funds from the beginning, they will move to the rural area and enjoy the low operating cost.

Our model predicts a significant efficiency loss from the location-choice distortion: once the borrowing constraint is removed, the entrepreneurs’ average log profit will increase by 13%, of which 23% is induced by the distortion in firms’ location choice and 77% is induced by the conventional investment channel.

Our paper contributes to three lines of literature. First, it is related to the literature investigating urban agglomeration economies. Most previous research in urban economics considers the static difference in firms’ output across regions, and is based on static models. We contribute to this literature by documenting a new fact regarding the difference in business-earnings growth rates between urban and rural areas, and by quantifying the sources of this growth-rate differential.

Second, this paper contributes to the literature on the aggregate impact of borrowing constraints by adding a location choice. Our paper highlights the interaction between borrowing constraints and the agglomeration effect. The borrowing constraints will distort entrepreneurs’ location choice, and decrease the aggregate investments through the location-specific productivity in different regions. Existing literature focuses on the impacts of financial friction on entrepreneurs’ investments \cite{Moll2014, MidriganXu2014}, whereas we show the bor-

\cite{Fajgelbaum2015} quantify the distortion in firms’ location choice induced by state taxes in the United States. In this paper, we quantify the distortion in firms’ location choice induced by borrowing constraints.

\cite{Brinkman2011} A notable exception is \cite{Brinkman2011}. To understand the entry, relocation, and exit rates of establishments between the central business district areas and the remaining areas within the Metropolitan Statistical Area (MSA), they develop and estimate a dynamic general equilibrium model. Our paper is different from their paper in that we are interested in understanding the growth-rate difference between firms in metro and non-metro areas. Also, we model borrowing constraints and a location-specific learning effect and investigate their implications.
rowing constraints can distort startup firms’ location choices and induce substantial welfare loss even in the long run.

Third, this paper is related to the literature studying the dynamics of young businesses in the United States. Haltiwanger et al. (2013) and Decker et al. (2014) find that start-ups and young businesses contribute the most to U.S. job creation. Our empirical findings complement their findings in that we show the growth rate of business profits is mainly observed among young businesses. We further document the growth rate of business earnings among young firms are mostly driven by metro, young firms.\(^5\)

The paper is organized as follows. Section 2 discusses the data and section 3 documents the main empirical findings. In section 4, we introduce the model. Calibration is discussed in section 5. The results are presented in section 6. The welfare implication is discussed in section 7. Section 8 concludes.

2 Data

We use the Survey of Income and Program Participation (SIPP) for this study, which is a nationally representative household-based survey of the U.S. population, designed to collect information for income and program participation. Each SIPP panel follows a large number of respondents, ranging from approximately 14,000 to 36,000 for three or four years. We use the 1996, 2001, 2004, and 2008 panels.\(^6\)

The SIPP can be useful to study the business-earnings dynamics in the United States. First, it is a large sample; thus, we can observe relatively many observations for businesses owners.

\(^5\)Using confidential establishment data from the Bureau of Labor Statistics, Renski (2008) documents the employment growth by new firms is faster in urban areas than in rural areas in the United States. Our findings are consistent with his findings in that not only employment but also profits by young firms grow faster in urban areas than in rural areas.

\(^6\)We did not include panels before the 1996 panel, because the survey design of the SIPP has changed since the 1996 panel, and some of the variables before and after 1996 panel are not consistent. Panels after the 1996 are not overlapping.
Second, it follows the same business over time; thus, we can observe the dynamics of a business as it ages. Third, unlike other establishment-based data, the SIPP provides business profit measures for each business and we can separate startup businesses from “new” businesses emerging from mergers and acquisitions. The SIPP covers both employer and non-employer businesses. The representativeness of the SIPP is discussed in Appendix A.

2.1 Variable Definition

Business owner: The SIPP interviews a respondent every four months (each wave covers four months). Each time, they ask whether the respondent owns a business. The respondent reports his/her main business and the second business if one exists. We define a respondent as a business owner in a given year if he/she reports owning a business at least once in that year. Throughout the paper, we focus on the characteristics of the primary business.

Business earning: Business owners are asked to report the profits from the businesses each month. They are also asked about the total amount of income received from the business. The business earnings measure is constructed by combining the answers to these two questions. We use the monthly earnings only for the survey month, because little variation occurs in monthly earnings within the same wave. The annual earnings are calculated in the following way. Suppose a respondent reported business earnings for only two out of three survey months, and the total amount of the business earnings for the two months was $5,000. Then his/her earnings

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7 The SIPP provides a self-reported earnings measure, and business owners may underreport their earnings (Hamilton (2000), Hurst et al. (2014)). Even so, we believe the underreporting does not affect the growth rate of earnings in a systemic way. For example, let the true business earnings in period 1 and in period 2 be $y_1$ and $y_2$, respectively. Although the business owners underreport their earnings, for example, by about 25%, the growth rate is calculated in the same manner as the one calculated by the true earnings. Another issue with the SIPP is that it over-samples a low-income group. However, as discussed in Appendix A, these low-income individuals are less likely to own a business, and the over-sampling is less likely to affect our results.

8 Decker et al. (2014) emphasize the importance of focusing on startup or young firms, instead of firms emerging from mergers and acquisition.

9 We use the term “business” and “firm” interchangeably.

10 The majority of business owners operate only one business. For example, in 2002, 90.52% of business owners operate only one business.
annual business earnings are calculated as $5,000 \times \frac{12}{2}$. All dollar terms are normalized by 1 USD in 2011.

Business age: The SIPP provides the date when the operation of the primary business began. By subtracting the start year from the survey year, we can calculate the business age.

Business exit: Every survey month, business owners are asked whether they still own the primary business they owned in the previous survey month. If they answer no, it is considered a business exit.

Owner characteristics: The SIPP provides information about business-owner characteristics including gender, race, age, years of education, and marital status.

Metro vs. non-metro: Among other information about business owners, the SIPP indicates whether they live in a metro area. The definition of metro area in the SIPP follows the U.S. Office of Management and Budget (OMB). The Metropolitan Statistical Areas (MSAs) have at least one urbanized area with a population of 50,000 or more, plus adjacent territory that has a high degree of social and economic integration with the core as measured by commuting ties. About 85% of the U.S. population resides in the metro areas. This metro definition reflects the idea that the adjacent periphery of a highly populated area is also under the influence of the populated area, and hence should be considered an integrated area (Friedmann and Millder (1965)). The definition of metro and non-metro is often used to characterize urban and rural areas in the United States. (e.g., Buss and Lin (1990), Forsyth (2005), Porter et al. (2004) and Plumner et al. (2008)).

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11 For example, the St. Louis, MO-IL MSA includes not only St. Louis County, where the population is much more than 50,000, but also nearby counties such as Monroe County.

12 The location information is for the owner’s living location, and the owner’s residential location and business location might be different. Owners living on the border of metro and non-metro areas or owners not physically present in their primary business may be a concern, but we consider these cases minor.
2.2 Sample Construction

By combining four panels, we make one unbalanced panel. Before the 2004 panel, the SIPP provides the metro information with a noise for some states due to a disclosure risk for respondents.\(^{13}\) We drop those observations. We also drop the businesses classified as Agriculture, Forestry and Fisheries, and Mining, because they are mostly located in non-metro areas and thus are unsuitable for comparison between metro and non-metro businesses. We also drop businesses classified as a Public Administration industry, as well as respondents who report at least twice in the three survey months that they do not have a job or whose age is less than 18. In addition, we drop non-business owners, those whose wage earnings are less than $1,000, and the observations without the metro information. Of 349,231 individual/year observations, 36,231 are for business owners.

2.3 Summary Statistics

Table 1 shows the summary statistics for the key variables. About 84% of observations are recorded in metro areas, which is consistent with the statistics by the OMB. The distribution of observations does not differ across regions conditional on each occupation (either worker or business owner). The proportion of business owners in each region (either metro or non-metro) is also similar at 10%. The proportion of incorporated business is, however, higher in metro areas. As is well documented, the mean and the median of wage and business earnings in metro areas are greater than those in non-metro areas. The median firm age in non-metro and metro areas is seven and eight years, respectively. In both regions, more than a quarter of firms started a business less than two years ago, suggesting “young” firms constitute a considerable proportion of the number of firms in both regions. The annual exit rate is 6% in both metro

\(^{13}\)The states free from this noise are Connecticut, New Jersey, New York, Pennsylvania, Rhode Island, Indiana, Missouri, Ohio, Washington D.C., Maryland, North Carolina, California, Nevada, and Utah.
and non-metro areas on average, but if we condition on firms whose age is less than four years, the exit rate becomes much higher: 9% for metro areas and 10% for non-metro areas.\textsuperscript{14}

Table 2 reports the distribution of firms across regions with respect to their employment size. The SIPP reports the firm size as a discrete measure: (1) from 0 to 24, (2) from 25 to 99, and (3) from 100 and above. Most firms are small in both regions. The proportion of firms categorized in the first bin is more than 95%. However, firms in metro areas consist of relatively more large firms compared to firms in non-metro areas. For example, the proportion of firms categorized into the third bin is 1.21% in metro areas, whereas it is about 0.56% in non-metro areas.

Figure 1 shows the industry composition in metro and non-metro areas. We see relatively more construction in non-metro areas, and relatively more professional, scientific, management in metro areas. Industry composition for other industries is similar across regions.

3 Business Earnings Dynamics between Metro and Non-metro Areas

Section 3.1 documents a pattern in the earnings-growth-rate difference between metro and non-metro areas. Section 3.2 discusses possible explanations for this growth-rate differential.\textsuperscript{15}

\textsuperscript{14}As an alternative exit measure, we define an exit if a respondent answers yes to the question “Do you still own the primary business that you owned in the previous survey month?” at \( t \) − 1, but does not answer yes at \( t \). This categorization includes those who did not respond to the question, and therefore the exit rate is calculated as large compared to our main categorization. Nevertheless, no significant difference exists in the exit rate between metro and non-metro firms with this alternative categorization.

\textsuperscript{15}The business-earnings growth rate is calculated as \( \ln Y_{t+1} - \ln Y_t \). The firm-growth literature recognizes the output process of a firm is similar to a mean-reverting process, meaning a high initial output more likely leads to a low output and vice versa. This effect alone generates a negative relationship between initial earnings and growth. To mitigate this problem, Neumark et al. (2011) and Haltiwanger et al. (2013) suggest the growth calculation as business-earnings growth rate = \( \frac{Y_{t+1} - Y_t}{0.5 \times (Y_{t+1} + Y_t)} \). As a robustness check, we conducted all the analyses in this section with this alternative measure. The main conclusions do not change.
3.1 Main Empirical Findings

Figure 2 shows the business-earnings growth rate between metro and non-metro areas conditional on firm ages. First, the distribution of the business earnings growth rate is more dispersed among young firms for all areas. Second, the growth rate of firms in metro areas is greater than in non-metro area only among young firms. For firms whose age is greater than or equal to four year, no growth-rate difference exists between the two regions.

Table 3 compares the mean difference between metro and non-metro firms. Consistent with Figure 2 we observe the growth-rate difference between metro and non-metro areas only among young firms. Moreover, the significantly positive growth by metro, young firms mainly drives this difference. On the other hand, the growth rate by non-metro, young firms is not statistically different from zero.

Cross-sectional regression

To further investigate the observed pattern in Figure 2 we conduct the following regression analysis:

\[
\ln Y_{t+1} - \ln Y_t = \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \text{Firm age}_{it} + \beta_3 \text{Firm age}^2_{it} + \beta_4 \text{Metro}_{it} + \beta_5 \text{Metro}_{it} \cdot \text{Firm age}_{it} \\
+ \text{StartYear}_i + \text{State dummy}_{it} + \epsilon_{it}.
\]  

(1)

\(Y_t\) represents the annual business earnings. We regress the business-earnings growth rates on the log earnings at \(t\), firm ages, the metro dummy, and their interactions, with a cohort fixed effect as well as the state fixed effect. The standard errors are clustered by each business.

We report the results in the first column of Table 4. \(\beta_1\) is estimated as -0.357, suggesting a 10% increase in the current business earnings leads to a 0.036-point decrease in the growth rates. \(\beta_2\) and \(\beta_3\) are both estimated significant, suggesting a non-linear relationship between
the earnings growth rates and firm ages.

The growth-rate difference across regions is captured by $\beta_4 + \beta_5 \text{Firm age}_{it}$. $\beta_4$ is estimated at -0.168, suggesting, after controlling for the current business earnings, the growth rates are, on average, 0.168 points higher among metro firms than non-metro firms. Consistent with Figure 2, $\beta_5$ is estimated to be significantly negative, suggesting the difference in the business-earnings growth rate across the regions is more pronounced among young firms.

Motivated by a non-linear relationship between the earnings growth rates and firm ages in the first regression, we conduct the same regression analysis, except we replace the firm ages with log firm ages. We report the results in the second column of Table 4. The results in the first regression still hold.

In the third column of Table 4 we report the results from a regression analysis similar to the second column of Table 4 except we include industry dummies. One or two particular industries might drive the growth-rate difference between metro and non-metro areas. The regression estimates, however, suggest that even after controlling for the industry fixed effect, we still observe the pattern.

The fourth column of Table 4 shows the results from a regression analysis similar to the third column of Table 4 except we include two firm characteristics: incorporation status and firm size measured by the number of employees. As discussed in section 2.3, the SIPP reports the firm size as a discrete measure: (1) from 0 to 24, (2) from 25 to 99, and (3) from 100 and above. Between two firms with the same initial profit level, the incorporated firm or the one with more employees exhibits a faster growth in earnings. The coefficients for the metro dummy decrease, which reflects the fact that the proportion of incorporated or large firms is higher in metro areas. The coefficients for firm age decrease, which reflects the fact that the proportion of incorporated or large firms is higher among old firms.

The final column of Table 4 shows the results from a regression analysis including various
owner characteristics. The younger the business owner, the higher the business-earnings growth rate becomes. The business-earnings growth rate is higher among male owners, owners with a college degree, or married owners. By contrast, the growth rates are not different with respect to the owners’ racial background. Interestingly, the coefficients for the metro dummy \((\beta_4)\) and for the interaction term between the metro dummy and firm age \((\beta_5)\) becomes much smaller once we include owner characteristics. This finding may indicate the difference in the business-earnings growth rates across metro and non-metro areas is to some extent explained by a different sorting pattern across the two areas.

Figure 3 plots the predicted business-earnings growth rate in metro and non-metro areas by using the estimates of the regression equation in the second columns of Table 4. The figure shows the difference in the business-earnings growth rate across regions is most pronounced among young firms, and the difference is mostly driven by young firms in metro areas.

**Panel regression**

Regression analyses based on equation (1) show business-earnings growth rates are higher in metro areas than in non-metro areas, and the difference is most pronounced among young firms. Table 3 suggests metro, young firms are the primary driver of this difference. From the last regression in Table 4, we also found some evidence that business owners located in metro and in non-metro areas are different, and this difference to some extent explains the observed growth difference. To further control for the unobserved difference between metro and non-metro firms, we turn to a panel regression as below:

\[
\ln Y_{it} = \alpha_0 + \alpha_1 \text{Firm age}_{it} + \alpha_2 \text{Incorporated}_{it} + \tau_i + u_{it}. \tag{2}
\]

We divide the sample into four groups: (1) metro firms whose age is less than four, (2) non-metro firms whose age is less than four, (3) metro firms whose age is greater than or equal to
four, and (4) non-metro firms whose age is greater than or equal to four. We run a fixed-effects panel regression with equation (2) for each sub-sample. The standard errors are clustered by each business.

Table 5 shows the panel regression results. The first column reports the results with metro, young firms. Consistent with the previous analyses, for metro, young firms, the business earnings grow as a firm ages. A one-year increase in the firm age on average leads to about a 5% increase in the business earnings. The increase in the growth rate is much more pronounced among young firms that become incorporated. The business earnings for the incorporated, metro, young firms grow about 20%.16

The second, third, and fourth columns of Table 5 show the panel regression results for firms that are non-metro and young, metro and old, and non-metro and old, respectively. Contrary to the result from metro, young firms, firm age and incorporated status are not associated with business-earnings growth. Business earnings among old, non-metro firms rather decreases as a firm ages.

3.2 Possible Explanations

The previous regressions use the observation for surviving firms. However, the exit decision by firms in metro and in non-metro areas can be quite different. For example, the competition in metro areas is higher, and relatively more-productive firms are selected to be out of the market in metro areas (Combes et al. (2012)). This selection effect can itself generate a higher average business-earnings growth rate in metro areas.

More-productive firms are more likely to be sorted into metro or urban areas in the first place due to a complementarity between firm productivity and the agglomeration effect

16Levine and Rubinstein (2013) argue the behavior of incorporated firms is more similar than non-incorporated firms to “entrepreneurs” that economic theories often describe. Consistent with Levine and Rubinstein (2013), the results from Table 5 show metro, young firms that become incorporated largely contribute to the observed difference in business-earnings growth rates between metro and non-metro areas.
Another literature on entrepreneurial finance documents that potential business owners and small business owners are more likely to be financially constrained (e.g., Evans and Jovanovic (1989); Holtz-Eakin et al. (1994); Cagetti and De Nardi (2006); Adelino et al. (2015); Schmalz et al. (Forthcoming)). Conditional on wealth before starting a business, firms located in metro area are more likely to be financially constrained because they are more productive. They may start a business with a suboptimal level of investment, and grow faster once they are able to finance using the previous year’s profits.

Finally, learning opportunities can be higher for firms in metro areas thanks to easier knowledge generation, diffusion, and accumulation (Duranton and Puga (2004)), and these opportunities can be particularly important for young firms. Or the learning about demand (Foster et al. (2016)) may be faster for young firms in metro areas than for young firms in non-metro areas. The high demand in the metro areas gives the firms better opportunities to learn how to decrease their production costs (Jovanovic and Nyarko (1996)). Although the initial productivity is the same, firms in metro areas may learn faster and hence enjoy faster earnings growth.

Understanding why the growth rate is different across regions, especially among young firms is important. It can shed light on the inequality of economic activity between metro and non-metro areas given that young firms contribute a significant amount to the local employment (Haltiwanger et al. (2013)) as well as the local economic growth (Glaeser et al. (2015)). In the next section, we develop a stylized firm-dynamics model with a locational choice that features three mechanisms discussed above. With the calibrated model, we quantify the extent to which each explanation contributes to the observed difference in business-earnings growth rates across regions. We will also use the calibrated model for counter-factual policy experiments.
4 The Model

The economy has two locations: an urban and a rural area. The economy consists of (1) a representative firm at each location, (2) a continuum of individuals who either choose to be a worker or an entrepreneur, and (3) hand-to-mouth workers who work only as a worker and never become an entrepreneur. We call the second group of individuals potential entrepreneurs. Both the representative firms and the entrepreneurs produce a homogeneous consumption good. The consumption goods are free to be traded between different locations, and the price of the consumption good is the same across all regions. It is normalized as 1. We first consider the representative firm’s problem.

4.1 Representative Firms

In each location \( j \), one representative firm produces the homogeneous goods. The production function of the representative firm in location \( j \) is

\[
y_{jt}^R = A_j k_{jt}^\alpha l_{jt}^{1-\alpha}, \quad j \in \{ \text{urban, rural area} \}, \quad 0 < \alpha < 1
\]

where \( A_j \) is the location-specific productivity, capturing agglomeration effects. \( y_{jt}^R \) is the homogeneous good the representative firm produces. \( k_{jt} \) and \( l_{jt} \) are the capital and labor the representative firm hires in location \( j \) and period \( t \).

The capital can move freely across different locations, and the rent per period is \( r \). The capital depreciates at rate \( \delta \). The profit of the representative firm is \( y_{jt}^R - (r + \delta) k_{jt} - w_j l_{jt} \). The optimality condition of the representative firm yields

\[
w_j = (1 - \alpha) A_j \left( \frac{k_{jt}}{l_{jt}} \right)^\alpha
\]  
(3)
\[ r = \alpha A_j \left( \frac{l_{jt}}{k_{jt}} \right)^{1-\alpha} \]  

(4)

and the marginal cost of the representative firm should be the same as the price of the consumption goods

\[ \frac{1}{A_j} \left( \frac{r}{\alpha} \right)^\alpha \left( \frac{w_j}{1-\alpha} \right)^{1-\alpha} = 1 \]  

(5)

Usually, the location-specific effect is modeled as a function of population density. Allowing the location-specific effect to be endogenous is computationally challenging in our model. Moreover, we argue that assuming \( A \) to be exogenous will not affect our main decomposition in section 6.2.

### 4.2 Potential Entrepreneurs

One unit of potential entrepreneurs is in the economy. In each period, they choose either to operate an individual-specific technology - that is, to become entrepreneurs - or to work for wages. This occupation choice allows endogenous entry and exit. We call these individuals potential entrepreneurs to differentiate them from hand-to-mouth workers who never become entrepreneurs. Each entrepreneur is characterized by heterogeneous ability \( e \), wealth \( a \) and firm age \( s \).

Consider potential entrepreneurs in location \( j \). If they set up their own business, the production function is

\[ y_{jt} = \psi (e, A_j, s) z_t \left( k_t^\alpha l_t^{1-\alpha} \right)^\eta, \quad 0 < \eta < 1 \]  

(6)

where \( \psi (e, A_j, s) \) is the permanent productivity when an entrepreneur with ability \( e \) and age \( s \) locates in location \( j \). We assume the entrepreneurs’ ability \( e \) and location productivity \( A_j \) are fixed over time. Hence, \( \psi \) is certain. Potential entrepreneurs can predict the path of \( \psi \) before
they enter the market. \( z_t \) is the transitory productivity shocks. \( k_t \) and \( l_t \) are the capital and labor hired by the entrepreneurs.

We assume \( \psi \) satisfies the following properties: \( \psi_e > 0, \psi_A > 0, \) and \( \psi_s \geq 0. \) The last condition means that when a firm becomes old, the productivity becomes higher \( \psi. \) We call this effect the learning effect of the firm. We also assume \( \psi eA > 0, \) meaning the entrepreneurs’ ability \( e \) and location productivity are complements.

The transitory productivity shock \( z \) follows a diffusion process:

\[
d\ln z_t = \mu(z) dt + \sigma(z) dB_t
\]

\( \mu(z) \) captures the persistence of the \( z \) shock, and \( B_t \) is a Brownian motion.

The expansion of entrepreneurs is restricted by borrowing constraints. Imperfection in financial markets is modeled with a collateral constraint on capital rental that is proportional to individuals’ financial wealth:

\[
k_{jt} \leq \phi a_t, \quad \phi \geq 1
\]

where \( \phi \) is the collateral constraint parameter.\[17\] The collateral constraint applies equally to all individuals in the economy, and influences the firm’s ability to expand. Hence, the profit per period for each individual is

\[
\pi_j(\psi_t, z_t, a_t) = \max_{k_t, l_t} \{ y_{jt} - (r + \delta) k_t - w_j l_t, w_j \theta \}
\]

s.t. equation (6) and (8)

where \( \theta \) is the efficient units of labor a potential entrepreneur can supply. The first term in

\[17\]In principle, \( \phi \) may be different across regions. Rural financial system may be less efficient because less competition Cetorelli and Strahan (2006) or may be more efficient because less asymmetric information Hoff and Stiglitz (1990). In the benchmark, we assume \( \phi \) is the same across region.
equation (9) is the profit if they choose to become entrepreneurs. The second term is the profit if the individuals choose to become workers.

Note we implicitly assume the selection effects across two regions are proportional to the wages in each region. First, the operating cost is higher if the wage in that region is higher. Second, the opportunity cost, captured by \( w_j \theta \), is also higher in a region where \( w_j \) is higher. Therefore, the select effect is higher in the urban area than in the rural area.

The potential entrepreneurs choose consumption \( c^e_j \) and the occupation each period to maximize the life-time utility:

\[
\max_{c^e_j} E_0 \int_0^\infty e^{-\rho t} u \left( c^e_j \right) dt \quad (10)
\]

\[
\text{s.t. } da = ra + \pi_j (z,a) - c^e_j \quad (11)
\]

\[
d\psi = \psi_s dt \quad (12)
\]

and equation (7)

where \( \rho > 0 \) is the discount rate of utility. The budget constraint (11) is the equation of wealth accumulation, and equation (12) captures the learning effect on the productivity when firms become older.

Let \( v_j (\psi, z, a) \) denote the value of the entrepreneur if locating in \( j \). The problem (10) can be written as

\[
(\rho + \omega) v_j (\psi, z, a) = \max_{c^e_j} u \left( c^e_j \right) + \partial_a v_j (\psi, z, a) \left[ ra + \pi_j (\psi, z, a) - c^e_j \right] + \\
\partial_s v_j (\psi, z, a) \psi_s + \partial_{\ln z} v_j (\psi, z, a) \mu (z) + \frac{1}{2} \partial_{\ln z \ln z} v_j (\psi, z, a) \sigma^2 (z) \quad (13)
\]

In each period, some potential entrepreneurs will be hit by death shocks. The arrival rate of the death shocks is \( \omega \). At the same time, in each period, \( \omega \) mass of new potential
entrepreneurs are born. The new entrants will draw their initial ability $e$, initial wealth $a$, and initial transitory productivity $z$ from a distribution $g(e,z,a)$. The new potential entrepreneurs need to choose their locations at the beginning. We assume the cost of switching locations is very expensive. Once the new individuals have settled down in one location, they cannot move. The new potential entrepreneurs choose the optimal locations given initial ability and wealth:

$$\max_{j \in \{urban, rural\}} \{ v_j (\psi(e, A_j, 0), z, a) - f_j \}$$

We interpret $f_j$ as the utility cost ($f_j > 0$) of gain ($f_j < 0$) that the potential entrepreneurs will get outside our model. We denote the location-choice function as $\chi(e, z, a)$, which maps the state variables to the location set $\{urban, rural\}$.

### 4.3 Hand-to-mouth Workers

A large proportion of the population in the data never start a business. We model those who never become an entrepreneur as a hand-to-mouth worker as follows. The economy contains a continuum of hand-to-mouth workers. Each hand-to-mouth worker is endowed with 1 unit of labor and tries to maximize his/her utility by choosing the consumption good $c^w_j$:

$$U_i = \max_{c^w_j, j \in \{urban, rural\}} \ln \gamma_j + \ln c^w_j - b \ln L_j + \epsilon_{ij}$$

s.t. $c^w_j = w_j$

where $\gamma_j$ is region-specific amenity, and $b \ln L_j$ captures the congestion effect on worker’s utility. $\epsilon_{ij}$ is the iid taste shocks, following a type I extreme distribution. Then the number of hand-
to-mouth workers choosing location \( j \) is

\[
L_j = \frac{\exp u_j}{\sum \exp u_j}
\]

where \( u_j = \ln \gamma_j + \ln w_j - b \ln L_j \).

### 4.4 Stationary Equilibrium

In the stationary equilibrium, the joint distribution \( \lambda_j(e, z, a, s) \) will satisfy the following Kolmogrov forward equation:

\[
\partial_t \lambda_j(e, z, a, s) = -\partial_s \lambda_j(e, z, a, s) - \partial_a \left[ \lambda_j(e, z, a, s) \left( ra + \pi_j(\psi, z, a) - c_j^w \right) \right]
\]

\[
-\partial_{lnz} \left[ \mu(z) \lambda_j(e, z, a, s) \right] + \frac{1}{2} \partial_{lnz}lnz \left[ \sigma(z)^2 \lambda_j(e, z, a, s) \right]
\]

\[
-\omega \lambda_j(e, z, a, s) + \omega g(e, z, a) I(\chi(e, z, a) = j, s = 0)
\]

where \( I(\cdot) \) is an indicator function. The first line of the equation captures the change in mass due to age and capital accumulation; the second line captures the change in mass due to the shifts of \( z \); the last line captures the death and birth of entrepreneurs. In the stationary equilibrium, \( \partial_t \lambda_j = 0 \).

The goods-market-clearing condition is as in equation (16). It says the total consumption should equal the total output:

\[
\sum_j \left[ c_j^w + \int c_j^e d\lambda_j \right] = \sum_j \left[ y_j^R + \int y_j d\lambda_j \right]
\]

where \( c_j^w \) is the consumption by hand-to-mouth workers at location \( j \), \( \int c_j^e d\lambda_j \) is the consumption by potential entrepreneurs at location \( j \), \( y_j^R \) is the output produced by the representative firm at location \( j \), and \( \int y_j d\lambda_j \) is the output produced by entrepreneurs at location \( j \).
The labor-market-clearing condition is as in equation (17). Let $\Omega = \{(e, z, a, s): \text{potential entrepreneurs choose to run the business}\}$ and $1 - \Omega = \{(e, z, a, s): \text{potential entrepreneurs choose to be workers}\}$. Equation (17) says the labor supply from the hand-to-mouth worker $l^w_j$ and potential entrepreneurs should equal the labor demand from the representative firm $l^R_j$ and the entrepreneur sector $l_j$:

$$l^w_j + \int_{1-\Omega} \theta d\lambda_j = l^R_j + \int_{\Omega} l_j d\lambda_j \quad \text{for all } j$$

To simplify the computation, we assume the economy is an open economy. Hence, $r$ is exogenously given. We can define the competitive stationary equilibrium as follows:

**Definition 1.** A competitive stationary equilibrium is prices $w_j$, location choice $\chi(e, z, a)$, value function $v_j(\psi, z, a)$, profit function $\pi_j(\psi, z, a)$, labor demand and capital demand of entrepreneurs and representative firms, and the joint distribution $\lambda(e, z, a, s)$ such that

(i) Potential entrepreneurs’ problem, representative firms’ problem, and hand-to-mouth workers’ problem are solved;

(ii) Goods market clears;

(iii) Labor market clears;

(iv) The stationary distribution satisfies equation (15).

## 5 Calibration

### 5.1 Specification

To quantify our model, we first assume a functional form of the productivity functions $\psi(e, A_j, s)$ and transitory productivity process $dlnz_t$. The functional form of $\psi(e, A_j, s)$ is set as a Cobb-
Douglas function:

\[ \psi (e, A_j, s) = e \times A_j^h \times \exp (-q_j (s^* - s)) \text{ if } s < s^* \quad (18) \]

\[ \psi (e, A_j, s) = e \times A_j^h \text{ if } s \geq s^* \quad (19) \]

where \( h \) is the elasticities of permanent productivity with respect to \( A_j \). The function of \( \psi \) shows a complementarity between entrepreneurs’ ability \( e \) and location productivity \( A_j \). \( q_j \) captures the learning effect in location \( j \). Equation (18) implies that if the firm age is less than \( s^* \), the productivity will improve by \( q_j \) every period. After age exceeds \( s^* \), the entrepreneurs cannot improve the productivity.

The diffusion process of \( \ln z \) follows an AR(1) process:

\[ d \ln z_t = -\nu \ln z_t dt + \sigma dB_t \]

where \( \nu \) is the persistence of the process. \( \sigma \) is the standard deviation of the innovation of \( z \).

Second, we normalize some parameters. We set \( q_{rural} = 0 \) because the rural entrepreneurs’ growth rate on average is always around 0 independent of the firm age. We normalize the fixed entry utility cost \( f_{rural} = 0 \) because we only care about the relative share of entrepreneurs in the urban and rural area. The \( f_{urban} \) will be interpreted as the utility difference between locating in the urban and rural area that is not considered in our model.

Third, we make assumptions on the initial distribution of new entrants \( g(e, z, a) \). The entrants draw their initial ability \( e \), initial transitory productivity shock \( z \), and initial wealth
level from three independent log normal distributions:

\[
\begin{align*}
\ln e & \sim N(\mu_e, \sigma^2_e) \\
\ln a & \sim N(\mu_a, \sigma^2_a) \\
\ln z & \sim N(0, \sigma^2_z)
\end{align*}
\]

5.2 Mapping Model to the Data

The model is fully characterized by a set of parameters: parameters related to the production technology \(\{\alpha, \delta, \eta, h, q_{urban}, s^*\}\), parameters related to the random component and distribution \(\{\nu, \sigma, \mu_e, \sigma_e, \mu_a, \sigma_a, \sigma_z\}\), and other parameters \(\{\rho, r, f_{urban}, \theta, \phi, w_j\}\). We fix the equilibrium wages as wages in the data for any set of parameters except for the parameters describing the behavior of hand-to-mouth workers. Fixing the equilibrium wages as wages in the data can be possible because we can always find a set of parameters describing the behavior of hand-to-mouth workers \(\{\gamma_j, L_j, b\}\) that support wages in the data as the equilibrium wages. Therefore, we do not estimate the hand-to-mouth worker parameters, and rather use them as free parameters to support wages in the data as the equilibrium wages.

Some of these parameters come directly from the data. For example, we set \(s^* = 3\) because, after three years, we do not observe a significant growth difference between urban and rural businesses in the data. The log wage for workers in each region is also directly from the data average. We normalize the rural average wage to be 1. As a consequence, the monetary unit in the model is 21,250 USD in 2011. After normalization, \(\{w_{urban}, w_{rural}\}\) are set as \(\{1.28, 1\}\). Remember we allow individuals to choose to be workers with the outside option \(\theta w_j\). By setting a higher wage in urban areas, we provide the entrepreneurs in urban areas more incentive to be out of business due to a higher outside option as well as a higher production cost. In other words, the selection effect is higher in urban areas. We directly use the entrants’ wealth
distribution in the data to measure the $\mu_a$ and $\sigma_a$: $\mu_a = 1.42$ and $\sigma_a = 1.81$. Finally, the proportion of hand-to-mouth workers is set as 73.1%. We get this number from the National Longitudinal Survey of Youths 1979 (NLSY 79), where 73.1% of respondents never start a business over 20 years.

We get some parameters from others’ research. We calibrate the model to match the annual data. We assume the entrepreneurs have a log utility, and the discount rate of entrepreneurs utility $\rho = 0.04$ to match the long run U.S. interest rate. In the production function of the representative firm, we assume $\alpha = 0.4$, which is consistent with the capital share of the U.S. data. We assume the capital depreciates with rate $\delta = 5\%$, and the long-run interest rate $r = 0.04$. We assume $\eta = 0.75$, which is consistent with the span-of-control parameter (Lucas (1978)). The annual death rate of entrepreneurs $\omega$ is assumed to be 6%, which is consistent with Haltiwanger et al. (2013). Once we know $\alpha$, $r$, and $w_j$, we can calculate $A_j$ from equation (5).

The remaining parameters are calibrated by matching the data moments with the simulated moments. We use the average of log business earnings in metro areas to identify $h$, the elasticities of permanent productivity with respect $A_{urban}$. We use the average of log business earnings in non-metro areas to identify the mean of entrepreneurial ability distribution $\mu_e$. We use the standard deviation of log business earnings to pin down the standard deviation of entrepreneurial ability distribution $\sigma_e$. To pin down the standard deviation of the initial transitory productivity shock $\sigma_z$, we use the standard deviation of log business earnings for startup businesses. We use the mean of the business-earnings growth rate and the autocorrelation of business earnings to identify the transitory productivity process parameters $\nu$ and $\sigma$. The efficiency unit of labor as a worker $\theta$ is identified by the proportion of entrepreneurs in the economy. Similarly, $f_{urban}$, the utility difference between locating in urban and rural

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19 Given the proportion of hand-to-mouth workers is 73.1%, the proportion of individuals who choose to be entrepreneurs is calculated as $\frac{x}{1-x}$, where $x$ is the proportion of business owners in the data.
areas is identified by the proportion of business owners located in metro areas.

In the model, the borrowing constraint parameter $\phi$ affects the business-earnings growth rate of young firms until they accumulate enough wealth. In particular, the business owners who start a business with a relatively small net worth will be more affected by the extent of borrowing constraints. Therefore, we target the business-earnings growth rate of young firms with relatively low wealth to identify $\phi$. Specifically, we target the mean growth rate of firms aged less than four years and the owners whose net worth is below the 25th percentile of the stationary wealth distribution. Unlike $\phi$, $q_{urban}$ affects the growth rate of all young firms in the urban area independent of their net worth. Given $\phi$, we can use the growth-rate difference between metro and non-metros area among young firms to pin down $q_{urban}$.

Table 6 reports the calibrated parameter values and the model fit. $\phi$ is 2.043, meaning entrepreneurs can invest up to about twice their wealth. The value is in line with other estimates (Evans and Jovanovic (1989), Midrigan and Xu (2014)). $q_{urban}$ is 0.06, indicating the productivity in the urban area grows about 6% per year for three years. $f_{urban}$ is 0.489. Given that all the money values are normalized by 21,250 USD, the average wage earnings in non-metro areas, the present discounted value of lifetime cost of locating in the urban area is about 10,000 USD. The estimated benefit from locating a business in the urban area is too large to explain the actual proportion of business owners in the data. $\theta$ is 0.220, which means entrepreneurs will start or keep running a business as long as the profit from the business is slightly more than 22% of wage earnings. It is well documented that business owners start or keep running a business even though the return from the business is less than wage earnings, due to non-pecuniary benefits from being an owner (Hamilton (2000)). The reason the extent of non-pecuniary benefit is too high is that we do not impose any cost for switching occupations.

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20 As a robustness check, we tried to target the mean growth rate of firms aged less than four years and the firm owners’ net worth is below the median of the stationary wealth distribution. The quantitative results change only slightly.
Suppose that after starting a business, the owner should keep the business for a long time due to a very high switching cost. Then the profit threshold above which an entrepreneur starts a business will be higher, and hence $\theta$ will be higher. The elasticity of entrepreneurial productivity with respect to the location-specific productivity, which is captured by $h$, is 1.311.

The calibrated model can replicate Figure 2. We plot the growth-rate difference in urban and rural areas. We separate firms by entrants (firms whose age is below three years) and incumbents (firms whose age is above three years). Figure 4a plots the density function of new entrepreneurs’ growth rates. The solid line shows the distribution of growth rates of entrepreneurs in urban areas and the dashed line shows the distribution of growth rates of entrepreneurs in rural areas. The entrants into urban areas grow much faster than entrants into rural areas. Figure 4b shows the growth rates of incumbents. On average, the growth rate of firms in urban areas is similar to that of firms in rural areas.

6 Results

6.1 Policy Function

To understand the location choice of the entrepreneurs, we plot the policy function of an entrepreneur in Figure 5. The x-axis represents the level of assets and the y-axis represents the level of the permanent productivity (we fix the temporary productivity shock $z = 1$). The upper-left corner of the graph denotes those firms with high productivity and low asset levels. They are more likely to locate in the urban area. The bottom-right corner denotes those firms with low productivity but high asset levels. Our model predicts they should locate in the rural area.

As shown in equation (18), a complementarity exists between the entrepreneurs’ ability $e$ and the agglomeration effect $A_j$. Hence, more-productive firms tend to sort into the urban
area. At the same time, the urban firms will face high production costs. Therefore, only productive firms are sorted into the urban area. Behrens et al. (2014) and Gaubert (2015) discuss these channels.

From Figure 5, we can see poor entrepreneurs are more likely to locate in the urban area. We can see this relation from the HJB equation (12). The FOC implies \( v_a = u'(c^e) \); that is, the marginal utility of wealth is the same as the marginal utility of consumption. Taking derivatives on the location productivity \( A \), we get \( v_aA = u''(c^e) \frac{dc^e}{dA} \). Given \( u \) is concave and \( c^e \) is increasing in the location productivity, for entrepreneurs with low wealth levels, the marginal utility of locating in the urban area is high \( (v_aA < 0) \), because small firms can accumulate wealth faster in the urban area due to the high location-specific productivity, and hence can get out of borrowing constraints faster.

6.2 Decomposition

In this subsection, we decompose the contributions of the growth-rate difference into different channels. When we shut down any channel in the economy, entrepreneurs will change their location choice. It may change the agglomeration effect in each location. To address this problem, we assume the agglomeration effect is only determined by the number of entrepreneurs in each location and fix the number of entrepreneurs in the counter-factual analysis.

First, we randomize the location choice while fixing the number of entrepreneurs being the same. In this economy, the growth can still come from the productivity difference, learning difference, and selection difference. We then remove the borrowing constraint, learning effect and the selection effect one by one.

The results are shown in Table 7. The second column reports the results when we randomly allocate entrepreneurs to different locations. The third column reports the results when we remove borrowing constraints. The growth-rate difference declines from 11.1% in the benchmark
economy to 3.76% in the economy without sorting and borrowing constraints. Hence, the first explanation, the sorting with borrowing constraints, can explain about 66.1% \( \frac{11.1 - 3.76}{11.1} \times 100 \) of the growth difference across regions. The third column reports the results when we shut down the learning effect. The growth difference falls from 3.76% to 0.5%. Thus, the learning effect can explain 29.4% \( \frac{3.76 - 0.5}{11.1} \times 100 \) of the growth difference. The growth difference driven by the selection effect is very small – less than 1%. Hence, the selection effect can account for at most 4.5% \( 100 - 66.1 - 29.4 \) of the growth difference.

6.3 The Role of Endogenous Location Choice

One interesting result in Table 7 is that the endogenous location choice will decrease the growth difference from 15.84% to 11.1% (first and second columns). To further understand this result, we compare the random location choice economy with the endogenous location choice economy by decomposing the growth rate change into four groups: urban (rural) firms in the benchmark economy reallocate to rural (urban) areas in the random-location economy. Within each reallocation group, we further classify firms into four groups: (not) financially constrained in both economies, financially constrained in the benchmark economy (random location economy) but not financially constrained in the random location economy (benchmark economy).

The results are reported in Table 8. The first panel reports the results for firms located in the urban area in the benchmark economy. The second panel reports the results for firms located in the rural area in the benchmark economy. As the panels show, the growth-rate difference in the benchmark economy and the random-location economy is mostly driven by financially constrained firms. For example, among urban firms reallocating to rural areas in the first panel, about 21% are financially constrained in both economies. Their growth rates sharply decline from 16% to -26%. Likewise, among rural firms reallocating to urban areas in
the second panel, about 10% are financially constrained in both economies, and their growth rates increase dramatically from -7% to 30%.

Given permanent productivity, those who have relatively high wealth levels tend to locate in rural areas. Some of those firms can also be financially constrained, but only because they occasionally receive very good temporary productivity shocks, and not because their initial investment is low compared to their steady-state level of investment. Due to the mean-preserving property of the temporary productivity shock, the productivity in the next period is low if the productivity in this period is high, and vice versa. Due to borrowing constraints, however, financially constrained rural firms cannot exploit a high temporary productivity shock, and as a result, they exhibit a low growth rate on average. When these firms relocate to urban areas, their permanent productivity increases and they will start to expand. Because they have relatively high wealth levels, we see a sharper increase in their growth rates after the relocation.

Given permanent productivity, individuals with low wealth levels tend to locate in urban areas. Some of their initial investment is low compared to the steady-state level, due to borrowing constraints, and they exhibit high growth rates as they accumulate wealth. When these firms are assigned to rural areas, they no longer have high investment demand, because their permanent productivity decreases. Moreover, they tend to have a lower net worth, and as a consequence, their growth rates decline substantially.

7 Welfare Implication of Borrowing Constraints

In this section, we further investigate the welfare implication of a policy relaxing borrowing constraints. We show that borrowing constraints are important to understanding the growth difference across regions. At the same time, an existing policy in the United States (e.g., the small business guaranteed loan program) specifically aims to relax borrowing constraints for
entrepreneurs. Therefore, an understanding of the impact of such a policy on start-up firms’ location choices and the welfare of economy is worthwhile.

Table 9 compares the welfare gains from removing borrowing constraints from the benchmark model. The welfare gains from removing borrowing constraints can come from two elements. First, firms will change their location choice. As the first and second columns show, about 6% of firms will move from rural areas to urban areas. Those firms will enjoy a higher agglomeration and learning effect in urban areas. The second benefit comes from the conventional mechanism: productive firms can invest optimally. Overall, the average log profit will increase from 0.0654 to 0.2002.

To separate these two effects, we show the results of an economy in which the location choice is the same as in the benchmark model although borrowing constraints are absent. We can see that if the location choice is the same as in the benchmark, the increase in log profit becomes smaller. The existing literature highlights this effect: borrowing constraints can distort the firms’ investments (Moll (2014)). Our paper points out another potential mis-allocation of the credit market friction through the distortion in location choices.

To understand this effect, we compare the location choices in the two economies in Figure 6. The solid line is the location choice in the benchmark economy, as in Figure 5. Above (below) the solid curve, firms will choose to locate in the urban (rural) areas. The dashed line plots the location choice without borrowing constraints. The policy function in this economy should be flat because the asset level does not matter any more. Above (below) the dashed line, firms will locate in the urban (rural) areas. Two types of firms will relocate after the borrowing constraints are removed. The first type is firms with high productivity and high asset levels. In the benchmark model, they cannot fully enjoy the high location productivity in urban areas, due to borrowing constraints, and instead stay in rural areas. Once the borrowing constraints are removed, they will choose to locate in urban areas. The second type is those with medium
productivity and low asset levels. They can accumulate wealth faster in urban areas, due to the high location-specific productivity, and hence can get out of borrowing constraints faster despite the high operating cost. Once they can fully borrow the optimal amount of funds from the beginning, they will locate in rural areas and enjoy the low operating cost.

Quantitatively, our decomposition shows the mis-allocation of the credit market friction through the location distortion is important. This new distortion accounts for a 23% \( \left( \frac{0.2002 - 0.1794}{0.2002 - 0.0654} \right) \times 100 \) decline in average log profit.

8 Conclusion

We document facts regarding the business-earnings growth rate between metro and non-metro areas in the United States. We develop a dynamic general equilibrium model that incorporates sorting, learning, and selection effects and quantify the extent to which these theories are important in explaining the observed difference in the business-earnings growth rate between metro and non-metro areas in the United States. We find the sorting and the learning theory respectively explain 66% and 30% of the observed difference in the business-earnings growth rate, whereas the contribution of the selection theory is marginal. As a relevant policy analysis, we show that reducing borrowing constraints can improve the aggregate efficiency not only by increasing firms’ investments but also by firms’ reallocation.

Our decomposition results suggest a substantial part of the agglomeration effect may come from a learning effect from young firms, and it is an important source of heterogeneity among young firms’ growth rate between metro and non-metro areas. Although the current model is silent about the mechanism behind the learning effect in metro areas, investigating the mechanism by which urban young firms increase their productivity will be important not only for understanding the source of the agglomeration effect, but also for understanding the nature of firm growth.
References


### Tables and Figures

Table 1: Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>Metro</th>
<th>Non-metro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Obs.</td>
<td>290,602</td>
<td>58,659</td>
</tr>
<tr>
<td>Number of Obs.(worker)</td>
<td>260,351</td>
<td>52,679</td>
</tr>
<tr>
<td></td>
<td>(83%)</td>
<td>(17%)</td>
</tr>
<tr>
<td>Number of Obs.(business owners)</td>
<td>30,251</td>
<td>5,980</td>
</tr>
<tr>
<td></td>
<td>(84%)</td>
<td>(16%)</td>
</tr>
<tr>
<td>Proportion of business owners</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>Proportion of incorporated business</td>
<td>0.38</td>
<td>0.31</td>
</tr>
<tr>
<td>Log wage earnings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(mean)</td>
<td>10.21</td>
<td>9.96</td>
</tr>
<tr>
<td>(median)</td>
<td>10.31</td>
<td>10.08</td>
</tr>
<tr>
<td>Log business earnings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(mean)</td>
<td>10.14</td>
<td>9.75</td>
</tr>
<tr>
<td>(median)</td>
<td>10.31</td>
<td>9.95</td>
</tr>
<tr>
<td>Firm age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(25th percentile)</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(median)</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Exit rate (Annual)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(young firms)</td>
<td>0.09</td>
<td>0.10</td>
</tr>
<tr>
<td>(all firms)</td>
<td>0.06</td>
<td>0.06</td>
</tr>
</tbody>
</table>

NOTE: This table shows the summary statistics for metro and non-metro observations. Young firms are firms whose age is less than four years.
Table 2: Firm Size Distribution across Regions

<table>
<thead>
<tr>
<th></th>
<th>Size 1</th>
<th>Size 2</th>
<th>Size 3</th>
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</thead>
<tbody>
<tr>
<td>All firms</td>
<td>95.88</td>
<td>2.91</td>
<td>1.21</td>
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<tr>
<td>Non-metro firms</td>
<td>97.39</td>
<td>2.05</td>
<td>0.56</td>
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<tr>
<td>Young firms</td>
<td>97.55</td>
<td>1.67</td>
<td>0.78</td>
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<tr>
<td>Non-metro</td>
<td>98.51</td>
<td>1.10</td>
<td>0.39</td>
</tr>
</tbody>
</table>

NOTE: This table reports the distribution of firms with respect to their number of employees. Size 1 refers to an employment size from 0 to 24. Size 2 refers to an employment size from 25 to 99. Size 3 refers to an employment size from 100 and above. Young firms are firms whose age is less than four years. All units are percentage.

Table 3: Business-Earnings Growth Rate between Metro and Non-metro Firms

<table>
<thead>
<tr>
<th></th>
<th>Metro</th>
<th>Non-metro</th>
<th>(A)—(B)</th>
<th>p—value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Obs.</td>
<td>Mean (A)</td>
<td>Obs.</td>
<td>Mean (B)</td>
</tr>
<tr>
<td>Young (age &lt; 4) firms</td>
<td>3,992</td>
<td>0.045</td>
<td>624</td>
<td>-0.029</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.018)</td>
<td></td>
<td>(0.054)</td>
</tr>
<tr>
<td>Old (age above 4) firms</td>
<td>9,196</td>
<td>-0.031</td>
<td>1,767</td>
<td>-0.018</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.011)</td>
<td></td>
<td>(0.027)</td>
</tr>
</tbody>
</table>

NOTE: This table reports the growth-rate difference between metro and non-metro firms with respect to firm age. Standard errors are in parentheses. The null hypothesis for the p—value is that the difference is zero, and the alternative hypothesis is that the difference is positive.
Table 4: Regression for Business-Earnings Growth Rate

<table>
<thead>
<tr>
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<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
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<tr>
<td>$\Delta Y / Y$</td>
<td>-0.357***</td>
<td>-0.357***</td>
<td>-0.368***</td>
<td>-0.396***</td>
<td>-0.426***</td>
</tr>
<tr>
<td></td>
<td>(0.0101)</td>
<td>(0.0101)</td>
<td>(0.0103)</td>
<td>(0.0115)</td>
<td>(0.0121)</td>
</tr>
<tr>
<td>ln($Y$)</td>
<td>0.168***</td>
<td>0.230***</td>
<td>0.223***</td>
<td>0.197***</td>
<td>0.179***</td>
</tr>
<tr>
<td></td>
<td>(0.0349)</td>
<td>(0.0572)</td>
<td>(0.0571)</td>
<td>(0.0621)</td>
<td>(0.0626)</td>
</tr>
<tr>
<td>ln(Firm age+1)</td>
<td>0.124***</td>
<td>0.122***</td>
<td>0.0980***</td>
<td>0.105***</td>
<td>0.105***</td>
</tr>
<tr>
<td></td>
<td>(0.0265)</td>
<td>(0.0264)</td>
<td>(0.0283)</td>
<td>(0.0283)</td>
<td>(0.0288)</td>
</tr>
<tr>
<td>Metro × ln(Firm age+1)</td>
<td>-0.0560**</td>
<td>-0.0548**</td>
<td>-0.0526**</td>
<td>-0.0452*</td>
<td>-0.0452*</td>
</tr>
<tr>
<td></td>
<td>(0.0233)</td>
<td>(0.0234)</td>
<td>(0.0253)</td>
<td>(0.0253)</td>
<td>(0.0254)</td>
</tr>
<tr>
<td>Firm age</td>
<td>0.0218***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.00437)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm age$^2$</td>
<td></td>
<td>-0.000296***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.000112)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metro × Firm age</td>
<td></td>
<td>-0.00479**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.00204)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of Employees [25, 100]</td>
<td></td>
<td>0.216***</td>
<td>0.201***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0511)</td>
<td>(0.0501)</td>
<td></td>
<td></td>
</tr>
<tr>
<td># of Employees ≥ 100</td>
<td></td>
<td>0.474***</td>
<td>0.430***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0636)</td>
<td>(0.0630)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incorporated</td>
<td></td>
<td>0.165***</td>
<td>0.140***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0178)</td>
<td>(0.0177)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner age</td>
<td></td>
<td></td>
<td>-0.00659***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.000842)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Univ.</td>
<td></td>
<td>0.138***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0169)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td></td>
<td>0.0679***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0184)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td>0.204***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0202)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td></td>
<td>0.0160</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0244)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>2.743***</td>
<td>2.128***</td>
<td>2.343***</td>
<td>2.138***</td>
<td>2.792***</td>
</tr>
<tr>
<td></td>
<td>(0.400)</td>
<td>(0.144)</td>
<td>(0.148)</td>
<td>(0.165)</td>
<td>(0.181)</td>
</tr>
<tr>
<td>StartYear</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>States</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Industry</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>15,579</td>
<td>15,579</td>
<td>15,579</td>
<td>14,786</td>
<td>14,658</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.183</td>
<td>0.183</td>
<td>0.188</td>
<td>0.193</td>
<td>0.207</td>
</tr>
</tbody>
</table>

NOTE: This table shows the regression estimates for the business-earnings growth rates. Standard errors are clustered by each business. $Y$ is business earnings. StartYear refers to the business start year fixed effect. States refers to the state fixed effect. *** p-value <0.01, ** p-value <0.05, * p-value<0.1
Table 5: Panel Regression for Business Earnings with Sub-samples

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) Metro young ln Y</th>
<th>(2) Non-metro young ln Y</th>
<th>(3) Metro old ln Y</th>
<th>(4) Non-metro old ln Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm age</td>
<td>0.0541*** (0.0184)</td>
<td>0.0502 (0.0462)</td>
<td>-0.00525 (0.00371)</td>
<td>-0.0218*** (0.00812)</td>
</tr>
<tr>
<td>Incorporated</td>
<td>0.195*** (0.0587)</td>
<td>0.174 (0.225)</td>
<td>0.0153 (0.0364)</td>
<td>-0.0869 (0.0943)</td>
</tr>
<tr>
<td>Constant</td>
<td>9.679*** (0.0310)</td>
<td>9.310*** (0.0835)</td>
<td>10.37*** (0.0569)</td>
<td>10.29*** (0.132)</td>
</tr>
<tr>
<td>Observations</td>
<td>8,984</td>
<td>1,527</td>
<td>17,831</td>
<td>3,574</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.007</td>
<td>0.005</td>
<td>0.000</td>
<td>0.006</td>
</tr>
<tr>
<td>Number of businesses</td>
<td>5,850</td>
<td>1,049</td>
<td>8,518</td>
<td>1,763</td>
</tr>
</tbody>
</table>

NOTE: This table shows the fixed effect panel regression of equation (2). Standard errors are clustered by each business. Y is business earnings. *** p-value <0.01, ** p-value <0.05, * p-value<0.1

Table 6: Parameters & Model Fit

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
<th>Target Moment</th>
<th>Model</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi$</td>
<td>2.043</td>
<td>growth average — young poor</td>
<td>0.076</td>
<td>0.061</td>
</tr>
<tr>
<td>$q_{urban}$</td>
<td>0.060</td>
<td>growth diff. — young</td>
<td>0.096</td>
<td>0.074</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>0.146</td>
<td>std. of growth rate</td>
<td>0.933</td>
<td>1.093</td>
</tr>
<tr>
<td>$\nu$</td>
<td>0.267</td>
<td>auto corr.</td>
<td>0.617</td>
<td>0.655</td>
</tr>
<tr>
<td>$f_{urban}$</td>
<td>0.489</td>
<td>entrp.%</td>
<td>0.234</td>
<td>0.386</td>
</tr>
<tr>
<td>$\theta$</td>
<td>0.220</td>
<td>urban entrp.%</td>
<td>0.697</td>
<td>0.835</td>
</tr>
<tr>
<td>$\mu_e$</td>
<td>0.546</td>
<td>average log rural profit</td>
<td>-0.211</td>
<td>-0.199</td>
</tr>
<tr>
<td>$h$</td>
<td>1.311</td>
<td>average log urban profit</td>
<td>0.186</td>
<td>0.174</td>
</tr>
<tr>
<td>$\sigma_e$</td>
<td>1.191</td>
<td>std. of log profit</td>
<td>1.105</td>
<td>1.409</td>
</tr>
<tr>
<td>$\sigma_z$</td>
<td>1.063</td>
<td>std. of first year profit</td>
<td>1.262</td>
<td>1.450</td>
</tr>
</tbody>
</table>

NOTE: This table shows targeted moments from the data and simulated moments by the model as well as the parameter estimates. “growth average — young poor” indicates the mean growth rate of firms aged less than four years whose owners’ net worth is below the 25\textsuperscript{th} percentile of the stationary wealth distribution. “growth diff. — young” indicates the growth-rate difference between metro and non-metro areas among firms aged less than four years.
Table 7: Decomposition Results

<table>
<thead>
<tr>
<th>Moment</th>
<th>(1) Benchmark</th>
<th>(2) Rand. Location</th>
<th>(3) No Constraints</th>
<th>(4) No Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>growth diff. — young</td>
<td>0.1110</td>
<td>0.1584</td>
<td>0.0376</td>
<td>0.0049</td>
</tr>
</tbody>
</table>

NOTE: This table shows the decomposition of the growth difference across the regions. The first column reports the benchmark model results. The second column reports the results when the location is randomized. In doing so, we keep the number of entrepreneurs the same as in the benchmark economy. The third column reports the results when the location is randomized and no borrowing constraints are present. The fourth column reports the results when the location is randomized and no borrowing constraints and no learning are present.

Table 8: Decomposition for Growth-Rate Changes from Benchmark to Random Location

<table>
<thead>
<tr>
<th>Group</th>
<th>Fraction</th>
<th>Ave growth in the benchmark</th>
<th>Ave Growth in the Rand. location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel (A): Urban Young Firm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban to Urban</td>
<td>0.5595</td>
<td>0.0647</td>
<td>0.0647</td>
</tr>
<tr>
<td>Urban to Rural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FF</td>
<td>0.2102</td>
<td>0.1572</td>
<td>-0.2614</td>
</tr>
<tr>
<td>FN</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NN</td>
<td>0.0383</td>
<td>-0.1230</td>
<td>-0.1080</td>
</tr>
<tr>
<td>NF</td>
<td>0.1921</td>
<td>-0.006</td>
<td>-0.0729</td>
</tr>
<tr>
<td>All Urban Firms</td>
<td>1</td>
<td>0.0646</td>
<td>0.0731</td>
</tr>
<tr>
<td>Panel (B): Rural Young Firm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural to Rural</td>
<td>0.5050</td>
<td>-0.0233</td>
<td>-0.0233</td>
</tr>
<tr>
<td>Rural to Urban</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FF</td>
<td>0.1025</td>
<td>-0.0743</td>
<td>0.3043</td>
</tr>
<tr>
<td>FN</td>
<td>0.1933</td>
<td>-0.0891</td>
<td>0.0921</td>
</tr>
<tr>
<td>NN</td>
<td>0.1988</td>
<td>-0.0542</td>
<td>-0.0227</td>
</tr>
<tr>
<td>NF</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>All Rural Firms</td>
<td>1</td>
<td>-0.0463</td>
<td>-0.0853</td>
</tr>
</tbody>
</table>

NOTE: This table shows the decomposition of growth-rate changes by young firms from the benchmark to the random-location economy. FF= financially constrained in the benchmark and the random-location economy; FN= financially constrained in the benchmark economy but not financially constrained in the random-location economy; NN=not financially constrained in either economy; NF= not financially constrained in the benchmark economy but financially constrained in the random-location economy.
Table 9: Model Predictions without Borrowing Constraints

<table>
<thead>
<tr>
<th>Moment</th>
<th>Benchmark</th>
<th>No Frictions</th>
<th>No Frictions &amp; Exog. Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>entrp.%</td>
<td>0.2338</td>
<td>0.3071</td>
<td>0.3015</td>
</tr>
<tr>
<td>urban entrp.%</td>
<td>0.6966</td>
<td>0.7569</td>
<td>0.6798</td>
</tr>
<tr>
<td>ave. log profit</td>
<td>0.0654</td>
<td>0.2002</td>
<td>0.1794</td>
</tr>
<tr>
<td>ave. urban log profit</td>
<td>0.1856</td>
<td>0.2971</td>
<td>0.2882</td>
</tr>
<tr>
<td>ave. rural log profit</td>
<td>-0.2107</td>
<td>-0.1017</td>
<td>-0.0515</td>
</tr>
</tbody>
</table>

NOTE: This table shows the model results without borrowing constraints. The second column reports the economy when no credit constraint is present, and the third column reports the results when the location choice is the same as in the benchmark model and borrowing constraints are removed.

Figure 1: Industry Composition between Metro and Non-metro Area (SIPP)

NOTE: This figure shows the industry composition between metro and non-metro businesses in the SIPP.
Figure 2: Business-Earnings Growth Rate: Young Firms

(a) Young (age < 4) firms
(b) Old (age above 4) firms

NOTE: This figure shows the distribution of business-earnings growth for metro and non-metro areas conditional on firm ages.

Figure 3: Predicted Business-Earnings Growth Rate and Firm Age

(a) Metro firms
(b) Non-metro firms

NOTE: This figure shows the business-earnings growth rate in metro and non-metro areas with respect to firm age (years) predicted by equation (2) in Table 4.
Figure 4: Growth Rates (Model)

(a) New entrepreneurs

NOTE: This figure plots the distribution of the growth rates of business profits in urban and rural areas.

(b) Incumbents

Figure 5: Policy Function

NOTE: This figure shows the location choice of an entrepreneur. The x-axis is the asset level and the y-axis is the productivity level. The parameters are the same as in section 5. We fix \( z = 1 \) in this graph.
Figure 6: Location Choice: Benchmark Model vs Model without Borrowing Constraint

NOTE: This figure compares the policy functions in the benchmark model and the model without the borrowing constraint. We assume $z=1$.

Appendix

A On the Representativeness of the SIPP

To check the representativeness of the SIPP, we refer to the Survey of Business Owners (SBO). The SBO provides the comprehensive information on demographic characteristics for business owners in the US. Table 10 compares the owner characteristics from the SIPP with the one from the SBO in 2002. The business owners in the SIPP are slightly younger or less educated, but the overall distribution is quite similar between the SIPP and the SBO. The SIPP oversamples a low-income group, but these low-income individuals are less likely to own a business, and as a result, the overall characteristics of business owners in the SIPP is quite similar to the SBO.

The SIPP may not cover firms with a very large number of employees. Once a firm becomes
large and has its ownership diversified, it is unlikely to be captured by the SIPP. However, these large firms constitute a very small portion of all firms. For example, according to the SBO, firms with more than 500 employees account for 0.09% among all firms in 2002. More importantly, these large firms are less likely to be young firms. Among firms with more than 500 employees, only 4.8% started a business within 4 years. Therefore, we believe our results on the young-firm dynamics will be less likely to be affected even if the SIPP does not capture firms with a very large number of employees.

Table 10: SIPP vs. SBO

<table>
<thead>
<tr>
<th></th>
<th>SIPP</th>
<th>SBO</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>88.97</td>
<td>91.68</td>
</tr>
<tr>
<td>Female</td>
<td>36.44</td>
<td>35.48</td>
</tr>
<tr>
<td>Owner age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>under 25</td>
<td>4.27</td>
<td>2.23</td>
</tr>
<tr>
<td>[25,34]</td>
<td>12.67</td>
<td>11.91</td>
</tr>
<tr>
<td>[35,44]</td>
<td>26.59</td>
<td>24.60</td>
</tr>
<tr>
<td>[45,54]</td>
<td>27.82</td>
<td>29.38</td>
</tr>
<tr>
<td>[55,64]</td>
<td>19.46</td>
<td>20.62</td>
</tr>
<tr>
<td>over 65</td>
<td>9.19</td>
<td>11.18</td>
</tr>
<tr>
<td>Highest degree completed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than high school</td>
<td>10.61</td>
<td>6.15</td>
</tr>
<tr>
<td>High school</td>
<td>25.87</td>
<td>28.75</td>
</tr>
<tr>
<td>Some college, but no degree</td>
<td>17.73</td>
<td>18.54</td>
</tr>
<tr>
<td>Associate degree</td>
<td>6.87</td>
<td>5.69</td>
</tr>
<tr>
<td>Bachelors degree (BA)</td>
<td>20.20</td>
<td>23.17</td>
</tr>
<tr>
<td>Above BA</td>
<td>14.14</td>
<td>17.65</td>
</tr>
</tbody>
</table>

NOTE: This table compares the business-owner characteristics from the SIPP with the one from the SBO in 2002.