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

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Abstract

We document that the growth rate of business earnings among young firms is significantly higher in metro areas than in non-metro areas. Agglomeration economies and firm selection (less productive firms are more likely to exit in metro areas) are known to explain a part of the productivity growth in urban areas, but less is known about the role of borrowing constraints. By developing a firm-dynamics model with a location choice, we show borrowing constraints interact with growth and location choices of firms, and contribute to a substantial part of the observed growth-rate difference between urban and rural young firms. Our model suggests the distortion in location choice due to borrowing constraints can induce non-trivial welfare loss.

Keywords: Firm Dynamics, Firm Sorting, Borrowing Constraint, Agglomeration economies, Firm Selection

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1 Introduction

Firms in urban areas are more productive than firms in rural areas (e.g., Melo et al. (2009)). Previous empirical studies have focused on the static difference between urban and rural outcomes. Using a US representative household-based survey, we document that the *growth* rate of business earnings among young firms is significantly higher in metro areas than in non-metro areas. Our regression estimates imply the business-earnings difference induced by this growth-rate difference can be substantial.

Haltiwanger et al. (2013) document the growth by young firms contributes a significant amount to the local employment growth. Therefore, understanding the growth difference between urban and rural young firms can shed light on the inequality of economics activity between metro and non-metro areas.

Existing literature suggests localized increasing returns, known as agglomeration economies, may explain this observed growth-rate difference between urban and rural young firms. For instance, firms in cities can improve their productivity faster by interacting with others more frequently (Glaeser (1999)). Firm selection (less productive firms are more likely to exit in metro areas) is often considered another mechanism. Due to the firm selection, surviving firms' productivity can be, on average, higher in metro areas than in non-metro areas.

Unlike the aforementioned mechanisms, the role of borrowing constraints on the growth-rate difference between urban and rural firms is not well known. The aim of this paper is to show borrowing constraints interact with growth and location choices of firms, and, as a result, contribute to a substantial part of the observed growth-rate difference between urban and rural young firms.

To this end, we develop a firm-dynamics model with a location choice between an urban and a rural area. In the model, agents with different entrepreneurial productivity and wealth first choose their permanent location (location choice), and then choose to be an entrepreneur or a worker (occupation choice) and investment in every period under borrowing constraints. Three additional assumptions are made: (1) Entrepreneurial productivity complements location-specific productivity, and location-specific productivity is higher in the urban area; (2) entrepreneurial productivity improves faster in the urban area; and (3) the outside option as a worker is higher in the urban area.

In an equilibrium, agents with higher ability are sorted into the urban area. Firms in the urban area require more investment (because they are more productive) and hence are more likely to be financially constrained. 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. We call this effect the "borrowing-constraint effect."

In addition to the borrowing-constraint effect, firms in the urban area grow faster due to higher productivity growth, which we call the "agglomeration effect." Finally, a higher wage in the urban area generates a "firm-selection effect" after the location choice: Higher operating costs and a higher outside option as a worker in the urban area force less productive entrepreneurs to exit to become workers.

Intuitively, we measure the contributions of each explanation as follows: (1) The growth rate of entrepreneurs with low wealth can be informative in measuring 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 in quantifying the agglomeration effect; (3) the observed wage difference across the regions can shed light on the extent of the firm selection.

Using the calibrate model, we quantify the contribution of each explanation to the observed growth-rate difference between metro and non-metro firms. First, we remove borrowing constraints from the benchmark model. The growth-rate difference decreases by 71% compared to the benchmark economy. Likewise, we remove the agglomeration effect (by making the growth of entrepreneurial productivity the same across the two regions) and the firm selection (by making the urban and the rural wage the same) from the benchmark model, respectively. The growth-rate difference decreases by 53% and 13%, respectively, compared to the benchmark economy. Overall, our finding shows that borrowing constraints explain a large part of the observed growth-rate difference between urban and rural firms.

Given the importance of borrowing constraints in explaining the growth-rate difference between urban and rural firms, we further evaluate the role of borrowing constraints on firms' location choices and the welfare of the economy. If borrowing constraints are removed, the aggregate efficiency will increase for 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 the reallocation of firms will also increase the aggregate efficiency. When borrowing constraints are present, some agents, especially low-wealth agents, locate in the urban area to accumulate wealth faster (thanks to the higher location productivity), and hence get out of borrowing constraints faster. Once they can fully borrow the optimal amount of funds from the beginning, they will locate in the rural area and enjoy the low operating cost. Our model predicts a non-trivial efficiency loss from the location-choice distortion: Once borrowing constraints are removed, the entrepreneurs' average profit increases by 14%, of which 16% is induced by the distortion in firms' location choice and 84% is induced by the conventional investment channel.

Our paper contributes to three lines of literature. First, it relates 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.[1] For example, Behrens et al. (2014) and Gaubert (2018) emphasize firm sorting, and Combes et al.

[1]A notable exception is Brinkman et al. (2015). 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 explicitly model a borrowing constraint and investigate its implications.

(2012) quantify firm selection. To understand the growth-rate difference between urban and rural firms, we develop a firm-dynamics model that incorporates the interaction between borrowing constraints and firms' location choice. Our novel finding is that borrowing constraints, in the presence of firm sorting, can explain a substantial part of the observed growth-rate difference between urban and rural firms.

Second, this paper contributes to the literature on the aggregate impact of borrowing constraints by adding a location choice. Early research on the financial constraint and its impact on economic growth includes King and Levine (1993), Jappelli and Pagano (1994), and Rajan and Zingales (1998).[2] More recent papers focus on quantifying the impact of financial friction on aggregate productivity (e.g., Buera et al. (2011); Moll (2014); Midrigan and Xu (2014)). Most existing literature, however, focuses on the impacts of financial friction on entrepreneurs' investments, abstracting entrepreneurs' location choice. We show financial friction can distort entrepreneurs' location choices and induce substantial welfare loss.

Third, this paper relates 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 US 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.[3]

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

[2]For a survey on this stream of literature, see Matsuyama et al. (2007) and Ang (2008).

[3]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.

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 US 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.[4]

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. 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,[5] and we can separate start-up businesses from "new" businesses emerging from mergers and acquisitions.[6]

Another important aspect of the SIPP is that it covers non-employer businesses, which are often not covered by establishment-based data. Note the number of businesses without paid employees is about three times the number of businesses with paid employees.[7] As a result, the summary statistics of our sample can be different from the ones from an establishment-based data set. Nevertheless, as shown in Appendix A, the summary statistics of our sample are similar to the ones from the Survey of Business Owners, the comprehensive survey for US

[4]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 the 1996 panel are not consistent.

[5]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.

[6]Decker et al. (2014) emphasize the importance of focusing on start-up or young firms, instead of firms emerging from mergers and acquisition.

[7]Source: the Survey of Business Owners (SBO).

business owners.

We now explain how we define relevant variables.

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.[8] 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.[9]

Business earnings: 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 annual business earnings are calculated as $\$5,000 \times \frac{12}{2}$. The monetary values are expressed in constant 2011 dollars.

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.

[8]We use the terms "business" and "firm" interchangeably.

[9]The majority of business owners operate only one business. For example, in 2002, 90.52% of business owners operate only one business.

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 US 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.[10] About 85% of the U.S. population resides in the metro areas.[11] 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 Plummer et al. (2008)).

By combining four panels, we make one unbalanced panel. Before the 2004 panel, the SIPP provides the metro information with noise for some states due to a disclosure risk for respondents.[12] 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, 36,261 are for business owners.

[10]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.

[11]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.

[12]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.

2.1 Summary Statistics

Table 1 shows the summary statistics for the key variables. About 83% 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 metro and non-metro areas is seven and eight years, respectively, suggesting young firms constitute a considerable proportion of the number of firms in both regions. The annual exit rate is 6% in both metro and non-metro areas on average, but if we condition on firms whose age is less than or equal to 3, the exit rate becomes much higher: 9% for metro areas and 10% for non-metro areas.[13]

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, and management in metro areas. Manufacturing and retail trade also seem to be over-represented in

[13] 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.

non-metro areas. Industry composition for other industries is similar across regions.

2.2 Business Earnings Dynamics between Metro and Non-metro Areas

We now document the difference in the business-earnings growth rate between metro and non-metro areas conditional on firm age. Table 3 shows the mean difference between metro and non-metro firms' growth rate.[14] The growth-rate difference between metro and non-metro areas is observed only among firms whose age is less than or equal to 3. 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. For firms whose age is greater than 3, no growth-rate difference exists between the two regions.

To further investigate the observed pattern regarding the difference in the business-earnings growth rate between metro and non-metro areas, we conduct the following regression analysis:

$$\begin{aligned}\ln Y_{it+1} - \ln Y_{it} = {} & \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln(\text{Firm age}_{it} + 1) + \beta_3 \text{Metro}_{it} \\ & + \beta_4 \text{Metro}_{it} \times \ln(\text{Firm age}_{it} + 1) + \text{StartYear dummy} + \text{State dummy} + \epsilon_{it}.\end{aligned} \tag{1}$$

Y_t represents the annual business earnings. We regress the business-earnings growth rates on the log earnings at t, log 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. β_1 is estimated as -0.357, suggesting a 10% increase in the current business earnings leads to a 3.6-percentage-point decrease in the

[14] 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 low output growth, 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.

growth rates. The growth-rate difference across regions is captured by $\beta_3 + \beta_4\text{Firm age}_{it}$. β_3 is estimated at 0.23, suggesting, after controlling for the current business earnings, the growth rates are, on average, 23 percentage points higher among metro start-up firms than non-metro start-up firms. Consistent with Table 3, β_4 is estimated to be significantly negative, suggesting the difference in the business-earnings growth rate across the regions is more pronounced among young firms.

In the second column of Table 4, we report the results from a regression analysis similar to the first column of Table 4, except we include industry-year 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-year fixed effect, we still observe the pattern.

The third column of Table 4 shows the results from a regression analysis similar to the first 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 2.1, 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

(β_3) and for the interaction term between the metro dummy and firm age (β_4) become 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 2 plots the predicted business-earnings growth rate in metro and non-metro areas by using the estimates of the regression equation in the second column 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.

2.3 Possible Explanations

Before discussing possible explanations for the findings in section 2.2, let us illustrate why understanding the growth-rate difference across metro and non-metro areas is relevant. If the initial earnings of a start-up firm (Y_0) are given, we can calculate the predicted earnings of the firm in the first year (Y_1) by using the estimates of the first regression in Table 4. By iterating this procedure, we can calculate earnings difference after some years (Y_t). For example, if the initial earnings are the mean of business earnings in non-metro area, the predicted earnings difference becomes about 40% after seven years (the median age for non-metro firms).

Agglomeration effect

Our finding that the business-earnings growth rate is higher in metro areas than in non-metro areas is in line with the well-known finding that firms and workers are, on average, more productive in cities where the economic activity is spatially concentrated (e.g., Melo et al. (2009), Rosenthal and Strange (2004)). Localized increasing returns, also known as agglomeration economies, have been considered the main reason behind the aforementioned fact. Learning opportunities can be higher for firms in metro areas thanks to easier knowledge generation, diffusion, and accumulation, and these opportunities can be particularly important for young firms. For example, Duranton and Puga (2001) propose a theoretical framework in which urban environments foster innovation by entrepreneurs.[15] Due to the agglomeration effect, firms in metro areas may grow faster than firms in non-metro areas.

Firm selection

We consider firm selection as another mechanism: Higher competition or higher operating costs in metro areas force less productive firms to exit. Due to the firm selection, the surviving firms' productivity can be, on average, higher in metro areas than in non-metro areas.

To check the firm selection as a potential mechanism behind the observed growth-rate difference between metro and non-metro areas, we estimate the following linear probability model of firm exit for firms whose age is less than or equal to 5:

$$\text{Exit}_{it+1} = \gamma_0 + \sum_{\text{Age}=0}^{5} \gamma_t^{rural} \text{Age}_{it} \times \text{Non-metro}_{it} + \sum_{\text{Age}=0}^{4} \gamma_t^{urban} \text{Age}_{it} \times \text{Metro}_{it} + u_{it}, \quad (2)$$

where u_{it} is an i.i.d. shock. Exit_{it+1} is the dummy variable for firm exit in year t+1. $(\text{Age} = s)_{it}$ is the dummy variable taking a value of 1 if firm i's age in year t is equal to s. Non-metro_{it} (Metro_{it}) is the non-metro (metro) dummy. Note $(\text{Age=5})_{it} \times \text{Metro}_{it}$ is the base group. We then test whether the exit probability is the same between metro and non-metro areas for each age group.

Table 5 shows the estimation results along with the test results for the null hypothesis that the exit probability is the same between metro and non-metro areas for each age group. In most age groups, we cannot reject the null hypothesis. For those rejected groups, the exit rate is higher in rural areas. Overall, the firm-exit rate is not higher in metro areas for all age groups, suggesting the firm selection may not be a major driving force behind the growth-rate

[15] In their model, new products are developed in diversified cities that facilitate search and experimentation in innovation. Once the ideal process is found, entrepreneurs switch to mass production and relocate to specialized cities where production costs are lower. For more micro-foundations of urban agglomeration economies, see Duranton and Puga (2004).

difference between metro and non-metro areas.

Borrowing constraints

In addition to the above two well-known mechanisms, we show borrowing constraints can also explain the observed growth-rate difference between metro and non-metro firms. First, the fact that urban firms are more productive than rural firms is well known (e.g, Behrens et al. (2014)). At the same time, the literature on entrepreneurial finance documents that potential business owners and small business owners face collateral constraints (e.g., Evans and Jovanovic (1989); Holtz-Eakin et al. (1994); Cagetti and De Nardi (2006); Adelino et al. (2015); Schmalz et al. (2017))). Conditional on wealth before starting a business, firms located in metro area are more likely to be financially constrained, because they are more productive (and hence require more investment) than firms located in non-metro areas due to the firm sorting. As a consequence, firms in metro areas 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.

To check the existence of borrowing constraints as a potential mechanism behind the business-earning difference, we estimate the following equation:

$$\ln(\text{first-year earning}_{it}) = \alpha_0 + \alpha_1 \text{wealth}_{it-1} + \alpha_2 \text{wealth}_{it-1} \times \text{Metro}_{it} + e_{it}, \tag{3}$$

where first-year earning$_{it}$ refers to the first-year business earnings by those who started a business in year t, wealth$_{it-1}$ refers to the net worth of the start-up owners (normalized by 100,000 USD) *before* they started a business, Metro$_{it}$ is the metro dummy, and e_{it} is an i.i.d. shock for log first-year business earnings. The idea behind equation (3) is the following. If a start-up owner is financially constrained, the initial investment will depend on the owner's borrowing capacity. The initial wealth is often considered to capture the owner's borrowing capacity (e.g., Evans and Jovanovic (1989)). Because we do not observe the initial investment, we use first-year business earnings as a proxy for the initial investment. If start-up owners in metro areas are financially constrained whereas start-up owners in non-metro areas are not, we expect the estimate for α_1 to be insignificant while the estimate for α_2 is significantly positive.

The column (1) at Table 6 shows the estimation result. Consistent with our prediction, the estimate for α_1 is insignificant. On the other hand, α_2 is estimated at 0.0446, suggesting an increase in net worth of 100,000 USD is associated with 4.46% additional increase in the initial business earnings, relative to non-metro areas, in metro areas. In column (2) of Table 6, we estimate equation (3) after including states and industry-year fixed effects. The result in column (1) is robust after controlling for those fixed effects. The findings in Table 6 support the view that borrowing constraints are particularly relevant for start-up owners in metro areas.[16]

Discussion

Disentangling the above three explanations 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)). Although we discussed some evidence regarding each mechanism, quantifying each one is difficult without further explanation of the data-generating process. 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 the business-earnings growth rates across regions. We also use the calibrated model for counterfactual policy experiments.

[16] A caveat about the regression equation (2) is that high wealth may also signal high ability. Therefore, the positive relationship between the initial wealth and the first-year earning may also reflect the fact that more able business owners enjoy faster growth.

3 The Model

The economy has two locations: an urban and a rural area. The economy consists of (1) a representative firm at each location and (2) a continuum of agents who either choose to be workers or entrepreneurs. Both the representative firms and 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.

3.1 Representative Firms

In each location j, one representative firm produces the homogeneous good. The production function of the representative firm in location j is

$$y_{jt}^{R} = A_j k_{jt}^{\alpha} l_{jt}^{1-\alpha}, \qquad j \in \{\text{urban}, \text{rural}\}, \;\; 0 < \alpha < 1.$$

y_{jt}^{R} is the homogeneous good that the representative firm produces, A_j is the location-specific productivity, and k_{jt} and l_{jt} are the capital and labor the representative firm hires in location j in period t.

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

$$w_j = (1-\alpha) A_j \left(\frac{k_{jt}}{l_{jt}}\right)^{\alpha}, \tag{4}$$

$$r = \alpha A_j \left(\frac{l_{jt}}{k_{jt}}\right)^{1-\alpha}. \tag{5}$$

The unit cost of the representative firm should be the same as the price of the consumption goods:

$$\frac{1}{A_j}\left(\frac{r}{\alpha}\right)^{\alpha}\left(\frac{w_j}{1-\alpha}\right)^{1-\alpha}=1. \tag{6}$$

We assume the location productivity is higher in the urban area than in the rural area ($A_{urban} > A_{rural}$). This assumption implies the urban wage is higher than the rural wage ($w_{urban} > w_{rural}$) according to equation (6).

3.2 Potential Entrepreneurs

In each period, ω mass of agents are born. The new entrants draw their ability e, initial transitory productivity z, and initial wealth a, which we explain below, from a distribution $g(e, z, a)$. The new entrants need to choose their locations at the beginning before they choose their occupations. We assume the cost of switching locations is very high so that once the new entrants have settled down in one location (either in the urban or rural area), they cannot move.[17] Once they locate in one area, in every period, they choose to operate an individual-specific technology – that is, to become entrepreneurs – or to work for wages. In each period, ω mass of agents are hit by death shocks, and therefore the measure of agents is constant over time in the economy, and we normalize it to be one.

Occupational choice

We first consider agents' occupational choice for those who already chose their location. Each agent is characterized by ability e, wealth a, transitory productivity z, and age s. Consider an agent in location j. Suppose the agent chooses to be an entrepreneur. If he sets up his own

[17]This assumption is consistent with our data: Entrepreneurs who change locations are very rare. For example, only 0.23% of metro-business owners move to a non-metro area. Likewise, only 1.63% of non-metro-business owners move to a metro area. Moreover, among all start-up owners (who were not business owners in the previous year), only 1.59% changed their location to start a business.

business, the production function is

$$y_{jt} = \psi_j \left(e, A_j, s\right) z_t \left(k_t^{\alpha} l_t^{1-\alpha}\right)^{\eta}, \quad 0 < \eta < 1, \tag{7}$$

where $\psi_j \left(e, A_j, s\right)$ is entrepreneurial productivity when the agent with ability e and age s locates in location j. We assume the agent's ability e and location productivity A_j are fixed over time. Hence, ψ_j is certain. The agent can predict the path of ψ_j before he chooses his location or occupation. z_t is the transitory productivity shock in year t. k_t and l_t are the capital and labor hired by the agent in year t if he chooses to be an entrepreneur.

We assume ψ_j satisfies the following properties: $\partial_e \psi_j > 0$ for all (A_j, s) and $\partial_s \psi_j \geq 0$ for all (A_j, e). In other words, entrepreneurial productivity increases with agents' ability and agents' age.[18] We also assume $\partial_e(\psi_{urban} - \psi_{rural}) > 0$ for all s: The marginal gains in entrepreneurial productivity from locating in the urban area relative to locating in the rural area increases with individual ability for all ages. This assumption generates firm sorting: Agents with higher ability ex ante choose to locate in the urban area.

Finally, we assume $\partial_s \psi_{urban} \geq \partial_s \psi_{rural}$ for all e: The increase in entrepreneurial productivity with respect to agents' age is greater in the urban area than in the rural area for all ability levels. Economists have considered localized increasing returns, also known as agglomeration economies, as the main reason behind the spatial concentration of economic activity in urban areas. A recent work by Roca and Puga (2017) provides evidence for dynamic agglomeration effects in urban areas. Several mechanisms (e.g., sharing, matching, and learning) may generate agglomeration economies (Duranton and Puga (2004)). Our goal is to quantify the impact of

[18] Note that age s in our model can be interpreted as the years of labor market experience. The literature does not provide a definite answer to whether different trajectories of labor market experience affect entrepreneurial productivity differently. Although a causal relationship between the experience as a worker and entrepreneurial ability is not well established, well-known suggestive evidence shows the experience as a worker, especially in small firms, is valuable for fostering entrepreneurial ability (Elfenbein et al. (2010)). Based on evidence that wage-work experience may be as valuable as self-employed experience for entrepreneurial learning, we take a simpler approach by assuming the entrepreneurial productivity (ψ) depends on age (s).

agglomeration economies on firm-growth rate. Because agglomeration economies by definition enhance productivity, we assume the growth in entrepreneurial productivity is higher in the urban area for all agents. We call this effect the agglomeration effect.[19]

The transitory productivity shock z follows a diffusion process:

$$d \ln z_t = \mu (z) \, dt + \sigma (z) \, dB_t, \tag{8}$$

where $\mu(z)$ 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 as a collateral constraint:

$$r k_t + w_j l_t \leq \phi a_t, \quad \phi \geq 1, \tag{9}$$

where ϕ is the collateral-constraint parameter. The borrowing constraint applies equally to all entrepreneurs in the economy and influences the firm's ability to expand.[20]

If the agent chooses to become a worker, he can supply θ units of labor. Hence, the profit per period for the agent is

$$\pi_{jt} (e, z_t, a_t, s) = \max \left\{ \max_{k_t, l_t} \{ y_{jt} - (r + \delta) k_t - w_j l_t \}, w_j \theta \right\} \quad \text{subject to} \tag{10}$$

$$y_{jt} = \psi_j (e, A_j, s) \, z_t \left(k_t^{\alpha} l_t^{1-\alpha} \right)^{\eta}, \quad r k_t + w_j l_t \leq \phi a_t, \quad 0 < \eta < 1, \quad \phi \geq 1.$$

The first term in equation (10) is the profit if the agent chooses to become an entrepreneur.

[19] In general, the source of location-specific productivity (A_j) might also come from the localized increasing returns, the agglomeration economies. The reason we call A_j location-specific productivity, not the agglomeration effect, is that A_j is time-invariant, and hence does not directly affect the firm growth without borrowing constraints.

[20] In principle, ϕ may be different across regions. A rural financial system may be less efficient because of less competition Cetorelli and Strahan (2006) or may be more efficient because of less asymmetric information Hoff and Stiglitz (1990). Given that no consensus exists regarding whether financial friction is worse in urban areas, we assume ϕ is the same across regions.

The second term is the profit if he chooses to become a worker.

Equation (10) implies two mechanisms that can generate the growth-rate difference between the urban and the rural area. First, the presence of borrowing constraints can generate the growth-rate difference when agents with higher ability are sorted into the urban area. Firms in the urban area require more investment (because they are more productive) and hence are more likely to be financially constrained. 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.

Second, the higher wage in the urban area implies firm selection. In each period, agents can choose to be workers with the outside option θw_j. Because the wage is higher in the urban area, entrepreneurs in the urban area have more incentive to be out of business due to a higher outside option as well as a higher operating cost.[21]

Given the per-period profit, the agent chooses consumption in each period (c_j) to maximize the lifetime utility:

$$\max_{c_j} E_0 \int_0^\infty e^{-(\rho+\omega)t} u\left(c_j\right) dt \tag{11}$$

$$\begin{aligned} \text{subject to} \quad da &= ra + \pi_j\left(e, z, a, s\right) - c_j \\ d\psi_j &= \partial_s \psi_j dt \\ d\ln z_t &= \mu\left(z\right) dt + \sigma\left(z\right) dB_t, \end{aligned}$$

where $\rho > 0$ is the discount rate of utility. The first constraint is the budget constraint of the agent in each period. The second constraint characterizes the agglomeration effect in our model. We drop the subscript t to simplify the notation.

[21] Combes et al. (2012) model firm selection as once-and-for-all exit. Given a non-homothetic preference, the city has a lower markup, and hence a higher productivity cut-off to survive. In our model, the high productivity cutoff comes from a high outside option (and a high operating cost) due to a high wage in the urban area. Although the specific mechanism through which firms exit is different between ours and Combes et al. (2012), both papers model the same idea: Either through a higher competition or through a higher operating cost, less productive entrepreneurs are more likely to exit in urban areas.

Let $v_j(e,z,a,s)$ denote the value of the agent if locating in j. The problem (11) can be written as

$$\begin{aligned}(\rho+\omega)\, v_j(e,z,a,s) &= \max_{c_j} \quad u(c_j) + \partial_a v_j(e,z,a,s)\left[ra + \pi_j(e,z,a,s) - c_j\right] + \\ &\quad \partial_s v_j(e,z,a,s)\, \partial_s \psi_j + \partial_{\ln z} v_j(e,z,a,s)\, \mu(z) + \frac{1}{2}\partial_{\ln z \ln z} v_j(e,z,a,s)\, \sigma^2(z)\,. \end{aligned} \tag{12}$$

Equation (12) suggests that within a short time interval (taking into account the discount rate and the exogenous death rate), the value comes from (i) consumption, (ii) the change of the asset, (iii) the increase in the productivity from the agglomeration effect, and (iv) the random productivity shock.

Location choice

Next, we consider the new entrants' location choice. Based on the value function defined in equation (12), a new entrant chooses the optimal location given his ability e, initial transitory productivity z, and initial wealth a:

$$\max_{j\in\{urban,rural\}} \left\{v_j(e,z,a,s=0) - f_j\right\}. \tag{13}$$

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

3.3 Stationary Equilibrium

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

$$\begin{aligned} \partial_t \lambda_j(e,z,a,s) &= -\partial_s \lambda_j(e,z,a,s) - \partial_a \left[\lambda_j(e,z,a,s)\left(ra + \pi_j(e,z,a,s) - c_j(e,z,a,s)\right)\right] \\ &\quad -\partial_{\ln z}\left[\mu(z)\lambda_j(e,z,a,s)\right] + \frac{1}{2}\partial_{\ln z \ln z}\left[\sigma(z)^2 \lambda_j(e,z,a,s)\right] \\ &\quad -\omega\lambda_j(e,z,a,s) + \omega g(e,z,a)\mathcal{I}(\chi(e,z,a) = j, s = 0), \end{aligned} \tag{14}$$

where $\mathcal{I}(.)$ 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 agents. In a stationary equilibrium, $\partial_t \lambda_j = 0$.

The goods-market-clearing condition is given in equation (15). It says the total consumption should equal the total output:

$$\sum_j \int c_j(e,z,a,s)d\lambda_j(e,z,a,s) = \sum_j \left[y_j^R + \int y_j(e,z,a,s)d\lambda_j(e,z,a,s)\right], \tag{15}$$

where $\int c_j(e,z,a,s)d\lambda_j(e,z,a,s)$ is the consumption by agents in location j, y_j^R is the output produced by the representative firm in location j, and $\int y_j(e,z,a,s)d\lambda_j(e,z,a,s)$ is the output produced by entrepreneurs in location j.

The labor-market-clearing condition is shown in equation (16). Let Ω= $\{(e,z,a,s)$: agents choose to run a business$\}$ and $1-\Omega$=$\{(e,z,a,s)$: agents choose to be a worker$\}$. Equation (16) says the labor supply from agents in location j should be equal to the labor demand from the representative firm and entrepreneurs in location j:

$$\theta \int_{1-\Omega} d\lambda_j(e,z,a,s) = l_j^R + \int_\Omega l_j(e,z,a,s)d\lambda_j(e,z,a,s) \quad \text{for every } j. \tag{16}$$

We assume the economy is an open economy. Hence, r is exogeneously 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 $v_j(e, z, a, s)$, policy functions of potential entrepreneurs and representative firms, and the joint distribution $\lambda_j(e, z, a, s)$ such that*

(i) Potential entrepreneurs' problem, representative firms' problem are solved;

(ii) Goods market clears;

(iii) Labor market clears;

(iv) The stationary distribution satisfies equation (14).

If the representative firm's labor demand is positive, w_j is determined by equation (6).[22] Given the wage (and the exogenous r), the location choice $\chi(e, z, a)$ and other policy/value functions are determined. Because equation (14) is a continuous-time Markov chain, a stationary distribution satisfying equation (14) exists (Sargent and Ljungqvist (2012)). Therefore, a competitive stationary equilibrium exists.[23]

4 Calibration

4.1 Specification

To quantify our model, we first assume a functional form of entrepreneurial productivity $\psi_j(e, A_j, s)$ and transitory productivity process $d \ln z_t$. The functional form of $\psi_j(e, A_j, s)$

[22]Note that as long as the labor supply $\theta \int_{1-\Omega} d\lambda_j(e, z, a, s)$ is greater than the labor demand from the entrepreneurs $\int_{\Omega} l_j(e, z, a, s) d\lambda_j(e, z, a, s)$, we have $l_j^R > 0$.

[23]A stationary distribution satisfying equation (14) is unique if the Markov chain defined in equation (14) is ergodic (Sargent and Ljungqvist (2012)). However, we are unable to prove it.

is set as a Cobb-Douglas function:

$$\psi_j(e, A_j, s) = e \times A_j^h \times \exp(-q_j(s^* - s)) \quad \text{if } s < s^* \tag{17}$$

$$\psi_j(e, A_j, s) = e \times A_j^h \quad \text{if } s \geq s^*, \tag{18}$$

where h is the elasticities of entrepreneurial productivity with respect to A_j. The function of ψ_j shows a complementarity between ability e and location productivity A_j. q_j captures the agglomeration effect in location j. Equation (17) implies that if an agent's age is less than s^*, the entrepreneurial productivity will increase by q_j every period. After age exceeds s^*, the agent cannot improve the entrepreneurial 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 ν is the persistence of the process. σ is the standard deviation of the innovation of z.

Second, we normalize some parameters. We set $q_{rural} = 0$ because non-metro firms' growth rate is, on average, zero independent of age. We also normalize the fixed entry utility cost $f_{rural} = 0$.

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

$$\ln e \sim N\left(\mu_e, \sigma_e^2\right), \quad \ln a \sim N\left(\mu_a, \sigma_a^2\right), \quad \ln z \sim N\left(0, \sigma_z^2\right).$$

4.2 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 $\{\omega, \rho, r, f_{urban}, \theta, \phi\}$. We fix the equilibrium wages as wages in the data for any set of parameters.

Some of these parameters come directly from the data. First, the log wage for workers in each region is 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 $\{1.28, 1\}$. We directly use the entrants' wealth distribution in the data to measure the μ_a and σ_a: $\mu_a = 1.42$ and $\sigma_a = 1.81$. We set $s^* = 3$.[24] Finally, the annual death rate of entrepreneurs ω is assumed to be 6%.[25]

We get some parameters from other sources. We calibrate the model to match the annual data. We assume agents have a log utility, and set the discount rate of utility (ρ) as 0.04 to match the long-run US interest rate. In the production function of the representative firm, we assume $\alpha = 0.4$, which is consistent with the capital share of the US 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)). Once we know α, r, and w_j, we can calculate A_j from equation (6).

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 ability distribution μ_e. We use the standard deviation of log business earnings to pin down the standard deviation of ability distribution σ_e. To pin down the standard deviation of the initial transitory productivity shock σ_z, we use

[24]The growth difference is significant only among firms whose age is smaller than or equal to 3. If $s^* > 3$, the model will definitely predict that urban firms whose age is greater than 3 will still grow faster than rural firms. Therefore, s^* must be less than or equal to 3 to be consistent with the empirical finding. Because we choose the upper bound of s^*, our decomposition result may over-estimate the contribution of the agglomeration effect.

[25]The annual death rate of agents (ω) is the same as the proportion of the new entrants among all agents (ω). Note that an agent hit by a death shock can be interpreted as someone who exits the labor force. Likewise, a new entrant can be interpreted as someone who enters the labor force for the first time. We use the proportion of new college graduates among all college-degree holders to set ω. We use these statistics to proxy for the proportion of individuals who entered the labor force for the first time.

the standard deviation of log business earnings for start-up businesses. We use the standard deviation of the business-earnings growth rate and the autocorrelation of business earnings to identify the transitory productivity process parameters ν and σ. The efficiency unit of labor as a worker θ is identified by the proportion of entrepreneurs in the economy.[26] Similarly, f_{urban}, the utility difference between locating in urban and rural areas, is identified by the proportion of business owners located in metro areas.

In the model, the collateral-constraint parameter ϕ 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 ϕ. Specifically, we target the mean growth rate of firms aged less than or equal to 3, and the firm owners' net worth is below the 25^{th} percentile of the stationary wealth distribution.[27] Unlike ϕ, q_{urban} affects the growth rate of all young firms in the urban area independent of their net worth. Given ϕ, we can use the growth-rate difference between metro- and non-metro-area young firms to pin down q_{urban}.

Table 7 reports the calibrated parameter values and the model fit. ϕ is 5.107, meaning entrepreneurs can invest up to about five times their wealth. 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, suggesting a cost of locating in the urban area. The effective unit of labor supply (θ) is 0.22, and the elasticity of entrepreneurial productivity with respect to the location-specific productivity (h) is 1.311.

[26] In reality, a large proportion of individuals never start a business over their lifetime. For example, in the National Longitudinal Survey of Youths 1979 (NLSY 79), 73.1% of respondents never start a business over 20 years. To closely link the potential business owners to data, the proportion of agents who choose to be entrepreneurs is calculated as $\frac{x}{1-0.731}$, where x is the proportion of business owners in the main sample.

[27] As a robustness check, we tried to target the mean growth rate of firms aged less than or equal to 3, and the firm owners' net worth is below the median of the stationary wealth distribution. The quantitative results change only slightly.

Using the calibrated model, we plot the growth-rate difference in the urban and the rural area. We separate firms by young firms (firms whose age is less than or equal to 3) and old firms (firms whose age is above 3). Figure 3a plots the density function of the young firms' growth rates, and Figure 3b shows the density function of old firms' growth rates. Young firms in the urban area grow faster than young firms in the rural area. On the other hand, the growth rates are similar between the urban old firms and the rural old firms.

5 Results

5.1 Policy and Value Functions

To understand the location choice of agents, we plot the policy function for location choice of an agent in Figure 4. The x-axis represents the level of assets (a) and the y-axis represents the level of ability (e) (we fix the temporary productivity shock $z = 1$). For comparison, we also plot the policy function when the borrowing constraint does not exist.

As shown in equation (17), a complementarity exists between ability e and location productivity A_j. Hence, more-productive firms tend to sort into the urban area. At the same time, the urban firms will face higher operating costs ($w_{urban} > w_{rural}$). Therefore, only productive firms are sorted into the urban area.[28] Without the borrowing constraint, the asset level does not affect agents' location choice.

When the borrowing constraint is present, however, the asset level matters for agents' location choice. We can see some agents, especially low-wealth agents, who would have located in the rural area without the borrowing constraint are now sorted into the urban area. To investigate more on the location choice, we plot the value function for each location for an agent with $(e, z, s) = (1, 1, 0)$ when the borrowing constraint is present (Figure 5). The marginal value of locating in the urban area ($v_{urban} - v_{rural}$) decreases as the level of wealth increases.

[28] A similar mechanism is discussed in Behrens et al. (2014) and Gaubert (2018).

As a result, a wealth threshold (about 21) exists such that agents with wealth below the threshold choose to locate in the urban area, and agents with wealth above the threshold choose to locate in the rural area. Our intuition is that, under our calibrated parameter values, financially constrained agents can accumulate wealth faster in the urban area due to high location productivity, and hence can get out of the borrowing constraint faster.

5.2 Decomposition

Now, we decompose the difference in the business-earnings growth rate between urban and rural young firms. First, we remove the borrowing constraint from the estimated economy by setting $\phi = \infty$, and compute the difference in the business-earnings growth rate between urban and rural young firms. The result is shown in the second column of Table 8. The growth-rate difference declines from 11.1% in the benchmark economy to 3.2% in the economy without the borrowing constraint. Hence, firm sorting under borrowing constraints explains about 71% ($\frac{11.1-3.2}{11.1} \times 100$) of the growth difference across regions.

Second, we remove the agglomeration effect from the estimated economy by setting $q_{urban} = 0$, and compute the difference in the business-earnings growth rate between urban and rural young firms. The result is shown in the third column of Table 8. The growth-rate difference declines from 11.1% in the benchmark economy to 5.2% in the economy without the borrowing constraint. Hence, firm sorting under borrowing constraints explains about 53% ($\frac{11.1-5.2}{11.1} \times 100$) of the growth difference across regions.

Finally, we remove firm selection from the estimated economy by setting $w_{urban} = w_{rural} = 1$, and compute the difference in the business-earnings growth rate between urban and rural young firms.[29] The result is shown in the fourth column of Table 8. The growth-rate difference declines from 11.1% in the benchmark economy to 9.7% in the economy without the borrowing

[29]We assume that the representative firm takes the wage as given and hires all the remaining labor once entrepreneurs have hired their workers.

constraint. Hence, firm sorting under borrowing constraints explains about 13% ($\frac{11.1-9.7}{11.1} \times 100$) of the growth difference across regions.

The decomposition result is consistent with the descriptive evidence discussed in section 2.3. Consistent with the evidence that borrowing constraints are particularly relevant for start-up owners in metro areas, the model predicts a substantial amount of the growth difference induced by the collateral constraint. Also in line with weak evidence of firm selection in section 2.3, our model predicts a rather small contribution of firm selection to the growth-rate difference between the urban and rural area.

To relate our findings to the previous literature, Combes et al. (2012) find firm selection cannot explain the spatial-productivity difference, consistent with our finding. In line with our result, Behrens et al. (2014) and Gaubert (2018) show firm sorting can play an important role in explaining spatial heterogeneity in productivity other than agglomeration economies. Our novel finding is that borrowing constraints, in the presence of firm sorting, can explain a substantial part of the observed growth-rate difference between urban and rural firms.

5.3 Welfare Implication of Borrowing Constraints

The results in section 5.2 suggest borrowing constraints are important to understanding the growth-rate difference between the urban and rural areas. At the same time, existing policies in the United States (e.g., the small business guaranteed loan program) specifically aim to relax borrowing constraints for entrepreneurs. In this section, we further investigate the welfare implication of a policy relaxing borrowing constraints on start-up firms' location choices and the welfare of economy.

In our model, the borrowing constraint generates inefficiency through two different channels. First, borrowing constraints can distort the firms' investments, often highlighted by the existing literature (e.g., Moll (2014)). In addition to this conventional channel, our model suggests another potential misallocation through the distortion in agents' location choice, discussed in section 5.1.

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. The result is presented in the third column of Table 9. Our decomposition suggests the misallocation through the location distortion is not trivial. The distortion through the location choice accounts for about a 16% ($\frac{0.2-0.174}{0.2-0.033} \times 100$) decline in average log profit, and about a 6% ($\frac{1.179-1.169}{0.179} \times 100$) decline in welfare, measured by the lifetime consumption level relative to the benchmark, due to borrowing constraints.

5.4 Robustness Checks

In this section, we conduct several robustness checks for our decomposition result. In the benchmark model, we assume no correlation between initial ability and initial wealth. As the first robustness check, we assume $\ln e$ and $\ln a$ follow a joint normal distribution with the mean $[\mu_e,\, \mu_a]$ and the co-variance matrix: $\begin{bmatrix} \sigma_e^2 & \rho\sigma_e\sigma_a \\ \rho\sigma_e\sigma_a & \sigma_a^2 \end{bmatrix}$. We use the same parameters as in the benchmark model including σ_e and σ_a, and assign $\rho = 0.1$.

The decomposition result is shown in the first row of Table 10 (Corr. initial a and e). When more-productive agents (whose investment level is higher) are assigned more wealth, all else being equal, the borrowing constraint is less likely to be binding. As a result, the contribution of the borrowing-constraint effect becomes smaller. Nevertheless, our main findings do not change: The borrowing constraint explains the largest part of the growth-rate difference, and the impact of firm selection is rather small.

As the second robustness check, we extend the model to assume that if the entrepreneur chooses to become a worker, the value is $w_j\psi_j^{\upsilon}\theta$, where $\upsilon > 0$. $\psi_j^{\upsilon}\theta$ is the efficient units of labor that the entrepreneur can supply to the market. We use the same parameters as in the benchmark model, and choose $\upsilon = 0.1$.

The decomposition result is shown in the second row of Table 10 (Outside option: $w_j \psi^{\nu} \theta$). When the outside option depends on entrepreneurial productivity, firm selection in the urban area becomes stronger because entrepreneurial productivity is higher in the urban area. However, our main findings do not change: The borrowing constraint explains the largest part of the growth-rate difference, and the impact of firm selection is rather small.

Previous literature on urban firm dynamics has suggested a role for different fixed costs in urban and rural areas (e.g., minimum land requirements for production). As the third robustness check, we investigate the implication of a minimum-investment requirement. In our model, a minimum requirement for production can be implemented as adding the following constraint into the entrepreneurs' problem in equation (10):

$$k_t > \bar{k}_j, \tag{19}$$

where $\bar{k}_j$ captures the minimum-investment requirement in each region. For simplicity, we assume $\bar{k}_{rural} = 0$ and $\bar{k}_{urban} > 0$.

Without the borrowing constraint, the above constraint is binding only for those whose optimal investment is less than $\bar{k}_{urban}$. These entrepreneurs are more likely to have lower ability; therefore, the addition of the minimum-investment requirement creates additional firm selection in the urban area.

When the borrowing constraint is present, the constraint is binding not only for low-ability agents, but also for low-wealth individuals who cannot finance up to $\bar{k}_{urban}$. Given that high-ability, low-wealth agents cannot start a business in the urban area, due to the minimum-investment requirement, agents' location choice may change as well. Therefore, theoretically, the borrowing constraint and the minimum-investment requirement would interact.

To check whether the minimum-investment requirement is quantitatively important in the presence of the borrowing constraint, we modify our benchmark economy by including equation (19) with $(\bar{k}_{rural}, \bar{k}_{urban}) = (0, 1.1)$. Note we normalize the monetary value by the average non-metro wage. Therefore, we set the minimum-investment level as 10% greater than the average non-metro wage. The decomposition result is shown in the third row of Table 10 (Min. investment requirement). The contribution of borrowing constraints is more pronounced in the presence of the minimum-investment requirement. However, even with the minimum-investment requirement, our main findings do not change: The borrowing constraint explains the largest part of the growth-rate difference, and the impact of firm selection is rather small.

5.5 Discussion

Note that we do not allow the agglomeration effect to depend on the distribution of agents or entrepreneurs. If the agglomeration effect depends on the distribution of agents or entrepreneurs, we need another equilibrium condition: The agent's problem is solved given an initial agglomeration effect, and the resulting (endogenous) distribution of agents or entrepreneurs should be consistent with the distribution that generates the initial agglomeration effect. Finding parameters that satisfy the aforementioned condition can be computationally challenging. For this reason, we incorporate the agglomeration effect in a reduced-form way.

A limitation of this modeling approach is that we cannot capture the interaction between borrowing constraints and the agglomeration effect. Suppose the agglomeration effect is a function of the population or entrepreneurs' distribution in an area. When the borrowing constraint is removed, the distribution of population and entrepreneurs in each region will change, which may in turn change the agglomeration effect. Our current model cannot capture this effect.

6 Conclusion

We document facts regarding the difference in the business-earnings growth rate between metro and non-metro areas in the United States. We develop a dynamic general equilibrium model that incorporates the agglomeration effect, borrowing constraints, and firm selection to quantify the extent to which these explanations are important in explaining the observed growth-rate difference between urban and rural firms. Our finding shows that borrowing constraints explain a large part of the observed growth-rate difference between urban and rural firms. Our model suggests reducing borrowing constraints can improve the aggregate efficiency not only by increasing firms' investments, but also by reducing misallocation of firms' location choice.

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Tables and Figures

Table 1: Summary Statistics

	Metro	Non-metro
Number of Obs.	290,602	58,659
Number of Obs.(worker)	260,351	52,679
	(83%)	(17%)
Number of Obs.(business owners)	30,251	5,980
	(84%)	(16%)
Proportion of business owners	0.10	0.10
Proportion of incorporated business	0.38	0.31
Log wage earnings		
(mean)	10.21	9.96
(median)	10.31	10.08
Log business earnings		
(mean)	10.14	9.77
(median)	10.31	9.95
Firm age		
(25th percentile)	2	3
(median)	7	8
Exit rate (Annual)		
(young firms)	0.09	0.10
(all firms)	0.06	0.06

NOTE: This table shows the summary statistics for metro and non-metro observations. Young firms are firms whose age is less than or equal to 3.

Table 2: Firm-Size Distribution across Regions

		Size 1 (%)	Size 2 (%)	Size 3 (%)
All firms	Metro	95.88	2.91	1.21
	Non-metro	97.39	2.05	0.56
Young firms	Metro	97.55	1.67	0.78
	Non-metro	98.51	1.10	0.39

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 or equal to 3. All units are percentage.

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

	Metro		Non-metro			
	Obs.	Mean (A)	Obs.	Mean (B)	(A)$-$(B)	$p-$value
Young (age $\leq$ 3) firms	3,992	0.045	624	-0.029	0.074	0.074
		(0.018)		(0.054)		
Old (age $>$ 3) firms	9,196	-0.031	1,767	-0.018	-0.013	0.686
		(0.011)		(0.027)		

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

VARIABLES	(1) $\Delta \ln Y$	(2) $\Delta \ln Y$	(3) $\Delta \ln Y$	(4) $\Delta \ln Y$
$\ln Y$	-0.357***	-0.362***	-0.386***	-0.418***
	(0.0101)	(0.0102)	(0.0114)	(0.0121)
Metro	0.230***	0.216***	0.206***	0.186***
	(0.0572)	(0.0570)	(0.0623)	(0.0628)
ln(Firm age+1)	0.124***	0.0723***	0.0999***	0.103***
	(0.0233)	(0.0235)	(0.0253)	(0.0254)
Metro× ln(Firm age+1)	-0.0560**	-0.0502**	-0.0532**	-0.0444*
	(0.0233)	(0.0235)	(0.0253)	(0.0254)
# of Employees $[25, 100)$			0.206***	0.191***
			(0.0509)	(0.0499)
# of Employees ≥ 100			0.469***	0.429***
			(0.0645)	(0.0637)
Incorporated			0.165***	0.139***
			(0.0176)	(0.0176)
Owner age				-0.00617***
				(0.000824)
Univ.				0.152***
				(0.0165)
Married				0.0656***
				(0.0184)
Male				0.215***
				(0.0189)
White				0.0309
				(0.0243)
Constant	2.128***	3.426***	1.932***	2.631***
	(0.144)	(0.155)	(0.161)	(0.178)
StartYear	Yes	No	Yes	Yes
States	Yes	Yes	Yes	Yes
Industry×Year	No	Yes	No	No
Observations	15,579	15,579	14,786	14,658
R-squared	0.183	0.187	0.188	0.203

NOTE: This table shows the regression estimates for the business-earnings growth rates. Y is business earnings. The growth rate is measured by $\ln Y_{t+1} - \ln Y_t$. StartYear refers to the business start-year fixed effect. States refers to the state fixed effect. Standard errors are clustered by each business. *** p-value <0.01, ** p-value <0.05, * p-value<0.1

Table 5: Regression for Young-Firm (age $\leq$ 5) Exit

	VARIABLES	Exit	Hypothesis	$p-$value
(1)	Age 0 $\times$ Non-metro	0.1204	(1) $-$ (2) $=$ 0	0.0697
		(0.0167)		
(2)	Age 0 $\times$ metro	0.0919		
		(0.0105)		
(3)	Age 1 $\times$ Non-metro	0.0499	(3) $-$ (4) $=$ 0	0.7943
		(0.0165)		
(4)	Age 1 $\times$ Metro	0.0459		
		(0.0102)		
(5)	Age 2 $\times$ Non-metro	0.011	(5) $-$ (6) $=$ 0	0.6183
		(0.0182)		
(6)	Age 2 $\times$ Metro	0.0197		
		(0.0107)		
(7)	Age 3 $\times$ Non-metro	0.0604	(7) $-$ (8) $=$ 0	0.0170
		(0.0194)		
(8)	Age 3 $\times$ Metro	0.0154		
		(0.0110)		
(9)	Age 4 $\times$ Non-metro	0.0123	(9) $-$ (10) $=$ 0	0.9559
		(0.02)		
(10)	Age 4 $\times$ Metro	0.0134		
		(0.0116)		
(11)	Age 5 $\times$ Non-metro	0.0169	(11) $=$ 0	0.4113
		(0.0207)		
(12)	Constant	0.0413		
		(0.0424)		
	States	Yes		
	Industry$\times$Year	Yes		
	Observations	11,286		
	R-squared	0.034		

NOTE: This table shows the estimates for a linear probability model of young-firm (age $\leq$ 5) exit. The base group is Age 5 $\times$ Metro. Standard errors in parentheses.

Table 6: Regression for Start-up Owners' Business Earnings

VARIABLES	(1) log(first-year earning)	(2) log(first-year earning)
Initial wealth	-0.0248	-0.0242
	(0.0206)	(0.0222)
Initial wealth×Metro	0.0446**	0.0381*
	(0.0211)	(0.0228)
States	No	Yes
Industry×Year	No	Yes
Observations	1,877	1,787
R-squared	0.006	0.121

NOTE: This table shows the regression estimates for start-up owners' business earnings. "First-year earning" refers to start-up owners' first-year business earnings. Standard errors in parentheses. *** p-value <0.01, ** p-value <0.05, * p-value<0.1

Table 7: Parameters & Model Fit

Parameters	Value	Target Moment	Model	Data
ϕ	5.107	growth average — young poor	0.062	0.061
q_{urban}	0.060	growth diff. — young	0.111	0.074
σ	0.146	std. of growth rate	0.920	1.093
ν	0.267	auto corr. of log profit	0.587	0.655
θ	0.220	entrp.%	0.213	0.386
f_{urban}	0.489	urban entrp.%	0.679	0.835
μ_e	0.546	average log rural profit	-0.230	-0.199
h	1.311	average log urban profit	0.157	0.174
σ_e	1.191	std. of log profit	1.074	1.409
σ_z	1.063	std. of first year profit	1.291	1.450

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 business-earnings growth rate of firms aged less than or equal to 3 whose owners' net worth is below the 25^{th} percentile of the stationary wealth distribution. "growth diff. — young" indicates the difference in the business-earnings growth rate between urban and rural firms aged less than or equal to 3.

Table 8: Decomposition

Moment	(1) Benchmark	(2) No Borrowing Constraint	(3) No Agglomeration Effect	(4) No Firm Selection
growth diff. — young	0.111	0.032	0.052	0.097

NOTE: This table shows the decomposition of the difference in the growth rate of business earnings between urban and rural firms aged less than or equal to 3. The first column reports the result from the estimated model. The second column reports the results when the borrowing constraint is removed ($\phi = \infty$) from the benchmark model. The third column reports the results when the agglomeration effect is removed ($q_{urban} = 0$) from the benchmark model. The fourth column reports the results when the firm selection is removed ($w_{urban} = w_{rural} = 1$) from the benchmark model.

Table 9: Model Predictions without Borrowing Constraints

Moment	(1) Benchmark	(2) No Frictions	(3) No Frictions & Exog. Location
ave. log profit	0.033	0.200	0.174
welfare	1	1.179	1.169

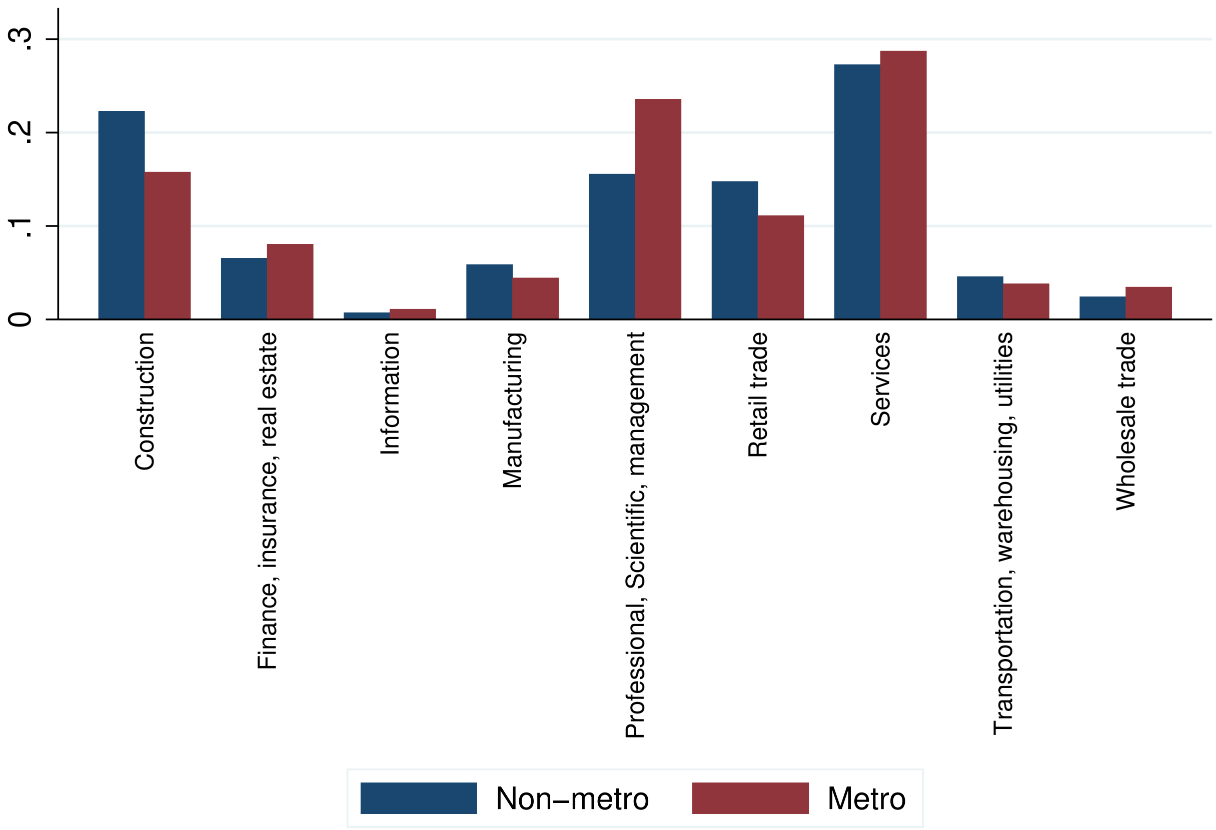
NOTE: This table shows the model results without borrowing constraints. The second column reports the economy when no credit constraint is present, and the third column reports the results when the location choice is the same as in the benchmark model and borrowing constraints are removed.

Table 10: Decomposition: Robustness Checks

growth diff. — young	Benchmark	No Borrowing Constraint	No Agglomeration Effect	No Firm Selection
Corr. initial a and e	0.122	0.046	0.059	0.107
Outside option: $w_j \psi^{\nu} \theta$	0.110	0.044	0.088	0.094
Min. investment requirement	0.111	0.023	0.079	0.096

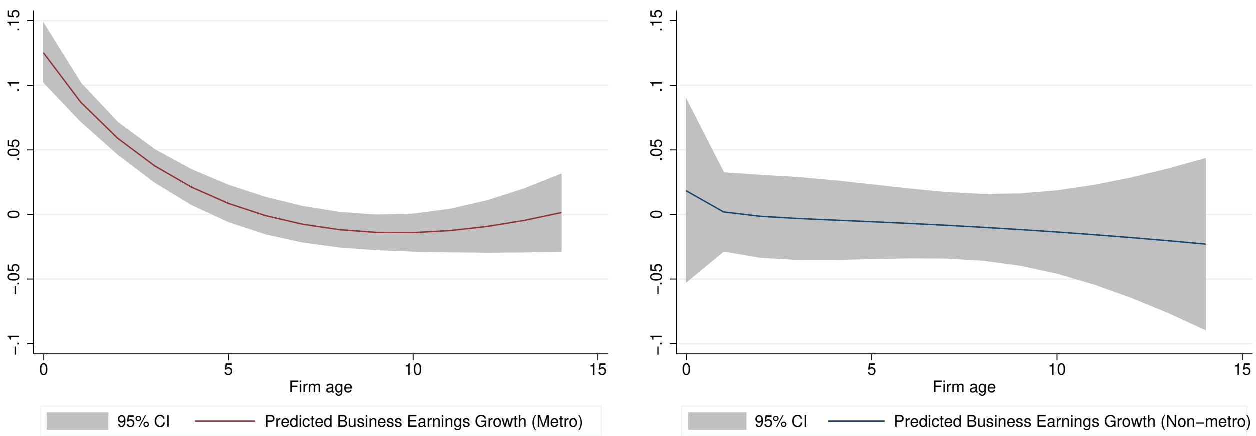
NOTE: This table shows the decomposition of the growth-rate difference between urban and rural young firms (aged less than or equal to 3) under different specifications: (1) the economy in which initial wealth and ability is positively correlated (the correlation is 0.1), (2) the economy in which the outside option as a worker is given by $w_j \psi^{\nu} \theta$ (ν is 0.1), and (3) the economy in which the minimum-investment requirement is imposed as $(\bar{k}_{rural}, \bar{k}_{urban}) = (0, 1.1)$. The decomposition method is identical to the one in Table 8.

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.

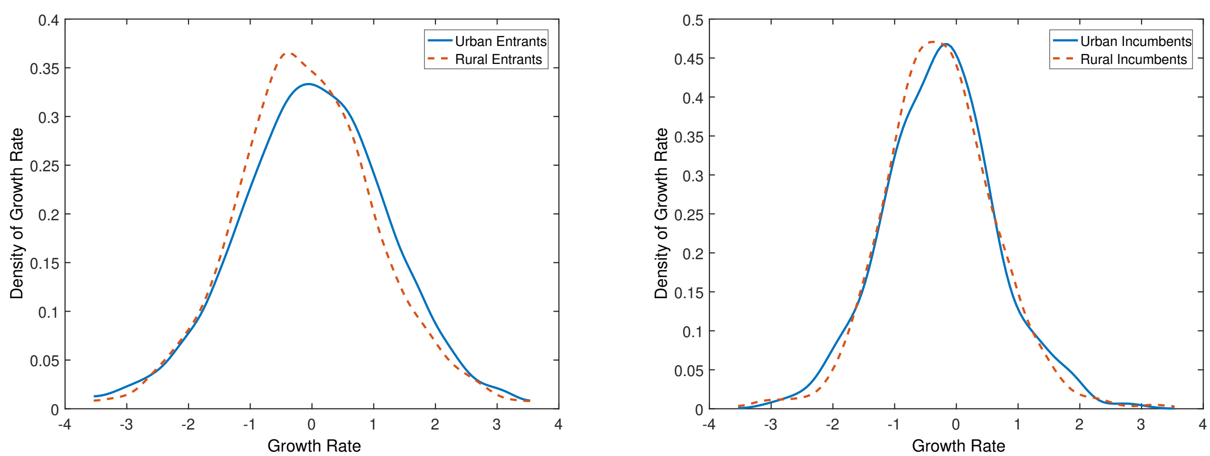
Figure 2: Predicted Business-Earnings Growth Rate and Firm Age



(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.

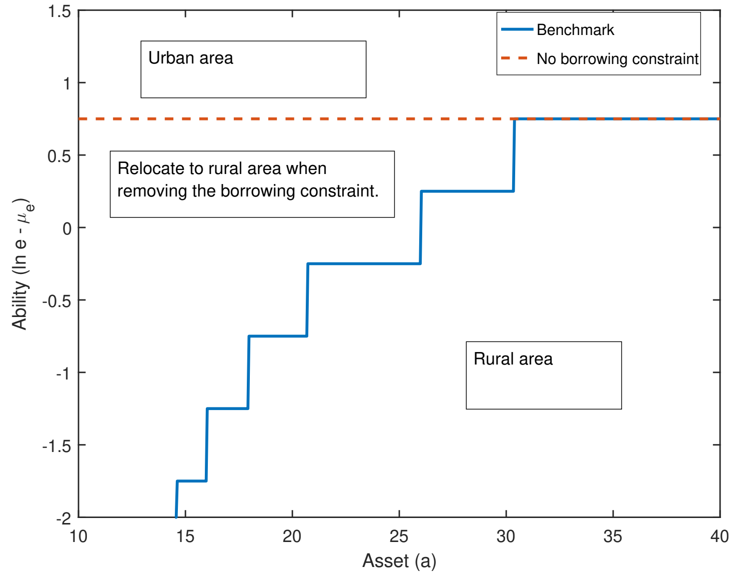
Figure 3: Simulated Growth-Rate Differences



(a) New entrepreneurs (b) Incumbents

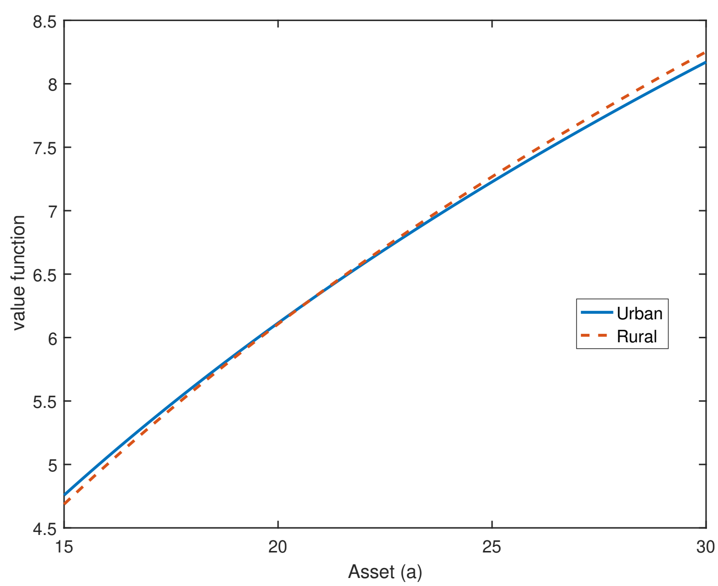
NOTE: This figure plots the distribution of simulated growth rates, measured by $\ln Y_{t+1} - \ln Y_t$, of business profits in urban and rural areas.

Figure 4: Policy Function for Location Choice



NOTE: This figure shows the policy function for the location choice of new entrants. The x-axis is the asset level (a) and the y-axis is the ability level ($\ln e - \mu_e$). The parameters are the same as in section 4. We fix the transitory shock (z) equal to 1 in this graph.

Figure 5: Value Function for Each Location



NOTE: This figure shows the value function for each location for those whose ability (e) and transitory shock (z) are both equal to 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 comprehensive information on demographic characteristics for business owners in the US. Table 11 compares the owner characteristics from the SIPP with the ones 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 over-samples 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 are quite similar to those in 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 four years. Therefore, we believe our results on the young-firm dynamics are less likely to be affected even if the SIPP does not capture firms with a very large number of employees.

Table 11: SIPP vs. SBO

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

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