Innovation and New Business Formation

Pu Liu
Department of Finance
Sam M. Walton College of Business
University of Arkansas
pliu@walton.uark.edu
479-575-6095

Yingying Shao*
Department of Finance
College of Business and Economics
Towson University
yshao@towson.edu
410-704-3839

Key Words: Innovation; New Business Formation; Financial Constraints.
JEL Codes: O3, G31, L26

*Corresponding author. Department of Finance, College of Business and Economics, Towson University, Towson, Maryland, 21252

Innovation and New Business Formation

Abstract

Using patent data for U.S. publicly trading firms from 1986 to 2018, this study investigates the impact of innovative activities in large corporate sector on the emergence of entrepreneurial activities at the county level. Consistent with the knowledge spillover theory of entrepreneurship, the results show that large firms' inventive activities exhibit a positive relationship with new business formation in the local manufacturing sector, and the positive effect is monotonic across startup firm size. Moreover, the study reveals that when inventing firms are financially constrained, the positive effect of their innovations on local new business formation becomes more pronounced, supporting the agency theory regarding the governance role of financial constraints in promoting efficient innovative outcomes.

Key Words: Innovation; New Business Formation; Financial Constraints.

Innovation and New Business Formation

1. Introduction:

According to resource-based theory, the success of new firms is critically determined by their internal resources such as assets, fundamental characteristics, information, and knowledge (Barney1991; Bhide 2003; Delmar and Wennberg 2010; Stuetzer et al. 2014). Other studies have identified regional factors such as economic growth, financial and social capital, external research clusters, and support services for their contribution to the creation of new businesses in the local area (Feldman 2001). Recently, represented by the knowledge spillover theory on entrepreneurship (KSTE, Acs et al. 2009, 2013), a growing stream of studies propone that innovating activities lead to the advancement of local knowledge bases, which further promote entrepreneurial activities in the nearby area (Block, Fisch, and van Praag 2017; Landström et al. 2012; Landström, Åström, and Harirchi 2015; Ribeiro-Soriano and Huarng 2013; Schmitz et al. 2017; Fritsch and Wyrwich 2018; Aldieri et al. 2019; Colombelli et al. 2019).

Given the importance of corporate innovations to local entrepreneurship, this study attempts to evaluate the extent to which corporate firms' financial constraints, as an important determinant to business innovative activities, influence the establishments of new businesses in the nearby area.

An extensive strand of finance literature has examined the role of the availability of financial resources to corporate innovations, albeit generated competing theories and mixed empirical results. Following Schumpeter (1942), the traditional view believes that abundant financial capital is beneficial to creative innovations. This is because without financial constraints, firms can undertake risky R&D projects hence stimulate inventions, especially when experiencing liquidity crunch (Henderson and Cockburn 1996; Cohen, Levin, and Mowery 1987; Aghion, Angeletos, Banerjee, and Manova 2010; Brown, Martinsson, and Petersen 2012; Acharya and Xu 2017). In this view, financially constrained firms tend to reduce their costly investments especially inventive activities due to the great uncertainties in returns (Canepa and Stoneman 2008; Hajivassiliou and Savignac 2007; Ayyagari et al. 2011; Amore et al. 2013).

However, recent studies document that largely available financial resources do not necessarily lead to more and better innovation (The Economist 1990; Jensen 1993; Jaffe 2000; Lanjouw and Schankerman 2004). Studies based on agency theory (Jensen 1988; Blanchard, Lopez-de-Silanes, and Shleifer 1994) propose a different role of financial constraints as a corporate governance mechanism in influencing firms' investment behavior. They argue for a "quiet life" agency story in which firm management prefers a quiet life: financial managers are reluctant to take additional risk when facing no financial constraints and takeover threat (Bertrand and Mullainathan 2003; Atanassov 2013; Sapra, Subramanian, and Subramanian 2014). This implies that firms with abundant financial recourses have less incentive to explore new opportunities to innovate, while financially constrained firms tend to make optimal investment decisions resulting efficient innovative outcomes. Recent empirical studies have documented evidence to this bright side of financial constraints in mitigating the "quiet life" agency problem and improving the efficiency of innovative activities (Almeida et al. 2013, 2019). While not directly related to investment decisions, recent literature in the psychological and managerial behavior suggests that entities can become more creative in optimizing their resources when facing limitations and constraints, and that abundant resource can actually be counterproductive and value destroying (Sonenshein 2017).

In this study, we relate county-level new business creation data to firm-level measurements of innovations and financial constraints. Specifically, we adopt the patent data for U.S. publicly trading firms constructed by Kogan et al. (2017)[1], and county-level new business creation in the manufacturing sector to form a large U.S. sample ranging from 1986 to 2018. We first document a positive effect of the innovations of publicly trading firms, measured respectively by the market value and citation weighted counts of patent grants, on local entrepreneurship measured at the county level. Our findings support the KSTE (Acs et al. 2009, 2013) that innovations, by contributing to the evolvement of local knowledge bases, spurs new business formation.

We next augment the analysis by including firms' financial constraints to investigate whether and how individual firms' financial capital availability influence the effect of innovation to new business formation. We find evidence that the positive

[1] We thank Kogan, Papanikolaou, Seru, and Stoffman (2017) for making these patent value data available at https://iu.app.box.com/v/patents.

relationship between corporate innovation and new business formation is more pronounced when firms are financially constrained. This finding supports the agency theory that argues for the bright side of financial constraints in shaping businesses' behavior and leading to efficient and valuable innovative outcomes, which further spur the local entrepreneurial activities.

Our paper contributes to the literature in multiple ways. In seeking the driving force of local entrepreneurship, the literature has identified a number of factors ranging from demographical characteristics, development of financial capital markets, institutional factors such as social capital, and availability of information and knowledge (Delmar and Wennberg, 2010; Stuetzer et al., 2014). Based on theories relating to the localization and spillover of knowledge, recent studies have argued that innovations may spur local business startups. In this strand of literature, previous studies mostly use state-level or country-level measures of innovations. This assumes that the effects of innovation will be uniform within a state however a state includes areas that vary widely in terms of economic infrastructure and development. Firms within the same state may have different lines of products and services to meet the needs from local business environment. Such heterogeneity makes pooled estimations at the state level inadequate in capturing the real economic effect of innovation in a smaller local setting. This study uses firm-level innovation data that allow us to better measure innovation at a micro level, hence provide a suitable solution to address the heterogeneity issue in empirical investigation.

Furthermore, this study adopts a newly developed market value-based measurement to describe the dynamics in firms' patenting activities[2]. Innovation is highly relevant to business value creation, however simply using counts and subsequent citations of patent grants is insufficient to measure the economic and financial impact of innovative activities. This is the first study, to the best of our knowledge, that provides the empirical evidence to the innovation-drive entrepreneurship literature by relating the market value of patents to the entrepreneurial activities in the local area.

Our investigation also contributes to the finance literature on the effect of financial constraints to investments using extended evidence from the real economy. In investigating the governance role of financial constraints in mitigating the "quiet life" agency problem associated with abundant financial capital, previous finance studies largely focus on evidence within the corporate sector. Out study takes a step further and documents that the positive role of firms' financial constraints in governing firms' risky investments is beneficial to the contribution of corporate innovations to local new business formation.

The rest of the paper is organized as follows. Section 2 reviews the literature that motivates our study. Section 3 describes data and sample formation, as well as the methodology for empirical tests. Section 4 presents the results and Section 5 concludes.

[2] We adopt the KPSS measure developed by Kogan et al. (2017) who use a firm's stock price reaction around its patents' announcement dates to proxy for the market value of its patents.

2. Literature review and hypotheses development

2.1 Regional resources and business formation

Observations from the dynamics of entrepreneurial activities reveal geographical clustering effect, in that new firms tend to be strongly tied to local contexts (Chatterji , Glaeser, and Kerr 2014; Fritsch 2013; Feldman 2001; Fritsch and Wyrwich 2018; Fritsch and Schindele 2011). Extensive studies have highlighted the role of local aspects including regional economic development and growth, social network and support services, availability of financial and research facilities, as well as local demographic characteristics in driving new business formation (Feldman 2001; Stam 2007).

Focusing on the importance of local knowledge bases, the knowledge spillover theory of entrepreneurship (Ace et al. 2009, 2013) proposes a stimulating effect of knowledge bases to the creation of new firms in the local area. The localization and spillover of knowledge from innovating activities will stimulate more innovation in the local community, leading to a higher demand for product, service, and labor, hence spur more real business activities in the local economy. Innovations by individual firms therefore create significant social welfare benefits through their positive impact on labor market by inducing more job generation. Qian et al. (2013) and Delgado et al. (2010) document the impact of knowledge and agglomeration, as alternative regional features in shaping the regional entrepreneurial activities, among studies relating innovation to entrepreneurship (Block, Fisch, and van Praag 2017;

Landström et al. 2012; Landström, Åström, and Harirchi 2015; Ribeiro-Soriano and Huarng 2013; Schmitz et al. 2017). In these studies, the evolvement of local knowledge bases is usually proxied by R&D investments (Audretsch and Keilbach 2007). Colombelli et al. (2020) use patent data as the proxy of local knowledge bases to investigate the relationship between local knowledge and new firm formation at the provincial level in Italy.

This view on innovation is different from the traditional view on innovation as a critical driving force of a profit maximizing economy. Past studies largely take an economic and financial performance perspective and document positive impact on firm return (Hall et al. 2010; Brown et al. 2009; Marsili and Salter 2005; Ebersberger et al. 2008), and on social wealth such as economic growth or labor market condition including employment and wage income (Kogan et al. 2017; Meyer-Krahmer 1998; Gali 1999; Ortiz and Fumás 2019; Mastrostefano and Pianta 2009).

2.2 Determinants of innovations

In seeking the determinants of innovations, the existing literature suggests that the innovation and associated financial benefits are related to firm size, employee skills, business cycle, as well as industry characteristics (Mao and Weather 2019; Ortiz and Fumás 2019; Gali 1999).

A number of studies pay attention to the interconnection of innovative activities, across industrial and geographical boundary. This line of research has identified that knowledge spillover occurs not only intra-industry, following the pioneers (Bernstein and Nadiri 1989; Klette and Kortum 2004; Bloom, et al. 2013), and that such spillover of knowledge tends to be localized and becomes the driving force of agglomeration of inventive activity. For example, Buzzard et al. (2017), among others, document a knowledge spillover effect identified via patent citations. They also find that such knowledge spillover effect is the strongest at small spatial scales and diminishes rapidly with distance. Howells (2002) further attributes the effect of geographical location to innovative activity and economic activity to tacit knowledge.

In the finance literature, a great number of studies empirically examine the impact of financial constraints on firms' investments in inventive activities, measured based on R&D investments, or outputs as patent grants (Hall 2002; Himmelberg and Petersen 1994; Gorodnichenko and Schnitzer 2010). Many of these studies use an investment-cash flow sensitivity approach to study the influence of financial constraints to firms' investments in R&D, and find mixed results.

Early studies believe that firms with financial slack and stable internal funds can afford to undertake risky R&D projects, benefit from technology spillovers within the firm, and thus stimulate inventions, especially when experiencing economic downturn (e.g., Henderson and Cockburn 1996; Cohen, Levin, and Mowery 1987; Aghion, Angeletos, Banerjee, and Manova 2010; Brown, Martinsson, and Petersen 2012; Acharya and Xu 2017). Whereas financially constrained firms may forego profitable growth opportunities when they become incapable of financing such opportunities, reduce or stop spending in inventive activities due to the great uncertainties in returns (Amore et al. 2013). Canepa and Stoneman (2008) report that firms from high tech industries and small firms in the U.K. are more likely to report a project being abandoned or delayed due to financial constraints. Hajivassiliou and Savignac (2007) make a similar observation based on French survey data. Ayyagari et al. (2011) find a positive relationship between the use of external finance and the extent of innovation.

However, recent studies document that abundant financial resources do not necessarily lead to more and better innovation. The Economist (1990) documents that "American industry went on an R&D spending spree, with few big successes to show for it". Other studies also show that firms' aggressive R&D expenditures are not associated with subsequent gains such as financial returns or technological patent grants (Jensen 1993; Jaffe 2000; Lanjouw and Schankerman 2004).

Studies based on agency theory (Jensen,1988; Blanchard, Lopez-de-Silanes, and Shleifer,1994) have attempted to explain and proposed a different role of financial constraints. They propose a "quiet life" agency story in which firm management prefer a quiet life. They are risk averse when facing no financial constraints and tend to shift their attention away from innovative activities that tend to be highly uncertain and intangible (Bertrand and Mullainathan 2003; Atanassov 2013; Sapra, Subramanian, and Subramanian 2014). This implies that the free cash flow agency problems are likely to occur when financial capital is abundant (Kumar and Langberg 2009; Hall and Lerner 2010).

Based on agency theory, facing limited availability of financial recourses, financially constrained firms tend to make optimal investment decisions resulting efficient innovative outcomes. Hence, financial constraints actually serve as an effective corporate governance mechanism in influencing corporate firms' investment behavior. Recent empirical studies have documented supportive evidence to this bright side of financial constraints in mitigating the "quiet life" agency problem and improving the efficiency of innovative activities (Almeida et al. 2013, 2019).

While not directly related to investment decisions, recent literature in the psychological and managerial behavior suggests that entities can become more creative in optimizing their resources when facing limitations and constraints, and that abundant resource abundance can actually be counterproductive and value destroying (Sonenshein, 2017).

The studies on innovation, however, largely based on the counts of grants and citations to describe firms' patenting activities, not from the value creation aspect of the patents. This is because measuring the direct economic value of patents as the output of innovation activities is challenging in empirical studies (Lerner and Seru 2015; Jaffe and de Rassenfosse 2016). Patent counts are subject to patent troll issue (Cohen, Gurun, and Kominers 2016). Patent citations are criticized for only reflecting the technological advancement rather than the market value of patentable inventions. In addition, citations tend to vary significantly cross technology class and lag behind the grant year, leading to a truncation bias (Seru 2014).

A recent study (Kogan et al. 2017) proposes a new approach (KPSS measure) to assess the market value of innovations using stock market price data. KPSS measures the value of a patent as the change in total market capitalization over a three-day window starting from the announcement day (Tuesday) when the patent is officially announced in the Official Gazette), to the Thursday in the same week[3]. In particular, the three-day return is decomposed into two parts: an idiosyncratic component that is unrelated to the newly granted patent, and a fraction that is related to the patent and viewed as the market value of patent. In their study, Kogan et al. (2017) show that this new measure has a strong relationship with substantial growth and creative destruction, supporting the Schumpeterian growth models (Schumpeter 1942). Compared to technological value-based measurement using patent counts, this market value-based measure shows a strong relationship with firm growth and the degree of creative destruction.

In this study, we adopt the KPSS measure and examine whether highly valued patent creates positive impact on local entrepreneurship. Given the advantage of the newly developed proxy of patents in capturing the private valuation of innovation at the firm-level, one would expect that the positive relationship between innovation and local entrepreneurship becomes more prevalent when the value creation feature of innovation is highly appraised in the market place.

[3] This return is estimated after adjusting for idiosyncratic stock return volatility and aggregate market risk.

We further investigate whether the relationship between patent value and local entrepreneurship is affected by innovating firms' financial constraints. The theoretical and empirical studies have documented competing findings regarding the impact of financial constraints on firms' investments in innovative activities, measured by R&D and/or patenting activities, therefore the evidence to the effect of financial constraints is an empirical one. Specifically, we propose and test the following hypotheses:

H1: There is a positive relationship between new business formation and local knowledge bases, which are proxied by the inventive activities in the corporate sector.

H2: The relationship between new business formation and local knowledge bases is affected by the financial constraints of firms engaging in inventive activities.

H2a: The relationship between new business formation and local knowledge bases is adversely affected by corporate firms' financial constraints, which force firms to reduce investments in risky innovative activities.

H2b: The relationship between new business formation and knowledge spillover is positively affected by corporate firms' financial constraints, when financially constrained firms optimize their investments and generate efficient innovative outcomes.

3. Sample construction and empirical methodology

3.1 Data

As shown in Scherer (1983) and Balasubramanian and Sivadasan (2011), the bulk of patenting activity occurs within the manufacturing sector. Thus, in this study we mainly consider the evidence from the manufacturing industries. As a robustness check, we also investigate the overall effect using the patenting activities in all industries. We exclude industries such as financial services or utilities, which operate under specific regulations. We start by building a panel dataset that merges firm-level patent value measurements with county-level new business formations for the period from 1986 to 2018. There are three main sources of data in this study: (1) publicly trading firms' accounting data from Compustat, (2) patent value data constructed by Kogan et al. (2017) based on the information on patents awarded by the U.S. Patent and Trademark Office (USPTO) as well as the citations made to these patents, and (3) historical new business formation data for the manufacturing sector from the County Business Pattern (CBP) database available from the Bureau of Economic Analysis (BEA). We use CBP business establishment data starting from 1986, the earliest year when BEA data are available[4].

This study adopts the patent dataset developed by Kogan et al. (2017)[5] that includes all patents granted to public firms by the U.S. Patent and Trademark Office (USPTO)[6]. For each publicly trading firm in the manufacturing industries, we follow Kogan et al. (2017) and sum up the real-value based market value of all patents granted in the same year to form firm-year estimations as the following:

---

[4] CBP data report industry-level business formation based on the standard industrial classification (SIC) from 1986 to 1997, and use NAICS for year starting from 1998. We carefully select the manufacturing sector from CBP data for these two time periods to form a consist time series of data for the manufacturing sector.

[5] Their data includes all patents granted to public firms by the U.S. Patent and Trademark Office (USPTO) ranging from1926 to 2019.

[6] The USPTO publishes the Official Gazette on every Tuesday. This publicly available information includes newly granted patents and related technical details.

$$SM_{k,t} = \sum \xi_{j,k,t}, \quad (1)$$

where $SM_{k,t}$ is market-based patent value of firm *k* in year *t*, and $\xi_{j,k,t}$ denotes the real-term market value of patent *j* issued to firm *k* in year *t*.

We also construct the citation weighted patent counts based on the following methodology:

$$CW_{k,t} = \sum (1 + \frac{C_j}{\overline{C_j}}), \quad (2)$$

where $CW_{k,t}$ is citation-weighted patent counts of firm k in year *t*, C_j is the number of forward citations received by the patent, and $\overline{C_j}$ is the average number of forward citations received by the patents that were granted in the same year as patent *j*. Kogan et al. (2017) use this scaling method to adjust for citation truncation lags (Hall, Jaffe, and Trajtenberg 2005). By construction, if a firm files no patents in a given year, both the market-based patent value $SM_{k,t}$ and citation-weighted patent counts $CW_{k,t}$ equal zero.

We retrieve the time series of headquarter information from companies' annual filings[7], and their accounting data from Compustat. The final sample is formed from merging the firm-level data with the county-level new business formation data. The resulting large panel data allows us to examine the heterogeneity in the real effect within a given county using the firm-level innovating activities.

[Insert Table 1 here]

[Insert Table 2 here]

[7] Compustat backfills the headquarter information of firms in the database. Although firms do not change their headquarter location frequently, we track their location information from annual reports to ensure the accuracy in defining the local community for firms with patent grants.

Table 1describes the dynamics of patenting activities among publicly trading companies over the sample period from 1986 to 2018. For each year from 1986 to 2018, Column (2) reports the number of manufacturing firms that receive patents grants. Column (3) reports the total patents grants of manufacturing firms. Columns (4) and (5) report patenting activities from both manufacturing and non-manufacturing firms. Columns (6) and (7) report the proportion of manufacturing firms in total patenting activities in terms of firm counts and patents counts respectively.

From Columns (2) and (3), one could see that inventive activities in general have been increasing over the years prior to the 2007 - 2009 financial crisis. The financial crisis created a sudden stop in external capital available to firms, creating an adverse impact on investments and innovations. In the post-crisis years, while the total counts of patent grants have increased over time as shown in Columns (2) and (3), Columns (4) and (5) show that the numbers of firms receiving patent grants never restore to the pre-crisis level, indicating that inventive activities have been concentrated among fewer firms.   Columns (6) and (7) report the proportion of patenting activities of manufacturing industries among all industries and show that the majority of the innovations are concentrating in the manufacturing industries, consistent with the observation from previous literature (Scherer 1983; Balasubramanian and Sivadasan 2011). However, the results also reveal a declining trend of concentration in the manufacturing industries, the proportion of patents granted in the manufacturing industries has dropped from 70+ percent in 1986 to 50+ percent in 2018.

Table 2 describes the dynamics of business establishments by aggregating county-level data in each year over the sample period. Column (2) reports the number of counties with firms receiving patent grants. It shows a peak around the year of 2000 and remains relatively stable recently at around 200 counties. Columns (3) to (5) report the dynamics of new business establishments in the manufacturing industries by employment size. Consistent with the findings in the literature on entrepreneurship, Table 2 shows that small businesses (with employment size less than 100) represent the majority of total new startups in the manufacturing sector. Moreover, Column (5) reveals that the proportion of small businesses slightly increases over time.

Figure 1 plots the numbers of new business establishments by employment size categories over the sample period. It shows a general declining trend in new business formation over time, consistent with the outsourcing trend among manufacturing firms driven by the globalization starting in the mid-1990s.

[Insert Figure 1 here]

[Insert Table 3 here]

Table 3 reports the distribution of patenting activities among public manufacturing firms across states. There are in total 47 states and D.C. with varying inventive activities over the sample period from 1986 to 2018. For each state, Column

(2) lists the number of publicly trading firms with patent grants in the manufacturing sector, and Column (3) lists the number of publicly trading firms with patent grants in all industries. Column (4) reports the counts of patent grants from manufacturing sector. Column (5) reports the proportion of manufacturing firms with patent grants in all industries. Colum (6) reports the proportion of patent grants from manufacturing sector in all industries based on forward citations of patent grants. While states like California have a large number of firms with a significant amount of patent grants in total, there are states such as Idaho having their patent grants concentrated in a handful number of firms.

Figure 2 geographically displays the total patent grants aggregated at the state level in a heat map view. It is revealed that regions in Northeast, South, and along the West coasts tend to have a larger scale of innovative activities, comparing to other regions.

[Insert Figure 2 here]

[Insert Figure 3 here]

Figure 3 depicts the dynamics in new business formation, aggregated as the state level across the nation. For each state, we first compute a time series of annual total new business formation from 1986 to 2018, we then take the median value of the time series and plot in a heat map view. It also shows a distinctive heterogeneity across nation in new business formation, consistent with the common findings in the entrepreneurship literature. Similar to the heatmap depicted in Figure 2, it is the

Northeast, South, and regions along the West coasts that report large total business formation, compared to other regions.

3.2 Empirical methods

The main objective of this study is to examine the relationship between publicly listed firms' innovative activities and entrepreneurial activities in the local area, and the effect of firms' financial constraints to the relation. We first estimate the following base line regression model:

$$Formation_{i,t} = \alpha + \beta_1 Innovation_{k,i,t} + V' + \delta^k + \tau_t \quad , \qquad (3)$$

where $Formation_{i,t}$ describes the new business formation in county *i* in year t. We use the logarithm of total number of new business formation and the growth rate in business formation respectively. $Innovation_{k,i,t}$ describes the innovative activities of firm *k* in county *i* in year *t* using three variables: the output of innovative activities, represented by market-based patent value $SM_{k,t}$, as well as citation-weighted patent counts $CW_{k,t}$; and the input of innovative activities measured as R&D spending to total assets ratio $RD_{k,t}$. Kogan et al. (2017) suggest that market value of patent facilitates the comparison across industries and across time, while direct comparisons based on the number of patent grants often need to take industry characteristics into consideration (Harhoff et al., 1999). In our tests, we use the logarithm value for these two measurements. Previous studies suggest that while R&D is a weak indicator of subsequent patent applications, it has a strong tie to contemporaneous patent applications (Hausman, Hall, and Griliches 1984; Hall, Griliches, and Hausman 1986; Lerner and Wulf 2007). In vector V', we include firm age, the logarithm of sales to capital firm size, and financial leverage to control for firms' fundamental characteristics. We also include the logarithm of annual GDP per capita and annual growth rate in GDP per capita in a given county to control for the local macroeconomic condition. All the variables are lagged by one year to control for the potential endogeneity issue.

Figures 2 and 3 reveal significant clustering in innovations and entrepreneurial activities across the nation. To control for the regional clustering effect, we follow the common approach in spatial analysis and include a CBSA dummy that takes the value of one if a county is in one of the top ten core-based statistical area (CBSA)[8] with most innovative activities, and zero otherwise. To control for the effect of alternative knowledge bases such as tacit knowledge not acquired by institutional training or driven by technological advances, we use the proportion of college graduates in total population to capture the heterogeneity in the knowledge and skillset of local employment market. δ^k and τ_t are dummy variables measuring firm and year fixed effects to control for omitted variables, respectively. Hall (2004) reports that U.S. patenting activity increased substantially starting in the mid-1980s, which is also reported in Table 1. The inclusion of year dummies allows us to control for aggregate trend. We also control for cluster standard errors at the county level.

[8] A core-based statistical area (CBSA) is a geographic area that consists of one or more counties that are closely tied to an urban center based on commuting distance. It is defined by the Office of Management and Budget based on Census 2000 data.

Previous studies mostly use state-level or country-level measures of innovations. This assumes that the effects of innovation will be uniform within a state however firms within the same state may have different lines of products and services to meet the needs from local business environment. Pooled estimations at the state level hence becomes inadequate in capturing the heterogeneity in the real economic effect of innovation in a smaller local setting. This analysis, conducted at the firm level and implemented using random effect GLS model, allows us to control for unobserved time-invariant firm effect hence the omitted factor bias.

One important question that we seek answer is whether firms' own internal financial condition would have an impact on the local business formation, as theories have suggested that financial constraints affect businesses' innovating activities. On the one hand, risk-averse firms facing financial constraints may choose to forgo investments in innovation due to the uncertainty embedded in inventive opportunities, thus reducing the simulative effect of innovation to the local economy and entrepreneurial activities. On the other hand, financial constraints may serve as an effective governance mechanism in preventing the quiet life agency problem and encourage business to make optimal investment decisions, which yield efficient innovative outcomes with significant technological value and economic value, and continuously serve as the driving force to local entrepreneurial activities.

We augment equation (3) with measures for financial constraints as the following:

$$Formation_{i,t} = \alpha + \beta_1 Innovation_{k,i,t} + \beta_2 FC_{k,i,t} + \beta_3 FC_{k,i,t} \cdot Innovation_{k,i,t} + V' + \delta^k + \tau_t, \quad (4)$$

where $FC_{k,i,t}$ describes the financial constraints of firm *k* in year *t*.

The studies in the literature generally define financial constraint as a substantial disparity between the cost of external financing and the opportunity cost of internal capital. However, the empirical issue is that financial constraints are not directly measurable. Although the literature has proposed several proxies of financial constraints, for example the measurements used in Fazzari et al. (1988), Whited (1998), Kaplan and Zingales (1997), Almeida et al. (2004), Almeida and Campello (2007), Hennessy and Whited (2007), Whited and Wu (2006), and Hadlock and Pierce (2010), there is no consensus on which proxy would be a suitable measurement. Many follow up studies show mixed results in using such measurements. One possible explanation is that some measurements in fact capture the financial distress but not the financial constraints[9]. In our study, we adopt two common measures of financial constraint and not distress, HP index[10] (Hadlock and Pierce 2010), and the WW index[11] (Whited and Wu 2006). The detailed calculations are reported in Appendix A. By construction, financially more constrained firms have higher HP index and higher WW index.

---

9 Opponents to KZ index believe that KZ index use more common characteristics that also capture firms' financial distress, while Kaplan and Zingales (2000) argue that financial distress can be considered a variation of financial constraint. The general findings in the literature show that the KZ index captures the distress aspect of financial constraint more than the HP index.

10 HP index is a combination of asset size and firm age and is calculated as (−0.737* Assets + 0.043*Assets^2 − 0.040*Age).

11 WW index is estimated as the linear combination of cash flow to total assets (−), sales growth (−), long-term debt to total assets (+), log of total assets (−), dividend policy indicator (−), and the firm's three-digit SIC industry sales growth (+).

According to Equation (4), the variable of key interest is the interaction between innovation and financial constraints. If financial constraints adversely limit firms' investments in innovation, we could expect that it will lead to a negative impact to the startup activities in the real economy, as reflected in a negative regression coefficient of the interaction term. However, as agency theory predicted, if financial constraints promote optimal investments in innovation and consequently efficient innovative outcome, we could expect that it will lead to a positive impact to the real economy, as reflected in a positive regression coefficient of the interaction term.

[Insert Table 4 about here]

Panel A of Table 4 reports the summary statistics of the firm level variables used in the regression analysis, Panel B reports the summary statistics of the county level variables and Panel C reports the correlation matrix. It is revealed that firms with patenting activities are generally large firm with median total sales at $400 million, the median leverage ratio is 0.15, and the median age of firms is 18 years. In terms of innovation measurements, a firm holds a 80(10) mean (median) counts of patents granted in a year, and a mean (median) value of $569 ($13) market value of all patents granted in a year respectively, indicating a large variation in the patenting activities.

4. Results

We first estimate the baseline regression to examine whether corporate innovations have contributed to new business formation in their local area. Table 5 reports the results of regressions using the full sample based on Equation (3). The dependent variable is the logarithm value of total business formation in manufacturing sector.

[Insert Table 5 about here]

As discussed in Section 3, the key variable of interest in this regression is the measurement of inventive activities of corporate firms in a given county. In Table 5, Columns (1) to (3) report the results of regressions using the three measures of innovative activities constructed from the manufacturing firms only. One could observe that the market value of patent grants (as the output of innovative activities) and R&D spending ratio (as the input to the innovative activities) show a significantly positive relationship with new business formation in the manufacturing sector. Columns (4) to (6) report the results of regressions using the three measures of innovative activities constructed from both manufacturing and non- manufacturing firms. The results reveal that the positive effects of innovation on new business formation are significant across all three measures of innovative activities and across industries, supporting hypothesis H1 formed upon the knowledge spill over theory to entrepreneurship. The effects of control variables on entrepreneurship activities are consistent with the findings in the existing literature. For example, the relationship between total business establishment and the growth rate in GDP per capita is significantly positive, consistent with the previous finding on regional economic growth potential as an important determinant to local entrepreneurship. The significant and negative coefficient of percentage of college graduate indicates the importance of tacit knowledge, while not acquired through institutional higher education, to the creation of new businesses. The top10 CBSA dummy is insignificant for regressions when innovations are measured only based on manufacturing industries (Columns (1) to (3)), but becomes significant in the regressions using innovations from all industries in Columns (4) to (6), indicating a cross-industry clustering effect.

[Insert Table 6 about here]

Table 6 reports the results of tests using two subsamples, following the common classification in the entrepreneurship literature based on the employment size of the new business formation. Panel A reports the results using the logarithm of new business formation as the dependent variable for small size business (employment size < 100), and Panel B reports the results using the large business formation subsample (employment size >= 100). In both Panel A and Panel B, Columns (1) to (3) report the results using innovation measures constructed from manufacturing firms only, and Columns (4) to (6) report the results using innovation measures constructed from both manufacturing firms and non-manufacturing firms. The results from both subsamples show in general a significant and positive relationship between innovation and new business formation, similar to those reported in Table 5 using the full sample. In addition, the effect is stronger for the subsample of large employment size. As a robustness check, we use employment size of 250 as the threshold for the classification for small vs large businesses, and the results remain unchanged[12].

[Insert Table 7 about here]

We next repeat regression model (3) by using alternative measurements of entrepreneurial activities. In Table 7, we use the growth rate in new business formation as the dependent variable in the regressions using the full sample. The results show that innovations have a positive impact on the growth rate in entrepreneurial activities in the local area, and the relationship is consistent across the three measurements of innovation. This further provides strong supportive evidence on the importance of innovation to local entrepreneurship development.

The results using subsamples are reported in Table 8. Unlike in the results from Table 6, where the contribution of innovation to the total number of new business formation is more pronounced in large new startup firms, in Table 8, the impact of innovation on the growth rate in new business formation is more pronounced in the small size subsample, as in Panel A. For the growth rate in large size startups, however, Panel B shows that the effect of market value of patent is negative and other effects of two other innovation variables are insignificant. This suggests that when innovations encourage more local entrepreneurship, the stimulating effect largely exists in the fast growth of small businesses but not large size startups.

[Insert Table 8 here]

[12] We don't report the results here for the sake of saving space, but the results are available upon requests.

Next, we repeat the regressions using the fraction of small business formation in total business formation as the dependent variable. The results in Table 9 show that innovation activities are significantly and positively related to the proportion of small business startup in the local area, revealing a driving effect to small size new businesses. This is consistent with the previous observations that small businesses represent an increasing and important role in the overall entrepreneurship in the manufacturing sector.

[Insert Table 9 here]

So far, our results have provided comprehensive evidence to support the innovation-driven entrepreneurship theory. We next examine the effect of firms' financial constraints on the relationship between innovation and entrepreneurship activities based on equation (4). The key variable of interest in this setting is the interaction between financial constraints and innovations. Table 10 reports the results using the full sample. Panel A reports the results using HP index as the measure of financial constraints, and Panel B reports the results using WW index as the alternative measure of financial constraints.

[Insert Table 10 here]

In Panel A of Table 10, the regression coefficients of the interaction term between innovations and financial constraints are statistically significant and positive for two patent-based measures of innovations. This is consistent with the agency theory proposing a governance role of financial constraints in promoting optimized innovative investments and efficient patent outcomes. The resulting efficient innovation outcomes, as represented by patents being highly valued by the market, or more citation weighted grants, may spur the demand for product and services in the local community, leading to an increase in new business formation at the aggregate level. The findings hence support hypothesis H2b that highlights the positive role of financial constraints in mitigating the agency problem related to financial recourses.

[Insert Table 11 here]

We next examine in detail the new business formation segmented by the employment size and report in Table 11. Panels A and B report the results from the subsample of small size startups. In Panels C and D, we report the results from the subsample of large size startups. From all Panels, we observe consistent results for the regression coefficients on the interaction terms between the measures of financial constraints and innovations. In particular, the regression coefficients are significant and positive for the interaction terms between patent-based measurements and financial constraint, but not for the R&D measurement.

Overall, the results suggest that the positive effects of financial constraints to the relationship between firms' innovations and the spur of local entrepreneurship become more pronounced when the patent outputs are efficiently generated. There is no such effect related to the innovative input R&D variable, consistent with the previous finding in the literature that R&D input activities don't necessarily lead to efficient and valuable patent outcome.

[Insert Table 12 here]

Table 12 reports the results using Equation (4) where the growth rate in new business formation is the dependent variable. The results in Panel A using HP index reveal the positive effect of financial constraints on the relationship between patent-based innovation measurement and growth in entrepreneurial activities, but a negative effect for the interaction term based on R&D variable. In Panel B, the effects on the interaction between WW index and patent-based innovation measurements become insignificant.

[Insert Table 13 here]

Table 13 reports the results using the proportion of small business in total new business establishment as the dependent variable. From the results in Panel A using the HP index and Panel B using the WW index, we see that in Columns (4) to (6), the positive effect of financial constraints is more pronounced when entrepreneurship is driven by all industry innovations.

So far, all empirical tests are based on a large sample that attempts to explain county-level business formation using firm-level innovative activities with a random effect estimator. While this approach allows us to observe the heterogeneity in the effect of innovation and financial constraints at the micro firm level to the entrepreneurial activities at the aggregate county-level, it has the potential weakness in not being able to utilize a fixed effect estimator, which are believed to be more appropriate in analyzing panel data. As a robustness check, we aggregate the firm-year innovation and other control variables into county-year measurements, and repeat the previous tests using the aggregated county level data. In particular, for firm-level accounting variables such as firm age, firm leverage, we take the median values for firms in a county as the county-level measure, for size variable, we take the sum of sales for firms in a year and take the logarithm.

[Insert Table 14 here]

Table 14 reports the results using the aggregate county level tests for the baseline regression as in equation (3). The Hausman tests reveal that a fixed effect estimator is more appropriate for this county-year panel data. In Panel A, the dependent variables are the logarithm of total new business formation. Columns (1) to (3) report the results using the full sample. Columns (4) to (6) report the results using the subsample of small size startups, and Columns (7) to (9) report the results using the subsample of large size startups. It is shown that when using county-level panel data, the significant effect of innovation on new business formation remain in most of the regressions. In Panel B, in Columns (1) to (6), the dependent variables are the growth rate in the new business creation. In Columns (7) to (9), the dependent variable is the proportion of small size new businesses in total new business establishments. We find weak evidence of innovation on the dynamics of entrepreneurship activities such as growth rate and composition in new business establishment. The results show a possible disadvantage of county level aggregated data in revealing the heterogeneity in the relationship between individual corporate innovations and entrepreneurial activities, when the latter are measured at the aggregate level.

5. Conclusions

This study provides complementary evidence to the ongoing study on the role of innovations in the real economy. Based on previous findings that the knowledge spillover effect of innovations tends to cluster in a small geographical scale, and that corporate innovations create social welfare benefits in inducing higher demand for business and labor, this study empirically examines the effect of individual firms' innovations to real economy in terms of new business formation. Using a large dataset that links publicly trading firms' innovative activities to aggregate new business formation in the local community, we find that in general, corporate innovations contribute to the increase of business establishment across different employment size. Furthermore, the results show that firms' internal financial condition, as measured by financial constraints, may enhance the positive role of innovations to new business formation by functioning as an effective governance mechanism in promoting efficient innovative outcomes such as patent grants. This finding has important policy implications to the role of financial capital resources in supporting innovations and economic development. While the external financing provided by the capital markets would allow firms become capable to seize investment opportunities, firms' internal financial resources also contribute to efficient innovative outcomes that further spur new entrepreneurial activities in the local community, creating social welfare benefits to the real economy.

REFERENCES

Acharya, V., and Xu, Z. (2017). Financial dependence and innovation: The case of public versus private firms. *Journal of Financial Economics*, 124(2), 223-243.

Acs, Z. J., Braunerhjelm, P., Audretsch, D. B., and Carlsson, B. (2009). The knowledge spillover theory of entrepreneurship. *Small Business Economics*, 32(1), 15–30.

Acs, Z. J., Audretsch, D. B., and Lehmann, E. E. (2013). The knowledge spillover theory of entrepreneurship. *Small Business Economics*, 41(4), 757–774.

Acs, Z. J., Åstebro, T., Audretsch, D. B., and Robinson, D. T. (2016). Public policy to promote entrepreneurship: A call to arms. *Small Business Economics*, 47(1), 35–51.

Acs, Z. J., Audretsch, D. B., Lehmann, E. E., and Licht, G. (2016). National systems of entrepreneurship. *Small Business Economics*, 46(4), 527–535.

Acs, Z. J., Braunerhjelm, P., Audretsch, D. B., and Carlsson, B. (2009). The knowledge spillover theory of entrepreneurship. *Small Business Economics*, 32(1), 15–30.

Agarwal, R., Audretsch, D., and Sarkar, M. B. (2007). The process of creative construction: Knowledge spillovers, entrepreneurship, and economic growth. *Strategic Entrepreneurship Journal*, 1(3), 263–286.

Aghion, P., G.-M. Angeletos, A., Banerjee, and Manova, K. (2010). Volatility and growth: Credit constraints and the composition of investment. *Journal of Monetary Economics*, 57, 246–265.

Aldieri. L., Makkonen, T., and Vinci, C. P. (2019). Spoils of innovation? Employment effects of R&D and knowledge spillovers in Finland, *Economics of Innovation and New Technology*, DOI: 10.1080/10438599.2019.1703754

Allayannis, G., and Mozumdar, A. (2004). The impact of negative cash flow and influential observations on investment-cash flow sensitivity estimates. *Journal of Banking and Finance*, 28 (5), 901-930.

Almeida, H., and Campello, M. (2007). Financial constraints, asset tangibility, and corporate investment. *Review of Financial Studies*, 20 (5), 1429-1460.

Almeida, H., Hsu, P., and Li, D. (2013). Less is more: Financial constraints and innovative efficiency. https://ssrn.com/abstract=1831786 or http://dx.doi.org/10.2139/ssrn.1831786.

Almeida, H., Hsu, P., Li, D., and Tseng, K. (2019). More cash, less innovation: The effect of the American Jobs Creation Act on patent value. *Journal of Financial and Quantitative Analysis*, 1-28. doi:10.1017/S0022109019000954

Amore, M.D., Schneider, C., and Zaldokas, A. (2013). Credit supply and corporate innovation. *Journal of Financial Economics*, 109 (3), 835-855.

Acharya, V., and Xu, Z. (2017). Financial dependence and innovation: The case of public versus private firms. *Journal of Financial Economics,* 124, 223–243.

Atanassov, J. (2013). Do hostile takeovers stifle innovation? Evidence from antitakeover legislation and corporate patenting. *Journal of Finance*, 68, 1097 - 1131.

Audretsch, D. B., and Keilbach, M. (2007). The theory of knowledge spillover entrepreneurship. *Journal of Management Studies*, 44(7), 1242–1254.

Ayyagari, M., Demirgűc-Kunt, A., and Maksimovic, V. (2011). Firm innovation in emerging markets: The roles of governance and finance. *Journal of Financial and Quantitative Analysis*, 46, 1545-1580.

Balasubramanian, N., and Sivadasan, J. (2011). What happens when firms patent? New evidence from U.S., Economic census data. *The Review of Economics and Statistics,* 93(1), 126-146.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, 17(1), 99–120.

Bernstein, J. I., and Nadiri, M. I. (1989). Research and development and Intraindustry spillovers: An empirical application of dynamic duality. *Review of Economic Studies*, 56, 249–267.

Bertrand, M., and Mullainathan, S. (2003). Enjoying the quiet life? Corporate governance and managerial preferences. *Journal of Political Economy,* 111, 1043–1075.

Bhide, A.V. (2003). The origin and evolution of new businesses: Oxford University Press.

Bhupatiraju, S., Nomaler, Ö., Triulzi, G., and Verspagen, B. (2012). Knowledge flows – Analyzing the core literature of innovation, entrepreneurship and science and technology studies. *Research Policy*, 41(7), 1205–1218.

Blanchard, O. J., Lopez-de-Silanes, F., and Shleifer, A. (1994). What do firms do with cash windfalls? *Journal of Financial Economics*, 36, 337–360.

Block, J. H., Fisch, C. O., and van Praag, M. (2017). The schumpeterian entrepreneur: A review of the empirical evidence on the antecedents, behaviour and consequences of innovative entrepreneurship. *Industry and Innovation*, 24(1), 61–95.

Bloom, N., Schankerman, M., and VanReenen, J. (2013). Identifying technology spillovers and product market rivalry. *Econometrica*, 81, 1347– 1393.

Braunerhjelm, P., Acs, Z. J., Audretsch, D. B., and Carlsson, B. (2010). The missing link: Knowledge diffusion and entrepreneurship in endogenous growth. *Small Business Economics*, 34(2), 105–125.

Brown, J. R., Fazzari, S. M., and Petersen, B. C. (2009). Financing innovation and growth: Cash flow, external equity, and the 1990s R&D boom. *Journal of Finance*, 64(1), 151–185.

Brown, J. R., Martinsson, G., and Petersen, B. C. (2012). Do financing constraints matter for R&D? *European Economic Review*, 56, 1512–1529.

Buzard, K., Carlino, G. A., Hunt, R. M., Carr, J. and Smith, T.E. (2017). Localized knowledge spillovers: Evidence from the spatial clustering of R&D labs and patent citations. FRB of Philadelphia Working Paper No. 17-32. Available at SSRN: https://ssrn.com/abstract=3047775

Canepa, A. and Stoneman, P. (2008). Financial constraints to innovation in the UK: Evidence from CIS2 and CIS3. *Oxford Economic Papers*, 60, 711–730.

Chatterji A., Glaeser, E., and Kerr, W. (2014). Clusters of entrepreneurship and innovation. *Innovation Policy and the Economy*, 14:129-166.

Cohen H. L., Gurun, U., and Kominers, S. (2016). The growing problem of patent trolling. *Science*, 6285, 521–522.

Cohen, W. M., Levin, R. C., and Mowery, D. C. (1987). Firm size and R&D intensity: A reexamination. *Journal of Industrial Economics*, 35, 543–565.

Colombelli, A., Orsatti, G., and Quatraro, F. (2019). Local knowledge composition and the emergence of entrepreneurial activities across industries: evidence from Italian NUTS-3 regions, *Small Business Economics.*

Delgado, M., Porter, M. E., and Stern, S. (2010). Clusters and entrepreneurship. *Journal of Economic Geography*, 10(4), 495–518.

Delmar, F., and Wennberg, K. (2010). Knowledge intensive entrepreneurship: the birth, growth and demise of entrepreneurial firms. Northampton: Edward Elgar.

Economist, 1990, Out of the ivory tower, February 3rd.

Ebersberger, B., Marsili, O., Reichstein, T., and Salter, A. (2008). Fortune favours the brave: The distribution of innovative returns in Finland, the Netherlands and the UK. *Structural Change and Economic Dynamics*, 19, 357–62.

Fagerberg, J., Landström, H., and Martin, B. R. (2012). Exploring the emerging knowledge base of 'the knowledge society'. *Research Policy*, 41(7), 1121–1131.

Fazzari, S., Hubbard. G., and Petersen, B. (1988). Financing constraints and corporate investment. Brookings Papers on Economic Activity, Economic Studies Program, The Brookings Institution, 19 (1), 141-195.

Feldman, M. P. (2001). The entrepreneurial event revisited: Firm formation in a regional context. *Industrial and Corporate Change*, 10(4), 861–891.

Fritsch, M., (2013). Entrepreneurship, innovation and regional development: An introduction. Papers in Regional Science, Wiley Blackwell, 92(3), 683–684.

Fritsch, M., and Schindele, Y. (2011). The contribution of new businesses to regional employment — an empirical analysis. *Economic Geography*, 87(2), 153–180.

Fritsch, M., and Wyrwich, M. (2018). Regional knowledge, entrepreneurial culture, and innovative start-ups over time and space—an empirical investigation. *Small Business Economics*, 51, 337–353.

Gali, J. (1999). Technology, employment, and the business cycle: Do technology shocks explain aggregate fluctuations? *American Economic Review*, 89, 249–271.

Gorodnichenko, Y., and Schnitzer, M. (2010). Financial constraints and innovation: Why poor countries don't catch up. NBER Working Paper 15792.

Hadlock, C.J., and Pierce, J.R. (2010). New evidence on measuring financial constraints: Moving beyond the KZ Index. *Review of Financial Studies*, 23 (5), 1909-1940.

Hajivassiliou, V. and Savignac, F. (2007). Financing constraints and a firm's decision and ability to innovate: Establishing direct and reverse effects. FMG Discussion Paper 594.

Hall, B. H. (2002). The financing of research and development. *Oxford Review of Economic Policy*, 18 (1), 35–51.

Hall, B. H. and Kramakz, F. (1998). Effects Of technology and innovation on firm performance, employment, and wages. *Economics of Innovation and New Technology*, 5, 99-108.

Hall, B. H., Griliches, Z., and Hausman, J. (1986). Patents and R and D: Is there a lag? *International Economic Review*, 27, 265–283.

Hall, B. H., Jaffe, A. B., and Trajtenberg, M. (2005). Market value and patent citations. *RAND Journal of Economics*, 36, 16–38.

Hall, B. H., and Lerner, J. (2010). The financing of R&D and innovation, in B. H. Hall, and N. Rosenberg, eds.: Handbook of the Economics of Innovation. Elsevier, Amsterdam, Netherlands, 610–638.

Hall, B. H., Mairesse, J., and Mohnen, P. (2010). measuring the returns to R&D. In Hall, B. H. and N. Rosenberg, *Handbook of the Economics of Innovation*, 1034-1076. Amsterdam and New York: Elsevier.

Harhoff, D., Narin, F., Scherer, F. M., and Vopel, K. (1999). Citation frequency and the value of patented inventions. *Review of Economics and Statistics*, 81, 511–515.

Hausman, J., Hall, B. H., and Z. Griliches, Z. (1984). Econometric models for count data with an application to the patents-R&D relationship. *Econometrica*, 52, 909–938.

Henderson, R., and Cockburn, I. (1996). Scale, scope, and spillovers: The determinants of research productivity in drug discovery. *RAND Journal of Economics*, 27, 32–59.

Himmelberg, C. P., and Petersen, B. C. (1994). R&D and internal finance: A panel study of small firms in high-tech industries. *Review of Economics and Statistics,* 76(1), 38–51.

Howells J.R.L. (2002). Tacit knowledge, innovation and economic geography. *Urban Studies*, 39:871-884.

Jaffe, A. B. (2000). The U.S. patent system in transition: Policy innovation and the innovation process. *Research Policy*, 29, 531–557.

Jaffe, A. B., and de Rassenfosse, G. (2016). Patent citation data in social science research: Overview and best practices (No. w21868). National Bureau of Economic Research.

Jensen, M. C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. *American Economic Review*, 78, 323–329.

Jensen, M. C. (1988). Takeovers: Their causes and consequences. *Journal of Economic Perspectives*, 2, 21–48.

Jensen, M. C. (1993). The modern industrial revolution, exit, and the failure of internal control systems. *Journal of Finance*, 48, 831–880.

Kumar, P., and Langberg, N. (2009). Corporate fraud and investment distortions in efficient capital markets. *RAND Journal of Economics*, 40, 144–172.

Kaplan, S.N., and Zingales, L. (1997). Do investment-cash flow sensitivities provide useful measures of financial constraints? *Quarterly Journal of Economics*, 112(1), 169-215.

Kaplan, S.N., and Zingales, L. (2000). Investment-cash flow sensitivities are not valid measures of financing constraints. *Quarterly Journal of Economics*, 115(2), 707-712.

King, R. G., and Ross, L. (1993a). Finance, entrepreneurship, and growth: theory and evidence. *Journal of Monetary Economics*, 32, 513–542.

King, R.G., and Ross, L. (1993b). Finance and growth: Schumpeter might be right. *The Quarterly Journal of Economics*, 108, 717–737.

Klette, T. J. and Kortum, S. (2004). Innovating firms and aggregate innovation. *Journal of Political Economy*, 112, 986–1018.

Kogan, L., Papanikolaou, D., Seru, A., and Stoffman, N. (2017). Technological innovation, resource allocation and growth. *Quarterly Journal of Economics*, 665-712.

Lamont, O., Polk, C., and Saa-Requejo, J. (2001), Financial constraints and stock returns. *Review of Financial Studies,* 14, 529-554.

Landström, H., Åström, F., and Harirchi, G. (2015). Innovation and entrepreneurship studies: One or two fields of research? *International Entrepreneurship and Management Journal*, 11(3), 493–509.

Landström, H., Harirchi, G., and Åström, F. (2012). Entrepreneurship: Exploring the knowledge base. *Research Policy*, 41(7), 1154–1181.

Lanjouw, J., and Schankerman, M. (2004). Patent quality and research productivity: Measuring innovation with multiple indicators. *Economic Journal,* 114, 441–465.

Lerner, J. and Seru, A. (2015). The use and misuse of patent data: Issues for corporate finance and beyond, Booth/Harvard Business School Working Paper.

Lerner, J. and Wulf, J. (2007). Innovation and incentives: Evidence from corporate R&D. *Review of Economics and Statistics,* 89, 634–644.

Mao, C. X. and Weathers, J. (2019). Employee treatment and firm innovation. *Journal of Business Finance and Accounting*, 46, 977-1002.

Marsili, O., and Salter, A. (2005). Inequality' of innovation: Skewed distributions and the returns to innovation in Dutch manufacturing. *Economics of Innovation and New Technology* ,14, 83–102.

Mastrostefano, V. and Pianta, M. (2009). Technology and jobs. *Economics of Innovation and New Technology*, 18(8), 729-741.

Meyer-Krahmer, F. (1998). The effects of new technologies on employment. *Economics of Innovation and New Technology*, 2, 131-149.

Ortiz, J. and Fumás, V. S. (2019). Technological innovation and the demand for labor by firms in expansion and recession. *Economics of Innovation and New Technology*, DOI: 10.1080/10438599.2019.1629535

Qian, H., Acs, Z. J., and Stough, R. R. (2013). Regional systems of entrepreneurship: The nexus of human capital, knowledge and new firm formation. *Journal of Economic Geography*, 13(4), 559–587.

Reynolds, P.D. (1997). Who Starts New Firms? - Preliminary Explorations of Firms-in-Gestation. *Small Business Economics*, 9, 449–462.

Ribeiro-Soriano, D. and Huarng, K. (2013). Innovation and entrepreneurship in knowledge industries. *Journal of Business Research*, 66 (10), 1964–1969.

Sapra, H., Subramanian, A., and Subramanian, K. V. (2014). Corporate governance and innovation: Theory and evidence. *Journal of Financial and Quantitative Analysis*, 49 (4), 957–1003.

Scherer, F.M. (1983). The propensity to patent. *International Journal of Industrial Organization*, 1, 107-128.

Schmitz, A., Urbano, D., Dandolini, G. A., de Souza, J. A., and Guerrero, M. (2017). Innovation and entrepreneurship in the academic setting: A systematic literature review. *International Entrepreneurship and Management Journal*, 13(2), 369–395.

Schumpeter, J. A. (1942). Capitalism, Socialism, and Democracy. New York, N.Y.: Harper.

Sonenshein, S. (2017). Stretch: Unlock the power of less – and achieve more than you ever imagined, New York: Harper Business.

Stam, E. (2007). Why butterflies don't leave: Locational behavior of new firms. *Economic Geography*, 83(1), 27–50.

Stuetzer, M., Obschonka, M., and Brixy, U. (2014). Regional characteristics, opportunity perception and entrepreneurial activities. *Small Business Economics*, 42, 221-244.

Table 1: Summary statistics: U.S. Patent Grants

This table provides summary statistics of patents granted to publicly trading firms in the U.S. For each year from 1986 to 2018, Column (2) reports the number of manufacturing firms that receive patents grants. Column (3) reports the total patents grants of manufacturing firms. Columns (4) and (5) report patenting activities from both manufacturing and non- manufacturing firms. Columns (6) and (7) report the proportion of manufacturing firms in total patenting activities in terms of firm counts and patents counts respectively.

Year (1)	# Manu. Ind. Firm (2)	# Manu. Ind. Patent (3)	# All Ind. Firm (4)	# All. Ind. Patent (5)	% Manu. Ind. Firm (6)	% Manu. Ind. Patent (7)
1986	422	10,957	523	15,113	81%	73%
1987	440	10,690	557	14,604	79%	73%
1988	492	12,403	632	16,870	78%	74%
1989	507	11,638	640	15,689	79%	74%
1990	545	14,314	702	18,647	78%	77%
1991	547	13,694	700	17,696	78%	77%
1992	574	15,386	746	19,615	77%	78%
1993	612	15,903	800	20,446	77%	78%
1994	675	16,748	861	21,347	78%	78%
1995	731	17,265	958	22,275	76%	78%
1996	747	17,121	998	21,979	75%	78%
1997	793	19,156	1,079	25,079	73%	76%
1998	847	19,677	1,138	25,351	74%	78%
1999	882	25,533	1,239	33,613	71%	76%
2000	818	26,057	1,236	35,205	66%	74%
2001	785	25,874	1,256	35,533	63%	73%
2002	858	28,132	1,258	37,710	68%	75%
2003	836	29,712	1,205	40,064	69%	74%
2004	870	32,002	1,228	41,806	71%	77%
2005	836	31,528	1,206	42,378	69%	74%
2006	790	29,759	1,171	39,981	67%	74%
2007	801	32,809	1,200	47,069	67%	70%
2008	768	28,775	1,119	40,503	69%	71%
2009	728	27,368	1,088	42,280	67%	65%
2010	712	29,001	1,077	46,075	66%	63%
2011	717	35,724	1,093	58,347	66%	61%
2012	707	35,593	1,080	57,942	65%	61%
2013	711	37,523	1,096	61,671	65%	61%
2014	715	42,927	1,110	70,527	64%	61%
2015	730	47,682	1,151	79,635	63%	60%
2016	687	43,143	1,107	77,964	62%	55%

2017	619	42,786	1,003	77,194	62%	55%
2018	506	40,907	909	77,225	56%	53%

Table 2: Summary statistics: U.S. New Business Formation

This table summarizes the data on new business formation in the manufacturing sector during the sample period from 1986 to 2018. For each year, Column (2) reports the number of counties where patenting firms locate. Columns (3) to (4) report the total number of new business formation for small size businesses (employment size <=100) and large size businesses (employment size >100). Colum (5) reports the proportion of small business in total new business formation.

Year	# of County	# of Small Size Business	# of Large Size Business	% of Small Size Business
(1)	(2)	(3)	(4)	(5)
1986	164	156,021	16,348	90.52
1987	172	164,754	16,552	90.87
1988	186	165,524	17,418	90.48
1989	181	163,589	17,567	90.30
1990	191	171,986	17,392	90.82
1991	193	171,072	16,746	91.08
1992	197	174,626	16,582	91.33
1993	197	172,809	16,645	91.21
1994	211	180,191	17,452	91.17
1995	206	178,542	17,559	91.05
1996	214	176,357	17,572	90.94
1997	219	182,818	18,289	90.91
1998	223	172,255	16,000	91.50
1999	227	171,558	15,967	91.49
2000	224	167,075	15,661	91.43
2001	220	162,258	15,120	91.48
2002	217	158,900	13,331	92.26
2003	217	158,249	13,144	92.33
2004	227	158,184	12,900	92.46
2005	216	153,041	12,729	92.32
2006	204	145,472	12,363	92.17
2007	214	148,136	12,227	92.38
2008	203	141,852	11,648	92.41
2009	208	138,533	10,344	93.05
2010	208	135,087	9,662	93.32
2011	205	130,758	9,756	93.06
2012	212	133,578	10,152	92.94
2013	202	127,497	9,961	92.75
2014	210	127,132	10,049	92.67
2015	211	125,496	10,221	92.47
2016	206	124,756	10,005	92.58
2017	199	123,860	9,953	92.56
2018	184	114,747	9,716	92.19

Table 3: Summary statistics: Patent Grants by States

This panel provides summary statistics of patent grants aggregated at the state level for the sample period from 1986 to 2018. There are 48 states (include D.C.) having firms with patent grants. For each state, Column (2) lists the number of publicly trading manufacturing firms with patent grants, and Column (3) lists the number of public firms with patent grants in all industries. Column (4) lists the number of patent grants in the manufacturing sector. Column (5) reports the proportion of manufacturing firms with patenting activities in all industries. Colum (6) reports the proportion of patent grants from manufacturing sector in all industries based on the number of patent grants.

State Name (1)	# of Manu. Firms (2)	# of All Firms (3)	# of patent grants of Manu. Firms (4)	% of Manu Firms (5)	% of Manu Firms based on patent grants (6)
Alabama	72	151	545	48	61
Arizona	211	309	3,055	68	66
Arkansas	10	61	16	16	3
California	5,887	9,171	263,170	64	69
Colorado	282	522	2,600	54	59
Connecticut	725	1,037	36,293	70	42
Delaware	78	95	14,758	82	98
D.C.	71	136	715	52	71
Florida	369	592	6,043	62	72
Georgia	333	562	3,410	59	57
Hawaii	2	11	3	18	23
Idaho	39	78	26,359	50	92
Illinois	1,322	1,834	73,453	72	88
Indiana	418	522	8,357	80	90
Iowa	114	150	2,423	76	78
Kansas	78	128	587	61	12
Kentucky	93	131	2,940	71	95
Louisiana	31	80	88	39	10
Maine	40	51	1,107	78	94
Maryland	343	517	10,826	66	82
Massachusetts	1,789	2,601	47,627	69	82
Michigan	784	966	62,193	81	81
Minnesota	1,108	1,466	35,718	76	85
Mississippi	1	17	2	6	2
Missouri	340	488	6,773	70	52
Montana	22	35	354	63	92
Nebraska	112	182	5,571	62	46
Nevada	41	116	168	35	6
New Hampshire	176	212	1,865	83	92
New Jersey	876	1,299	31,810	67	50

New Mexico	13	25	101	52	86
New York	1,450	2,547	47,678	57	23
North Carolina	304	443	4,056	69	42
North Dakota		2		0	0
Ohio	968	1,274	33,473	76	84
Oklahoma	45	144	821	31	22
Oregon	348	429	8,347	81	80
Pennsylvania	1,057	1,433	48,581	74	70
Rhode Island	109	135	2,562	81	86
South Carolina	117	132	935	89	86
South Dakota	39	48	169	81	85
Tennessee	158	234	2,750	68	87
Texas	1,021	1,997	45,563	51	48
Utah	256	337	3,350	76	83
Vermont	2	12	9	17	24
Virginia	280	545	5,301	51	58
Washington	484	824	7,063	59	12
Wisconsin	590	735	8,199	80	88

Table 4: Summary statistics

This table provides statistics for the variables used in the regression analysis for the sample period between 1986 to 2018. Panel A reports firm-level variables including market-based patent value SM, and citation weight patent grants CW. RD/TA is estimated Panel B reports county-level variables and Panel C reports the correlation matrix.

Panel A: U.S. manufacturing firms

Variable	Mean	Median	StdDev	P5	P95
SM	568.77	13.30	3,108.27	0.36	2360.38
CW	80.14	10.87	366.90	1.20	312.64
RD/TA	0.09	0.05	0.11	0.00	0.35
Sale ($million)	3,978.46	399.62	16,498.36	7.07	16,889.60
Age	22.56	18.00	16.35	4.00	55.00
Leverage	0.17	0.15	0.16	0.00	0.47

Panel B: County level variables

Variable	Mean	Median	StdDev	P5	P95
Total establishment	821.64	490.00	1,444.61	44.00	2576.00
Growth in establishment	-0.01	-0.01	0.05	-0.07	0.07
Ln(GDP/Cap)	10.59	10.69	0.35	10.04	11.05
Growth in GDP/Cap	1.66	1.70	2.30	-2.40	5.20
% of College Grad.	26.65	25.10	10.83	11.90	47.70
Top10 CBSA	0.23	0.00	0.42	0.00	1.00

Panel C: Correlation matrix

	Total establishment	Growth establishment	Ln(SW)ln	Ln(CW)	RD/TA	Ln(Sale)	Ln(Age)	Leverage	Ln(GDP/Cap)	GDP/Cap growth	% of College Grad.	top10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(12)	(11)
(1)	1											
(2)	-0.09	1										
(3)	0.04	0.08	1									
(4)	0.06	0.03	0.84	1								
(5)	0.10	0.03	-0.13	-0.02	1							
(6)	-0.05	-0.04	0.73	0.51	-0.55	1						
(7)	-0.08	-0.04	0.39	0.27	-0.37	0.58	1					
(8)	-0.05	0.00	0.17	0.08	-0.28	0.34	0.22	1				
(9)	0.01	-0.22	0.17	0.10	0.19	0.03	0.08	-0.07	1			
(10)	0.07	0.05	-0.01	-0.02	0.02	-0.06	-0.08	-0.02	-0.10	1		
(11)	0.16	-0.12	0.14	0.12	0.29	-0.05	-0.05	-0.13	0.61	-0.08	1	
(12)	0.16	-0.08	0.13	0.13	0.09	0.04	-0.01	-0.10	0.15	0.04	0.27	1

Table 5 Innovation and New Business Formation

This table presents the results of regression equation (3). The dependent variable is Logarithm of total number of new business formation. All regressions are executed based on random effect GLS model. Robust z-statistics in parentheses. *,**,*** mean significant at 10%, 5% an 1% respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	0.006**			0.007***		
	(2.247)			(3.497)		
Ln(CW)		0.004			0.007***	
		(1.152)			(2.628)	
RD/TA			0.110**			0.116***
			(2.351)			(3.491)
Ln(Sale)	0.006	0.009*	0.012**	-0.001	0.003	0.007
	(1.227)	(1.876)	(2.353)	(-0.130)	(0.739)	(1.552)
Ln(Age)	0.010	0.009	0.009	0.017	0.016	0.017
	(0.713)	(0.665)	(0.670)	(1.368)	(1.297)	(1.346)
Leverage	-0.014	-0.018	-0.016	-0.001	-0.006	-0.004
	(-0.587)	(-0.768)	(-0.687)	(-0.051)	(-0.271)	(-0.174)
Ln(GDP/Cap)	-0.207***	-0.201***	-0.202***	-0.190***	-0.183***	-0.184***
	(-5.786)	(-5.754)	(-5.783)	(-6.303)	(-6.149)	(-6.157)
GDP/Cap growth	0.004***	0.004***	0.004***	0.004***	0.004***	0.004***
	(4.451)	(4.526)	(4.506)	(6.574)	(6.748)	(6.802)
% of College Grad.	-0.007**	-0.007**	-0.007**	-0.010***	-0.010***	-0.010***
	(-2.128)	(-2.139)	(-2.164)	(-3.577)	(-3.597)	(-3.618)
Top10 CBSA	0.048	0.049	0.049	0.048*	0.049*	0.049*
	(1.337)	(1.363)	(1.368)	(1.802)	(1.829)	(1.848)
Constant	9.859***	9.787***	9.779***	9.792***	9.714***	9.702***
	(30.385)	(31.268)	(31.249)	(36.664)	(36.856)	(36.818)
Observations	22,919	22,919	22,919	29,633	29,633	29,633
Year RE	YES	YES	YES	YES	YES	YES

Table 6 Innovation and New Business Formation: by Employment size

This table presents the results of regression equation (3). The dependent variable is Logarithm of total number of new business formation based on different employment size. Panel A reports the results for new businesses with employment size less than 100, and Panel B reports the results for new businesses with employment size greater than or equal to 100. All regressions are executed based on random effect GLS model. Robust z-statistics in parentheses. *,**,*** mean significant at 10%, 5% an 1% respectively.

Panel A Small business new formation

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	0.006**			0.007***		
	(2.153)			(3.320)		
Ln(CW)		0.004			0.006**	
		(1.126)			(2.527)	
RD/TA			0.113**			0.115***
			(2.409)			(3.457)
Ln(Sale)	0.006	0.009*	0.012**	-0.000	0.003	0.007
	(1.275)	(1.892)	(2.373)	(-0.043)	(0.768)	(1.561)
Ln(Age)	0.011	0.010	0.010	0.017	0.017	0.017
	(0.774)	(0.727)	(0.731)	(1.411)	(1.345)	(1.390)
Leverage	-0.014	-0.018	-0.016	-0.002	-0.007	-0.005
	(-0.600)	(-0.774)	(-0.692)	(-0.110)	(-0.316)	(-0.221)
Ln(GDP/Cap)	-0.190***	-0.185***	-0.186***	-0.173***	-0.167***	-0.167***
	(-5.264)	(-5.226)	(-5.256)	(-5.689)	(-5.540)	(-5.550)
GDP/Cap growth	0.002***	0.003***	0.003***	0.003***	0.003***	0.003***
	(2.969)	(3.064)	(3.059)	(4.462)	(4.632)	(4.689)
% of College Grad.	-0.006*	-0.006*	-0.006*	-0.009***	-0.009***	-0.009***
	(-1.805)	(-1.815)	(-1.841)	(-3.219)	(-3.237)	(-3.258)
Top10 CBSA	0.046	0.046	0.046	0.044	0.045*	0.046*
	(1.237)	(1.261)	(1.267)	(1.643)	(1.668)	(1.685)
Constant	9.562***	9.492***	9.483***	9.500***	9.426***	9.415***
	(29.166)	(30.028)	(30.010)	(35.275)	(35.455)	(35.421)
Observations	22,919	22,919	22,919	29,633	29,633	29,633
Year RE	YES	YES	YES	YES	YES	YES

Panel B Large business new formation

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	0.012***			0.014***		
	(3.443)			(4.444)		
Ln(CW)		0.013***			0.015***	
		(2.919)			(4.043)	
RD/TA			0.164***			0.257***
			(2.950)			(5.419)
Ln(Sale)	0.005	0.010*	0.016***	-0.009*	-0.003	0.006
	(0.876)	(1.874)	(2.934)	(-1.914)	(-0.553)	(1.264)
Ln(Age)	0.016	0.014	0.015	0.030**	0.028**	0.030**
	(1.146)	(1.015)	(1.097)	(2.432)	(2.287)	(2.413)
Leverage	-0.075**	-0.083***	-0.080***	-0.035	-0.044	-0.039
	(-2.432)	(-2.686)	(-2.576)	(-1.275)	(-1.598)	(-1.419)
Ln(GDP/Cap)	-0.388***	-0.378***	-0.379***	-0.360***	-0.349***	-0.351***
	(-9.697)	(-9.619)	(-9.669)	(-10.405)	(-10.185)	(-10.250)
GDP/Cap growth	0.014***	0.014***	0.015***	0.015***	0.015***	0.016***
	(14.054)	(14.119)	(14.112)	(17.418)	(17.710)	(17.799)
% of College Grad.	-0.019***	-0.019***	-0.019***	-0.022***	-0.023***	-0.023***
	(-6.244)	(-6.278)	(-6.305)	(-8.565)	(-8.626)	(-8.666)
Top10 CBSA	0.106***	0.108***	0.108***	0.094***	0.095***	0.097***
	(3.214)	(3.262)	(3.283)	(3.748)	(3.803)	(3.849)
Constant	9.577***	9.444***	9.439***	9.379***	9.229***	9.213***
	(26.030)	(26.356)	(26.340)	(29.441)	(29.409)	(29.340)
Observations	22,811	22,811	22,811	29,483	29,483	29,483
Year RE	YES	YES	YES	YES	YES	YES

Table 7: Innovation and Growth in New Business Formation

This table presents the results of regression equation (3). The dependent variable is growth rate of new business formation using the full sample. All regressions are executed based on random effect GLS model. Robust z-statistics in parentheses. *,**,*** mean significant at 10%, 5% an 1% respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	0.001***			0.001***		
	(4.466)			(3.695)		
Ln(CW)		0.000**			0.001***	
		(2.460)			(3.628)	
RD/TA			0.006**			0.004*
			(2.281)			(1.729)
Ln(Sale)	0.000	-0.001***	-0.001***	-0.000	-0.001***	-0.001***
	(0.932)	(-3.838)	(-3.628)	(-0.325)	(-4.965)	(-4.162)
Ln(Age)	-0.000	0.000	-0.000	0.001**	0.001**	0.001**
	(-0.133)	(0.200)	(-0.024)	(2.062)	(2.200)	(2.090)
Leverage	-0.002	-0.001	-0.002	-0.001	0.000	-0.001
	(-1.400)	(-0.735)	(-1.122)	(-0.701)	(0.044)	(-0.477)
Ln(GDP/Cap)	-0.025***	-0.026***	-0.026***	-0.026***	-0.026***	-0.026***
	(-23.126)	(-23.506)	(-23.277)	(-24.703)	(-25.094)	(-24.864)
GDP/Cap growth	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	(6.361)	(5.945)	(6.047)	(8.860)	(8.493)	(8.643)
% of College Grad.	0.000***	0.000**	0.000***	0.000***	0.000***	0.000***
	(3.218)	(2.473)	(2.976)	(4.606)	(4.029)	(4.428)
Top10 CBSA	-0.004***	-0.004***	-0.004***	-0.006***	-0.007***	-0.007***
	(-6.059)	(-6.502)	(-6.300)	(-11.350)	(-11.816)	(-11.604)
Constant	0.257***	0.263***	0.262***	0.256***	0.260***	0.259***
	(23.162)	(23.858)	(23.801)	(24.313)	(24.965)	(24.893)
Observations	22,497	22,497	22,497	29,127	29,127	29,127
Year RE	YES	YES	YES	YES	YES	YES

Table 8: Innovation and Growth in New Business Formation: by Employment Size

This table presents the results of regression equation (3). The dependent variable is growth rate of new business formation based on different employment size. Panel A reports the results for new businesses with employment size less than 100, and Panel B reports the results for new businesses with employment size greater than or equal to 100. All regressions are executed based on random effect GLS model. Robust z-statistics in parentheses. *,**,*** mean significant at 10%, 5% an 1% respectively.

Panel A Small business new formation

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	0.001***			0.000***		
	(3.405)			(2.600)		
Ln(CW)		0.001***			0.001***	
		(2.959)			(4.156)	
RD/TA			0.006**			0.003
			(2.149)			(1.311)
Ln(Sale)	0.000	-0.001***	-0.001***	-0.000	-0.001***	-0.001***
	(0.011)	(-4.396)	(-3.846)	(-1.459)	(-5.750)	(-4.514)
Ln(Age)	-0.000	-0.000	-0.000	0.000	0.001	0.000
	(-0.676)	(-0.396)	(-0.624)	(1.425)	(1.527)	(1.442)
Leverage	-0.002	-0.001	-0.002	-0.001	-0.000	-0.001
	(-1.421)	(-0.819)	(-1.237)	(-0.757)	(-0.082)	(-0.608)
Ln(GDP/Cap)	-0.025***	-0.026***	-0.026***	-0.026***	-0.026***	-0.026***
	(-22.467)	(-22.778)	(-22.565)	(-24.166)	(-24.496)	(-24.292)
GDP/Cap growth	-0.000	-0.000	-0.000	0.000	0.000	0.000
	(-0.103)	(-0.438)	(-0.342)	(1.637)	(1.330)	(1.475)
% of College Grad.	0.000**	0.000	0.000*	0.000***	0.000***	0.000***
	(2.070)	(1.414)	(1.938)	(3.319)	(2.819)	(3.199)
Top10 CBSA	-0.003***	-0.003***	-0.003***	-0.005***	-0.006***	-0.006***
	(-4.712)	(-5.125)	(-4.892)	(-9.638)	(-10.080)	(-9.847)
Constant	0.262***	0.267***	0.266***	0.261***	0.264***	0.264***
	(22.814)	(23.375)	(23.323)	(24.144)	(24.679)	(24.610)
Observations	22,497	22,497	22,497	29,127	29,127	29,127
Year RE	YES	YES	YES	YES	YES	YES

Panel B Large business new formation

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	-0.003***			-0.002***		
	(-6.647)			(-5.554)		
Ln(CW)		-0.000			0.000	
		(-0.535)			(0.311)	
RD/TA			-0.007			-0.008
			(-0.962)			(-1.147)
Ln(Sale)	0.002***	-0.000	-0.001*	0.001**	-0.001	-0.001*
	(3.413)	(-1.073)	(-1.781)	(2.499)	(-1.457)	(-1.783)
Ln(Age)	0.002**	0.003***	0.003***	0.004***	0.004***	0.004***
	(2.438)	(2.807)	(2.741)	(4.066)	(4.248)	(4.171)
Leverage	-0.006	-0.004	-0.004	-0.004	-0.002	-0.002
	(-1.450)	(-0.894)	(-0.920)	(-0.968)	(-0.396)	(-0.542)
Ln(GDP/Cap)	-0.019***	-0.020***	-0.020***	-0.019***	-0.020***	-0.020***
	(-7.454)	(-8.005)	(-7.901)	(-7.443)	(-7.834)	(-7.738)
GDP/Cap growth	0.007***	0.007***	0.007***	0.008***	0.008***	0.008***
	(25.580)	(25.173)	(25.168)	(29.386)	(29.066)	(29.062)
% of College Grad.	0.000	0.000	0.000	0.000	0.000	0.000
	(1.321)	(0.603)	(0.693)	(1.188)	(0.660)	(0.819)
Top10 CBSA	-0.012***	-0.013***	-0.013***	-0.018***	-0.018***	-0.018***
	(-7.912)	(-8.237)	(-8.294)	(-12.533)	(-12.876)	(-12.866)
Constant	0.156***	0.177***	0.176***	0.153***	0.169***	0.168***
	(6.306)	(7.234)	(7.199)	(6.158)	(6.825)	(6.795)
Observations	22,384	22,384	22,384	28,971	28,971	28,971
Year RE	YES	YES	YES	YES	YES	YES

Table 9: Innovation and Small business formation

This table presents the results of regression equation (3). The dependent variable is the proportion of small business formation in total new business formation. All regressions are executed based on random effect GLS model. Robust z-statistics in parentheses. *,**,*** mean significant at 10%, 5% an 1% respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	0.010*			0.023***		
	(1.722)			(4.539)		
Ln(CW)		0.022***			0.035***	
		(2.927)			(5.522)	
RD/TA			0.134			0.539***
			(1.580)			(6.703)
Ln(Sale)	-0.013*	-0.012	-0.003	-0.048***	-0.041***	(-3.023)
	(-1.763)	(-1.545)	(-0.427)	(-7.376)	(-6.113)	-0.058***
Ln(Age)	-0.073***	-0.076***	-0.074***	-0.059***	-0.062***	(-3.049)
	(-3.200)	(-3.326)	(-3.209)	(-3.078)	(-3.301)	-0.167***
Leverage	-0.134**	-0.140**	-0.137**	-0.165***	-0.178***	(-3.039)
	(-2.162)	(-2.242)	(-2.188)	(-3.040)	(-3.237)	-1.500***
Ln(GDP/Cap)	-1.530***	-1.523***	-1.524***	-1.508***	-1.493***	(-20.435)
	(-17.686)	(-17.819)	(-17.908)	(-20.200)	(-20.274)	0.003*
GDP/Cap growth	0.003	0.003*	0.003*	0.003	0.003*	(1.947)
	(1.595)	(1.660)	(1.724)	(1.611)	(1.830)	-0.054***
% of College Grad.	-0.054***	-0.054***	-0.054***	-0.053***	-0.054***	(-12.892)
	(-10.619)	(-10.655)	(-10.558)	(-12.846)	(-12.957)	0.316***
Top10 CBSA	0.308***	0.308***	0.309***	0.312***	0.314***	(13.259)
	(10.284)	(10.327)	(10.367)	(13.078)	(13.282)	(6.703)
Constant	23.297***	23.194***	23.192***	23.053***	22.842***	22.823***
	(29.226)	(29.522)	(29.524)	(33.157)	(33.386)	(33.377)
Observations	22,920	22,920	22,920	29,633	29,633	29,633
Year RE	YES	YES	YES	YES	YES	YES

Table 10: Innovation and New Business Formation: Financial constraints

This table presents the results of the regression equation (4). The dependent variable is Logarithm of total number new business formation. Panel A and Panel B report respectively the results of regression using HP index and WW index as the measurement of financial constraints. See Appendix for details of constructing the two measurements. All regressions are executed based on random effect GLS model. Robust z-statistics in parentheses. *,**,*** mean significant at 10%, 5% an 1% respectively.

Panel A: HP index

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	0.076***			0.055***		
	(7.556)			(6.426)		
FC x Ln(SM)	0.018***			0.013***		
	(6.758)			(5.409)		
Ln(CW)		0.067***			0.043***	
		(4.791)			(3.571)	
FC x Ln(CW)		0.016***			0.009***	
		(3.954)			(2.831)	
RD/TA			-0.137			-0.132
			(-0.638)			(-0.866)
FC x RD/TA			-0.087			-0.091*
			(-1.117)			(-1.670)
FC	0.022	-0.010	0.017	0.007	-0.011	0.008
	(0.768)	(-0.349)	(0.581)	(0.310)	(-0.451)	(0.317)
Ln(Sale)	0.015***	0.015***	0.013**	0.005	0.005	0.007
	(2.821)	(2.607)	(2.335)	(1.078)	(1.120)	(1.437)
Ln(Age)	0.013	0.012	0.012	0.017	0.016	0.016
	(0.808)	(0.756)	(0.763)	(1.283)	(1.163)	(1.193)
Leverage	0.010	-0.013	-0.016	0.016	-0.002	-0.002
	(0.430)	(-0.574)	(-0.660)	(0.745)	(-0.101)	(-0.102)
Ln(GDP/Cap)	-0.159***	-0.184***	-0.194***	-0.162***	-0.176***	-0.181***
	(-4.483)	(-5.186)	(-5.288)	(-5.500)	(-5.915)	(-5.809)
GDP/Cap growth	0.003***	0.004***	0.004***	0.003***	0.004***	0.004***
	(3.681)	(4.400)	(4.432)	(5.902)	(6.655)	(6.662)
% of College Grad.	-0.005*	-0.006*	-0.007**	-0.009***	-0.009***	-0.010***
	(-1.699)	(-1.925)	(-2.092)	(-3.237)	(-3.426)	(-3.568)
Top10 CBSA	0.045	0.049	0.049	0.045*	0.048*	0.048*
	(1.244)	(1.363)	(1.347)	(1.676)	(1.786)	(1.823)
Constant	9.316***	9.504***	9.730***	9.459***	9.572***	9.692***
	(29.254)	(30.528)	(30.301)	(37.192)	(38.145)	(36.080)
Observations	22,920	22,920	22,920	29,633	29,633	29,633
Year RE	YES	YES	YES	YES	YES	YES

Panel B: WW index

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	0.039***			0.032***		
	(6.030)			(5.807)		
FC x Ln(SM)	0.101***			0.074***		
	(4.856)			(4.413)		
Ln(CW)		0.034***			0.026***	
		(4.171)			(3.762)	
FC x Ln(CW)		0.092***			0.058***	
		(2.999)			(2.594)	
RD/TA			0.018			0.010
			(0.198)			(0.150)
FC x RD/TA			-0.476			-0.600**
			(-1.201)			(-2.060)
FC	0.007	-0.035	0.204*	0.024	0.010	0.159
	(0.068)	(-0.295)	(1.816)	(0.286)	(0.104)	(1.575)
Ln(Sale)	0.017***	0.019***	0.018***	0.009	0.010*	0.010**
	(2.792)	(2.968)	(2.892)	(1.603)	(1.851)	(1.964)
Ln(Age)	0.002	0.007	0.010	0.013	0.015	0.018
	(0.146)	(0.444)	(0.696)	(0.969)	(1.192)	(1.421)
Leverage	-0.003	-0.018	-0.016	0.011	-0.003	0.001
	(-0.120)	(-0.773)	(-0.675)	(0.522)	(-0.117)	(0.025)
Ln(GDP/Cap)	-0.195***	-0.197***	-0.200***	-0.184***	-0.182***	-0.183***
	(-5.484)	(-5.639)	(-5.668)	(-6.164)	(-6.125)	(-6.094)
GDP/Cap growth	0.003***	0.004***	0.004***	0.003***	0.004***	0.004***
	(3.884)	(4.407)	(4.284)	(5.954)	(6.679)	(6.654)
% of College Grad.	-0.006*	-0.006**	-0.007**	-0.009***	-0.010***	-0.010***
	(-1.922)	(-2.011)	(-2.089)	(-3.351)	(-3.437)	(-3.529)
Top10 CBSA	0.048	0.050	0.049	0.048*	0.049*	0.049*
	(1.334)	(1.372)	(1.354)	(1.795)	(1.812)	(1.817)
Constant	9.676***	9.673***	9.763***	9.681***	9.653***	9.699***
	(29.813)	(30.994)	(30.970)	(36.839)	(37.495)	(36.585)
Observations	22,510	22,510	22,510	29,064	29,064	29,064
Year RE	YES	YES	YES	YES	YES	YES

Table 11 Innovation, New Business Formation and Financial constraints: by Employment Size

This table presents the results of the regression equation (4) using subsamples by new business employment size. The dependent variable is Logarithm of total number of new business formation. Panels A & B reports respectively the results using HP index and WW index as the measurement of financial constraints, for new businesses with employment size less than 100. Panels C & D reports respectively the results using HP index and WW index for new businesses with employment size greater than or equal to100. See Appendix for details of constructing the two measurements. All regressions are executed based on random effect GLS model. Robust z-statistics in parentheses. *,**,*** mean significant at 10%, 5% an 1% respectively.

Panel A: Small employment size using HP Index

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	0.074***			0.053***		
	(7.270)			(6.174)		
FC x Ln(SM)	0.018***			0.012***		
	(6.526)			(5.218)		
Ln(CW)		0.065***			0.040***	
		(4.597)			(3.353)	
FC x Ln(CW)		0.016***			0.009***	
		(3.782)			(2.647)	
RD/TA			-0.115			-0.124
			(-0.533)			(-0.816)
FC x RD/TA			-0.080			-0.087
			(-1.026)			(-1.613)
FC	0.021	-0.010	0.016	0.006	-0.011	0.007
	(0.754)	(-0.323)	(0.549)	(0.268)	(-0.441)	(0.277)
Ln(Sale)	0.015***	0.015***	0.013**	0.005	0.005	0.007
	(2.791)	(2.577)	(2.343)	(1.086)	(1.100)	(1.424)
Ln(Age)	0.014	0.013	0.013	0.018	0.016	0.016
	(0.871)	(0.819)	(0.818)	(1.306)	(1.197)	(1.217)
Leverage	0.009	-0.014	-0.016	0.014	-0.003	-0.003
	(0.373)	(-0.590)	(-0.671)	(0.648)	(-0.158)	(-0.152)
Ln(GDP/Cap)	-0.144***	-0.168***	-0.178***	-0.146***	-0.160***	-0.165***
	(-4.027)	(-4.697)	(-4.817)	(-4.946)	(-5.349)	(-5.266)
GDP/Cap growth	0.002**	0.002***	0.003***	0.002***	0.003***	0.003***
	(2.185)	(2.920)	(2.976)	(3.775)	(4.538)	(4.568)
% of College Grad.	-0.004	-0.005	-0.006*	-0.008***	-0.009***	-0.009***
	(-1.397)	(-1.617)	(-1.775)	(-2.900)	(-3.082)	(-3.214)
Top10 CBSA	0.042	0.046	0.046	0.041	0.044	0.045*
	(1.151)	(1.263)	(1.250)	(1.526)	(1.629)	(1.662)
Constant	9.036***	9.217***	9.437***	9.182***	9.294***	9.407***

	(28.183)	(29.355)	(29.171)	(35.926)	(36.800)	(34.847)
Observations	22,920	22,920	22,920	29,633	29,633	29,633
Year RE	YES	YES	YES	YES	YES	YES

Panel B: Small Employment Size using WW index

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	0.039***			0.031***		
	(5.917)			(5.735)		
FC x Ln(SM)	0.100***			0.073***		
	(4.809)			(4.417)		
Ln(CW)		0.034***			0.026***	
		(4.120)			(3.703)	
FC x Ln(CW)		0.090***			0.057**	
		(2.950)			(2.575)	
RD/TA			0.020			0.005
			(0.216)			(0.082)
FC x RD/TA			-0.492			-0.620**
			(-1.241)			(-2.139)
FC	0.004	-0.034	0.200*	0.019	0.008	0.157
	(0.045)	(-0.290)	(1.765)	(0.226)	(0.082)	(1.547)
Ln(Sale)	0.017***	0.019***	0.018***	0.009	0.010*	0.010*
	(2.781)	(2.942)	(2.869)	(1.612)	(1.830)	(1.936)
Ln(Age)	0.003	0.008	0.011	0.013	0.016	0.019
	(0.219)	(0.512)	(0.758)	(1.018)	(1.240)	(1.466)
Leverage	-0.003	-0.019	-0.016	0.010	-0.004	-0.000
	(-0.141)	(-0.776)	(-0.671)	(0.456)	(-0.160)	(-0.014)
Ln(GDP/Cap)	-0.179***	-0.181***	-0.183***	-0.167***	-0.166***	-0.166***
	(-4.968)	(-5.115)	(-5.147)	(-5.544)	(-5.515)	(-5.489)
GDP/Cap growth	0.002**	0.003***	0.003***	0.002***	0.003***	0.003***
	(2.441)	(2.955)	(2.874)	(3.889)	(4.584)	(4.574)
% of College Grad.	-0.005	-0.005*	-0.006*	-0.008***	-0.009***	-0.009***
	(-1.611)	(-1.697)	(-1.772)	(-3.006)	(-3.089)	(-3.176)
Top10 CBSA	0.046	0.047	0.046	0.045	0.045*	0.045*
	(1.236)	(1.272)	(1.254)	(1.639)	(1.654)	(1.658)
Constant	9.382***	9.380***	9.468***	9.390***	9.367***	9.411***
	(28.601)	(29.730)	(29.739)	(35.389)	(36.014)	(35.192)
Observations	22,510	22,510	22,510	29,064	29,064	29,064
	YES	YES	YES	YES	YES	YES

Panel C: Large Employment Size using HP index

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	0.112***			0.081***		
	(9.041)			(7.002)		
FC x Ln(SM)	0.026***			0.018***		
	(7.894)			(5.748)		
Ln(CW)		0.106***			0.077***	
		(6.324)			(4.734)	
FC x Ln(CW)		0.024***			0.016***	
		(5.081)			(3.554)	
RD/TA			-0.138			0.122
			(-0.575)			(0.558)
FC x RD/TA			-0.113			-0.064
			(-1.279)			(-0.816)
FC	-0.005	-0.049	-0.007	-0.041	-0.070**	-0.048*
	(-0.162)	(-1.514)	(-0.234)	(-1.621)	(-2.530)	(-1.791)
Ln(Sale)	0.014**	0.013**	0.013**	-0.008	-0.007	-0.001
	(2.239)	(2.009)	(2.072)	(-1.471)	(-1.192)	(-0.252)
Ln(Age)	0.015	0.008	0.007	0.016	0.008	0.007
	(0.807)	(0.457)	(0.416)	(1.024)	(0.553)	(0.477)
Leverage	-0.040	-0.077**	-0.079**	-0.013	-0.041	-0.041
	(-1.296)	(-2.474)	(-2.529)	(-0.473)	(-1.475)	(-1.449)
Ln(GDP/Cap)	-0.338***	-0.366***	-0.379***	-0.343***	-0.356***	-0.368***
	(-8.441)	(-9.157)	(-9.248)	(-9.868)	(-10.183)	(-10.217)
GDP/Cap growth	0.013***	0.014***	0.015***	0.015***	0.015***	0.016***
	(13.673)	(14.340)	(14.352)	(17.245)	(17.837)	(17.832)
% of College Grad.	-0.018***	-0.019***	-0.019***	-0.022***	-0.023***	-0.023***
	(-5.857)	(-6.040)	(-6.292)	(-8.392)	(-8.530)	(-8.797)
Top10 CBSA	0.100***	0.106***	0.107***	0.091***	0.095***	0.098***
	(3.005)	(3.234)	(3.236)	(3.615)	(3.788)	(3.913)
Constant	8.946***	9.129***	9.452***	9.076***	9.130***	9.336***
	(24.691)	(25.745)	(25.824)	(29.217)	(29.831)	(29.107)
Observations	22,812	22,812	22,812	29,483	29,483	29,483
Year RE	YES	YES	YES	YES	YES	YES

Panel D: Large Employment Size using WW index

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	0.057***			0.056***		
	(7.057)			(7.255)		
FC x Ln(SM)	0.136***			0.121***		
	(5.304)			(5.154)		

Ln(CW)		0.049***			0.047***	
		(4.607)			(4.719)	
FC x Ln(CW)		0.111***			0.092***	
		(2.973)			(2.893)	
RD/TA			0.030			0.085
			(0.299)			(0.971)
FC x RD/TA			-0.638			-0.968**
			(-1.345)			(-2.299)
FC	0.084	0.047	0.321**	0.110	0.081	0.278**
	(0.732)	(0.335)	(2.382)	(1.037)	(0.680)	(2.284)
Ln(Sale)	0.023***	0.025***	0.027***	0.008	0.011*	0.013**
	(3.333)	(3.595)	(3.797)	(1.352)	(1.757)	(2.204)
Ln(Age)	0.009	0.012	0.017	0.027**	0.030**	0.034***
	(0.597)	(0.827)	(1.135)	(2.148)	(2.337)	(2.669)
Leverage	-0.062**	-0.086***	-0.081**	-0.016	-0.040	-0.033
	(-1.993)	(-2.750)	(-2.572)	(-0.558)	(-1.434)	(-1.151)
Ln(GDP/Cap)	-0.373***	-0.371***	-0.374***	-0.354***	-0.348***	-0.350***
	(-9.368)	(-9.447)	(-9.474)	(-10.297)	(-10.159)	(-10.176)
GDP/Cap growth	0.014***	0.014***	0.014***	0.015***	0.015***	0.015***
	(13.322)	(13.958)	(13.773)	(16.561)	(17.438)	(17.469)
% of College Grad.	-0.018***	-0.019***	-0.019***	-0.022***	-0.022***	-0.023***
	(-5.945)	(-6.038)	(-6.151)	(-8.225)	(-8.342)	(-8.527)
Top10 CBSA	0.104***	0.107***	0.107***	0.094***	0.095***	0.096***
	(3.151)	(3.228)	(3.211)	(3.709)	(3.748)	(3.774)
Constant	9.342***	9.296***	9.406***	9.231***	9.144***	9.218***
	(25.491)	(26.049)	(26.034)	(29.474)	(29.720)	(29.164)
Observations	22,403	22,403	22,403	28,915	28,915	28,915
Year RE	YES	YES	YES	YES	YES	YES

Table 12 Innovation and Growth in New Business Formation

This table presents the results of the regression equation (4). The dependent variable is the growth rate in total number new business formation. Panel A and Panel B report respectively the results of regression using HP index and WW index as the measurement of financial constraints. See Appendix for details of constructing the two measurements. All regressions are executed based on random effect GLS model. Robust z-statistics in parentheses. *,**,*** mean significant at 10%, 5% an 1% respectively.

Panel A HP index

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	0.001**			0.001		
	(2.442)			(1.467)		
FC x Ln(SM)	0.000***			0.000***		
	(3.723)			(2.587)		
Ln(CW)		0.002***			0.002***	
		(3.410)			(3.396)	
FC x Ln(CW)		0.000***			0.000**	
		(2.756)			(2.523)	
RD/TA			-0.054***			-0.050***
			(-6.175)			(-6.233)
FC x RD/TA			-0.017***			-0.016***
			(-5.764)			(-5.976)
FC	0.003***	0.004***	0.005***	0.002**	0.002***	0.004***
	(3.971)	(4.119)	(6.461)	(2.501)	(2.579)	(5.115)
Ln(Sale)	0.001***	0.000	0.000	0.000	-0.000	-0.000
	(3.015)	(0.827)	(0.553)	(0.949)	(-1.552)	(-1.185)
Ln(Age)	0.003***	0.003***	0.003***	0.002***	0.003***	0.003***
	(4.241)	(4.829)	(4.601)	(4.093)	(4.677)	(4.758)
Leverage	-0.001	-0.000	-0.000	-0.000	0.001	0.001
	(-0.631)	(-0.162)	(-0.110)	(-0.283)	(0.377)	(0.430)
Ln(GDP/Cap)	-0.026***	-0.026***	-0.025***	-0.026***	-0.026***	-0.026***
	(-23.269)	(-23.282)	(-23.238)	(-24.765)	(-24.948)	(-24.834)
GDP/Cap growth	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	(6.226)	(6.012)	(6.084)	(8.806)	(8.557)	(8.669)
% of College Grad.	0.000***	0.000**	0.000***	0.000***	0.000***	0.000***
	(3.090)	(2.459)	(2.582)	(4.330)	(3.802)	(3.852)
Top10 CBSA	-0.004***	-0.004***	-0.004***	-0.006***	-0.007***	-0.007***
	(-6.237)	(-6.643)	(-6.750)	(-11.418)	(-11.842)	(-11.783)
Constant	0.258***	0.259***	0.267***	0.257***	0.258***	0.265***
	(23.467)	(23.467)	(24.446)	(24.519)	(24.659)	(25.481)
Observations	22,497	22,497	22,497	29,127	29,127	29,127

Year RE	YES	YES	YES	YES	YES	YES

Panel B: WW index

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	-0.000			0.000		
	(-1.096)			(0.126)		
FC x Ln(SM)	0.001			0.001**		
	(1.222)			(2.028)		
Ln(CW)		0.001**			0.001***	
		(1.983)			(2.858)	
FC x Ln(CW)		0.001			0.002	
		(0.848)			(1.506)	
RD/TA			-0.019***			-0.019***
			(-4.734)			(-5.023)
FC x RD/TA			-0.076***			-0.077***
			(-3.958)			(-4.587)
FC	0.005	0.018**	0.024***	0.008	0.014**	0.021***
	(0.648)	(2.217)	(3.219)	(1.286)	(2.319)	(3.566)
Ln(Sale)	0.000	0.000	0.000	0.000	0.000	0.000
	(1.329)	(0.558)	(0.502)	(1.326)	(0.318)	(0.348)
Ln(Age)	0.000	0.001	0.001	0.001***	0.001***	0.001***
	(0.718)	(1.278)	(1.434)	(3.048)	(3.253)	(3.444)
Leverage	-0.003	-0.001	-0.001	-0.001	-0.000	0.000
	(-1.529)	(-0.822)	(-0.727)	(-0.762)	(-0.007)	(0.064)
Ln(GDP/Cap)	-0.026***	-0.026***	-0.026***	-0.026***	-0.026***	-0.026***
	(-22.935)	(-23.362)	(-23.164)	(-24.404)	(-24.834)	(-24.580)
GDP/Cap growth	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
	(6.131)	(5.715)	(5.807)	(8.499)	(8.185)	(8.304)
% of College Grad.	0.000***	0.000**	0.000***	0.000***	0.000***	0.000***
	(3.105)	(2.370)	(2.737)	(4.440)	(3.843)	(4.134)
Top10 CBSA	-0.004***	-0.004***	-0.004***	-0.006***	-0.007***	-0.007***
	(-5.973)	(-6.474)	(-6.479)	(-11.123)	(-11.578)	(-11.493)
Constant	0.257***	0.263***	0.264***	0.255***	0.259***	0.260***
	(22.778)	(23.454)	(23.702)	(23.824)	(24.369)	(24.621)
Observations	22,089	22,089	22,089	28,561	28,561	28,561
Year RE	YES	YES	YES	YES	YES	YES

Table 13 Financial Constraints, Innovation, and Small Business Formation

This table presents the results of the regression equation (4). The dependent variable is the proportion of small business in total new business formation. Panel A and Panel B report respectively the results of regression using HP index and WW index as the measurement of financial constraints. See Appendix for details of constructing the two measurements. All regressions are executed based on random effect GLS model. Robust z-statistics in parentheses. *,**,*** mean significant at 10%, 5% an 1% respectively.

Panel A: HP index

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	0.008			0.132***		
	(0.794)			(6.874)		
FC x Ln(SM)	-0.017			0.028***		
	(-1.050)			(5.557)		
Ln(CW)		0.014			0.148***	
		(1.494)			(5.597)	
FC x Ln(CW)		0.011			0.030***	
		(0.651)			(4.040)	
RD/TA			-0.129			-0.663**
			(-1.244)			(-1.979)
FC x RD/TA			0.176			-0.427***
			(0.257)			(-3.535)
FC	-0.091	-0.172*	-0.142	0.061	0.012	0.080*
	(-0.898)	(-1.699)	(-1.534)	(1.476)	(0.261)	(1.800)
Ln(Sale)	0.010	0.005	0.006	-0.030***	-0.027***	-0.013*
	(1.173)	(0.496)	(0.646)	(-3.963)	(-3.432)	(-1.659)
Ln(Age)	-0.063*	-0.062*	-0.063*	-0.007	-0.029	-0.033
	(-1.701)	(-1.674)	(-1.703)	(-0.221)	(-0.983)	(-1.107)
Leverage	-0.053	-0.059	-0.057	-0.115**	-0.160***	-0.153***
	(-0.606)	(-0.682)	(-0.655)	(-2.096)	(-2.909)	(-2.746)
Ln(GDP/Cap)	-1.529***	-1.535***	-1.529***	-1.460***	-1.467***	-1.480***
	(-10.479)	(-10.756)	(-10.690)	(-19.070)	(-19.421)	(-19.571)
GDP/Cap growth	0.002	0.002	0.002	0.001	0.003*	0.003*
	(0.721)	(0.728)	(0.753)	(0.942)	(1.650)	(1.737)
% of College Grad.	-0.057***	-0.057***	-0.057***	-0.053***	-0.053***	-0.054***
	(-7.466)	(-7.505)	(-7.417)	(-12.936)	(-12.961)	(-13.142)
Top10 CBSA	0.286***	0.285***	0.287***	0.299***	0.307***	0.311***
	(6.808)	(6.749)	(6.863)	(12.876)	(13.161)	(13.465)
Constant	23.238***	23.305***	23.281***	22.490***	22.411***	22.770***
	(17.425)	(17.970)	(17.843)	(32.074)	(32.847)	(33.167)
Observations	11,489	11,489	11,489	29,633	29,633	29,633

Year RE	YES	YES	YES	YES	YES	YES

Panel B: WW index

	(1)	(2)	(3)	(4)	(5)	(6)
Ln(SM)	0.077***			0.097***		
	(6.287)			(9.031)		
FC x Ln(SM)	0.200***			0.204***		
	(5.503)			(6.802)		
Ln(CW)		0.086***			0.101***	
		(4.892)			(6.827)	
FC x Ln(CW)		0.192***			0.189***	
		(3.362)			(4.254)	
RD/TA			-0.597***			-0.484***
			(-4.210)			(-3.984)
FC x RD/TA			-3.958***			-5.676***
			(-5.726)			(-9.332)
FC	0.363*	0.276	1.164***	0.749***	0.604***	1.359***
	(1.771)	(1.170)	(5.256)	(4.118)	(3.094)	(7.165)
Ln(Sale)	0.021**	0.020*	0.024**	0.000	0.003	0.013
	(2.011)	(1.876)	(2.372)	(0.016)	(0.336)	(1.385)
Ln(Age)	-0.075***	-0.075***	-0.062**	-0.052***	-0.054***	-0.038*
	(-3.132)	(-3.124)	(-2.517)	(-2.630)	(-2.749)	(-1.883)
Leverage	-0.110*	-0.140**	-0.116*	-0.125**	-0.165***	-0.124**
	(-1.779)	(-2.229)	(-1.817)	(-2.293)	(-2.985)	(-2.206)
Ln(GDP/Cap)	-1.515***	-1.514***	-1.509***	-1.505***	-1.490***	-1.492***
	(-17.430)	(-17.600)	(-17.620)	(-20.024)	(-20.088)	(-20.236)
GDP/Cap growth	0.002	0.003	0.003	0.001	0.003	0.003
	(1.024)	(1.462)	(1.402)	(0.754)	(1.529)	(1.543)
% of College Grad.	-0.053***	-0.053***	-0.053***	-0.053***	-0.053***	-0.054***
	(-10.387)	(-10.425)	(-10.451)	(-12.532)	(-12.643)	(-12.856)
Top10 CBSA	0.304***	0.306***	0.304***	0.311***	0.313***	0.314***
	(10.068)	(10.189)	(10.191)	(12.913)	(13.124)	(13.253)
Constant	23.048***	22.975***	23.154***	22.910***	22.674***	22.856***
	(28.791)	(29.211)	(29.320)	(32.796)	(33.094)	(33.293)
Observations	22,510	22,510	22,510	29,064	29,064	29,064
Year RE	YES	YES	YES	YES	YES	YES

Table 14: County level regression

This Table reports the results using the aggregate county level data for the baseline regression as in equation (3). In Panel A, the dependent variables are the logarithm of total new business formation. Columns (1) to (3) report the results using the full sample. Columns (4) to (6) report the results using the subsample of small size startups, and Columns (7) to (9) report the results using the subsample of large size startups. Panel B reports the results on the dynamics of new business establishments. Columns (1) to (3) report the results using the growth rate of all establishment as the dependent variable. Columns (4) to (6) report the results using the growth rate as the dependent variable using small size subsample, and Columns (7) to (9) report the results using the proportion of small size startups in total new business establishments as the dependent variable.

Panel A: Total number of new business establishments

	Establishment (All)			Establishment (Small Size)			Establishment (Large Size)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln(SM)	0.011***			0.013***			0.023***		
	(2.995)			(3.578)			(3.472)		
Ln(CW)		0.008**			0.010**			0.011	
		(2.325)			(2.046)			(1.273)	
RD/TA			0.101			0.128			0.248*
			(1.455)			(1.619)			(1.820)
Ln(Sale)	0.013	0.019***	0.025***	0.009	0.018***	0.025***	0.009	0.028***	0.038***
	(1.603)	(3.294)	(4.438)	(1.185)	(2.949)	(4.198)	(0.803)	(2.745)	(3.429)
Ln(Age)	0.003	0.002	0.002	0.027**	0.026**	0.026**	0.034*	0.032	0.033*
	(0.345)	(0.274)	(0.233)	(2.577)	(2.485)	(2.494)	(1.726)	(1.591)	(1.673)
Leverage	-0.056	-0.067**	-0.070**	-0.010	-0.024	-0.028	0.003	-0.026	-0.027
	(-1.601)	(-2.010)	(-2.108)	(-0.286)	(-0.721)	(-0.830)	(0.044)	(-0.460)	(-0.472)
Ln(GDP/Cap)	0.144***	0.150***	0.146***	-0.088***	-0.081***	-0.086***	-0.291***	-0.278***	-0.288***
	(9.248)	(9.696)	(9.409)	(-3.818)	(-3.572)	(-3.836)	(-7.858)	(-7.724)	(-7.821)
GDP/Cap growth	0.001**	0.002***	0.002***	0.003***	0.003***	0.003***	0.016***	0.017***	0.017***

	(2.428)	(3.148)	(3.197)	(3.500)	(4.154)	(4.187)	(11.452)	(12.295)	(12.333)
% of College Grad.	0.004***	0.003***	0.003***	-0.013***	-0.013***	-0.013***	-0.024***	-0.025***	-0.025***
	(3.938)	(3.633)	(3.477)	(-10.339)	(-10.559)	(-10.620)	(-9.243)	(-9.359)	(-9.400)
Top10 CBSA	-0.004	-0.003	-0.001	-0.011	-0.010	-0.007	0.004	0.009	0.012
	(-0.285)	(-0.217)	(-0.073)	(-0.558)	(-0.478)	(-0.350)	(0.192)	(0.400)	(0.529)
Constant	7.280***	7.193***	7.220***	6.991***	6.881***	6.915***	7.075***	6.886***	6.946***
	(46.929)	(47.645)	(47.700)	(30.724)	(31.284)	(31.721)	(19.526)	(19.834)	(19.888)
Observations	6,732	6,732	6,732	6,732	6,732	6,732	6,638	6,638	6,638
R-squared	0.393	0.390	0.389	0.310	0.307	0.306	0.452	0.448	0.449
Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES

Panel B: *Dynamics of new business establishments*

	Establishment growth (All)			Establishment growth (Small Size)			% of Small Size Establishment		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln(SM)	0.000			-0.001			0.000		
	(0.729)			(-0.687)			(0.010)		
Ln(CW)		0.001**			0.002*			0.013	
		(2.230)			(1.922)			(0.697)	
RD/TA			-0.004			-0.023**			0.222
			(-0.750)			(-2.377)			(1.041)
Ln(Sale)	-0.001	-0.001	-0.000	-0.001	-0.003***	-0.002***	-0.000	-0.006	0.004
	(-1.423)	(-1.562)	(-1.029)	(-1.256)	(-3.224)	(-3.305)	(-0.010)	(-0.343)	(0.214)
Ln(Age)	-0.001	-0.000	-0.001	0.000	0.001	0.000	0.078*	0.080*	0.080*
	(-0.759)	(-0.676)	(-0.880)	(0.233)	(0.418)	(0.150)	(1.849)	(1.898)	(1.922)

Leverage	-0.000	0.000	-0.001	0.015**	0.017**	0.015**	0.211*	0.220*	0.217*
	(-0.019)	(0.017)	(-0.214)	(2.233)	(2.501)	(2.268)	(1.655)	(1.732)	(1.662)
Ln(GDP/Cap)	-0.020***	-0.020***	-0.020***	-0.034***	-0.035***	-0.034***	-1.262***	-1.262***	-1.271***
	(-13.254)	(-13.675)	(-13.163)	(-8.582)	(-8.672)	(-8.294)	(-12.585)	(-12.779)	(-12.806)
GDP/Cap growth	0.002***	0.002***	0.002***	-0.000*	-0.000**	-0.000*	0.003	0.003	0.003
	(13.817)	(13.944)	(13.971)	(-1.821)	(-1.992)	(-1.940)	(1.246)	(1.237)	(1.235)
% of College Grad.	0.000***	0.000***	0.000***	0.001***	0.001***	0.001***	-0.060***	-0.060***	-0.060***
	(3.824)	(3.888)	(3.953)	(3.592)	(3.733)	(3.839)	(-15.165)	(-15.273)	(-15.223)
Top10 CBSA	0.000	0.000	0.000	-0.002	-0.003	-0.002	0.028	0.024	0.027
	(0.083)	(0.014)	(0.135)	(-0.431)	(-0.572)	(-0.472)	(0.328)	(0.284)	(0.323)
Constant	0.221***	0.218***	0.218***	0.350***	0.353***	0.349***	19.490***	19.479***	19.535***
	(14.864)	(15.428)	(15.191)	(8.934)	(9.081)	(8.920)	(18.950)	(19.391)	(19.443)
Observations	6,569	6,569	6,569	6,569	6,569	6,569	6,732	6,732	6,732
R-squared	0.113	0.113	0.113	0.026	0.026	0.026	0.642	0.642	0.642
Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES	YES

Figure 1: Total New Business Formation between 1986 and 2018

This figure depicts the total number of new business formation by employment size in the manufacturing industries over the sample period.

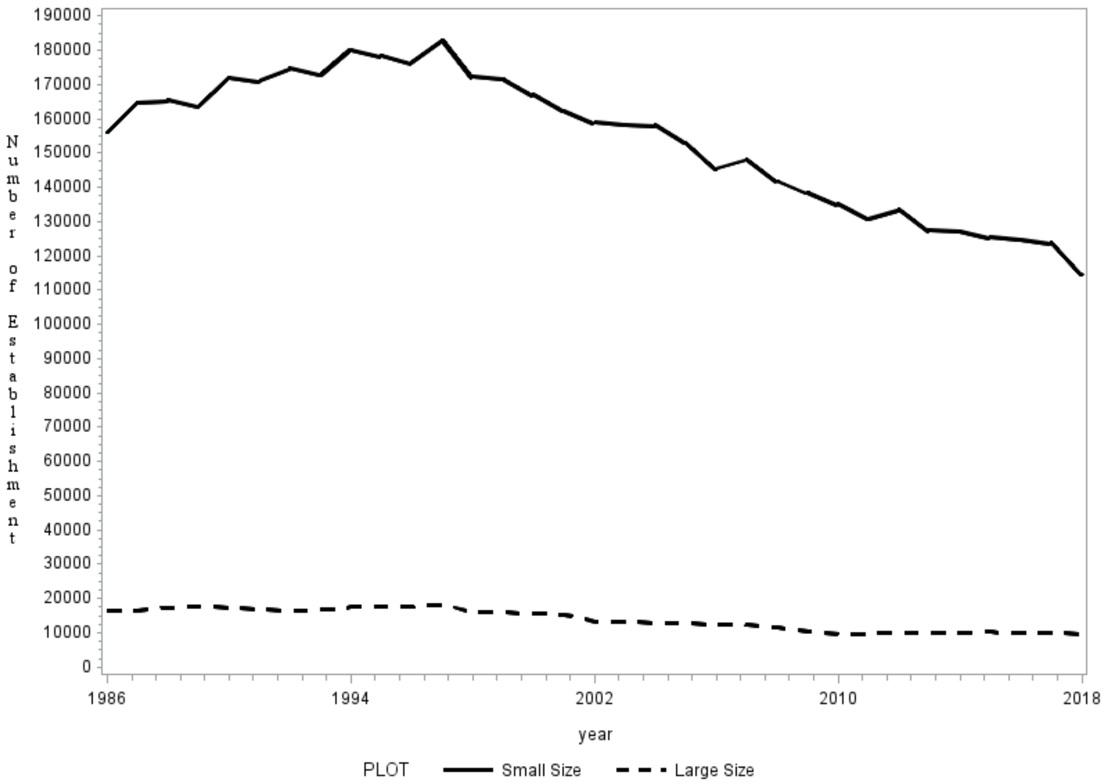


Figure 2: Total patent grants by State

This figure depicts the aggregate total number of patent grants in each of 47 States and D.C. in the sample between 1986 and 2018.

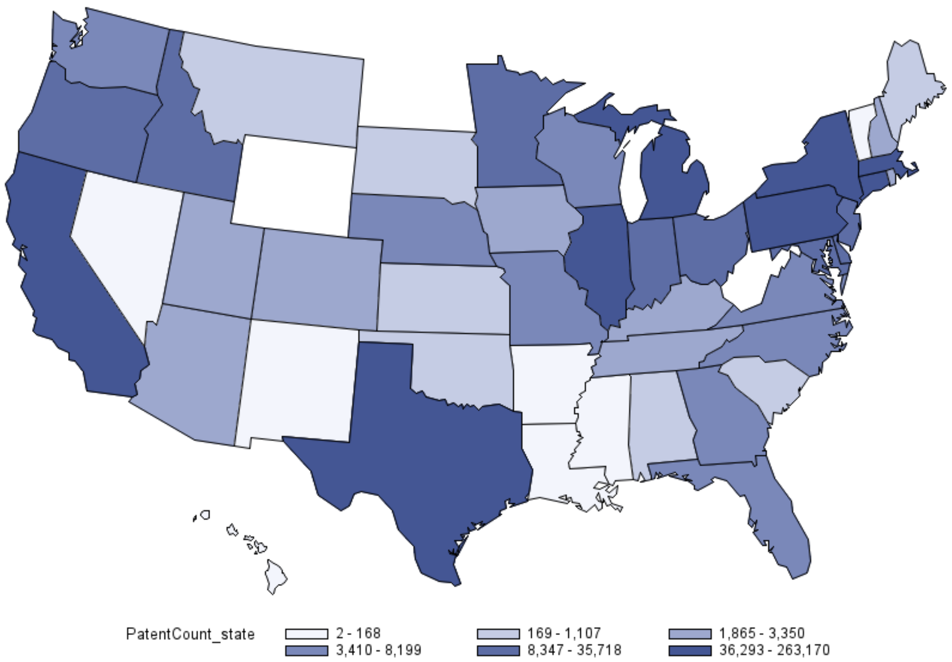
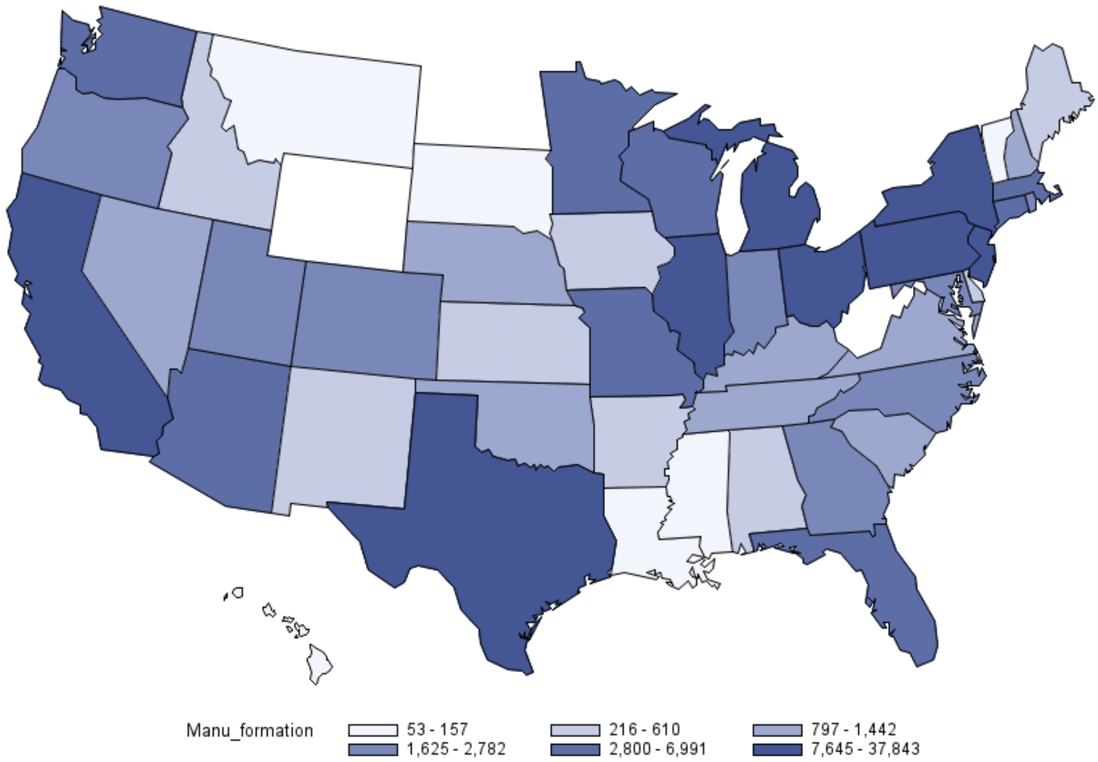


Figure 3: Total new business formation by State

This figure depicts the median value of annual total number of new business formation in each of 47 States and D.C. in the sample between 1986 and 2018.



Appendix A: Variable Definitions

Variable	Estimation
HP	The HP index is constructed as HP = -0.737Size + 0.043Size2 – 0.040Age, Size = log(total assets (at), Age = number of years the firms is listed with a non-missing fiscal year end stock price on Compustat.
WW	The WW index is estimated as WW=–0.091*CF – 0.062*DIVPOS + 0.021*TLTD – 0.044*LNTA + 0.102*ISG – 0.035*SG, where CF is the ratio of cash flow to total assets; DIVPOS is an indicator that takes the value of one if the firm pays cash dividends; TLTD is the ratio of the long-term debt to total assets; LNTA is the natural log of total assets; ISG is the firm's three-digit SIC industry sales growth; and SG is the firm's sales growth.