Do Interest Rates Affect VC Fundraising and Investments?

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Abstract

We examine whether interest rates affect venture capital (VC) fundraising, demand and investments. Lower interest rates fuel VC fundraising by making VC funds more attractive to limited partners (LPs) such as pension funds compared to alternative asset classes (e.g. bonds). We present evidence that higher interest rates make venture capital "cheaper" compared to bank loans and, consequently, boost VC demand from entrepreneurs. VC investment activity is influenced by supply and demand dynamics. Investments increase at high interest rates especially when VC supply is commensurate or higher than VC demand. These results are statistically significant and economically meaningful.

Key Words: Venture Capital, VC, Fundraising, Demand, Investments, Interest Rates

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1.   Introduction

Venture Capital (VC) generates economic prosperity by financing young, high growth firms and providing value-adding activities (Sorensen, 2007). The extant literature theorized a strong link between a thriving VC industry and economic growth (Gompers and Lerner, 2001; Kortun and Lerner, 2000; Samila and Sorenson, 2011). Entrepreneurship is commonly considered a key determinant of an economy's capacity for wealth creation, job growth, and competitiveness (Hochberg, Ljungqvist and Lu, 2010), as well as the driving force behind some of the most vibrant entrepreneurial sectors of the global economy over the past decades (Jeng and Wells, 2000). Another lever of economic growth is monetary policy, and in particular the level of interest rates, which significantly influence a country's economic activity. Previous studies found that interest rates affect consumption, asset prices (Gilchrist and Leahy, 2002), inflation (Chari, Manuelli and Jones, 1995), risk appetite (Ioannidou, Ongena and Peydro, 2015), entrepreneurship and economic growth (King and Levine, 1993).

However, the question still remains as to whether lending interest rates affect VC fundraising, demand and investments. Our study addresses this question. With the exception of Gompers and Lerner (1999) and Van Pottelsberghe and Romain (2004), no study to date has examined the impact of interest rates on VC investments. Our study contributes to this line of research adding a demand-supply empirical model tested on a multi-country sample. In fact, Gompers and Lerner has focused on the U.S. market while we have a comprehensive dataset covering the twenty most important VC markets. Further, although both papers by Gompers and Lerner (1999) and by Van Pottelsberghe and Romain (2004) acknowledge the interaction between VC supply and demand dynamics, they do not account for VC demand (i.e. entrepreneurs looking to raise funds). Therefore, our study is the first to consider the interaction between demand and supply in the VC industry, and to associate those to the level of lending interest rates.

The aim of this paper is threefold. First, we explore the relationship between the level of interest rates and VC fundraising considering the potential returns available to limited partners (LPs) from alternative asset classes such as bonds. Second, we then investigate VC demand considering the costs of debt as an alternative source of funds for entrepreneurs and start-ups. Finally, we study VC investments considering the interplay between VC demand

(i.e. entrepreneurs looking for funding) and VC availability (i.e. amount of VC funding available for investment). Our results are consistent with the hypothesis that market players compare potential returns and costs in choosing their economic strategy.

1.1 Interest Rates and VC Fundraising

The existing literature documents the relationship between interest rates and various indicators of economic activity, as well as the relationship between macroeconomic conditions and VC activity (Cumming and Macintosh, 2006; Jeng and Wells, 2000; Gompers and Lerner, 1999; Lerner, 2002). However, the relationship between the level of interest rates and VC activity (fundraising, demand and investments) remains unexplored. Why should interest rates alter the VC market? There are two reasons that suggest there should be a significant relationship between interest rates and VC activity. First, from a supply perspective, VC firms[3] raise funds mainly from pension funds, banks and insurance companies. Gompers and Lerner (1999: 158) argue that "the willingness of investors to commit money to venture capital funds is dependent upon the expected rate of return from these investments relative to the return they expect to receive from other investments [...] if interest rates rise, the attractiveness of investing in venture capital funds may deteriorate. This would decrease the willingness of investors to supply venture capital at all prices". Similarly, Mason and Harrison (2002) as well as Cumming and Macintosh (2006) argue that falling interest rates reduce returns achievable from other investments, encouraging investors to invest in alternative asset classes (e.g. VC) that have the potential to offer higher returns.

Practitioners have also emphasized this mechanism. One of the Sequoia Capital's partners has framed this idea as follows: "With interest rates close to zero, you can't make money in the bond market, so the bond people now invest in stocks, and people who invest in stocks invest in private growth rounds. [Once interest rates rise] there will be less money chasing companies all the way down the spectrum"[4] (Lin, 2015). Hence, this anecdotal evidence suggests that interest rates affect VC fundraising activities. In this paper, we argue

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[3] In this paper, we refer to VC firms as 'firms'. Start-ups or companies, which receive VC financing, are referred to as 'companies'.

[4] Article accessible at https://techcrunch.com/2015/12/01/sequoia-capitals-alfred-lin-on-why-ubers-valuation-is-twice-that-of-airbnb/

that LPs are more likely to commit more capital to VC firms when interest rates are low. When interest rates are low, LPs are unable to earn high returns by investing in other asset classes.

Previous studies investigated the drivers of VC fundraising. At the firm level, Kaplan and Schoar (2005) and Gompers and Lerner (1999) show that better performing and more reputable VCs are more likely to raise funds as well as more equity. However, Kaplan and Schoar find that this relationship is concave so that top performing VC firms grow proportionally less than average performing VC. Further, Cumming, Fleming and Suchar (2005) show that significantly more capital is allocated to venture capitalists that provide financial and strategic/management expertise to entrepreneurial firm. At the industry level various studies (e.g. Black and Gilson, 1998; Gompers, Kovner, Lerner and Scharfstein, 2008; Kaplan and Schoar, 2005) argue that market cycles, in particular positive performance associated with hot public markets, as well as new entrants have a strong effect on the overall fundraising. In addition, Gompers and Lerner (1999) find that regulatory changes affecting pension funds, capital gains tax rates, overall economic growth, and R&D expenditures significantly impact VC fundraising. We contribute to these studies by shedding light on whether interest rates have a significant impact on VC fundraising. We expect to find a negative relationship between interest rates and VC fundraising (*Fundraising Hypothesis*).

1.2 Interest Rates and Demand for VC

Research on the determinants of VC demand is limited, mainly due to the empirical difficulty of measuring demand. Cosh, Cumming and Hughes (2009) investigate a number of financing sources available, including VC. The researchers find that ventures seeking capital are typically able to secure their requisite financing from at least one of the different available sources. However, external finance is often not available in the form that a firm would like. In relation to VC, they find that demand is higher for young innovative ventures with growth ambitions. However, they find that innovative ventures are less likely to raise VC. Van Pottelsberghe and Romain (2004) theoretically describe the interrelationship between VC demand and supply, yet they only test VC intensity (VC investments divided by GDP). Their measure is an adjusted measure of investments - rather than supply and demand - and they

speculate on the potential supply and demand mechanisms leading to their findings. They find that interest rates positively impact VC intensity. The authors conjecture that this finding is driven by demand effects – entrepreneurs try to raise VC when interest rates are higher. Investigating bank finance, Cressy (1996) shows that the provision of finance is demand-driven, with banks supplying funds elastically and business requests governing take-up. The author argues that firms self-select for funds on the basis of the human capital endowments of the proprietors with better businesses are more likely to borrow.

None of these studies considered the direct impact that interest rates might have on demand for venture capital. We contribute to these studies by arguing that increasing lending interest rates are expected to have a negative impact on the attractiveness of debt capital from entrepreneurs' point of view. With high interest rates, entrepreneurs might find bank loans to be disproportionately more expensive than equity capital, and vice versa. We argue that high interest rates make venture capital "cheaper" compared to bank loans and, consequently, boost VC demand from entrepreneurs. Everything being equal, we expect that entrepreneurs' preferences will shift toward debt capital when interest rates are low, and toward equity capital (e.g. VC) when interest rates are high (*VC Demand Hypothesis*).

1.3 Interest Rates and VC Investments

Disentangling fundraising and investing taking into consideration supply and demand dynamics is key to fully understand the impact of interest rates in the VC industry. Previous studies suggested the relationship between interest rates and VC investments to be both positive and negative. As previously mentioned, Gompers and Lerner (1999) find a positive relationship between interest rates and VC fundraising. Van Pottelsberghe and Romain (2004) find that interest rates positively impact VC intensity (i.e. VC investments). They argue that higher interest rates encourage entrepreneurs to seek VC and this leads to more investments. Jeng and Wells (2000) analyze the determinants of venture capital investments in 21 countries. They find that IPOs are the strongest driver of venture capital investing. Also private pension funds as well as government policies have a positive influence on VC investments. Surprisingly, GDP and market capitalization growth are not significant.

We argue that VC supply and demand jointly shape the relationship between interest rates and VC investments. To the best of our knowledge our paper is the first to model the relationship between lending interest rates and VC supply and demand dynamics. Investments are determined by the interplay of VC supply (i.e. VC firms looking to invest) and VC demand (i.e. entrepreneurs seeking funding). On the supply side, VCs can only invest the amount of capital that they have raised but not invested. On the demand side, entrepreneurs will compete with each other for the capital available and this will impact their optimal choice. When the demand for VC is stronger than the supply, entrepreneurs may not have the possibility to choose their favorite funding source and might end up with a sub-optimal fund raising. However, when the VC supply is stronger than the demand, entrepreneurs will choose the optimal capital structure depending on the costs and benefits of each funding source. In this scenario, entrepreneurs will prefer VC when banks charge high interest rates, and vice versa.

We investigate the relationship between interest rates and VC activity with a comprehensive dataset of 273,067 VC investments spanning 35 years in the 20 major VC markets worldwide. We find that low interest rates boost VC fundraising around the world even after controlling for various macroeconomic variables. The economic magnitude of this effect is significant. A one percent increase in interest rates reduces VC fundraising by $647 mil in the following year. This equals to 3.2% of the average amount fundraised in a year. In addition, we find that higher interest rates boost VC demand. The magnitude of this effect is also significant: a one percent increase in interest rates increases VC demand by 2.53% in the following year. Finally, we investigate the determinants of VC investments by running a model in which we concurrently consider the demand for VC (measured by internet searches for VC) and the supply of VC (measured by the level of VC equity available for investment). We find a strong interplay between interest rates, VC demand-supply, and VC investments. We find that when there is high demand but low supply, interest rates have a negligible effect on investments. However, when there is high supply and low demand (hence when entrepreneurs can choose), investments significantly increase with the increase in interest rates.

Perhaps the leading alternative explanation for the impact of interest rates on VC activity is simply the economic cycle. It is possible that VC fundraising, supply, demand and investments are all influenced by the economic cycle that is linked to the level of interest rates. To rule of the possibility that our measure of interest rates merely proxy for economic activity, our models explicitly control for a variety of dimensions of economic activity. An alternative explanation is that developed economies have both lower interest rates and better VC markets. A VC market requires a fertile ground to flourish. Investors necessitate a strong capital market to exit their investments as well as robust institutions to protect their interests (Gompers, Kovner, Lerner and Scharfstein, 2008). To rule out this alternative explanation we control for economic growth (GDP growth, foreign direct investments, capitalization of public markets) and institutional quality (corruption). Lending interest rates continue to have a significant impact on VC activities even after controlling for these variables.

Finally, the level of interest rates is also linked to the banking activity. It could be argued that interest rates affect banking activities by, for example, making more convenient for banks to lend to start-ups. Therefore, it is possible that when interest rates are high, debt capital will be broadly available to ventures and, therefore, VC demand will be reduced. To rule out this alternative explanation we include two variables to control for the level of debt capital available: banking capital to assets ratio (better capitalized systems can lend more) and banking sector leverage (less leveraged systems can lend more). We only find a significant effect for the latter measure, and it reduces the level of VC investments. Albeit the inclusion of this variable, we still find consistent results.

Our contribution is threefold. First, we show an important link that exists between two fundamental economic drivers: lending interest rates and VC activity. Further research is warranted to examine whether our results can be generalized to similar markets such as private equity and angel financing, which are responsible for a significant share of funding of innovative ventures around the world. Second, our results provide additional evidence to explain the booms and busts of VC markets (Lerner, 2002). Part of the explanation for this may be due to the cyclicality of interest rates. Third, we shed light on VC supply and demand dynamics. The VC industry is two sided: VCs can be considered a platform to match the capital raised from LPs and the capital needed to finance entrepreneurial ventures. Our results

provide initial evidence that the cost of debt capital (i.e. lending interest rates) balances the supply and demand of VC. Considering that VCs understand technology ventures better than banks, a sustained period where entrepreneurs raise cheap debt capital rather than VC might lower the ventures' future chances of success and therefore the overall economic growth. In addition, our results are also linked to the study of Nanda and Rhodes-Kropf (2013) that found a relationship between hot markets and ventures' outcomes. We show that the amount of VC investments (i.e. hot markets) is impacted by supply and demand dynamics that are influenced by the level of interest rates.

The remainder of the paper is structured as follows. Section 2 describes our sample and data. Section 3 analyzes the effect of interest rates on VC activity (fundraising, demand and investments). Section 4 concludes the paper.

2. Sample and Data

2.1 Data Sources and Sample

Our VC related data come from the Thomson One Banker database. The sample used in this study includes all VC investments made by VC firms between January 1980 and December 2015.[5] We concentrate on VC firms and companies located in the following 20 countries: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Israel, Japan, Malaysia, Netherlands, New Zealand, Norway, Singapore, South Korea, Sweden, Switzerland, United Kingdom and United States. These countries are considered to be the most attractive countries for VC investments[6], and therefore, attract the vast majority of VC investments worldwide. We exclude investments in real estate, and we consider the following investment stages: seed, early, expansion and later stage. Our analysis excludes any investments by buyout firms, angel investors and by VC firms whose name is not reported in the dataset.[7] The final sample consists of 273,067 VC investments carried out by 9,695

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[5] VC researchers pointed out the important industry effects of the 1979 implementation of the ERISA that allowed pension funds to invest in VC funds (Jeng and Wells, 2000; Gompers and Lerner, 1999). To reduce the confounding influence of these changes, we start the data collection in 1980. In addition, for the majority of variables the data coverage is not sufficient prior to 1980.

[6] We used the "Venture Capital & Private Equity Country Attractiveness Index" Source: http://blog.iese.edu/vcpeindex/ranking/

[7] In the initial dataset, there were 13% (40,364) observations for which VC firm name was indicated as "Undisclosed"

individual VC firms. The unit of analysis is at the unique combination of venture-VC firm in each investment round.

Four variables are of major interest to our paper: interest rates, VC fundraising, VC supply, VC demand and VC investments. We collect the measure of interest rates at the country level. However, to receive more fine-grained results, we collect the other three variables at the regional level for the U.S. (interest rates do not vary at the regional level) and at the national level for all other countries. We measure the interest rates with the level of lending interest rates (%), which we collect from the International Monetary Fund website. It is defined as "the bank rate that usually meets the short- and medium-term financing needs of the private sector" (IMF). We measure *VC fundraising* with the dollar amount ($ mil) raised by VC firms in each year-location. We measure *VC supply* with the dollar amount ($ mil) available for investment by VC firms in each year-location. This measure can differ from fundraising since it accounts for the amount previously invested. These measures are reported in the Thomson One Banker dataset.

We measure *VC demand* with the level of Internet searches on Google for the term "venture capital". Alternative and potentially more accurate searches such as "raise venture capital" or "get venture capital" do not have enough multi-year-country coverage to be representative. This measure, with its own limitations, offers a general overview of the level of VC demand in each location (U.S. region and other countries). Ideally, to measure VC demand, we would have the number of business plans submitted to each VC worldwide longitudinally. However, this information is not available. We believe that the amount of Internet searches is a relatively precise proxy for VC interest and demand. We collect this measure from Google Trends. We normalize this measure by comparing the searches in each location vis-à-vis the national U.S. searches. This measure ranges from 0 to 100. Finally, we measure the level of VC investments with known equity invested ($ mil) reported by the Thomson One Banker database.[8]

Following previous studies (Gompers and Lerner, 1999; Jeng and Wells, 2000) we control for a large number of VC firm related factors as well as macro factors. Our analysis

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[8] As a robustness check, we also use the number of unique rounds of investments as an additional proxy for VC Investments.

requires information about VC firm characteristics and VC industry dynamics, which we collect from Thomson One Banker. Gompers (1996) showed that VC age and VC firm experience affect their investment strategies. Hence, we consider the age of the VC firm at time of investment (*VC age)*. Consistent with prior studies (Black and Gilson, 1998) we control for public market conditions through the number of VC backed IPOs at the country-year level. More specifically, we count the number of previous IPOs by a VC firm. In our analysis, we control for start-up's age at the time of VC investment (*Start-up Age*). In addition, we control for VC industry dynamics (i.e. VC offer) in the focal country (*VC Equity Available)* as well as abroad (*VC Equity Available Abroad*) by including in our analysis the sum of all fund sizes in a given year in and outside the focal country.

We supplement our dataset with various macroeconomic variables. Information about macro-variables have been sourced mainly from the OECD database and, where missing, from the IMF database. To control for various macroeconomic conditions and for country's development level, we use the following variables: foreign direct investments (*FDI)*, inflation measured by consumer price index (*CPI*), annual growth in GDP (*Growth in GDP*), market capitalization of listed domestic companies (*Market Capitalization*), and gross domestic savings as a percent of GDP (*Gross Domestic Savings*). Data sources for these variables can be found in the Appendix. The extant literature argues that VC supply may be affected by patents and trademarks (Romain and Van Pottelsberghe, 2004), hence, we include the number of patent and trademark applications in each year/country in our analysis. We also control for *Unemployment and Self-employment*, which are likely to impact the VC demand; since if more individuals are unemployed or self-employed, demand for VC may be higher.

In addition, we control for conditions in the banking industry by including in our analysis banking sector leverage ratio in each country and banking capital to assets ratio, which we collect from OECD database. Finally, since our sample contains 20 countries, it's important to take into consideration the different legal origins and the quality of corporate governance measured by the corruption in government (*Corruption*). This variable has a scale between 0 and 10, and low index ratings indicate high levels of corruption. Finally*,* we supplement our models with VC firm regional-country dummies, industry and year dummies.

2.2   Baseline Specification

To investigate the effect of interest rates on VC fundraising, we run the baseline model where the dependent variable is the *VC fundraising$_{t+1}$* in the country/region of VC firm headquarters, proxied by the next period's equity amount raised ($mil) by VC firms in our sample. To control for endogeneity and to shed light on the potential causal effect of interest rates on VC fundraising, we use lagged independent variables (at time *t*) associated with characteristics of the country/region where the VC firm is based. In all our models we remove interest rates' outliers and we cluster the standard errors around the VC firm. Our main coefficient of interest is *Lending Interest Rates* and we expect it to be negative.

To shed light on whether interest rates have a causal effect on demand for venture capital, we replicate our baseline model. Our dependent variable is VC demand$_{t+1}$ in the country/region of the focal venture. All independent variables (at time *t*) are associated with characteristics of the country/region where the start-up company is based. According to our hypothesis, we expect to find the coefficient of *Lending Interest Rates* to be positive. We re-run our main results with observations, where lending interest rates are under 20%. We control for that the fact that ownership structure (independent and captive) of VC firms might have an impact on the relationship between lending interest rates and VC activity. Hence, we replicate our analysis with independent and bank-affiliated VC firms separately.

Finally, to examine the effect of lending interest rate on VC investment, we replicate our baseline model with the inclusion of the interaction term between lending interest rates, VC demand and VC supply. In order to test our third hypothesis we need to include all other interactions between these three variables. Hence, we consider the interplay of VC supply (i.e. VC firms looking to invest) and VC demand (i.e. entrepreneurs seeking funding). The dependent variable is VC investments$_{t+1}$, proxied by the next period's known equity invested. Considering that the interpretation of three way interactions is challenging, to help interpret our findings, we follow Hoetker's (2007) recommendation of reporting marginal effects at meaningful values of our key independent variable and moderators (see Table VIII).

[Insert Table 1 Here]

2.3   Descriptive Statistics

Table 1 (Panel A) reports the annual distribution of VC fundraising, demand and investments. Although we collect data from 1980, the number of observations drops in the first three years of your examined time period (1980-1982) because of the requirements we impose on the dataset. More specifically, for our main analysis we only use observations for which the interest rate is lower than 12.5% and where Thomson One Banker provides the name of VC firm. VC fundraising varies across the examined time period.

In 1983, the average VC fundraising is $750.70 mil whereas prior to the dot-com bubble it starts to significantly increase. For example, by 1998, the average fundraising is $4,852.55 mil, and it reaches its peak in 2000 ($15,148.01 mil). Following the burst of the dot-com bubble, VC fundraising decreases by an astonishing 65.41%. The development of VC industry is captured by a significantly higher number of VC investments in recent years compared to earlier years in our sample. The amount of known equity invested by VC firms follows the same dynamics with its peak of $4089.77-4668.81 mil around the 1999-2000 time period. The average lending interest rate in our sample of 20 countries varied between its lowest level of 3.10% of 2012 to its peak of 12.02% in 1984.

Panel B presents the country distribution. 88% of the investments are made by VC firms located in the same country as the start-up company. There are 223,223 investments completed by ventures headquartered in the US, which account for 81.75% of our sample. In addition, Canada received 5.16% of VC investments, and followed by United Kingdom with 3.83% of investments. To control for this, we use country-regional dummies. In our sample, Germany has the highest average lending interest rate of 9.66%, whereas Japan has the lowest average level of lending interest rate of 2.01%. In our dataset, 9,695 unique VC firms made investments during the examined time period.

[Insert Table 2 here]

Table 2 presents the top ten VC firms by number of VC investments in our sample. 1.08% of all investments is conducted by an independent VC firm, New Enterprise Associates, Inc., which has headquarters in California, US. There are two major captive VC firms in our sample. Pliant Corp is a captive (bank-owned) VC firm, which completed 0.81%

of investments in our sample. In addition, corporate-owned VC firm, Intel Capital Corp, made 0.55% of all investments.

[Insert Table 3 here]

We present descriptive statistics in Table 3. The average lending rate in our sample is 6.41%. On average, VC firms raised $20085.48mil, with the maximum value of $101426.90 mil. The average known equity invested is $1292.96 mil, whereas the average demand for VC is 18.76. In terms of macroeconomic variables, the sample of our courtiers experienced foreign direct investments, which is about 2.16% of GDP. The average inflation is 2.55%, and unemployment (self-employment) is around 6.10% (9.01%) of total labor force. On average the annual growth in GDP is 2.86% in the final sample of 20 countries. Entrepreneurship seems to be key to the development of these countries since the average number of patent (trademark) applications is 145169.00 (165036.70). High corruption ratings (on a scale from 0-10) indicate low corruptions levels. In our sample, the level of corruption is low with the average corruption in government index of 8.54. Banking sector leverage is around 9.69% in our final sample.

The average VC firm has been operating for 13.16 years prior to making an investment in the examined time period. The average VC equity available (abroad) is $28572.97 mil ($23342.58 mil). Prior to VC investments in a given year, on average, VC firms conducted 11.36 initial public offerings (IPOs) of its start-up companies. In a given year, there are about 33.71 VC firms actively investing[9]. Pairwise correlations are presented in Table 4.

[Insert Table 4]

3. Empirical Results

3.1 Interest Rates and VC Fundraising

In this section, we investigate the link between lending interest rates and VC fundraising (*Fundraising hypothesis)*. Table 5 presents the OLS regression results, where the dependent variable in all models is the next period's amount raised ($mil) by VC firms. In line with to our prediction, we find that interest rates have a positive and statistically

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[9] For this variable, we used regional data for the US and national data for all other countries.

significant effect on VC fundraising (model 1). The coefficient estimate of lending interest rate is -647.17 and it's significant at 0.1% percent level. Hence, this statistical and economically significant result suggests that LPs might prefer to invest in more traditional asset classes, rather than committing their capital to VC firms as interest rates increase. Figure 1 shows the relationship between interest rates and VC fundraising. Therefore, LPs contribute capital to alternative investment class (e.g. VC) when interest rates are low, and when they are unlikely to earn high returns somewhere else. However, as interest rate increases, LPs' investment allocation preferences changes, and their allocations to venture capital decreases. Overall, our presented results are consistent and provide empirical support for the argument that lower interest rates reduce potential return LPs can earn from other investments, encouraging investors to commit more capital to VC firms (Gompers and Lerner, 1999; Mason and Harrison, 2002; Cumming and Macintosh, 2006).

[Insert Table 5 and Figure 1]

We find that VC firms tend to be more active in raising additional capital in those countries, which are considered to be attractive markets for foreign direct investments. In line with Gompers and Lerner (1999), we present evidence that VC fundraising is higher in countries with growing economies (as reflected by positive growth in GDP coefficient of 828.382). VC fundraising is also positively associated with the number of filed trademark applications. Hence, entrepreneurial activity in the country is one of the triggers for VC firms' fundraising. Also, VC firms headquartered in countries with higher gross domestic savings demonstrate higher fundraising levels. In contrast, we find that VC fundraising is negatively related to unemployment and self-employment. Hence, LPs tend to commit less capital to VC firms located in countries whose economy is going through some tough economic conditions, captured by higher unemployment rates. Interestingly, we present evidence that VC firms' fundraising is negatively affected by VC equity already available in the country. Hence, LPs are reluctant to commit more funds to an industry, where there is a sufficient level of "dry powder", and hence will be more competition among VC firms for start-ups. Overall, we find that VC fundraising is higher in countries with booming, healthy economies with high entrepreneurial activity.

In addition, we test our *Fundraising Hypothesis* using observations for independent VC firms only, and captive (bank) VC firms. Prior studies argue that captive and independent VC funds differ along a number of criteria. For example, bank-affiliated (captive) funds have different strategic goals (Hellmann *et al*, 2004) and they also have easier access to debt capital. Woolfman (1993) found that captive VCs have unlimited access to finance. Hellmann *et al* (2004) show that bank-affiliated VC funds provide financing to start-ups in hopes to build an existing relationship and hopefully the start-up will approach the parent bank for a future loan. Hence, we re-run all our tests using VC investments conducted by independent VC firms (model 2) and banks VC firms only (model 3). We still find that interest rates have a statistically significant (at 5%) negative impact on VC fundraising. In contrast, although the coefficient for bank owned VCs is directionally consistent (negative), it loses significance. This shows that the fundraising activity of VCs affiliated with banks is not influenced by interest rates. Hence, we contribute to the existing literature by reporting that the ownership structure of VC firms have important implications for the capacity of the VC to fundraise, in particular in relation to changes in interest rates. In addition, in model (3) we report that more reputable VC firms (captured by VC Firm Age and higher number of successfully complete IPOs) tend to raise more funds from LPs. This result is consistent with past studies such as Kaplan and Schoar (2005) and Gompers and Lerner (1999).

We also re-run our baseline model (1) using interest rates above our current level of 12.5%. We include observations with interest rates up to 20% (model 4). Our main results remain the same. Overall, we find that lower interest rates fuel VC fundraising by making VC funds more attractive to limited partners. Hence, the market players compare potential returns in choosing their investment strategy.

3.2   Interest Rates and Demand for VC

We next look at the impact of interest rates on demand for venture capital. In Table 6, we present results of the multivariate analysis, where the dependent variable is VC demand$_{t+1}$ in the company/region of the focal venture. For this set of analysis the amount of observations drops significantly due to the inclusion of our dependent variable. As explained above we do not have data about VC demand prior to 2004. Therefore, only observations

from 2003 onward are included. We specify our dependent variable at *t+1*. In line with our *VC Demand Hypothesis*, results of model 1 show that lending interest rates have a positive and statistically significant (at 0.1% level) impact on VC demand. This finding suggests that when interest rates increase, entrepreneurs are more keen to attain VC financing, along with VC expertise and connections. Hence, high interest rates make venture capital "cheaper" compared to bank loans and, consequently, boost VC demand from entrepreneurs. The magnitude of this effect is also significant: a one percent increase in interest rates increases VC demand by 2.53% in the following year.

[Insert Table 6 and Figure 2]

Figure 2 depicts the relationship between interest rates and VC demand. At low interest rates, entrepreneurs shy away from VC to avoid giving away any equity in their business to venture capitalists. However, as interest rates increase, entrepreneurs find more traditional financing (e.g. loans) less attractive, and are more willing to look for VC financing.

We present evidence that entrepreneurs' demand for venture capital is positively related to inflation and unemployment. Hence, we find that VC demand is positively associated with gross domestics savings and trademark applications. Hence, entrepreneurs are more likely to look for VC financing in growing economies and in case entrepreneurial activity is booming in the country. VC demand is higher in countries, which are considered to be attractive investment markets from the foreign direct investment prospective as the statistically significant (at 0.1% level) *FDI* coefficient of .177 indicates. In addition, VC equity available and equity available abroad are positively related to VC demand. Hence, entrepreneurs tend to consider VC financing when VC offer is high, and hence, there will be more competition among VC firms for the same set of start-up companies. These conditions are optimal for entrepreneurs since it will allow them to choose their optimal financing method and better terms with VC firm(s).

We find that the following variables are negative related to VC demand: growth in GDP and market capitalization. Hence, these findings indicate that VC financing is more prominent financing method in younger, growing economies. In addition, VC demand is negatively associated with the number of patent applications and the level of self-

employment. Demand for an alternative source of financing is also lower in countries with lower levels of corruption levels and start-up age. The latter finding suggests that older start-ups tend to prefer more either debt financing or equity offerings, as opposed to VC financing. It could also reflect the fact that venture capitalists tend to target very young companies, which are still in their seed stage. We confirm our results by re-running our main analysis with observations for which lending interest rate is lower than 20%.

Considering that our hypothesis is based on the assumption that entrepreneurs compare the cost of debt (i.e. interest rates) to the cost of VC (i.e. equity sold), it is important to take into consideration the level of debt available in the market when analyzing demand for venture capital financing. One could argue that better capitalized banking systems can lend more, hence we control for it by including in our regression banking capital to assets ratio. In addition, we control for banking industry leverage since less leveraged systems can potentially lend more to entrepreneurs. We re-run our baseline model, with the inclusion of two bank industry related variables: banking capital to assets ratio (model 3) and banking sector leverage (model 4). We present evidence that the banking capital to assets ratio variable does not have a significant impact on VC demand. We re-confirm our main result that lending interest rates have a positive impact on VC demand (model 3). This result is significant at 0.1 percent level. We also find that VC demand is higher in countries with more leveraged banking sector. Overall, we present evidences that lower (higher) interest rates soften (strengthen) VC demand by making VC equity less (more) attractive to entrepreneurs compared to alternative funding sources (e.g. bank loans).

3.3   Interest Rates and VC Investments

The multivariate analysis of VC investments, moderated by supply and demand dynamics, is presented in Table 7. We find that lending interest rate has a statistically significant and positive impact on VC investments (model 1). Not surprisingly, VC firm tend to invest more capital with higher VC demand and VC equity available. VC firms tend to be more actively investing in growing countries and those with higher foreign direct investments. VC investments are positively associated with entrepreneurial activity, which is captured by significant .003 patent application's coefficient. We present evidence that VC

firms consider the environment for realizing their returns. For example, we find that VC firms prefer to invest in start-ups, which are located in countries in which it will be easier to exit an investment via an initial public offering (IPO), as indicated by significant market capitalization coefficient. In addition, VC firms invest more in countries with higher inflation and unemployment. VC firms also prefer investing in countries with lower government corruption levels. We find that VC investments are also negatively associated with GDP growth, number of trademark applications, self-employment, VC equity available abroad).

[Insert Table 7 and Figure 3]

Since we argue that VC supply and demand jointly shape the relationship between interest rates and VC investments, we include the interaction variables in model (2). All terms, including the interactions, are very significant. This shows that interest rates, VC demand and supply jointly shape the amount of VC invested. Lending interest rate by itself continues to have a statistically significant (at 0.1 percent level) impact on VC investments. Presented results indicate that with higher VC supply, interest rates have a significant positive impact on VC investments. Hence, when there is more intense supply of VC funding, entrepreneurs have the possibility to choose and are more likely to receive VC. In this situation, following the reasoning highlighted in our *demand hypothesis* entrepreneurs will choose VC at higher levels of interest rates. To the best of our knowledge, our paper is the first to model the relationship between lending interest rates and VC investment controlling for VC supply and demand dynamics. We re-run our main results controlling for banking sector-related variables (model 3 and 4). When we control for banking capital to assets ratio the sign of lending interest changes, however, it is only significant at 5% level (model 3). However, in model (4), when we include banking sector leverage in our analysis, we still find consistent results: lending interest rate has a positive and statistically significant impact (at 0.1 percent level) on VC investments.

[Insert Table 8 and Figure 3]

To facilitate the interpretation of our results we report the marginal effects of lending interest rates on VC activity (Table 8) and the margins plots (Figure 3). In model 1 we report the results related to the *fundraising hypothesis.* As lending interest rates increase, it has a negative marginal effect on VC fundraising. Results show that as interest rates move from

18

1% to 11%, VC fundraising decreases by 36.7%. Model 2 reports the results related to the *VC demand hypothesis.* We find that as lending interest rates increase, VC demand also increases. Results show that an increase of interest rates from 1 to 11% leads to a 27.1% increase in VC demand. The relationship between interest rates and VC investments contingent on the level of VC demand and supply are presented in models (3) – (6) or in Figure 3. We report the marginal effects considering the variables of VC supply and demand one standard deviation above and below their respective means. We find that investments increase at high interest rates especially when VC is abundant. The effect is particularly strong when supply is high and demand low. This finding suggests that when the VC supply is stronger than the VC demand, entrepreneurs choose the optimal capital structure depending on the costs and benefits of each funding source. In this scenario, entrepreneurs prefer VC financing when banks charge high lending interest rates. Overall, we present results that demand/supply dynamics have an effect on the relationship between interest rates and VC investments.

4. Conclusion

We examine whether and how interest rates influence VC activity. We expect the level of interest rates to have an effect on VC fundraising and demand. In terms of fundraising we expect higher interest rates to discourage LPs, such as banks and pension funds, to allocate capital to VC funds. These investors are less likely to find attractive the risky returns offered by VC funds when they can obtain satisfactory returns from less risky alternative investments. Therefore, we expect higher interest rates to limit the amount that VC funds are able to fundraise. We find strong support for this effect.

On the demand side we expect higher interest rates to encourage entrepreneurs to raise VC rather than debt. We expect that, everything being equal, the higher the lending interest rates, the higher the demand for VC. This effect is strong and significant. However, when we add a measure of banking lending capacity (banking sector leverage), the effect loses significance (keeping the same sign). We interpret this finding with the fact that, to disentangle the dynamics triggering VC investments, it is important to concurrently consider VC demand and supply.

Evidence derived from plausible measures of VC demand (i.e. internet searches for "venture capital") helps us to unravel the dynamics that govern VC investments. In fact, VC investments arise when the demands from the entrepreneurs looking for finance are met by the supply of VCs looking for investment opportunities. We find that interest rates have a positive effect on VC investment, but we also find that this relationship is particularly strong when VC supply is commensurate or higher than demand. In these situations, entrepreneurs can choose their preferred funding source especially when VC demand is weak (i.e. less entrepreneurs looking for VC) and VC supply is strong (i.e. more VC available for investment).

Our results contribute to the literatures on entrepreneurial finance and interest rates. We complement previous research that investigated the relationship between interest rates and VC activities (Gompers and Lerner, 1999; Mason and Harrison, 2002; Cumming and Macintosh, 2006; Romain and Van Pottelsberghe, 2004). In particular, our model brings together supply and demand dynamics that help to reconcile seemingly contradictory findings. We also contribute to previous studies that documented the effects of interest rates on a number of economic indicators (Gilchrist and Leahy, 2002; Chari, Manuelli, and Jones, 1995; Ioannidou, Ongena, Peydro, 2015; King and Levine, 1993). We show that interest rates significantly impact VC activities, both from a demand and supply side.

Our results have important policy implication. If lower interest rates reduce the amount of VC invested, it may lead to a funding problem in the long-term. VCs possess valuable skills to support innovation and ventures' growth; therefore, if ventures raise capital from alternative sources, they might face future growth problems. An unanswered question is whether interest rates have a longer-term effect in the entrepreneurial environment, for example, by lowering future chances of success or reducing the innovation output. Our results suggest that economic policy makers should consider the long-term impact of their monetary policy decisions on entrepreneurial activities. We leave an examination of the overall welfare effects of interest rates to future work.

References

Black, B. S., & Gilson, R. J. (1998). Venture capital and the structure of capital markets: banks versus stock markets. *Journal of Financial Economics*, *47*, 243–277.

Chari, V. V, Manuelli, R. E., & Jones, L. E. (1995). The Growth Effects of Monetary Policy, *19*(4).

Cressy, R. (1996). Are Business Startups Debt-Rationed? *Economic Journal* 106 (438), 1253-1270.

Cosh, A. Cumming, D. & Hughes, A. (2009). Outside Enterpreneurial Capital. *Economic Journal* 119(540), 1494-1533.

Cumming, D. J., & MacIntosh, J. G. (2006). Crowding out private equity: Canadian evidence. *Journal of Business Venturing*, *21*(5), 569–609.

Gilchrist, S., & Leahy, J. V. (2002). Monetary policy and asset prices. *Journal of Monetary Economics*, *49*(1), 75–97.

Gompers, P. A. (1996). Grandstanding in the venture capital industry. *Journal of Financial Economics*, *42*(1), 133–156.

Gompers, P., & Lerner, J. (1999). *What drives venture capital fundraising? National bureau of economic research*.

Gompers, P. A., & Lerner, J. (2001). The Venture Capital revolution. *The Journal of Economic Perspectives*, *15*(2), 145–168.

Gompers, P.A., Kovner, A., Lerner, J., & Scharfstein, D. (2008). Venture capital investment cycles: The impact of public markets. *Journal of Financial Economics* 87, 1–23.

Mason, C. M., & Harrison, R. T. (2002). Barriers to investment in the informal venture capital sector. *Entrepreneurship & Regional Development*, *14*(3), 271-287.

Hellmann, T., Lindsey, L. and Puri, M. (2004). 'Building Relationships Early: Banks in Venture Capital.' *Stanford University working pape*r.

Hochberg, Y. V., Ljungqvist, A., & Lu, Y. (2010). Networking as a Barrier to Entry and the Competitive Supply of Venture Capital. Journal of Finance 65 (3), 829-859.

Hoetker, G. 2007. The use of logit and probit models in strategic management research: Critical issues. *Strategic Management Journal*, 28(4): 331.

Ioannidou, V., Ongena, S., & Peydro, J.-L. (2015). Monetary Policy, Risk-Taking, and Pricing: Evidence from a Quasi-Natural Experiment. *Review of Finance*, *19*, 95–144.

Jeng, L., & Wells, P. (2000). The determinants of venture capital funding: evidence across countries. *The Journal of Corporate Finance*, *6*(3), 241–289.

King, R. G., & Levine, R. (1993). Finance, entrepreneurship and growth. *Journal of Monetary Economics*, *32*(3), 513–542.

Kortun, S., & Lerner, J. (2000). Assessing the Contribution of Venture Capital to Innovation. *The RAND Journal of Economics*, *31*(4), 674–692.

Lerner, J. (2002). *Boom and Bust in the Venture Capital Industry and the Impact on Innovation. Federal Reserve Bank of Atlanta Economic Review* (Vol. 4).

Nanda, R. & Rhodes-Kropf, M. (2013). Investment cycles and startup innovation. *Journal of Financial Economics* 110, 403–418.

Romain, A., & Van Pottelsberghe, B. (2004). *The determinants of venture capital: Additional evidence*. Deutsche Bundesbank.

Samila, S., & Sorenson, O. (2011). Venture capital, entrepreneurship, and economic growth. *The Review of Economics and Statistics*, *93*(1), 338–349.

Sorensen, M. (2007) How Smart Is Smart Money? A Two-Sided Matching Model of Venture Capital. *Journal of Finance* 62 (6), 2725-2762.

Woolfman, G. (1993). A Summary of the Current Investment Preferences of the UK Venture Capital Industry, Taken from the 1993 UK Venture Capital Database. Levy Gee, London.

Table I. VC Fundraising and Investments

This table presents the annual (Panel A) and country distribution (Panel B) of VC investments, VC fundraising and lending interest rates. The sample consists of VC investments completed by VC firms located in the sample of 20 countries between 1980 and 2015. *Number of VC Investments* is the number of VC investments in a particular year or country. *% of VC Investments* is the percentage of VC investments in a particular year or country/region divided by the total number of VC investments in the sample. *Average VC Fundraising* is the average amount raised ($ mil) by VC firms in a particular year or country. *VC Investments: Known Equity Invested* is the amount of known equity invested ($ mil) by VC firms in a particular year or country. *VC Investments: Number of Rounds* is the number of ventures receiving an investment in a given year. *Average Lending Interest Rate (%)* is the average lending interest rate in a particular year or country.

Panel A. Annual Distribution

Year	Number of VC Investments	% of VC Investments	Average VC Fundraising	VC Investments: Known Equity Invested	Average Lending Interest Rate (%)
1982	12	0.00	190.48	127.43	11.16
1983	4,419	1.62	750.76	701.09	10.78
1984	4,927	1.80	547.20	487.95	12.02
1985	4,430	1.62	615.03	515.35	9.94
1986	4,764	1.74	706.10	782.46	8.35
1987	4,743	1.74	723.88	756.79	8.22
1988	4,277	1.57	682.33	425.08	9.30
1989	4,001	1.47	1062.85	731.53	10.84
1990	3,332	1.22	565.65	241.26	9.98
1991	2,750	1.01	388.92	122.47	8.58
1992	3,275	1.20	868.44	480.41	6.38
1993	2,832	1.04	709.32	360.86	6.06
1994	3,006	1.10	1231.78	930.13	7.16
1995	3,906	1.43	1595.66	1135.33	8.78
1996	5,506	2.02	1867.68	974.28	8.00
1997	7,399	2.71	2478.35	1408.62	8.07
1998	9,097	3.33	4852.55	2618.73	8.11
1999	15,557	5.70	8959.74	4089.77	7.73
2000	26,313	9.64	15148.01	4668.81	8.66
2001	16,094	5.89	5238.89	2421.56	6.87
2002	10,546	3.86	668.28	1279.16	5.00
2003	10,862	3.98	1588.57	879.59	4.54
2004	12,339	4.52	2669.91	1153.55	4.63
2005	10,957	4.01	4957.20	999.42	5.84

2006	10,840	3.97	5616.98	1724.64	7.56
2007	11,690	4.28	5299.78	1372.51	7.70
2008	10,811	3.96	5048.35	919.96	5.14
2009	7,580	2.78	3432.81	844.02	3.19
2010	8,567	3.14	2782.21	777.95	3.11
2011	9,618	3.52	4181.66	398.13	3.15
2012	9,281	3.40	5228.27	783.33	3.10
2013	9,631	3.53	2978.84	426.35	3.08
2014	10,216	3.74	7495.27	501.99	3.11
2015	9,489	3.47	6267.78	153.42	3.28

Panel B. Country Distribution

Company Nation	Number of VC Investments	% of VC Investments	Average Lending Interest Rate (%)
Australia	2,332	0.85	8.40
Belgium	922	0.34	7.75
Canada	14,079	5.16	5.27
Denmark	320	0.12	8.01
Finland	920	0.34	4.91
France	4,433	1.62	6.78
Germany	2,131	0.78	9.66
Hong Kong	404	0.15	7.50
Israel	2,051	0.75	6.96
Japan	1,813	0.66	2.01
Malaysia	183	0.07	6.92
Netherlands	1,519	0.56	3.76
New Zealand	220	0.08	7.48
Norway	590	0.22	5.73
Singapore	777	0.28	5.67
South Korea	3,761	1.38	7.31
Sweden	1,520	0.56	4.85
Switzerland	1,407	0.52	3.31
United Kingdom	10,462	3.83	3.88
United States	223,223	81.75	6.76
Total	273,067	100	6.53

Table II. Top 10 Major VC Firms by Number of VC Investments
This table presents the names of VC firms, which have completed the highest number of VC investments in a sample of 20 countries between 1980 and 2015. *VC Firm Name* is the official name of a VC firm. *VC Firm-Nation* is the nation in which a particular VC firm is headquartered. In parentheses, VC firm's headquarters region is specified. *Firm Type* indicated whether a particular VC firm is independent or captive (bank/insurance company-owned, corporate-owned, etc.). *Number of Investments* is the number of VC investments conducted by a particular VC firm. *% of Investments* is the percent of VC investments conducted by a particular VC firm divided by the total number of VC investments in the sample.

	VC Firm Name	VC Firm- Nation	Firm Type	Number of VC Investments	% of VC Investments
1	New Enterprise Associates, Inc.	US (N. California)	Independent	2961	1.08%
2	Kleiner Perkins Caufield & Byers LLC	US (N. California)	Independent	2389	0.87%
3	Pliant Corp	US (New York Tri - State)	Bank/Insurance	2206	0.81%
4	Sequoia Capital	US (N. California)	Independent	1623	0.59%
5	Accel Partners & Co Inc	US (N. California)	Independent	1580	0.58%
6	U.S. Venture Partners	US (N. California)	Independent	1571	0.58%
7	Oak Investment Partners	US (New York Tri - State)	Independent	1549	0.57%
8	Intel Capital Corp	US (N. California)	Corporate	1506	0.55%
9	Mayfield Fund	US (N. California)	Independent	1453	0.53%
10	Draper Fisher Jurvetson	US (N. California)	Independent	1415	0.52%

Table III. Descriptive Statistics
This table presents descriptive statistics of the main variables used in the analysis.
The sample consists of VC investments completed by VC firms located in the sample of 20
countries between 1980 and 2015. All variable definitions can be found in the Appendix.

Variable	Mean	Std. Dev.	Min	Max
Lending Interest Rate (%)	6.41	2.57	.50	12.46
Amount Raised ($mil)	20085.48	22237.41	.343	101426.90
Known Equity Invested ($ mil)	1292.96	2188.72	0.22	12345.86
VC Demand: internet searches (Scale from 0 to 100)	18.76	14.76	3.50	86.41
FDI (% of GDP)	2.16	3.24	-3.62	87.44
CPI (%)	2.55	1.12	-4.02	11.34
Growth in GDP (%)	2.86	1.81	-5.91	15.24
Unemployment (%)	6.10	1.78	1.30	18.60
Market Capitalization (% of GDP)	111.89	49.21	4.84	1254.46
Gross Domestic Savings ($ Bil)	19.71	4.35	12.956	54.28
Patent Applications	145169.10	90133.22	4.00	384201.00
Trademark Applications	165036.70	91257.96	1.00	283230.00
Self-employment (%)	9.01	3.80	6.60	50.60
Corruption (Index: Scale from 0 to 10)	8.54	.91	4.82	10.00
VC Equity available ($ mil)	28572.97	28586.57	.34	110230.60
VC Equity available abroad ($ mil)	23342.58	27211.73	188.48	149874.70
Number of IPOs	11.36	22.00	0.00	236.00
VC Firm Age	13.16	10.91	0.00	58.00
Banking Sector Leverage	9.69	6.62	1.49	51.55

Table IV. Pairwise Correlation Matrix

This table provides a pairwise correlation matrix of the variables used in the empirical analysis. The sample consists of VC investments completed by VC firms located in the sample of 20 countries between 1980 and 2015. All variable definitions can be found in the Appendix. * denotes statistical significance at the 5% level.

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
[1]	Lending Interest Rate	1									
[2]	Amount Raised	0.0973	1								
[3]	Known Equity Invested	0.2574*	0.8760*	1							
[4]	Number of Unique Rounds	0.0701*	0.5284*	0.5024*	1						
[5]	FDI	-0.0230*	0.0917*	0.0758*	-0.0793*	1					
[6]	CPI	0.5676*	0.0305*	0.0812*	0.0738*	-0.1261*	1				
[7]	Growth in GDP	0.5270*	0.0740*	0.1708*	-0.0165*	0.0738*	0.2347*	1			
[8]	Unemployment	-0.3455*	-0.2876*	-0.3783*	-0.3841*	-0.1616*	-0.2585*	-0.2660*	1		
[9]	Market Capitalization	-0.2661*	0.3059*	0.2757*	0.4517*	0.3205*	-0.3384*	0.0144*	-0.3448*	1	
[10]	Gross Domestic Savings	-0.2892*	0.2714*	0.1488*	0.7562*	-0.2371*	-0.1250*	-0.2503*	-0.1493*	0.3860*	1
[11]	Men Pension Age	-0.1966*	0.0986*	0.0210*	0.2034*	-0.1000*	-0.0363*	-0.0206*	0.0528*	0.1251*	0.3263*
[12]	Patent Application % Change	0.2593*	0.1645*	0.2304*	0.2876*	-0.0114*	0.0927*	0.3256*	-0.2919*	0.1966*	0.1598*
[13]	Trademark Application % Change	-0.0272*	-0.0109*	-0.0116*	-0.0314*	-0.0023	-0.0336*	0.0002	-0.0216*	0.0496*	-0.0368*
[14]	Self-employment	0.0450*	-0.1533*	-0.1551*	-0.4935*	0.1301*	-0.0500*	0.2748*	-0.0653*	-0.2283*	-0.5986*
[15]	Insider Law Enforcement Dummy	-0.0281*	0.0209*	0.0174*	0.0664*	0.0156*	-0.0050*	-0.0201*	0.0183*	0.0532*	0.0661*
[16]	Common Law Dummy	0.0396*	0.1017*	0.1101*	0.3927*	-0.2569*	0.1820*	-0.0274*	-0.0454*	0.1806*	0.4169*
[17]	Corruption	0.0823*	0.0078*	0.0347*	0.1306*	0.0182*	-0.0152*	-0.0502*	0.1286*	0.0390*	0.1319*
[18]	Number of Firms	0.0943*	0.9318*	0.8450*	0.4811*	0.0779*	-0.0154*	0.1143*	-0.2907*	0.2948*	0.2444*
[19]	Fund Size	0.0441*	0.9809*	0.8869*	0.5154*	0.0776*	-0.00051*	0.0260*	-0.2701*	0.3158*	0.2827*
[20]	Number of IPOs	-0.0366*	0.2373*	0.1966*	0.1194*	-0.0189*	-0.0216*	-0.0283*	-0.0476*	0.0783*	0.1284*

	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]
[13] Trademark Application % Change	-0.0274*	1										
[14] Self-employment	0.0161*	0.0412*	1									
[15] Insider Law Enforcement Dummy	0.0175*	0.0008	-0.1033*	1								
[16] Common Law Dummy	0.0953*	-0.0769*	-0.5918*	0.0530	1							
[17] Corruption	0.0234*	0.0326*	-0.4866*	-0.0364**	-0.0021	1						
[18] Number of Firms	0.1927*	-0.0149*	0.0913*	-0.0293*	0.0753*	-0.0316*	1					
[19] Fund Size	0.1511*	-0.0123*	-0.1776*	0.0242	0.1210*	0.0280*	0.9512*	1				
[20] Number of IPOs	0.0275*	-0.0059*	-0.0803*	0.0175*	0.0738*	0.0013	0.2766*	0.2591*	1			
[21] VC Firm Age	-0.0033	-0.0068*	-0.0470*	0.0037	0.0326*	-0.0116*	0.0615*	0.0649**	0.1407*	1		
[22] Banking Sector Leverage	-0.2063*	0.0131*	0.3364*	0.0089*	-0.1532*	-0.5699*	-0.1016*	-0.1262*	-0.0389*	0.0045*	1	

Table V. The Effect of Interest Rates on VC Fundraising

This table presents results of an OLS regression on the next period's VC fundraising. The dependent variable is the amount of VC raised at T+1 in the country of the focal VC firm. The sample consists of VC investments completed by VC firms located in the sample of 20 countries between 1980 and 2015. In Column 1 all observations in the sample are used. In Column 2 and 3 only observations of independent VC firms and bank VCs respectively are used. Although in models 1 to 3 we restrict observations where *lending interest rate* is smaller or equal to 12.5%, in column we extend the sample up to 20%. All included macroeconomic variables are considered in the country (or region where possible) of the VC firm. All variable definitions can be found in the Appendix. Heteroskedasticity-consistent standard errors (clustered on VC Firm) are shown in parentheses. We use ***, **, * to denote significance at 0.1, 1, and 5 percent levels, respectively.

	Interest Rates < 12.5%	Independent VCs only	Bank VCs only	Interest Rates < 20%
	[1]	[2]	[3]	[4]
Lending Interest Rate	-647.170***	-616.978*	-332.888	-761.362***
	(223.603)	(314.819)	(513.242)	(149.068)
FDI	563.180***	564.862***	835.961***	565.656***
	(96.562)	(122.050)	(251.725)	(93.944)
CPI	-84.186	-586.283	1306.135	-272.133
	(286.023)	(391.935)	(737.537)	(249.628)
Growth in GDP	828.382***	904.896***	697.833	816.340***
	(203.046)	(291.336)	(432.924)	(212.189)
Unemployment	-1569.832***	-1701.026***	-852.559	-1597.214***
	(275.767)	(314.336)	(879.691)	(252.946)
Market Capitalization	-2.426	12.645	-11.215	-1.045
	(4.463)	(7.345)	(12.254)	(4.256)
Gross Domestic Savings	1265.660***	1366.879***	1122.082***	1267.836***
	(125.846)	(169.835)	(279.733)	(122.051)
Patent Applications	-.286***	-.280***	-.341***	-.287***
	(.013)	(.016)	(.027)	(.012)
Trademark Applications	.571***	.585***	.588***	.561***
	(.024)	(.033)	(.058)	(.022)

30

Self-employment	-2799.000***	-1794.181***	-4281.412***	-2644.46***
	(396.685)	(592.267)	(874.833)	(398.259)
Corruption	-70.234	-15.088	-69.123	-77.415
	(57.028)	(55.077)	(141.618)	(55.508)
VC Equity available	-.094***	-.071***	-.175***	-.087***
	(.020)	(.025)	(.046)	(.019)
VC Firm previous IPOs	-.652	-1.989	4.792*	-.678
	(1.468)	(1.267)	(1.913)	(1.456)
VC Firm Age	.364	-.502	13.326*	.156
	(1.206)	(1.213)	(5.940)	(1.191)
Start-up Age	-2.953	-1.425	.793	-3.081
	(2.955)	(3.326)	(6.830)	(2.915)
Constant	-12531.560*	628.367	19186.460**	19261.060***
	(5980.858)	(8564.818)	(13325.51)	(5440.846)
VC Firm Regional-Country Dummies	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES
Year Dummies	YES	YES	YES	YES
R^2	93.21%	94.14%	92.23%	93.12%
No. of observations	245,188	187,251	19,193	251,227

Table VI. The Effect of Interest Rates on VC demand

This table presents results of an OLS regression on the next period's VC demand. The dependent variable is the amount of VC demand at T+1 in the company-region of the focal venture. We measure VC demand with the internet searches of the terms "venture capital". The sample consists of VC investments completed by VC firms located in the sample of 20 countries between 1980 and 2015, yet only observations from 2004 are available due to unavailability of the dependent variable prior to this period. Column 1 and 2 have the same observations despite different interest rates thresholds because from 2004 none of the countries had interest rates higher than 12.5%. In Column 3 we include "banking capital to assets" ratio, while in Column 4 we include "banking sector leverage". All included macroeconomic variables are considered in the country (or region where possible) of the focal venture. All variable definitions can be found in the Appendix. Heteroskedasticity-consistent standard errors (clustered on VC Firm) are shown in parentheses. We use ***, **, * to denote significance at 1, 5, and 10 percent levels, respectively.

	Interest Rates < 12.5%	Interest Rates < 20%	Banking Capital to Assets	Banking Sector Leverage
	[1]	[2]	[3]	[4]
Lending Interest Rate	.476***	.476***	.880***	.113
	(.134)	(.134)	(.134)	(.187)
FDI	.177***	.177***	.075**	.185***
	(.024)	(.024)	(.028)	(.028)
CPI	.705***	.705***	1.219***	.448**
	(.175)	(.175)	(.187)	(.145)
Growth in GDP	-.247**	-.247**	.020	-.100
	(.080)	(.080)	(.078)	(.111)
Unemployment	2.291***	2.291***	2.81***	1.595***
	(.115)	(.115)	(.157)	(.138)
Market Capitalization	-.014***	-.014***	-.014***	-.008
	(.002)	(.002)	(.002)	(.008)
Gross Domestic Savings	.000***	.000***	.000***	.000*
	(.000)	(.000)	(.000)	(.000)
Patent Applications	-.000***	-.000***	-.000***	-.000***
	(.000)	(.000)	(.000)	(.000)

	(1)	(2)	(3)	(4)
Trademark Applications	.000***	.000***	.000**	.000**
	(.000)	(.000)	(.000)	(.000)
Self-employment	-1.478***	-1.478***	-2.435***	-2.362***
	(.314)	(.314)	(.447)	(.326)
Corruption	-4.460***	-4.460***	-4.671***	-4.458***
	(.734)	(.734)	(.810)	(.689)
VC Equity available	.000***	.000***	.000***	.000***
	(.000)	(.000)	(.000)	(.000)
VC Equity available abroad	.000***	.000***	.000***	.000***
	(.000)	(.000)	(.000***)	(.000***)
VC Firm previous IPOs	-.001	-.001	-.001	-.001
	(.001)	(.001)	(.001)	(.001)
VC Firm Age	-.001	-.001	-.000	-.001
	(.001)	(.001)	(.000)	(.001)
Start-up Age	-.012***	-.012***	-.012***	-.011***
	(.003)	(.003)	(.003)	(.003)
Banking Capital to Assets			.010	
			(.098)	
Banking Sector Leverage				.357***
				(.038)
Constant	49.836***	49.836***	58.540***	53.514***
	(8.426)	(8.426)	(10.489)	(8.529)
VC Firm Regional-Country Dummies	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES
Year Dummies	YES	YES	YES	YES
R^2	89.26%	89.26%	89.56%	89.31%
No. of observations	105,492	105,492	93,039	104,225

Table VII. The Effect of Interest Rates on VC Investments

This table presents results of an OLS regression on the next period's VC investments. The dependent variable is the amount of VC invested at T+1 in the company-region of the focal venture. The sample consists of VC investments completed by VC firms located in the sample of 20 countries between 1980 and 2015. In Column 1 and 2, all observations in the sample are used. In Column 3 and 4, only observations of independent VC firms are used. All included macroeconomic variables are considered in the country (or region where possible) of the focal venture. All variable definitions can be found in the Appendix. Heteroskedasticity-consistent standard errors (clustered on VC Firm) are shown in parentheses. We use ***, **, * to denote significance at 1, 5, and 10 percent levels, respectively.

	[1]	[2] Interest Rates <12.5%	[3] Banking Capital to Assets	[4] Banking Sector Leverage
Lending Interest Rate	19.129*	184.55***	-40.565*	239.684***
	(9.613)	(13.539)	(16.085)	(18.834)
VC Demand (internet searches)	5.197***	19.399***	-55.835***	21.598***
	(.465)	(1.371)	(2.040)	(1.311)
VC Equity Available	.021***	-.145 ***	-.180***	-.145***
	(.002)	(.003)	(.005)	(.003)
Lending Interest Rate*VC demand		-5.817***	-.365	-6.069***
		(.315)	(.344)	(.323)
Lending Interest Rate* VC Equity Available		.009***	.010***	.009***
		(.000)	(.000)	(.000)
VC Demand*VC Equity Available		.001***	.005***	.001***
		(.000)	(.000)	(.000)
Lending Interest Rate*VC Demand* VC Equity Available		.000***	-.000	.000***
		(.000)	(.000)	(.000)
FDI	8.361*	9.660***	25.069***	9.150*
	(3.373)	(4.048)	(4.336)	(4.134)

34

	(1)	(2)	(3)	(4)
CPI	99.876*** (10.149)	25.151* (9.919)	84.074*** (9.499)	221.363*** (26.256)
Growth in GDP	-73.058*** (16.303)	-28.768 (15.617)	-54.689*** (15.135)	-42.285* (17.956)
Unemployment	20.122* (8.554)	112.758*** (7.764)	31.856* (13.204)	324.527*** (16.882)
Market Capitalization	.826* (.380)	1.481*** (.380)	1.507*** (.354)	8.305*** (.741)
Gross Domestic Savings	.000*** (.000)	.000*** (.000)	.000*** (.000)	.000*** (.000)
Patent Applications	.003** (.001)	.000 (.000)	-.018*** (.000)	.000 (.001)
Trademark Applications	-.029*** (.002)	-.023*** (.003)	-.012*** (.001)	-.040*** (.003)
Self-employment	-76.035*** (19.546)	-54.294* (22.360)	-6.693 (34.445)	-30.265 (22.477)
Corruption	179.087*** (18.805)	12.256 (20.459)	43.536 (32.434)	-571.568*** (49.152)
VC Equity Available Abroad	-.007** (.002)	.007* (.003)	.050*** (.004)	-.000 (.003)
VC Firm Previous IPOs	-.077 (.081)	-.057 (.064)	.014 (.062)	.052 (.061)
VC Firm Age	-.052 (.132)	-.021 (.092)	-.087 (.096)	-.017 (.092)
Start-up Age	-.053 (.228)	-.192 (.169)	-.301 (.205)	-.020 (.183)
Bank Capital to Assets			-10.403 (7.825)	
Banking Sector Leverage				-54.910***

				(4.494)
Constant	191.360**	-831.440**	209.040	1825.951***
	(203.110)	(279.429)	(695.232)	(423.514)
VC Firm Regional-Country Dummies	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES
Year Dummies	YES	YES	YES	YES
R^2	84.49%	90.09%	90.87%	90.37%
No. of observations	93,754	93,754	81,334	92,792

Table VIII. Marginal Effects of Lending Interest Rates on VC Fundraising, VC Demand and VC Investments

Lending Interest Rates	DV: Fundraising	DV: Demand	DV: investments			
			Low Demand Low Supply	Low Demand High Supply	High Demand Low Supply	High Demand High Supply
	[1]	[2]	[3]	[4]	[5]	[6]
1	24109.71***	17.569***	581.027***	-1232.285***	1021.203***	157.326*
	(1277.285)	(.527)	(46.514)	(45.633)	(50.812)	(68.366)
3.5	22491.79***	18.760***	982.785***	-450.808***	995.444***	767.020***
	(718.546)	(.192)	(17.386)	(21.837)	(24.225)	(34.908)
6	20873.86***	19.951***	1384.543***	330.668***	969.684***	1376.714***
	(161.682)	(.151)	(20.669)	(19.864)	(18.975)	(25.386)
8.5	19255.94***	21.142***	1786.301***	1112.146***	943.925***	1986.408***
	(401.190)	(.486)	(50.382)	(42.844)	(43.606)	(54.327)
11	17638.01***	22.332***	2188.059***	1893.623***	918.165***	2596.103***
	(959.555)	(.823)	(81.461)	(69.281)	(72.189)	(90.220)

*** $p < 0.001$, * $p < 0.05$.

Marginal effects keeping other covariates at mean values. Standard errors in parentheses.

Figure 1. The relationship between interest rates and VC fundraising. This figure shows the relationship between interest rates, measured by the level of lending interest rates, and VC investments, measured by the amount of equity capital invested by the VC firms (in millions of USD) in each year and location.
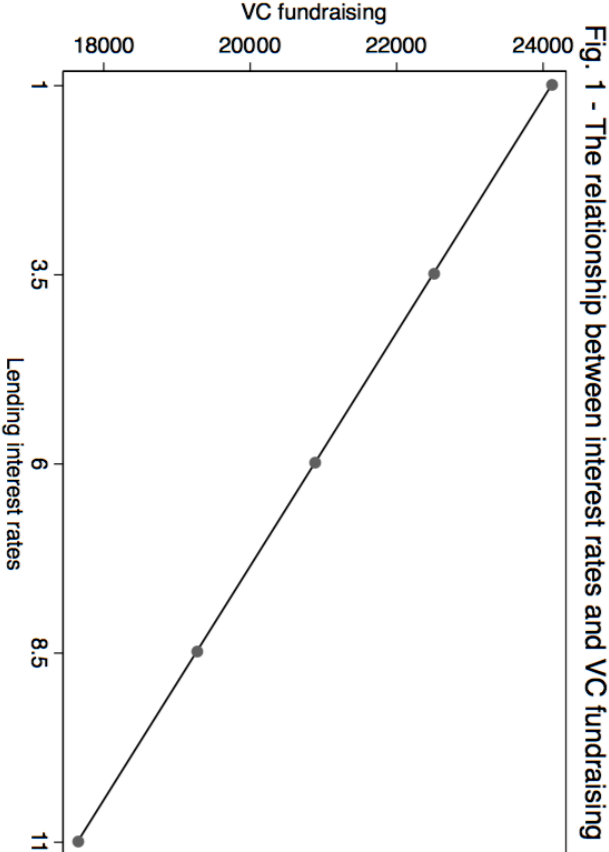

Fig. 1 - The relationship between interest rates and VC fundraising

Figure 2. The relationship between interest rates and VC investments. This figure shows the relationship between interest rates, measured by the level of lending interest rates, and VC investments, measured by the amount of equity capital invested by the VC firms (in millions of USD) in each year and location.
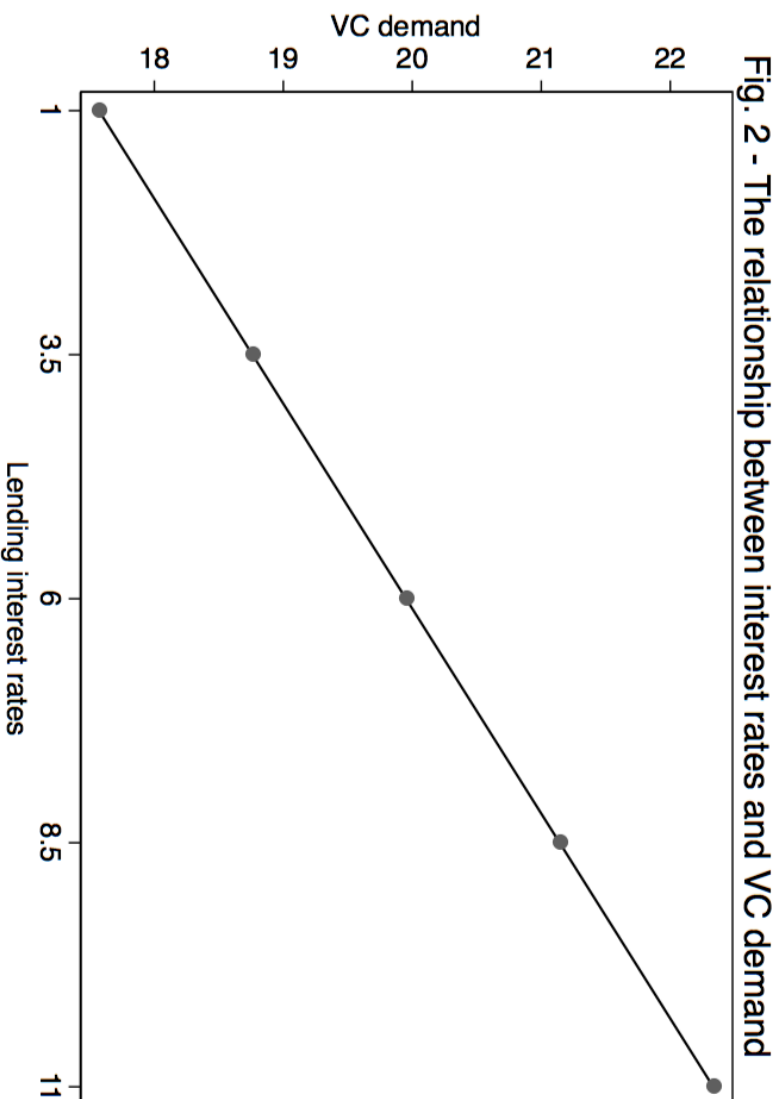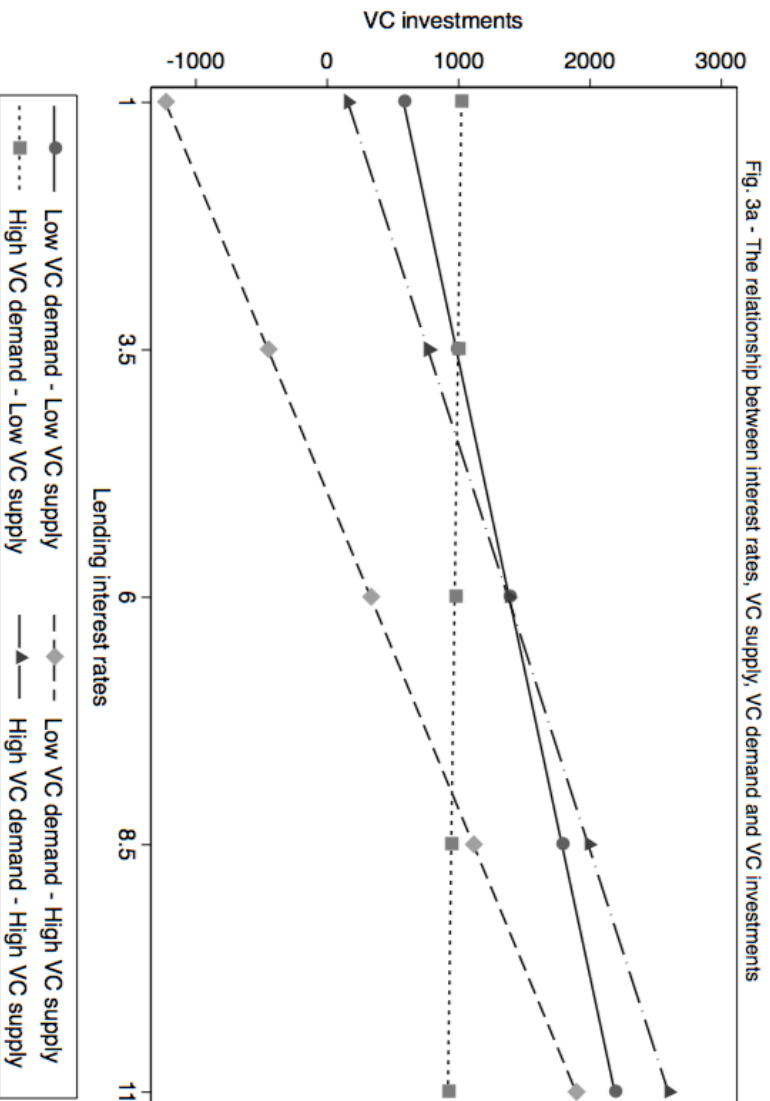

Fig. 2 - The relationship between interest rates and VC demand

Figure 3. The relationship between interest rates, VC supply, VC demand and VC investments. These figures shows the relationship between interest rates and VC investments contingent on the level of VC demand and supply. VC demand is measured by the level of self-employment while VC supply is measured by the VC equity raised for investment (in millions of USD). "Low VC demand" represents a level of self-employment 1 S.D. below the mean (self-employment = 6.6%), while "High VC demand" represents a level of self-employment 1 S.D. above the mean (self-employment = 20%). "Low VC supply" represents a level of VC equity raised 1 S.D. below the mean (VC equity raised = 1,000), while "High VC supply" represents a level of VC equity raised 1 S.D. above the mean (VC equity raised = 10,000). Both figures are based on the regressions reported in table VII but figure 3a is based on model 2, while figure 3b is based on model 3.
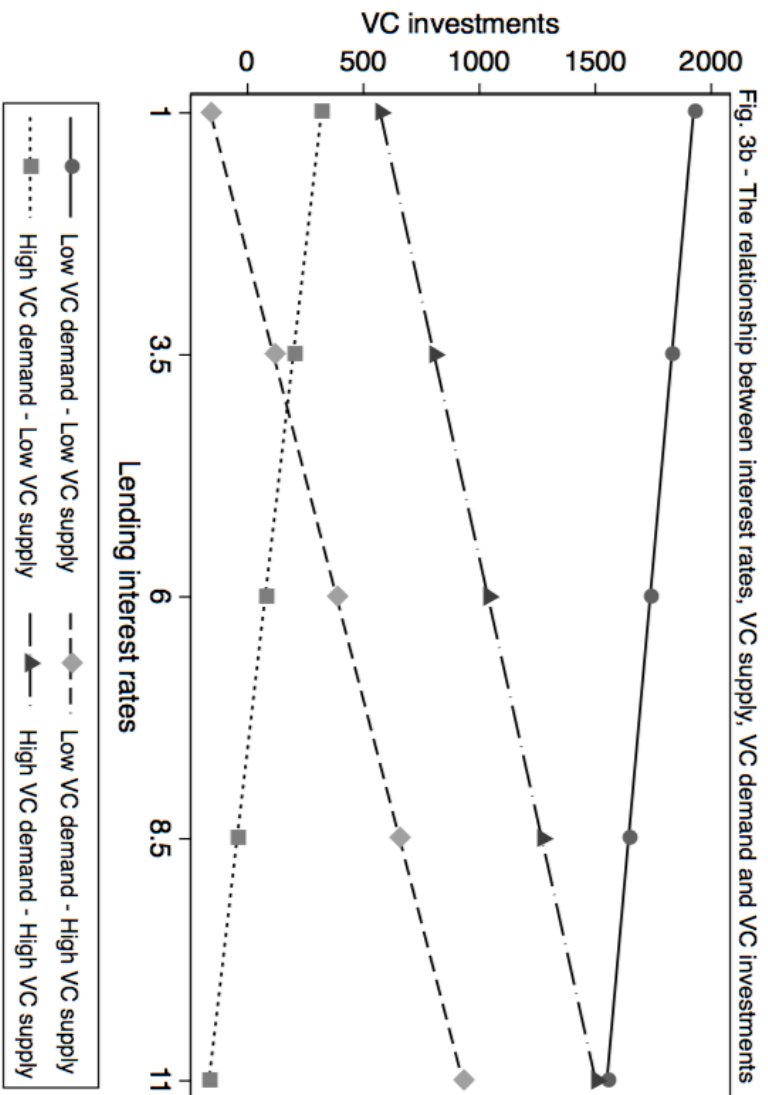

Fig. 3a - The relationship between interest rates, VC supply, VC demand and VC investments

Legend:
- Low VC demand - Low VC supply
- High VC demand - Low VC supply
- Low VC demand - High VC supply
- High VC demand - High VC supply

Fig. 3b - The relationship between interest rates, VC supply, VC demand and VC investments

Legend:
- Low VC demand - Low VC supply
- High VC demand - Low VC supply
- Low VC demand - High VC supply
- High VC demand - High VC supply

VC investments

Lending interest rates

Appendix. Definitions of Variables

Variable	Definition	Source
Lending Interest Rate	The lending interest rate (%) is specified in percent. "Lending rate is the bank rate that usually meets the short- and medium-term financing needs of the private sector." (Data Source Definition)	International Monetary Fund, International Financial Statistics and data files.
Amount Raised	Amount Raised in Range ($ Mil): This variable accounts of the amount of VC equity fundraised. For this variable, we used regional data for the US and national data for all other countries. (Data Source Definition)	Thomson One Banker
Known Equity Invested	Known Equity Invested ($ Mil): This variable accounts for the amount of known VC equity invested. For this variable, we used regional data for the US and national data for all other countries. (Data Source Definition)	Thomson One Banker
VC Demand (internet searches)	VC Demand (internet searches): The level of Internet searches on Google for the term "venture capital". We normalize this measure by comparing the searches in each location vis-à-vis the national U.S. searches. This measure ranges from 0 to 100.	Google Trends
FDI	Foreign direct investment, net inflows (% of GDP): "Foreign direct investment are the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series shows net inflows (new investment inflows less disinvestment) in the reporting economy from foreign investors, and is divided by GDP. " (Data Source Definition)	International Monetary Fund, International Financial Statistics and Balance of Payments databases, World Bank, International Debt Statistics, and World Bank and OECD GDP estimates.
CPI	Inflation, consumer prices (annual %): "Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. The Laspeyres formula is generally used." (Data Source Definition)	International Monetary Fund, International Financial Statistics and data files.

Term	Definition	Data Source
Growth in GDP	GDP growth (annual %): "Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2005 U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources." (Data Source Definition)	World Bank national accounts data, and OECD National Accounts data files.
Unemployment	Unemployment, total (% of total labor force) (national estimate): "Unemployment refers to the share of the labor force that is without work but available for and seeking employment. Definitions of labor force and unemployment differ by country." (Data Source Definition)	International Labour Organization, Key Indicators of the Labour Market database.
Market Capitalization	Market capitalization of listed domestic companies (% of GDP): "Market capitalization (also known as market value) is the share price times the number of shares outstanding (including their several classes) for listed domestic companies. Investment funds, unit trusts, and companies whose only business goal is to hold shares of other listed companies are excluded. Data are end of year values."(Data Source Definition)	World Federation of Exchanges database.
Gross Domestic Savings	Gross domestic savings (% of GDP): "Gross domestic savings are calculated as GDP less final consumption expenditure (total consumption)."(Data Source Definition)	World Bank national accounts data, and OECD National Accounts data files.
Patent Applications	Patent Applications: "Patent applications are worldwide patent applications filed through the Patent Cooperation Treaty procedure or with a national patent office for exclusive rights for an invention--a product or process that provides a new way of doing something or offers a new technical solution to a problem. A patent provides protection for the invention to the owner of the patent for a limited period, generally 20 years." (Data Source Definition)	World Intellectual Property Organization (WIPO), WIPO Patent Report: Statistics on Worldwide Patent Activity. The International Bureau of WIPO assumes no responsibility with respect to the transformation of these data.

Variable	Definition	Data Source
Trademark Applications	Trademark Applications: "Trademark applications filed are applications to register a trademark with a national or regional Intellectual Property (IP) office. A trademark is a distinctive sign which identifies certain goods or services as those produced or provided by a specific person or enterprise. A trademark provides protection to the owner of the mark by ensuring the exclusive right to use it to identify goods or services, or to authorize another to use it in return for payment. The period of protection varies, but a trademark can be renewed indefinitely beyond the time limit on payment of additional fees. Direct resident trademark applications are those filed by domestic applicants directly at a given national IP office." (Data Source Definition)	World Intellectual Property Organization (WIPO), WIPO Patent Report: Statistics on Worldwide Patent Activity. The International Bureau of WIPO assumes no responsibility with respect to the transformation of these data.
Self-employment (%)	Self-employed, total (% of total employed): "Self-employed workers are those workers who, working on their own account or with one or a few partners or in cooperative, hold the type of jobs defined as a "self-employment jobs." i.e. jobs where the remuneration is directly dependent upon the profits derived from the goods and services produced. Self-employed workers include four sub-categories of employers, own-account workers, members of producers' cooperatives, and contributing family workers." (Data Source Definition)	International Labour Organization, Key Indicators of the Labour Market database.
Corruption	Corruption index (ICRG): Corruption in government index. Low ratings indicate "high government officials are likely to demand special payments" and "illegal payments are generally expected throughout lower levels of government" in the form of "bribes connected with import and export licenses, exchange controls, tax assessment, policy protection, or loans." Scale from 0 to 10. Average of the months of April and October in the monthly index between 1982 and 1995." (Data Source Definition)	La Porta, R., López-de-Silanes,F., Shleifer, A. and Vishny, R. (1999). "The Quality of Government", *Journal of Law, Economics and Organization*.
VC Equity Available ($ mil)	*VC Equity Available ($ mil)*: This variable is the sum of all fund sizes in a given year in the focal country. This is a measure that captures VC offer in the focal country.	Thomson One Banker
VC Equity Available Abroad ($ mil)	*VC Equity Available Abroad ($ mil)*: This variable is the sum of all fund sizes in a given year outside of the focal country. This is a measure that captures VC offer around the world.	Thomson One Banker

Variable	Description	Source
Start-up Age	Start-up Age: This measure captures the age of a start-up.	Thomson One Banker
Number of IPOs	Number of IPOs: This measure captures the VC firm successful experience. It is measured by the amount of IPOs that the VC firm had up to the focal year.	Thomson One Banker
VC Firm Age	VC Firm Age: This measure captures the age of the focal VC firm in years.	Thomson One Banker
Banking Sector Leverage	Banking Sector Leverage: "This indicator presents the ratio between the financial assets of the banking sector and their equity, also known as the equity multiplier ratio. Leverage is computed as the ratio of selected financial assets to total equity." (Data Source Definition)	OECD Data (https://data.oecd.org/corporate/banking-sector-leverage.htm)
Banking Sector Capital to Assets Ratio	Banking Sector Capital to Assets Ratio: "Ratio of bank liquid reserves to bank assets is the ratio of domestic currency holdings and deposits with the monetary authorities to claims on other governments, nonfinancial public enterprises, the private sector, and other banking institutions." (Data Source Definition)	World Bank Data