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Essays On Entrepreneurial Financing

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Abstract

This thesis consists of three chapters on the impact of different government policies on entrepreneurial financing. In the first chapter, by quantitatively evaluating the impact of different personal bankruptcy regimes on entrepreneurship in a life-cycle model with occupational choices, I conclude that personal bankruptcy law affect entrepreneurship mainly through the insurance effect rather than the borrowing cost effect. In addition, I find that variations in bankruptcy regimes have very different impacts on households with different abilities, and changes in the length of post-bankruptcy punishments have the largest impact on entrepreneurship compared to variations in other dimensions of the bankruptcy regime. In the second chapter, I demonstrate in a model that firms could be credit-constrained due to aggregate uncertainty and the government could offer insurance in the form of loan guarantees to ease borrowing constraints for small businesses, thus increase the efficiency of the overall economy. The third chapter shows that different regulation on equity financing by financial institution could be an explanation for the large disparity in sectoral allocation of investments by Venture Capital industries between developed countries. I develop a simple principal-agent model shows that when three commonly documented characteristics of the high-tech industry coexist, the ability for lenders to vary the level of control contingent on performance becomes key. Thus venture capitalists as equity holders have a clear advantage in financing young high-tech firms in countries where equity financing from banks is not allowed.

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London, Canada — Ye Jia
Dec 22, 2010

To my Parents, and my wife Xin Zhan.

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Chapter 1

Introduction

My dissertation consists of three separate papers on entrepreneurial financing. A unifying theme in this work is the impact of government policies on entrepreneurship. Different types of government policies could have large impact on the financing of entrepreneurial firms, and thus have the potential to greatly shape a country/region's entrepreneurial sector.

The first chapter examines the impact of personal bankruptcy laws on entrepreneurship. Limited personal liability has long been thought to promote entrepreneurship by providing partial insurance through debt relief in the event of business failure. However, providing this insurance through debt relief makes borrowing more costly and tightens borrowing constraints. To examine the quantitative effects of these two opposing forces on entrepreneurship, I study a life cycle model where households choose between running a risky business and working. Households in the model differ in entrepreneurial abilities and face both labor income and business productivity risks. I calibrate the model to the U.S. economy, and then consider the effect of alternative personal bankruptcy regimes. For reasonable parameter values, a less lenient (higher post bankruptcy garnishment of income) bankruptcy law deters households with moderate entrepreneurial ability from entering entrepreneurship, while variations in bankruptcy systems have negligible effects on higher ability households' occupational choice decisions. The effect of personal bankruptcy law on the level of entrepreneurship is driven primarily by the insurance effect rather than the borrowing cost effect. Consequently, entrepreneurs prefer more lenient bankruptcy regimes that provide higher insurance values.

The second chapter assesses whether insurance against aggregate risk (such as the current economic downturn) could be an important rationale for popular government operated loan-guarantee programs for small and medium enterprises (SME). I demonstrate in a model that firms could be credit-constrained due to aggregate uncertainty, because financial institutions face high borrowing cost during economic downturns. Since it has relatively lower borrowing costs during recession, the government could offer insurance in the form of loan guarantees to ease borrowing constraints for small businesses. I prove that under certain conditions, a program with net present value of zero could be socially beneficial. Furthermore, I show that a guarantee program with a fixed fee is associated with adverse-selection, and leads to the "over-lending" problem. Thus, the high cost of obtaining guarantees and thorough qualification requirements can be viewed as tools to mitigate this problem.

The third chapter shows that different regulation on equity financing offered by financial institution could be an explanation for the large disparity in sectoral allocation of Venture Capital (VC) investments between developed countries. During the 1990s, various European governments introduced policies that encourage VC investments with the hope of replicating the U.S. VC industry's success in financing high-tech firms. Recent data suggests that VC investments concentrate in high-tech sectors only in those countries where banks are not allowed to offer equity financing. To help explain this fact, I develop a simple principal-agent model of start-up financing with both private information and hidden actions, where the equity investor can vary the level of control over the firm and the debt investor cannot. The model shows that when three commonly documented characteristics of the high-tech industry coexist, namely: (i) a high degree of information asymmetry, (ii) a high level of uncertainty about returns, and (iii) a large amount of R&D investment preceding production, then the ability for lenders to vary the level of control contingent on performance becomes key. Unlike debt, equity ownership provides control over a firm during normal operations. Thus venture capitalists as equity holders have a clear advantage in financing young high-tech firms in countries where equity financing from banks is not allowed; in countries with no such restriction, they no longer have this advantage. This result helps explain why most

European governments' efforts in promoting VC activities failed to attract such investments in high-tech industries.

Chapter 2

The Impact of Personal Bankruptcy Law on Entrepreneurship

2.1 Introduction

Personal bankruptcy is often used as an exit strategy for failing small businesses that are solely owned, since business debts of sole proprietorships are legally personal liabilities.[1] In addition, owners of small corporations are frequently asked to provide personal guarantees when applying for business loans.[2] Hence, most small business owners file for personal bankruptcy when they are in financial distress. In fact, Lawless and Warren (2005) reported that up to 20% of personal bankruptcy filings are attributable to small business failures

[1] In the U.S., more than 78% of businesses are sole proprietorships; the number is even higher in Europe, at around 82%.

[2] Berger and Udell (1998) examine the data from the Survey of Small Business Financing, find that up to 52% of all small business loans from financial institutions have personal guarantees against them, and 93% have either personal guarantees or personal assets against them.

in the U.S.

There is considerable differences in personal bankruptcy regimes across developed countries that offer such option to individuals. In the U.S., a Chapter 7 filing provides debtors with a "fresh start" by discharging all unsecured debts in exchange for all (non-exempted) assets. A crucial feature of Chapter 7 is that all future income of the filer is protected. In contrast, most other developed countries require filers to repay debts from both assets and post-bankruptcy income. For instance, the length of post-bankruptcy income garnishment currently ranges from no year in U.S. to 6 years in Germany to 8-10 years in France. Since Personal bankruptcy is important for entrepreneurs, one would expect there is a link between these cross-country differences in personal bankruptcy regimes and differences in entrepreneurship.

This chapter examines the quantitative effects of different personal bankruptcy regimes on entrepreneurship, output, and welfare. Many have argued that an entrepreneur-friendly bankruptcy law has helped to create a more vibrant entrepreneurial sector in the U.S. Recently, heated debates among policy-makers in Europe led to reforms of personal bankruptcy regimes in the region (White, 2007; Armour and Cumming, 2008): Germany introduced its first personal bankruptcy law in 1999 and subsequently reduced the length of post-bankruptcy garnishment periods; and there is also an initiative to reduce the harshness of personal bankruptcy at the EU level.[3] However, the impact of different aspects

[3]Clearly going toward the other direction, U.S. introduced the *Bankruptcy Abuse Prevention and Consumer Protection Act* in 2005, which made it more difficult for individuals to obtain

of personal bankruptcy regime on entrepreneurship deserves a more careful investigation.

How does personal bankruptcy law affect entrepreneurship? On the one hand, personal bankruptcy provides small business debtors partial insurance by offering an option to discharge debt in case of business failures. This makes borrowing to start a risky business more attractive since it reduces the cost of failure by limiting the borrower's liability. It increases business owners' abilities to smooth across states in an incomplete market by giving some contingency to the debt contract. However, this insurance comes at a price, since financial intermediaries charge a higher premium on loans to cover default risks, which makes borrowing more costly and tightens the borrowing constraint. Thus, as personal bankruptcy weakens entrepreneurs' ability to commit to future debt repayment, it decreases their ability to invest at the efficient scale. This trade-off suggests that any evaluation of bankruptcy regimes needs to consider the effect on borrowing costs and constraints versus the value of insurance against "bad lucks"[4].

This trade-off is especially relevant for entrepreneurship because there is a large literature on financial constraints for entrepreneurs (Evans and Leighton, 1989; Evans and Jovanovic, 1989). On the borrowing cost side, Berkowitz and White (2004) find that it is harder to get financing for entrepreneurs in U.S.

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a discharge from indebtedness, although it is intended to prevent abuse of the bankruptcy system (White, 2007). Small business debtors, however, were specifically excluded from these changes (Armour and Cumming, 2008).

[4]Livshits, MacGee, and Tertilt (2007) examine a similar trade-off for consumers .

states with generous asset exemptions.[5] On the insurance side, there is evidence to suggest that the "insurance effect" of personal bankruptcy actually dominates in determining the level of entrepreneurship. Fan and White (2003) find that the probability of households owning businesses is 35% higher in states with unlimited as opposed to low exemptions. Many empirical studies on cross-country differences in bankruptcy laws have also found that people are less likely to become entrepreneurs in countries with less "forgiving" regimes (Lee, Yamakawa, and Peng, 2007; Armour and Cumming, 2008).

To quantify the impact of personal bankruptcy law on entrepreneurship, I construct an incomplete market life-cycle model with occupational choice. Households differ in entrepreneurial abilities, they make repeated occupational choices between working and running a risky business, and they (workers and entrepreneurs) also make bankruptcy decisions, taking a bankruptcy system as given. Workers face uninsurable idiosyncratic labor income risk, and entrepreneurs face uninsurable idiosyncratic productivity risk, where the production risk is higher compared to the labour income risk. But they face the same bankruptcy law. Firms operated by different ability entrepreneurs are assumed to have different probability distributions over a finite number of productivity realizations, such that those businesses run by high-ability households are more likely to get higher productivity draws compared to those run by low-ability households.

[5] In the U.S., all states have their own specific asset exemptions for Chapter 7 bankruptcy. For instance, homestead exemptions range from $5,000 in Georgia to unlimited in Florida (as long as the property does not exceed half an acre in a municipality or 160 acres elsewhere).

A bankruptcy regime is exogenously given and specifies the following: 1) the length of post-bankruptcy income garnishment; 2) the income exemption level; 3) the fraction of income garnisheed above exemption level; and 4) the asset exemption level, which captures the main ways that personal bankruptcy laws differ across countries. Households can save or borrow via one period non-contingent bonds in a perfect competitive financial market. Intermediaries can observe a household's current labor income shock, entrepreneurial ability level, current level of borrowing, level of business capital, and age. Hence, intermediaries charge a default premium according to the individual-specific risk of each loan. As an equilibrium result, the price of loans is a function of all these observables.

In this model, an increase in the severity of bankruptcy punishment (i.e., lowering exemption levels or increasing the fraction or length of post bankruptcy-income garnishment) decreases the endogenous household default probability and raises the expected repayments from bankruptcy filers, thereby relaxing the borrowing constraints. As a result, households are also less willing to take risks, as the insurance value provided by the bankruptcy system decreases.

I first calibrate the model to match several key moments of the U.S. economy, and then consider the steady-state effects of alternative personal bankruptcy regimes on the calibrated U.S. economy. Specifically, I start with the calibrated model and perform the following four sets of counterfactual experiments: in the first two, I separately vary the length and the fraction of post-bankruptcy income garnishment; in the third experiment, I vary the level of asset exemption level; lastly, I set bankruptcy regimes in four counterfactuals to replicate the regimes of Canada, the UK, Germany, and France.

The key insight from these counterfactual exercises is that variations in bankruptcy regimes have very different impacts on households with different entrepreneurial abilities. First, variations in bankruptcy regimes have negligible effects on the occupational choices of households with high entrepreneurial ability, because businesses run by these entrepreneurs are less risky (i.e., severe failures are less likely to occur for them). Second, harsh bankruptcy punishments mainly deter households with moderate entrepreneurial ability from entering entrepreneurship, since failure is more likely to happen, so variations in bankruptcy policy have a much bigger impact on their occupational decisions. In other words, this quantitative exercise suggests that the insurance effect of personal bankruptcy law on entrepreneurs completely dominates the borrowing cost effect, mainly through affecting the occupational decisions of households with moderate ability levels. As a result, the extensive margin effect of a more lenient personal bankruptcy regime is to encourage more households to undertake risky entrepreneurship,[6] although, these additional businesses are less productive because the households on the margin are those with moderate entrepreneurial abilities. On the "intensive margin," a more lenient personal bankruptcy regime lowers the average firm size, because, first,

[6]This finding agrees with the empirical results of Armour and Cumming (2008) and White (2007).

the firms on the margin are run by moderate ability households, their lower expected productivity means they want to operate at a smaller scale; second, more lenient regime increases borrowing cost, which limits entrepreneurs' ability to invest at the efficient scale.

Although the model suggests that a more lenient bankruptcy regime leads to a drop in average firm size and average productivity in the entrepreneurial sector, the total output of the economy actually rises. This is because risk-averse households choose to pursue entrepreneurship only if the expected business return is much higher than the sum of expected wage income and the risk-free return of the investment, such that the difference between the two is large enough to compensate for the risk that the household is undertaking. Consequently, entrepreneurial households prefer more lenient regimes because they bear more risks compared to worker households, so the insurance value provided by personal bankruptcy is more important to them. On the other hand, worker households prefer less lenient regimes because labour income risk is more moderate compared to business risk, such that they care more about the ability to smooth consumption across time through borrowing.

Among different dimensions of personal bankruptcy law, variations in the length (periods) of post-bankruptcy punishment appear to have the largest impact on entrepreneurship; changes in fraction of garnishment also have large impact. Increase in length and fraction of post-bankruptcy garnishment monotonically lowers the level of entrepreneurship and discourages moderate-ability households from entering entrepreneurship. On the other hand, changes in the asset exemption level only have a modest effect. In particular, increasing the asset exemption level encourages entrepreneurship first and then discourages it once past a certain level. This inverted U-relationship between the two is consistent with the findings of Akyol and Athreya (2011) and Meh and Terajima (2008).

Given that the bankruptcy code mainly affects the occupational decisions of households with moderate ability levels, the model replicates three key facts on cross-country differences in entrepreneurship: less lenient bankruptcy regimes are associated with 1) lower levels of entrepreneurship,[7] 2) higher proportions of bigger and maturer firms in the economy, and 3) lower business turnover rates. The ability of the model to account for these facts is driven by the result that tougher bankruptcy law reduces the fraction of moderate-ability entrepreneurs in the economy, while higher ability entrepreneurs (whose occupational decisions are rarely affected by change in bankruptcy regimes) operate bigger firms and they survive longer. Thus, an increase in the level of entrepreneurship lowers the average productivity in the entrepreneurial sector, because the firms on the margin are operated by moderate-ability households. Note that these results depend on the crucial assumption that the households' entrepreneurial ability determines the likelihood of suffering severer failures. One support for this view is the observation that older firms are less likely to

[7]This result is consistent with the empirical findings of Armour and Cumming (2008), who estimated that a ten year reduction of garnishment time increases the self-employment rate by 1.5%.

fail compared to younger firms.

The chapter is organized as follows. Section 2 reviews the related empirical and theoretical literature. Section 3 documents different personal bankruptcy regimes and some empirical facts of entrepreneurship across some developed countries. Section 4 describes the model. The benchmark parameterizations are presented in Section 5. Section 6 shows the counterfactual results. Section 7 concludes.

2.2 Literature Review

In addition to the study of Armour and Cumming (2008), which shows that more lenient bankruptcy regimes are associated with an increase in the self-employment rate in their sample of fifteen countries over sixteen years, this chapter is also related to other empirical literatures on the impact of bankruptcy policies on entrepreneurship. White (2007) shows that the probability of becoming self-employed is higher in states with higher homestead exemptions in the U.S. Berkowitz and White (2004) find that it is harder for small business owners to get external financing in U.S. states with high asset exemptions. Paik (2010) in a recent paper finds that the probability of becoming self-employed within unincorporated firms declined after the bankruptcy reform act of 2005, which made qualifying for Chapter 7 bankruptcy harder. However, these works are likely to suffer from country- or state-specific effects, such as tax rates or banking regulations. In another paper, Georgellis, Howard, university Consortium for Political, and Research (2006) investigate the impact of marginal income tax rates and bankruptcy exemptions on entrepreneurship, finding an S-shaped relationship between bankruptcy exemptions and entrepreneurship. This means that the relationship between asset exemption and levels of entrepreneurship is not monotone.

This chapter is closely related to Akyol and Athreya (2011), Meh and Terajima (2008), and Herranz, Krasa, and Villamil (2009), who also study macroeconomic models of occupational choice with the presence of a bankruptcy system. Akyol and Athreya (2011) study the effect of different asset exemption levels on entrepreneurship, and find that a personal bankruptcy system encourages entrepreneurship, and alters the timing, size, and financing of projects. In their model, high-ability households are assumed to have higher average productivity as entrepreneurs and workers, rather than affecting the distribution of productivity shocks. Meh and Terajima (2008) find that eliminating asset exemption increases the level of entrepreneurship and welfare; but on the other hand, eliminating the bankruptcy system leads to a large fall in the level of entrepreneurship and welfare. Herranz, Krasa, and Villamil (2009) analyze the impact of owners' personal characteristics such as risk tolerance or optimism and the bankruptcy system on firm performances, finding that reducing bankruptcy exclusion periods can lead to large welfare gains. They find that the welfare effects for firm owners are much greater than in those consumer studies and that the insurance effect of corporate bankruptcy is more important than the interest rate effect, which agrees with the finding of this chapter.

This chapter differs in three key ways from these earlier papers: first, households have different entrepreneurial abilities in my model. For instance, higher-ability households' are less likely to face severe failures compared to moderate-ability households and are more likely to experience higher productivity shocks.[8] This is a natural assumption because certain individuals are better fitted to run businesses, as in the Lucas (1978) span-of-control type of frame work. These additions allow me to derive the implied productivity differences in the entrepreneurial sectors under each bankruptcy regime, which arises from variations in the quantity (extensive margin) and quality (intensive margin) of entrepreneurs. Second, this model features variation in length of post-bankruptcy garnishments. This is important because personal bankruptcy laws in developed countries differ from each other mainly along this dimension. In fact, I show that variations in the length of post-bankruptcy punishments have the largest impact on entrepreneurship compared to variations in other dimensions of the bankruptcy regime. Third, liquidation costs are incorporated in this chapter. As discussed in many studies, the value of

[8]As opposed to Akyol and Athreya (2011), who assume that only the average productivity depends on ability, I assume that the support for productivity draw is the same regardless of ability, but the distribution over the set is different. I.e, if two identical firms are run by entrepreneurs with different ability, the possible outcomes of the businesses are the same, but the higher ability entrepreneurs is more likely to get good outcomes. It is difficult to imagine that two identical firms run by different ability entrepreneurs could both fail badly (or have tremendous success) but generate large difference in their losses (returns).

capital lost in the liquidation process can be substantial: the average liquidation costs cited range from 36.5% to 45% (Shleifer and Vishny, 1992). This has a large influence on the occupational decisions of entrepreneurs who are not doing well, because it substantially increases the cost of quitting business.

There are also other theoretical studies of default and entrepreneurship: Cagetti and De Nardi (2006) study a model of similar occupation choices and find that tighter borrowing constraints generate less wealth concentration and reduce average firm size, aggregate capital, and the fraction of entrepreneurs. In their model, however, limited commitment only limits borrowing, as production is risk-less, so default does not occur in their equilibrium, such that there is no trade-off between insurance effect and borrowing cost effect. Landier (2005) studies a multiple-equilibrium model based on endogenous stigma of failure, in which the cost of failure depends on the particular equilibrium outcome. In his model, there is only the continuation decision and no occupational choice, and the cost of quitting business does not depend on any particular bankruptcy regime.

A number of recent papers have studied the economic effects of personal bankruptcy law on consumers in dynamic equilibrium models. Livshits, MacGee, and Tertilt (2007) study a model with income garnishment that allows interest to vary with household characteristics such as age, loan size, and income shock. They showed that the U.S. Chapter 7 system leads to welfare gain compared a system that has no personal bankruptcy, as was the case in Germany prior to 1999. They also show that expense shocks and life-cycle effects are important factors to consider when comparing bankruptcy regimes. Chatterjee, Corbae, Nakajima, and Rios-Rull (2007) examine a similar model without life cycle and expense shocks; their results show that mean-testing under Chapter 7 leads to large welfare gains. Athreya (2008) incorporates social insurance policy in a similar setting, and finds that the U.S. bankruptcy system creates severe credit constraints, eliminating bankruptcy lowers (raises) consumption inequality among the young (old). He also argues that the social insurance policy is an important factor to consider when evaluating the effect of bankruptcy policy on consumption smoothing. In an earlier paper, Athreya (2002) builds on Aiyagari (1994), assuming one interest rate for all and finding that eliminating the bankruptcy system improves welfare. Li and Sarte (2006), in a similar setting to Athreya (2002), incorporate aggregate production and a partial asset exemption as well as the choice between Chapter 7 and 13 in the model and find that eliminating the bankruptcy system reduces welfare. Clearly, though, these models do not account for risk-taking entrepreneurial activities.

2.3 Entrepreneurships and Personal Bankruptcy Law Across Countries

This section first presents the differences in personal bankruptcy law for five developed countries: the U.S., Canada, the UK, Germany, and France.[9] Key statistics of entrepreneurship for the five countries are presented next.

Personal bankruptcy regimes vary in five key dimensions across countries: 1) the length of the repayment obligation (periods of post-bankruptcy garnisheeing); 2) the income exemption; 3) the fraction of income above exemption level that is garnisheed; 4) the asset exemption; and 5) other punishments. A bankruptcy policy is more "forgiving" or lenient if exemption levels are higher and the fraction that is garnisheed, length of repayment period, and other punishments are lower.

Table 2.1 summarizes the details of personal bankruptcy regimes in five countries at year 2004[10]: France, Germany, the UK, Canada, and the United States. The first four countries require borrowers to repay from both assets

[9]This group of five developed countries are selected because entrepreneurship data from GEM and data on bankruptcy regimes (taken from White (2007)) are readily available. There is a group of other similar European developed countries just simply do not offer discharge option to individuals, for instance Spain, Switzerland and Italy. Japan did not offer such option until 2005.

[10]Most statistics about entrepreneurship in this chapter are taken from around 2003-2004; the personal bankruptcy laws around this period are the most relevant ones. Germany only introduced its personal bankruptcy law in 1999. A couple of countries changed their laws after 2004: the U.S. introduced the *Bankruptcy Abuse Prevention and Consumer Protection Act* of 2005, and UK reduced the repayment period from three to one year later. For more detail, see White 2007.

and subsequent income after bankruptcy.[11] French bankruptcy law is the least "forgiving" (or the most pro-creditor): exemptions are low, most income above exemption level is garnisheed, and the repayment period can last up to ten years. U.S. Chapter 7, on the other hand, is the most "forgiving" (or most pro-debtor) : the asset exemption level is very high, and there is no garnisheeing of post-bankruptcy income. It should be clear that the countries in Table 2.1 are organized in order: from left to right is the least to the most lenient system.

Table 2.2 gives seven key entrepreneurship statistics for these five countries: 1) proportion of the adult population that owns and manages a business;[12] 2) proportion of young firms;[13] 3) fraction of survey respondents reply as being self-employed (European Union 2004);[14] 4) fraction of businesses younger than 3 years; 5) proportion of firms with zero employees; 6) fraction of employer firms with fewer than 20 employees; and 7) annual entry/exit rate. The first two statistics are taken from the Global Entrepreneurship Monitor 2003 global report, while the third and fourth are taken from Flash Eurobarometer Survey 160, which was conducted in 2004 for the European Union.[15] Statistics on the

[11] Although the Canadian bankruptcy law includes rules for post bankruptcy garnishment, most filers actually do not have pay from their future income. This will be addressed in the counterfactual experiment.

[12] The definition of entrepreneur here follows that of the GEM's, i.e an individual between the age of 18-64 who are currently owner-manager of an established business.

[13] In the survey, a new business owner is defined as an owner-manager of a firm that has paid wages or salaries for more than 3, but less than 42 months

[14] The definition in this survey is different from that of the GEM's, i.e being self-employed vs. owner-manger of a business.

[15] These survey data are used because that government-published statistics differ quite a bit in definitions of entrepreneurs (even in the definition of self-employment, for that matter) and methodology used for measurement across countries. These survey data, on the other hand, are collected in a consistent fashion across countries: all the questionnaires and conducting

proportion of employer firms with fewer than twenty employees and entry/exit rates are from Bartelsman, Haltiwanger, and Scarpetta (2007).

There are three observations about these statistics: first, there exists a positive relationship between the leniency offered by a country's bankruptcy regime and its level of entrepreneurship. In the GEM 2003 data, France, whose has the toughest bankruptcy law, has the smallest proportion of adult population identified as entrepreneurs, 4.22%, versus 7% for Germany, 8.8% for the UK, 9.7% for Canada, and 10.6%[16] for the U.S. The same pattern is observed in the Flash Eurobarometer Survey 160 data.[17] Second, there seems to exist a negative relationship between how pro-creditor a bankruptcy regime is and the share of maturer firms in the economy; thus, the business turnover rate is higher for those countries with more "forgiving" regimes. This trend is observed consistently across different measures and data sources as well. Third, there is also weak evidence that suggests that countries with less "forgiving" regimes also have lower shares of smaller firms. To summarize, countries with less lenient (more pro-creditor) personal bankruptcy regimes have fewer entrepreneurs, and they also have higher shares of larger firms, higher shares of older firms, and lower business turnover rates.

methodology are the same for all participating countries.

[16]There are several data sources that report U.S. has a low self-employment rate when compared to others, this is due to the definition of self-employment across countries. For instance, in the U.S. official data, a self-employed individual for a corporation is not counted towards self-employment, but is counted in the Canadian data. Which gives reason to use the survey data from GEM here.

[17]The large deviation in scale between these two different measures is because that the GEM's number is owner-manager out of the adult population, while Eurobarometer measures self-employment out of survey replies.

These observations suggest that the "quality" of active entrepreneurs is higher in countries with tougher bankruptcy laws. In general, better firms would grow bigger and survive longer, which is the reason behind the selection effect of tough bankruptcy law on entrepreneurs: moderate-ability entrepreneurs do not start businesses and high-ability ones get to grow their businesses bigger and longer partially because of the lowered borrowing costs.

2.4 Model

I extend the model of Livshits, MacGee, and Tertilt (2007) to include occupational choice and small business ventures. This is a life-cycle model. Each generation lives for J periods (including retirement periods), is comprised of a continuum of ex-ante identical households of measure 1. Households maximize discounted life-time utility from consumption, face idiosyncratic uncertainty about labour income and business return. There is no aggregate uncertainty, and the risk-free interest rate is exogenously given. Markets are incomplete: the only assets in this economy are household-specific one-period, non-contingent bonds. There is no market for insurance.

2.4.1 Household

Each household maximizes its expected lifetime utility,

$$E_0 \sum_{j=1}^{J} \beta^{j-1} n_j u\Big(\frac{c_j}{n_j}\Big)$$

where $\beta \in (0, 1)$ is the intertemporal discount factor, c_j is the consumption at age j. $u(\cdot)$ is the with-in period utility function, where $u(\cdot)' > 0$, $u''(\cdot) < 0$. n_j is the equivalence scale unit of family size at age j. The introduction of family size is important to explain the hump-shaped consumption profile over the life cycle.[18]

For each period, households can choose either to work for labour income in the corporate sector or enter risky entrepreneurship for the next period, $e' \in \{0, 1\}$ (e stands for entrepreneur); unlike Meh and Terajima (2008), households cannot work and run a business at the same time. Following Livshits, MacGee, and Tertilt (2007), the labor income of household i at age j depends upon its labour productivity and endowment:

$$y_j^i = \epsilon_j^i \bar{y}_j$$

$$\epsilon_j^i = z_j^i \eta_j^i$$

where ϵ_j^i is the household's stochastic labour productivity at age j and $\bar{y}_j$ is the deterministic average life-cycle profile of earnings. The household's productivity is the product of persistent shock z_j^i and a transitory shock η_j^i.

[18]For detail, see Gourinchas and Parker (2002), Davies (1988), and Fernandez-Villaverde and Krueger (2004).

At the beginning of life (period 1), every household draws a permanent entrepreneurial ability level $\rho \in \{\underline{\rho}, ...\bar{\rho}\}$ (which does not change over time). This ability level ρ determines the household's distribution of idiosyncratic business productivity shock $\theta \in \{\underline{\theta}, ...\bar{\theta}\}$, so that while the realization of θ' is unknown, ρ is known by everyone before occupational choices are made. The distribution function of θ conditional on having the ability level ρ is denoted by $\Phi_\rho(\theta)$. I will assume that once conditioned on a particular ability level, θ is independent and identically distributed over time, independent of income shocks and having only finite support. The gross period return from a business is given by:

$$F(\theta, k) = f(\theta, k) + (1 - \delta)k = \theta k^\alpha + (1 - \delta)k$$

where $k \in [0, \infty)$ is the capital (asset) of the firm, $0 < \alpha < 1$ is the return-to-scale parameter, and δ is the deprecation parameter. Note that the actual return does not directly depend on ρ, although the distribution of θ does. In this model, households that decide to run a risky business are called entrepreneurs, while the remainder of the population is referred as workers.

2.4.2 Bankruptcy Regime

A household, either a worker or an entrepreneur, with debt level $d > 0$ has the option to declare bankruptcy; the household bankruptcy state is denoted $b \in \{0, 1\}$, with $b = 1$ indicating filed for bankruptcy. To capture the features of bankruptcy provisions across a number of different countries, this chapter incorporates the following. First and most importantly, post-bankruptcy income garnishment is incorporated. Secondly, period income and business assets used for repayment are treated differently. In contrast to labour income or income from a business that is almost costless to garnishee, the reported liquidation costs of business capital range from 36.5% to 45%.[19] In particular, the bankruptcy system in this model specifies five different type of costs frequently mentioned in the literature:

1. income garnishment: income of current and G periods after bankruptcy is garnisheed at rate γ and transferred to creditors subject to an exemption level $\bar{w}$;

2. liquidation of assets: business assets above the exemption level $\bar{x}$ are seized by creditors for liquidation, where the liquidation cost is ζ;

3. transaction cost: filers lose fraction λ of their consumption during the bankruptcy and garnisheeing period;

4. exclusion from entrepreneurship: filers cannot run a business during garnisheeing periods. [20]

5. exclusion from credit market: filers cannot borrow during the bankruptcy

[19] Liquidation costs are calculated as fraction of book value that is lost during the liquidation process

[20] Only Canada and the UK specifically state that bankrupts are not allowed to run a business during these periods; given the limited access to financial markets and heavy garnisheeing of income of other regimes, one's ability to start a business is effectively limited.

and garnisheeing periods.[21]

A household's garnishment status is denoted $g \in \{0, 1...G\}$, which is the number of garnishment periods left (i.e., a household not under garnishment has $g = 0$, while a household that just declared bankruptcy has $g = G$).

To illustrate how one's income and assets are treated after filing bankruptcy, it is convenient to define the amount of resources left after the bankruptcy decision-making as A. Specifically, if a household does not file for bankruptcy and is not under garnishment, A is simply:

$$A(d, k, \theta, \epsilon, e, g = 0, b = 0) = e \times F(\theta, k) + (1 - e) \times \epsilon \bar{y}_j - d \tag{2.1}$$

where $F(\theta, k)$ is the gross return from running a business. Note that $e = 0$ and $k = 0$ for a worker household.

The resources an entrepreneur with business capital size k, productivity shock θ, has left after declaring personal bankruptcy is given by:

$$\begin{aligned} &A(d, k, \theta, \epsilon, e = 1, g = 0, b = 1) = \\ &max\{f(\theta, k) - \gamma \max\{f(\theta, k) - \bar{w}, 0\}, 0\} + (1 - \zeta) \min\{(1 - \delta)k, \bar{x}\} \end{aligned} \tag{2.2}$$

Where $f(\theta, k)$ is the value of production, $\gamma \max\{f(\theta, k) - \bar{w}, 0\}$ is the amount that is garnisheed for repaying creditors, and the third is the post-liquidation value of business capital that is exempted. Similarly, for a worker with labour productivity ϵ and age j, the resources at hand after declaring bankruptcy are,

$$A(d, k, \theta, \epsilon, e = 0, g = 0, b = 1) = \epsilon \bar{y}_j - \gamma \max\{\epsilon \bar{y}_j - \bar{w}, 0\} \tag{2.3}$$

[21] I do not exclude households from saving, as it is not specified in bankruptcy laws. Furthermore, unlike loans, a financial institution is unlikely to reject deposits(or investments) based on one's credit history.

The resources at hand of a worker under post-bankruptcy income garnishment are (when $g > 0$)[22]:

$$A(d, k, \theta, \epsilon, e = 0, g > 0, b = 0) = \epsilon \bar{y}_j - \gamma \max\{\epsilon \bar{y}_j - \bar{w}, 0\} - d \tag{2.4}$$

2.4.3 Financial Intermediation

The set-up in the financial market follows closely the bankruptcy literature[23] in which the risk-free saving interest rate r^f is exogenously given.[24] Loans take the form of one-period bond contracts. The face value of these bonds is denoted by d, which is the amount to be received (repaid in the case of borrowing) the next period. The convention is that $d > 0$ denotes borrowing, and $d < 0$ denotes saving. The market for bonds is perfectly competitive.

While these loans are non-contingent because the face value does not depend on the realization of any value, the option to declare bankruptcy introduces a partial contingency. To capture the household-specific risk of bankruptcy, intermediaries charge household-specific bonds prices. When making loans, intermediaries are assumed to be able to observe the total level of borrowing, the size of the business, ability level, current earning shock, and household age.

[22] I do not consider garnisheeing of interest rate income because incorporating it greatly increases the computational intensity. Livshits, MacGee, and Tertilt (2007) mention that very few households save after declaring bankruptcy in their set-up, and it was not quantitatively important.

[23] Such as the work of Livshits, MacGee, and Tertilt (2007), Akyol and Athreya (2011), and Meh and Terajima (2008).

[24] This assumption constraints the model in a partial equilibrium setting. One might worry that the level of entrepreneurship might affects the overall capital market, which in turn affect the equilibrium risk-free interest rate. However, these kind of second order effects are likely small: first, the U.S. has an open capital market, in which the risk-free interest rate is determined internationally. Second, the small business loan market in the U.S. is relatively small, valued at $300 billion, only accounts for 0.3% of the U.S. $101 trillion capital market.

The price of a bond issued by a household of age j, an ability level ρ, with current labour productivity shock ϵ, and portfolio choice (d, k) is denoted by $q^d(d, k, \epsilon, \rho, j)$.

When making loans to households, intermediaries maximize the expected profit and incur a transaction cost τ per unit of loan. In equilibrium, perfect competition ensures that intermediaries earn zero expected profits on *each* loan they issue.[25] The actual realized profit from each loan can be positive or negative.

2.4.4 Timing within the Period

The model timing is as follows. At the beginning of a period, households observe their labour productivity and business productivity shocks (ϵ, θ). Given the realized value of (ϵ^i, θ^i), their beginning-of-period portfolio (d,k) and occupation e, households decide whether to file for bankruptcy or not. Note that households under garnishment are not allowed to file for bankruptcy. If a household files for bankruptcy, income is then garnisheed and assets above $\bar{x}$ are seized by the creditor; all unsecured debts are discharged, and the household is left with disposable income A as specified in (2.2) or (2.3), depending on occupation status. If a household is under garnishment (i.e., having filed for bankruptcy in the recent past), income is then garnisheed, and it is left with (2.4). Given the value of disposable income A, households then choose their

[25] This assumption is stronger than the typical zero profit condition, since we usually assume that the financial institution would make zero expected profit from its entire loan portfolio, which means it is possible to cross-subsidize between loans. The zero profit condition here does not allow intermediaries to do that.

current consumption c, occupation for the next period e', and portfolio (d', k'). The above is summarized in Figure 2.1.

2.4.5 Household's Problem

I define $V_j(\epsilon, A, g, \rho)$ to be the post-bankruptcy decision value function of an age-j household. Similarly, define $W_j(d, k, \epsilon, \theta, \rho, g, e)$ as the pre-bankruptcy decision value function of an age-j household whose beginning-of-period shocks, portfolio, and status as $(\epsilon, \theta), (d, k)$ and (ρ, g, e), respectively. The value function at age $V_{J+1}(.)$ is set to 0. The pre-bankruptcy decision value function of an age-j household is given by:

$$W_j(d, k, \epsilon, \theta, \rho, g, e) = \max_{b \in \{0,1\}} V_j(\epsilon, A, g, \rho) \tag{2.5}$$

where different disposable income A are defined as in (2.1) and (2.4) for $b = 0$, (2.2) and (2.3) for $b = 1$. The post bankruptcy decision value function is defined as follows:

$$V_j(\epsilon, A, g, \rho) = \max_{c, d', k', e'} u(\frac{c}{n_j}) + \beta E[W_{j+1}(d', k', \epsilon', \theta', \rho, g', e')|\epsilon, \rho] \tag{2.6}$$

subject to

$$\frac{c}{(1-\lambda)^{I(g,b)}} + k' - q^d(d', k', \epsilon, \rho, j)d' = A - L(k, e', d)\zeta k \tag{2.7}$$

$$g' = G \text{ if } b = 1 \tag{2.8}$$

$$g' = g - 1 \text{ if } g > 1 \tag{2.9}$$

$$c > 0, k' \in \{0, ...\bar{k}\} \tag{2.10}$$

Equation (2.7) is the budget constraint. The first term on the right-hand side is the disposable income at hand, A. On the left-hand side, c is the current consumption, d' is the bond position that is multiplied by its associated market price, and k' is the business capital for the next period. $I(g, b)$ is an identification function for transaction cost, which takes a value of 1 if $g > 0$ or $b = 1$, or 0 otherwise. If $e' = 0$, the household chooses to become a worker in the next period. If $e' = 1$ and $k' > 0$, the household becomes an entrepreneur in the next period. $L(\cdot)$ is an identification function for liquidation cost; it takes the value of 1 if an entrepreneur household decides to liquidate its business without filing for bankruptcy, or 0 in all other cases. Equations (2.8) and (2.9) are the law of motion for garnishment status.

2.4.6 Problem of Intermediaries

A competitive financial market implies that intermediaries make zero profits on unsecured debt made to each type of household. Thus, there is no cross-subsidization across different types of borrowers. Now, denote $\phi(d', k', \epsilon, \rho, j)$ as the probability that a household of age j, the ability level ρ, current labour shock ϵ, and portfolio choice (d', k') will declare bankruptcy tomorrow. The zero profit condition on loans to each type of household implies that:

$$q^d(d', k', \epsilon, \rho, j) = \bar{q}^d\{1 - \phi(d', k', \epsilon, \rho, j)[1 - E(\frac{\Gamma}{d'}|b = 1)]\} \tag{2.11}$$

where $\bar{q}^d = \frac{1}{1+r^f+\tau}$ is the price of unsecured loans $(d' > 0)$ when the probability of default is zero. $E(\frac{\Gamma}{d'}|b = 1)$ is the expected rate of recovery through garnishment of income and liquidation of assets, where Γ is defined as:

$$\Gamma = \begin{cases} \gamma \max\{\epsilon_j \bar{y}_j - \bar{w}, 0\} + GP(j, \epsilon), & \text{if } e = 0; \\ \gamma \max\{f(\theta, k) - \bar{w}, 0\} + (1 - \zeta)\max\{(1 - \delta)k - \bar{x}, 0\} + GP(j, \epsilon), & \text{if } e = 1. \end{cases}$$

where $GP(j, \epsilon)$ is the expected present value of post-bankruptcy income garnishment, which only depends on the household's age, current labour productivity shock, and the length of garnishments, that is:

$$GP(j, \epsilon) = E[\sum_{t=1}^{\min\{G, J-j\}} (\bar{q}^d)^t \gamma[\max\{\epsilon_{j+t}\bar{y}_{j+t} - \bar{w}, 0\}]|\epsilon_j] \tag{2.12}$$

Note that these garnishments are discounted by $\bar{q}^d$, since these repayments resemble default-risk free loans.

2.4.7 Equilibrium

Equilibrium is defined as follows:

Definition 1. *Given a bankruptcy rule* $(G, \bar{x}, \bar{w}, \gamma, \zeta)$ *and risk-free interest rate* r^f *and transaction cost* τ *, an equilibrium is a set of value functions,* V *and* W*, and policy functions* d, k, e *and* b*, a default probability* $\phi(d', k', \epsilon, \rho, j)$*, and a pricing function* q^d *such that:*

1. *the value functions* V *and* W *solve the household problem, and* d, k, e *and* b *are the associated optimal policy functions; and*
2. *the bond prices* q^d *are determined by zero profit condition (2.11);*
3. *The default probabilities are correct:* $\phi(d', k', \epsilon, \rho, j) = E(b_{j+1}(d', k', \epsilon, \rho))$.

2.5 Benchmark Parameterizations

The benchmark is calibrated to match several key moments from the U.S. economy. The parameters to be calibrated are related to households preferences and demographic, labour market income process, entrepreneurial production, intermediation rates, and the bankruptcy system.

2.5.1 Demographics and Preference

The model period is 1 year. Households live for 57 periods. Agents begin life at age 20 and retire at 65, which counts as the first 45 periods in which agents receive income shocks and entrepreneurial productivity shocks, while the last 12 periods correspond to retirement.[26] I adopt the family size life cycle profile from Livshits, MacGee, and Tertilt (2007), which is based on U.S. census data for 1990.[27] I assume there are five levels of entrepreneurial abilities; from low to high, are $\{\rho_1, \rho_2, \rho_3, \rho_4, \rho_5\}$, while the fraction of population endowed with each ability level is $\{10\%, 20\%, 40\%, 20\%, 10\%\}$,[28] respectively.

The period utility function is $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$, where $\frac{1}{\sigma}$ is the intertemporal elasticity of substitution. The annual discount factor is set at 0.96 and $\sigma = 2$.

[26] I assume that households die at $20 + 57 = 77$ years old, since the reported average life expectancy is around 76-78 for the U.S.

[27] They use the average of equivalence scales as reported in Fernandez-Villaverde and Krueger (2001).

[28] This is to approximate a normal distribution. I want to work with the most general case here. One can argue that entrepreneurial ability is correlated with education (Akyol and Athreya (2011)), experience, race, sex and other things. Although, there is no one single observable characteristic dominantly determines it. But most would agree that the ability distribution should have a thin tail on the right. In fact, in this model the top two ability groups determine most of the action in the entrepreneurial sector, thus the predictions of the model does not change for most distribution with a thin tail on the right.

2.5.2 Labour Productivity

The average age-profile of earning $\bar{y}_j$ is from Livshits, MacGee, and Tertilt (2007). The persistent idiosyncratic shock, ϵ, is assumed to follow a four-state Markov process. I set $\rho_\epsilon = 0.99$, and $\sigma^2_\epsilon = 0.016$, and the transitory shock is set to $\sigma^2_\eta = 0.068$. When discretizing the transitory shock, I assume that 5% of the population receives a positive (negative) shock each period. The procedure used to approximate this AR(1) process using a Markov process is from Tauchen and Hussey (1991). There is no uncertainty during retirement in which income is composed of 30% of the household's pre-retirement period (45th period) labour income plus 35% of the average labour income of the economy. I assume that households face no uncertainty during retirement because rational agents should have perfectly diversified up to that time.

2.5.3 Intermediation Sector

The risk-free interest rate is set to 4%, which is the average return on capital reported by Mcgrattan and Prescott (2001). The transaction cost is set at 4%, which is used by Livshits, MacGee, and Tertilt (2007).[29] This implies a risk-free return on savings for a one-year period of 4% and a risk -free lending rate of 8%.

[29]They claim the one they used is slightly less than the average cost of making credit card loans reported by Evans and Schmalensee (2005).

2.5.4 Entrepreneurial Production

I pick the group of $\Phi_\rho(\theta)$ and the set of θs such that the implied mean and standard deviation of return on assets (ROA) from the benchmark model would match the corresponding statistics for sample firms in the 1993 Survey of Small Business Financing from Herranz, Krasa, and Villamil (2009). The support of θ has five elements (see Table 2.3). The lowest state is -3.14. This implies that if $\theta = -3.14$, a small firm loses not only the depreciated capital, but more than its capital stock.[30] Typically, a bankrupt firm, is not only indebted to its banks.[31] These firms are usually in much severe financial distress; they frequently owe their suppliers, employees, and sometimes to their customers as well.[32]

The liquidation cost ζ is set to 35%, which is close to the mean reported for U.S. companies by Shleifer and Vishny (1992). The return to scale parameter, α, is used to match the fraction of entrepreneurs in the data. The fraction of population that is owner-manager of a business is 10.6% in the U.S.[33] Unlike Meh and Terajima (2008), I do not assume that there is a minimal size requirement to start a business, as a household cannot be an entrepreneur and worker at the same time in this model.[34] Finally, the annual deprecation rate is set to 8%.

[30]Note that under this setting, smaller firms are riskier and more profitable at the same time, because the marginal return (loss) to capital is higher for smaller firms (this is due to diminishing return to capital). According to Herranz, Krasa, and Villamil (2009)'s calculation, more than 2% of firms in their sample have a return to assets ratio lower than -100%.

[31]Again, these bank loans are usually secured by equipment, land, etc.

[32]Trade credit is very important to small business, as means of financing. Trade credit as share of all small business debts in the U.S. is comparable to debts from financial institutions (Berger and Udell, 1998). Obviously they take the form of unsecured debts.

[33]From the 2003 survey of Global Entrepreneur Monitor (Reynolds, Bygrave, Autio, and Arenius, 2004).

[34]Adding minimal size requirements does not seem to affect the result.

2.5.5 Bankruptcy Law

There are five parameters of the bankruptcy regime that need to be chosen: periods of post-bankruptcy income garnishment G, income exemption $\bar{w}$, asset exemption $\bar{x}$, the garnishment rate γ, and transaction cost λ. Under Chapter 7, G is set to 1 since Chapter 7 indicates that filers would have to act in "good faith," which is usually interpreted as some period of repayment. γ is calibrated to match the fraction of entrepreneur bankruptcies. Asset exemption $\bar{x}$ is set to 0.9, which is in line with the estimates of $50,000 used by Akyol and Athreya (2011).[35] The transaction cost is set to 15%, though previous studies have tried to capture income garnishments, stigma cost, or even the cost of exclusion from the credit market by one garnisheeing parameter. It does not seem to fit this study, because income garnishment rules are specified in all countries' bankruptcy regimes except for the U.S. Income exemption level $\bar{w}$ is set to 0 for the same reason.

Using the same logic as Meh and Terajima (2008), the bankruptcy rate of entrepreneurs (1.66%) is obtained by multiplying the fraction of entrepreneur bankruptcies and the overall bankruptcy rate, and then dividing by the fraction of the entrepreneurs in the economy.

I do not try to match the total personal bankruptcy filing because I want to concentrate on entrepreneurship, and there is no expense shock in the model. Thus, I target only the fraction of households filing bankruptcy for the two reasons modeled in this chapter: business failure and job loss, which accounts for

[35] The original source is from Rodriguez, Diaz-Gimenez, Quadrini, and Rior-Rull (2002).

about 0.378% of the population. [36] A large fraction of personal bankruptcies are caused by surprise expenses in the U.S., for instance, medical expenses count for roughly one third of total bankruptcy cases (Domowitz and Sartain, 1999).[37] In addition, family issues such as divorces (22.1% from Sullivan, Warren, and Westbrook (1999)) and expenses associated with an unplanned child also play a significant role. In this model, the only reason for a worker to file bankruptcy is job loss (having a very low labour income shock). Sullivan, Warren, and Westbrook (1999) claimed that 67% of bankruptcies were filed because of job loss, but this number has been criticized as exaggerated. The survey of Panel Study of Income Dynamics (PSID) shows that only 23% of filers gave job loss as their primary or secondary reason for filing (White, 2007), which is the number use here.

2.5.6 Fit of the benchmark model

The benchmark calibration fits very well with all the preceding targets, as presented in Table 2.6. In particular, the model replicates the level of entrepreneurship, and more importantly the distribution of the return on assets really well, since this is the key to capture just how risky running a small business is in the U.S. In addition, as shown in Table 2.7, the benchmark model also matches the hump shape of age-profile of U.S. entrepreneurs and the age-profile of bankruptcy filers fairly well.

[36](20% (business failure) + 23% (job loss)) $\times$ 0.88% (fraction of bankrupts among population) = 0.378%

[37]Sullivan, Warren, and Westbrook 1999 report that only 19.3% of bankrupts claim medical expenses as the cause of bankruptcy, although Jacoby, Sullivan, and Warren 2000 suggest that 34% of bankrupts owed large amounts of medical debt.

2.6 Results

This section is organized as follows. The first part describes the counterfactual experiments. The second part present the results in detail, and analyzes the basic forces at work in the model.

The first set of three counterfactual exercises are designed to study the effect on the benchmark model when altering one aspect of personal bankruptcy regime at a time: in the first set, I increase the periods of garnishment one year at a time from 1 to 9 years, and present the result in Table 2.8. In the second set, I study the effect of changes in the fraction of garnishment γ, the result is presented in Table 2.9. And the third set of counterfactuals exercises deals with changes in asset exemptions, with the result presented in Table 2.10. The following key statistics are reported for each set: 1) the level of entrepreneurship measured as a fraction of households being entrepreneurs, 2) the average size of businesses in the entrepreneurial sector, 3) the average productivity of businesses in the entrepreneurial sector relative to the benchmark U.S. economy, 4) the fraction of new/exiting businesses, and 5) the fraction of entrepreneurs within each ability group. All numbers are reported on an annual basis.

The fourth set of counterfactuals are designed to examine the impact of alternative personal bankruptcy regimes from Canada, UK, Germany, and France on the steady-state equilibrium outcome of the calibrated U.S. Economy. Thus, for each counterfactual, I only alternate those parameter values associated with the bankruptcy law, namely the length of garnishment periods G, the garnishment rate γ, the income exemption $\bar{w}$, and the asset exemption

$\bar{x}$. The bankruptcy parameters used in these four counterfactuals as well as for the benchmark are reported in Table 2.11. When available, these numbers are directly calculated as specified in bankruptcy laws. The length of post-bankruptcy garnisheeing is: G=3 for the UK, G=6 for Germany, and G=9 for France. As for Canada, although the bankruptcy law specifies that garnishment can last up to 3 years, the majority of debts are discharged within 9 months, which makes this bankruptcy procedure quite similar to Chapter 7, so I set G equal to 1 in that situation. The income exemption used for the UK, Canada and Germany counterfactuals, $\bar{w} = 0.375$, is obtained from dividing $21,000 by $56,000 (the average income used by Meh and Terajima (2008)). Similarly, that number is 0.35 for the French counterfactual. Once again, the same set of five key statistics are reported in Table 2.12 and 2.13 for these counterfactuals; in addition, the fraction of entrepreneurs declaring bankruptcy and the total fraction of households declaring bankruptcy are also reported. All numbers are reported on an annual basis. A quick glance will show that the model does a good job of matching the facts described in section 2: less lenient bankruptcy systems lead to 1) lower levels of entrepreneurship, 2) higher fractions of larger, older firms in the economy, and 3) lower business turnover rates. A more detailed breakdown of the results follows.

First, the bankruptcy regime has a significant impact on the “extensive” margin of entrepreneurship. This can be seen in the first row of Tables 2.8, 2.9, 2.10 and 2.12: variations in the post-bankruptcy garnishments appear to have a large impact on the level of entrepreneurship. The fraction of entrepreneurs decreases monotonically as the length and fraction of post-bankruptcy garnishments increases: from 10.71% under the benchmark case to 7.32% when length of garnishment reaches 9 periods, and to 9.47% when fraction of income garnisheed increases to 100%. It should not be a surprise that variation in the length of garnishments has such a large impact, because the present value of expected amount of income garnishments (loss of future income) goes up almost twice when garnishment periods goes from 1 to 2 periods, and goes up almost 740% when increased to 9 periods, not counting the 15% transaction cost. Furthermore, exclusion from borrowing greatly reduces bankrupt households' ability to smooth their consumption across time, and exclusion from entrepreneurship takes away big part of their earning potentials.

There appears to be an inverted U-relationship between the asset exemption level and the level of entrepreneurship: the fraction of entrepreneurs increases from 10.02% when $\bar{x} = 0.05$ (roughly $2800) to 10.71% when $\bar{x} = 0.9$, then declines to 10.21% when $\bar{x} = 2$ (roughly $11,200). This is mainly caused by an inverted U-relationship between the asset exemption level and the number of moderate-ability entrepreneurs, as shown on the second last row of Table 2.10. It suggests that the borrowing cost effect of bankruptcy law on moderate-ability households' decision dominates for low level of asset exemptions, but once pass the current average U.S. level, insurance effect tend to dominates. As for high-ability households, insurance dominates throughout this exemption range.

Lastly, when different countries' regimes are adopted, the level of entrepreneurship decreases from 10.71% under the U.S. benchmark case to 9.75% under the Canadian regime, 9.1% under the UK regime, 7.32% under the Germany regime, and 6.43% under the French regime. Notably, most of these changes are coming from the lower ability households. As shown in Tables 2.8, 2.9, 2.10 and 2.12, the fraction of entrepreneurs out of the highest ability households barely changed for every set of benchmark counterfactuals; in fact, it is always within the range of 60%-65%. There seems to exist an U-shaped relationship between the level of entrepreneurship and the "forgiveness" of bankruptcy law within this high-ability group when it comes to the length of garnishment: it declined first from 62.9% when $G = 1$ to 60.3% when $G = 4$, then increased to 63.8% when $G = 9$. This result suggests that, even for high-ability entrepreneurs, the bankruptcy punishments need to be really tough for the lowered borrowing cost to start encouraging entrepreneurship. When it comes to varying the level of garnishment and asset exemptions, the level of entrepreneurship within this high-ability group tends to increase monotonically with the forgiveness of the bankruptcy regime. On the other hand, the fraction of entrepreneurs for the households in the next ability level dropped drastically and monotonically as the bankruptcy regimes become less lenient for all but the case of asset exemption level. There is an inverted U-relationship between the asset exemption and the fraction of entrepreneurs in this "moderate" ability group.

The intuition behind the vastly different effects of bankruptcy regime on different ability households is clear: severe failures are less likely to occur for high-ability entrepreneurs. Since bankruptcy only occurs in these bad states, changes in the insurance effect and borrowing cost from varying bankruptcy policies are relatively small for high-ability households. As for moderate-ability households, failure is more likely to occur, so variation in the bankruptcy regime has a much larger impact on their occupational decisions, and it appears that the insurance effect completely dominates the borrowing effect. It is clear that when the length of garnishment is high, as it is under the French and Germany bankruptcy regimes, little insurance value is provided against failure since bankruptcy filers would have very little disposable income for 6 to 10 years after filing. Consequently, the entrepreneur bankruptcy rate drops more than five times and the overall bankruptcy rate drops close to four times from the benchmark U.S. case to the France counterfactual.

As for business dynamics, the fraction of new firms decreases as the regime becomes less lenient. This is due to two reasons: 1) as the fraction of better firms increases, failure in the pool of active businesses is less likely to occur, and 2) filing for bankruptcy and quitting business become more expensive. Similarly, the turnover rate decreased quite a bit, from 10.41% to 6.98% from the benchmark model to the French counterfactual.[38]

Now let us turn to the impact on the "intensive" margin of entrepreneurship, namely the size of firms. For the U.S. benchmark model, the average firm capital size is 15.23, which corresponds to $852,000, which went up to just over $1,000,000 when I set the length of garnishment to $G = 9$ under the first set of counterfactual exercises, and went up even higher for the counterfactual under the French regime. This shift is for two reasons. First, the rate of return for capital is higher for high-ability entrepreneurs, so as the fraction of

[38]This is a static model, so turnover rate is simply two times the fraction of new firms.

"better" firm increases, the average size increases. Second, though having a fairly small effect, the lowered borrowing cost from tougher systems allows entrepreneurs to borrow more and accumulate wealth faster. On the other hand, the capital size appears to have a U-shape relationship with asset exemption, this again being due to the change in ability composition of entrepreneurs. As discussed above, there is a inverted U-relationship between asset exemption and the fraction of entrepreneurs among moderate-ability households: as the share of moderate-ability entrepreneurs goes down, the average size of businesses goes up.

When it comes to comparing the impact of different aspects of personal bankruptcy regimes, the length of post-bankruptcy punishment clearly has the largest impact: prolong it to 9 periods alone lead to a 31.65% drop in the level of entrepreneurship, a 7.4% increase in average productivity, and a 26.1% increase in the average size of firm capital. It has a very large impact on the occupational choice of the moderate-ability households: again, changing from the benchmark case to 9 periods of garnishment caused the fraction of entrepreneurs among this ability group to decrease from 21.97% to 4.7%, which accounted for the majority of the change in the level of entrepreneurship. The level of income garnisheed also had moderate impact on entrepreneurship: increasing the fraction from 25% to 100% lead to a 13.2% drop in the level of entrepreneurship, a 5.7% increase in average productivity, and a 10.3% increase in the average size of firm capital. On the other hand, changes in asset exemption have only modest impact on the entrepreneurial sector.

The changes in the ability composition of entrepreneur households associated with tougher bankruptcy regimes result in an increase in the average productivity in the entrepreneurial sector, which went up 7.4% when I increase the length of garnishment to 9 periods, went up 5% when I increase the fraction of garnishment to 100%, and went up 2.2% when the asset exemption is dropped to 0.05 (roughly $3,000). In fact, the adoption of the French regime led to a 8.3% increase in the average productivity. This result suggests that if the quality of entrepreneurs is the main policy concern, then those less “forgiving” regimes are more favorable in comparison to the U.S. Chapter 7 system. One should note, however, that as the level of entrepreneurs increases, the overall output in the economy increases despite the drop in average firm size. This is because for any *risk-averse* household to run a business, the expected return from the business has to be greater than the expected wage income plus the risk-free gross return from the invested capital (whether internally or externally financed). More specifically, the difference would have to be large enough to compensate for the risk these entrepreneur households are bearing. Thus, the aggregate output is the highest in the benchmark U.S. case and the lowest in the French counterfactual, although the firms in the French counterfactual are bigger on average, but it is not enough to offset the drop in the overall level of entrepreneurship.

One should be careful when interpreting these partial equilibrium results, because aggregate movements of labour between the entrepreneurial sector and the corporate sector, and changes in the aggregate capital stock (which affect the risk-free rate of return) are not captured here. For instance, an increase in the level of entrepreneurship means fewer workers in the corporate sector, so the wage rate in the corporate sector would rise, which discourages entrepreneurship by increasing the opportunity cost. Many have argued (Cagetti and De Nardi, 2006; Evans and Jovanovic, 1989; Evans and Leighton, 1989) that more potential entrepreneurs in an environment with default lead to higher stock of capital, because entrepreneurs want to save more proportionally to avoid borrowing constraints. This leads to a lower equilibrium risk-free interest rate, which encourages entrepreneurship (this effect amplifies my result, as a higher level of entrepreneurship encourages more households to run businesses). On the other hand, a higher level of entrepreneurship increases the demand for capital, which drives the risk-free interest rate higher. A higher risk-free rate discourages entrepreneurship and limits entrepreneurs' ability to invest in efficient size. But, it is unlikely that these second-order effects will reverse the main results of this chapter.

2.6.1 Welfare Analysis

Ex-ante welfare gains or losses for each of the counterfactuals are presented in Table 2.7. These numbers are calculated as consumption equivalence in gains and losses when compared to the benchmark U.S. case. The first row reports the overall welfare changes,[39] and the following five rows report the decomposition of these gains and losses among different ability groups.

[39] This is calculated by assuming that before households are born, households do not know their entrepreneurial ability, but know the distribution of abilities among population.

The first row of Table 14 shows that overall welfare increases as the personal bankruptcy laws become less lenient. The U.S. benchmark case implies the lowest ex-ante welfare, and the French counterfactual has the highest. However, when separated in to different ability groups, the two groups with the highest entrepreneurial ability actually experience welfare gain when the bankruptcy regime gets more lenient, with the gains being higher for the top ability group. The three groups with lowest ability levels (pure worker types), on the other hand, all have welfare losses when the leniency of the bankruptcy regime increases. This result implies that entrepreneurs actually prefer the U.S. regime, which gives the most insurance value, and workers prefer the French regime, which gives the lowest borrowing cost. This is because labour income risk is more moderate when comparing to productivity risks.[40] Because they face lower risks, worker households care more about the ability to smooth consumption over time through borrowing. Since a more lenient bankruptcy regime limits their ability to borrow, their welfare drops.[41] On the other hand, entrepreneurial households care more about insurance value provided by the bankruptcy system. Because productivity risk is larger relative to labour income risks, the effect of insurance value outweighs the effect from increased borrowing cost for entrepreneur households. Thus, their welfare improves as the regime become more lenient. Lastly, the overall welfare decreases as the

[40]In fact, labour shock never go to the negative region, although productivity risk did (the lowest shock being -3.14).

[41]This result may disappear if the type of expense shock from Livshits, MacGee, and Tertilt (2007) is incorporated here. However, as they mentioned in their paper, the sources and magnitude of expense shock differs across countries. A more detailed discussion is offered in the conclusion.

personal bankruptcy laws become more lenient because worker households outweighs entrepreneur households in proportions.

2.7 Conclusion

The main finding of this chapter is that variations in bankruptcy regimes have little effect on high-ability households' occupational choices, change in the length (periods) of post-bankruptcy punishment appears to have the largest impact on entrepreneurship, and asset exemption had only a modest effect. When it comes to moderate-ability households' occupational choices, the insurance effect completely dominates the borrowing cost effect. This result suggests that a very lenient bankruptcy regime like the U.S. Chapter 7 system does encourage entrepreneurship, though it lowers the average productivity in the entrepreneurial sector, but increases the overall production in the economy. The result also helps explain the U.S.' higher turnover rate and lower average business size compared to other developed nations.

The model suggests that worker households prefer less lenient regimes due to moderate wage income risks. A large fraction of U.S. personal bankruptcies are due to medical causes and other surprise expenses rather than income loss or business failures. Livshits, MacGee, and Tertilt (2007) showed that once these expense shocks are incorporated, given reasonable parameter values[42] the Chapter 7 regime leads to a welfare gain on comparison to a no-bankruptcy

[42] Most of variables concerning labour income shocks and financial intermediation used here are taken directly from their paper.

(no leniency) regime. It is reasonable to say that once expense shock is incorporated in this model, both worker households and entrepreneur households in the U.S. would prefer the U.S. regime. Unlike the U.S., the other four countries all have some form of universal health-care systems. Thus, the fraction of bankruptcies due to medical reasons is very small.[43] In addition to low exposure to surprise medical expenses, workers in Europe also enjoy better job security (Lazear, 1990) and less earning inequity;[44] which means that they face even fewer risks compare than their U.S. counterparts. Because they face less risks, they would prefer a less lenient system because the insurance value provided by bankruptcy does not matter for them. However, given the large differences between the welfare impact on workers and entrepreneurs; policy makers, especially in Europe, should think about treating personal bankruptcies caused by business failures separately.

This model can be extended to several directions. In this chapter, I assume that the entrepreneurial ability is immediately observed by households and intermediaries. Suppose that households and banks can only observe the history of business outcomes, but not the actual ability level. In that situation, households would like to start businesses earlier in life when they are most financial constrained, while at the same time mature firms enjoy a lower borrowing cost. Obviously, this would greatly increase the computational intensity as belief updating comes into play. The other interesting direction is taking the effect of "learning by doing" from running a business into the model. In that situation,

[43] Although most medical practices in France are operated privately, patients are reimbursed by the state for up to 85% of medical costs.

[44] See Livshits, MacGee, and Tertilt (2007).

the potential earnings from being an entrepreneur also increase with experience, rather than remaining constant as they are in this chapter.

Another interesting extension is to look at entrepreneurship in different industries. Since different industries are inherently different in their riskiness, bankruptcy policy may have adverse effects. However, one must pay attention to more than just debt contract when considering such industries, because equity-type financing with ownership clearly suits those very risky sectors (i.e., high-tech).

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Table 2.1: Personal Bankruptcy Law Across Countries Prior 2005

	France	Germany	UK	Canada	U.S. Chapter 7
Asset exemption	modest household goods exemption	modest household goods exemption	household goods and pension exemption, homestead exemption is around $2000	varies across provinces, largest homestead exemption is $40,000	varies across states, some states with unlimited homestead exemption
Income exemption	$6000 for singles, $15000 for family of three	$21000 for couples, up to $38,000 for families per year	"reasonable domestic needs"	$21,000 for singles; $40,000 for families of four	unlimited
Percent of nonexempt income that goes to creditors	increase from 5% to 100% when income exceeds $20,000 for singles or $23,000 for family of four	100% in years 1-3, 90% in year 4 and 85% in year 5	30%-50%	50%	None
length of repayment obligation	8-10 years	6 years	up to 3 years	9 months to 3 years	None
other punishments	discharge contingent on debtors' efforts to find/hold a job	discharge contingent on debtors' efforts to find/hold a job	debtor cannot borrow, manage a business, hold some public offices for 3 years	debtor cannot borrow, manage a business, hold some public offices before discharge	repeat filing not allowed for 6 years

Sources: all information are taken from White's (2007) summary table. Her original sources are Ziegel (2007), Kilborn (2004), Kilborn (2005), BankruptcyCanada.com, The Insolvency Service (2007), and Ramsay (2003). All figures are in U.S. dollars.

Table 2.2: Entrepreneurship Across Countries

Source		France	Germany	UK	Canada	U.S.
Global Entrepreneurship Monitor, 2004	% of population that is owner-manager	4.22%	7%	8.8%	9.7%	10.6%
	Fraction of new firms out of all firms	9.0%	8.4%	11.3%	12.7%	13.9%
Flash Eurobarometer Survey 160, (2004), % report as self-employment out of survey replies	Entrepreneurs	10%	18%	18%	N.A.	22%
	Business younger than 3 years	33%	40%	44%	N.A.	62.5%
(Bartelsman, Haltiwanger, and Scarpetta, 2007)	Fraction of all employer-firms with less than 20 employees	82%	89.6%*	N.A.	86.7%	88%
	Entry/Exit rate	11%/7.5%	6%/6%*	N.A.	11%/10.5%	12%/10%
Mills and Timmins 2006	Fraction of zero-employee firms	N.A.	N.A.	69.3%	58.2%	77.3%

Note: At the time there is no personal bankruptcy law in Germany. Though other data are taken after 1999, it should be clear that Germany's economy might still be in transition.

Table 2.3: Business Shocks

state		1	2	3	4	5
productivity	θ	-3.14	-1.47	0.2	1.87	3.52
Ability levels	ρ_1	0.165	0.31	0.33	0.17	0.025
	ρ_2	0.13	0.275	0.33	0.205	0.06
	ρ_3	0.095	0.24	0.33	0.24	0.095
	ρ_4	0.06	0.205	0.33	0.275	0.13
	ρ_5	0.025	0.17	0.33	0.31	0.165

The probabilities of occurrence for ability level ρ_3 is the five state approximation of the normal distribution $N(0.2, 2)$. Other groups' probability distributions are obtained by shifting weights of different states. For instance, $\Phi_{\rho 4}$ is obtained by shifting 7% weights from the low productivity states 1 and 2 to high productivity states 4 and 5, $\Phi_{\rho 5}$ is obtained by shifting 14% from the low productivity states 1 and 2 to high productivity states 4 and 5. similarly, $\Phi_{\rho 2}$ and $\Phi_{\rho 1}$ are obtained by shifting weights from high productivity states to low productivity states.

Table 2.4: Moments Targeted in the Benchmark in Annual Values

Moments	Values	Source
Fraction of Entrepreneurs	10.6%	GEM (2003)
Overall annual bankruptcy rate (job loss+business failure)	0.378%	Own calculation*
Fraction of Entrepreneurs declare bankruptcy	1.66%	Own calculation**

**obtained by adding the fraction of bankrupts are entrepreneurs(20%, from Sullivan, Warren, and Westbrook (1999)) and fraction of bankrupts reports job-loss as filing reason (23%, PSID) then multiplied by the over all bankruptcy rate (0.88% from Athreya (2004)).*

***obtained by multiplying the fraction of bankrupts are entrepreneurs(20%, from Sullivan, Warren, and Westbrook (1999)) and the the over all bankruptcy rate (0.88% from Athreya (2004)) then divide by the fraction of the entrepreneurs in the economy (10.6%, from GEM 2003 (Reynolds, Bygrave, Autio, and Arenius, 2004)).*

Table 2.5: Calibrated Parameters of the Benchmark Economy

Parameters		Values	
Fixed Parameters	σ	Relative risk aversion	2
	β	Discount factor	0.96
	J	Lifetime	57
	ρ_ϵ	coefficient of autocorrelation of labour income	0.99
	$\sigma^2_{\epsilon,3}$	Variance of persistent labour shock	0.016
	σ^2_η	Variance of transitory labour shock	0.068
	δ	Depreciation parameter	8%
	ζ	Liquidation cost	35%
	r^f	Risk free rate	4%
	τ	Annual transaction costs when making loans	4%
	$\bar{x}$	Asset exemption	0.9
Endogenously calibrated parameters	γ	Income garnishment rate	0.433
	α	Degree of return to scale	0.643
	λ	Transaction cost for bankrupts	15%

Table 2.6: Moments Targeted in the Benchmark in Annual Values

Moments	Data	Benchmark
Fraction of Entrepreneurs	10.6%	10.71%
Overall annual bankruptcy rate (job loss+business failure)	0.378%	0.391%
Fraction of Entrepreneurs declare bankruptcy	1.66%	1.69%
Mean of Return on Assets	1.3	1.313
Standard Deviation of Return on Assets	1.575	1.612

Table 2.7: Age Profiles of Entrepreneurs and Bankrupts

Fraction Of Population Being Entrepreneur By Age Group

Age Group	Below 35	35-44	45-54	Above 55
Model	6.8%	14.3%	12.7%	12.6%
Data	5.6%	12.5%	15.4%	11.4%

Fraction Of Population Filed For Bankruptcy By Age Group

Age Group	Below 35	35-44	45-54	Above 55
Model	0.33%	0.44%	0.39%	0.36%
Data (Job loss and business failure only)	0.31%	0.38%	0.37%	0.26%

Table 2.8: Variation In Length Of Garnishment

G	1	2	3	4	5	6	7	8	9
% Entre.	10.71	10.12	9.63	9.13	8.75	8.47	8.13	7.83	7.32
Average size	15.23	15.67	16.04	16.39	16.83	17.47	18.09	18.57	19.21
Ave productivity	1	1.01	1.029	1.036	1.043	1.049	1.055	1.062	1.074
Entry/Exit %	5.21	5.055	4.92	4.75	4.43	4.09	3.91	3.79	3.55
% Entre./ρ_1	0	0	0	0	0	0	0	0	0
% Entre./ρ_2	0	0	0	0	0	0	0	0	0
% Entre./ρ_3	0.025%	0.01%	0.004%	0	0	0	0	0	0
% Entre./ρ_4	21.97%	17.45%	16.2%	15.5%	13.3%	11.5%	9.4%	7.6%	4.7%
% Entre./ρ_5	62.9%	62.3%	61.4%	60.3%	60.9%	61.7%	62.5%	63.1%	63.8%

Fraction of Income Garnisheed $\gamma = 0.433$, *Asset Exemption* $\bar{x} = 0.9$, *Income Exemption* $\bar{w} = 0$

Table 2.9: Variation In Fraction Garnisheed

γ Fraction garnisheed	0.25	0.433	0.65	1
% of Entrepreneur	10.91	10.71	10.27	9.47
Average size	15.01	15.23	15.76	16.55
Average productivity	0.993	1	1.019	1.05
Entry/Exit %	5.24	5.21	5.13	4.97
% of Entre./ρ_1	0	0	0	0
% of Entre./ρ_2	0	0	0	0
% of Entre./ρ_3	0.024%	0.025%	0.019%	0
% of Entre./ρ_4	22.88%	21.97%	19.98%	16.1%
% of Entre./ρ_5	63.24%	62.9%	62.65%	62.51%

Length of garnisheeing $G = 1$*, Asset exemption* $\bar{x} = 0.9$*, Income exemption* $\bar{w} = 0$

Table 2.10: Variation In Asset Exemption Garnisheed

$\bar{x}$ asset exemption	0.05	0.45	0.9	1.5	2
% of Entrepreneur	10.02	10.43	10.71	10.52	10.21
Average size	15.87	15.54	15.23	15.59	15.76
Average productivity	1.022	1.01	1	1.017	1.02
Entry/Exit %	5.09	5.15	5.21	5.18	5.12
% of Entre./ρ_1	0	0	0	0	0
% of Entre./ρ_2	0	0	0	0	0
% of Entre./ρ_3	0.014%	0.024%	0.025%	0.027%	0.017%
% of Entre./ρ_4	18.98%	20.08%	21.97%	20.96%	19.22%
% of Entre./ρ_5	62.23%	62.59%	62.9%	63.26%	63.65%

Length of Garnisheeing $G = 1$*, fraction of garnisheed* $\gamma = 0.433$ *, Income exemption* $\bar{w} = 0$

Table 2.11: Bankruptcy Parameters Used In Counterfactuals

Parameters		France	Germany	England	Canada	U.S.
Periods of post-bankruptcy garnishments	G	9	6	3	1	1
Asset exemptions	$\bar{x}$	0.05	0.05	0.1	0.35	0.9
Income exemptions	$\bar{w}$	0.335	0.375	0.375	0.375	0.0
Fraction of income garnisheed	γ	0.95	0.9	0.5	0.5	0.433

Table 2.12: Counterfactual (Regimes Resemble Other Countries' Laws) Results

	France	Germany	UK	Canada	U.S.
% of Entrepreneurs	6.43%	7.32%	9.1%	9.75%	10.71%
% of Entrepreneur that bankrupts	0.32%	0.38%	1.32%	1.57%	1.69%
Average Size	19.78	18.43	17.23	16.07	15.23
Average productivity	1.083	1.068	1.044	1.013	1
Fraction of New/All Businesses	3.49%	3.77%	4.32%	4.97%	5.21%
Overall fraction of Bankrupts	0.091%	0.098%	0.278%	0.331%	0.391%

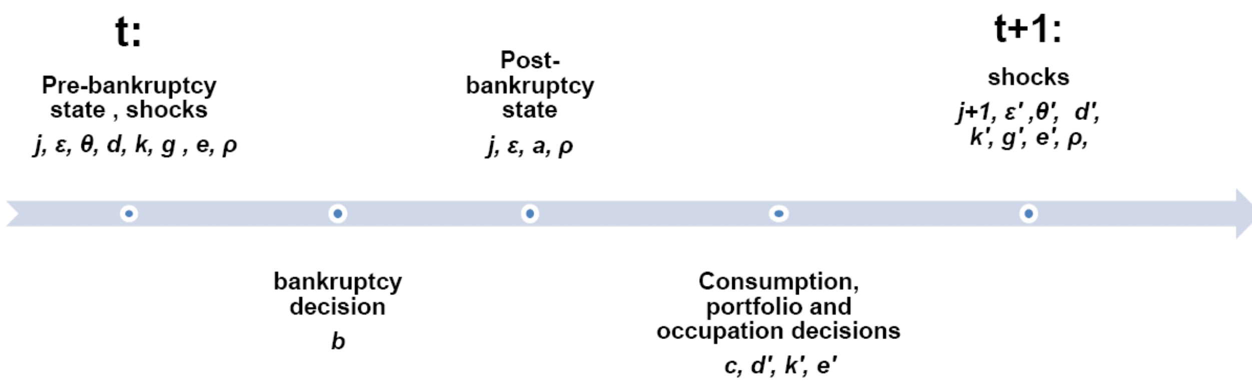
Table 2.13: Fraction Of Entrepreneurs Within Different Ability Level Groups

	France	Germany	UK	Canada	U.S.
ρ_1	0	0	0	0	0
ρ_2	0	0	0	0	0
ρ_3	0	0	0	0.002%	0.025%
ρ_4	0.0%	4.85%	14.65%	17.65%	21.97%
ρ_5	64.3%	63.5%	61.7%	62.1%	62.9%

Table 2.14: Welfare Gain/Loss Relative To Benchmakr U.S. Case

Countries	Canada	UK	Germany	France
Ex-ante ALL households	+0.0008%	+0.009%	+0.024%	+0.054%
Households with ability ρ_1	+ 0.0009%	+0.0021%	+0.083%	+0.161%
Households with ability ρ_2	+0.0009%	+0.0021%	+0.083%	+0.161%
Households with ability ρ_3	+ 0.0009%	+0.0021%	+0.083%	+0.161%
Households with ability ρ_4	-0.0002%	-0.062%	-0.172%	-0.328%
Households with ability ρ_5	-0.03%	-2.14%	-3.653%	-6.259%

Figure 2.1: Timing



Chapter 3

Small Business Loan Guarantees as Insurance Against Aggregate Risks

3.1 Introduction

Small businesses[1] are commonly viewed as an important source of job creation and the engine of economic growth. Based on the belief that they face disproportional difficulties in accessing debt financing due to financial market inefficiencies, small business loan guarantee programs have become a major component of entrepreneurship policies in North America.[2] Currently, the popular Small Business Administration's (SBA's) 7(a) and 504(a) programs provide guarantees for around $76 billion in loans in the U.S., and the Canadian Small

[1] Both US and Canada defines small business as ones that has fewer than 100 employees (less than 50 if it is service based in Canada), and a medium-sized business as ones that with fewer than 500 employees.

[2] Most developed countries have some kind of business loan guarantee programs in place, with some of them operated by the government directly and others provided by trade unions.

Business Financing Program (CSBFP) backs close to $1 billion in new loans every year.

Despite the popularity of these programs, many skeptics question the effectiveness and rationale behind these programs. Much of the attention has been put on the "no-subsidy" policy of the SBA's guarantee programs: throughout its tenure, the George W. Bush administration required that the SBA's guarantee programs run at a zero subsidy rate (Mercer, 2006).[3] Indeed, since 2005, the popular 7(a) and 504(a) programs met the "zero subsidy" requirement until the economy took a downturn in 2008.[4][5] Understandably, the policy has generated strong criticism from the public since its inception:

> *For an Administration that likes to trumpet the "ownership" society, it's a bit perplexing: President Bush wants to eliminate the federal subsidies that support the nation's smallest business.* -CFO Magazine

In fact, throughout the 1990s, even without the "zero subsidy" policy in place, the SBA programs generated profits for the government, which sparked strong criticism because it simply "*puts money in bank for U.S.*" (Crenshaw, 2001). The

[3]These subsidy rates are calculated without the inclusion of the agency's administrative costs . However, the SBA has many other functions in promoting SMEs. Less than 15% of the agency's budget goes into the administration of credit programs, and an even lesser amount goes into guarantee programs.

[4]They actually maintained a negative estimated subsidy rate, i.e, they were making a profit; for details see Figure 1 (SBA, 2010).

[5]Even for fiscal year 2009, when U.S. suffered a severer recession, the estimated program subsidy is still less than 6% of the loans it guarantees, despite an increase of 10 fold from previous year. In fact, the low default rates of these guaranteed loans in the U.S. have attracted many research interests (Andradey and Lucas, 2009).

public certainly has good reason for questioning it: most studies of the small business guarantee program view it as a reallocation of resources from one set of agents to another in the economy to address financial market inefficiency caused by information asymmetry or moral hazards; without subsidies, it simply cannot improve the small businesses sector, since the government does not have an information or technology advantage over private agents (Williamson, 1994; Li, 1998). As noted by Vogel and Adams (1997), Honohan (2009) and Zecchini and Ventura (2009), the design of guarantee programs even with subsidies, in general does not address these commonly cited market imperfections.

This chapter, in clear contrast, argues that if the government has an advantage in providing aggregate insurance compared to financial institutions, then a guarantee program with zero subsidy can significantly improve the efficiency of the economy. It is widely accepted that financial institutions' cost of borrowing goes up during economic downturns compared to government, so it is difficult for them to rollover losses into future periods.[6] Thus, ex-ante, they may restrict their exposure to these risks by rationing loans. A stable government, on the other hand, enjoys a relatively lower borrowing cost because of its lower risk of default and monopoly rights to future tax revenues. In other words, the government could smooth its spending across periods more easily. In this case,

[6] Two forces might drive up the cost of borrowing for financial institutions: first, the supply of deposits goes down during a recession; second, the institutions have to pay a higher risk premium on their borrowing, since the risk of default goes up. Evidently, the spread of corporate bonds in the financial sector goes up during economic down-turns (Barth, Li, and Phumiwasana, 2009). Furthermore, the risk premium would be higher if they increased their exposure to aggregate risks ex-ante.

the government can offer insurance against aggregate uncertainty in the form of loan guarantees by charging a fee (really a premium in this case). The program could improve the efficiency of the economy by lowering borrowing costs for firms that are financially constrained due to aggregate uncertainty.

To demonstrate this, I start with a standard two-period production economy model with financial friction of costly state verification motivated by Townsend (1979) and Li (1998), then incorporate a simple notion of aggregate uncertainty (in the form of productivity shocks) into the model. Heterogeneous agents in the economy are endowed with different levels of wealth and quality of projects, and they make consumption, occupational, saving/borrowing, and investment decisions. I first show that the introduction of aggregate uncertainty leads to a lower level of entrepreneurship and that some firms are even more financially constrained compared to the already inefficient economy with just costly state verification. I then prove that if the administrative cost of running guarantee program is zero (or very low) and the government could charge fees depending on project quality, then there exists a guarantee program with a net present value of zero that leads to the exact (or very close to the exact) allocation of the economy without aggregate uncertainty.

However, it might be too costly for the government to charge different fees to different firms. Thus, in reality, guarantee fees are usually fixed for certain range of guarantees. I show that within this framework, a guarantee program with a fixed fee leads to an adverse-selection problem, and benefits low-quality firms more than high-quality firms. In particular, under the program, relatively high-quality firms under-invest and apply for only minimum necessary guarantees; while relatively low-quality firms over-invest and apply for the maximum level of guarantees. Further more, it encourages low-quality projects that are not financially constrained due to aggregate uncertainty to participate in the guarantee program as well. In other words, it creates the "over-lending" problem and could potentially lead the economy to a less efficient state.[7] To ease the adverse-selection problem, certain controls have to be put into place, i.e, only projects with quality above a certain threshold should be allowed into the guarantee program. However, direct selection of projects is often difficult. Thus, the controversial high fixed cost of applying for guarantee and the strict selection process can be viewed as mechanisms for overcoming the adverse-selection problem by screening out low-quality projects. In addition, I show that in this environment, as long as the guarantee program meets the "zero-subsidy" requirement, it leads to a more efficient allocation of resources. However, the "zero-subsidy" requirement cannot completely overcome the adverse-selection problem; even in that situation, the high-quality firms under the program are subsidizing those of low-quality.

The model here is built on that of Li's (1998), in which she studied a framework with financial frictions caused by private information and moral hazard,

[7]The now-famous paper of Meza (2002) draws a similar conclusion: subsidy programs might lead to over-lending in the aggregate economy and reduces overall economy efficiency due to information asymmetry.

and the friction drives a wedge between internal and external funds and induces borrowing constraints just as in Townsend (1979) and Gale and Hellwig (1985). Li (1998) finds that direct grants are the best way to promote entrepreneurship and that guarantee programs attract risker projects with few assets. She 2002 drew a similar conclusion in another paper in a dynamic and general equilibrium framework. The other strand of literature on financial frictions focuses on adverse-selection, in which borrowers have hidden knowledge about their likelihood of repayment. Williamson (1994) studies the effect of federal credit programs in both environments (costly state verification and costly screening) and finds that these programs do not improve the efficiency of allocation when the government is assumed not enjoy any informational advantage. Innes (1991) finds that the government can often increase social welfare by offering subsidized debt contracts; but guarantee programs lead to constrained inefficiencies. Meza (2002) suggests that government-subsidized guarantee programs lead to more lending to business than what is socially optimal due to adverse selection, much like the finding of this chapter about fixed guarantee fees. Of course, most of these previous studies focus on the interaction between financial friction and idiosyncratic risks and do not see insurance against aggregate uncertainty as rationale for government intervention.

There have been many empirical studies that have tried to determine the effectiveness of these guarantee programs. Craig, Jackson, and Thomson (2007) find that SBA guaranteed lending has a small positive influence on the rate of economic growth in local markets, and they also find a positive correlation between the average annual level of employment and the level of SBA guaranteed lending in local market in a later work Craig, Jackson, and Thomson (2008), especially for low income markets. Riding and Haines (2001) first illustrate variations in guarantee programs in the U.S., Canada and the UK, and then present a detailed cost-benefit analysis of the Canadian Small Business Loans Act (CSBFP's predecessor) program. The study finds that it is an efficient way of job creation, but questions whether government's intervention in the credit market is warranted. Measuring additionality has always been difficult in these kind of studies, as noted by Honohan (2009) and Riding, Madill, and Haines (2007).

The rest of the chapter is organized as follows. Section 2 provides a brief description of loan guarantee programs in the U.S. and Canada. Section 3 describes the baseline model. Section 4 analyze the guarantee program with a fixed fee and provides policy discussion. Section 5 concludes.

3.2 Loan Guarantee Programs in U.S. and Canada

A common loan guarantee covers part of a financial institution's losses in the event of a default, thus reducing the lending risk. In general, the program is open to small businesses that would otherwise not qualify for a conventional loan, because of that, borrowers are required to submit proofs of ineligibility for bank loans. Typically, guarantors set fees in an attempt to recover costs of honoring defaults.

The eligibility for these guarantee programs usually contain three key criteria:

The business has to be small: this is evaluated either on the number of employees or the revenue/sales size;

Sound repayment prospects: careful evaluations from the financial institution and possibly from the guarantee providing agencies are performed; there are strict collateral requirements and pledge of personal guarantee are usually mandatory;

Incrementality: lenders and borrowers have to demonstrate ineligibility of loans under similar terms without the guarantee.

These programs usually require a lot of effort in preparation, such as a large amount of paper work from both borrowers and lenders. In addition, these programs require packaging fee ranging from $250-$2000, plus other upfront costs like attorney and other kinds of professional fees of up to $5000 (Green, 2005). More details about the SBA and CSBFP guarantee programs follow.

In the U.S., the SBA was created under Public Law 163 in 1953 to make direct loans, loans partnered with financial institutions, and to provide loan guarantees. Later on, the SBA shifted the majority of its credit programs to providing guarantees. The popular 7(a) and 504(a) program has expanded drastically over the last three decades: from backing 16,800 loans valued at about $2.8b in 1986 (Rhyne, 1988), to 54,756 guaranteed loans were made in 2009, valued at $16.9b. Historically, a borrower seeking a loan applies to the SBA for a guarantee through a financial institution that participates in the program. To be deemed as eligible, the lender must prove that the business could not obtain loans under the same terms without the guarantee and the prospect of repayment is good. Originally, SBA staff reviewed each application. If approved, a guarantee of up to 85% of loans up to $150,000 and a guarantee of up to 75% for loans higher than $150,000 could be advanced. Loans are secured to the extent that tangible assets were available and personal guarantee are required.[8] However, the SBA has moved away from approval of all loan applications, and moved towards more responsibility to the lending institution. More recently, after the spike in default rate in the 80's (Mandel, 1992; Rhyne, 1988), the agency has concentrated lending with the more efficient and responsible lenders and also encouraged other lenders to emulate their examples (Riding and Haines, 2001). These efforts have resulted in increased efficiency and a reduced rate of defaults. As noted before, during the most of the 1990's, these programs had generated profits for the agency until the downturn in early 2000. Currently, there are three levels of guarantee fee (paid at closing) for the 7(a) program: 2% of guaranteed portion for Up to $150,000 guarantees, 3% of guaranteed portion for between $150,000-$700,000

[8]Even if these loans are secured, the value of collateralized assets in general decreases during a economic downturn. Which means that financial institutions will ration loans due to aggregate uncertainty without third party guarantee.

of guarantees and 3.5% of guaranteed portion for Over $700,000. In addition, a 0.55% fee on the guaranteed portion is charged annually. Borrowers under the 504(a) are charged a lower fee of 2.5% on the guaranteed portion because these loans are quite safer since only acquisition of fixed assets are eligible.[9]

In Canada, the SBLA (Small Business Lending Act) has provided guarantee for small business loans through approved lenders since its inception in 1961 (Riding and Haines, 2001). The program was then replaced by the current Canada Small Business Financing Program (CSBFP) in 1999. In general, borrowers apply for loans from approved lending institutions to obtain guaranteed loans. Unlike the SBA programs, the financial institution have full discretion over loan making decision, and the Canadian government takes a passive role in this case. Industry Canada is responsible primarily for maintaining registration of the loans and honoring the guarantee in case of default. However, the 1999 reform of the program requires the ministry to put more attention on cost recovery. Right now, the borrower pays a 2% registration fee and an additional annual fee of 1.25% to the guarantor.

3.3 Model

I extend the baseline model of Li (1998) to include aggregate risk. Consider a two periods economy populated by a continuum of agents of measure one.

[9]These fixed assets, being machinery or real estate, must be used as collateral.

Agents' preference over consumption is represented by $U(c_1) + c_2$, where $c_i, i \in \{1,2\}$ denotes the consumption in period i. Standard assumptions on $U(\cdot)$ apply here, such that $U(\cdot)' > 0$, $U''(\cdot) < 0$. Each agent is endowed with some internal wealth ω and a project which they can choose to operate in the second period. The distribution of wealth is represented by the cumulative distribution function $\Phi(\omega)$ on interval $[\underline{\omega}, \bar{\omega}]$, where $0 < \underline{\omega} < \bar{\omega}$. Projects are indexed by their probability of success p,[10] the distribution of p is represented by the cumulative distribution function $\Gamma(p)$. In particular, a success project yields $\theta f(k)$ and a failed one returns nothing, where θ is the aggregate productivity and k is the total investment. $f(k)$ is assumed to be both increasing and concave in k. For simplicity, I assume that there are only two aggregate states: a "good" state occurs with probability γ where the aggregate productivity parameter is θ_h and a "bad" state where the aggregate productivity parameter is θ_l, where $\theta_h > \theta_l$. Furthermore, the aggregate state is only realized when project returns are realized. It is connivent to denote the unconditional expected aggregate productivity as $\bar{\theta} = \gamma\theta_h + (1-\gamma)\theta_l$.

In period 1, given the endowment of wealth s and a project p, an agent makes a consumption-saving decision and an occupational decision. In particular, the agent chooses consumption in this period c_1 , saving for the second period s and whether to pursue entrepreneurship with the project. In period

[10]This represents the quality of the projects. Once can view this as the sum of probabilities of all states that the firm has enough to repay their debt; even incase that collateralized assets are liquidized. In that situation, the more fixed assets a firm has, then the higher is the quality of the firm.

2, an entrepreneur decides how much to invest k and how much to borrow (if her saving is not enough to finance the project). A worker, on the other hand, receives his income from lending and a fixed wage payment of q.

The only private information in this economy is the outcome of the projects, which is revealed to the entrepreneur; all other information is public, like the level of wealth, the quality of projects and the aggregate productivity. Following Townsend (1979), an outsider could learn the project's outcome by paying an verification cost; this gives a role for a large financial intermediary who takes deposits from a large number of agents and lends to a large number of entrepreneurs, due to its ability to economize on verification costs. However, random verification strategies are ruled out for simplicity. Following Li (1998), this verification cost takes the form of $\beta + \eta b$, where b denotes borrowing, β is a fix cost and η is a per-unit cost on verification.

Loans take the form of one-period bond contracts. The face value of these bonds is denoted by x, which is the amount that is to be repaid at the end of second period. The market for bonds is perfectly competitive. While these loans are non-contingent as the face value does not depend on the realization of any value, entrepreneurs will default once their projects fail, in which case the verification takes place. I assume that the intermediary can not take on any aggregate risk, such that no one can provide insurance against aggregate shock except the government.[11] Thus, in equilibrium the financial intermediary is perfectly diversified with respect to idiosyncratic project risks, earns zero profits, and will have a nonstochastic return on its portfolio.

Suppose that the rate of return on deposits that the financial intermediary pays to investors is r, then it follows that the intermediary is willing to offer a loan to an entrepreneur if the expected return is also r, assuming there are no transaction costs. Then, a loan contract with an entrepreneur that has project p, saving s and capital size k has to satisfy the following:

$$px = r(k-s) + (1-p)[\beta + \eta(k-s)] \tag{3.1}$$

The loan also has to satisfy a set of feasibility constraints for the entrepreneur, such that she has at least enough to pay back the loan if her project successes, regardless of the aggregate state:[12]

$$x \leq \theta_h f(k) \tag{3.2}$$

$$x \leq \theta_l f(k) \tag{3.3}$$

[11] i.e., if this is a dynamic model, I assume that the cost of capital for financial institution during a downturn is infinity for simplicity. Discussion about a more general formulation is provided in foot note 11.

[12] A more general way of modeling the situation is to explicitly state the cost of covering for losses during a downturn, say it costs the financial institution $(1+\bar{\epsilon})$ for every unit of loss that it incurs during a downturn. And the same loss costs the government $(1+\underline{\epsilon})$. Here, ϵ can be view as the borrowing cost for rolling over losses to the next period in a dynamic model. Then, the zero profit condition (3.1) becomes:

$$px - (1-\gamma)(1+\epsilon)\min\{0, x - \theta_l f(k)\} = r(k-s) + (1-p)[\beta + \eta(k-s)]$$

and constraint (3.3) is omitted. As long as there is a wedge between $\bar{\epsilon}$ and $\underline{\epsilon}$, such that the borrowing cost is lower for the government, most of the main results persist.

Given the assumption that $\theta_l < \theta_h$, (3.2) can be omitted. The introduction of the state dependent feasibility constraint (3.3), which clearly induces a borrowing constraint, is the main difference between this model and Li's (1998). In particular, for a low enough θ_l, the constraint (3.3) binds for some entrepreneurs with low initial wealth and good quality projects: the low return of projects at this "bad" state limits entrepreneurs' ability to invest at the efficient scale, even if it rarely occurs. The inability of the financial intermediary to self-insure against this newly introduced aggregate uncertainty begs the role for a third party that can offer such insurance. I am not implying that banks in reality cannot smooth across states, I make such extreme assumption just to illustrate that there is a large wedge between the borrowing cost of financial institutions and the government during a downturn. Such that, the government enjoy advantage in smoothing across states (across time in a dynamic framework) compared to financial institutions.

An entrepreneur requires external financing with saving s and project p solves the following maximization problem by choosing k:

$$v^e(s,p) = \max_k \ \bar{\theta} p f(k) - \delta p x + (1-\delta) r (s-k) \tag{3.4}$$

subject to:

$$x \leq \theta_l f(k)$$

$$px = r(k-s) + (1-p)[\beta + \eta(k-s)]$$

$$\delta = \begin{cases} 1 & \text{if } k > s; \\ 0 & \text{otherwise.} \end{cases}$$

where $\bar{\theta} = \gamma\theta_h + (1-\gamma)\theta_l$ is again the unconditional expected aggregate productivity.

The second period consumption of a representative worker with saving s is consisting of the labour income q and a gross risk-less return on saving s:

$$v^w(s) = q + rs \tag{3.5}$$

Thus a representative agent with wealth ω and project p in period 1 chooses his/her first period consumption c_1, saving s, his/her occupation and investment level k. Such that he/she solves the following problem:

$$\max_{c_1,s,e} \quad U(c_1) + Ec_2 \tag{3.6}$$

subject to:

$$c_1 + s = w, \tag{3.7}$$

$$c_2 = e \times v^e(s,p) + (1-e) \times v^w(s), \tag{3.8}$$

$$e \in \{1, 0\}. \tag{3.9}$$

Condition (3.7) states that the sum of an agent's consumption in period 1 and saving cannot exceed his asset endowment. Condition (3.8) says that an agent's second period expected consumption depends on his/her occupation, an entrepreneur has $v^e(s,p)$ and a worker has $v^w(s)$. Condition (3.9) restricts the occupation indicator e to be binary: it takes the value of 1 if the agent chooses to be an entrepreneur and 0 when he chooses to be an worker.

Given the above problem, the level of saving is pinned down by the following first-order condition:

$$U(w-s)' = \begin{cases} \frac{\partial v^e(s,p)}{\partial s}, & \text{if } e = 1; \\ r, & \text{if } e = 0. \end{cases}$$

The left side is the marginal loss of utility from an additional unit of saving and the right side is the marginal benefit from saving (either marginal return from lending to the intermediary or the marginal product from the additional capital).

Equilibrium is defined as follows:

Definition 2. *Given initial endowment distribution of wealth $\Phi(\omega)$ and projects $\Gamma(p)$, verification cost of β and η, an equilibrium is a set of allocation of consumption profile $\{c_1, c_2\}$ saving s, occupation decision e and capital k for each pair of w,p such that*

1. *given the interest rate r and initial endowment of (ω, p), each agent chooses consumption profile $\{c_1, c_2\}$, saving s, occupation e and capital k, to maximize his/her utility subject to his/her constraints;*
2. *given the interest rate r, all loan contract satisfies condition (1) and (3);*
3. *capital market clears:*

$$\int_\omega \int_p [k(\omega,p) - s(\omega,p)]\delta(\omega,p) d\Phi(\omega) d\Gamma(p) = \int_\omega \int_p s(\omega,p)[1-\delta(\omega,p)] d\Phi(\omega) d\Gamma(p)$$

The left side is the aggregate demand of credit from all entrepreneurs, made up of all borrowing from external financed entrepreneurs and savings from internally funded entrepreneurs. The right side is the total supply of credit which is simply the sum of savings from all workers.

3.3.1 The case of second best without aggregate uncertainty

Note that the first best allocation can only be achieved when there is no information asymmetry. As discussed by Li (1998), in that case, direct lending performs as well as intermediation. In particular, the occupational decision is determined solely by the quality of projects and is independent of an agent's level of wealth endowment.

Once the there is information asymmetry, then inefficiency comes as wealth endowment enters the occupational decision: some relatively low quality projects get carried out by richer owners; on the other hand, some agents cannot undertake their high quality projects due to insufficient internal wealth. To see this, let us first look at the solution to an agent's problem when there is no aggregate uncertainty and that $\bar{\theta}$ is high enough such that constraint $x \leq \bar{\theta} f(k)$ does not bind.[13] A borrowing entrepreneur equates the marginal product of capital to the marginal cost of funds such that: $\bar{\theta} p f_k(k) = r + (1-p)\eta$; a self- financing entrepreneur equate the marginal product of capital to the return from additional saving such that: $\bar{\theta} p f_k(k) = r$. Thus any additional wealth would raise her utility first at rate $r + (1-p)\eta$ by reducing future borrowing needs (when

[13] In this case, the entrepreneur's problem is the same problem as in (4), minus the $x \leq \theta_l f(k)$.

$k > s$), then at rate $\bar{\theta} p f_k(k)$ (whenever $\bar{\theta} p f_k(k) > r + (1-p)\eta$) and then at rate r through increased saving (when $k \leq s$). For a worker, any additional wealth would increase his utility by r through additional saving, which is less than $r + (1-p)\eta$. That is, for relatively low level of wealth, additional bit of wealth raises an entrepreneur's utility more than that of a worker's; for higher level of wealth, additional wealth raises their utility at the same rate. Thus, given a good enough project,[14] an agent's occupational decision follows a simple cut-off rule:

Result 1. *Given a high enough p, there exist a cut-off level of wealth $\hat{\omega_p}$ such that agents with wealth $\omega < \hat{\omega_p}$ choose to be workers and agents with wealth $\omega \geq \hat{\omega_p}$ choose to be entrepreneurs.*

It is obvious that a better project would increase an entrepreneur's utility since $v^e_p(s, p) > 0$. The worker's utility, on the other hand, does not change with the quality of the projects. The occupational decision then follows a simple cut-off rule regarding project quality for a given wealth endowment:

Result 2. *Given w, there exist a cut-off level of $\hat{p_\omega}$ such that agents with project $p < \hat{p_\omega}$ choose to be workers and agents with project $p \geq \hat{p_\omega}$ choose to be entrepreneurs.*

If an agent chooses to be an entrepreneur and requires external financing,

[14] It is possible for a project to have a low enough quality such that an agent never choose to operate it regardless of his wealth endowment.

the optimal choice of firm capital size k^* is pinned down by the following condition:

$$p\bar{\theta}f(k^*) = r + (1-p)\eta \tag{3.10}$$

Such that the marginal return on capital is equal to the marginal cost from obtaining external funding. For those self-financed entrepreneurs who does not carry additional savings, the optimal level of capital is pinned by the condition that $U'(\omega - s) = p\bar{\theta}f(k^*)$. The rest of entrepreneurs invest at efficient scale: $p\bar{\theta}f(k^*) = r$.

3.3.2 The case with aggregate uncertainty

The introduction of aggregate uncertainty makes starting a business even more difficult for poorer households. Note that as the financial intermediary cannot take on any aggregate risk, the condition $x \leq \theta_l f(k)$ induces a natural credit constraint for each household. In the second period, given a pair of saving and project (s, p), there is a limit on the maximum amount of capital that can be raised from both internal and external sources combined: this limits on capital (firm size), denoted by $\bar{k}_{s,p}$, can be pinned down by the equation $x = \theta_l f(k)$ while holding the zero-profit condition (1), such that:

$$p\theta_l f(\bar{k}_{s,p}) = r(\bar{k}_{s,p} - s) + (1-p)[\beta + \eta(\bar{k}_{s,p} - s)] \tag{3.11}$$

Thus, given project p, a richer agent (with higher ω) has a larger range of capital to choose from than a relatively poorer agent.[15] Thus, if $\underline{\omega}$ is low enough, some poor households endowed with good quality projects are going to be excluded from entrepreneurship or cannot invest in efficient scale due to the lack of internal resources. In the case when an entrepreneur is constrained, she runs a firm with size equal to $\bar{k}_{s,p} < k^*$, and the marginal return on capital is higher than $r + (1-p)\eta$. When compared to the second best case, there are less entrepreneurs, and some of those remaining entrepreneurs run smaller firms, the aggregate output is obviously lower.[16]

3.3.3 Government operated loan guarantees

In this section, I show that in the presence of aggregate uncertainty, there exists a government operated guarantees scheme that has a Net Present Value of zero that leads to higher aggregate output. The same program cannot lead to output improvement in the absence of such risks.

The government loan guarantee program will be operated through the financial intermediary, since the government cannot economize on verification cost.[17] This program guarantees ϕ proportion of each private loans for a targeted group. The targeted group in this case will be those who are credit constrained due to the existence of aggregate risk, i.e firms with $\bar{\theta} p f_k(k) >$

[15]A formal proof is provided in Appendix A to show that $\bar{k}_{s,p}$ is decreasing in s.

[16]Fewer entrepreneur and higher fraction of smaller firms lead to reduction in demand for credit in the economy, so equilibrium interest rate has to fall. A falling interest rate encourages more agents to undertake entrepreneurship, and entrepreneurs operate larger firms. But this second order effect is going to be dominated by the direct effect.

[17]Unless itself became the sole provider for all loans in the economy.

$r + (1-p)\eta$ when there is no guarantee program. In order to recover the costs of honoring defaults, the government charges a proportional fee τ on the guaranteed portion ϕx.

Under this loan guarantee program, the zero profit condition on a loan for the financial intermediary is given by:

$$\begin{aligned} \gamma[px + (1-p)\phi x] + (1-\gamma)(\phi x + p\theta_l f(k)) & \\ = r(k-s) \quad + \quad (1-p)[\beta + \eta(k-s)] & \quad (3.12) \\ x \quad \leq \quad \theta_l f(k) + \phi x & \quad (3.13) \end{aligned}$$

where $px + (1-p)\phi x$ is the expected recovery amount under normal aggregate condition, and $\phi x + p\theta_l f(k)$ is for under aggregate downturn. One of the key assumption I am making here is that the government could costlessly smooth across different states, this follows from the assumptions that it enjoys a lower borrowing cost in the bad "state".[18] The guarantee fee does not show up here because I assume that it is paid directly by entrepreneurs; I could assume it is paid through the intermediary without having any impact on model results, since the intermediary makes zero profit on each loan.

As for the government program, let's first assume that the government can charge individual entrepreneurs at different rate τ. Such that the requirement of $NPV = 0$ is satisfied when the expected outlay and income of the program

[18] Again, this point would be much clear in a dynamic model, however the goal of this paper is to use the simplest framework to illustrate the intuition of a government operated guarantee program as insurance against aggregate risks.

cancel out each other for every single loan:

$$(1-p)\phi x + (1-\gamma)p\phi x = \phi x\tau \tag{3.14}$$

The left side is the expected payments to the financial intermediary in honoring defaults when projects fail or in the event of aggregate downturn, and the right side is the total fee collected. The above condition can be reduced to:

$$\tau = 1 - p\gamma \tag{3.15}$$

This condition implies that the fee charged should be decreasing in the project quality p, such that a better project should pay lower percentage guarantee fees. The reason for this, is that the guarantee covers not only aggregate risk, but also firm's idiosyncratic risk.

Now, consider the expected profit for an entrepreneur who receives loan guarantees:

$$v^e(s,p) = \max_k \ \bar{\theta}pf(k) - [\gamma px + (1-\gamma)\theta_l f(k)] - \tau\phi x \tag{3.16}$$

subject to:

$$\gamma[px + (1-p)\phi x] + (1-\gamma)[\phi x + p\theta_l f(k)] = r(k-s) + (1-p)[\beta + \eta(k-s)]$$

$$x \leq \theta_l f(k) + \phi x$$

$$\tau = 1 - p\gamma$$

Where $\gamma px + (1-\gamma)\theta_l f(k)$ is the expected repayment to the bank, and $\tau\phi x$ is the guarantee fee paid to the government program. Substituting conditions (3.12) and (3.15) into the objective function, we have:

$$v^e(s,p) = \max_k \ \bar{\theta}pf(k) - r(k-s) - (1-p)[\beta + \eta(k-s)] \qquad \textbf{(3.17)}$$

subject to:

$$x \leq \theta_l f(k) + \phi x$$

Clearly, the objective function is the same as in the case without aggregate uncertainty, which means that the optimal level of capital is pinned down by the same marginal conditions as before. Then, as long as government is able to charge individual specific guarantee fees that depends on p, the program covers only the aggregate risk but not idiosyncratic risks, such that entrepreneurs have no incentive to apply for a higher level of guarantee than what is required. The equilibrium allocation is the same as the situation without aggregate risk:

Result 3. *If the government is able to charge individual specific guarantee fees, then there exist a loan guarantee program with $\tau(p) = 1 - \gamma p$ and $\phi \in [0,1]$ with net-present-value of zero that leads to the same allocation as the case without aggregate uncertainty.*

In other words, the introduction of this particular guarantee program leads to a more efficient allocation of resources.[19] The competitive equilibrium is similarly defined as before: it is a resource allocation of workers, entrepreneurs

[19] Note that this allocation is not Pareto superior to the equilibrium allocation without the guarantee program. Because of the increase in demand for credit, equilibrium interest rate goes up, thus those externally financed entrepreneurs not under the guarantee program pay a higher interest rate and operate a smaller project.

and interest rate, together with a guarantee fee schedule such that the following three conditions are satisfied: first, all agents optimize by choosing consumption, saving, occupation, investment and whether to participate in the guarantee program, subject to their constraints; second, the credit market clears; third, the guarantee program has a net present value of zero, such that:

$$\int_\omega \int_p (1-p\gamma)\phi(\omega,p,\tau)x(\omega,p,\tau)d\Phi(\omega)d\Gamma(p) = \int_\omega \int_p \tilde{\tau}\phi(\omega,p,\tau)x(\omega,p,\tau)d\Phi(\omega)d\Gamma(p)$$

$$\text{Where } \tau = 1 - p\gamma$$

3.4 Guarantee program with a fixed guarantee fee

It could be difficult for the government to charge different guarantee fees based on project quality. For instance, the quality of project might not be directly observable and it is costly to evaluate each individual project in detail and assign a specific rate.[20] Even if the financial institutions know more about the quality of projects due to screening, they do not have incentive to share it with the government. Thus, it might be convenient for the program to announce a specific percentage guarantee fee $\tilde{\tau}$ as in the Canadian case, and give a range of $\phi \in [0, \bar{\phi}]$ that entrepreneurs can choose from. In that case, given $\tilde{\tau}$, an

[20] This is a more common case: the individual operating the firm and its associated financial institution usually has more information about the quality of the firm than the government.

entrepreneur's expected profit is given by:

$$v^e(s,p) \quad = \max_{k,\phi} \ \bar{\theta}pf(k) - [\gamma px + (1-\gamma)\theta_l f(k)] - \tilde{\tau}\phi x \tag{3.18}$$

subject to:

$$\begin{aligned} &\gamma[px + (1-p)\phi x] + (1-\gamma)[\phi x + p\theta_l f(k)] = r(k-s) + (1-p)[\beta + \eta(k-s)] \\ &x \leq \theta_l f(k) + \phi x \\ &\phi \in [0, \bar{\phi}] \end{aligned} \tag{3.19}$$

Once we substitute the zero profit condition (3.12) into the objective function, we have:

$$\begin{aligned} v^e(s,p) = \max_{k,\phi} \quad & \bar{\theta}pf(k) - r(k-s) - (1-p)[\beta + \eta(k-s)] \\ & + (1-p\gamma-\tilde{\tau})\frac{r(k-s) + (1-p)[\beta+\eta(k-s)] - (1-\gamma)p\theta_l f(k)}{\frac{\gamma p}{\phi} + (1-p\gamma)} \end{aligned}$$

From the above equation we can see that, if $1 - p\gamma > \tilde{\tau}$, then the expected profit is strictly increasing in ϕ and vice-versa. I denote the cut off project quality as $\tilde{p_\tau}$, where $1 - \tilde{p_\tau}\gamma = \tilde{\tau}$. That is, under the guarantee program, an entrepreneur with relatively low quality project ($p < \tilde{p_\tau}$) chooses the highest possible guarantee level $\bar{\phi}$, and those with higher quality projects choose ϕ where $x = \theta_l f(k) + \phi x$. This is because, for an entrepreneur with project $p < \tilde{p_z}$, her guarantee payment $\tilde{\tau}\phi x$ is less than the expected payment from the guarantee program to the bank, $(1 - p\gamma)\phi x$. Then, for any amount of loan x, a higher ϕ leads to a higher expected profit for this entrepreneur, as the marginal cost of obtaining higher ϕ is always lower than the marginal benefit. The same intuition applies to entrepreneurs with $p > \tilde{p_\tau}$, but in the opposite direction. It should be clear that in this case, the high-quality firms are subsidizing those of low-quality ones. However, as government is the sole entity to provide insurance against aggregate risks, for a low enough $\tilde{\tau}$ it is still beneficial for some relatively high quality projects to participate in the program.

The optimal level of capital (firm size) for an entrepreneur under the program can be pinned down by the following first order condition with respect to k:

$$\bar{\theta} p f_k(k) + (1 - p\gamma - \tilde{\tau}) \frac{r + (1-p)\eta - (1-\gamma) p \theta_l f_k(k)}{\frac{\gamma p}{\phi} + (1 - p\gamma)} = r - (1-p)\eta \qquad (3.20)$$

It shows that the optimal level of k also depends on the sign of $[1 - p\gamma - \tilde{\tau}]$. In particular, given that $r + (1-p)\eta - (1-\gamma)p\theta_l f_k(k)$ is positive, entrepreneurs under the program with $p > \tilde{p_\tau}$ chooses k^* such that $\bar{\theta} p f_k(k) > r - (1-p)\eta$; entrepreneurs under the same program with $p < \tilde{p_\tau}$ invest at level where $\bar{\theta} p f_k(k) < r - (1-p)\eta$. In other words, under this program with fixed $\tilde{\tau}$, when compared to the case without aggregate uncertainty, entrepreneurs with relatively lower quality projects over-invest and entrepreneurs with relatively higher quality projects under-invest.

Result 4. *Given a government guarantee program with fixed fee $\tilde{\tau}$ and a guarantee range $[0, \bar{\phi}]$, lower quality projects benefit more from it when compared to higher quality ones. When compared to the case without aggregate uncertainty, entrepreneurs with $p < \tilde{p_\tau}$ choose $\bar{\phi}$ and over-invest their projects; entrepreneurs with $p > \tilde{p_\tau}$ choose $\phi = \frac{x - \theta_l f(k)}{x}$ and under-invest their projects.*

Just as any insurance policy with a fixed premium, there is a adverse-selection problem associated with this guarantee program. This problem arises for two reasons: first, when $\tilde{\tau}$ increases, the benefit in participating in the program decreases, some constrained entrepreneurs with high quality projects are not going to participate in the program. Second, due to the asymmetry of benefits from participation in the program between high and low quality projects, all constrained entrepreneurs with project $p < \tilde{p_\tau}$ will want to participate in the program. In fact, if the program is open to anyone who wishes to obtain a guarantee, some workers with relatively lower quality projects under the case without aggregate uncertainty became entrepreneurs as well under this guarantee program. Due to this adverse-selection problem and the asymmetry between benefits obtained by high and low quality projects, the program generates losses in the absence of additional qualification requirements. In addition, the interest rate is higher as the demand for credit goes up, thus entrepreneurs not receiving a guarantee operate smaller firms when compared to the case without aggregate uncertainty.

Result 5. *A fixed fee loan guarantee program without additional qualification constraints has to be financed by subsidy (i.e has a $NPV < 0$), and lead to an "over-lending" problem due to adverse-selection.*

3.4.1 Policy Discussion

For any $\tilde{\tau}$, the government's constraint $NPV = 0$ holds as long as[21]

$$\int_\omega \int_p (1-p\gamma)\phi(\omega,p,\tilde{\tau})x(\omega,p,\tilde{\tau})dpd\omega = \int_\omega \int_p \tilde{\tau}\phi(\omega,p,\tau)x(\omega,p,\tilde{\tau})dpd\omega \quad (3.21)$$

It should be clear that if the guarantee program only allows projects above certain quality threshold to participate in it, then the program could maintain a NPV of zero or above. In fact, for any fixed fee $\tilde{\tau}$, there exists a unique qualification level $\underline{p}^{\tilde{\tau}}$, such that if the program only allows projects with $p > \underline{p}^{\tilde{\tau}}$ to participate in the program, then the NPV of the program is zero. This is easily done in theory, especially in an environment where p is observable. Intuitively, to keep the NPV to be around zero, a higher guarantee fee would result in a lower quality requirement and a lower guarantee fee would need a higher quality requirement. However, a requirement of "zero subsidy" might be a simple way to encourage the guarantor agencies to put more effort in screening. That is, as long as the program has $NPV = 0$, we know that the relatively high-quality projects benefit from the program or else they would not participate.

A qualification requirement based on quality is easy to do in theory. However, in reality, it is sometimes hard for a lender and especially the guarantor to learn the "true" quality of a project. There is a quite extensive literature on credit rationing caused by entrepreneur's hidden knowledge of project quality

[21]Here, for all entrepreneurs who are not credit constrained due to aggregate risk, choosing to participate in the guarantee program lead to lower expected profit as they will be subsidizing lower quality projects.

as in Stiglitz and Weiss (1981). In that case, the use of collateral and personal guarantees as a self-selection and incentive mechanism can effectively mitigate the problem (Chan and Thakor, 1987; Bester, 1987). Then the mandatory requirement of collateral and personal guarantees by these guarantee programs can be viewed as means to mitigate the adverse-selection problem by screening out low-quality projects. In addition, the CSBFP and 504(a) program restricts the use of loans for acquisition of fixed assets only, further strengthening the prospects of repayments. As mentioned in section 2, starting from 1990, both countries' programs have paid more attention to cost recovery. For instance, the SBA concentrated lending with the more efficient and responsible lenders, which is a way of encouraging better screening among firms. Clearly this is corresponding to the second criteria of sound prospects of repayment.

In the context of this model, the third selection criteria of incrementality can be viewed as means to screen out those projects that are not constrained due to the presence of aggregate uncertainty; i.e projets paying interest rate of $r+(1-p)\eta$. However, note that given the opportunity to participate in the program, these entrepreneurs would increase the amount of external financing; and in fact, they would not qualify for the amount requested for the same rate under the program. That is, technically, they would have met the incrementality criteria. Thus, it has to be used in conjunction with the second criteria to be effective.

The third comment is around the controversial high upfront cost of obtaining these loan guarantee, i.e, packaging fee from the guarantors themselves, complex paperwork and other professional fees (Green, 2005). These costs could be viewed as deadweight loss in the efficiency sense. However, the existence of these fixed cost could prevent entrepreneurs with low benefit from the guarantee programs to participate in it. In particular, those entrepreneurs with relatively low-quality projects and high wealth who are not credit constrained due to aggregate uncertainty. Thus, these upfront cost may in fact lower the cost of these programs, then reduce the subsidy from high-quality projects to low-quality entrepreneurs.

3.5 Conclusion

This chapter shows that insurance against aggregate risk can be an important rationale for small business loan guarantee programs. I demonstrate that in a model, firms may be credit constrained because they are more prone to default risks due to aggregate fluctuations and changes in financial institutions' cost of capital. The current loan-guarantee scheme promotes firm growth by providing insurance and is socially beneficial in the presence of aggregate risks; the same cannot be said in the absence of such risks. Furthermore, there is a potential adverse-selection problem associated with the current guarantee fee structure. However, strict selection process and high fixed cost of obtaining guarantees, in theory, could mitigate the problem and help maintain the low cost status of these programs.

In this framework, I assume that financial intermediaries face higher cost of covering for losses (high borrowing cost) during an economic downturn rather than derive the cost endogenously. Obviously, it cannot be done in a static model. An interesting extension is to study a dynamic version with the possibility of default by a financial institution. Such that, the high borrowing cost during economic downturn arise endogenously. Also, quantitative cost/benifit evaluation of the guarantee program could be performed in such a framework.

Another possible extension is to study the effect of guarantee program under aggregate uncertainty in an environment with the other kind of information asymmetry mentioned in the literature; namely, when entrepreneurs have hidden knowledge about the quality of their projects (Stiglitz and Weiss, 1981; Williamson, 1994). In particular, there is one more adverse-selection problem with bank lending as well.

Even though the Bush adminstration required that guarantee programs to be operated on a "zero-subsidy" status, at the awakening of the recent financial crisis lead recession, these programs clearly did not have enough resources to cover the increase in demand for honoring defaults. There are two potential reasons for this: first, the guarantee program was under the new policy for too short of a period, such that it did not build up enough resources to cover losses caused by such a drastic event; second, there is little experience on project defaults and the consequent losses due to aggregate uncertainty(Honohan, 2009), to the extent that the lack of information makes designing the "correct" scheme difficult; in particular, it is difficult to set the correct risk-premium. Needless to say, this is an interesting topic for future research.

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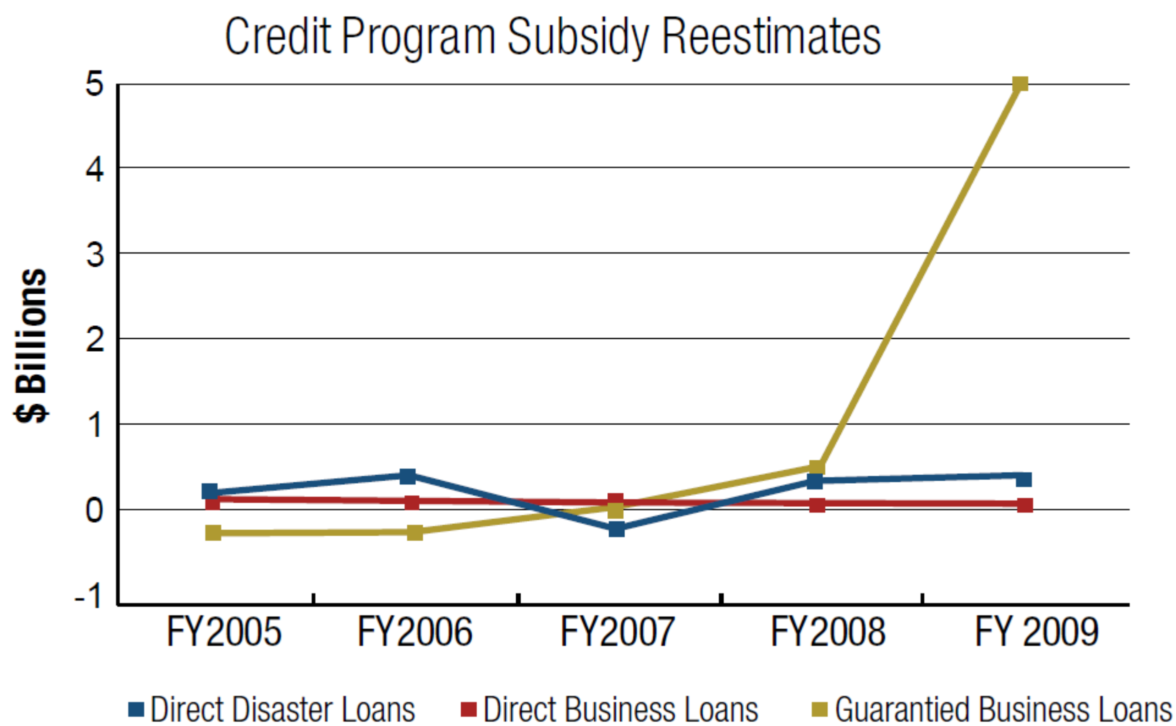

Figure 3.1: Program subsidies estimates for SBA programs, source: Small Business Adminstration (SBA, 2010)

Chapter 4

Financing High-Tech Start-Ups: Equity Ownership Matters

4.1 Introduction

The importance of U.S. venture capitalists' role in fostering innovative high-tech firms over the past 30 years has been well documented. Apple Computers, Cisco Systems, Google, Microsoft, SUN are just a few but the most famous U.S. companies to get funding from venture capital (henceforth, VC) firms while young. Consequently, there has been a dramatic expansion of public programs that encourage the formation of VC funds across Europe around mid to late 1990s (Tejada, 2003; Baygan, 2003b,a; Baygan and Freudenberg, 2000). These programs are all backed by one common rationale: VC has spurred technology innovation in the U.S., and can do so elsewhere. However, despite European governments' efforts, we see that only a few of the European countries have comparable levels of VC investments in their high-tech sectors as the U.S. today. (For details see Figure 4.3.)

Public policies that encourage high-tech investments are commonly rationalized by the belief that young high-tech firms face more difficulties in obtaining external financing, especially debt financing. The most commonly documented reasons for these firms not be able to get external financing are the following (Carpenter and Petersen, 2002; Himmelberg and Petersen, 1994). First, the returns to high-tech investments are skewed and highly uncertain, as R&D projects usually have a low probability of financial success. Second, a high level of information asymmetry is likely to exist between firms and potential investors, such that firm managers have much better information than outsiders about the prospects of the firm's investments. Third, high-tech investments often have limited collateral value, as R&D investments have little value in the event of failure. These studies (Carpenter and Petersen, 2002; Himmelberg and Petersen, 1994) claim that VC investment is better fitted for high-tech industries for the following reasons. First, venture capitalists' expertise in monitoring and screening may help to solve the adverse selection and information asymmetry problems. Second, by taking an equity position in the venture firm, the VC firms can share proportionately in profit, guaranteeing that VC firms benefit if the firm does well.

However, there is nothing preventing banks from doing the same type or level of monitoring, at least from a legal stand point of view. Even if banks lack the necessary expertise in performing these tasks, "experts" can be hired to do it, as long as it is profitable. In fact, most major commercial banks in Canada have subsidiaries created for providing equity financing to young high-tech firms (Groupe Secor Inc. 1998).[1] Further more, banks do have the ability to write contingent contracts such that the interest rates they charge are based on a firm's performance. In theory, this would allow them to share the upside profit. So, what is so special about equity financing? The control rights come with the partial ownerships.[2] More specifically, voting rights, cash flow rights and the ability to allocate and negotiate these rights contingent on portfolio firm's performances. It is well known that, as opposed to debt contracts, typical VC contracts specify detailed provisions on the allocation regarding control rights (Bascha and Walz, 2001). Furthermore, VC investors usually hold disproportional control over the firm. Even if the VC firm holds only a small share of the common stock, it still maintained effective control over the board, directly through reserved seats or through a disproportionate share of votes. Also, in the case of asset sales or large expenditures, approval from venture investors is required.

As argued by Gompers (2004), banks in the U.S. cannot undertake the same type of deal that venture capitalists do, because regulations limit banks' ability to hold shares in non-financial firms, and so they cannot freely do equity

[1]This is a special case within the four countries group of Denmark, Sweden, Canada and U.S. In the other three countries, even the subsidiaries of commercial banks cannot offer equity financing freely, at least not until early 2000.

[2]Mainly through the use of convertible securities by VC in the U.S.

financing.[3] It turns out these restrictive regulations only exist in a few of the developed countries, namely Denmark, Sweden, Canada and the U.S., which all have disproportionately high levels of VC investments concentrated in their high-tech industries compared to other developed nations. (See Figure 4.3 for details.)

To illustrate the importance of the ability to vary the level of control contingent on performance by investors in the high-tech sector, I develop a simple principal-agent model of start-up financing with information asymmetry, moral hazard and R&D investments. In particular, the entrepreneur learns the true "type" of the project after R&D investments are made while the investors only get a signal, which a contract can formulate contingencies on. On top of that, the entrepreneur can choose to deviate and "eat" investments in any period, for a private benefit. The existence of this moral hazard problem makes it harder to solve the information asymmetry problem by varying payoffs to the entrepreneur and/or investment levels. This is because the private benefit from deviating does not depend on the outlook of the project, but the actual investment level. One crucial assumption of this model is that the moral hazard problem can be directly tackled by varying the level of control over the firm, as is the case for a typical VC contract: when a portfolio firm is not performing well, the VC firm monitors more intensively and gains more control over the firm. I show that when these three commonly documented characteristics of

[3] After the Gramm-Leach-Bliley Act being signed to law in 1999, U.S. banks are permitted to take equity in commercial firms through their merchant banking subsidiaries. Though long-term control of commercial firms by banks is still restricted (Krainer, 2000)

the high-tech firm coexist, namely: (i) a high degree of information asymmetry, (ii) a high level of uncertainty about returns, and (iii) a large amount of R&D investment preceding production, then the ability for lenders to vary the level of control contingent on performance becomes key.

This result provides support for the view that ownership-equity type financing is better suited to fund young high-tech firms (though, not necessarily from a VC firm). Thus, in countries where equity financing from commercial banks is restricted, VC firms have a clear advantage in investing in the high-tech sector. Indeed, VC firms in the four countries mentioned above do invest heavily in high-tech industries. However, one cannot simply conclude that countries with fewer VC investments in high-tech have a smaller high-tech sector compared to the U.S. The UK, for instance, has a fairly large pharmaceutical industry. Even if the European policy makers insist that their high-tech industries do need additional support, the lack of funding is certainly not the main challenge these industries face. If it was profitable to invest in these industries, commercial banks would have provided all the equity financing needed before VC firms came along. Germany's banks in particular are famous for getting involved in the business decision making in firms they invest in (lend to); sometimes the bank manager may sit on the board even when only debt financing is offered. Thus, as VC firms no longer have an advantage in offering equity financing in most European countries, they have to compete with commercial banks in all sectors. In fact, the use of debt financing still dominates equity financing within the European VC industry, which suggests that these firms are more like traditional banks compared to their North American counterparts. The other evidence for this view is that the European private equity industry is very concentrated in later stage financing, as VC investments by volume are much less than those of the buy-out funds.

Many studies have tried to explain why VC is special. Ueda (2004) study a model in which the venture capitalist has advantage in evaluating a project, but can ”steal” it from an entrepreneur. We share the same prediction that projects with higher returns, higher risk and lower collateral values are financed through a venture capitalist. Holmstrom and Tirole (1997) develop a model of financial intermediaries that can monitor an entrepreneur's effort, and they show a similar result that entrepreneurs finance through equity if they are short of collateral. Black and Gilson (1998), argues that the non-financial services offered by venture capital loses its efficiency as portfolio company matures, such as monitoring, advisory services and reputational capital. That's why an active stock market is important for a successful venture capital industry. This view is shared by Baygan and Freudenberg (2000) and others. However, these papers' results do not help explain the cross country differences in sectoral allocation of venture capital investments. For instance, several countries with less active stock markets have a comparable total and per-capita level of venture capital investment as the United states, but all have much lower levels of high-tech VC investments.

There are several other papers that deal with allocation of control rights in venture capital financing. Cornelli and Yosha (2003) argue that VC firms use staging and convertible securities together as a solution to the conflict of interest between the VC firms and the entrepreneur, much like in this chapter. Berglöf (1994) claims that state-contingent allocation of control rights through convertible securities allocates control to the party that has the higher outside option. Bascha and Walz (2001) show that state-contingent control rights help implement the first best decision regarding IPO's. Schmidt (2003) argues that usage of convertible debt can implement efficient effort levels from both the VC and the entrepreneur. Unlike these papers, I show the importance of the investor's ability to vary level of control. I isolate this effect from the complicated two-sided bargaining process between the entrepreneurs and investors over payoffs or control rights, and the final IPO exit decisions. In particular, I show that having controlling ownership becomes more important as the levels of uncertainty about returns increases, and when information asymmetry and moral hazard problems worsen.

The rest of the chapter is organized as follows: Section 2 summarizes the facts about banking regulation and venture capital investments across countries; Section 3 describes the model; a characterization of the optimal contracts offered by debt and equity investors is presented in Section 4; and Section 5 Concludes.

4.2 Banking Regulations and Venture Capital Investments Across Countries

First, I present the regulations on commercial banks holding equities in non-financial firms for a sample of 17 European and North American countries. First, the restrictive ones: Denmark's commercial banks may not hold permanent, decisive participation in a non-financial firm; Canadian banks can hold at most 10% of total share of a non-financial firm;[4] Portugal's bank can hold only up to 25% of voting power in non-financial firms that they invest in; Sweden's bank can only hold up to 5%; and U.S. banks are not allowed to offer equity financing, unless the firm in question is small and is in financial distress. Even in that situation, banks are still prohibited to get involved with the business decision making.

All other countries' regulation in the sample follow closely the EC banking ACT II, which allows banks to take equity stakes in non-financial firms. Among these countries, only two countries enforce extra restrictions: in the Netherlands, banks are required to get permits from the government in order to hold more than 25% of share in a non-financial firm; In UK, banks are required to remove the equity holdings from their assets when reporting for banking risk, if the holding is more than 15% of the firm's outstanding share.

The statistics on VC investments are taken from publications by the U.S.

[4] As mentioned before, they are allowed to set up subsidiaries that provide equity financing.

venture capital association (2006), Canadian venture capital association (2006) and the European venture capital association (2006).[5] Figure 4.1 shows the total flow of VC investments in 2004-2005 as fraction of GDPs for all sample countries. Although U.S.' VC industry is the oldest, other countries are catching up pretty fast, as Canada, Sweden and UK's total investment levels as share of GDP have already surpassed that of U.S' with this measure (also on a per-capita basis). Figure 4.2 presents that high-tech as fraction of total VC investments levels for the same group of countries. Greece's VC industry is particular high in this category simply because Greek VC firms can only invest in the high-tech sector, and as a result the total VC investment level is the lowest among all these countries. Ireland's number is high for a very similar reason. It is clear that the fraction of VC investments went to the high-tech sector is very low for the UK. Figure 4.3 reports the VC investments in high-tech sector as fraction of GDPs for these countries. The group of four countries, Canada, Denmark, Sweden and U.S. clearly stand out from the rest. Sweden's share, which is the lowest among these four countries, is still more than twice as much that of Belgium's, whose is the fifth highest among all sample countries. U.S. has almost four times as much.

After examining these statistics, it is safe to conclude that countries with stricter restrictions on commercial banks holding controlling equity in non-financial firms have disproportionate high levels of VC investments in their

[5] My own calculation is reported whenever necessary.

high-tech sector, except Portugal. Which suggests that the VC firms in these four countries enjoy certain advantages in investing in the high-tech sector. I construct a simple model in the next section to help understand why equity financing with ownership is more suitable for high-tech firms.

4.3 Model

A project involves a risk-neutral entrepreneur/manager with an idea, and a risk-neutral investor, either a VC firm or a bank. The entrepreneur (manager) does not have any wealth, thus she needs external financing to start a project. Only the VC firm and bank can commit to contractual arrangements, though they have all the bargaining power in designing the contract by assumption.

The project takes three periods to mature (an R&D period, a production period and a final period). In the first period financial contract is signed then followed by R&D investment. In the second period, the entrepreneur first decides whether to leave the contract arrangement or not, then production investment is made. In the final period investment returns are realized, and claims are settled.

Each entrepreneur only has one project or idea. It costs a fixed amount of investment $\bar{I}_{R\&D}$ to undertake the Research & Development in period 1. Production investment I can be chosen from the interval $[0,1]$ in period 2, conditional on $\bar{I}_{R\&D}$ was spent. In period 3 the investment generates a verifiable financial return equaling 0 (failure) or $I \times R$ (success). Each project is one of two types, good or bad, which differs in probability of success.[6]

Project	good	bad
Probability of success	p_h	p_l
Probability of being type i	η	$1 - \eta$

I assume that

$$\Delta p = p_h - p_l > 0 \tag{4.1}$$

and denote the unconditional probability of successes as $\hat{p} = \eta p_h + (1 - \eta) p_l$. Furthermore, the rate of return on investment capital is assumed to be 0 for simplicity, and only type good projects are economically viable:

Assumption 1. *:* $p_h R - \frac{\bar{I}_{R\&D}}{\eta} > 1 > p_l R$

The reason that $\frac{\bar{I}_{R\&D}}{\eta}$ is on the left-side instead of $I_{R\&D}$ is because that there is no way of separating the bad projects from the good ones in the first period. Thus, $I_{R\&D}$ is necessary for all projects, even if none of the bad projects continue on past the second period. In other words, $I_{R\&D}$ for bad projects is a part of the necessary upfront cost for good projects, then for the good projects to be economically viable, their return has to cover not only their share of the R&D investments, but also the bad ones'.

[6]An alternative way of modeling this is to assume projects differ in rate of returns (i.e. $R_H > R_L$) but have the same probability of success. Since all parties are risk-neutral, the model's qualitative predications do not change

In the absence of proper incentives or monitoring, the entrepreneur may "eat" the investment for a private benefit (after which the project will fail). The private benefit from this action is equal to a share ϵ of the investment I in that period, where $\epsilon \in (0, 1)$. On top of that, the entrepreneur also has an outside option, where she can work somewhere else for a wage $\tilde{w}$ per period. I assume that,

Assumption 2. *:* $2\tilde{w} > \epsilon \times 1 > \tilde{w}$

Such that the private benefit derived by deviating from a fully funded project is higher than the payoff of working for one period, so the entrepreneur has incentive to continue a fully funded type bad project. On the other hand, it's not worthwhile to participate in the contract just for the sake of investment eating.

This hidden action need not solely represents the situation where the entrepreneur uses all resources for personal use. It is to capture two types of agency costs commonly exist with entrepreneurial firms (Gompers and Lerner, 2004): first, entrepreneurs might want to invest in research or projects that have high personal returns but not high monetary payoffs to their financiers. Take the example of a biotechnology firm: the manager may choose to invest in research that brings greater recognition in the scientific community but provides less financial returns. Second, the entrepreneur might possess private information and choose to continue investing in a project with less expected payoffs. For example, managers might learn the demand for a new product is low, but want to keep the company going because they have private benefits from managing their own firms.

On top of the moral hazard problem described above, there is also information asymmetry between the entrepreneur and her financier (like the second case described above). At the time when a contract is signed, neither the entrepreneur nor her financier knows the true type of the project. The entrepreneur learns her project's true type at the second period, with certainty. On the other hand, only a fraction λ projects' true type is revealed to their financiers. I will formulate the information obtained by investors in period 2 as a signal, where θ is drawn from the set $\{H, M, L\}$, such that:

$$\begin{aligned} Prob\{i = good|\theta = H\} &= Prob\{i = bad|\theta = L\} = 1 \\ Prob\{i = good|\theta = M\} &= 1 - Prob\{i = bad|\theta = M\} = \eta \end{aligned}$$

So, from the viewpoint of financiers, projects with signal H are of the good type, those with signal L are of the bad type. They are not sure about the true type for projects with signal M, but know that with probability η they are of the good type. Timing of model is illustrated in Figure 4.5.

I assume that the main difference between the two kinds of financier is that a venture capitalist as equity holder can eliminate the moral hazard problem (investment eating) by monitor more intensely and place tighter control over a firm at a fixed cost c, the bank as debt holder, on the other hand, cannot. Suppose that an venture firm's performance is in question, but not bad enough such that it needs to be terminated. In this situation, the probability that the entrepreneur is going to use company resources for private benefits (both cases discussed above) goes up, especially if the entrepreneur secretly knows that the outlook of the firm is bad. To solve this problem, an VC firm could send someone over to monitor the management more intensely. And more importantly, VC firms are able to directly intervene with the management, and take away key control rights if they deem it necessary. The debt investor, on the other hand, could monitor the firm more intensely, but lack the ability to directly intervene. They have to use other means to solve the problem: raise interest rates, and lower or stop further funding.[7]

I will end this section with some interpretations of variations in key variables in the model:

- Decrease in λ (fraction of projects' true type is known to its financiers) represents increase in the degree of information asymmetry;
- Increase in level of uncertainty about returns can be achieved by increase the speared of uncertainty Δp while keeping the unconditional probability of success $\hat{p}$ fixed;
- Higher R&D investment is simply represented by higher $I_{R\&D}$;
- The moral hazard problem worsens as ϵ increases.

[7]The other difference between the two, is the ability to request collateral. However, as discussed before, high-tech investments in general have little collateral value.

4.4 Optimal Contracts

In this section, I derive the optimal contracts that the bank and the VC firm offers.[8] It should be clear that these contacts are written in the way as a *take it or leave it* offer to the entrepreneur.

4.4.1 Bank contract

A contract can be characterized by $\Psi = \{I_M, I_H, y_M, y_H\}$ where y_θ is the final payoff to the entrepreneur upon project success and I_θ is the investment level at the production period. These variables have subscripts denoting a particular signal, since the bank can alter investments and payoffs contingent on signals. In principle, $I_{R\&D}$ and$\{y_L, I_L\}$ should also be specified in the contract, but the formal cannot be chosen and the later are trivially set to $\{0, 0\}$ (since bad projects are not economically viable), thus they are omitted from the contract specification.

Although a typical loan contract states interest rates rather than payoffs to the borrower, there is a one-to-one mapping between the two in this model, ie: $r_\theta = \frac{RI_\theta - y_\theta}{I_{R\&D}+I_\theta}$. To denote the contract in this fashion makes it easier to compare the bank contract to its counterpart offered by the VC firm.

Given model specification, there are only two types of contract that could be the most profitable one for the bank depending on parameter values:

[8] Optimal with respect to the tools that each investor has in designing the contract

1. Fund all projects with signal M and H fully, not screening out bad projects with medium signal;
2. Fund only projects with signal H fully, but place a credit limit for projects with signal M so that entrepreneurs with bad project leave.

I will call the first *no credit rationing* contract, and the second *credit rationing* contract.

no credit rationing contract

The contracting problem where the bank fully funds all projects with signal M and H without screening is the following:

$$\max_{I_M \in [0,1], I_H \in [0,1]} E_0(\pi)$$

subject to:

$$E_0(y) \geq 2\tilde{w} \tag{4.2}$$

$$E_0(y) \geq \epsilon I_{R\&D} + \tilde{w} \tag{4.3}$$

$$E_1(y|\theta, i = G) \geq \tilde{w} \quad \forall \theta \tag{4.4}$$

$$E_1(y|\theta, i = G) \geq \epsilon I_\theta \quad \forall \theta \tag{4.5}$$

$$E_1(y|\theta = M, i = B) \geq \epsilon I_M \tag{4.6}$$

(4.2) and (4.4) are just participation constraints; (4.3), (4.5) are (4.6) are the incentive compatible constraints such that entrepreneurs who should continue to run projects do not “eat” the investments. This is a linear maximization problem with only linear constraints. Here, either (4.2) or (4.3) binds with equality depending on which of the following values is higher: $\{\tilde{w}, \epsilon I_{R\&D}\}$. (4.6) binds with equality, such that $p_h y_M = \epsilon$. The solution to the contract problem is

$$\Psi^{ncr} = \{I_M^{ncr} = 1, I_H^{ncr} = 1, y_M^{ncr} = \frac{\epsilon}{p_h}, y_H^{ncr} = \frac{\max\{\tilde{w}, \epsilon I_{R\&D}\} + (1-(1-\eta)\lambda)\tilde{w} - (1-\lambda)\frac{\epsilon}{p_h}\hat{p}}{p_h \eta \lambda}\}$$

Note that under this contract, all *good* projects get fully funded. Although, there is a fraction $(1-\lambda)$ of *bad* projects also get fully funded, which generate losses. All entrepreneurs with medium signals are paid less than those with high signals in the third period if project success; in other words, they pay a higher interest rate. The expected profits for the bank under this contract is:

$$\pi^{ncr} = \eta(p_h R - 1) + (1-\eta)(1-\lambda)(p_l R - 1) - I_{R\&D} - [1 - \lambda(1-\eta)]\tilde{w} - \max\{\tilde{w}, \epsilon I_{R\&D}\}$$

The first term is the return from type good project, and the second term is the loss from bad project, and the last two terms represent the payoff to the expected entrepreneur.

credit rationing contract

The contract problem when a bank try to screen out bad projects with medium signal is:

$$\max_{I_M \in [0,1], I_H \in [0,1]} E_0(\pi)$$

subject to:

$$\begin{aligned} E_0(y) &\geq 2\tilde{w} && (4.7) \\ E_0(y) &\geq \epsilon I_{R\&D} + \tilde{w} && (4.8) \\ E_1(y|\theta, i = G) &\geq \tilde{w} \quad \forall \theta && (4.9) \\ E_1(y|\theta, i = G) &\geq \epsilon I_\theta \quad \forall \theta && (4.10) \\ E_1(y|\theta = M, i = B) &\leq \tilde{w} && (4.11) \\ \epsilon I_M &\leq \tilde{w} && (4.12) \end{aligned}$$

(4.7),(4.8), (4.9) and (4.10) are the same as before. (4.11) and (4.12) are the incentive compatible constraints to make sure that entrepreneur with bad project but medium signal does not stay or eat investment. Again, either (4.7) or (4.8) holds with equality. (4.11) and (4.12) both bind, such that $p_h y_M = \tilde{w}$ and $\epsilon I_M = \tilde{w}$. The contract is simply:

$$\Psi^{cr} = \{I_M^{cr} = \frac{\tilde{w}}{\epsilon}, I_H^{cr} = 1, y_M^{cr} = \frac{\tilde{w}}{p_h}, y_H^{cr} = \frac{\max\{\tilde{w}, \epsilon I_{R\&D}\}}{p_h \eta \lambda} + \frac{\tilde{w}(1 - \frac{1-\lambda}{p_h})}{p_h \lambda}\}$$

Under this contract, none of the type bad project gets funded in the second period, but fraction $(1 - \lambda)$ of the good projects only get partially funded. Obviously, their potentials are not fully captured. Expected profit from this contract is:

$$\pi^{cr} = \eta\lambda(p_h R - 1) + \eta(1 - \lambda)\frac{\tilde{w}}{\epsilon}(p_h R - 1) - I_{R\&D} - [1 - (1 - \eta)]\tilde{w} - \max\{\tilde{w}, \epsilon I_{R\&D}\}$$

The first term is the return from project with signal H, the second term is the return from type good project with signal M, and the last two terms represent the expected payoff to the entrepreneur The bank's contract problem can be simply summarized as:

$$\pi^{Bank} = \max_{\Psi^{ncr}, \Psi^{cr}} \{\pi^{ncr}, \pi^{cr}\}$$

Proposition 1. *The spread between expected profits of the credit rationing contract and the non-credit rationing contract ($\pi^{cr} - \pi^{ncr}$) is:*

1. *increasing in the spread of uncertainty Δp while holding $\hat{p}$ constant;*
2. *decreasing(increasing) in λ when π^{cr} is higher(lower) than π^{ncr} .*

Proof: See Appendix B.

In other words, the credit rationing contract is used by the bank when there is a high degree of information asymmetry and the level of uncertainty about return is high. Note that, even in this relatively simple setup, the tools employed by most commercial banks in solving the agency problem are featured: varying interest rates and level of further lending contingent on firm performance. Though, even with these tools at hand, banks either have to finance some bad projects under the no credit rationing contract or the investment level is inefficiently low for some good projects under the credit rationing contract.

4.4.2 Venture capital contract

By assumption, an VC firm can also alternate the investment level and the payoff to the entrepreneur. Clearly, it can offer both contracts that the bank offers. Thus, I will only derive the contract where the VC firm alters level of control to eliminate the investment eating problem. Note that an VC firm only places tighter control on a project with medium signal, not those with high signals, since given assumption 2, we know that $\epsilon < 2\tilde{w}$. On top of that, if $I_{R\&D}$ is big enough, an VC firm places tighter control on all projects in the $R\&D$ period as well. At first, I just specified the case where $I_{R\&D}$ is not big enough for the VC firm to start tightening control in the first period, which happens when $\epsilon I_{R\&D} < \tilde{w} + c$

$$\max_{I_M \in [0,1], I_H \in [0,1]} E_0(\pi)$$

subject to:

$$E_0(y) \geq 2\tilde{w} \tag{4.13}$$

$$E_0(y) \geq \epsilon I_{R\&D} + \tilde{w} \tag{4.14}$$

$$E_1(y|\theta, i = G) \geq \tilde{w} \quad \forall\theta \tag{4.15}$$

$$E_1(y|\theta, i = G) \geq \epsilon I_\theta \quad \forall\theta \tag{4.16}$$

$$E_1(y|\theta = B, i = B) \leq \tilde{w} \tag{4.17}$$

Again, (4.13) and (4.15) are the participation constraints, (4.14) (4.16) are the incentive compatible constraints such that entrepreneurs who should continue to run projects do not “eat” the investment, and (4.17) is just to make entrepreneur with bad project and medium signal quit, note that this problem has one constraint less than the bank's credit-constraint contract problem, as the investment eating problem has been taken care of by placing tighter control over the firm for projects with medium signals.

Now, consider the case where R&D investment is big enough so that VC firm will pace tighter control in the first period: the only change is that constraint (4.14) is replaced by $E_0(y) \geq 2\tilde{w}$. The full solution to this contract problem is characterized by:

$$\Psi^{vc} = \{I_M = 1, I_H = 1, y_M = \frac{\tilde{w}}{p_h}, y_H = \frac{\Lambda - (1-\eta)\tilde{w} - (1-\lambda)\eta\frac{\tilde{w}}{p_l}}{p_h \eta \lambda}\}$$

where

$$\Lambda = \begin{cases} \tilde{w}, & \text{if } \tilde{w} \geq \epsilon I_{R\&D} \text{ or } \epsilon I_{R\&D} < \tilde{w} + c; \\ \epsilon I_{R\&D}, & \text{otherwise;} \end{cases}$$

Expected profit from this contract is:

$$\pi^{VC} = \eta(p_h R - 1) - I_{R\&D} - (1-\lambda)c - [1-(1-\eta)]\tilde{w} - \min\{c, \max\{\epsilon I_{R\&D}, \tilde{w}\}\}$$

Here, as the VC firm is able to screen out all bad projects for a fixed cost c, they are able to fund all type good projects at the efficient size of 1. Note that, this solution features the characteristic of a typical VC contract: when a portfolio firm does well, the manager gets better payoff and retains more control rights; if it is not doing so well, the manager gets lower payoff and retains fewer control rights; if the firm is doing really bad, no further funding is provided.

Proposition 2. *The spread between expected profits of the VC contract and the bank contract ($\pi^{VC} - \pi^{Bank}$) is:*

1. *decreasing in λ when c is relatively small;*
2. *increasing in the spread of uncertainty Δp while keeping $\hat{p}$ constant;*
3. *increasing in $I_{R\&D}$;*
4. *increasing in ϵ.*

Proof: See Appendix C.

Clearly, when these three characteristics of the high-tech industry coexist, the equity contract is better fitted. Mainly due to the interaction between the information asymmetry and the moral hazard problem, such that the private benefit from this hidden action only depends on the investment level, but not on the prospect of the project itself, which makes it harder to solve the agency problem by simply varying payoff and/or interest rates.

The above proposition shows that the ability for the principal to retain control rights is important for financing young high-tech firms. Thus, the model predict that in countries where equity financing from commercial banks is restricted, VC firms would have advantage in investing in that sector. In countries where such restriction is not in place, VC firms lose this advantage. Thus, VC investments should be more concentrated in high-tech sector where these restriction exists. Indeed, this prediction is consistent with the empirical facts presented in section 2.

4.5 Conclusion

This chapter assesses the importance of controlling ownership in financing young high-tech firms. I build a simple principal agent model that will show equity financing is better suited for projects with (i) a high degree of information asymmetry, (ii) a high level of uncertainty about returns, and (iii) a large amount of R&D investment preceding production. This result helps explain the observed difference in sectoral allocation of VC investments across countries. Such that in countries where commercial banks are allowed to offer equity financing, VC investments do not concentrate in the high-tech sector, as they no longer hold this advantage.

This result suggests two possible reasons for why most European governments' efforts in attract investment in high-tech sector by encouraging VC investments have failed: first, commercial banks have already provided all the investments needed by the high-tech sector, the addition of VC was not needed;

second, the profitability of high-tech firms in Europe is not high enough, such that it is a problem of lack in demand rather than supply of financing. Clearly, this issue deserves more careful investigation.

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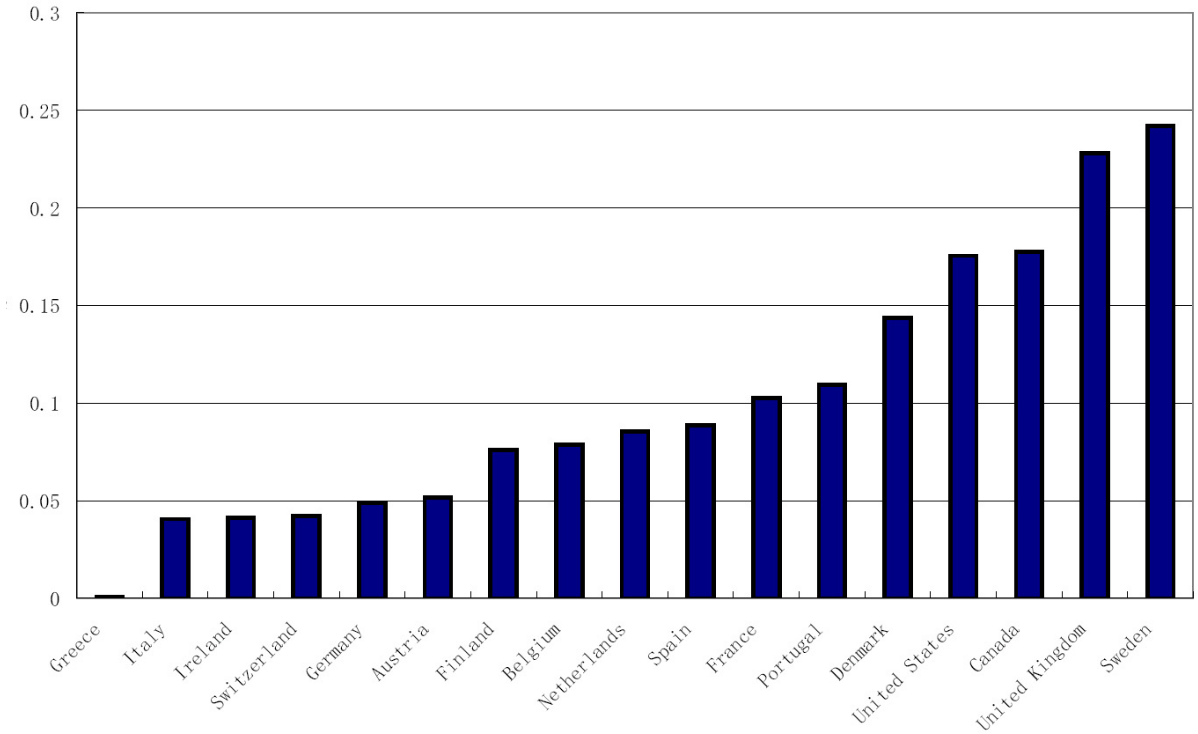


Figure 4.1: Venture capital investments as fraction of GDP, 2004-2005

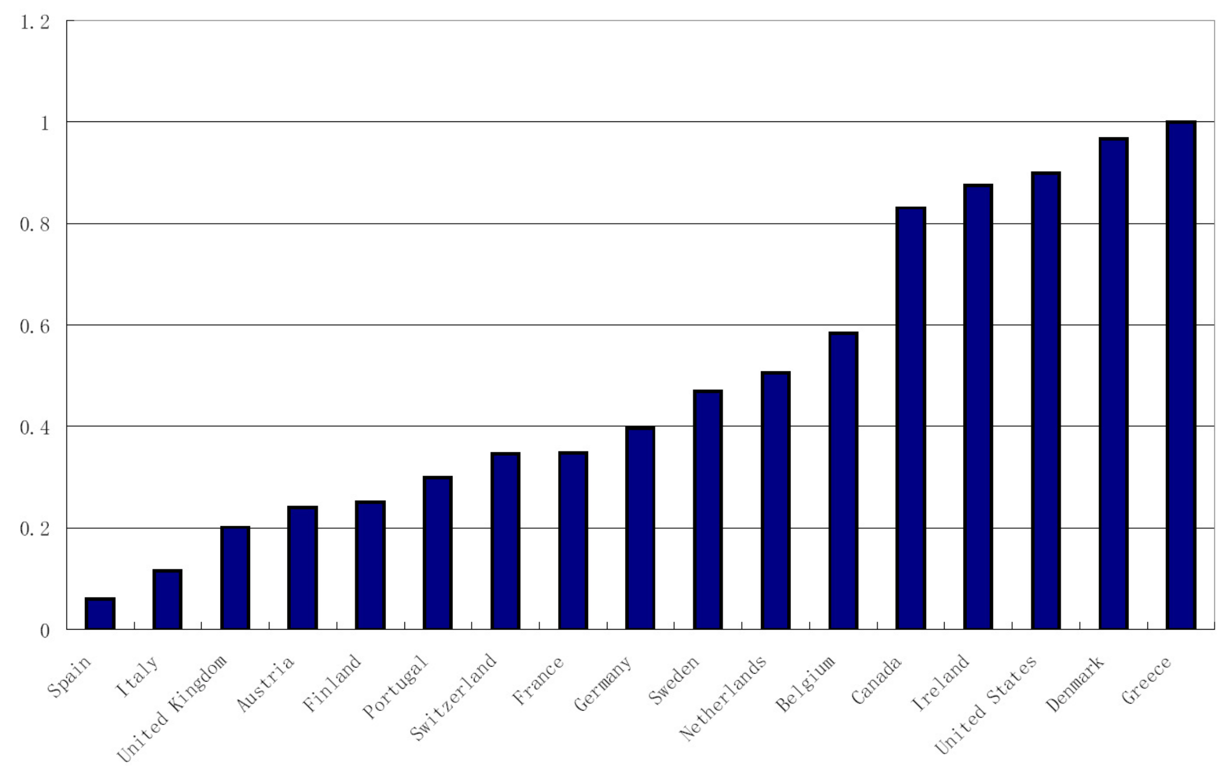


Figure 4.2: Fraction of venture capital investments goes into high-tech sector, 2004-2005

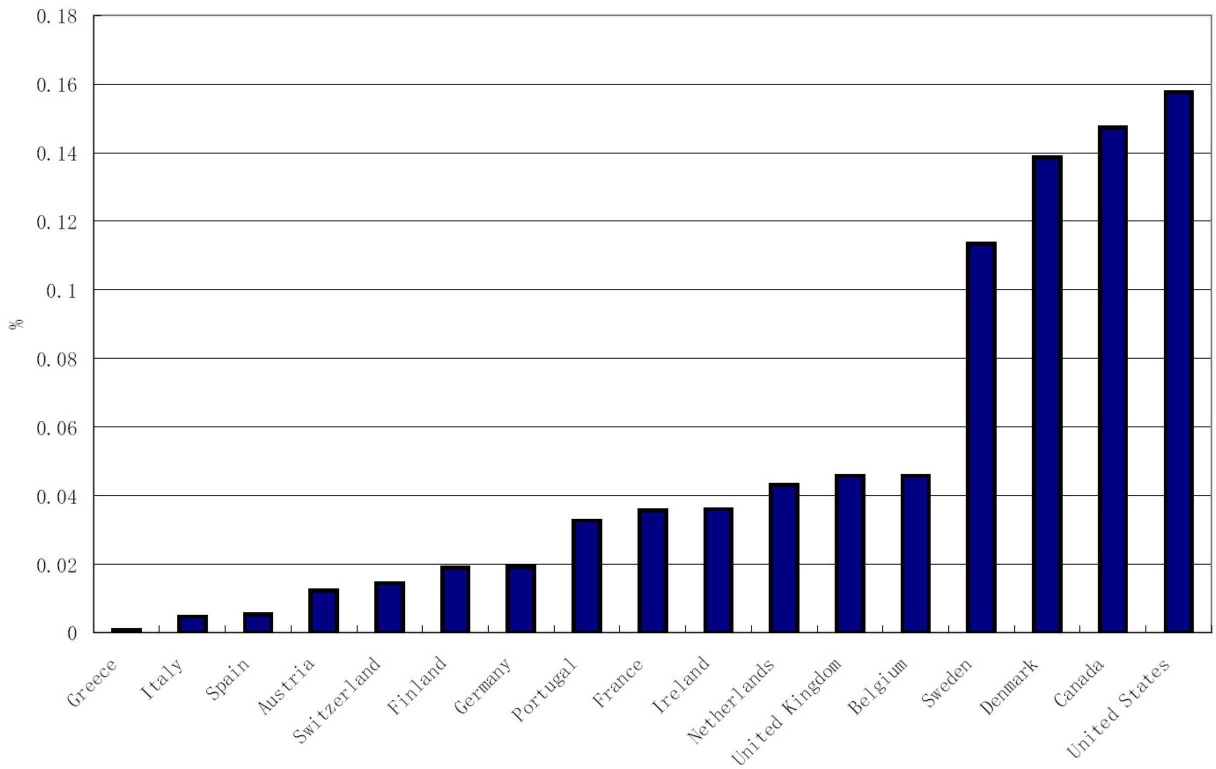
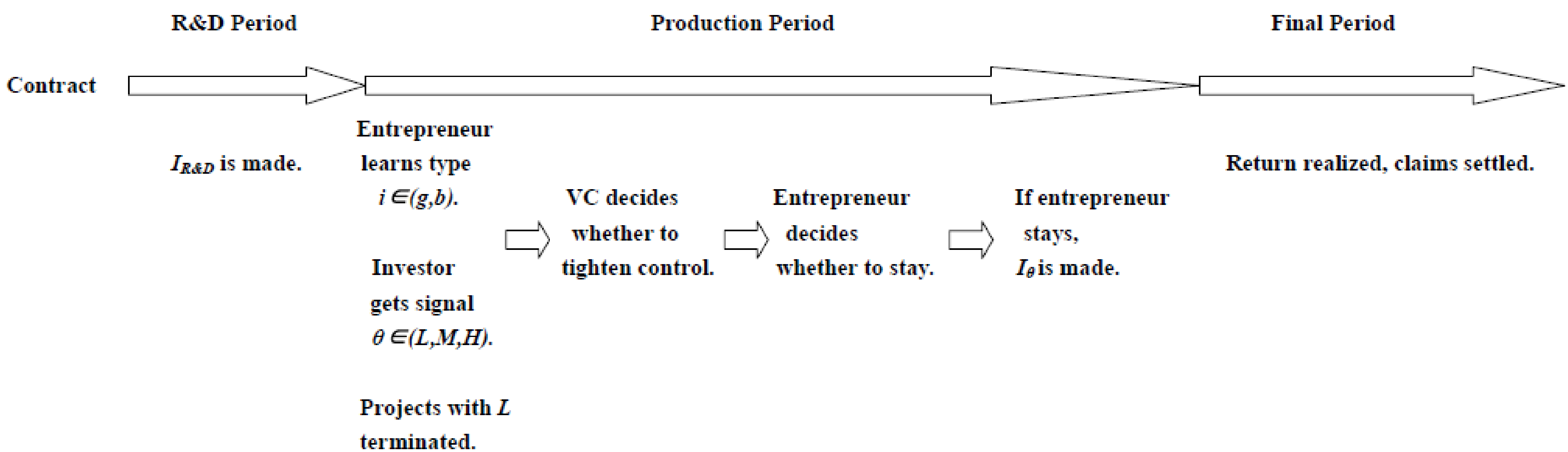


Figure 4.3: Venture capital high-tech investments as fraction of GDP, 2004-2005

Figure 4.4: Timing



Chapter 5

Conclusion

This thesis makes several contributions to the filed of entrepreneurial financing. Several cases of how government policies, whether intended to affect entrepreneurs or not, could have large impact on the entrepreneurial sector are demonstrated here. In the first chapter, I show that variations in bankruptcy regimes have little effect on high-ability households' occupational choices, change in the length (periods) of post-bankruptcy punishment appears to have the largest impact on entrepreneurship, and asset exemption had only a modest effect. When it comes to moderate-ability households' occupational choices, the insurance effect completely dominates the borrowing cost effect. This result suggests that a very lenient bankruptcy regime like the U.S. Chapter 7 system does encourage entrepreneurship, though it lowers the average productivity in the entrepreneurial sector, but increases the overall production in the economy. The results also help explain the U.S.' higher turnover rate and lower average business size compared to other developed nations. The model also suggests that entrepreneur households prefer more lenient bankruptcy regimes and worker households prefer less lenient regimes due to moderate wage income risks.

The second chapter shows that insurance against aggregate risk can be an important rationale for small business loan guarantee programs. Firms may be credit constrained because they are more prone to default risks due to aggregate fluctuations and changes in financial institutions' cost of capital. The current loan-guarantee scheme promotes firm growth by providing insurance and is socially beneficial in the presence of aggregate risks; the same cannot be said in the absence of such risks. Furthermore, I show that there is a potential adverse-selection problem associated with the current guarantee fee structure. However, strict selection process and high fixed cost of obtaining guarantees, in theory, could mitigate the problem and help maintain the low cost of these programs.

The thrid chapter assesses the importance of controlling ownership in financing young high-tech firms. I build a simple principal agent model that will show equity financing is better suited for projects with (i) a high degree of information asymmetry, (ii) a high level of uncertainty about returns, and (iii) a large amount of R&D investment preceding production. This result helps explain the observed difference in sectoral allocation of VC investments across countries. Such that in countries where commercial banks are allowed to offer equity financing, VC investments do not concentrate in the high-tech sector, as they no longer hold this advantage.

Appendix A

Change of $\bar{k}_{\omega,p}$ with respect to change in saving s

In this section, I will show how does the limit on capital $\bar{k}_{\omega,p}$ change with saving s. First, equation (3.11) which is used to determine $k_{\omega,p}$ can be re-written as:

$$\bar{k}_{\omega,p}[r + (1-p)\eta] - p\theta_l f(\bar{k}_{\omega,p}) = [r + (1-p)\eta]s - (1-p)\beta$$

The first and second term on the left side are both increasing in $k_{\omega,p}$; but given the assumption that $f()$ is concave, and the region of k we are interested is where the marginal product capital is close to r, the left side has to be increasing in $\bar{k}_{\omega,p}$. The right side on the other hand, is clearly increasing in s. Thus, the limits on capital $k_{\omega,p}$ is increasing in s

Appendix B

Proof of Proposition 1

The spread between expected profits of the credit rationing contract and the non-credit rationing contract can be written as:

$$
\begin{aligned}
& \pi^{cr} - \pi^{ncr} \\
= \; & \eta\lambda(p_h R - 1) + \eta(1-\lambda)\frac{\tilde{w}}{\epsilon}(p_h R - 1) - I_{R\&D} - [2-(1-\eta)]\tilde{w} \\
& -\eta(p_h R - 1) - (1-\eta)(1-\lambda)(p_l R - 1) - I_{R\&D} - [2-\lambda(1-\eta)]\tilde{w} \\
= \; & (1-\lambda)[1 - \hat{p}R + (1-\eta)\tilde{w} + \eta\frac{\tilde{w}}{\epsilon}(p_h R - 1)] \qquad \text{(B.1)}
\end{aligned}
$$

1. increasing in the spread of uncertainty Δp while keeping $\hat{p}$ constant;

   Proof. I will prove this by separately proving that the spread between expected profits of the credit rationing contract and the non-credit rationing contract is increasing: first, when increasing p_h and lowering η while keeping $\hat{p}$ and p_l constant; second, when lowering p_l and increasing η while holding $\hat{p}$ and p_h constant; third, when lowering p_l and increasing p_h while holding $\hat{p}$ and η constant. Any other way of increasing in the spread of uncertainty Δp is just a linear combination of the three.

   (a) We can express p_h in terms of η, p_l and $\hat{p}$:

   $$p_h = \frac{\hat{p} - (1-\eta)p_l}{\eta} \qquad \text{(B.2)}$$

take this into (B.1) we have:

$$\pi^{cr} - \pi^{ncr} = (1-\lambda)\{1 - \hat{p}R + (1-\eta)\tilde{w} + \frac{\tilde{w}}{\epsilon}[(\hat{p} - p_l)R - \eta(1 - p_l R)]\}$$

Now, we can see that the partial derivative $\frac{\partial(\pi^{cr}-\pi^{ncr})}{\partial\eta} = -\tilde{w} - (1 - p_l R)$ is negative. Thus, when we increase p_h, and lower η, while holding p_l and $\hat{p}$ constant, $\pi^{cr} - \pi^{ncr}$ increases .

(b) Given (B.1), we can see that the partial derivative $\frac{\partial(\pi^{cr}-\pi^{ncr})}{\partial\eta} = (p_h R - 1)\frac{\tilde{w}}{\epsilon} - \tilde{w}$. Given that $(p_h R - 1) > 2\tilde{w}$ and $\epsilon < 2\tilde{w}$, this partial derivative is positive. Thus, when we increase η, and lower p_l, while holding p_h and $\hat{p}$ constant, $\pi^{cr} - \pi^{ncr}$ increases .

(c) It is clear from (B.1) that $\pi^{cr} - \pi^{ncr}$ is increasing in p_h when holding η and $\hat{p}$ constant.

Thus, we can conclude that $\pi^{cr} - \pi^{ncr}$ is increasing in the spread of uncertainty Δp while keeping $\hat{p}$ constant.

2. decreasing(increasing) in λ when π^{cr} is higher(lower) than π^{ncr}.

Proof. It is easy to see this as $\pi^{cr} - \pi^{ncr} = (1-\lambda) \times [1 - \hat{p}R + (1-\eta)\tilde{w} + \eta\frac{\tilde{w}}{\epsilon}(p_h R - 1)]$. When the second term is positive, $\pi^{cr} - \pi^{ncr}$ is decreasing in λ as $(1-\lambda)$ is decreasing in λ. Similarly, when the second term is negative, $\pi^{cr} - \pi^{ncr}$ is increasing in λ.

Appendix C

Proof of Proposition 2

The spread between expected profits of the VC contract and the bank contract can be written as:

$$\begin{aligned}
& \pi^{VC} - \max\{\pi^{ncr}, \pi^{cr}\} \\
= & \min\{\pi^{VC} - \pi^{ncr}, \pi^{VC} - \pi^{cr}\} \\
= & \min\{(1-\lambda)(1-\eta)(1-p_l R + \tilde{w}) - (1-\lambda)c + \max\{\max\{\epsilon I_{R\&D}, \tilde{w}\} - c, 0\}, \\
& \eta(1-\lambda)(1-\frac{\tilde{w}}{\epsilon})(p_h R - 1) - (1-\lambda)c + \max\{\max\{\epsilon I_{R\&D}, \tilde{w}\} - c, 0\}\}
\end{aligned}$$

Given that $\min\{,\}$ is a linear operator, all I need to do is separately prove that

$$\begin{aligned}
& \pi^{VC} - \pi^{ncr} \\
= & (1-\lambda)(1-\eta)(1-p_l R + \tilde{w}) - (1-\lambda)c + \max\{\max\{\epsilon I_{R\&D}, \tilde{w}\} - c, 0\}
\end{aligned} \quad \text{(C.1)}$$

and

$$\begin{aligned}
& \pi^{VC} - \pi^{cr} \\
= & \eta(1-\lambda)(1-\frac{\tilde{w}}{\epsilon})(p_h R - 1) - (1-\lambda)c + \max\{\max\{\epsilon I_{R\&D}, \tilde{w}\} - c, 0\}
\end{aligned} \quad \text{(C.2)}$$

are both

1. decreasing in λ;

2. increasing in the spread of uncertainty Δp while keeping $\hat{p}$ constant;

3. increasing in $I_{R\&D}$;

4. increasing in ϵ.

Proof. 1. decreasing in λ:
Given (C.2) and (C.1), it is easy to see that both of these are decreasing in λ. Because $(1-\lambda)$ is decreasing in λ, and that both $(1-\eta)(1-p_lR+\tilde{w})$ and $\eta(1-\frac{\tilde{w}}{\epsilon})(p_hR-1)$ are positive.

2. increasing in the spread of uncertainty Δp while keeping $\hat{p}$ constant:
Once again I will use the same strategy as I used in (B) by separately proving that both $\pi^{VC}-\pi^{ncr}$ and $\pi^{VC}-\pi^{cr}$ are increasing when: first, when increasing p_h and lower η while keeping $\hat{p}$ and p_l constant; second, when lower p_l and increasing η while holding $\hat{p}$ and p_h constant; and third, when lower p_l and increasing p_h while holding $\hat{p}$ and η constant.

   (a) From (C.1), it is easy to see that $\pi^{VC}-\pi^{ncr}$ is decreasing in η when p_l and $\hat{P}$ is held constant, because $(1-\eta)$ is decreasing in η and $(1-\lambda)(1-p_lR+\tilde{w})$ is positive.
   For $\pi^{VC}-\pi^{cr}$, let's take $(B.2)$ into (C.2) then:

$$\pi^{VC}-\pi^{cr}=(1-\lambda)(1-\frac{\tilde{w}}{\epsilon})(\hat{p}R-p_lR-\eta(1-p_lR))-(1-\lambda)c+\max\{\max\{\epsilon I_{R\&D},\tilde{w}\}-c,0\}$$

   From the above equation we can see that the partial derivative $\frac{\partial(\pi^{VC}-\pi^{cr})}{\partial\eta}=-(1-p_lR)$ is negative, thus (C.2) is also decreasing in η when p_l and $\hat{P}$ is held constant.

   (b) By replacing p_l with $\frac{\hat{p}-\eta p_h}{1-\eta}$ in $(C.1)$, we have:

$$\pi^{VC}-\pi^{ncr}=(1-\lambda)[1+\tilde{w}-\hat{p}R+\eta(p_hR-1-\tilde{w})]-(1-\lambda)c+\max\{\max\{\epsilon I_{R\&D},\tilde{w}\}-c,0\}$$

   The above term is increasing in η when $\hat{p}$ and p_h are both held constant, because $(1-\lambda)(p_hR-1-\tilde{w})$ is positive by assumption.
   It is easy to see that $\pi^{VC}-\pi^{cr}$ is increasing in η when p_h is held constant.

   (c) From (C.1), we can see that $\frac{\partial(\pi^{VC}-\pi^{ncr})}{\partial p_l}=-(1-\lambda)(1-\eta)R$ is negative, thus $\pi^{VC}-\pi^{ncr}$ is decreasing in p_l when η is held constant.
   Also, from (C.2), we can see that $\frac{\partial(\pi^{VC}-\pi^{cr})}{\partial p_l}=\eta(1-\lambda)(1-\frac{\tilde{w}}{\epsilon})R$ is positive, thus $\pi^{VC}-\pi^{cr}$ is increasing in in p_h when eta is held constant.

3. increasing in $I_{R\&D}$:
   Both $\pi^{VC}-\pi^{ncr}$ and $\pi^{VC}-\pi^{cr}$ are increasing in $I_{R\&D}$, because $\max\{\max\{\epsilon I_{R\&D}, \tilde{w}\}-c, 0\}$ is increasing in $I_{R\&D}$.

4. increasing in ϵ:
   $\pi^{VC} - \pi^{ncr}$ is increasing in ϵ since $\max\{\max\{\epsilon I_{R\&D}, \tilde{w}\} - c, 0\}$ is increasing in ϵ.

   On the other hand, because $(1 - \frac{\tilde{w}}{\epsilon})$ is increasing in ϵ and $\eta(1-\lambda)(p_h R - 1)$ is positive, $\pi^{VC} - \pi^{cr}$ is also increasing in ϵ.

Currirculum Vitae

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