

# Productive Entrepreneurship and Economic Development with Limited Contract Enforcement\*

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## Abstract

Cross-country data shows a positive correlation between a nation's contract enforcement level and its ability to adopt modern technologies. I study the role entrepreneurial incentives play in shaping this empirical observation. I develop and solve a life-cycle model with limited financial contract enforcement, entrepreneurial heterogeneity (ability and financial pledgeability) and technology choice. In the model production processes can be undertaken using either the Traditional or the Modern technology. Depending on the entrepreneurial ability, the modern technology can be more productive relative to the traditional technology, but the former requires a long-term investment making entrepreneur's pledgeability important in his choice. In equilibrium the level of contract enforcement and entrepreneurial characteristics endogenously determine (1) the investment size and (2) the technology choice. Key results of the paper indicate that when financial contract enforcement is weak, the investment size and the intensity of modern technology use of entrepreneurial firms are positively correlated with financial pledgeability. Collateral-building associated with short term investment is important for the results. I calibrate the model to study its quantitative properties. Quantitative experiments illustrate sizeable positive effects of financial contract enforcement on aggregate output and aggregate modern technology adoption for the U.S. economy. Furthermore, counterfactual analysis shows that if financial contract enforcement in Turkey (a low enforcement economy) improves to the U.S. level (a high enforcement economy), output rises by 13-15%; and one third of this change is due to the increase in the rate of modern technology adoption.

*Keywords:* Productive Entrepreneurship, Technology Choice and Contract Enforcement.

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# 1 Introduction

How does financial contract enforcement affect technological backwardness? And, what role do entrepreneurial incentives play in shaping this relationship? This paper addresses these two questions by studying the implications of limited contract enforcement in a model of entrepreneurship with endogenous technology choice. The purpose of my inquiry is to identify “constraints to modern technology adoption” as an underlying channel through which the limited financial contract enforcement can be important for economic performance.

World Bank studies document that collateral and bankruptcy laws differ across countries, as does the strength of legal systems in which the laws are enforced<sup>1</sup>. Figure 1 shows that the level of financial contract enforcement<sup>2</sup> has high cross-country variation and per capita income is on average higher in economies with high contract enforcement<sup>3</sup>. The direction of causation cannot be taken for granted; however, economic theory suggests that well-established institutions such as strong financial contract enforceability, can affect economic performance by shaping individual incentives at underlying economic transactions<sup>4</sup>.

Identification of channels which are important for explaining the role of institutions in the process of economic development is crucial for structural policy analysis. The current paper shows that the impact of financial contract enforcement on entrepreneurial technology choice may be an essential channel through which contract enforcement stimulates the level of economic development. To motivate my analysis I consider the following empirical observation: Figure 2 plots for 36 countries the ratio between average information technology (IT) investment and the aggregate physical investment for the 1985-1993 time period against contract enforcement levels of each country<sup>5</sup>. IT investment, which is considered as the modern technology of the 1980s by many economists, had been undertaken more intensely in countries with high contract enforcement levels. The close similarity between figure 1 (GDP

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<sup>1</sup>The World Bank [4]

<sup>2</sup>Articles by La-Porta et al. [33] provides empirical evidence for the existence of a positive correlation between the institutions that affect the enforcement of contracts and economic development.

<sup>3</sup>Legal Rights Index developed by the *World Bank* against real per capita GDP. Legal rights index captures the ability to enforce collateral and bankruptcy laws of legal systems. The value indices range from 0 to 10, with higher scores indicating better enforcement.

<sup>4</sup>North [31]

<sup>5</sup>Figure 3 plots for the same set of countries the ratio between average information technology (IT) investment and the aggregate real GDP for the 1985-1993 time period against contract enforcement levels of each country.

against contract enforcement) and figure 2 (IT investment intensity against contract enforcement) indicates that the lack of ability to adopt modern production processes in developing countries might be an important factor in explaining the role of contract enforcement in economic development.

The argument that “entrepreneurial incentives are important in structural transformation of countries from low-income, primary-based societies to high income-technology based societies” dates back to Joseph Schumpeter’s analysis in *The Theory of Economic Development* in 1911<sup>6</sup>. However, only during the recent couple of decades have policy analysts started to focus on the role of entrepreneurial investment to generate economic progress. Rapid growth of entrepreneurial activity in countries such as Brazil, China and India, and in contrast the need for a developed entrepreneurial sector in many stagnant economies stimulated this interest. It is important to note that although the allocation of resources to private entrepreneurs is important for a society’s well being, much more critical is the way the resources get used up by entrepreneurs. Quoting from Baumol [7]:

... The basic hypothesis is that, while the total supply of entrepreneurs varies among societies, the productive contribution of society’s entrepreneurial activities varies much more because of their allocation between productive and unproductive activities. This allocation is heavily influenced by the relative payoffs society offers to such activities. This implies that policy can influence the allocation of entrepreneurship more effectively than it can influence its supply. ...

As William J. Baumol points out, what matters is not “who gets what” but “who gets what and how does he use it”. Secure property rights (Wiggins [42]), rule of law (Parker [32]), and better competition policies (Dutz et al. [16]) are important institutions in allocating entrepreneurs away from unproductive forms of entrepreneurship towards productive entrepreneurship. The institution of our interest in this essay is “financial contract enforcement”. I explore the following question: If all entrepreneurs have access to similar types of production technologies, how do institutions related with contract enforcement affect objectives such that some entrepreneurs choose to employ the modern technology whereas some others more traditional means of production? My answer to this question is related to the differences in maturity of investment projects which are associated with the application

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<sup>6</sup>Schumpeter [39]

of a traditional technology and the application of a modern technology.

Modern technology adoption is not only associated with the installment of a new production-line or on-the-spot adjustment to the old machinery but also with the acquisition of advanced knowledge necessary for the efficient functioning of the production process. Therefore, on-the-job training of the workforce including the entrepreneur himself is an essential characteristic which distinguishes modern technology adoption from traditional technology installment. The complex nature of modern technology adoption entails an initial long-term investment, an organizational structure with long-term objectives as well as high entrepreneurial skills. Traditional technology on the other hand can become operational without the acquisition of intensive production techniques, and hence neither long-term investment coupled with long-term objectives nor high entrepreneurial skills are necessary for starting the production process. Therefore, the relative dominance between short-term and long-term objectives is expected to be important in determining the probability of modern technology choice of entrepreneurial firms<sup>7</sup>. The theoretical model of this paper aims to show that contract enforceability is capable of generating financial constraints in such a way that long-term objectives get distorted and modern technology becomes too costly to employ for a certain group of entrepreneurs.

To analyze the effects of financial contract enforcement on entrepreneurial investment and economic development, I develop a model of entrepreneurship with endogenous technology choice. The key mechanism generated by the model is: Entrepreneurs choose to invest in the *modern technology* instead of the *traditional technology* only if they can raise enough finance to make a sufficiently large enough investment.

Specifically, I construct a life-cycle general equilibrium model with heterogeneous entrepreneurs and limited contract enforcement. In the model entrepreneurs live for three periods and can start up businesses when they are young and middle aged. Entrepreneurs are heterogeneous in terms of the quality of their entrepreneurial capital and financial pledgeability. Entrepreneurial capital comes in indivisible units. Therefore, entrepreneurs can operate only a single investment project during a given period in time. The entrepreneurial capital can be allocated to undertake investment projects using the

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<sup>7</sup>Broehl [9] provides empirical evidence supporting the argument that advanced technology adaptation is related with the dominance of long term incentives. Using survey data on agrarian producers in India, Broehl [9] shows that advanced technology users' objectives are associated with the maximization of long term returns whereas producers who employ standard production technologies focus on short-term returns.

traditional technology; or the modern technology. The latter requires a long-term investment and long-term financing (2-period investment projects and 2-period financing) whereas the former is associated with a short-term investment and short-term financing (1-period investment projects and 1-period financing). External long-term finance is costly relative to external short-term finance. Entrepreneurs with high ability can become relatively productive in operating modern, long-term-oriented production technologies, but the level of their pledgeability and relative costliness of long-term finance is important in their choice. Investment projects can be started up using any type of production technology during the first period of the investment-life-cycle. In section 2, I present a benchmark model in which entrepreneurs do not upgrade (or downgrade) technology after their initial discrete choice. Section 4 extends the benchmark model by incorporating partnership formations over investment projects through which entrepreneurs get the opportunity to switch from one type of technology to the other during later stage of their lifetime.

One key assumption of the model is that both short-term and long-term investment opportunities have diminishing returns to scale property which generates a “span of control” for entrepreneurs a la Lucas [29]<sup>8</sup>. Diminishing returns to scale assumption creates a non-degenerate firm size distribution in the unique steady state equilibrium of the economy. The implications of **contract enforcement** on entrepreneurial investment and finance behavior are as the following. **When financial contract enforcement is weak:**

1. **Initial plant size is positively correlated with entrepreneurial financial pledgeability.**

This is an immediate result of financial constraints generated by limited contract enforcement. Low pledgeability generates tighter financial constraints and in return small scale investment projects.

2. **Plant size and modern technology use are positively correlated.**

- i. **More of the small scale, high-ability, low-pledgeability type of young entrepreneurs start up by employing the traditional technology.** When an entrepreneur has very low pledgeability in the financial market, binding financial constraints make short-term in-

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<sup>8</sup>Atkeson et al. [3], Basu et al. [6] and Guner et al. [20] show empirical evidence for the existence of diminishing returns to scale at establishment level.

vestment in the traditional technology beneficial. The life-cycle feature of the model creates a “collateral building effect” associated with the use of short-term investment. Short-term investment horizons lead to a quick internalization of investable funds. Entrepreneurs with high levels of pledgeability face less stringent financial constraints. Therefore, “collateral building” is not as important, and as a result for these types of entrepreneurs there is a weak relationship between financial pledgeability and modern technology use.

ii. **Fewer of the small scale, high-ability, low-pledgeability entrepreneurs switch to employing modern technologies later during their lifetime.** Contract enforcement plays an important role by allowing (or not allowing) sufficient accumulation of assets during the early stage of an entrepreneur’s lifetime who started up with the traditional technology, such that he can switch to the modern technology later during his lifetime.

3. **Demand for long-term funds is lower for entrepreneurs with low financial pledgeability.** Due to the relative cost of funds, entrepreneurs do not choose to borrow long-term as long as they do not invest long-term. Therefore, in economies with weak contract enforcement the demand for long-term funds is lower for entrepreneurs with lower financial pledgeability relative to the entrepreneurs with higher financial pledgeability.

Using U.S. manufacturing data, Romeo [37], Kelley and Brooks [24] show that larger scale establishments employ more advanced and complex technologies relative to small scale enterprises. Dunne [15] shows that plant size is positively correlated with advanced technology diffusion whereas plant age and advanced technology adoption are not correlated. These empirical relations fit the behavior of entrepreneurial firms presented at (2(i)) and (2(ii)). In the appendix of the paper, I provide a firm level empirical analysis to test the effects of pledgeability on financial structure. The empirical study shows that firms with low financial pledgeability choose long-term finance less often relative to firms with high financial pledgeability which is compatible with the results at (3).

I calibrate the steady state equilibrium of the model for Turkish (a low enforcement economy) and the U.S. (a high enforcement economy) aggregate and firm level<sup>9</sup> statistics. The main purpose

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<sup>9</sup>I match distribution of funds across small, medium size, and large firms; as well as the ratio between outstanding long-term debt and total assets for the same size groups.

of the quantitative analysis is to study the effects of the main policy variable, the level of contract enforcement, on modern technology use and economic development. I study quantitative experiments as well as a counterfactual policy analysis. Quantitative experiments provide two important results: Economies with weak contract enforcement are characterized by lower per capita income and they are less likely to adopt modern, long-term-oriented production processes. The former result would have emerged, even if technology was not a choice variable for entrepreneurs. Distortions in the allocation of capital across entrepreneurs, which was also pointed out by Antunes et al. [2] and Quintin [35], are important for this result. However, the isolated effects of modern technology use on economic performance in response to lower financial contract enforcement are quantitatively important as well. Counterfactual policy analysis documents the aggregate effects of a rise in contract enforcement due to the shift in technology choice and changes in investment size distribution in isolation for a low enforcement economy. In particular, if the financial contract enforcement level of Turkey improves to the U.S. level, output rises by 13-15%; and about one third of this change is due to the increase in the rate of modern technology adoption.

#### *Related Literature*

There is a large literature which studies the role of entrepreneurship on aggregate economic performance. The seminal articles by Lucas [29] and Kihlstrom and Laffont [25] are the first studies of entrepreneurship in general equilibrium theory. Other important papers on entrepreneurship in macroeconomic theory are Lloyd-Ellis and Bernhardt [28] and Cagetti and De Nardi [10] (entrepreneurship and wealth distribution), Jiang et al. [41] (entrepreneurship and ability heterogeneity), and Newman [30] (entrepreneurship and risk taking). Evans and Jovanovic [17], Holtz-Eakin et al. [21], and Hurst and Lusardi [22] are classical studies on financial constraints and entrepreneurial decision making.

This paper is related to the growing literature which concentrates on the effects of limited contract enforcement on entrepreneurship and aggregate performance. Quadrini [34] and Cagetti and De Nardi [10] study the effects of limited contract enforcement on entrepreneurial wealth accumulation and aggregate saving dynamics. Cooley et al. [12] study how limited enforceability is related with entrepreneurial commitment to investment projects and aggregate volatility. Antunes et al. [2] and Quintin [35] have studied quantitative implications of limited contract enforcement for occupation choice and the efficiency of aggregate resource allocation across entrepreneurs.

In this paper, I am interested in the effects of limited contract enforcement on entrepreneurship and aggregate resource allocation as in Antunes et al. [2] and Quintin [35]; however, the objective of my study differs from theirs as I study the implications of limited contract enforcement on the aggregate allocation of resources, along with the distribution of factors of production across different technological opportunities. Also, different from Antunes et al. [2], Quintin [35], Cagetti and De Nardi [10], and Quadrini [34], the equilibrium analysis in my paper is related to the effects of contract enforcement on the quality of entrepreneurial investment, instead of the effects of contract enforcement on the overall level of entrepreneurship.

The rest of the paper is organized as follows. Section 2 develops the economic environment for the benchmark model. Section 3 presents the optimal behavior and the general equilibrium of the model. Section 4 extends the benchmark model to incorporate partnership formations over investment projects. Section 5 presents the quantitative analysis. Section 6 concludes.

## 2 The Benchmark Economic Model

Time is discrete and denoted as  $t = 0, 1, 2, 3, \dots$ . The economy is populated with 3-period-lived overlapping generations, in addition to the initial old and the initial middle-aged agent at  $t = 0$ . The population is constant where every period a continuum of young agents with unit measure enter the economy. There are two types of agents: financiers and entrepreneurs. There is a single good in the economy which can be consumed, stored, or invested.

### 2.1 Economic Agents

#### 2.1.1 Financiers

Being a financier or not is not a choice variable at the beginning of the life-time. An agent born in period  $t$  becomes a financier with an exogenously given probability  $\mu$ . By being a financier he inherits a special type of “Lucas tree”. The tree generates a consumption good flow at the beginning of the financier’s lifetime. The amount of the consumption good received by financiers is homogeneous and without loss of generality normalized to 1. The consumption good is perfectly divisible; any fraction

of it can be stored, lent or consumed. The consumption good does not depreciate, therefore it can be stored for multiple periods, setting the minimum one-period (short-term) interest rate to 1. Denote  $c^y$ ,  $c^m$  and  $c^o$  as consumption at youth, middle-age and old respectively. Financiers who are born in period  $t$  have preferences over the consumption good which are similar to Diamond and Dybvig [14]:

$$U_F(c_t^y, c_{t+1}^m, c_{t+2}^o) = \phi u(c_{t+1}^m) + (1 - \phi)u(c_{t+2}^o) \quad (1)$$

Where  $u(\cdot)$  is a concave utility function with  $u'(\cdot) > 0$  and  $u''(\cdot) \leq 0$ . Financiers do not get utility from the first period consumption.  $\phi$  is a random variable standing in for a preference shock in the following way:

$$\phi = \left\{ \begin{array}{ll} 1 & \text{with probability } \pi \\ 0 & \text{with probability } (1 - \pi) \end{array} \right\}$$

The probability of getting hit by the shock is denoted as  $\pi$ . Depending on the realization of the shock, some financiers need to consume (early) when they are middle aged and do not get any utility from the third period consumption. Financiers who do not get hit by the preference shock, get utility from the third period consumption only. Unlike in Diamond and Dybvig [14], the realization of  $\phi$  is publicly observable because bank-runs are not the purpose of this study. The expected lifetime utility of a financier born in period  $t$  can be written as:

$$W(c_t^y, c_{t+1}^m, c_{t+2}^o) = \pi u(c_{t+1}^m) + (1 - \pi)u(c_{t+2}^o). \quad (2)$$

### 2.1.2 Entrepreneurs

An agent becomes an *entrepreneur* with probability  $(1 - \mu)$  at the beginning of his lifetime. Entrepreneurs produce the consumption good by undertaking investment projects. Unlike financiers, entrepreneurs do not receive a consumption good flow at the beginning of their lifetime, therefore they borrow in the financial market to produce the consumption good. They are risk neutral and care about the third period consumption only. Each entrepreneur is endowed with one unit of indivisible human (entrepreneurial) capital which is essential for the production process.

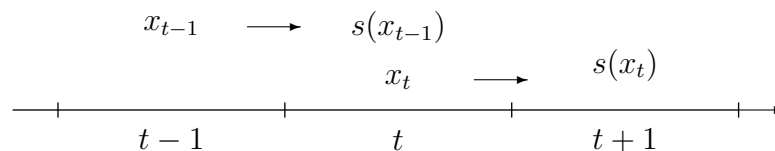
Entrepreneurs can start up investment projects when they are young and middle aged. Each in-

vestment project is operated by a single entrepreneur at a given period in time. There are two types production technologies in which the indivisible entrepreneurial capital can be allocated: the Modern Technology (Technology-M) which makes use of modern production techniques and the Traditional Technology (Technology-T) which makes use of traditional production techniques. Technology-T does not require advanced knowledge regarding the production process, therefore the product cycle of an entrepreneurial firm is shorter if he chooses to employ the traditional technology. Therefore traditional technology investment can be financed using short-term funds. However, modern technology investment is associated with the application of advanced knowledge, which makes on-the-job training of the workforce as well the entrepreneurial training necessary. To simplify the complexity of algebra I assume that absorption of advanced knowledge requires *long-term investment* and *long-term financing*, and *high entrepreneurial ability*. Throughout the paper, I use the concepts “technology-T project” and “short-term investment project”, and “technology-M project” and “long-term investment project” interchangeably.

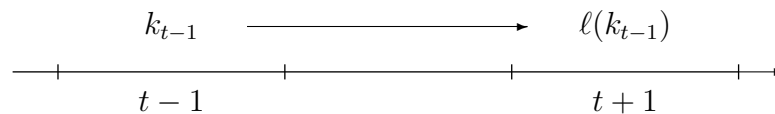
In the benchmark model, entrepreneurs who start up with one type of technology, continue to use the same technology throughout their lifetime. Section 4 extends the model in such a way that entrepreneurs have the option to switch to long-term investment projects even if they have started with short term investment opportunities. Figure 4 summarizes the lifetime entrepreneurial investment opportunities of the benchmark model.:

Figure 4. Technology Choice.

**Traditional Technology Investor**



**Modern Technology Investor**



Specifically; technology-T, short-term and technology-M, long-term investment opportunities are rep-

resented as the following: Consider a young entrepreneur  $i$  born in period  $t - 1$ , and denote  $k_{t-1}$  as the size of the capital investment of the young entrepreneur in period  $t - 1$ . If he chooses to invest in a long-term investment opportunity, he will obtain the following amount of returns in period  $t + 1$ :

$$\ell_i(k_{t-1}) = \theta_i f(k_{t-1}).$$

Where  $\theta_i$  is a publicly observable and independently and identically distributed (i.i.d.) entrepreneur specific quality parameter setting entrepreneur specific long-term project productivity.  $\theta_i$  is realized before entrepreneur  $i$  starts conducting investment projects. The parameter  $\theta$  is distributed with the cumulative distribution function  $F(\theta)$  across young entrepreneurs with support  $[0, \bar{\theta}]$  which stays constant throughout the lifetime of entrepreneur  $i$ .  $f(\cdot)$  is a strictly concave return function. Denote  $R_2^i(t - 1)$  as the non-negative long-term gross interest rate charged to entrepreneur  $i$ . The profit function associated with long-term investment becomes:

$$\max_{k_{t-1}} \{\ell_i(k_{t-1}) - R_2^i(t - 1)k_{t-1}\}.$$

Now, consider a firm owner  $j$  born in period  $t - 1$  who chooses to conduct a short-term investment project using the technology-T when he is young. Unlike in a technology-M investment project, the technology-T investment yields proceedings in period  $t$  when the entrepreneur is middle aged. The return function associated with a short-term investment opportunity in period  $t - 1$  is as the following:

$$s_j(x_{t-1}) = z_j A f(x_{t-1})$$

Where  $z_j$  is a technology-T specific publicly observable<sup>10</sup> i.i.d. productivity shock with  $z_j = \{z_g, z_b\}$  and  $z_g > z_b$ .  $A$  is a technology-T specific productivity parameter, with  $z_g A < \bar{\theta}$  which implies that a fraction of entrepreneurs are more productive in conducting long-term investment projects using the modern technology rather than short-term investment projects using the traditional technology.  $x_{t-1}$  is the total capital investment in the short-term project in period  $t - 1$ . Note that  $x$  and  $k$  denote the same type good, but for notational convenience different letters are assigned to the capital used by

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<sup>10</sup>At the beginning of an entrepreneur's lifetime.

the two different investment opportunities.  $R_1^j(t-1)$  is a non-negative short-term gross interest rate charged to the entrepreneur  $j$ , the profit maximization for a short-term investor is as the following:

$$\max_{x_{t-1}} \{s_{tj}(x_{t-1}) - R_1^j(t-1)x_{t-1}\}.$$

When entrepreneur  $j$  becomes middle-aged he has the option to re-invest in a secondary short-term project using the technology-T. The returns to the second investment project are:

$$s_j(x_t) = Af(x_t)$$

Returns of the second period short-term investment project get realized in period  $t+1$  when the entrepreneur is old, and they are not subject to idiosyncratic productivity shocks.

## 2.2 The Financial Market

Lenders and borrowers interact directly in competitive investable funds markets (short term and long-term). There is no financial intermediation, and neither a secondary trading market for financial claims.

Financial contract enforcement is limited in the economy: Borrowers can default by not repaying the full amount they owe. If they default, a firm specific fraction of production returns can be seized by courts (institutions which enforce financial contracts) and transferred to lenders. Limited enforceability generates financial constraints as in the Kehoe and Levine [23] framework which represent incentive compatibility constraints. Different from the Kehoe and Levine [23] setting, in the current model borrowers are not excluded from the credit market upon default.

Specifically, individual compatibility constraints for a *young* entrepreneur  $j$  have the following structure:

$$\frac{\lambda_j^S}{\zeta} z_j Af(m) \geq R_1^j m \tag{3}$$

$$\frac{\lambda_j^L}{\zeta} \theta_j f(m) \geq R_2^j m \tag{4}$$

Constraint (3) is the financial constraint associated with short-term investment, whereas constraint (4) is the financial constraint associated with long-term investment. For a *middle-aged* entrepreneur the second period short-term investment opportunity is constrained in the following way if has chosen to invest short-term during the first period of his lifetime:

$$\frac{\lambda_j^S}{\zeta} Af(m) \geq R_1^j(m - n) \quad (5)$$

$m$  is the working capital invested and  $n$  is the amount of earnings retained (internal finance) if the entrepreneur has chosen to have a short-term investment horizon when he was young. Financial constraints (3), (4) and (5) are interpreted as the following: If an entrepreneur chooses not to commit to repay, the lender can seize only a fraction  $\frac{\lambda_j^k}{\zeta}$  of the entrepreneur's end of contract period final output. Here,  $\lambda$  measures an entrepreneur's reputation in the financial market, which is i.i.d., with a cumulative distribution function  $G(\lambda)$  over  $[0, \bar{\lambda}]$ . Thus,  $1/\zeta$  is an economy-wide parameter and measures how efficiently the financial contracts are enforced.

**Assumption 1.**  $\lambda_j^S = \min\{a, \lambda_j\}$ ,  $\lambda_j^L = \lambda_j$ , with  $a > 0$ .

The existence of the lower bound  $a$  implies  $\lambda_j^S \geq \lambda_j^L$ .  $\lambda_j^S \geq \lambda_j^L$  holds with strict inequality only for entrepreneurs with very low levels of financial pledgeability. The lower bound  $a$  captures the effects of an exogenously given short-term micro-credit mechanism on entrepreneurial technology choice. In this economy, all borrowers are treated equally in the financial market if they are below the threshold pledgeability level  $a$  and choose to operate short-term investment projects<sup>11</sup>.

Information is complete in the financial market, and pledgeability levels get realized before financial market transactions. Therefore the following result follows immediately:

**Lemma 2.1**  $R_1^j = R_1$  and  $R_2^j = R_2$  for every entrepreneur  $j$ .

**Proof** Suppose there is an entrepreneur  $i$  and an entrepreneur  $j$  such that  $R_1^i > R_1^j$ . Since no-arbitrage does not hold in this case, all entrepreneurs will compete for lending to entrepreneur  $i$

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<sup>11</sup>Microcredit mechanisms allow entrepreneurs with little or no financial market reputation to borrow with short-term maturities.

because  $E_f[R_1^i] > E_f[R_1^j]$ , where  $E_f[R_1^i]$  stands in for expected returns from entrepreneurial financing. Competition will diminish the interest rate gap between the two entrepreneurs until  $R_1^j = R_1^i$  holds. Similar reasoning can be applied to show that  $R_2^j = R_2^i$  for any  $i$  and  $j$ .  $\square$

### 2.3 Time-line of Events

The flow of events is as the following. At the beginning of period  $t$ , preference shocks of middle-aged financiers who were born in period  $t - 1$  get realized. After that, entrepreneurs collect returns from period  $t - 1$  short-term investment (S.T.) projects and returns from period  $t - 2$  long-term (L.T.) projects. Debt repayment takes place, and agents consume. Productivity and pledgeability levels of young entrepreneurs are fully observed after consumption takes place. Entrepreneurs sell financial claims against future investment returns. And finally, young and middle aged entrepreneurs start to produce. Figure 5 summarizes the flow of events.

## 3 Optimal Behavior and General Equilibrium

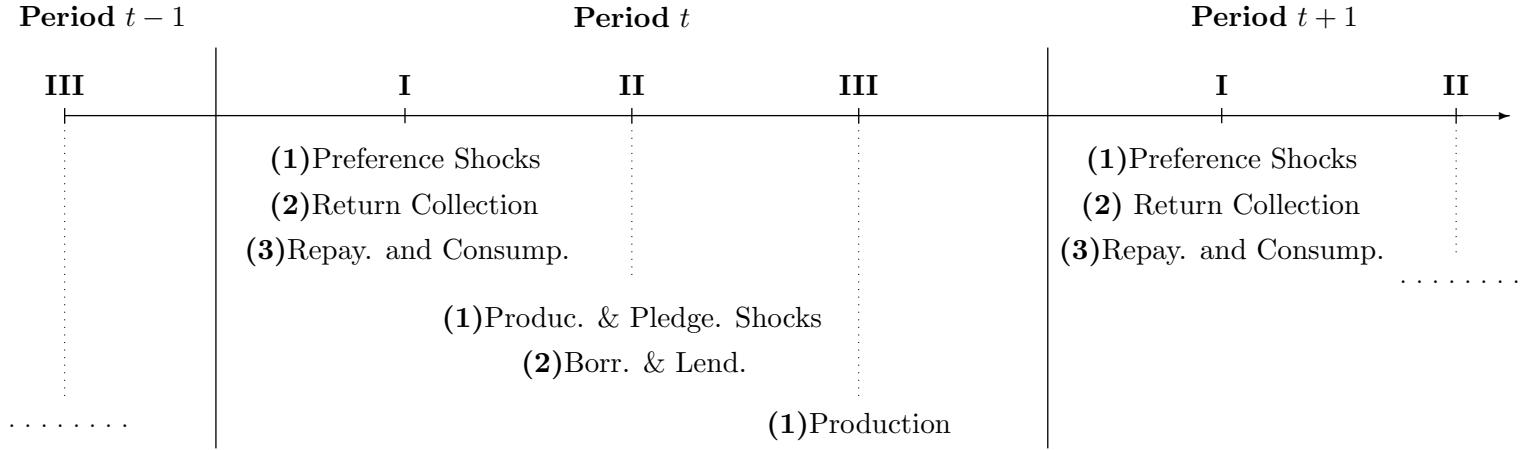
### 3.1 Financier's Program

Denote  $s$  as the share of financier's initial funds allocated to short-term lending; financier's consumption optimization over his life-time is given as:

$$\begin{aligned} W(c^m, c^o) &\equiv \max_{c^m, c^o, s} && \pi u(c^m) + (1 - \pi)u(c^o) \\ & s.t. && c^m \leq R_1 s \\ & && c^o \leq (R_1)^2 s + R_2 s \end{aligned}$$

To maximize lifetime utility, financiers decide on the optimum fraction of investable funds to lend as short-term ( $s^{opt}$ ) and long-term ( $1 - s^{opt}$ ). Suppose financiers preferences are log-linear. Remembering that returns from the first period short term lending can again be used to finance short term projects, we can derive financier's maximization problem as:

Figure 5. Flow of Events.



$$W(s^{opt}) \equiv \max_s \{ \pi \log(sR_1) + (1 - \pi) \log(s(R_1)^2 + (1 - s)R_2) \}$$

Taking first order conditions yields optimum share of funds allocated to short-term lending. If  $R_1$  and  $R_2$  are greater than 1, and  $R_2 > (R_1)^2$ :

$$s^{opt} = \frac{\pi R_2}{R_2 - (R_1)^2}$$

**Proposition 3.1** *If  $R_2 \leq (R_1)^2$  then  $s^{opt} = 1$ . If  $R_2 > (R_1)^2$ , then  $s^{opt}$  is increasing in the short-term interest rate ( $R_1$ ), the probability of getting hit by an adverse liquidity shock ( $\pi$ ), but decreasing in the long-term interest rate ( $R_2$ ).*

### 3.2 Entrepreneur's Program

A young entrepreneur has to decide on: (1) technology choice and hence the investment horizon, and (2) the size of the capital investment. Investment decisions are made recursively. Taking optimum short-term investment size ( $x_1^{opt}$ -optimum first period short-term investment and  $x_2^{opt}$ -optimum second period short-term investment) and optimum long-term investment size ( $k^{opt}$ ) the young entrepreneur compares the lifetime value functions associated with short-term investment ( $V^S$ ) and long-term investment

$(V^L)$ , and optimizes the investment horizon:

$$\max\{V^S(x_1^{opt}, x_2^{opt}), V^L(k^{opt})\} \quad (6)$$

Dropping the time subscripts and using the result obtained in lemma 2.1, for entrepreneur  $j$  with a short-term investment horizon, the optimum capital investment levels are determined by taking first order conditions at the following maximization problem:

$$V^S(x_1^{opt}, x_2^{opt}) \equiv \max_{x_1, x_2} \{R_1(z_j Af(x_1) - R_1 x_1) + Af(x_2) - R_2 x_2\} \quad (7)$$

$$s.t. \quad \frac{\lambda_j^S}{\zeta} z_j Af(x_1) \geq R_1 x_1 \quad (8)$$

$$\frac{\lambda_j^S}{\zeta} Af(x_2) \geq R_1(x_2 - z_j Af(x_1) + R_1 x_1) \quad (9)$$

If the same entrepreneur  $j$  had chosen to have a long-term investment horizon when he was young, the optimum long-term capital investment level is determined by solving:

$$V^L(k^{opt}) \equiv \max_k \{\theta_j f(k) - R_2 k\} \quad (10)$$

$$s.t. \quad \frac{\lambda_j^L}{\zeta} \theta_j f(k) \geq R_2 k \quad (11)$$

(8) and (9) are financial constraints associated with short-term investment, whereas (11) is the financial constraint associated with long-term investment.

**Remark** An immediate result is as the following: firms who are constrained due to financial pledgeability and/or limited contract enforceability are smaller. The RHSs of constraints in (8), (9) and (11) are decreasing in  $\lambda_j$  and  $1/\zeta$ , whereas the LHSs are constant. Therefore, heterogeneity in pledgeability is a determinant of firm size whenever financial constraints are binding.

Suppose,  $f(m) = m^\alpha$  for  $m \in \{x, k\}$  with  $0 < \alpha < 1$ . The following lemma shows that we can characterize three types of entrepreneurs depending on the level of financial pledgeability.

**Lemma 3.2** (1) *There exists threshold levels  $\lambda^*(z_j)$  for  $z_j \in \{z_g, z_b\}$ , such that constraint (9) is*

binding when

$$\lambda_j \leq \lambda^*(z_j)$$

with

$$\lambda^*(z_g) \leq \lambda^*(z_b).$$

(2) There exists a threshold  $\lambda^{**}$  such that constraints (8) and (11) are binding when

$$\lambda_j \leq \lambda^{**}$$

with

$$\lambda^{**} > \lambda^*(z_b).$$

**Proof** (1) The left hand side of (9) is monotonically increasing in  $\lambda_j$  and  $z_j$  and the right hand side is constant which implies the result obtained in lemma 3.2.1. (2) When constraints (8) and (11) are not binding, the first order conditions yield the following optimum capital investment levels:

$$s'(x_1^{**}) = R_1 \Rightarrow x_1^{opt} = x_1^{**} = \left( \frac{\alpha z_j A}{R_1} \right)^{\frac{1}{1-\alpha}} \quad (12)$$

$$\ell'(k^{**}) = R_2 \Rightarrow k^{opt} = k^{**} = \left( \frac{\alpha \theta_j}{R_2} \right)^{\frac{1}{1-\alpha}} \quad (13)$$

When constraints (8) and (11) are binding then first order conditions yield:

$$x_1^{opt} = x_1^* = \left( \frac{\lambda_j z_j A}{\zeta R_1} \right)^{\frac{1}{1-\alpha}} \quad (14)$$

$$k^{opt} = k^* = \left( \frac{\lambda_j \theta_j}{\zeta R_2} \right)^{\frac{1}{1-\alpha}} \quad (15)$$

Where  $x_1^{**} > x_1^*$  and  $k^{**} > k^*$  when  $\lambda_j \geq \lambda^{**} \equiv \zeta \alpha$ . The result in lemma 3.2.2. follows. The first period short-term investment works as a collateral for the second period short-term investment. Therefore,  $\lambda^{**} > \lambda^*(z_b)$ .  $\square$

Given  $z_j$ ,  $\lambda^*(z_j)$  and  $\lambda^{**}$  partitions the space of entrepreneurs into three categories regarding their level of pledgeability: Low pledgeability, intermediate level pledgeability and high pledgeability; or in

other words entrepreneurs who are financially constrained when young and middle aged, entrepreneurs who are financially constrained only when young, and finally entrepreneurs who are never financially constrained.

Define a critical value  $\underline{a}$ .

**Assumption 2:** *The lower bound  $a$  is small enough ( $a \leq \underline{a}$ ) such that only the entrepreneurs in “low pledgeability” category face a heterogeneity in financial pledgeability across two investment opportunities.*

Using assumption 2 and the results from lemma 3.2 we can derive value functions associated with short-term and long-term investment for each pledgeability category.

### 1. *Entrepreneurs with high financial pledgeability:*

The following value functions are associated with entrepreneurs for whom  $\lambda_j \geq \lambda^{**}$  holds. Using the unconstrained optimum capital investment levels we can characterize:

$$\begin{aligned} V^S(x_1^{**}, x_2^{**}) &= (1 - \alpha) \left[ (z_j A)^{\frac{1}{1-\alpha}} R_1 \left( \frac{\alpha}{R_1} \right)^{\frac{\alpha}{1-\alpha}} + A^{\frac{1}{1-\alpha}} \left( \frac{\alpha}{R_1} \right)^{\frac{\alpha}{1-\alpha}} \right] \\ V^L(k^{**}) &= (1 - \alpha) \theta_j^{\frac{1}{1-\alpha}} \left( \frac{\alpha}{R_2} \right)^{\frac{\alpha}{1-\alpha}} \end{aligned}$$

An entrepreneur with a high level of financial pledgeability will choose to invest in the modern technology if his entrepreneurial quality  $\theta_j$  is greater than a threshold  $\underline{\theta}^h$  determined as:

$$\theta_j \geq \underline{\theta}^h \equiv A \left[ z_j^{\frac{1}{1-\alpha}} R_1 \left( \frac{R_1}{R_2} \right)^{\frac{\alpha}{1-\alpha}} + \left( \frac{R_1}{R_2} \right)^{\frac{\alpha}{1-\alpha}} \right]^{(1-\alpha)} \quad (16)$$

Note that  $(1 - F(\underline{\theta}^h))$  determines the fraction of high pledgeability entrepreneurs who are willing to undertake long-term investment projects;  $(1 - F(\underline{\theta}^h))$  also sets the benchmark aggregate long-term investment intensity. In a frictionless economy (high  $1/\zeta$  such that constraints (8), (9) and (11) do not bind), a fraction  $(1 - F(\underline{\theta}^h))$  of the entrepreneurial population chooses to invest in the modern technology. Financial constraints generated by weak legal enforcement or low financial pledgeability create deviations from the benchmark investment composition.

## 2. *Entrepreneurs with intermediate levels of financial pledgeability:*

When constraint (8) is binding, but (9) is not ( $\lambda^{**} \geq \lambda_j \geq \lambda^*(z_j)$ ), value functions associated with short-term and long-term investment can be characterized as the following;

$$\begin{aligned} V^S(x_1^*, x_2^{**}) &= \left(1 - \frac{\lambda_j}{\zeta}\right) (z_j A)^{\frac{1}{1-\alpha}} R_1 \left(\frac{\lambda_j}{\zeta R_1}\right)^{\frac{\alpha}{1-\alpha}} + (1 - \alpha) A^{\frac{1}{1-\alpha}} \left(\frac{\alpha}{R_1}\right)^{\frac{\alpha}{1-\alpha}} \\ V^L(k^{**}) &= \left(1 - \frac{\lambda_j}{\zeta}\right) \theta_j^{\frac{1}{1-\alpha}} \left(\frac{\lambda_j}{\zeta R_2}\right)^{\frac{\alpha}{1-\alpha}} \end{aligned}$$

An entrepreneur with an intermediate level financial pledgeability will choose to operate a long-term investment project if his long-term project quality  $\theta_j$  is greater than  $\underline{\theta}^m(\lambda_j; \zeta)$ :

$$\theta_j \geq \underline{\theta}^m(\lambda_j; \zeta) \equiv A \left[ z_j^{\frac{1}{1-\alpha}} R_1 \left(\frac{R_1}{R_2}\right)^{\frac{\alpha}{1-\alpha}} + \frac{1 - \alpha}{1 - \frac{\lambda_j}{\zeta}} \left(\frac{\zeta \alpha}{\lambda_j}\right)^{\frac{\alpha}{1-\alpha}} \left(\frac{R_1}{R_2}\right)^{\frac{\alpha}{1-\alpha}} \right]^{(1-\alpha)}. \quad (17)$$

### **Proposition 3.3**

- (i.)  $\underline{\theta}^m(\lambda_j; \zeta)$  is monotonically decreasing in  $\lambda_j$  for  $\lambda_j \in (\lambda_j^*(z_j), \lambda_j^{**})$ .
- (ii.)  $\underline{\theta}^m(\lambda_j; \zeta_1) > \underline{\theta}^m(\lambda_j; \zeta_2)$  for  $\zeta_1 > \zeta_2$
- (iii.)  $\underline{\theta}^m(\lambda_j; \zeta) \geq \underline{\theta}^h$  for all  $\lambda_j \in (\lambda_j^*(z_j), \lambda_j^{**})$ .

The results in proposition 3.3 show that financial constraints not only limit the investment size but also influence the investment horizon choice of an entrepreneur. Entrepreneurs, whose financial pledgeability take intermediate values may switch to operate long-term investment projects when they become more pledgeable.  $\underline{\theta}^m(\lambda_1; \zeta) \leq \underline{\theta}^m(\lambda_2; \zeta)$  for  $\lambda_1 \geq \lambda_2$ , which implies that the measure of entrepreneurs investing long-term whose pledgeability level is  $\lambda_1$  ( $(1 - F(\underline{\theta}^m(\lambda_1; \zeta)))$ ) is greater than the the measure of entrepreneurs investing long-term whose pledgeability level is  $\lambda_2$  ( $(1 - F(\underline{\theta}^m(\lambda_2; \zeta)))$ ). Entrepreneurs with intermediate levels of pledgeability are constrained during the first period of their lifetime, but unconstrained during the second period if they have chosen to operate short-term investment projects. However, if they invest long-term, financial constraints affect their lifetime investment opportunities. There is a complementarity between the size of the investment and the modern technology use because the life-cycle feature of the model generates a ‘‘collateral building’’ role associated with short-term investment which distorts

entrepreneurial incentives to undertake long-term investment which make use of the modern technology. The need for internalization of investable funds during the early phase of investment activity is similar to “collateral effects” in Kiyotaki and Moore [27] and Kiyotaki [26]. Because of the declining benefits associated with collateral building, entrepreneurs switch to long-term investment as their pledgeability increases and/or the economy-wide limited contract enforcement improves. Therefore, entrepreneurs who are at the low end of the distribution within “intermediate levels of financial pledgeability entrepreneurs” choose to invest short-term more intensely relative to those who are at the high end of the same distribution. The third result obtained in proposition 3.3 shows that, because of the collateral building effect the aggregate long-term investment intensity of entrepreneurs with intermediate levels of pledgeability is below the benchmark aggregate long-term investment intensity, that is for each  $\lambda_j \in [\lambda^*(z_j), \lambda^{**})$ ,  $(1 - F(\underline{\theta}^m(\lambda_j; \zeta))) < (1 - F(\underline{\theta}^h))$ .

### 3. *Entrepreneurs with low financial pledgeability:*

Finally if both (8) and (9) are binding ( $\lambda_j \leq \lambda^*(z_j)$ ), the optimum size of the first period short-term investment in technology-T is given by  $x_1^* = \left(\frac{\lambda_j z_j A}{\zeta R_1}\right)^{\frac{1}{1-\alpha}}$ , whereas the optimum size of the second period short-term investment is

$$x_2^* = h(\lambda_j, z_j) \tag{18}$$

**Lemma 3.4**  $h(\lambda_j, z_j)$  is non-decreasing in both  $\lambda_j$  and  $z_j$ .

**Proof** The right hand side of (9) is monotonically decreasing in  $z_j$  (and in  $\lambda_j$ ) whereas the left hand side is constant (monotonically increasing in  $\lambda_j$ ). For  $\lambda_j \geq \lambda^*(z_j)$  constraint (9) is non-binding. Therefore,  $h(\lambda_j, z_j)$  is non-decreasing in  $z_j$  and  $\lambda_j$ .  $\square$

For an entrepreneur with low financial pledgeability, optimum long-term capital investment is given by

$$k^* = \left(\frac{\lambda_j \theta_j}{\zeta R_2}\right)^{\frac{1}{1-\alpha}}. \tag{19}$$

For low financial pledgeability entrepreneurs lifetime value functions associated with short-term

and long-term investment can be derived as the following:

$$\begin{aligned} V^S(x_1^*, x_2^*) &= \left(1 - \frac{\lambda_j}{\zeta}\right) (z_j A)^{\frac{1}{1-\alpha}} R_1 \left(\frac{\lambda_j}{\zeta R_1}\right)^{\frac{\alpha}{1-\alpha}} + Ah(\lambda_j, z_j)^{\frac{\alpha}{1-\alpha}} - R_1 h(\lambda_j, z_j)^{\frac{1}{1-\alpha}} \\ V^L(k^*) &= \left(1 - \frac{\lambda_j}{\zeta}\right) \theta_j^{\frac{1}{1-\alpha}} \left(\frac{\lambda_j}{\zeta R_2}\right)^{\frac{\alpha}{1-\alpha}} \end{aligned}$$

Using the value functions associated with short-term and long-term investment evaluated at respective optimum investment levels, an entrepreneur with low financial pledgeability chooses to operate a long-term investment project only if:

$$\theta_j \geq \underline{\theta}^l(\lambda_j; \zeta).$$

**Proposition 3.5**

- i. There exists a critical level pledgeability  $\lambda^c$ , such that for all low pledgeability entrepreneurs with  $\lambda_j \leq \lambda^c$ ,  $\underline{\theta}^l(\lambda_j; \zeta)$  is constant in  $\lambda_j$ , and for all entrepreneurs with  $\lambda_j \geq \lambda^c$ ,  $\underline{\theta}^l(\lambda_j; \zeta)$  is monotonically decreasing in  $\lambda_j$ .*
- ii. When  $\lambda_j \leq \lambda^c$ , then  $\underline{\theta}^l(\lambda_j; \zeta)$  is constant in  $\zeta$ . For  $\lambda_j > \lambda^c$ ,  $\underline{\theta}^l(\lambda_j; \zeta)$  is increasing in  $1/\zeta$ .*

**Proof** First consider the effect of pledgeability on the lifetime value function associated with short-term investment for an entrepreneur  $j$ . Consider the inequality (9), which determines the second period investment of an entrepreneur with a short-term horizon. Using the optimum (constrained) first period short-term investment level, we can re-write (9) in implicit function form as;

$$H(x_2, \lambda_j^S) \equiv \frac{\lambda_j^S}{\zeta} Ax_2^\alpha - R_1 \left[ \left(1 - \frac{\lambda_j^S}{\zeta}\right) (z_j A)^{\frac{1}{1-\alpha}} R_1 \left(\frac{\lambda_j^S}{\zeta R_1}\right)^{\frac{\alpha}{1-\alpha}} \right] = 0 \quad (20)$$

An entrepreneur with a low level financial pledgeability invests all his first period income into the second period short-term investment opportunity. Therefore,

$$\frac{\partial V^S(x_1^*, x_2^*)}{\partial \lambda} = \frac{\partial V^S}{\partial x_2} \frac{\partial x_2}{\partial \lambda} \quad (21)$$

By defining  $\gamma(\lambda_j^S) \equiv \left(1 - \frac{\lambda_j^S}{\zeta}\right) (\lambda_j^S)^{\frac{\alpha}{1-\alpha}}$  we can derive,

$$\frac{\partial x_2}{\partial \lambda} = -\frac{\partial H/\partial \lambda}{\partial H/\partial x_2} = \frac{Ax_2^\alpha + (z_j A)^{\frac{1}{1-\alpha}} R_1^{\frac{1-2\alpha}{1-\alpha}} \gamma'(\lambda_j^S)}{R_1 - \lambda_j^S \alpha Ax_2^{\alpha-1}}$$

and

$$\frac{\partial V^{ST}}{\partial x_2} = \alpha Ax_2^{\alpha-1} - R_1.$$

where  $\gamma'(\lambda_j^S)$  is the derivative of  $\gamma(\lambda_j^S)$  with respect to  $\lambda_j$ . Hence,  $\frac{\partial V^S(x_1^*, x_2^*)}{\partial \lambda}$  can be characterized as:

$$\frac{\partial V^S(x_1^*, x_2^*)}{\partial \lambda} = \underbrace{\left(\frac{\alpha Ax_2^{\alpha-1} - R_1}{R_1 - \lambda_j^S \alpha Ax_2^{\alpha-1}}\right)}_{\Sigma(\lambda_j^S)} \left(Ax_2^\alpha + (z_j A)^{\frac{1}{1-\alpha}} R_1^{\frac{1-2\alpha}{1-\alpha}} \gamma'(\lambda_j^S)\right) \quad (22)$$

$\lambda_j \leq \lambda^{**}(z_j)$  ensures that  $\Sigma(\lambda_j^S)$  is positive.

Now consider the financial constraint (11) which determines the investment size of a constrained entrepreneur with a long-term horizon. The effect of pledgeability on the value function associated with long-term investment can be derived as:

$$\frac{\partial V^L(k^*)}{\partial \lambda} = \frac{\partial V^L}{\partial k} \frac{\partial k}{\partial \lambda} = \gamma'(\lambda_j^L) \theta_j \left(\frac{1}{1-\alpha}\right)^{\frac{1}{1-\alpha}} \quad (23)$$

The effect of pledgeability on long-term investment intensity can be recovered by comparing (22) and (23). That is firms choose to invest short-term if:

$$\Sigma(\lambda_j^S) \left(\frac{Ax_2^\alpha}{\gamma'(\lambda_j^L)} + \frac{A^{\frac{1}{1-\alpha}} R_1^{\frac{1-2\alpha}{1-\alpha}} \gamma'(\lambda_j^S)}{\gamma'(\lambda_j^L)}\right) \geq \theta_j \left(\frac{1}{1-\alpha}\right)^{\frac{1}{1-\alpha}} \quad (24)$$

Remembering  $\lambda$  is bounded below by  $a$  for low pledgeability entrepreneurs; if the entrepreneur has a short-term investment horizon, we can observe that,

$$\begin{aligned}\lim_{\lambda_j \rightarrow 0} \Sigma(\lambda_j^S) &= \lim_{\lambda_j \rightarrow 0} \left( \frac{\alpha Ax_2^{\alpha-1} - R_1}{R_1 - a\alpha Ax_2^\alpha} \right) = M \\ \lim_{\lambda_j \rightarrow 0} \gamma'(\lambda_j^S) &= \lim_{\lambda_j \rightarrow 0} \left[ \frac{\alpha}{1-\alpha} (\lambda_j + a)^{\frac{2\alpha-1}{1-\alpha}} (1 - \lambda + a) - (\lambda_j + a)^{\frac{\alpha}{1-\alpha}} \right] = N\end{aligned}$$

Where  $M$  and  $N$  are constants. We can also obtain:

$$\lim_{\lambda_j \rightarrow 0} \gamma'(\lambda_j^L) = \lim_{\lambda_j \rightarrow 0} \left[ \frac{\alpha}{1-\alpha} (\lambda_j)^{\frac{2\alpha-1}{1-\alpha}} (1 - \lambda) - (\lambda_j)^{\frac{\alpha}{1-\alpha}} \right] = 0$$

If  $\lambda_j$  is close enough to the low end of the pledgeability distribution, the left hand side of the inequality (24) diverges to positive infinity, whereas the right hand side converges to a constant.  $\theta^l(\lambda_j = 0) = 0$ , which implies that for very low levels of financial pledgeability, local improvements in the level of pledgeability do not result with any changes in investment horizon composition. For  $\lambda_j$  high enough,

$$\Sigma(\lambda_j^S) \left( \frac{Ax_2^\alpha}{\gamma'(\lambda_j^L)} + \frac{A^{\frac{1}{1-\alpha}} R_1^{\frac{1-2\alpha}{1-\alpha}} \gamma'(\lambda_j^S)}{\gamma'(\lambda_j^L)} \right) \leq \theta_j \left( \frac{1}{1-\alpha} \right)^{\frac{1}{1-\alpha}}$$

holds, in which case local improvements in financial pledgeability leads to increases in long-term investment intensity. Therefore, there exists a critical  $\lambda^c$ , such that for  $\lambda_j \geq \lambda^c$  low pledgeability entrepreneurs become long-term oriented in the face of rising pledgeability as it is the case for intermediate level financial pledgeability entrepreneurs. The results in part (b) can be obtained in a similar way.  $\square$

Proposition 3.5 shows that, for each  $\lambda_j \in [0, \lambda^*(z_j)]$ , the measure of entrepreneurs who invest in long-term investment projects is smaller than the measure of entrepreneurs with any “intermediate” level of financial pledgeability who are willing to undertake long-term investment opportunities. If there are incremental improvements in pledgeability of a low pledgeability entrepreneur or if there are improvements in economy-wide contract enforceability, the probability of long-term investment tendency for such an entrepreneur increases only if the level of his pledgeability is above the critical value  $\lambda^c$ . As I have shown, diminishing returns to scale associated

with both types of investment projects along with the existence of a lower bound pledgeability “a” for short-term borrowing drive this result.

Pledgeability plays a crucial role in determining investment size and investment composition of financially constrained firms. Proposition 3.3 together with proposition 3.5 prove that entrepreneurs with low pledgeability have smaller scales of productions and they are more short-term oriented, hence invest relatively more in traditional production technologies, compared to entrepreneurs with high levels of financial pledgeability. Define  $1 - \Theta(\lambda_j)$  as the fraction of entrepreneurs investing long-term for a given level of pledgeability  $\lambda_j$ . Keeping interest rates constant, table 1 reports the main analytical results.

The aggregate investment composition depends on endogenous cut-off points  $\lambda^c$  and  $\lambda^{**}$ . The effects of limited contract enforcement on these two cut-offs are as follows:

**Proposition 3.6** *If  $1/\zeta$  (the strength of contract enforcement) increases cut-off points  $\lambda^c$  and  $\lambda^{**}$  decline, and as a result the aggregate long-term investment intensity of the economy increases.*

**Proof**  $\frac{\partial \lambda^{**}}{\partial (1/\zeta)} < 0$  follows from lemma 3.2, and  $\frac{\partial \lambda^c}{\partial (1/\zeta)} < 0$  from proposition 3.5.  $\square$

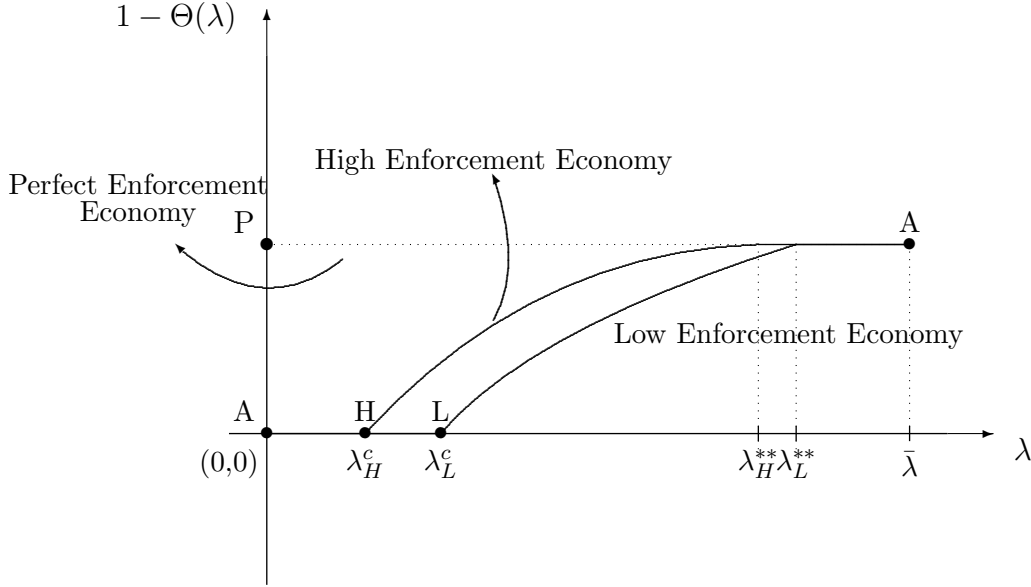
Figure 6 draws intensity of modern technology adoption as a function of financial pledgeability for three economies: A high-contract-enforcement economy (AHA Curve), a low-contract-enforcement economy (ALA Curve), and the perfect enforcement economy (PA). AHA curve lies above ALA curve which implies that high contract enforcement economy is characterized with higher aggregate long-term investment intensity.

One should note that the aggregate effects of financial contract enforcement are twofold: First, as the strength of contract enforcement improves per capita income increases which diminishes the returns to collateral building, and entrepreneurs switch to long-term investment projects. Second, when using the technology-M, entrepreneurs get to exploit their intrinsic ability, and be more productive. Therefore, in the presence of a technology choice as described above the level of economic development determines the entrepreneurial technology choice which further feeds back into the level of economic development.

Table 1: Enforcement and Investment Composition

Increase in	$1 - \Theta(\lambda_j)$ of Low Pledge.		$1 - \Theta(\lambda_j)$ of Interm. Pledge.	$1 - \Theta(\lambda_j)$ of High Pledge.
	$\lambda_j \leq \lambda^c$	$\lambda^c \leq \lambda_j \leq \lambda^*$	$\lambda^* \leq \lambda_j \leq \lambda^{**}$	$\lambda_j \geq \lambda^{**}$
$\lambda_j$ or $1/\zeta$	<i>No Change</i>	Increases	Increases	<i>No Change</i>

Figure 6. Effects of Enforceability on Advanced Technology Use



The analytical results show that my model can mimic the firm level technology use behavior for the U.S. economy, and also the correlation between the aggregate advanced technology investment intensity and contract enforceability. At the firm level small scale enterprises entrepreneurial firms in this model choose to invest in modern technological opportunities less often compared to large scale companies. This finding corroborates with empirical results documented by by Romeo [37], Kelley and Brooks [24], and Dunne [15]. And at the aggregate level, high contract enforceability is associated with advanced technology adaptability. The model does not associate modern technology use with high uncertainty, risk or large set-up costs, instead long-term investment horizons associated with modern technology adoption drive our analytical results. In the appendix of the paper, I provide a firm level empirical analysis to test the effects of pledgeability on financial structure. The empirical study shows that firms with low financial pledgeability choose long-term finance less often relative to firms with high financial pledgeability which is compatible with my findings as well.

### 3.3 General Equilibrium

**Definition** Denote  $S^S(R_1^*, R_2^*)$  and  $S^L(R_1^*, R_2^*)$  as the supply of short term and the long-term loanable funds respectively, and  $D^S(R_1^*, R_2^*)$  and  $D^L(R_1^*, R_2^*)$  as the demand for short term and the long-term loanable funds. The steady state equilibrium of the economy is given by constant short term ( $R_1^*$ ) and long-term ( $R_2^*$ ) interest rates at which agents optimize and markets clear in the following way:

$$\begin{aligned} S^S(R_1^*, R_2^*) &= D^S(R_1^*, R_2^*) \\ S^L(R_1^*, R_2^*) &= D^L(R_1^*, R_2^*) \end{aligned}$$

**Proposition 3.7** *The steady state equilibrium of the economy exists and it is unique and is characterized by  $\{R_1^*\}_t = R_1^*$  and  $\{R_2^*\}_t = R_2^*$  for all  $t$ .*

**Proof** Simple comparative statics at  $x_1^*$ ,  $x_2^*$ ,  $x_1^{**}$ ,  $x_2^{**}$ ,  $k^*$  and  $k^{**}$  shows that for all periods, due to the concavity in investment projects optimum (constrained and unconstrained) short-term and long-term capital demands are decreasing in respective interest rates. As proposition 3.1 shows the share of loanable funds allocated to short-term lending is increasing in short-term interest rate, whereas it is decreasing in long-term interest rate. Neither capital, nor the technological level evolve in the economy. Therefore, the economy is in steady state from the beginning of time. The result in proposition 3.7 follows.  $\square$

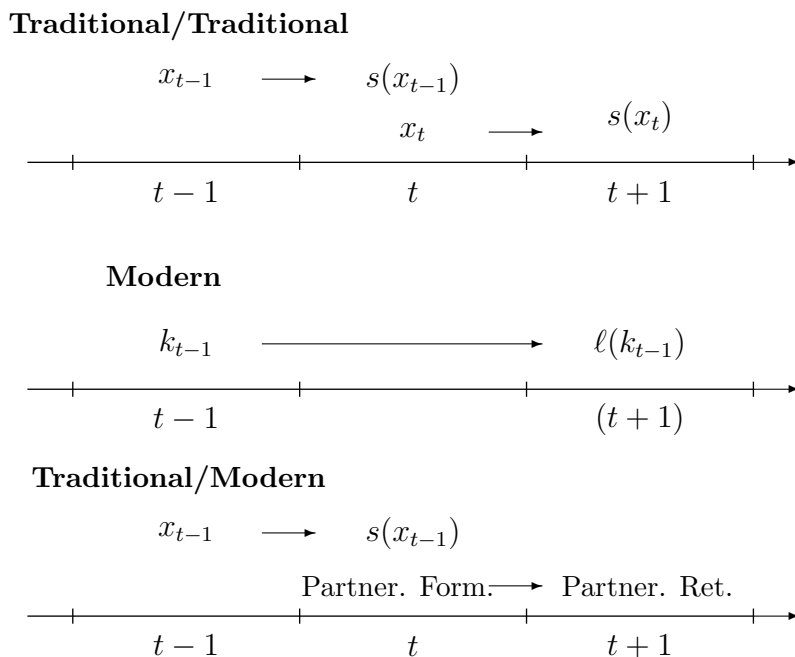
Two types of equilibria can be characterized in this setting. In the first case:  $R_2^* = (R_1^*)^2 = 1$ , which emerges when the demand for loanable funds is too small, making a positive fraction of financier use storage technology in equilibrium. Very weak contract enforce-ability can be a cause for this type of an equilibrium, in which incremental changes in contract enforceability do not have any effect on equilibrium interest rates. When contract enforcement is sufficiently strong the second type of equilibrium can prevail where  $R_2^* > R_1^* \geq 1$ . In this case there is adequate demand for both types of capital (short-term and long-term); and in this case incremental changes in contract enforceability affect both short-term and long-term interest rates.

## 4 Partnerships over Long-Term Investment Projects

In this section I extend the benchmark model developed in section 3 by allowing partnership formations over long-term investment projects which use the modern technology. This extension is valuable to consider because it allows “collateral building” in that an entrepreneur can start-up with low productivity traditional technology projects, build up collateral, and later on switch to modern technology investment projects where he can exploit his entrepreneurial quality. I modify the benchmark economic model such that long-investment projects can be operated by a single entrepreneur or by two partner middle-aged entrepreneurs who take charge of the business consecutively. Figure 7 summarizes the lifetime investment options of an entrepreneur when partnership formations are allowed.

At the beginning of each odd-numbered period after productivity and pledgeability levels get realized, entrepreneurs who are willing to form a partnership meet in a frictionless matching market. Each two-partner owned long-term project is started up by a “primary partner”, who is in charge of the project during its first period. During the second period of the project, the “secondary partner” takes over and finishes the investment project. Therefore, in the partnership market middle aged entrepreneurs (potential primary partners) meet with young entrepreneurs (potential secondary partners).

Figure 7. Technology Choice with Partnerships.



In the partnership market, potential primary partners make contract offers to potential secondary partners. If a young entrepreneur rejects the contract offer the primary partner can instantaneously make another offer to the same young agent, or move to someone else. Potential primary partners can make infinitely many offers, and common knowledge of rationality applies. Contract offers are settled in terms of the consumption good transfers to be made to the secondary partner at the end of his lifetime, which is denoted with  $\tau$ . Secondary partner receives the profits from the long-term project. Once both agents agree on contractual terms, partnership contracts are perfectly enforceable. As the primary partner works on the long-term project during the first period of the partnership, the secondary partner operates a short-term investment project. When a partnership is formed, from that point on financiers see the two partners as a single entity (a joint venture). The productivity level of the long-term project initiated by the joint venture ( $\theta_v$ ) is determined as  $\theta_v = \min\{\theta_p, \theta_s\}$  where  $\theta_p$  is the entrepreneurial quality of the primary entrepreneur and  $\theta_s$  is the quality of the secondary entrepreneur. Any borrowing made by the potential partners after the joint venture is formed is subject to the pledgeability constraint of the joint venture which is determined as  $\lambda_v = \min\{\lambda_p, \lambda_s\}$ . Entrepreneurs may leave the market without forming a partnership. In this default case unmatched middle-aged entrepreneurs operate a short-term investment project, and unmatched young entrepreneurs operate short-term or long-term projects.

## 4.1 Time-line of Events

The flow of events in a given odd numbered period  $t$  and in an even numbered period  $t + 1$ , is slightly different from the benchmark model. At the beginning of period  $t$  (odd numbered), first preference shocks of financiers born in period  $t - 1$  get realized. After that entrepreneurs collect project returns from period  $t - 1$  short-term investment projects and returns from period  $t - 2$  long-term projects. Debt repayment takes place, and agents consume. Productivity and pledgeability levels of young entrepreneurs get publicly observed after consumption takes place. Partnership market opens, middle aged and young agents contract on partnership terms, once contracts are settled entrepreneurs sell financial claims against future investment returns. Young and middle aged entrepreneurs start to produce. In period  $t + 1$  (even numbered), after short-term and long-term returns get collected middle

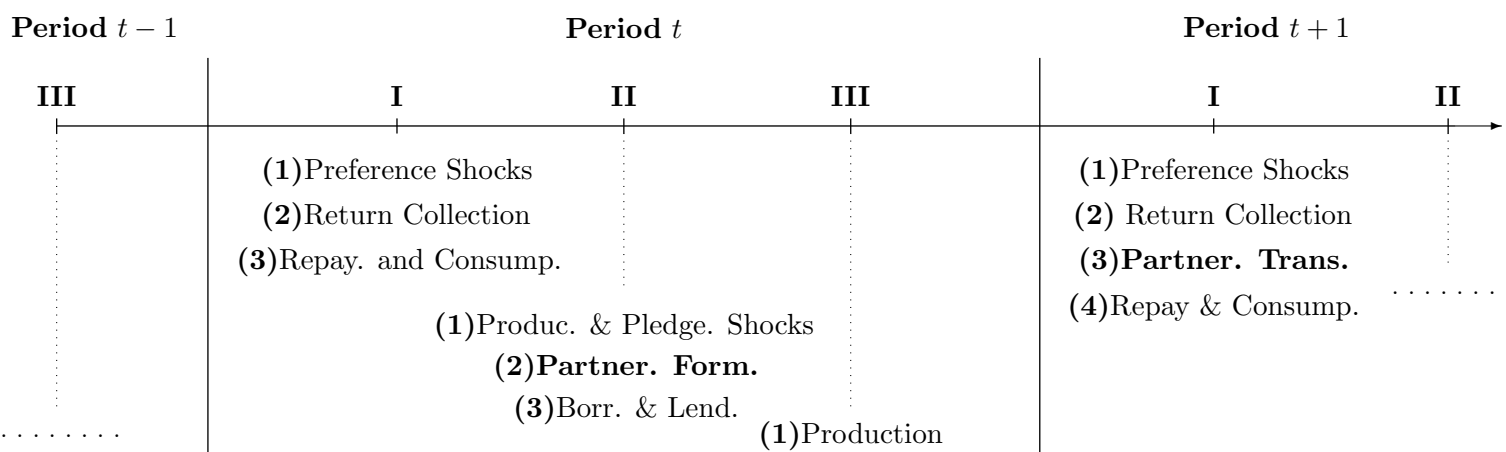
aged partners (young in  $t$ ) transfer wealth to old partners. The timeline of events after this point on is the same as in period  $t$  except the partnership market does not open during the period. Figure 8 summarizes the flow events in an economy where partnership formations are allowed.

## 4.2 A Partnership Equilibrium

The characterization of equilibrium in the partnership market is crucial for the determination of optimal technology use.

I assume that contractual terms get determined such that the primary and the secondary partners share the surplus generated by the partnership with equal division which is sufficient for the existence of stationary equilibria. I am not interested in analyzing commitment problems associated with partnership formations, because it is not the purpose of this paper to characterize a broad set contractual relationships. What I would like to emphasize is that some entrepreneurs can start-up with low productivity technology-T investment projects, build up collateral, and later on switch to technology-M investment projects where they can exploit their entrepreneurial quality. The following proposition provides an equilibrium characterization for the joint venture productivity and pledgeability levels<sup>12</sup>.

Figure 8. Flow of Events.



**Proposition 4.1** *Every middle aged entrepreneur  $(\theta_i, \lambda_i)_t$  born in period  $t$ , gets matched with his*

<sup>12</sup>Again, there are other equilibria which may arise in this setting. But I study the properties of the most intuitive and analytically the most tractable one to serve the purpose of the paper.

identical twin,  $(\theta_i, \lambda_i)_{t+1}$ , from the younger generation. The implied productivity and pledgeability of the joint venture are given as  $\theta_v = \theta_i$ , and  $\lambda_v = \lambda_i$  respectively.

**Proof** Remember that productivity and pledgeability levels of a joint venture are determined as  $\theta_v = \min\{\theta_p, \theta_s\}$  and  $\lambda_v = \min\{\lambda_p, \lambda_s\}$  respectively, and  $\theta_v$  and  $\lambda_v$  jointly determine the surplus generated by the partnership. Keeping this in mind suppose there is a joint venture in equilibrium with the following partner characteristics:  $(\theta_i, \lambda_i)_t$  and  $(\theta_i, \lambda_i)_{t+1}$ . We should check whether unilateral deviations from this match can create extra surplus for any of the partners. Take the middle aged agent  $(\theta_i, \lambda_i)_t$ : Keeping  $\theta_i$  constant, we know that the middle-aged entrepreneur  $i$  will not choose to contract with any young agent  $z$  with  $\lambda_z < \lambda_i$ , and no young agent  $w$  with  $\lambda_w > \lambda_i$  is going to accept a partnership offer from  $i$ . The analog result holds when we keep  $\lambda_i$  constant and vary  $\theta$ . The proposed match between “identical twins” across two generations is thus an equilibrium outcome.  $\square$

### 4.3 Entrepreneur’s Program

#### 4.3.1 Profitable Partnerships

Consider a middle-aged entrepreneur  $(\theta_i, \lambda_i)_t$ , born in period  $t$ , who has invested short-term when he was young. In odd-numbered periods middle aged entrepreneurs get to make contract offers to young entrepreneurs. The middle aged entrepreneur  $(\theta_i, \lambda_i)_t$  has two options in period  $t + 1$  if  $t$  is even: (1) Investing in a short-term investment project again, or (2) Forming a partnership with his identical twin from the younger generation and starting up a long-term investment project. Whether he will choose the latter option over the former depends on the amount of monetary transfers,  $\tau$ , the secondary partner can promise to make him. Of course,  $\tau$  depends on the amount of accumulated wealth of the potential secondary partner from his first period short-term investment project and the secondary partner’s ability to borrow against the future returns of the joint venture. I assume that at the end of the first period of a two-period-long partnership, the secondary partner can borrow against the  $\lambda_i/\zeta$  fraction of the previously unpledgeable part of the future investment returns.

Using the results obtained in section 3 (optimum capital investment levels  $(x_1^{opt}, x_2^{opt})$ , and  $k^{opt}$ ) for constrained and unconstrained entrepreneurs), and the result in proposition 4.1, we can derive an

upper bound for  $\tau$ :

$$\tau \leq \bar{\tau} \equiv \underbrace{[s(x_1^{opt}(\lambda_i; z_i)) - R_1 x_1^{opt}]}_{m_1 \equiv 2^{nd} \text{ partner's income}} + \underbrace{\left[ \frac{\lambda_i}{R_1 \zeta} \left( 1 - \frac{\lambda_i}{\zeta} \right) \ell(k_2^{opt}(\lambda_i; \theta_i)) \right]}_{b \equiv \text{borrowings against future returns}} \quad (25)$$

As one can observe the right hand side of the inequality increases in the level of entrepreneurial pledgeability and economy-wide contract enforcement. A middle aged entrepreneur chooses to become the primary partner of a long-term project only if:

$$(R_1 - 1)m_1 + s(x_2^{opt}(\lambda_i; z_i)) - R_1(x_2^{opt} - m_1) \leq \left[ \frac{\lambda_i}{R_1 \zeta} \left( 1 - \frac{\lambda_i}{\zeta} \right) \ell(k_2^{opt}(\lambda_i; \theta_i)) \right] \quad (26)$$

Similarly a young agent  $(\theta_i, \lambda_i)_{t+1}$  agrees on to be the partner of his identical  $(\theta_i, \lambda_i)_t$  twin from the older generation if:

$$(R_1 - 1)m_1 + s(x_2^{opt}(\lambda_i; z_i)) - R_1(x_2^{opt} - m_1) \leq \left[ \left( 1 - \frac{\lambda_i}{\zeta} \left( 1 - \frac{\lambda_i}{\zeta} \right) \right) \ell(k_2^{opt}(\lambda_i; \theta_i)) - R_2 k_2^{opt}(\lambda_i; \theta_i) \right] \quad (27)$$

Both inequalities, (26) and (27), should be satisfied for the existence of an equilibrium with partnerships.

The necessary and sufficient conditions for the existence of a  $\lambda_i$  for every  $\theta_i$  such that the right hand sides of (26) and (27) are greater than the respective left hand sides depend on a analytically unsolvable set of parameters. However, applying the reasoning in the proofs of propositions 3.3 and 3.5 we can show that the following result holds:

**Proposition 4.2** *For a given level of long-term productivity level  $\theta_i$ , the higher the pledgeability level of a prospected joint venture,  $\lambda_i$ , the higher is the probability of the existence of a profitable joint venture.*

The interpretation of this result is similar to the result we obtained in the previous section. When the amount which can be invested in modern technology, long-term projects is low, it is not beneficial to form a partnership. Therefore, when the economy-wide enforce-ability is low it is not optimal for entrepreneurs with low financial worthiness to switch from short-term investment to long-term investment during the second period of their lifetime.

### 4.3.2 Young Entrepreneur's Program and General Equilibrium

A young entrepreneur decides which technology paths to follow ((Modern,Modern),(Traditional,Modern), and (Traditional,Traditional)) at the beginning of his life-time. Therefore, the technology choice problem of a young entrepreneur is:

$$\max\{V^{SS}(x_1^{opt}, x_2^{opt}), V^{SL}(x_1^{opt}, k_2^{opt}), V^{LL}(k_1^{opt})\}$$

$V^{SS}(x_1^{opt}, x_2^{opt})$ ,  $V^{SL}(x_1^{opt}, k_2^{opt})$ , and  $V^{LL}(k_1^{opt})$  represent life-time value functions associated with being a short-term entrepreneur in both periods, a short-term entrepreneur in the first period and switching to being a long-term entrepreneur during the second period, and being a long-term entrepreneur in both periods, respectively.

As in section 3, for every pledgeability level  $\lambda_i$  we derive threshold levels to determine lifetime technology paths. Except this time we need to derive two of them, namely  $\bar{\theta}_1(\lambda_i)$  and  $\bar{\theta}_2(\lambda_i)$ . For a given  $\lambda_i$ , when  $\theta_i \geq \bar{\theta}_2(\lambda_i)$  the entrepreneur  $i$  chooses to become an investor using the technology-M at the beginning of his lifetime. If  $\bar{\theta}_1(\lambda_i) \leq \theta_i \leq \bar{\theta}_2(\lambda_i)$ , during the first period the entrepreneur chooses to operate the technology-T; however, he switches to the technology-M when he is middle-aged. And, finally entrepreneurs with  $\theta_i \leq \bar{\theta}_1(\lambda_i)$  choose to operate the technology-T throughout their life-cycle.

We can obtain the following results regarding the fraction of long-term projects undertaken in the economy:

**Proposition 4.3** *The aggregate investment in technology-M projects is greater in an economy where partnership formations are allowed relative to an economy where partnership formations are not allowed.*

In the current set-up, after building up collateral, entrepreneurs have a second chance to invest long-term. Therefore, aggregate investment in technology-M projects is higher relative to the no-partnerships economy.

**Proposition 4.4** *The total fraction of young entrepreneurs starting up businesses in technology-M is smaller when partnership formations are allowed.*

Due to the collateral effect some entrepreneurs are better off starting up with the technology-T and later on switching to use the technology-M during their middle-age.

Financier’s program is not altered, and since the total amount of long-term capital demand is greater when partnership formations are allowed, the equilibrium long-term to short-term interest rate ratio with partnerships  $(R_2^*/R_1^*)^P$  is high higher than that of without partnerships  $(R_2^*/R_1^*)^{NP}$ .

## 5 Quantitative Analysis

In this section I calibrate the unique steady state of the model for Turkish and the U.S. key aggregate and firm level statistics, and conduct policy experiments. The objective of the quantitative analysis is studying the effects of financial contract enforcement on economic performance and aggregate modern technology adoption. An increase in modern technology use is important for aggregate productivity because in long-term investment projects entrepreneurs’s intrinsic ability contribute to individual economic performance as well as the size of the investment project. I analyze the aggregate effects of financial contract enforcement due to changes in investment size distribution and changes in modern technology adoption rate in isolation. All the tables which I refer to in this section are in the appendix. In tables 4-11, “short-term output” denotes output from traditional investment, and “long-term output” denotes output from modern investment.

### 5.1 Benchmark Calibration for the U.S. Economy

I calibrate the model to match 11 key moments we observed in the U.S. aggregate as well as in U.S. firm level data. Table 4 lists the target moments and the behavior of the model with (2nd column) and without (3rd column) partnership formations. In table 4, the share of entrepreneurs for the U.S. economy is chosen as in Quadrini [34]. Private debt to output ratio is from Antunes et al. [2]. Firm level data is obtained from the Compustat North America. I used average values for the following cross-sectional averages over the 1997-2006 time period: Aggregate Long-Term (L.T.) Debt to Total Assets ratio; Average Long-Term Debt to Total Assets ratio for large scale, medium size, and small firms separately; the ratio between Total Outstanding Debt by Large Firms and Aggregate Debt, the ratio between Total Outstanding Debt by Medium Size Firms and Aggregate Debt, and the ratio

between Total Outstanding Debt by Small Firms and Aggregate Debt. Firm size classes are defined according to the employment level in the following way: Small firms have less than 500 employees, medium size firms have less 5000 and more than 500 employees and large firms have more than 5000 employees. The classification of small, medium size and large in the model is according to the level of financial pledgeability. Small firms in the model are firms owned by entrepreneurs for whom the level of financial pledgeability is low ( $\lambda_j \leq \lambda^*(z_j)$ ). Medium size firm owners are taken as the entrepreneurs with intermediate level of pledgeability ( $\lambda^*(z_j) \leq \lambda_j \leq \lambda^{**}$ ). And large firm owners are high pledgeability entrepreneurs who have  $\lambda_j \geq \lambda^{**}$ . Short term interest rates are calculated using the historic annual average rates (1990-2008) of 3-month U.S treasury bills, and long-term interest rates using the historic annual average rates (1990-2008) of 5-year U.S treasury bills.

The values assigned to model parameters are listed in table 5. Columns 3 and 4 show parameter values of the model with and without partnerships respectively. I assume that cumulative distribution of long-term project quality is given by  $F(\theta) = \theta^{1/\kappa}$  with support  $[0, \bar{\theta}]$ , and cumulative distribution of financial pledgeability is given by  $G(\lambda) = \lambda^{1/\sigma}$  with support  $[a, \bar{\lambda}]$  for short-term pledgeability and with support  $[0, \bar{\lambda}]$  for long-term pledgeability. Calibrated values of  $\kappa$  and  $\sigma$  are greater than one, which implies that the distribution is concentrated at low pledgeability and low ability entrepreneurs. I define the model period to be 25 years.

The share of financiers is calibrated such that the population share of non-entrepreneurs of the U.S. economy can be captured. The probability of facing a liquidity shock is calibrated such that the aggregate long-term (L.T.) debt to total assets ratio of the model matches the same variable for the U.S. economy. The remaining parameters in table 5 are calibrated to match the remaining target moments listed in table 4.

Cagetti and De Nardi [10] and Antunes et al. [2] define a contract enforcement parameter similar to the one I introduced in section 2. Cagetti and De Nardi [10] calibrate the value of the contract enforcement parameter for the U.S. economy as 0.25, and Antunes et al. [2] calibrate it as 0.26. The value of contract enforcement ( $1/\zeta$ ) in my model is 0.32 when partnerships are allowed and 0.34 when partnerships are not allowed. The reason for the divergence between their calibrated values of financial contract enforcement and mine is that in my model limited contract enforcement not only affects firm size but also the investment horizon composition of individual entrepreneurs. Due to this

important structural distinction between the two settings the calibrated values of contract enforcement are different. As we can observe in table 4 both models match targeted U.S. baseline statistics well along a number of dimensions.

## 5.2 A Quantitative Experiment: The Effect of Limited Contract Enforcement on Economic Performance

In this section, I study the behavior of the aggregate variables as we vary the the level of contract enforcement away from the U.S. benchmark. I analyze the effects of variation in the level of contact enforcement on aggregate output; the total output produced by low pledgeability, intermediate, and high pledgeability firms; the aggregate fraction of output produced using the modern technology, and finally the fraction of output produced using the modern technology by low, intermediate, and high pledgeability firms.

In table 6, the 3rd and the 4th columns report the effects of changes in contract enforcement on aggregate variables in the partnership economy and on aggregate variables in the no-partnership economy (the model where partnership formations are not allowed) respectively. In this quantitative experiment I analyze the aggregate implications of halving (replacing  $1/\zeta_P$  with  $1/(2 \times \zeta_P)$  and  $1/\zeta_{NP}$  with  $1/(2 \times \zeta_{NP})$ ) the strength of financial contract enforcement for the U.S. economy. Using the legal rights index developed by the World Bank, we can give an interpretation to this exercise. The index scores range from 1 to 10 where higher scores indicate better enforcement of collateral and bankruptcy laws. U.S. had a legal rights index of 8 in 2009. Halving the financial contract enforcement implies changing the strength of this institution from the benchmark U.S. to the level of, for instance, Argentina, Mexico or Thailand whose legal rights scores are 4 as of 2009.

In table 6 we can observe that as the level of contract enforcement decreases ( $1/\zeta$  decreases), per capita output declines. This is a result driven by the decrease in the efficiency of allocation of capital across entrepreneurs, increases in the fraction of firms which are financially constrained, and also by the decline in firm level productivity due the compositional switch in technology use. The effects of limited contract enforcement on aggregate output is larger in the no-partnership economy. The reason for this result is that a relatively larger compositional change in technology use occurs in an economy where

partnership formations are not allowed. When I analyze the effect of the level of contract enforcement on the breakdown of output and investment horizon composition across firm size classes, I keep the size class of a firm the same before and after the change in the level of contract enforcement occurs. When the level of contract enforcement weakens in the economy, the output of all pledgeability (size) classes decrease. High pledgeability large firms, who were financially unconstrained ex-ante, could have experienced an increase in their aggregate production due to the general equilibrium effect captured by the decreases in short-term and long-term interest rates. However, some of the high pledgeability firms become financially constrained as the level of contract enforcement weakens. The decrease in the investment and output size of ex-post-constrained high pledgeability firms dominate the increases in the investment and output size of ex-post-unconstrained firms, hence the aggregated output produced by large firms decreases. As the level of contract enforcement decreases, intermediate and low pledgeability firms experience an output decline relatively larger than that of high pledgeability ones. Diminishing returns to scale associated with both types of investment opportunities is the reason for this relationship. Also when financial contract enforcement becomes weaker all entrepreneurs become more short-term oriented; however, small and intermediate pledgeability firms experience a larger compositional shift relative to high pledgeability firms. As pointed out in the analytical section “collateral building” effect associated with short-term investment is the reason for this pattern. Therefore, the level of pledgeability is important in determining the effect of limited contract enforcement on output produced and investment horizon composition. As we can see in table 6 the quantitative effect of financial contract enforcement on investment horizon composition is as important as the quantitative effect of financial contract enforcement on economic performance. These quantitative effects show that if long-term investment had spillover effects as in Griliches [19], Aghion et al. [1] and Romer [38], the magnitude of the impact of an improvement in contract enforceability on economic well being would have been even larger. One should also note that interest rates are determined endogenously in this exercise. Exogenous interest rates are expected to amplify the quantitative implications reported in this section.

An important question which needs to be answered is: “What percentage of the aggregate effects of the variations in financial contract enforcement can be explained by the feedback effects generated through the changes in aggregate modern technology adoption?” In order to study whether financial

contract enforcement has sizeable effects on aggregate output through modern technology use, I consider the following second exercise: I conduct the same quantitative experiment, however this time by not allowing for a compositional change in technology employment after financial contract enforcement level diminishes from the benchmark U.S. level. In order to do that I keep the investment behavior (short-term or long-term) for each entrepreneur the same before (as in the benchmark calibration) and after the structural change in contract enforcement. Table 7 reports the results. It is important to note that in this exercise the aggregate effects of contract enforcement are associated only with the changes in the firm size distribution. Worsening the financial contract enforcement tightens financial constraints for low and intermediate financial pledgeability firms, and as a result they start to operate smaller scale investment projects. Table 7 implies that a significant portion of the aggregate effects of financial contract enforcement is due to the changes at entrepreneurial investment composition. About 17-22% of the aggregate effects of financial contract enforcement are due to the changes in modern technology use. Table 8 summarizes the breakdown of the implications of financial contract enforcement due to changes in the firm size distribution and due to the compositional shift in modern technology use.

### **5.3 Counterfactual Experiments for a Developing Economy: The Case of Turkey**

It is crucial to study the behavior of the model for a low-enforcement economy to fully illustrate the effects of financial contract enforcement on economic development. For this purpose in this section, at first I re-calibrate the steady state equilibrium of the model to match key aggregate statistics of the Turkish economy. Turkey is a fast growing developing economy; however, its financial system suffers from limited financial contract enforcement. World Bank [5] reported the legal rights scores of Turkey ranging from 1 to 4 between 2001-2009, whereas the legal rights scores of the U.S. as ranging from 7 to 8 for the same time period<sup>13</sup>.

The benchmark calibration results for the Turkish economy can be found in tables 9 and 10. The aggregate variables for the Turkish economy are obtained in the following way. The annual interest

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<sup>13</sup>The legal rights index ranges from 1 to 10 where higher scores indicate better enforcement of collateral and bankruptcy laws.

rates are targeted to be 2% for the short-term interest rate, and 6% for the long-term interest rate. The Turkish economy experienced very high real interest rates over the past few decades (over 15% annual). Therefore, for comparability of the two economies in a meaningful way I choose not to use Turkish real interest rates for the benchmark calibration. The share of entrepreneurs is chosen as 2% following Cetindamar [11]. Private debt to output ratio is 0.2 which I obtained from IMF's International Financial Statistics. Firm level data is from International Financial Corporation and follows the sample statistics in Demirguc and Maksimovic [13]. Table 7 lists the target moments and the behavior of the model with (2nd column) and without (3rd column) partnership formations.

After calibrating the steady state equilibrium of the model for the Turkish economy, I conduct two counterfactual policy experiments. In the first exercise, I replace Turkey's baseline contract enforcement level (0.13 for the partnership economy, and 0.14 for the no-partnership economy) with the contract enforcement level of the U.S. (0.32 for the partnership economy, and 0.34 for the no-partnership economy), keeping other parameters as in the benchmark calibration of Turkey. My main objective in this exercise is to study how the per capita output would be if the financial contract enforcement of the Turkish economy was as in the United States. Table 11 reports the results. We can observe that a structural change in financial contract enforcement has an important impact (a 13-15% increase in per capita output) on economic performance.

As in the U.S. quantitative experiment, I study the effects of financial contract enforcement on economic performance due to changes in establishment size distribution and changes in modern technology adoption in isolation. Table 12 reports the results for the case when entrepreneurs' investment structure remains the same before and after the improvement in financial contract enforcement. Table 12 implies that a significant portion of the aggregate effects of financial contract enforcement is due to the changes at entrepreneurial investment horizon composition. About 31 to 33% of the aggregate effects of financial contract enforcement are due to the changes in modern technology use. Table 13 summarizes the breakdown of the implications of financial contract enforcement due to improvements in the firm size distribution and due to the change in technology adoption rate.

Financial contract enforcement is important for a country's modern technology adoption rate as well as its investment size distribution, both of which have quantitatively sizeable effects for the level of economic development.

## 6 Conclusion

I have developed a framework to study the effects of limited contract enforcement on entrepreneurial decision making regarding modern technology use and economic development. I have shown that limited contract enforcement not only affects the aggregate output of an economy but also its modern technology use. Key analytical results of the paper have suggested that when financial contract enforcement is weak, the plant size is positively correlated with entrepreneurial financial pledgeability, more of the high-ability, low-pledgeability type of young entrepreneurs start-up using the traditional technology, and fewer of the high-ability, low-pledgeability entrepreneurs who started up employing the traditional technology switch to the modern technology later during their life-time. I calibrated the steady-state equilibrium of the model to match key aggregate statistics of the U.S. and the Turkish economy. The quantitative analysis have indicated that variations in economy-wide contract enforcement parameter have sizeable effects on the plant size distribution, and on the fraction of entrepreneurs employing the modern technology. The changes in the modern technology use feeds back into the level of economic development and vice versa. The counterfactual experiments have shown that if the level of financial contract enforcement of the Turkish economy was hypothetically changed to the level of financial contract enforcement of the United States, the Turkish output would rise by 13-15%. About one third of this variation is due to the feedback effects generated by the rise in entrepreneurial modern technology use.

The first contribution of the paper is that modern technology adoption is not associated with high risk, uncertainty, and large set-up costs; instead it requires an adaptation period (e.g. workforce and entrepreneurial training) to produce initial returns and necessitates a long-term investment for entrepreneurial firms. Many economists have pointed out the importance of adaptation periods to modern production techniques as an internal part of modern technology adoption. Quoting from Solo [40]:

... At the simplest level advanced technologies are adapted on the spot by adjusting or modifying machines which are in use elsewhere or processes and techniques which are practiced elsewhere to a particular need or circumstance. However, a machine or technique only expresses and partially embodies a corpus of knowledge. The mastery of that knowledge

and its use to design the appropriate mechanisms and techniques can be understood also as an adaptation of advanced technology and one that conveys a wider range and a greater power of assimilation than is possible through on the spot adjustments or modifications of already designed and practiced techniques. ...

Nonetheless, to the best of my knowledge this paper is the first attempt at examining the effects of financial constraints generated by limited contract enforcement to technology adoption in a context where adaptation period is relevant for entrepreneurs' technology choice. In my model, limited enforcement of financial contracts create distortions in long-term incentives, and makes modern technology adoption costly for small scale start-ups. Productive entrepreneurship through modern technology adoption prevails only when the initial investment size is sufficiently high, creating a complementarity between the establishment size and the modern technology use.

The second contribution of the paper is the analysis of a "collateral building" channel through which the strength of contract enforcement becomes crucial for the level of economic development. My analysis shows that in a high financial contract enforcement economy, ability to build up large enough collateral when young to be used at later stages of investment life-cycle is relatively higher compared to an economy characterized with low financial contract enforcement.

And finally, the third contribution of the paper is the study of the aggregate implications of financial contract enforcement on investment size distribution and modern technology adoption in isolation. The quantitative analysis has indicated that variations in financial contract enforcement has substantial impact on the investment size distribution and the modern technology adoption. Both channels have sizeable effects on economic development.

The analytical and quantitative findings of the model confirms the predictions by Baumol [7]. The allocation of resources away from unproductive forms of entrepreneurship towards productive entrepreneurship matters for the level of economic development. My paper shows that institutional development in financial contract enforcement is an effective way for allocating entrepreneurs towards productive entrepreneurship.

My results have implications for firm level investment behavior as well. The model shows that low-pledgeability, small-scale firms undertake structurally different investment projects compared to high-

pledgeability, large-scale establishments. Small firms operate flexible short-term investment projects whereas large firms operate illiquid long-term investment projects. The structural difference in investment behavior across firms with different establishment sizes may become important for the propagation mechanisms as analyzed by agency costs models such as Bernanke et al. [8] and Gertler and Gilchrist [18]. Therefore, small scale firms which operate on relatively shorter investment horizons are expected to show different responses to real shocks compared to large scale establishments, making business cycle properties of the model interesting to study.

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# Appendix

## Long-Term Investment, Long-Term Finance, and Financial Pledgeability

Long-term investment is expected to be less risky to undertake if it can be financed using long-term funds. Development studies, such as Demirguc-Kunt and Maksimovic [13], point out sufficient long-term financing directed to long-run, growth-enhancing projects as a must for persistent economic development. In this section, I present a panel data analysis to test the sensitivity of debt maturity structure to firm level financial pledgeability. Using U.S. firm level data, I show that firms with low financial pledgeability choose long-term financing less intensely relative to firms with high financial pledgeability. The results are more pronounced for firms operating in industries with high external finance dependency.

I use Compustat Industrial Annual Database for the analysis. The sample is comprised of 4120 publicly traded firms, and the time series dimension of the panel is 1997-2005. The hypothesis to be tested is that low financial pledgeability is associated with short-termism in firm financing.

To test this hypothesis, I estimate the following fixed-effect regression equation:

$$\begin{aligned} (LT\ Debt/Total\ Assets)_{it} &= \alpha_i + \gamma_{st} \\ &+ \beta_1 * \log(NWorth_{it}) \\ &+ \sum_{j=2}^3 \beta_j (\log(NWorth_{it}) * External\ Finance\ Dependency_{jt}) \\ &+ \gamma_1 * \log(Prof_{it}) + \gamma_2 * RDI + \gamma_3 * \log(Size_{it}) + \epsilon_{it} \end{aligned} \quad (28)$$

The left hand side variable (*Long Term Debt*)/(*Total Assets*) is proxied with the total outstanding debt which does not mature within one year over total assets.

The variables included in the regression analysis as independent variables are as the following:  $\alpha_i$  captures firm fixed effects, and  $\gamma_{st}$  are industry specific time-fixed effects. Net worth (*NWorth*) taken as (*Total Assets* – *Total Debt*) measures firm level balance sheet conditions (financial pledgeability). I test the sensitivity of debt structure to the interactive effect of industry external finance dependency and net worth. For this purpose, using 3-digit NAICS codes, I group industries according to their

external finance dependency levels and create a “external finance dependency” dummy variable:

As in Rajan and Zingales [36], I define the average external finance dependency ( $AEFD$ ) of industry  $j$  as:

$$AEFD_j = (\sum_{i=1}^{N_j} (Cash\ Flow\ From\ Operations - Capital\ Expenditures) / (Capital\ Expenditures)_i) / N_j,$$

where  $i \in \{1, \dots, N_j\}$  are firms operating in industry  $j$ .

$(External\ Finance\ Dependency)_2 = 1$  and 0 otherwise if  $0.3 < AEFD_j < 0.6$ ,  $\beta_2$  is the associated coefficient measuring the interactive effect.

$(External\ Finance\ Dependency)_3 = 1$  and 0 otherwise if  $AEFD_j > 0.6$  and  $\beta_3$  is the associated coefficient.

Hence, firms operating in industries with low external finance dependency have

$(External\ Finance\ Dependency)_2 = (External\ Finance\ Dependency)_3 = 0$ , firms in industries with intermediate levels of external finance dependency have  $(External\ Finance\ Dependency)_2 = 1$ ,  $(External\ Finance\ Dependency)_3 = 0$ , and firms in industries with high levels of external finance dependency have  $(External\ Finance\ Dependency)_2 = 0$ ,  $(External\ Finance\ Dependency)_3 = 1$ .

I control for three additional independent variables which may have effects on the liability structure of the firm: I proxy profitability ( $Prof_{it}$ ) with  $((Total\ Sales - Total\ Cost\ of\ Goods\ Sold) / Size)$ . R&D intensity ( $RDI$ ) is  $R\&D\ Expenditures / Total\ Assets$ . Total number of employees is used to proxy firm size ( $Size$ ).

I trim 1% tails of sample distributions to control for outlier effects. Summary statistics regarding each variable’s distribution can be found in table 5<sup>14</sup>.

To control for the feedback from financial structure to net worth I use first lagged series of the net worth variable as an instrument for itself, and estimate the model using 2-stage-least-squares (2SLS) methodology. In table 6, I report estimation results from 2SLS estimation as well as OLS (panel) for comparison purposes.

The net effect of net worth on debt structure ( $LT\ Debt / Total\ Assets$ ) for firms operating in industries with low external finance dependency is captured by  $\hat{\beta}_1$ , for firms operating in industries with intermediate levels of finance dependency the same effect can be found by adding up  $\hat{\beta}_1$  and  $\hat{\beta}_2$  and for firms in industries which highly depend on external finance, the net effect of net worth on debt

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<sup>14</sup>The sample does not contain firms with negative profits and negative net worth.

Table 2: Summary Statistics

Variable	Mean	Standard Deviation	Median
Long-Term Debt/Total Assets	0.37	0.10	0.23
Net Worth (Millions of \$'s)	143.20	695.43	154.18
Profitability (Millions of \$'s)	1.30	0.94	0.71
R&D Intensity	0.018	0.023	0.007
Size (#(Employees))	2100	523	627

All variables are from Compustat North America (average values between 1997-2005). Net Worth is defined as  $TotalAssets - TotalDebt$ . Profitability is computed using  $((Total\ Sales - Total\ Cost\ of\ Goods\ Sold)/EmploymentSize)$ . R&D Intensity is  $R\&D\ Expenditures/TotalAssets$ .

Table 3: Coefficient Estimates

Dependent Variable: Financial Structure	OLS	2SLS
log(Net Worth) (Low Ext. Fin Dep.) ( $\hat{\beta}_1$ )	0.2209** (4.39)	0.02918**(2.12)
log(Net Worth) (Med. Level Ext. Fin Dep.) ( $\hat{\beta}_2$ )	0.1192** (3.19)	0.5901** (4.81)
log(Net Worth) (High Ext. Fin Dep.) ( $\hat{\beta}_3$ )	0.0951* (1.99)	0.04324*(1.96)
log(Profitability) ( $\hat{\gamma}_1$ )	0.3391** (5.12)	0.7012** (4.37)
R&D Intensity ( $\hat{\beta}_2$ )	0.1040 (1.50)	0.0882*(1.98)
log(Firm Size) ( $\hat{\beta}_3$ )	0.7912** (6.12)	0.1466** (5.90)

Both regressions include firm and industry time fixed effects. The values in parentheses are t-statistics. \*,\*\* indicate significance at 10% and 5% level, respectively.

structure is found by adding up  $\hat{\beta}_1$  and  $\hat{\beta}_3$ .

We can observe that the effect of net worth on short-term finance intensity, is positive and statistically significant in both estimation results. The coefficients associated with interactive terms suggest that, the elasticity debt structure (uses of short-term debt) with respect to net worth increases as the industry external finance dependency rises.

The theoretical model in section 2 explains this firm level regularity in a context where contract enforcement is limited. In the analyzed context, financial constraints due to limited contract enforcement and life-cycle properties of the model generate a “collateral building” (internalization of investment finance in the short run) role associated with short-term investment for financially less pledgeable firms. Therefore, when contract enforcement is limited firms with low ratings use short-term funds instead of choosing rather costly long-term financing.

# Quantitative Analysis

## Benchmark Calibration (U.S.)

Table 4: Basic Statistics U.S. against Model

	U.S.	Model w. Partner.	Model w/o Partner.
Annual Interest Rate (%) (S.T.)	2.0	1.97	1.91
Annual Interest Rate (%) (L.T.)	6.0	5.71	5.61
% of Entrepreneurs	9	9	9
Private Debt to Output Ratio (Agg.)	1.98	2.03	2.04
L.T. Debt to Total Assets Ratio (Agg.)	0.37	0.32	0.31
L.T. Debt to Total Assets Ratio (Avg. for Sm.)	0.33	0.30	0.29
L.T. Debt to Total Assets Ratio (Avg. for Md.)	0.38	0.35	0.34
L.T. Debt to Total Assets Ratio (Avg. for Lg.)	0.48	0.51	0.52
Debt of Sm. (Agg.) to Debt (Agg.)	0.21	0.24	0.18
Debt of Md. (Agg.) to Debt (Agg.)	0.45	0.45	0.49
Debt of Lg. (Agg.) to Debt (Agg.)	0.34	0.31	0.33

The entrepreneurial share is from Quadrini [34]. Private Debt to Output Ratio is from Antunes [2]. Firm level data is from Compustat North America with 1997-2006 averages. Avg. stands for average, Agg. for aggregate, Sm. for Small, Md. for Medium Size, Lg. for Large.

Table 5: Parameter Values for the Baseline Economy (U.S.)

Parameter	Description	Partner.	No Partner.
$\mu$	% of Financiers	91	91
$1 - \pi$	% of Liquidity Shock	0.18	0.14
$1/\zeta$	Contract Enforcement	0.32	0.34
$(1 - \alpha)$	DRS of Investment Projects	0.23	0.24
$A$	Product. of S.T. Projects	3.37	3.14
$\gamma$	Prob. of a Good Prod. Shock	0.63	0.61
$\bar{z}$	$\bar{z} = \gamma z_g + (1 - \gamma)z_b$	1.35	1.29
$F(\theta) = \theta^{\frac{1}{\kappa}}$	Distribution of Ability	$\kappa = 4.28$	$\kappa = 4.19$
$\bar{\theta}$	Upper Bound for Ability	9.18	9.21
$G(\lambda) = \lambda^{\frac{1}{\sigma}}$	Distribution of pledgeability	$\sigma = 1.99$	$\sigma = 1.92$
$\bar{\lambda}$	Upper Bound for Financial pledgeability	0.82	0.85

The lower bound of short-term financial pledgeability  $a$  is normalized to be 0.02. This value is not binding for the benchmark calibration of the model.

## Policy Analysis (U.S.)

Table 6: The Effects of Limited Contract Enforcement (U.S.)

	Changes in Enforcement			
	$\zeta_P = 1/0.32$	$\zeta'_P = 2 \times 1/0.32$	$\zeta_{NP} = 1/0.34$	$\zeta'_{NP} = 2 \times 1/0.34$
Annual Interest Rate (%) (S.T.)	1.97	1.99	1.91	1.92
Annual Interest Rate (%) (L.T.)	5.71	5.62	5.61	5.49
Output Per Capita (Aggregate)	100	94	100	91
Out. Per Capita ( $\lambda_j \geq \lambda^{**}$ )	40	39	41	39
Out. Per Capita ( $\lambda^*(z_j) \leq \lambda_j \leq \lambda^{**}$ )	39	37	38	35
Out. Per Capita ( $\lambda_j \leq \lambda^*(z_j)$ )	21	18	21	17
S.T. to L.T. Out. Ratio (Agg.)	0.65	0.68	0.68	0.69
S.T. to L.T. Out. Ratio ( $\lambda_j \geq \lambda^{**}$ )	0.55	0.56	0.53	0.54
S.T. to L.T. Out. Ratio ( $\lambda^*(z_j) \leq \lambda_j < \lambda^{**}$ )	0.61	0.64	0.62	0.67
S.T. to L.T. Out. Ratio ( $\lambda_j \leq \lambda^*(z_j)$ )	0.73	0.76	0.75	0.78

All the reported results are for aggregate variables, e.g. “Out. Per Capita ( $\lambda^*(z_j) \leq \lambda_j \leq \lambda^{**}$ )” stands for aggregate output produced by all “large”-high pledgeability entrepreneurs.  $\zeta_P$  and  $\zeta_{NP}$  stand for the economy-wide enforcement parameter for the partnership and the no-partnership economy respectively.

Table 7: The Effects of Limited Contract Enforcement (U.S.) (With Controlling for the Compositional Change)

	Changes in Enforcement			
	$\zeta_P = 1/0.32$	$\zeta'_P = 2 \times 1/0.32$	$\zeta_{NP} = 1/0.34$	$\zeta'_{NP} = 2 \times 1/0.34$
Annual Interest Rate (%) (S.T.)	1.97	1.99	1.91	1.91
Annual Interest Rate (%) (L.T.)	5.71	5.64	5.61	5.53
Output Per Capita (Aggregate)	100	95	100	93
Out. Per Capita ( $\lambda_j \geq \lambda^{**}$ )	40	39	41	39
Out. Per Capita ( $\lambda^*(z_j) \leq \lambda_j \leq \lambda^{**}$ )	39	38	38	36
Out. Per Capita ( $\lambda_j \leq \lambda^*(z_j)$ )	21	18	21	18
S.T. to L.T. Out. Ratio (Agg.)	0.65	0.67	0.68	0.69
S.T. to L.T. Out. Ratio ( $\lambda_j \geq \lambda^{**}$ )	0.55	0.56	0.53	0.54
S.T. to L.T. Out. Ratio ( $\lambda^*(z_j) \leq \lambda_j < \lambda^{**}$ )	0.61	0.63	0.62	0.65
S.T. to L.T. Out. Ratio ( $\lambda_j \leq \lambda^*(z_j)$ )	0.73	0.75	0.75	0.77

Table 8: The Isolation of Effects of Contract Enforcement (Variation from Baseline U.S.)

	Breakdown of Effects Due (in %)			
	Partnership	Economy	No-Partnership	Economy
	Size	Tech.	Size	Tech.
	Dist.	Adop.	Dist.	Adop.
Output Per Capita (Aggregate)	83	17	78	22
Out. Per Capita ( $\lambda_j \geq \lambda^{**}$ )	99	1	99	1
Out. Per Capita ( $\lambda^*(z_j) \leq \lambda_j \leq \lambda^{**}$ )	50	50	67	33
Out. Per Capita ( $\lambda_j \leq \lambda^*(z_j)$ )	99	1	75	25
S.T. to L.T. Out. Ratio (Agg.)	67	33	99	1
S.T. to L.T. Out. Ratio ( $\lambda_j \geq \lambda^{**}$ )	99	1	99	1
S.T. to L.T. Out. Ratio ( $\lambda^*(z_j) \leq \lambda_j < \lambda^{**}$ )	67	33	60	40
S.T. to L.T. Out. Ratio ( $\lambda_j \leq \lambda^*(z_j)$ )	67	33	67	33

## Benchmark Calibration (Turkey)

Table 9: Basic Statistics Turkey against Model

	U.S.	Model w. Partner.	Model w/o Partner.
Annual Interest Rate (%) (S.T.)	2.0	1.91	1.87
Annual Interest Rate (%) (L.T.)	6.0	5.55	5.43
% of Entrepreneurs	5	5	5
Private Credit to Output Ratio (Agg.)	0.20	0.22	0.25
L.T. Debt to Total Assets (Agg.)	0.14	0.13	0.15
L.T. Debt to Total Assets (Avg. of Sm.)	0.07	0.06	0.07
L.T. Debt to Total Assets (Avg. of Md.)	0.09	0.10	0.10
L.T. Debt to Total Assets (Avg. of Lg.)	0.20	0.23	0.24
Debt of Sm. (Agg.) to Debt (Agg.)	0.20	0.22	0.23
Debt of Md. (Agg.) to Debt (Agg.)	0.27	0.25	0.26
Debt of Lg. (Agg.) to Debt (Agg.)	0.53	0.53	0.51

The entrepreneurial share is from Cetindamar [11]. Private Debt to Output Ratio is from IMF's International Financial Statistics. Firm level data is from International Financial Corporation.

Table 10: Parameter Values for the Baseline Economy (Turkey)

Parameter	Description	Partner.	No Partner.
$\mu$	% of Financiers	95	95
$1 - \pi$	% of Liquidity Shock	0.20	0.17
$1/\zeta$	Contract Enforcement	0.13	0.14
$(1 - \alpha)$	DRS of Investment Projects	0.26	0.27
$A$	Product. of S.T. Projects	2.83	2.91
$\gamma$	Prob. of a Good Prod. Shock	0.53	0.52
$\bar{z}$	$\bar{z} = \gamma z_g + (1 - \gamma) z_b$	1.31	1.33
$F(\theta) = \theta^{\frac{1}{\kappa}}$	Distribution of Ability	$\kappa = 6.92$	$\kappa = 6.82$
$\bar{\theta}$	Upper Bound for Ability	6.19	6.23
$G(\lambda) = \lambda^{\frac{1}{\sigma}}$	Distribution of pledgeability	$\sigma = 2.33$	$\sigma = 2.17$
$\bar{\lambda}$	Upper Bound for Financial pledgeability	0.75	0.79

The lower bound of short-term financial pledgeability  $a$  is normalized to be 0.02 as in the U.S case. This value is not binding for the benchmark calibration of the model.

## Counterfactual Policy Analysis (Turkey)

Table 11: The Effects of Limited Contract Enforcement (From Baseline Turkey to Baseline U.S.)

	Changes in Enforcement			
	$\zeta_P^T = 1/0.13$	$\zeta_P^{US}$	$\zeta_{NP}^T = 1/0.14$	$\zeta_{NP}^{US}$
Annual Interest Rate (%) (S.T.)	1.91	1.95	1.87	1.90
Annual Interest Rate (%) (L.T.)	5.55	5.65	5.43	5.52
Output Per Capita (Aggregate)	100	115	100	113
Out. Per Capita ( $\lambda_j \geq \lambda^{**}$ )	35	34	38	37
Out. Per Capita ( $\lambda^*(z_j) \leq \lambda_j \leq \lambda^{**}$ )	38	45	35	41
Out. Per Capita ( $\lambda_j \leq \lambda^*(z_j)$ )	27	36	27	35
S.T. to L.T. Out. Ratio (Agg.)	0.89	0.81	0.92	0.84
S.T. to L.T. Out. Ratio ( $\lambda_j \geq \lambda^{**}$ )	0.74	0.74	0.75	0.75
S.T. to L.T. Out. Ratio ( $\lambda^*(z_j) \leq \lambda_j < \lambda^{**}$ )	0.90	0.80	0.93	0.84
S.T. to L.T. Out. Ratio ( $\lambda_j \leq \lambda^*(z_j)$ )	0.94	0.81	0.95	0.83

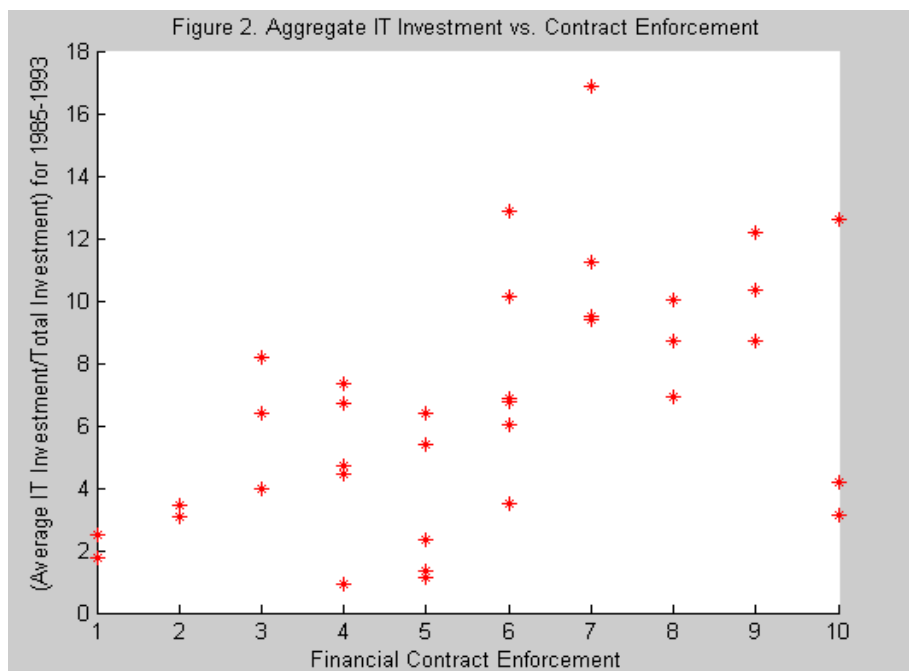
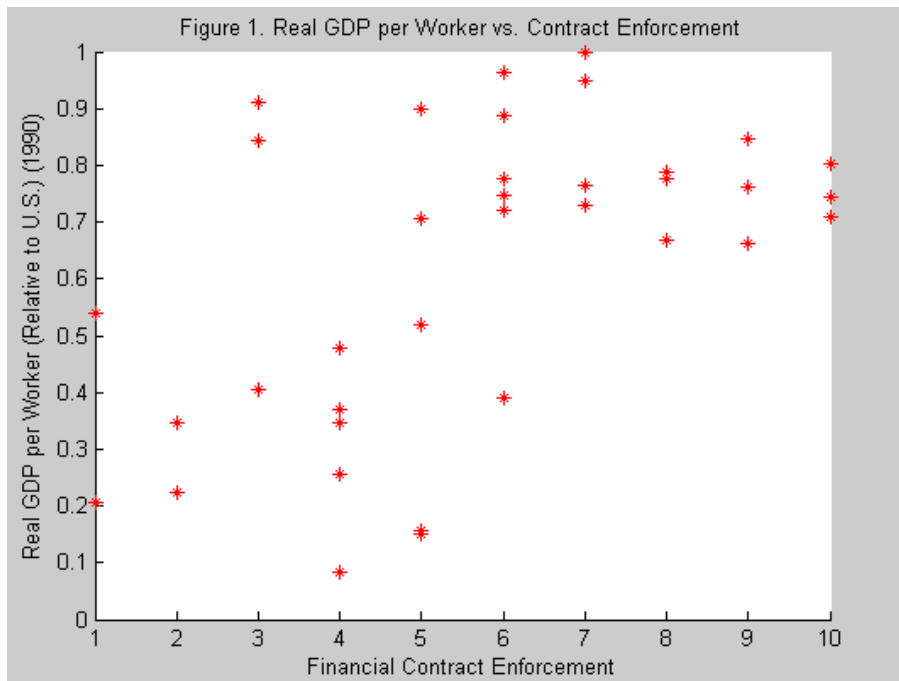
$\zeta_P^T$ ,  $\zeta_{NP}^T$ ,  $\zeta_P^{US}$ ,  $\zeta_{NP}^{US}$  stand for the economy-wide enforcement parameter for the partnership and the no-partnership economy for Turkey and the U.S. respectively.

Table 12: The Effects of Limited Contract Enforcement (From Baseline Turkey to Baseline U.S.) (With Controlling for the Compositional Change)

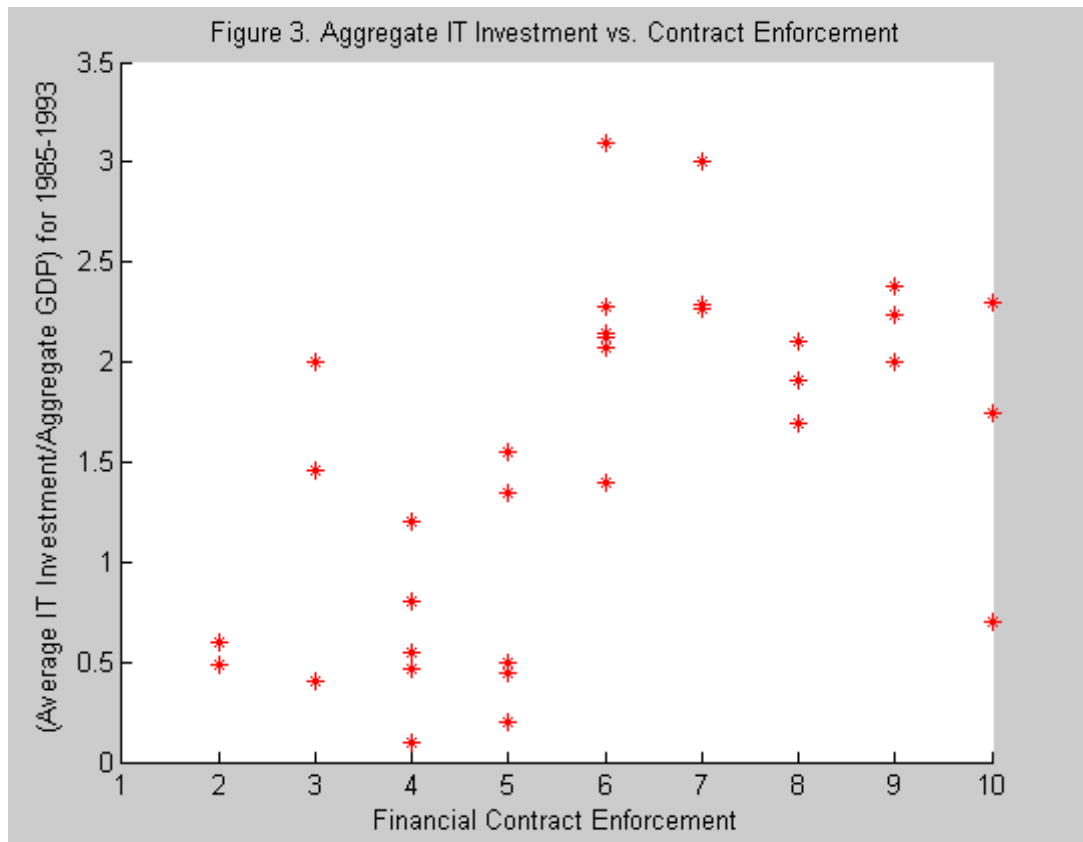
	Changes in Enforcement			
	$\zeta_P^T = 1/0.13$	$\zeta_P^{US}$	$\zeta_{NP}^T = 1/0.14$	$\zeta_{NP}^{US}$
Annual Interest Rate (%) (S.T.)	1.91	1.96	1.87	1.92
Annual Interest Rate (%) (L.T.)	5.55	5.61	5.43	5.50
Output Per Capita (Aggregate)	100	110	100	109
Out. Per Capita ( $\lambda_j \geq \lambda^{**}$ )	35	34	38	37
Out. Per Capita ( $\lambda^*(z_j) \leq \lambda_j \leq \lambda^{**}$ )	38	43	35	39
Out. Per Capita ( $\lambda_j \leq \lambda^*(z_j)$ )	27	33	27	33
S.T. to L.T. Out. Ratio (Agg.)	0.89	0.86	0.92	0.90
S.T. to L.T. Out. Ratio ( $\lambda_j \geq \lambda^{**}$ )	0.74	0.74	0.75	0.75
S.T. to L.T. Out. Ratio ( $\lambda^*(z_j) \leq \lambda_j < \lambda^{**}$ )	0.90	0.86	0.93	0.90
S.T. to L.T. Out. Ratio ( $\lambda_j \leq \lambda^*(z_j)$ )	0.94	0.91	0.95	0.93

Table 13: The Isolation of Effects of Contract Enforcement (From Baseline Turkey to Baseline U.S.)

	Breakdown of Effects Due (in %)			
	Partnership	Economy	No-Partnership	Economy
	Size	Tech.	Size	Tech.
	Dist.	Adop.	Dist.	Adop.
Output Per Capita (Aggregate)	67	33	69	31
Out. Per Capita ( $\lambda_j \geq \lambda^{**}$ )	99	1	99	1
Out. Per Capita ( $\lambda^*(z_j) \leq \lambda_j \leq \lambda^{**}$ )	71	29	67	33
Out. Per Capita ( $\lambda_j \leq \lambda^*(z_j)$ )	67	33	75	25
S.T. to L.T. Out. Ratio (Agg.)	37	63	25	75
S.T. to L.T. Out. Ratio ( $\lambda_j \geq \lambda^{**}$ )	99	1	99	1
S.T. to L.T. Out. Ratio ( $\lambda^*(z_j) \leq \lambda_j < \lambda^{**}$ )	40	60	33	67
S.T. to L.T. Out. Ratio ( $\lambda_j \leq \lambda^*(z_j)$ )	23	77	17	83



**Source:** *Figure 1:* Scatter plot of relative (to U.S.) real GDP per worker (1990) against the level of contract enforcement. GDP data is from Penn World Tables. Contract Enforcement Data is from the World Bank (2001): Legal Rights Index is taken as the measure of contract enforcement. The data ranges from 1 (worst legal rights) to 10 (best legal rights), and measures the quality in the enforcement of collateral and bankruptcy laws. *Figure 2:* Scatter plot of the average (1985-1993) annual IT investment as a percentage of total investment, against the level of contract enforcement. IT investment data is from Dewan and Kreamer (1998): Data comprises total values of the revenue paid to vendors for hardware, data communications, software, and services.



**Source:** *Figure 3:* Scatter plot of the average (1985-1993) annual IT investment as a percentage of aggregate GDP, against the level of contract enforcement.