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LONG-TERM INVESTMENT AND NET-WORTH BUILDING WITH LIMITED CONTRACT ENFORCEMENT

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This paper develops a firm dynamics model augmented with an endogenous net-worth-building feature at the firm level and investigates how opportunities for entrepreneurs to accumulate wealth can mitigate the implications of limited enforceability for resource allocation, productivity, and macroeconomic development. In the steady-state equilibrium of the model, financially constrained entrepreneurs select short-term investment projects because short-term investment enhances net-worth building and relaxes credit constraints. The limited contract enforceability suppresses macroeconomic output; however, entrepreneurial net-worth building offsets the per capita income losses. I calibrate the steady state of the model for the U.S. economy as a baseline and conduct quantitative exercises. The counterfactual simulations reveal that net-worth building could reduce, for instance, about two-thirds of the per capita income discrepancy between the United States and Brazil that can be attributed to limited enforcement. The theoretical and quantitative results from the paper are highly relevant to financial development and entrepreneurship policies implemented in developing countries.

Keywords: Net-Worth Building, Limited Enforcement, Allocations, Total Factor Productivity

1. INTRODUCTION

Limited contract enforceability imposes a major obstacle to economic development. For example, La-Porta et al. (1998) document that the level of bankruptcy

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and collateral enforcement exhibit large cross-country variation and the per capita income is on the average higher in economies with strong enforcement institutions. Asiedu and Villamil (2002), Jeong and Townsend (2007), Antunes et al. (2008), Azariadis and Kaas (2008), Quintin (2008), and Buera et al. (2013) all argue that financial contract enforcement is important for macroeconomic development because stronger enforcement eases the allocation of external finance to profitable firms that have weak net-worth positions and increases the aggregate productivity of the macroeconomy at quantitatively important proportions. Limited financial enforceability could—and in fact does—constrain the availability of external finance.[1] However, as a response to this supply-side limitation, profitable establishments would *build net worth* and generate internal finance—as also argued, for instance, by Khan (2001) and Banerjee and Moll (2010).

This paper investigates how opportunities for entrepreneurs to accumulate wealth can mitigate the implications of limited enforceability for resource allocation, productivity, and macroeconomic development. To address this question, I develop a firm dynamics model augmented with an endogenous net-worth-building decision at the firm level and investigate the effects of financial contract enforcement on entrepreneurship and aggregate economic performance. The dynamic general equilibrium model allows a formal analysis of the theoretical argument that financially constrained entrepreneurs seek opportunities to accumulate wealth, and furthermore allows exercises to test and estimate the quantitative impact of net-worth building when financial enforcement is limited.

The model features a continuum of finitely lived households that pay fixed costs of entry to operate entrepreneurial firms. Following entry, entrepreneurs undertake a discrete investment-horizon choice between a short-term project—which pays off in the short run—and a long-term project—which pays off in the long run. In the frictionless benchmark, all entrepreneurs invest long-term. Limited contract enforceability generates endogenous credit constraints and alters the investment horizon choice for the entrepreneurs with low initial net worth. At the firm level, in the steady-state equilibrium of the model, financially constrained entrepreneurs sort into the short-term investment project because short-term cash flows induce reinvestment, enhance *net-worth building,* and relax credit constraints. At the aggregate level, limited contract enforceability suppresses the steady-state per capita output; however, entrepreneurs' endogenous net-worth-building response mitigates the per capita income losses.

To explore the implications of entrepreneurs' endogenous net-worth building in explaining the relationship between contract enforceability and macroeconomic development, I calibrate the steady state of the model for the U.S. economy as a baseline. Systematic variations of the enforcement limit from its baseline value reveal that lowering the strength of financial contract enforcement of the U.S. economy, for instance, by 50% could lower the steady-state per capita output by 9% in the absence of entrepreneurial net-worth building. For the same institutional analysis, my results reveal that with endogenous net-worth building the contraction in per capita output would be only by 1%.

To quantify the role of enforceability and net-worth building in explaining cross-country income differences, I also use estimates of financial contract enforcement limits for several countries from the OECD, Africa, Latin America, and Asia, keeping remaining parameters at the U.S. baseline level and studying counterfactual policy experiments. The purpose of this inquiry is to explore what fraction of actual cross-country income differences contract enforcement explains, *with* and *without* endogenous net-worth building. The simulations show that in the absence of endogenous net-worth building, 27% of the per capita income difference, for instance, between Brazil and the United States could be explained by the enforceability differences between these two countries. If financially constrained entrepreneurs are allowed to build net worth as a response to limited financial enforceability, the per capita income difference between Brazil and the United States that can be accounted by enforceability differences will be only 9%.

The theoretical and quantitative predictions of the model are important for understanding the development effects of financial frictions: (I) The key argument of the paper, in this respect, is that financial constraints can sort entrepreneurs into different production opportunities, which in turn alters the development implications of financial imperfections by quantitatively significant proportions. (II) The model generates an interesting complementarity between technology growth plans and finance. In an economy where, for instance, contract enforceability is limited and a positive measure of entrepreneurs engage in net-worth building, a rise in long-term productivity stimulates the profitability of financially unconstrained firms. The growth in short-term project productivity, on the other hand, stimulates the profitability of financially constrained firms. Therefore, depending on the distribution of the constrained and the unconstrained firms in an economy, technology growth plans that raise the productivity of short-term projects could be beneficial in financially less developed countries, whereas long-term productivity growth plans could benefit the macroeconomic performance in financially developed countries. This key conclusion of the paper is that the subsidization of technology adoption from abroad should take into account the extent of financial market imperfections in developing countries.

Many studies in the past considered the slow technology acquisition of developing countries from abroad as a *barrier* to riches. For example, Mokyr (1990) proposes that the lack of resistance against foreign technology adoption explains many growth successes throughout the history and all around the world. My analysis in this paper suggests a different perspective. Even in the absence of costly technology acquisition, the adoption of modern production technologies that are advanced in financially developed countries does not necessarily stimulate the aggregate productivity levels in financially less developed countries. Financial development could be a determinant for the technology appropriateness. Therefore, government policies that tend to stimulate technology adoption from abroad should take into account the extent of financial market imperfections in developing countries.

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 Schumpeter (1911). Following the Schumpeterian proposition, an extensive literature studied the role of entrepreneurship in macroeconomic development. The seminal articles by Lucas (1978) and Kihlstrom and Laffont (1979) are the first studies of entrepreneurship in general equilibrium theory. Other important papers on entrepreneurship and macroeconomics are Cagetti and De Nardi (2006) (entrepreneurship and wealth distribution), Jiang et al. (2010) (entrepreneurship and ability heterogeneity), and Newman (2007) (entrepreneurship and risk taking). Evans and Jovanovic (1989) and Hurst and Lusardi (2004) are classical studies on financial constraints and entrepreneurial decision making.

There is also a large literature that studies the effects of institutions on entrepreneurial productivity. In this respect, Baumol (1996) is a seminal article that suggests that although increasing the amount of resources allocated to private entrepreneurs is important for a society's well-being, much more critical is the way the private sector uses these resources. According to Baumol's hypothesis, what matters is not "who gets what" but "who gets what and how does he use it." Secure property rights [Wiggens (1995)] and rule of law [Parker (2007)] are expected to be important institutions in turning entrepreneurs away from unproductive forms of entrepreneurship toward productive entrepreneurship. In this paper, I study the effects of institutional design on "productive entrepreneurship" as well, but differently from the previously mentioned studies, in my framework I build on a macro-development point of view. The institution of interest in this paper is "financial contract enforcement." Therefore, this research is related to the growing literature focusing on the effects of financial frictions, and in particular financial contract enforceability, on entrepreneurship and aggregate economic performance. Quadrini (1999), Cagetti and De Nardi (2006), and Buera et al. (2013) study the effects of limited contract enforcement on entrepreneurial wealth accumulation and aggregate saving dynamics. Cooley et al. (2004) uncover how limited enforceability is related to entrepreneurial commitment to investment projects and aggregate volatility. Antunes et al. (2008), Quintin (2008), and Buera et al. (2013) study the quantitative implications of limited contract enforcement for occupation choice and the efficiency of aggregate capital allocation across entrepreneurs by emphasizing the misallocation inefficiencies due to lack of financial contract enforcement.[2] As in Antunes et al. (2008), Quintin (2008), and Buera et al. (2013), I concentrate on the effects of limited contract enforcement for entrepreneurship and aggregate resource allocation as well; however, my objective differs from these studies, as I study the implications of limited contract enforcement not only for the aggregate misallocation of capital among a distribution of entrepreneurs, but also incorporating the firm-specific implications of contract enforcement on the allocation of entrepreneurial capital across different investment opportunities within a firm. Closely related to this literature, Banerjee and Moll (2010), similarly to the argument of this paper, also suggest that theoretically financial constraints should dissipate over time for infinitely lived firms, because financially constrained firms have incentives to retain earnings and build net worth over time. In this

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paper, differently from Banerjee and Moll (2010), I study the general equilibrium firm dynamics with an explicitly modeled net-worth-building choice for *finitely* lived establishments and quantify the macroeconomic effects of entrepreneurs' net-worth-building response against external finance limits.

The rest of the paper is organized as follows. Section 2 presents a stripped down version of the framework as a three-period investment model. Section 3 extends the three-period model into a general equilibrium firm dynamics model. Section 4 presents the measurement and the benchmark calibration of the model for the U.S. economy. Section 5 provides an extensive set of quantitative policy exercises. Section 6 discusses the relationship between the technology appropriateness and the financial contract enforceability. Section 7 concludes.

2. THE THREE-PERIOD MODEL

In this section, I present a simple three-period model in order to illustrate the key underlying mechanism—whose dynamic general equilibrium properties I will analyze in Section 3. Suppose that there are three time-periods (0, 1, 2), a continuum of risk-neutral entrepreneurs, and a single good that can be consumed or invested. At the beginning of period 0, every entrepreneur i is endowed with $w_{0,i}$ units of the consumption good and two investment options—heterogeneous in productivity and cash-flow frequency—to be described later. I assume that $w_{0,i}$ is distributed with a cumulative distribution function $G(w_0)$. Financial markets meet in periods 0 and 1, allowing the trade of the initial consumption good holdings among entrepreneurs.

2.1. Entrepreneurs and Production

There are two stylized investment paths available to entrepreneurs: The *Net-Worth-Building Path* and the *Long-Term-Investment Path*. Entrepreneurs choose the investment path at the beginning of period 0. Inputs used up in both types of investment options depreciate completely.

On a *net-worth-building* path, entrepreneurs undertake a short-term investment project in period 0, which returns $s_1(k_0^{\mathrm{S}})$ units of the consumption good in period 1 for every k_0^{S} units of investment. Following the collection of period-0 investment returns, net-worth builders have access to a second short-term investment project in period 1. The period-1 short-term project generates $s_2(k_1^{\mathrm{S}})$ units of income flow in period 2 for every k_1^{S} units of investment. I assume that $s_1(k^{\mathrm{S}}) = s_2(k^{\mathrm{S}}) = s(k^{\mathrm{S}})$ $\forall k$. Let r denote the cost of capital between any two consecutive periods.

Agents who choose the *long-term-investment* path receive $\ell(k^{\mathrm{L}})$ units of the consumption good in period 2 for every k^{L} units of investment in period 0. The two-period opportunity cost of capital is denoted by r_{L}.

Assumption 1. $\ell(\hat{k}) > (1 + r)s(\hat{k})$ for any $\hat{k} \in [0, \infty)$.

Assumption 1 implies that in the absence of any financial constraints, long-term investment strictly dominates net-worth building: The key difference between net-worth building and long-term investment is that building up net worth in the short run causes the firm to forego a more productive investment opportunity that pays off in the long run. Another interpretation of the productivity heterogeneity across investment projects is that the full capacity of a technology can be realized only if entrepreneurs are patient enough to wait for the long-term outcome. Forcing the technology to produce cash flow in the short run—by going for the net-worth building option—results in a lower overall life-cycle performance. Financial constraints—in the form of enforceability limits—will distort the relative value of the two investment horizon options and generate room for *the ability to build net worth* to improve firm-level economic performance of initially less wealthy entrepreneurs.

Assumption 2. $s(k)$ and $\ell(k)$ satisfy the standard decreasing-returns-to-scale properties.

Assumption 2 ensures an interior solution and a role for entrepreneurial net worth in determining the distribution of capital among producers.

2.2. The Financial Market

Entrepreneurs trade financial claims in a market that meets in periods 0 and 1. In period-0 financial market short-term claims against r units of period-1 investment returns and r_{L}-units of long-term claims against period-2 investment returns are traded in exchange for one unit of period-0 consumption good. In the financial market of period 1 only short-term claims—against period-2 investment returns—are sold. There is perfect capital mobility between short-term and long-term financial markets, implying that $r_{\mathrm{L}} = r^2$. Moreover, for the current three-period model, I set $r = 1$, which I relax in the dynamic general equilibrium extension of Section 3.

Borrowing is subject to a *limited enforceability* constraint. Specifically, entrepreneurs can abscond with the $1 - \lambda$ fraction of the cash flow and avoid repayment. In this respect, the parameter λ resembles an economywide institutional quality level measuring the effectiveness of courts and financial institutions in enforcing contractual repayment. As a key property of the model, I assume that a defaulting entrepreneur cannot be excluded from future financial market transactions. Therefore, repayment beyond a fraction λ of a project's cash flow cannot be enforced.

Formally, for an entrepreneur with a net-worth-building investment path, enforcement constraints on period-0 and period-1 borrowing take the forms

$$\lambda s_1(k^{\mathrm{S}}_{0,i}) \geq b^{\mathrm{S}}_{0,i}, \tag{1}$$

$$\lambda s_2(k^{\mathrm{S}}_{1,i}) \geq b^{\mathrm{S}}_{1,i}, \tag{2}$$

where $b^{\mathrm{S}}_{0,i}$ and $b^{\mathrm{S}}_{1,i}$ are externally financed short-term capital investment in period 0 and 1, respectively.

For a long-term investor, on the other hand, the limited enforceability constraint takes the form

$$\lambda\ell(k^{\mathrm{L}}_{0,i}) \geq b^{\mathrm{L}}_{0,i}, \tag{3}$$

where $b^{\mathrm{L}}_{0,i}$ is the externally financed long-term period-0 capital investment.

2.3. Timing

The sequence of events in periods 0, 1, and 2 is as follows:

I. Period 0. Investment horizon choice
   i. Entrepreneur decides on the project type: long-term investment vs. net-worth building.
   ii. Financial market opens: short-term and long-term trade of the period-0 endowment among entrepreneurs at the interest rate $r = r_{\mathrm{L}} = 1$.
   iii. Capital investment.
   iv. Consumption.

II. Period 1. Reinvestment stage
   i. Net-worth builders collect investment returns.
   ii. Debt repayment for net-worth builders.
   iii. Financial market opens: short-term trade of the period-1 endowment at the interest rate $r = 1$.
   iv. Capital *re*investment for net-worth builders.
   v. Consumption.

III. Period 2. Project finalization
   i. Return collection for both net-worth builders and long-term investors.
   ii. Debt repayment.
   iii. Consumption.

2.4. Optimizing Behavior

I assume without loss of generality that entrepreneurs do not discount the future. Denoting entrepreneur i's consumption in period t by $c_{t,i}$ and the consumption good savings that are not invested in his own technology by $v_{t,i}$, a net-worth-building entrepreneur's optimization problem is specified as

$$\max_{\{c_{t,i}, v_{t,i}, k^{\mathrm{S}}_{t,i}, b^{\mathrm{S}}_{t,i}\}} \sum_{t=0}^{t=2} c_{t,i} \quad \text{s.t.} \tag{4}$$

$$w_{0,i} + b^{\mathrm{S}}_{0,i} \geq c_{0,i} + k^{\mathrm{S}}_{0,i} + v_{0,i}, \tag{5}$$

$$s_1(k^{\mathrm{S}}_{0,i}) + b^{\mathrm{S}}_{1,i} + v_{0,i} \geq c_{1,i} + k^{\mathrm{S}}_{1,i} + b^{\mathrm{S}}_{0,i} + v_{1,i}, \tag{6}$$

$$s_2(k^{\mathrm{S}}_{1,i}) + v_{1,i} \geq c_{2,i} + b^{\mathrm{S}}_{1,i}, \tag{7}$$

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$$\lambda s_1(k^{\mathrm{S}}_{0,i}) \geq b^{\mathrm{S}}_{0,i}, \quad (8)$$

$$\lambda s_2(k^{\mathrm{S}}_{1,i}) \geq b^{\mathrm{S}}_{1,i}, \quad (9)$$

and $c_{t,i}$ and $k^{\mathrm{S}}_{t,i}$ are non-negative. Constraints (5)–(7) are resource constraints for period 0 through period 2, and (8) and (9) are limited enforceability constraints as delineated previously.[3]

Similarly, a long-term investor solves the following optimization problem:

$$\max_{\{c_{t,i}, v_{t,i}, k^{\mathrm{L}}_{t,i}, b^{\mathrm{L}}_{t,i}\}} \sum_{t=0}^{t=2} c_{t,i} \quad \text{s.t.} \quad (10)$$

$$w_{0,i} + b^{\mathrm{L}}_{0,i} \geq c_{0,i} + k^{\mathrm{L}}_{0,i} + v_{0,i}, \quad (11)$$

$$v_{0,i} \geq c_{1,i} + v_{1,i}, \quad (12)$$

$$\ell(k^{\mathrm{L}}_{0,i}) + v_{1,i} \geq c_{2,i} + b^{\mathrm{L}}_{0,i}, \quad (13)$$

$$\lambda \ell(k^{\mathrm{L}}_{0,i}) \geq b^{\mathrm{L}}_{0,i}, \quad (14)$$

and $c_{t,i}$ and $k^{\mathrm{L}}_{0,i}$ are non-negative. Constraints (11)–(13) are resource constraints for period 0 through period 2, and (14) is the limited enforceability constraint.

Finally, the entrepreneur's investment horizon choice is the simple discrete choice problem delineated as

$$\max\{V^{\mathrm{S}}, V^{\mathrm{L}}\}, \quad (15)$$

where V^{S} is the lifetime value associated with the net-worth building path, and V^{L} is the lifetime value from being a long-term type investor.

Optimum capital allocation. For notational convenience I drop the individual specific subscripts, and denote the Lagrange multipliers as ξ^J_t (associated with resource constraints); ζ^J_t (enforceability constraints); and $\vartheta^J_{c,t}$ (non-negativity of consumption) and $\vartheta^J_{k,t}$ (non-negativity of capital), where J refers to the type of entrepreneur (S: net-worth builder, and L: long-term investor). Note that by Assumption 2, capital investment is always strictly positive, yielding $\vartheta^J_{k,t} = 0$ for all J and t.

For a net-worth builder (S-type), the first-order optimality conditions are given by

$$c_0: \; 1 + \vartheta^{\mathrm{S}}_{c,0} = \xi^{\mathrm{S}}_0, \quad (16)$$

$$c_t: \; 1 + \vartheta^{\mathrm{S}}_{c,t} = \xi^{\mathrm{S}}_t, \quad (17)$$

$$k_0: \; \left[\lambda \zeta^{\mathrm{S}}_0 + \xi^{\mathrm{S}}_1\right] s'_1(k^{\mathrm{S}}_0) = \xi^{\mathrm{S}}_0, \quad (18)$$

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$$k_1 : \left[\lambda \zeta_1^{\mathrm{S}} + \xi_2^{\mathrm{S}}\right] s_2'(k_1^{\mathrm{S}}) = \xi_1^{\mathrm{S}}, \tag{19}$$

$$b_0 : \xi_0^{\mathrm{S}} = \zeta_0^{\mathrm{S}} + \xi_1^{\mathrm{S}}, \tag{20}$$

$$b_1 : \xi_1^{\mathrm{S}} = \zeta_1^{\mathrm{S}} + \xi_2^{\mathrm{S}}, \tag{21}$$

and the complementary slackness conditions.

As I present in the following proposition, the first-order conditions of a net-worth-building entrepreneur yield the "backloading" property: Consumption will be postponed to later periods as long as the enforceability constraint (1) (and (2)) is binding.

PROPOSITION 2.1.

i. *If the enforceability constraint (1) is binding, but (2) is slack, then* $c_0 = 0$ *and/or* $c_1 = 0$.
ii. *If both (1) and (2) are binding, then* $c_0 = 0$ *and* $c_1 = 0$.

Proof. See Appendix A. ■

Binding enforceability constraints in periods 0 and 1 also imply that $v_{0,i} = 0$ and $v_{1,i} = 0$. Define $w_1 \equiv s_1(k_0^{\mathrm{S}}) - b_0^{\mathrm{S}}$, where w_1 denotes the entrepreneur's net worth in period 1. Then, for all net-worth builders, if period-0 and/or period-1 enforceability constraints are binding, backloading implies that

1. $w_1 > w_0$, and
2. $k_1^{\mathrm{S}} > k_0^{\mathrm{S}}$.

Therefore, entrepreneurs who choose the net-worth-building path expect a rise in capital investment over time. This is the so-called "dissipation of capital constraints" property, previously emphasized by other studies such as Banerjee and Moll (2010) and Buera and Shin (2013).

If financing constraints are not binding in either of the two periods, then $k_1^{\mathrm{S}} = k_0^{\mathrm{S}}$, and net-worth building, although it is still present, does not lead to capital deepening over time.

For a net-worth builder, capital investment for period 0 and period 1 is pinned down by Lagrange multipliers ξ_t^{S}:

$$s_1'(k_0^{\mathrm{S}}) = \frac{\xi_0^{\mathrm{S}}}{\lambda \xi_0^{\mathrm{S}} + (1-\lambda)\xi_1^{\mathrm{S}}}, \tag{22}$$

$$s_1'(k_1^{\mathrm{S}}) = \frac{\xi_1^{\mathrm{S}}}{\lambda \xi_1^{\mathrm{S}} + (1-\lambda)\xi_2^{\mathrm{S}}}. \tag{23}$$

Note that nonbinding enforceability constraints yield $\zeta_0^{\mathrm{S}} = \zeta_1^{\mathrm{S}} = 0$, which in turn means that $\xi_0^{\mathrm{S}} = \xi_1^{\mathrm{S}} = \xi_2^{\mathrm{S}}$ for Lagrange multipliers associated with budget constraints. The unconstrained optimum capital allocation from (22) and (23) then

TABLE 1. Financial constraint status of entrepreneurs

Type-1	Type-2	Type-3
$\zeta_0^S = 0$	$\zeta_0^S > 0$	$\zeta_0^S > 0$
$\zeta_1^S = 0$	$\zeta_1^S = 0$	$\zeta_1^S > 0$

solves

$$s_1'(k_0^S) = 1, \tag{24}$$

$$s_2'(k_1^S) = 1. \tag{25}$$

When financial constraints in both periods bind, then $\xi_0^S > \xi_1^S > \xi_2^S$, and therefore

$$s_1'(k_0^S) > s_2'(k_1^S) \quad \text{and} \quad k_0^S < k_1^S.$$

Capital investment schedules for a long-term investor solve

$$\ell'(k_0^L) = \frac{\xi_0^L}{\lambda\xi_0^L + (1-\lambda)\xi_2^L}. \tag{26}$$

Similarly to a net-worth builder's optimization problem, when the financing constraint is not binding,

$$\ell'(k_0^L) = 1, \tag{27}$$

and when the financing constraint is binding,

$$\ell'(k_0^L) > 1.$$

Endogenous investment horizon. In order to understand the endogenous selection of entrepreneurs into investment types (net-worth builder vs. long-term investor), we should recognize that there are three general class of entrepreneurs in the economy. Specifically, *assuming* that all entrepreneurs choose the net-worth-building path in period 0, Table 1 categorizes entrepreneurs according to the value of their Lagrange multipliers associated with enforceability constraints:

LEMMA 2.2. *All type-1 entrepreneurs choose the long-term-investment path.*

Proof. See Appendix A. ■

Because Lagrange multipliers associated with enforceability constraints decline with an entrepreneur's net worth, types can be ranked according to entrepreneurs' initial wealth holdings. Specifically, $w_{0,\text{type}-1} > w_{0,\text{type}-2} > w_{0,\text{type}-3}$, where $w_{0,\text{type}-j}$ is the marginal period-0 net-worth holding in each type distribution,[4] with $w_{0,\text{type}-3}$ denoting the lowest period-0 net worth. Clearly, for any entrepreneur i with $w_{0,i}$ that satisfies $w_{0,\text{type}-1} < w_{0,i} < w_{0,\text{type}-2}$, the period-0 enforceability constraint binds, whereas the period-1 enforceability constraint is slack. For an entrepreneur with $w_{0,\text{type}-2} < w_{0,i}$, both period-0 and period-1 enforceability constraints are binding.

For a Type-1 entrepreneur,

$$V^{\mathrm{L}}(w_{0,\text{type}-1}) > V^{\mathrm{S}}(w_{0,\text{type}-1}),$$

and furthermore, for $w_0 > w_{0,\text{type}-1}$,

$$\frac{\partial V^{\mathrm{L}}}{\partial w_0} = \frac{\partial V^{\mathrm{S}}}{\partial w_0} = 0.$$

Using this property, I conclude the discussion on endogenous investment horizon choice with the following proposition.

PROPOSITION 2.3. *There exists an entrepreneur indexed by η with a net-worth-building investment path and initial physical endowment $w_{0,\eta} \geq 0$ such that all entrepreneurs with $w_{0,i} > w_{0,\eta}$ invest long-term, whereas all with $w_{0,i} \leq w_{0,\eta}$ build net worth.*

Proof. See Appendix A. ■

Clearly as the enforceability limit λ rises, the output in the economy expands for both net-worth builders and long-term investors. An important effect of λ on the aggregate economic performance is through the adjustment of endogenous investment horizon selection of entrepreneurs. The following proposition summarizes the investment composition effect of limited enforceability.

PROPOSITION 2.4. *Consider two countries, h and l, with identical endowment distributions, interest rates ($r = r_{\mathrm{L}} = 1$), and entrepreneurial production functions but different enforceability limits. Suppose that $\lambda^h > \lambda^l$. The critical entrepreneurs who are indifferent between net-worth building and long-term investment in these two countries can be ranked as $w^h_{0,\eta} < w^l_{0,\eta}$.*

Proof. See Appendix A. ■

The key messages that I would like to highlight from this three-period model are as follows:

1. Enforceability constraints suppress economic performance but net-worth building, if this option is present for entrepreneurs, offsets the distortionary effects of tight enforcement limits.
2. Financially poor entrepreneurs benefit the most from net-worth building.
3. The aggregate fraction of net-worth builders decreases with rising enforceability.

In the dynamic general equilibrium model of the next section, I present the importance of investment horizon choice in explaining the effects of enforceability constraints on cross-country income differences. In the quantitative analysis of Section 5, I show that the effects of better enforcement on the allocation efficiency and as a result on the per capita income can easily be overestimated when financially constrained entrepreneurs' endogenous net-worth-building response is neglected.

3. THE OVERLAPPING GENERATIONS EXTENSION WITH FIRM DYNAMICS

This section extends the three-period model into a firm life-cycle framework with three-period-lived overlapping *firms* and *financiers*. Time is indexed with t, as usual, and continues forever. In every period a continuum of risk-neutral young agents with unit mass enter the economy. The periods in an agent's life-cycle are called $youth$, $middleage$, and old. Young agents supply labor in return for a wage income, and then decide whether or not to become entrepreneurs and in which projects to specialize. The two key differences between the OLG model of this section and the three-period model from the previous section are that (a) the size of the entrepreneurial sector and (b) the preinvestment-stage aggregate endowment stock are to be determined endogenously in the general equilibrium of the economy.

3.1. Properties of the OLG Framework

There are two types of goods in the economy, *capital* and *the consumption good*. The consumption good has three uses: It can be consumed, invested in an entrepreneurial project, or stored at a periodic rate of r_{storage}. Capital, which is essential for consumption good production, is generated by entrepreneurial investment projects (short-term and long-term), which utilize the consumption good as the only factor of production. Following the specification of the three-period model, short-term investment projects are initiated by either a young or a middle-aged net-worth builder. A short-term project returns $s^J_{t,i}(k_{t-1,i})$ units of capital in period t for every $k_{t-1,i}$ units of consumption good invested in period $t-1$, where J is the youth (y) or the middle age (m) in the life-cycle of an entrepreneur i. Long-term investment projects can be started only by young entrepreneurs. A long-term project returns $\ell^y_{t,i}(k_{t-2,i})$ units of capital in period t for every $k_{t-2,i}$ units invested in period $t-2$.

Capital does not posses an intrinsic consumption value, but serves as an input for the production of the consumption good: The consumption good is produced by a constant-returns-to-scale production technology, specified as $Y_t = F(X_t, N_t)$, where X_t is the aggregate capital stock, which is an aggregation over short-term and long-term project output in period t, to be delineated later. Capital earns R_t units of return, denominated in terms of the consumption good. The labor input, N_t, is inelastically supplied by young agents each endowed with 1 unit of labor; hence, $N_t = 1$ in all time periods. The aggregate labor compensation is denoted by W_t.

Following the compensation of the labor effort, W_t, young agents decide whether to enter the entrepreneurial sector and produce capital. To capture the initial net worth heterogeneity across entrepreneurs, I assume that there exists an *idiosyncratic* fixed cost of entry to become an entrepreneur, f_i, which is drawn from a time-invariant cumulative distribution function $G(f)$ following the compensation of the labor effort. The entry cost must be covered ex ante, before specializing in an investment project. Entrepreneur i incurs the fixed cost of entry if and only if the lifetime profits from entrepreneurship are larger than f_i.

Ex post, the presence of the entry cost reduces entrepreneur-specific net-worth to $w^y_{t,i} = W_t - f_i$. Let V_i again denote the value of lifetime profits, with $V_i = \max\{V^S_i, V^L_i\}$. Then there exists a critical entrepreneur with identity μ that satisfies $V_\mu = f_\mu$ with

$$G(V_\mu) = \mu.$$

The variable μ also determines the fraction of entrepreneurs in the society.

Agents trade consumption good holdings to finance investment projects. In the financial market, the one-period interest rate—relevant for short-term investment—is denoted as r_t, whereas the two-period interest rate—relevant for long-term investment—is denoted as r^L_t. The market clearance between short-term and long-term financial markets implies that $r^L_t = r_t r_{t+1}$. Limited enforceability constraints, as specified by (1), (2), and (3), constrain the trade of financial claims, the average size of entrepreneurial investment projects, and the profitability of entrepreneurship. The profitability of entrepreneurship in turn determines the size of the entrepreneurial sector. The events within any arbitrary period t occur according to the following sequence:

1. Short-term cash-flow realization from projects started in period $t-1$,
2. Long-term cash-flow realization from projects started in period $t-2$,
3. Consumption good sector employs capital and labor and produces,
4. Compensation of suppliers of capital and labor,
5. Consumption,
6. Agent-specific entry fees are realized,
7. Entry decision of young agents,
8. Investment path decision of young agents,
9. Borrowing/lending of the consumption good,
10. Short-term project investment (by young and middle-aged agents),
11. Long-term project investment by young agents.

3.2. Distributions and the Aggregate Capital Stock

The limited enforceability determines the distributions and the aggregate capital stock produced by entrepreneurial projects. To this end, as in the three-period model, there is a critical entrepreneur η_t in every t, such that young entrepreneurs with $w^y_{t,i} \le w^y_{t,\eta_t}$ choose the net-worth-building investment path with weak contract enforceability. Furthermore, the aggregate fraction of net-worth builders decreases with a rise in the limit of enforceability. In the model calibration of Section 4, I will concentrate on parameterizations of the model satisfying Assumption 1 under perfect financial contract enforceability.

The stock of capital available for consumption good production at any t is an aggregation over the short-term and the long-term project output,

$$X_t = \int_{\mu_{t-1}}^{\eta_{t-1}} s_{t,i}^{y}(k_{t-1,i})d_i + \int_{\eta_{t-2}}^{1} \ell_{t,i}^{y}(k_{t-2,i})d_i + \int_{\mu_{t-2}}^{\eta_{t-2}} s_{t,i}^{m}(k_{t-1,i})d_i, \quad \textbf{(28)}$$

where μ_t is the time-varying identity of the critical entrepreneur who is indifferent between producing and staying as a financier.

3.3. Steady State

DEFINITION. *The dynamic general equilibrium of the economy is characterized by an infinite stream of one-period rental rates of the consumption good among entrepreneurs ($\{r_t\}_{t=0}^{\infty}$), rates of capital return ($\{R_t\}_{t=0}^{\infty}$), and wage rates ($\{W_t\}_{t=0}^{\infty}$), at which agents optimize and financial, capital, and labor markets clear.*

I am primarily interested in understanding the effects of limited contract enforcement on economic development and the implications of the availability of an investment-horizon choice for the aggregate effects of limited enforceability. Therefore, I concentrate on steady-state equilibria for the rest of the dynamic macro analysis.

Assumption 3. Short-term and long-term investment projects satisfy

$$\frac{\partial s(k)}{\partial k}\frac{k}{s(k)} = \frac{\partial \ell(k)}{\partial k}\frac{k}{\ell(k)}.$$

Assumption 3 ensures that the shares of factor income in short-term and long-term projects are equal. Specifically, if the short-term project has the functional form $s(k) = \theta_s k^{\alpha}$, this implies for the long-term project a functional form of $\ell(k) = \theta_{\ell} k^{\alpha}$. This simplification makes the distribution of entrepreneurs across investment projects tractable without affecting the qualitative features of the model.

PROPOSITION 3.1. *There exists a unique stationary equilibrium characterized by constant r, R, W for all t and a time-invariant distribution of financiers and entrepreneurs (determined by μ) and a time-invariant distribution of net-worth builders and long-term investors (determined by η).*

Proof. See Appendix A. ■

Note that because of the existence of an entrepreneurial span of control, the distribution of funds across entrepreneurs determines the capital stock in the economy. There are two important steady-state cases to consider: $r = r_{\text{storage}}$ and

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$r > r_{\text{storage}}$. In the former case an increase in resource input for any individual i, regardless of his wealth status, causes an expansion in the steady-state capital stock. For the case of $r > r_{\text{storage}}$, an increase in the resource input for i causes a contraction in resources allocated to some other individual j within the economy. The span of control implies that such reallocations improve the steady-state capital stock only if they imply a redistribution of resources from (inefficiently) large firms to small firms.

In a steady-state equilibrium with $r > r_{\text{storage}}$, entrepreneurs' demand for investable funds is high enough so that the rate of return from providing finance to entrepreneurial capital production exceeds the return from storage. When $r = r_{\text{storage}}$, the steady-state demand for finance is low, and therefore, a positive fraction of the aggregate investable funds are allocated to the storage technology. In Appendix B, I solve a parameterized version of the model. Using this framework, I show that for plausible parameter conditions that can represent the U.S. economy, the unique steady-state equilibrium implies that $r = r_{\text{storage}}$. Therefore, in the benchmark calibration of Section 4, I will assign a value for the storage technology—consistent with average return on government bonds in post-World War II data—and allow a positive fraction of the aggregate investable funds to be saved outside the capital producing sector using the storage technology.

Financial contract enforceability clearly inhibits entrepreneurial capital production and macroeconomic development. The presence of net-worth building, as I investigated in the previous section, mitigates the contraction in entrepreneurs' lifetime profits when enforcement is limited and enhances the flow of investable funds to entrepreneurs.

PROPOSITION 3.2. *(i) The steady-state wage rate W and hence the steady-state per capita income are lower, the lower the limit of enforceability. (ii) The availability of net-worth building mitigates the distortionary effects of tight enforcement constraints and generates cross-country income differences among countries with similar levels of financial enforceability.*

Proof. See Appendix A. ■

There is clear interaction between the ability to generate internal finance through net-worth building and the extent of macro-development implications of limited enforceability. The next two sections aim to quantify the importance of net-worth building for aggregate economic performance.

4. MEASUREMENT AND BENCHMARK CALIBRATION

I make functional form assumptions and calibrate the OLG model so that its steady-state equilibrium matches the key macroeconomic statistics of the U.S. economy. In Section 5, using this quantitative framework, I measure the effects of financial enforceability on firms' investment, net-worth building, and macroeconomic development.

TABLE 2. Model parameterization for the U.S. economy

Parameter	Value	Empirical motivation
Period length	5 years	To match the average lifetime of U.S. nonfinancial firms [based on Haltiwanger et al. (2013)]
α	0.9	Share of profits in the U.S. [based on Gollin (2002)]
γ	0.35	Capital share of income in the U.S. [based on Gollin (2002)]
β	0.92	Calibrated to match the fraction of entrepreneurs in the U.S. [based on Quadrini (1999)]
θ_ℓ	0.39	Calibrated to match a capital–output ratio in the private sector of 2.5 for the U.S. economy as documented in Maddison (1995)
λ	1	Perfect enforcement

I start by assuming that the entrepreneurs' capital investment projects have the following functional form:

$$s(k) = \theta_s k^\alpha, \text{ with } 0 < \alpha < 1, \tag{29}$$

$$\ell(k) = \theta_\ell k^\alpha, \tag{30}$$

and that the consumption good production sector operates via a Cobb–Douglas production technology:

$$F(X, N) = X^\gamma N^{1-\gamma} \text{ with } 0 < \gamma < 1. \tag{31}$$

I also assume that the fixed cost of entry into entrepreneurship by young agents is drawn from a cumulative distribution function,

$$G(f) = f^{1/\beta}, \tag{32}$$

with $\beta > 0$. Note when β equals 1, entrepreneurial wealth is uniformly distributed across entrepreneurs ex post entry. When β is less than 1, the ex post entry wealth distribution concentrates among poor individuals.

In addition to the financial contract enforcement limit λ, the parameter space of the model includes $\theta_s, \theta_\ell, \alpha, \gamma$, and β. As I present in Table 2, some parameters are calibrated to match aggregate statistics of the U.S. economy, whereas others are assigned with values based on the existing empirical evidence from past research.

The details of the model parameterization are as follows.

The standard three-period OLG models concerned with understanding the household's life-cycle behavior assume a period length of about 20 years. Differently from these studies, in this paper, the unit of analysis is a firm. For the U.S. economy the lifespan of nonfinancial firms, for the years between 1997 and 2012, averages around 10 years, as suggested by Haltiwanger et al. (2013). In

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my OLG model all entrepreneurs run firm projects for two periods, when middle-aged and old. Therefore, following the empirical evidence from U.S. nonfinancial firms, I choose the length of a model period to be 5 years. The capital share of income from consumption good production, γ, is chosen as 0.35 following Gollin (2002). The capital income share from investment projects, α, is equated to 0.90 so that entrepreneurs' profit share is about 10%, as suggested by Gollin (2002) and Antunes et al. (2008).

The remaining parameters to be assigned values are the productivity of short-term and long-term projects, θ_s–θ_l as a bundle, the parameter β governing the distribution of fixed cost of entry into entrepreneurial production, and finally the strength of financial contract enforceability λ. Some studies concerned with understanding the relative cross-country income effects of financial development, such as Buera and Shin (2013) and Buera et al. (2013), treat the U.S. economy as a benchmark without financial market distortions. Furthermore, the widely used World Bank Legal Rights Index (2012), capturing the quality of collateral and bankruptcy enforcement, reports an index value of 9 out of 10 for the U.S. economy. Therefore, I assign a baseline value of 1 to λ. The model is then parameterized so that with perfect financial contract enforcement all young agents who decide to enter the entrepreneurial production sector undertake long-term investment projects. Formally, when $\lambda = 1$, all individuals with

$$f_i \leq V^{\mathrm{L}} = (1-\alpha)\theta_\ell \left(\frac{\alpha\theta_\ell}{r^2}\right)^{\frac{\alpha}{1-\alpha}}$$

become entrepreneurs.

This identification strategy allows me to calibrate the two remaining model parameters, θ_ℓ and β. I choose θ_ℓ to be 0.39 and β to be 0.92 so that in the baseline (1) the capital–output ratio for the private entrepreneurial sector equals 2.5, as documented for the U.S. economy by Maddison (1995), and (2) the percentage of entrepreneurs over the total population is about 9%, matching the aggregate empirical evidence presented by Quadrini (1999).

Finally, I set the borrowing rate, r, equal to 3%, which is the average rate of annual return on U.S. government bonds in the post-World War II data. The choice of parameter values and an annual rate of return from financing of 3% then imply that in the steady state about 36% of aggregate income is invested in entrepreneurs' capital-producing projects.

The benchmark specification of the model matches the U.S. economy well along the dimensions that were calibrated (the first four statistics in Table 3), as well as an additional statistic that was not targeted: The aggregate private credit–output ratio. Data from the World Bank Development Indicators show that over the last 16 years (1997–2012), private credit as a share of aggregate income in the United States was about 1.89. The benchmark calibration produces a credit–output ratio of 2.06 for the U.S. economy.

TABLE 3. Benchmark model vs. U.S. economy

	Model	U.S. economy
Annual interest rate (%)	3	3
% of entrepreneurs (%)	9	9
Entrepreneur's profit share	10	10
Capital–output ratio	2.5	2.5
Credit–output ratio	2.06	1.89

An important remark about the benchmark specification is that I did not calibrate a parameter value for the productivity of short-term investment projects. There are two reasons for not doing this calibration: (1) It is empirically not possible to distinguish firms' "short-term project" output from "long-term project" output, and (2) the key purpose of this paper is not to estimate the productivity differences across investment projects, but to investigate when net-worth building *is* an option for the entrepreneurial sector, especially in developing countries, and what would be the impact of this in explaining cross-country income differences due to limited financial development. Therefore, in the following quantitative exercises, I assign alternative values to θ_s—relative to the benchmark productivity value of long-term projects—and study the quantitative impact of limited financial enforceability on macroeconomic development in two different scenarios: (1) An economy *with* net-worth building, and (2) an economy *without* net-worth building. The parameter choices for θ_s will be disciplined by Assumption 1: Given the period borrowing rate, for the U.S. baseline calibration there is an upper bound $\bar{\theta}_s$ thus all unconstrained entrepreneurs specialize in long-term projects only if $\theta_s \leq \bar{\theta}_s$. Therefore, I will study two cases for short-term project productivity with (i) $0 < \theta_s < \bar{\theta}_s$ and (ii) $\theta_s = 0$, which I delineate in the next section.

5. QUANTITATIVE EXERCISES

I investigate the quantitative properties of the model in explaining the income differences across nations due to cross-country variation in contract enforceability. I conduct two types of quantitative exercises: In the first quantitative analysis, I simply vary the level of financial contract enforcement of the U.S. economy and study the quantitative implications of contract enforceability for macroeconomic performance. In the second quantitative analysis, I run counterfactuals. In this latter experimental analysis, I use estimates of contract enforcement for several developed and developing countries and keep the other parameters at the U.S. level. The purpose of the counterfactual exercise is to investigate (1) what the level of U.S. output per capita would be if financial contract enforcement of the country were the same as in, for instance, in Brazil, and (2) what role firms' endogenous net-worth-building response plays in mitigating cross-country income losses due to limited contract enforceability. To this latter end, I will conduct the quantitative

TABLE 4. Quantitative effects of enforcement limits

	(a) No net-worth building $\theta_s = 0, \theta_\ell = 0.39$	(b) Net-worth building $\theta_s = 0.31, \theta_\ell = 0.39$
Baseline economy: $\lambda = 1$		
Per capita output (relative to the baseline)	1	1
% of entrepreneurs	9	9
Credit–output ratio	2.06	2.06
Capital–output ratio	2.5	2.5
% of net-worth builders	0	0
Enforcement limit $\lambda = 0.75$		
Per capita output (relative to the baseline)	0.99	0.99
% of entrepreneurs	9	9
Credit–output ratio	2.02	2.02
Capital–output ratio	2.45	2.45
% of net-worth builders	0	0
Enforcement limit $\lambda = 0.5$		
Per capita output (relative to the baseline)	0.91	0.98
% of entrepreneurs	10.5	9.7
Credit–output ratio	1.84	1.69
Capital–output ratio	2.38	2.92
% of net-worth builders	0	100
Enforcement limit $\lambda = 0.25$		
Per capita output (relative to the baseline)	0.70	0.89
% of entrepreneurs	9.3	9.6
Credit–output ratio	1.53	1.13
Capital–output ratio	2.23	2.86
% of net-worth builders	0	100
Enforcement limit $\lambda = 0$		
Per capita output (relative to the baseline)	0.22	0.69
% of entrepreneurs	3.0	8.4
Credit–output ratio	0	0
Capital–output ratio	1.74	2.70
% of net-worth builders	0	100

Note: Per capita output is measured as the steady state per capita output produced by the consumption good sector.

exercises in two alternative environments: (1) An economy suitable for net-worth building ($0 < \theta_s < \bar{\theta}_s$, $\bar{\theta}_s$ as defined previously) and (2) an economy where net-worth building is not possible ($\theta_s = 0$).

5.1. Aggregate Implications of Contract Enforceability

Table 4 presents the quantitative implications of financial contract enforceability for a set of key macroeconomic development indicators: Consumption good output per capita (relative to the baseline), credit–output ratio and capital–output ratio in

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the entrepreneurial sector, the share of entrepreneurs in the population, and the share of net-worth builders in the entrepreneurial sector.

To investigate the contribution of net-worth building to explaining the enforcement–development nexus, I consider two model specifications: A no-net-worth-building model—as presented in column (a) of Table 4—and a net-worth-building model—as presented in column (b) of Table 4. In the no-net-worth-building model, the productivity of short-term projects, θ_s, is set equal to zero, and hence, all entrepreneurs operate using the long-term-investment path. In the model with net-worth building, the productivity of short-term projects is chosen as 0.31. I assign this value to the short-term project productivity because the value of θ_s that makes financially unconstrained entrepreneurs indifferent between long-term investment and net-worth building in the U.S. benchmark equals 0.32. Therefore, $\theta_s = 0$ and $\theta_s = 0.31$ characterize the two extreme cases that are relevant for my analysis.

In Table 4, I vary the financial contract enforcement limit between $\lambda = 1$ and $\lambda = 0$. The fraction of net-worth builders in the entrepreneurial sector remains at 0% when λ is high enough to make long-term investment profitable for all entrepreneurs. Specifically, when $\lambda = 0.75$, as in the baseline model with $\lambda = 1$, all entrepreneurs choose the long-term-investment path even when a highly productive net-worth-building investment path is available to them with ($\theta_s = 0.31$, $\theta_\ell = 0.39$). Therefore, as the limit of financial contract enforcement λ declines from the benchmark value of 1 to $\lambda = 0.75$, the *consumption good* output per capita contracts. And the contractions in output per capita are by exactly the same proportion in both models, because in both model specifications all entrepreneurs invest long-term. When $\lambda = 0.5$ or lower, all entrepreneurs engage in net-worth building to offset the distortionary effects of limited contract enforcement. Therefore, for these low levels of λ, the contraction in output per capita is much more severe when net-worth building is not an option for the entrepreneurial sector ($\theta_s = 0$). For example, when contract enforcement shrinks to 0.25, the per-capita output contracts to 70% of the baseline per capita output value in the model specification without net-worth building. The presence of net-worth building, $\theta_s = 0.31$, mitigates the effects of limited contract enforcement by quantitatively significant proportions, so that with $\lambda = 0.25$ the output per capita decreases only to 89% of the baseline level in the model with net-worth-building opportunity.

The ratio between the credit and the output in the entrepreneurial sector declines with contractions in the financial contract enforceability as well. The key difference between the two models regarding this variable is that overall the credit–output ratio is lower in the model with net-worth building. This result is driven by the larger entrepreneurial consumption-good holdings enabled by the endogenous net-worth-building property. For the same underlying reason—that the entrepreneurs generate their own internal finance when λ is low—in the model with net-worth building the capital–output ratio in the entrepreneurial sector first declines (when $\lambda = 1$ goes down to $\lambda = 0.75$) and then increases (as $\lambda = 0.5$ goes down to $\lambda = 0.25$). Without net-worth building, the capital–output ratio decreases monotonically as the contract enforcement limit declines.

In both specifications of the model, as long as λ is greater than or equal to 0.25, the fraction of entrepreneurs remains around 9–10% of the entire population. The stability of the population size of the entrepreneurial sector with respect to variation in λ is a quite intuitive outcome. Low financial enforceability constrains borrowing and the profitability of entrepreneurship and reduces the flow into entrepreneurship. However, at the same time, in countries with weak enforceability, aggregate capital production is low, which increases the rate of return from entrepreneurship and fosters the flow into entrepreneurship. This theoretical as well as quantitative property of my model can be confronted with the cross-country empirical evidence concerning the relationship between development and entrepreneurship. For example, among others, in a seminal work, De Soto (2000) argues that the developing countries do not necessarily have a smaller supply of entrepreneurs than the industrialized countries. Barriers to entrepreneurial finance and business growth are where developed and developing countries differ from each other—as I also emphasize in this paper.

Next, I move on to investigating the cross-country income differences that variations in financial contract enforceability can explain and the potential effects of net-worth building in reducing the income discrepancies between nations that could be attributed to limited contract enforceability.

5.2. Counterfactual Experiments with Contract Enforceability

In this section, I use estimates of financial contract enforcement limits for several countries, keep the remaining parameters at the U.S. baseline level, and study counterfactual policy experiments. The purpose of this inquiry is to examine (1) what fraction of actual cross-country income differences contract enforcement could explain, and (2) by what percentage, relative to the actual output difference, firms' net-worth building behavior mitigates the distortionary effects of limited contract enforceability. I conduct the counterfactual experiments for a number of OECD economies and African, Latin American, and Asian countries. I constrain my discussion to the counterfactuals from a set of representative countries from each region: Brazil, Mexico, Turkey, Cameroon, and South Korea. However, results for a larger set of countries are also available in Tables 5–9.

I estimate the financial contract enforcement limits using the World Bank's Legal Rights Index (2012). The Legal Rights Index measures the strength of collateral and bankruptcy laws[5] and it is available for the period between 2003 and 2012. Following the methodology of Antunes et al. (2008), to determine the parameter estimate of λ for each country, I multiply the ratio of a country's legal rights index—averaged over 2003–2012—to the average legal rights index of the United States over the same time period by the U.S. baseline financial contract enforceability ($\lambda = 1$). Table 5 presents the average Legal Rights Index of each country and the estimated financial contract enforcement limits. The estimates of

TABLE 5. Legal rights index and estimates of enforceability

	Legal rights index	Estimate of λ
United States	9	1
OECD		
France	6.2	0.69
Germany	7.5	0.83
Greece	4	0.44
Portugal	3	0.33
Spain	6	0.67
Turkey	4	0.44
African countries		
Angola	3	0.33
Cameroon	3.67	0.41
Egypt	3	0.33
Ghana	7	0.78
Madagascar	2	0.22
Uganda	7	0.78
Latin American countries		
Argentina	4	0.44
Bolivia	1	0.11
Brazil	3	0.33
Chile	4.44	0.49
Ecuador	3	0.33
Mexico	5.22	0.58
Asian countries		
China	5	0.56
Indonesia	3	0.33
Philippines	4	0.44
Singapore	10	1.11
South Korea	8	0.89
Thailand	5	0.56

Notes: The strength of legal rights index "measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending." Furthermore, "the index ranges from 0 to 10, with higher scores indicating that these laws are better designed to expand access to credit." The legal rights index of each country is an average over the period 2003–2012. The estimate of λ is computed as the value of a country's legal rights index relative to the legal rights of the United States, with baseline $\lambda = 1$.

λ exhibit a large cross-country variation: For instance, countries such as Germany, South Korea, and Ghana obtained high values of the Legal Rights Index over the last 10 years, and therefore, the λ estimates are all above 0.75 for these countries. Turkey, Cameroon, and Chile have intermediate levels of the reported Legal Rights Iindex and the resulting λ estimates for these countries vary between 0.44 and 0.49. Finally, Angola, Bolivia, and Indonesia were assigned relatively low Legal Rights Indices, resulting in λ estimates of 0.33 or below.

The results from the counterfactual policy experiments are organized as follows in Tables 6–9: Column (a) documents the World Bank reports of per capita output—relative to the United States—and the credit-to-output ratio for each country averaged over the time period 1997–2012. Columns (b) and (c) present the macro-development implications of replacing the $\lambda = 1$ from the U.S. baseline calibration with each country's respective enforcement limit for the two model specifications (the no-net-worth-building model in column (b) and the net-worth-building model in column (c)). I study the effects of λ on four macro indicators: Per capita output relative to the baseline, the population share of entrepreneurs, the credit–output ratio, and the fraction of net-worth builders in the entrepreneurial sector. Each panel contains a group of OECD, African, Latin American, and Asian countries. The countries are ordered in panels according to the estimates of their financial enforcement limits.

As already pointed out in the previous section, a comparison of the counterfactual exercises reported in columns (b) and (c) of Tables 6–9 shows that the cross-country income differences attributed to weak financial contract enforcement limits are quantitatively higher in the absence of net-worth building. Specifically, for example, if the financial contract enforcement limit of the United States were to be lowered to the level of Brazil ($\lambda = 0.33$), the per capita income would shrink to 77 % of the baseline value if net-worth building were not an option for the entrepreneurial sector. With net-worth building, the per capita output shrinks only to 92% of its baseline value—as all entrepreneurs sort into the net-worth-building path when λ is as low as 0.33. These numbers imply the following: The per capita output of Brazil over the last 16 years averaged around 15% of the U.S. per capita income. The model without entrepreneurial net-worth building attributes about 27% of this income difference to limited financial enforceability in Brazil. The model with net-worth building predicts that only 9% of the per capita income difference between Brazil and the United States can be accounted for by contract enforceability differences. For the case of the Brazilian counterfactual, 100% of the entrepreneurs exploit the net-worth-building investment when net-worth building via productive short-term projects is available to them. Therefore, it would be instructive to discuss a counterfactual analysis where positive fractions of entrepreneurs choose long-term and net-worth-building investment paths. In this respect, for instance, if the financial contract enforcement of the United States were to be lowered to the level of Mexico ($\lambda = 0.58$), in the net-worth-building model 37% of the entrepreneurs would choose the long-term- investment path, whereas the remaining 63% of them would go for the net-worth-building investment path. The net-worth-building model attributes only a 1% of the *actual* income difference between the United States and Mexico to the differences in enforcement limits. The no-net-worth-building model suggests that 7% of the actual income difference between the two countries can be explained by limited contract enforceability.

Similar quantitative implications of net-worth building can be observed for Turkey and Cameroon as well: Ignoring the endogenous net-worth-building response of financially constrained entrepreneurs could cause a threefold

TABLE 6. Counterfactual experiments with λ (OECD)

	(a) Data	(b) Model with $\theta_s = 0$, $\theta_\ell = 0.39$	(c) Model with $\theta_s = 0.31$, $\theta_\ell = 0.39$
Germany ($\lambda = 0.83$)			
Per capita output (relative to U.S.)	0.81		
Credit–output ratio	1.12		
Per capita output (relative to the baseline)		0.99	0.99
Entrepreneurs (%)		9	9
Credit–output ratio		2.05	2.05
Net-worth builders (%)		0	0
France ($\lambda = 0.69$)			
Per capita output (relative to U.S.)	0.79		
Credit–output ratio	0.99		
Per capita output (relative to the baseline)		0.99	0.99
Entrepreneurs (%)		9.3	9.3
Credit–output ratio		2.01	2.01
Net-worth builders (%)		0	0
Spain ($\lambda = 0.67$)			
Per capita output (relative to U.S.)	0.58		
Credit–output ratio	1.50		
Per capita output (relative to the baseline)		0.98	0.98
Entrepreneurs (%)		9.4	9.4
Credit–output ratio		2.00	2.00
Net-worth builders (%)		0	0
Greece ($\lambda = 0.44$)			
Per capita output (relative to U.S.)	0.49		
Credit–output ratio	0.79		
Per capita output (relative to the baseline)		0.87	0.96
Entrepreneurs (%)		8.7	9
Credit–output ratio		1.78	1.60
Net-worth builders (%)		0	100
Turkey ($\lambda = 0.44$)			
Per capita output (relative to U.S.)	0.16		
Credit-output ratio	0.27		
Per capita output (relative to the baseline)		0.87	0.96
Entrepreneurs (%)		10.5	9
Credit–output ratio		1.78	1.60
Net-worth builders (%)		0	100
Portugal ($\lambda = 0.33$)			
Per capita output (relative to U.S.)	0.42		
Credit–output ratio	1.50		
Per capita output (relative to the baseline)		0.77	0.92
Entrepreneurs (%)		10.0	9.5
Credit–output ratio		1.64	1.34
Net-worth builders (%)		0	100

Notes: Per capita output (relative to the United States) is in real terms and is computed as an average over the period 1997–2012. Credit–output ratio is the average "financial resources provided to the private sector—as a fraction of the aggregate GDP—such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment" over the period of 1997–2012. Both variables are computed using World Bank Data.

TABLE 7. Counterfactual experiments with λ (African countries)

	(a) Data	(b) Model with $\theta_s = 0$, $\theta_\ell = 0.39$	(c) Model with $\theta_s = 0.31$, $\theta_\ell = 0.39$
Ghana ($\lambda = 0.78$)			
Per capita output (relative to U.S.)	0.02		
Credit–output ratio	0.13		
Per capita output (relative to the baseline)		0.99	0.99
Entrepreneurs (%)		9	9
Credit–output ratio		2.04	2.04
Net-worth builders (%)		0	0
Uganda ($\lambda = 0.78$)			
Per capita output (relative to U.S.)	0.01		
Credit–output ratio	0.10		
Per capita output (relative to the baseline)		0.99	0.99
Entrepreneurs (%)		9	9
Credit–output ratio		2.04	2.04
Net-worth builders (%)		0	0
Cameroon ($\lambda = 0.41$)			
Per capita output (relative to U.S.)	0.02		
Credit–output ratio	0.10		
Per capita output (relative to the baseline)		0.84	0.95
Entrepreneurs (%)		10.5	9.2
Credit–output ratio		1.74	1.53
Net-worth builders (%)		0	100
Angola ($\lambda = 0.33$)			
Per capita output (relative to U.S.)	0.06		
Credit–output ratio	0.11		
Per capita output (relative to the baseline)		0.77	0.92
Entrepreneurs (%)		10	9.5
Credit–output ratio		1.64	1.33
Net-worth builders (%)		0	100
Egypt ($\lambda = 0.33$)			
Per capita output (relative to U.S.)	0.04		
Credit–output ratio	0.45		
Per capita output (relative to the baseline)		0.77	0.92
Entrepreneurs (%)		10	9.5
Credit–output ratio		1.64	1.33
Net-worth builders (%)		0	100
Madagascar ($\lambda = 0.22$)			
Per capita output (relative to U.S.)	0.01		
Credit–output ratio	0.09		
Per capita output (relative to the baseline)		0.67	0.87
Entrepreneurs (%)		9	9.6
Credit–output ratio		1.46	1.05
Net-worth builders (%)		0	100

Note: See Notes to Table 6.

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TABLE 8. Counterfactual experiments with λ (Latin American countries)

	(a) Data	(b) Model with $\theta_s = 0$, $\theta_\ell = 0.39$	(c) Model with $\theta_s = 0.31$, $\theta_\ell = 0.39$
Mexico ($\lambda = 0.58$)			
Per capita output (relative to U.S.)	0.18		
Credit–output ratio	0.21		
Per capita output (relative to the baseline)		0.94	99
Entrepreneurs (%)		10	9.3
Credit–output ratio		1.91	1.74
Net-worth builders (%)		0	63
Chile ($\lambda = 0.49$)			
Per capita output (relative to U.S.)	0.20		
Credit–output ratio	0.74		
Per capita output (relative to the baseline)		0.89	0.97
Entrepreneurs (%)		10.5	9.8
Credit–output ratio		1.82	1.65
Net-worth builders (%)		0	100
Argentina ($\lambda = 0.44$)			
Per capita output (relative to U.S.)	0.17		
Credit–output ratio	0.16		
Per capita output (relative to the baseline)		0.87	0.96
Entrepreneurs (%)		10.5	9
Credit–output ratio		1.78	1.60
Net-worth builders (%)		0	100
Brazil ($\lambda = 0.33$)			
Per capita output (relative to U.S.)	0.15		
Credit–output ratio	0.41		
Per capita output (relative to the baseline)		0.77	0.92
Entrepreneurs (%)		10	9.5
Credit–output ratio		1.64	1.33
Net-worth builders (%)		0	100
Ecuador ($\lambda = 0.33$)			
Per capita output (relative to U.S.)	0.13		
Credit–output ratio	0.22		
Per capita output (relative to the baseline)		0.77	0.92
Entrepreneurs (%)		10	9.5
Credit–output ratio		1.64	1.33
Net-worth builders (%)		0	100
Bolivia ($\lambda = 0.11$)			
Per capita output (relative to U.S.)	0.03		
Credit–output ratio	0.47		
Per capita output (relative to the baseline)		0.54	0.79
Entrepreneurs (%)		7.4	9.1
Credit–output ratio		1.22	0.63
Net-worth builders (%)		0	100

Note: See Notes to Table 6.

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TABLE 9. Counterfactual experiments with λ (Asian countries)

	(a) Data	(b) Model with $\theta_s = 0$, $\theta_\ell = 0.39$	(c) Model with $\theta_s = 0.31$, $\theta_\ell = 0.39$
Singapore ($\lambda = 1$)			
Per capita output (relative to U.S.)	0.77		
Credit–output ratio	1.02		
Per capita output (relative to the baseline)		1	1
Entrepreneurs (%)		9	9
Credit–output ratio		2.06	2.06
Net-worth builders (%)		0	0
South Korea ($\lambda = 0.89$)			
Per capita output (relative to U.S.)	0.39		
Credit–output ratio	1.24		
Per capita output (relative to the baseline)		0.99	0.99
Entrepreneurs (%)		9	9
Credit–output ratio		2.06	2.06
Net-worth builders (%)		0	0
China ($\lambda = 0.56$)			
Per capita output (relative to U.S.)	0.06		
Credit–output ratio	1.17		
Per capita output (relative to the baseline)		0.94	0.98
Entrepreneurs (%)		10.2	9.7
Credit–output ratio		1.90	1.67
Net-worth builders (%)		0	98
Thailand ($\lambda = 0.56$)			
Per capita output (relative to U.S.)	0.08		
Credit–output ratio	1.17		
Per capita output (relative to the baseline)		0.94	0.98
Entrepreneurs (%)		10.2	9.7
Credit–output ratio		1.90	1.67
Net-worth builders (%)		0	98
Philippines ($\lambda = 0.44$)			
Per capita output (relative to U.S.)	0.04		
Credit–output ratio	0.33		
Per capita output (relative to the baseline)		0.87	0.96
Entrepreneurs (%)		10.5	9
Credit–output ratio		1.78	1.60
Net-worth builders (%)		0	100
Indonesia ($\lambda = 0.33$)			
Per capita output (relative to U.S.)	0.04		
Credit–output ratio	0.27		
Per capita output (relative to the baseline)		0.77	0.92
Entrepreneurs (%)		10	9.5
Credit–output ratio		1.64	1.33
Net-worth builders (%)		0	100

Note: See Notes to Table 6.

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overestimation of the cross-country income difference between the United States and Turkey, as well as between the United States and Cameroon, that can be accounted for by limited enforceability.

An interesting special case to consider is South Korea. South Korea has a high contract enforcement limit with $\lambda = 0.89$. As also emphasized in the previous section, when λ takes such a high value, all entrepreneurs, regardless of their initial net worth, invest long-term. Therefore, both specifications of the model attribute about 1–2% of the cross-country income difference between the United States and South Korea to limited enforceability.

Concentrating on the income variation within each country group, the no-net-worth-building model attributes 36% of the income variation among OECD countries, 650% of the income variation among African countries, 91% of the income variation among Latin American countries, and finally 29% of the income variation among Asian countries to discrepancies in financial enforcement limits. The net-worth-building model, on the other hand, accounts for only 10% of the income variation among OECD countries, 236% of the income variation among African countries, 50% of the income variation among Latin American countries, and finally 10% of the income variation among Asian countries by discrepancies in financial enforcement limits.

Finally, the model with the net-worth-building feature fits the cross-country variation in private credit–output ratio somewhat better than the model without net-worth building. The no-net-worth-building model overestimates the credit–output ratio by significantly larger proportions: For example, for Latin American countries, the average[6] credit–output ratio is about 0.3. The no-net-worth-building model predicts an average credit–output ratio of 1.61, whereas the average credit–output ratio estimate of the net-worth-building model is 1.38. I would like to note that both models mostly overestimate the credit–output ratio, except for the case of the United States. A potential explanation for this pattern could be related to non-enforcement-related financial frictions, such as financial market transaction taxes, intermediation costs, or inflation, that suppress the aggregate credit available—especially in developing countries. Because I do not model such additional dimensions of financial market imperfections, the cross-country credit–output ratio estimates from both model specifications exceed the credit–output ratio observed in the cross-country data.

6. TECHNOLOGY GROWTH AND FINANCIAL MARKETS

The model produces an interaction between the limit of financial contract enforceability and appropriate technology growth and assigns an interesting role to financial market imperfections in explaining global technology diffusion patterns. To illustrate this property of the model, consider two countries—A and B—sharing an identical project productivity bundle, $\Theta = \{\theta_s, \theta_\ell\}$. Suppose that Assumption 1 holds between θ_ℓ and θ_s and also that $\theta_s > 0$.

There are two productivity development options—uniformly available to both A and B—specified as $\Theta'_\ell = \{\theta_s, (1+\tau)\theta_\ell\}$ and $\Theta'_s = \{(1+\tau)\theta_s, \theta_\ell\}$ with $\tau > 0$. Furthermore, suppose that A is a financially developed country with high contract enforceability, and without loss of generality assume that $\lambda_A = 1$. In contrast, contract enforceability is limited in B, with $\lambda_B < 1$. In country A, by construction of the model, all entrepreneurs choose the long-term-investment path. Therefore, the Θ'_ℓ is the suitable productivity growth plan there.

If country B's enforceability limit is low enough, then a positive measure of entrepreneurs engage in net-worth building in the steady-state equilibrium. My quantitative analysis reveals that in a country with λ less than 0.56, all entrepreneurs are net-worth builders. In such a financially constrained country, entrepreneurial profitability and aggregate economic performance are likely to increase relatively more with a Θ'_s type of growth plan.

This theoretical corollary of the model suggests that there could be a slow diffusion of production techniques from developed to developing countries. Many studies in the past considered the slow acquisition of technology from abroad by developing countries as a *barrier* to riches. For example, Mokyr (1990) proposes that the lack of resistance against foreign technology adoption explains many growth successes throughout the history and all around the world. Among others, Caselli (1999), Chen et al. (2002), Fernandes and Kumar (2007), and Cole et al. (2012) suggest various forms of technology acquisition costs and technology appropriateness that can inhibit technology flows from developed to developing countries and widen the per capita income differences across nations.

My analysis in this paper suggests a different perspective. Even in the absence of costly technology acquisition, the adoption of modern production technologies that are advanced in financially developed countries does not necessarily stimulate the aggregate productivity levels in financially less developed countries. Financial development could be a determinant of technology appropriateness. Therefore, government policies that tend to stimulate technology adoption from abroad should take into account the extent of financial market imperfections in developing countries. I leave a detailed qualitative as well as quantitative analysis of limited contract enforceability on technology adoption to future research.

In the quantitative exercise I considered two extreme cases for the (θ_s, θ_ℓ) bundle in order to measure the potential impact of the capacity to build net worth on mitigating the aggregate effects of contract enforceability. The productivity bundle could be calibrated as well, using data from financially unconstrained firms. For instance, the frequency of a firm's cash flows (scaled by total assets) is an indication of whether a firm operates on short- or long-term horizons, and productivity over each investment horizon can be aggregated across firms to measure the aggregate short-term and long-term productivity of investment projects.

With cross-country information to measure (θ_s, θ_ℓ) for a sample of countries, the gap between long-term and short-term productivity $(\theta_\ell - \theta_s)$ is expected to be smaller in financially less developed economies, as in such countries the fraction of financially constrained economies is higher, which in turn increases the demand for innovation and adoption of technologies that benefit short-term productivity growth, as I delineated in this section. Therefore, the measured impact of net-worth building in mitigating limited enforcement frictions in financially less developed societies could be substantial. A full-fledged empirical estimation of the cross-country differences in $(\theta_\ell - \theta_s)$ I leave to future work.

7. CONCLUSION

I developed a firm dynamics model with entrepreneurial net-worth building and investigated the effects of financial contract enforcement on macroeconomic development. At the firm level, in the steady-state equilibrium of this model, financially constrained entrepreneurs select short-term investment projects because short-term investment enhances net-worth building and relaxes credit constraints. In the aggregate level, limited contract enforceability suppresses the steady-state per capita output; however, entrepreneurs' endogenous net-worth-building response offsets the per capita income losses.

I calibrated the steady state of the model for the U.S. economy as a baseline and conducted quantitative exercises with (a) systematic variations in enforcement limits and (b) counterfactual policy experiments by exploiting actual cross-country differences in enforceability. Systematic variations in enforcement show that lowering the strength of financial contract enforcement of the U.S. economy, for instance, by 50% could lower the steady-state per capita output by 9% in the absence of entrepreneurial net-worth building. With endogenous net-worth building, the contraction in per capita output would be only by 1%. The counterfactual simulations show that in the absence of endogenous net-worth building, 27% of the per capita income difference, for instance, between Brazil and the United States could be explained by the enforceability differences in these two countries. If financially constrained entrepreneurs are allowed to build net worth as a response to limited financial enforceability, the per capita income difference between Brazil and the United States that can be accounted by enforceability differences would only be 9%.

The theoretical and quantitative predictions of the model are important for understanding the development implications of financial market imperfections. In this respect, the key argument of the paper is that financial constraints could sort entrepreneurs into different production opportunities, which in turn alters the macroeconomic effects of financial imperfections by quantitatively significant proportions. The model also generates an interesting complementarity between optimal technology growth plans and finance. Depending on the distribution of the constrained and unconstrained firms in an economy, technology growth plans that raise the productivity of short-term projects could be beneficial in financially less developed countries, whereas long-term productivity growth plans could benefit macroeconomic performance in financially developed countries. Hence, policies that aim to stimulate technology adoption from abroad might need to take into

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account the extent of financial market imperfections in developing countries. I leave a detailed investigation of this to future research.

NOTES

1. For example, Johnson et al. (1999) and Beck et al. (2008) provide survey evidence for the negative impact of contract enforcement limitations on external credit.

2. The seminal works on misallocation and aggregate economic performance are Restuccia and Rogerson (2008) and Hsieh and Klenow (2013).

3. Constraints 5–9 take $r = 1$ as specified previously.

4. Assuming that there exists an entrepreneur indexed by type $-$ 1 with $w_{0,\text{type}-1}$ who is financially unconstrained at the margin within the distribution of all entrepreneurs.

5. The Legal Rights Index varies between 0 and 10, with higher values indicating a stronger institutional environment.

6. The simple average of credit–output ratio for the six Latin American countries in the sample.

7. Figure A.1 draws the value functions and the investment horizon choice of entrepreneurs for the relevant two cases.

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APPENDIX A. PROOFS

A.1. PROOF OF PROPOSITION 2.1

(i) Suppose the enforceability constraint (1) is binding, and both $c_0 > 0$ and $c_1 > 0$ at the same time. The binding enforceability constraint in period 0 implies (from the complementary slackness condition) that $\zeta_0^S > 0$. Furthermore, complementary slackness

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conditions associated with positive consumption yield

$$\vartheta^{S}_{c,0} = \vartheta^{S}_{c,1} = 0.$$

Thus, from (16) and (17), we get $\xi^{S}_{0} = \xi^{S}_{1} = 1$. Using this condition in (20) provides $\zeta^{S}_{0} = 0$, a contradiction.

The proof of part (ii) follows from the same line of thought. ■

A.2. PROOF OF LEMMA 2.2

The result follows from Assumption 1. Specifically, defining k^{S*}_{0} and k^{S*}_{1} as the optimum capital investment that solves (24) and (25), and k^{L*}_{0} as the optimum capital that solves (27), Assumption 2 implies that $V^{L}(k^{L*}_{0}) > V^{S}(k^{S*}_{0}, k^{S*}_{1})$. ■

A.3. PROOF OF PROPOSITION 2.3

To prove the statement of the proposition, we need to show that the ratio $\frac{V^{L}}{V^{S}}$ is an increasing function of w_0 for type-2 and type-3 entrepreneurs. For type-2 entrepreneurs, note that there could be a critical entrepreneur indexed with η within the type-2 distribution of entrepreneurs ($w_{0,\text{type}-1} < w_{0,\eta} < w_{0,\text{type}-2}$) only if $\zeta^{L}_{1,\eta} > 0$, because if $\zeta^{L}_{1,\eta} = 0$, then all type-2 entrepreneurs will select the long-term-investment path to exploit the productive advantage of long-term investment. Defining $\pi_t(k^{J}_{t-1})$ as entrepreneurial profits from periodic investment projects, the value of long-term investment exceeds that of the net-worth building path for a type-2 entrepreneur if and only if

$$\underbrace{\frac{\partial \pi_1(k^{S}_{0})}{\partial w_0} + \underbrace{\frac{\partial \pi_2(k^{S}_{1})}{\partial w_0}}_{=0}}_{\partial V^{S}/\partial w_0} < \underbrace{\frac{\partial \pi_1(k^{L}_{0})}{\partial w_0}}_{\partial V^{L}/\partial w_0}. \tag{A.1}$$

Both the left-hand side (LHS) and the right-hand side (RHS) of (A.1) are positive. Therefore, V^{S} and V^{L} are monotonically increasing in w_0.

If the critical entrepreneur η is a type-3 entrepreneur, the value of long-term investment exceeds that of net-worth building if and only if

$$\underbrace{\frac{\partial \pi_2(k^{S}_{1})}{\partial w_1}\frac{\partial w_1(k^{S}_{0})}{\partial w_0} + \frac{\partial \pi_1(k^{S}_{0})}{\partial w_0}}_{\partial V^{S}/\partial w_0} < \underbrace{\frac{\partial \pi_1(k^{L}_{0})}{\partial w_0}}_{\partial V^{L}/\partial w_0}. \tag{A.2}$$

Again, both the LHS and RHS of (A.2) are positive. There are two subcases that deserve attention: (i) $V^{L}(w_{0,\text{type}-3}) > V^{S}(w_{0,\text{type}-3})$, and (ii) $V^{S}(w_{0,\text{type}-3}) > V^{L}(w_{0,\text{type}-3})$, where $w_{0,\text{type}-3}$ is the poorest entrepreneur in the economy. Consider case (i) first. Because both the V^{S} and the V^{L} are monotonically increasing, and the same is true for value functions associated with type-2 entrepreneurs, and because $V^{\mathrm{L}}(w_{0,\text{type}-1}) > V^{\mathrm{S}}(w_{0,\text{type}-1})$ by Lemma 2.2, then for all entrepreneurs, (A.1) and (A.2) hold and $V^{\mathrm{L}}(w_{0,i}) > V^{\mathrm{S}}(w_{0,i})$. Therefore, $w_{0,\text{type}-3} = w_{0,\eta}$. Consider now case (ii). Given the monotonicity conditions described previoiusly, there exists a $w_{0,\eta} > w_{0,\text{type}-3}$ such that all entrepreneurs with $w_{0,i} \geq w_{0,\eta}$ choose the long-term-investment path.[7] ■

A.4. PROOF OF PROPOSITION 2.4

Note that the claim of the proposition trivially holds if $V^{\mathrm{L}}(w^l_{0,\text{type}-3}) > V^{\mathrm{S}}(w^l_{0,\text{type}-3})$, where $w^l_{0,\text{type}-3}$ is the poorest entrepreneur in country l. If $V^{\mathrm{L}}(w^l_{0,\text{type}-3}) < V^{\mathrm{S}}(w^l_{0,\text{type}-3})$, then by Proposition 2.3 there exists an entrepreneur η with $w^l_{0,\eta} > w^l_{0,\text{type}-3}$ who is indifferent between net-worth building and long-term investment. Suppose η undertakes the net-worth-building path. A rise in λ stimulates entrepreneur η's borrowing capacity, which could also be sustained by increasing his initial wealth holdings. Because any borrower with $w_{0,i} > w_{0,\eta}$ is a long-term investor, then as a response to a rise in λ, the entrepreneur η should switch to the long-term-investment path, which implies the claim of the proposition. ■

A.5. PROOF OF PROPOSITION 3.1

(i) Existence. Existence is implied by the CRS property of the consumption good production function: The return on capital investment, R_t, equals $F'(X_t)$, which is a decreasing function of X. The return from entrepreneurial capital finance cannot be lower than r_{storage} (the return on the storage technology). Therefore, there exists a stationary equilibrium with $F'(X) = R$, where X is the steady-state level of capital stock per worker.

(ii) Uniqueness. The three-period model showed that for any distribution of initial entrepreneurial wealth, there exists a critical entrepreneur η who determines the distribution of entrepreneurs as net-worth builders and long-term investors. Therefore, a unique stationary wage rate implies the uniqueness of the aggregate distribution of entrepreneurs and the aggregate capital stock. The stationary wage rate (W) satisfies $W(X) = (1-\gamma)F(X)$, where γ is the share of capital in consumption production. The aggregate wage bill of the young is invested in capital production as long as the return from investment is greater than the return on storage technology. In addition to this, middle-aged entrepreneurs' short-term capital return is reinvested in short-term projects as well. Denote the aggregate short-term output return to middle-aged entrepreneurs in a steady-state by $S(x)$, where

$$S(X) = F'(X)\int_{\mu}^{\eta} s_i^y(k_{y,i})d_i,$$

and the aggregate investable funds available for capital investment projects as $A(X) = W(X) + S(X)$ with $A'(X) > 0$ and $A''(X) < 0$. The aggregate capital production in a steady state is

$$X = \int_{\mu<i<\eta} s_i^y[A(X)\kappa^y_{s,i}]d_i + \int_{i>\eta} \ell_i^y[A(X)\kappa^y_{\ell,i}]d_i + \int_{\mu<i<\eta} s_i^m[A(X)\kappa^m_{s,i}]d_i,$$

where $\kappa^{\tau}_{j,i} \in (0,1)$ is the fraction of resources allocated to entrepreneur i in a steady state. There are no secondary markets in this current framework; therefore, the output of

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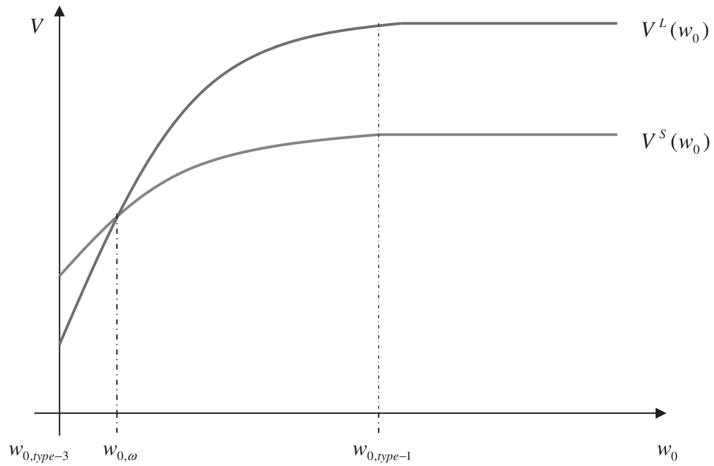
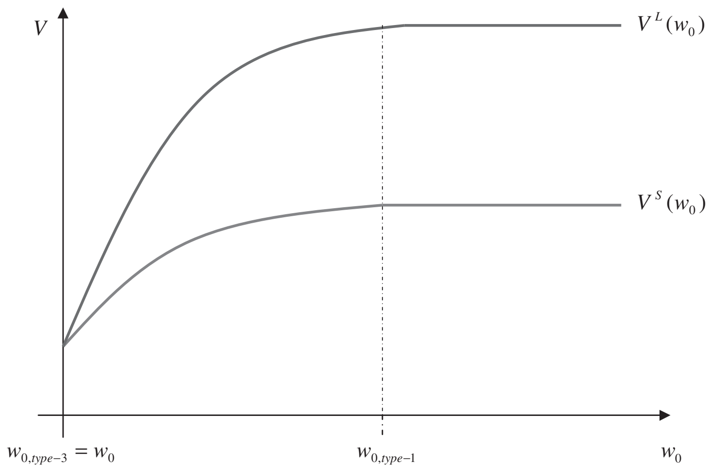


Case 1: Some Net-Worth Building



Case 2: No Net-Worth Building

FIGURE A.1. Value of investment and entrepreneur's wealth.

short-term projects, $S(X)$, can only be re invested in short-term projects. This implies that the aggregate demand for long-term capital investment in a steady state should satisfy

$$W(X) \geq \int_{i>\eta} \ell_i^y [A(X)\kappa_{\ell,i}^y] d_i.$$

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Note that if the implied steady-state r is greater than the return on storage technology (r_{storage}), then

$$\int_{\mu<i<\eta} \kappa^{y}_{s,i} d_i + \int_{i>\eta} \kappa^{y}_{\ell,i} d_i + \int_{\mu<i<\eta} \kappa^{m}_{s,i} d_i = 1.$$

Following Assumption 3, suppose that $s(k) = \theta_s k^\alpha$ and $\ell(k) = \theta_\ell k^\alpha$; then

$$X = [A(X)]^\alpha \left[\theta_s \int_{\mu<i<\eta} (\kappa^{y}_{s,i})^\alpha d_i + \theta_\ell \int_{i>\eta} (\kappa^{y}_{\ell,i})^\alpha d_i + \theta_s \int_{\mu<i<\eta} (\kappa^{m}_{s,i})^\alpha d_i \right].$$

The steady-state capital stock, X, then satisfies

$$[A(X)]^\alpha \left[\theta_s \int_{\mu<i<\eta} (\kappa^{y}_{s,i})^\alpha d_i + \theta_\ell \int_{i>\eta} (\kappa^{y}_{\ell,i})^\alpha d_i + \theta_s \int_{\mu<i<\eta} (\kappa^{m}_{s,i})^\alpha d_i \right] = X. \qquad \textbf{(A.3)}$$

The LHS of equation (A.3) is strictly decreasing in X, whereas the RHS is linear. Therefore, there exists a unique X that solves (A.3). The uniqueness of X implies the uniqueness of $W(X)$, and an invariant distribution of the population as *entrepreneurs and financiers* and an invariant distribution of entrepreneurs as *net-worth builders and long-term investors*.

A similar conclusion follows for the case of $r = r_{\text{storage}}$. However, when $r = r_{\text{storage}}$, only a fraction of the aggregate wage earnings is allocated to capital producing investment projects. Therefore, letting $\kappa_i^j \in (0, 1)$ again be the fraction of the aggregate resources allocated to entrepreneur i in a steady state,

$$\int_{\mu<i<\eta} \kappa^{y}_{s,i} d_i + \int_{i>\eta} \kappa^{y}_{\ell,i} d_i + \int_{\mu<i<\eta} \kappa^{m}_{s,i} d_i < 1.$$

For the case of $r = r_{\text{storage}}$, the unique stationary X still solves

$$[A(X)]^\alpha \left[\theta_s \int_{\mu<i<\eta} (\kappa^{y}_{s,i})^\alpha d_i + \theta_\ell \int_{i>\eta} (\kappa^{y}_{\ell,i})^\alpha d_i + \theta_s \int_{\mu<i<\eta} (\kappa^{m}_{s,i})^\alpha d_i \right] = X.$$

■

A.6. PROOF OF PROPOSITION 3.2

(i) The result follows trivially from the monotone effects of higher financial enforceability: In an economy with high λ, the entrepreneurial investment and hence the capital production is higher for financially constrained firms. This in turn implies a higher steady-state consumption good production, wage rate, and per capita income.

(ii) In the absence of endogenous net-worth building, firms with low w_i are stuck with long-term investment horizons, which in turn lowers lifetime entrepreneurial profits for the constrained firms, suppressing the aggregate macroeconomic output. ■

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APPENDIX B. PARAMETERIZED SOLUTION OF THE STEADY STATE

Suppose that the entrepreneurs' capital investment projects and the consumption good production have the functional forms assigned at (29)–(30). In an economy with perfect enforceability, if the entire aggregate supply of investable funds is allocated to entrepreneurial investment projects, then the evolution of the capital stock is stated as follows:

$$\eta_{t-2}^{1-\alpha}\theta_\ell[W(X_{t-2})]^\alpha = X_t.$$

Using $W(X_{t-2}) = (1-\gamma)X_{t-2}^\gamma$,

$$\eta_{t-2}^{1-\alpha}\theta_\ell[(1-\gamma)X_{t-2}^\gamma)]^\alpha = X_t. \tag{B.1}$$

The capital-market clearance condition in this economy is stated as follows:

$$\eta_{t-2}\left(\frac{\alpha\theta_\ell R_t}{r_{t-2}}\right)^{\frac{1}{1-\alpha}} = (1-\gamma)X_{t-2}^\gamma.$$

Using $R_t = \gamma X_t^{\gamma-1}$,

$$\eta_{t-2}\left(\frac{\alpha\theta_\ell\gamma X_t^{\gamma-1}}{r_{t-2}}\right)^{\frac{1}{1-\alpha}} = (1-\gamma)X_{t-2}^\gamma. \tag{B.2}$$

In the steady-state equilibrium $X_t = X$, $\eta_t = \eta$, and $r_t = r$ for all t. Solving (B.1) and (B.2) together for r in the steady state yields

$$r = \frac{\alpha\gamma}{1-\gamma}. \tag{B.3}$$

In Section 4, I present that $\alpha = 0.9$ and $\gamma = 0.35$ are parameter values that can be supported with existing empirical evidence for the U.S. economy. These parameter choices for equation (B.3) then imply a real rate of return from entrepreneurial finance, r, that is strictly less than 1. Therefore, in order to match an empirically plausible annual real rate of return—1.03 for the U.S. economy—one must allow a nondegenerate fraction (less than 100%) of the aggregate investable funds to be allocated to entrepreneurial investment projects.