Riding the Cycle*

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We study the interplay between the business cycle and financial contracting. If the success probability of an investment project is increasing in both the business cycle state and the borrower's effort, then the borrower can free-ride on the cycle. In a model of financial contracting with moral hazard, we show that this free-riding generates *procyclical* agency costs. The overall effect of business cycle conditions on credit availability depends on how changes in agency costs compare to cycle-induced changes in the net present value of investment projects. In a dynamic extension, we endogenize the business cycle as a function of the output realized through past credit contracts. The dynamic economy has a unique stable steady state. If agency frictions in the economy are sufficiently strong, a small shock to the business cycle can cause the economy to fluctuate between business cycle ups and downs. The cycles are induced by the interplay of the negative agency cost effects and the positive output effects of the business cycle. Our theory sheds new light upon the observed patterns of secured and unsecured credit in U.S. data from 1981 to 2012.

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1 Introduction

Aggregate economic conditions, commonly referred to as the business cycle, matter for the performance of individual investment projects. Projects which would do well in booms may fail in recessions. Projects which would fail in recessions may do well in booms. If financial market participants anticipate this dependence of project outcomes on the state of the economy, financial market outcomes become a function of the business cycle. However, the business cycle itself depends on financial market outcomes. In this paper, we explore this interplay between financial market outcomes and the business cycle. We study the question of optimal financial contracting when the business cycle is directly influencing the success probability of investment projects. More specifically, we aim to understand how overall credit availability and the type of financial contracts written between cash-constrained entrepreneurs and outside investors depend on the state of the business cycle. We then explore how the outcome of financial contracting influences the evolution of the business cycle which in turn impacts future financial contracting outcomes.

When aggregate production is high, external finance becomes available at lower collateral requirements. Azariadis et al. [2015] report a strong positive correlation between unsecured credit and GDP in U.S. data between 1981 and 2012. They further document that this correlation is stronger than the correlation between secured credit and GDP. Asea and Blomberg [1998] find that bank lending standards systematically vary over the business cycle. When aggregate output is high, banks reduce their lending standards while they tighten the lending standard when aggregate output is low. Similarly, the Senior Loan Office Survey conducted by the Federal Reserve indicates that commercial banks in the U.S. countercylically adjust their lending standards when granting loans to businesses. These empirical patterns indicate that the quantity as well as the type of credit contracts change with the business cycle.

Our theoretical starting point is a model of financial contracting with moral hazard similar to Holmström and Tirole [1998]. An entrepreneur requires outside finance from an investor to start working on an investment project. The success probability of this project is a function of the entrepreneur's unobserved effort. We extend the contracting problem by assuming that aside from borrower effort, the observed state of the business cycle influences project success probability. The entrepreneur and the investor take the business cycle as exogenously given when contracting. Our key assumption is that effort and cycle are substitutes in determining a project's success probability. This implies that the marginal effect of effort on a project's success probability is higher when the business cycle is low. We investigate how the state of the business cycle affects the entrepreneur's ability to raise external funds from the investor through a contract which induces the entrepreneur to work. We call such a contract an *incentive contract* and find that the business cycle has two conflicting effects on a borrower's ability to raise external funds through such a contract. The first effect, which we label *profitability effect*, reflects the fact that a high business cycle increases the net present value of a project which is operated by an incentivized borrower. This effect facilitates a borrower's access to incentive contracts. The second effect results from the fact that a high business cycle makes the borrower more inclined to shirk and ride the cycle for project success. In order to prevent the borrower from shirking, the outside investor has to pay a rent. This *agency effect* of the business cycle impedes the borrower's access to finance through an incentive contract. Agency costs are procyclical as a high business cycle requires the outside investor to pay a higher rent to the borrower to prevent him from shirking. The overall effect of the business cycle on the ability of a borrower to raise external funds through an incentive contract depends on the relative strength of these two conflicting effects.

For a sufficiently high state of the business cycle, a second type of financial contracts may arise: *non-incentive contracts*. Non-incentive contracts are contracts through which the outside investor provides funds to entrepreneurs who cannot credibly commit to exert effort. The investor is well aware that the borrower will shirk and ride the cycle. However, when the business cycle is sufficiently high such a contract will still finance a positive NPV project. Non-incentive contracts give those borrowers access to funds who would be credit-constrained otherwise. That is, the existence of non-incentive contracts implies that overall credit availability is increasing in the business cycle. Entrepreneurs prefer an incentive contract to a non-incentive contract. However, only entrepreneurs with a sufficiently high asset endowment can credibly commit to exert effort and are able to obtain an incentive-contract. There is a threshold level of endowment below which an entrepreneur will not be able to obtain an incentive contract. Whether this entrepreneur obtains a non-incentive contract depends on whether the business cycle is above a threshold level which makes this type of contracts profitable.

In a next step, we study a dynamic extension of our baseline model to endogenize the business cycle. We assume that the cycle in $t + 1$ is a function of the realization of all projects financed in t: The more projects are successful, the higher the cycle in the next period. For simplicity, we assume that entrepreneurs live for one period only. They are born with a random draw from an asset distribution, try to obtain finance from an outside investor, consume a fixed fraction of whatever return they have from investing into the investment project, and die. That is, each generation of entrepreneurs is born into a given asset distribution and leaves behind a new asset distribution from which a new generation of entrepreneurs draw their initial endowments. We show that in the economy without moral hazard, there exists a unique steady state business cycle and asset endowment distribution to which the economy eventually converges. Uniqueness and existence of this steady state follow from the assumption that the business cycle is increasing but concave in the outcome of investment projects. That is, many successful projects in our economy increase the future business cycle (and hence, the future success probability of investment projects), but decreasingly so the higher the cycle. As entrepreneurs consume a fixed fraction of their assets before disappearing, this implies that the economy will converge to a steady state business cycle with a corresponding asset distribution.[1]

For the dynamic economy with agency frictions, we find that there is a tension between more production and hence higher asset endowment due to higher states of the business cycle on the one side, and increasing agency costs of the business cycle on the other side. That is, the dynamic trade-off is one between an *endowment effect* and an *agency effect* of the business cycle. For low states of the business cycle, the entrepreneurs' asset endowment grows faster than the agency rents. This gives more entrepreneurs access to incentive contracts and increases the business cycle over time. There exists a threshold level for the business cycle after which the agency rents increase faster in the business cycle than the asset endowment and as a result, fewer entrepreneurs have access to incentive contracts. We find that the dynamic economy has a unique steady state to which the economy converges. If the endowment effect is sufficiently strong, then the economy converges to this steady state monotonically. If, however, the agency effect is sufficiently strong, then a higher business cycle can decrease the access to outside finance so much that the business cycle decreases over time. This implies that it is possible that the economy converges to its steady state with damped oscillations. A strong agency effect implies that as the business cycle increases, fewer agents will have access to incentive contracts. If this effect outweighs the endowment effect, production in the economy goes down as the business cycle increases further. In the following period, a lower business cycle implies lower agency frictions and hence, more agents will be able to obtain incentive contracts again which outweighs the direct negative effect of a lower business cycle on production through lower success probabilities. The economy then grows again, shrinks in the following period and so on until the economy eventually converges to a stable steady state. That is, we find that in the dynamic economy with distortions, the economy may fluctuate between times when the agency effect dominates the endowment effect (and the business cycle worsens), and times where the endowment effect dominates the agency effect (and the business cycle improves).

Procyclical agency costs and the existence of non-incentive contracts create a feedback between aggregate output and the equilibrium mix of credit contracts which may help explain the observed cyclical patterns of unsecured credit and lending standards in U.S. data. More specifically, our theory implies that the amount of uncollateralized debt is increasing in the business cycle as borrowers free ride on the cycle within non-incentive contracts. Further, non-incentive contracts increase borrower leverage as even borrowers with low asset endowments will be able to obtain credit. This is in line with the observed empirical pattern of lenders loosening their lending standard leading to higher borrower leverage. We conclude that, while a more serious empirical assessment is necessary (work in progress), our theory seems promising in explaining stylized facts about financial contracting and aggregate output.

[1] These dynamics are similar to Solow [1957] where the existence and uniqueness of the steady state rely on decreasing marginal product of capital and linear depreciation.

Related Literature. Our work is related to the large literature on business cycle dynamics with financial frictions. Famously, Bernanke et al. [1999] (henceforth BGG 1999) provide a financial accelerator model in which agency frictions amplify business cycle shocks. In their model, a borrower's net worth determines the 'external finance premium' which is the premium an outside investor has to be paid to be compensated for the agency cost. When a borrower's net worth is low, then this premium is high and equilibrium lending is decreased. If borrower's net worth is procyclical, then financial frictions propagate and amplify shocks to net worth. While BGG (1999) impose a costly state verification setup as in Townsend [1979] to motivate asymmetric information between an entrepreneur and an outside investor, our paper focuses on a moral hazard problem similar to Holmström and Tirole [1998] [2011]. Despite this difference, our paper shares many features of the BGG framework. The asset distribution in our model is equivalent to borrower's net worth in their model, and in both models agency frictions are mitigated if the borrower has more assets/endowments to pledge to an outside investor. However, a major difference to BGG is that in our model the business cycle does not have an unambigously positive effect on the ease with which a borrower can raise external funds. In BGG agency costs are strictly counteryclical as an improving business cycle increases borrower's net worth and thereby decreases the agency friction unambiguously. In our model, on the other hand, a higher business cycle induces the borrower to shirk and ride the cycle, which he can only be prevented from with a higher rent (agency effect). This renders agency costs *procyclical* in our model. A higher business cycle in our model might still increase the credit availability in the economy because projects get a higher net present value (profitability effect), but this channel is a distinctly different channel from the one in BGG.

Azariadis et al. [2015] document the above mentioned cyclical patterns of unsecured credit and aggregate production. They explain these patterns using a model in which unsecured firm credit arises from self-enforcing borrowing constraints. More specifically, unsecured credit in their model arises as borrowers care about their credit reputation. In our setup, unsecured credit arises as lenders allow borrowers to free ride on the (sufficiently high) business cycle. Leverage dynamics over the business cycle have further been studied by Halling et al. [2016], Adrian and Shin [2010], and Erel et al. [2011]. We contribute to this line of research by establishing the procylicality of leverage as a result of procyclical agency costs. That is, higher aggregate output makes it harder for entrepreneurs to credibly commit to high effort. As a result, more entrepreneurs end up with non-incentive contracts which implies higher economy-wide leverage. Kiyotaki and Moore [1997] study the interplay between the business cycle and asset prices. They show how a deterioration of asset prices during economic downturns further exacerbates the downturn. While our dynamic model does not explicitly feature asset prices, the business cycle impacts the economy's total asset endowment and thereby influences financial contracting. This implies an exacerbation of economic downturns through shrinking asset endowments. Myerson [2012] proposes a model of moral hazard driven credit cycles in which the moral hazard problem arises on the side of the financial intermediary. In his model, credit cycles arise as banker agency rents can be spread out through a banker's career. In our model, agency rents are static, and credit cycles arise from the dynamic interaction of credit contracts and aggregate output. Reichlin and Siconolfi [2004] study the joint effects of moral hazard and adverse selection for financial contracting. They find that endogenous cycles may arise due to a switch of equilibrium financial contracting. More specifically, the equilibrium in their model is described by 'pooling' contracts in which all borrowers obtain the same contract irrespective of their project selection, or 'separating' contracts in which borrowers self-select into contracts designed for their respective project choice. While our model only considers moral hazard in financial contracting, we similarly find distinct types of contracts in the model economy: incentive and non-incentive contracts. The dynamics of our economy are driven by the endogenous fluctuations of the fraction of entrepreneurs sorted into either of these two contracts.

The rest of this paper is organized as follows. Section 2 presents our model economy which we use to study the impact of the business cycle on financial contracting with moral hazard. We first solve the model for optimal financial contracts. In section 3, we endogenize the business cycle and study the dynamics resulting from the interplay between the business cycle and financial contracting. In section 4, we discuss the implications of our theoretical analysis for the observed cyclical patterns of secured and unsecured credit in U.S. data. Section 5 concludes.

2 Static Model: Exogenous Business Cycle

In each period t, there is a unit mass of agents with initial wealth, A_i, distributed uniformly on $[0, A_t]$. Each agent is born with an idea that generates a payoff of y if it is successful but costs I to be carried out. Agents are cash-constrained such that $A_t < I$ and are protected by limited liability. They seek outside funding for the remaining $I - A_i$ units of capital from a principal. The probability of success, $f(a_i, b_t)$, depends on the agent's effort, $a_i \in \{a_L, a_H\}$, and the business cycle in period t, $b_t \in [\underline{b}, \overline{b}]$. Exerting high effort, a_H, comes at a cost of k. Agents make take-it-or-leave it offers to the principals whose outside option is 0. We can then distinguish between two types of contracts: *incentive contracts* as well as *non-incentive contracts*. In incentive contracts, the agent will exert high effort while he will shirk in non-incentive contracts. Both can arise due to the heterogeneity of A_i following the logic in Holmström and Tirole [2011]: the agent's incentive constraint as well as the principal's participation constraint have to be satisfied at the same time for incentive contracts to be feasible. This will only be feasible for agent's with an initial endowment $A_i > \hat{A}$ as derived below.

The timing in our economy within any given period t is as follows:

1. Agents are endowed with endowment $A_i \sim U[0, A_t]$ (wealth in t is $W_t = \frac{A_t}{2}$).

2. The business cycle b_t is observed and contracts are signed.

3. The projects' outcomes realize according to $f(a_i, b_t)$.

Assumptions on success probabilities. We make the following assumptions throughout the analysis:

(i) $f(a_H, b)y - k > f(a_L, b)y \quad \forall b$: The net present value (NPV) of a project is always higher when the agent works.

(ii) $\frac{\partial f(a_i,b)}{\partial b} > 0$ and $\frac{\partial^2 f(a_i,b)}{\partial b^2} < 0 \quad \forall b$: Success probabilities are increasing and concave in the business cycle.

(iii) $\Delta f(b) \equiv f(a_H, b) - f(a_L, b) > 0$, $\Delta_b f(b) < 0$ and $\Delta_{bb} f(b) > 0 \quad \forall b$: Success probabilities are always higher when the agent works, and the difference between working and shirking is decreasing and convex in the business cycle.

(iv) $f(a_H, \underline{b})y - I - k > 0 > f(a_L, \underline{b})y$: At the lowest level of the business cycle, only exerting effort generates an NPV positive project.

(v) $\exists\ \tilde{b} : f(a_L, \tilde{b})y = I$: There exists a level of the business cycle such that shirking on a project becomes NPV positive.

(vi) $A_t < I \quad \forall t$: No agent will ever be self-financed.

Assumption (i) and Assumption (ii) are natural assumptions. Assumption (iii) requires some explanation. It states that the business cycle increases the probability of success more when the agent shirks compared to when he works. Suppose that shirking when the business cycle is low almost certainly leads to failure, while when the business cycle is very favorable even shirking might lead to a nearly certain good outcome. Then the difference in success probabilities from working compared to shirking ($\Delta f(b)$) is very high when the cycle is low, and very low when the cycle is high. For the success probability of shirking to catch up with the success probability of working over the business cycle a relatively larger increase in success probability for shirking over the cycle is needed, i.e. $\Delta_b f(b) > 0$. By assuming convexity of $\Delta f(b)$, we basically assume that this catching up happens mostly at lower levels of the business cycle and fades out at higher levels. Assumption (iv) and (v) ensure that there will always be incentive contracts available in the economy, while non-incentive contracts only become profitable after the business cycle has passed a threshold $\tilde{b}$. Assumption (vi) ensures that all agents in the economy need some external finance. While we could allow agents to become self-financed eventually, it would water down the dynamics of our main mechanism without qualitatively affecting the analysis.

2.1 Analysis: Static Equilibrium Financial Contracting

We begin our analysis by determining the distribution of contracts given a particular business cycle state, b, and wealth implied by A. Holmström and Tirole [2011] show that the initial wealth of an agent determines whether he is able to receive an incentive contract. Therefore, there will be a cutoff value of initial wealth, $\hat{A}(b)$, such that all agents with $A_i \geq \hat{A}(b)$ will obtain an incentive contract while all other agents with $A_i < \hat{A}(b)$ will either receive no contract or a non-incentive contract.

The cutoff $\hat{A}$ is determined by the compatibility of the relevant constraints at the contracting stage which are the agent's incentive compatibility constraint and the principal's participation constraint. These are given by

$$f(a_H, b)x_i - k \geq f(a_L, b)x_i \qquad \text{(incentive-compatibility)}$$

$$f(a_H, b)(y - x_i) \geq I - A_i. \qquad \text{(participation)}$$

Given that the agent makes a take-it-or-leave-it offer to the principal, the principal's participation constraint will be binding and it follows that $x_i = y - \frac{I-A_i}{f(a_H,b)}$. However, this is only a feasible incentive contract if this x_i induces the agent to exert effort, i.e., if $x_i \geq \frac{k}{\Delta f(b)}$ which implies the following condition

$$\hat{A}(b) := I - f(a_H, b)\left(y - \frac{k}{\Delta f(b)}\right) \leq A_i. \tag{1}$$

In the words of Holmström and Tirole [2011], the agent's pledgeable income is less than the net present value of the project due to the agency cost. As a result, the asset endowment of agents has to be sufficiently high for an agent to receive an incentive contract.

The contribution of our work is to connect the success probabilities of projects with the business cycle state b. We summarize the contracting stage as well as the distribution of contracts in the following lemma.

Proposition 1 (Incentive and Non-Incentive Contracts.)**.**
All agents with $A_i \geq \hat{A}(b)$ will receive an incentive contract and exert effort. Hence, the aggregate amount of effort in the economy is $1-\frac{\hat{A}(b)}{A_t}$. If the business cycle is sufficiently high, $b \geq \tilde{b}$, all remaining agents will receive non-incentive contracts, where $\tilde{b} = f^{-1}(a_l, \cdot)\left(\frac{I}{y}\right)$. If the business cycle is low, $b < \tilde{b}$, agents with $A_i < \hat{A}(b)$ receive no contracts.

With this result at hand, we aim to understand how the distribution of contracts and the distribution of effort changes with the business cycle. First, consider the effects on incentive contracts. Given our assumptions that, independently of effort, the probability of a project succeeding is increasing in the business cycle ($f_b(\cdot, b) > 0$) and that successes are less informative about effort in high business cycle states ($\Delta_b f(b) < 0$), the business cycle has two effects in the contracting stage: (i) *profitability effect*: the probability of a success becomes higher and, hence, the profitability of projects increases, and, (ii) *agency effect*:

because the informativeness of a success about effort decreases, the agent is more inclined to shirk when the business cycle is high, because b and a are substitutes, and a higher rent is necessary to induce the agent to exert effort. The two effects go in opposite directions and $\hat{A}$ may be either increasing or decreasing in effort. Second, when the business cycle increases it may surpass the threshold level $\tilde{b}$ such that non-incentive contracts also become feasible and the total amount of projects discontinuously jumps up.

Corollary 1. *The share of non-incentive contracts may increase with the business cycle for two reasons:*

1. *b increases above the threshold $\tilde{b}$ such that non-incentive contracts will become profitable and will be signed,*

2. *b is above $\tilde{b}$ and increases the cutoff level $\hat{A}(b)$.*

The cutoff level $\hat{A}(b)$ can be either increasing or decreasing in the business cycle depending on the relative strengths of the profitability and the agency effect. $\hat{A}(b)$ is convex if $\Delta f(b)$ is not too convex.

To understand the last part of Corollary 1, consider the derivative of $\hat{A}(b)$ with respect to the business cycle

$$\frac{\partial \hat{A}}{\partial b} = \underbrace{-f_b(a_H, b)\left(y - \frac{k}{\Delta f(b)}\right)}_{\text{profitability effect: } < 0} - \underbrace{\frac{\Delta_b f(b)}{\Delta f(b)} f(a_H, b) \frac{k}{\Delta f(b)}}_{\text{agency effect: } \lesseqgtr 0} \tag{2}$$

That is, the profitability effect increases the net present value of projects and thus decreases the threshold value of asset endowment $\hat{A}$. For the agency effect, the sign is ambiguous whenever $\Delta_b f(b) < 0$, i.e., when effort and cycle are substitutes. Then the agent becomes harder to incentivize, and profitability and agency effect go in opposite directions.[2] To see the convexity of $\hat{A}$ when $\Delta_b f(b) < M$ with $M > 0$, consider the second derivative of $\hat{A}$ with respect to b

$$\begin{aligned}\frac{\partial^2 \hat{A}}{\partial b^2} =& - f_{bb}(a_h, b)\left(y - \frac{k}{\Delta f(b)}\right) - \\ & \frac{k}{\Delta f(b)^2}\left(2(\Delta_b f(b) f_b(a_H, b) - \frac{f(a_H, b)}{\Delta f(b)} \Delta_b f(b)^2) + f(a_h, b)\Delta_{bb} f(b)\right)\end{aligned}$$

The only term that can be negative is the very last one including $\Delta_{bb} f(b)$. Hence, if the difference $\Delta f(b)$ is not too convex, $\hat{A}(b)$ is convex which implies that the agency effect becomes relatively more important the higher the business cycle.

[2]If effort and cycle are complements, then $\Delta_b f(b) > 0$ and it becomes cheaper to incentivize agents when the cycle goes up. This implies that $\frac{\partial \hat{A}}{\partial b} < 0$. We abstract from this case as it is of less theoretical interest.

2.2 Numerical Illustration: Incentive and Non-Incentive Contracts

Consider $f(a,b) = 1 - e^{-(a+b)}$. In this specification, effort and business cycle are substitutes and the cutoff $\hat{A}$ is given by

$$\hat{A}(b) = I - (1 - e^{-(a_H+b)}) \left(y - \frac{k}{e^{-b}(e^{-a_L} - e^{-a_H})} \right)$$

and its derivative with respect to the business cycle by

$$\frac{d\hat{A}(b)}{db} = -e^{-(a_H+b)}y + \frac{ke^{a_H+a_L}}{e^{-b}(e^{a_H} - e^{a_L})}$$

It is easy to see that in this case $\hat{A}(b)$ is convex and that $\frac{d\hat{A}(b)}{db} > 0$ for b sufficiently large. Non-incentive contracts become profitable whenever $f(a_L, b)y \geq I$ which implies in this case that

$$(1 - e^{-a_L - b})y \geq I$$
$$\tilde{b} := \ln\left(\frac{y}{y - I}\right) - a_L \leq b.$$

Figure 1 shows the distribution of contracts graphically. The black line represents $\hat{A}(b)$ and all agents with $A_i \geq \hat{A}(b)$ receive incentive contracts. The agents with $A_i < \hat{A}(b)$ receive non-incentive contracts only if $b \geq \tilde{b}$.

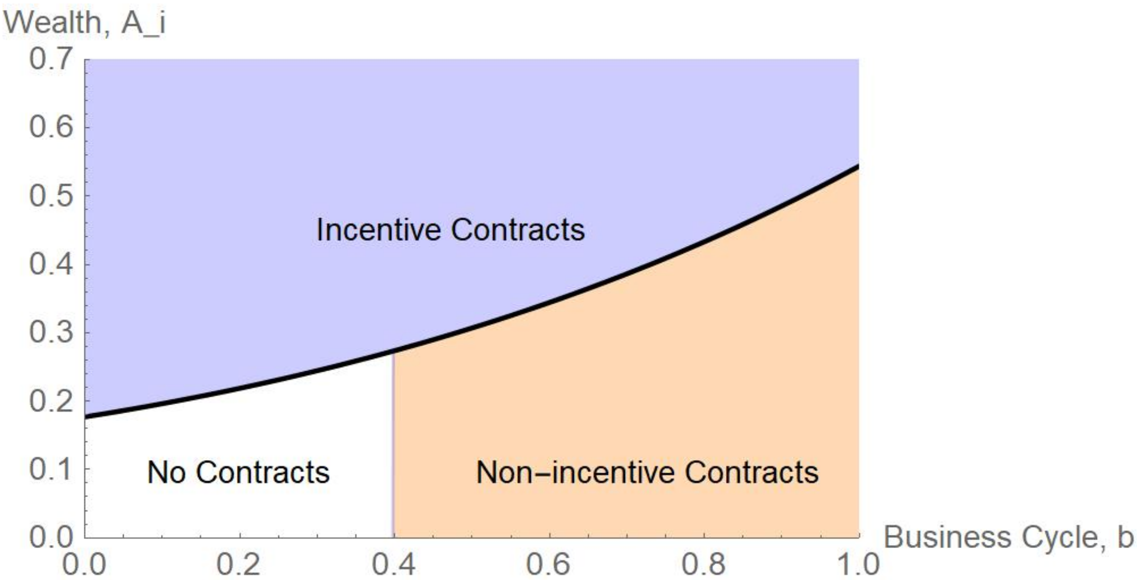

Figure 1: Illustration of distribution of contracts among agents as a function of the business cycle for $a_H = 3,\ a_L = 2,\ k = 0.02,\ y = 1.1,\ I = 1$

This example is constructed such that the agency effect of a higher business cycle always dominates the profitability effect, even at low levels of b. That is, $\hat{A}(b)$ is monotonically increasing in b. As the business cycle increases, the agents' pledgeable income decreases and hence, fewer agents will be able to obtain incentive contracts. However, if the cycle exceeds the threshold level $\tilde{b}$, non-incentive contracts become profitable and allow agents without incentive contracts to obtain outside funds.

3 Dynamic Model: Endogenous Business Cycles

In this subsection, we show how the economy evolves when the business cycle is endogenously determined by the performance of contracts in the previous period. We assume that $b_t = b(A_t)$ with $b(\cdot)$ increasing and weakly concave. Hence, higher output in the last period translates into a higher business cycle period in the present period. Given a distribution of contracts we can derive the law of motion of wealth in the economy. For simplicity, we just consider A_t instead of W_t which is directly given by $W_t = 2A_t$. The transition between periods is then given by:

- Project outcomes are realized and new wealth is given by the profits $W_{t.2}$.
- Agents consume an exogenously given fraction c of wealth and disappear thereafter.
- $(1-c)W_{t.2} = W_{t+1}$ is the new wealth and A_i in $t+1$ is distributed according to $U[0, A_{t+1}]$ with $A_{t+1} = 2W_{t+1}$.
- The new business cycle is $b_{t+1} = b(A_{t+1})$ where b is an increasing weakly concave function.

3.1 First Best Dynamics

In a frictionless economy, there is no agency conflict and each agent exerts effort. The law of motion for the asset distribution in such an economy is given by

$$A_{t+1} = (1-c)\left[f(a_H, b(A_t))y - I - k\right] \tag{3}$$

The steady state of this economy is reached at $A_{t+1} = A_t \equiv A^{FB}$. It is straightforward to see that A_{t+1} is increasing and concave given our assumptions on f. Figure 2 illustrates the Solow-type dynamics. There is a unique stable steady state at $A^{FB} > 0$. There is no trivial steady state at $A_{t+1} = A_t = 0$ since $A^{FB}_{t+1}(A_t = 0) > 0$ which follows from our assumption that exerting effort always is NPV positive, even at the lowest possible state of the business cycle.

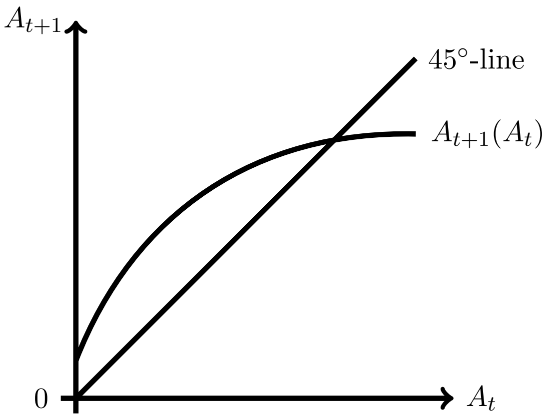

Figure 2: First Best Steady State

3.2 Dynamics in Economy with Distortions

In the economy with agency frictions, there will be agents which cannot credibly commit to exert effort, and these agents will not obtain an incentive contract. Let λ_t denote the fraction of agents which receive incentive contracts. It is given by

$$\lambda(A_t) \equiv \min\{\max\{1 - \frac{\hat{A}_t}{A_t}, 0\}, 1\} \in [0, 1] \tag{4}$$

where $\hat{A}_t$ is the threshold value of asset endowment derived in Proposition 1.

Lemma 1. *Assume that $\hat{A}$ is increasing and convex in the economy's asset endowment A_t. Further assume that there exists an A_t such that $\hat{A}_t < A_t$. Then, $\exists\ A^0 > 0, A^1 > A^0 > 0$ such that $\hat{A}^0 = A^0$ and $A^1 = \hat{A}^1$. It holds that $\lambda_t = 0 \quad \forall A_t \notin [A^0, A^1]$. Further, $\exists\ \bar{A} \in (A^0, 1)$ such that $\lambda' > 0$ if $A_t < \hat{A}$ and $\lambda' \leq 0$ if $A_t \geq \hat{A}$. Moreover, $\lambda'' \leq 0 \quad \forall A_t$.*

Corollary 1 established that the threshold $\hat{A}$ is increasing and convex in A if the agency effect dominates the profitability effect for all A_t, and that if $\Delta f(b)$ is not too convex, we get that $\frac{\partial \hat{A}}{\partial A} > 0$ for all A_t. Lemma 1 shows that under these assumptions, the fraction of agents with access to incentive contracts is non-monotonic in asset endowment A_t. For low values of A_t, an increase in the asset endowment leads to an increase in the fraction of agents with access to incentive contracts. This increase is due to the fact that, even though the agency costs are increasing as A_t increases, more agents pass the threshold level $\hat{A}$ of asset endowment. We call this the *endowment effect*. For sufficiently high values of A_t, however, further increases in A_t lead to a decrease in the fraction of agents with access to incentive contracts. This is the case as agency costs are convex in A_t and, eventually, outweigh the endowment effect of higher values of A_t. Figure 3 illustrates with a stylized example.

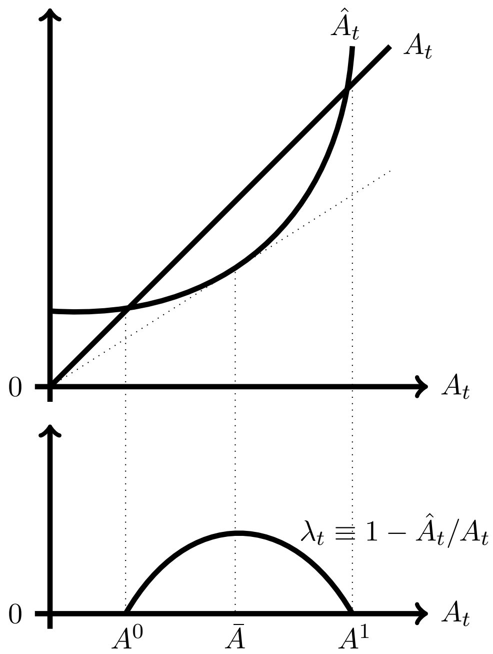

Figure 3: Evolution of λ_t (fraction of agents with incentive contracts)

As the figure shows, there exists a threshold level A^0 below which no agent will be able to obtain an incentive contract. Similarly, there is a threshold level A^1 above which agency costs are so high that no agent will obtain an incentive contract. Furthermore, the (weak) convexity of $\hat{A}$ implies that λ_t is (weakly) concave in A_t.

For the rest of this subsection, assume that non-incentive contracts are feasible even at the lowest level of the business cycle (i.e. $\tilde{b} = b(0)$). This implies that agents without access to incentive contracts will always be able to obtain non-incentive contracts. In the economy with distortions, the law of motion for asset endowment is then given by

$$h(A_t) = (1-c)\left[\lambda(A_t)\underbrace{[f(a_H, b(A_t))y - I - k]}_{\equiv m(A_t)} + (1-\lambda(A_t))\underbrace{[f(a_L, b(A_t))y - I]}_{\equiv g(A_t)}\right] \qquad (5)$$

where $m(A_t)$ denotes the asset accumulation through incentive contracts, and $g(A_t)$ denotes the asset accumulation through non-incentive contracts. Given our assumptions on success probabilities, it holds that $m > g$ and $m' < g'$. That is, the law of motion for the distorted economy is a convex combination of the law of motion of the economy only with incentive contracts ($m(A_t)$) and the law of motion for the economy with only non-incentive contracts ($g(A_t)$) where the weighing factor is given by the fraction of agents with access to incentive contracts ($\lambda(A_t)$). The economy with only incentive contracts has a unique stable steady state (as shown in Figure 2). Since $h(A_t)$ is a convex combination of $m(A_t)$ and $g(A_t)$, it is bounded below by $g(A_t)$ and bounded above by $m(A_t)$ for all A_t. This implies that the distorted economy has a unique steady state.

Proposition 2 (Existence and Uniqueness of Steady State.).
There is exactly one steady state in the distorted economy. This steady state is globally stable.

The unique steady state is stable in the sense that independent of the initial asset endowment A_t, the economy converges to its steady state. That is, the steady state is a sink. However, as the next Proposition shows, the type of convergence towards the steady state depends on the severity of the agency friction.

Proposition 3 (Convergence to Steady State.).
The distorted economy converges to its unique steady state A^* with damped oscillations if, in steady state, a sufficiently high fraction of agents is without access to incentive contracts: $\exists\, x \in (0,1)$ s.t. $h'(A^*) < 0$ if $\frac{\hat{A}(A^*)}{A^*} \in (x, 1)$. Otherwise, the economy converges to its steady state monotonically.

Convergence in damped oscillations requires the law of motion for the distorted economy, $h(A_t)$, to be negatively sloped at the steady state. Proposition 3 shows that this is possible if, in steady state, sufficiently many entrepreneurs are without access to incentive contracts - that is, if agency costs are sufficiently high. Intuitively, as A_t passes the threshold $\bar{A}$, the growth process of the distorted economy may be non-monotonic: An increase of A_t above $\bar{A}$ increases the number of agents without incentive contracts as agency costs become sufficiently strong. This reduces production in that period. At the same time, output in the economy increases for every given contract as the success probability increases. These two effects go in opposite direction. Proposition 3 shows that if, in steady state, the fraction of agents without access to incentive contracts is sufficiently large, then the first effect dominates the former, and more asset endowment leads to less production. Less production leads to less asset endowment in the next period which in turn reduces the agency costs in that period. This alleviation of agency frictions allows more agents to obtain incentive contracts in the next period, thereby increasing production next period. This, in turn, increases the agency costs in the period after, thereby increasing the amount of agents without incentive contracts leading to a decrease in output, and so on. The economy fluctuates between periods of production growth and production decline until steady state is reached. If, however, the fraction of credit constrained entrepreneurs is sufficiently low in steady state, then the second effect dominates the first, and the economy monotonically converges to its steady state. Figure 4 illustrates the two types of convergence.

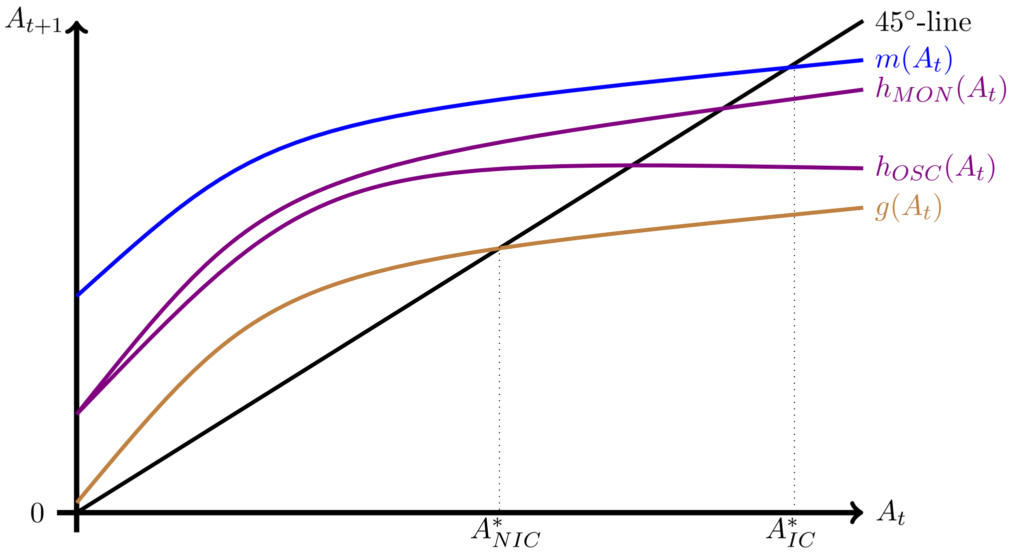

Figure 4: Steady State of the Distorted Economy

The figure demonstrates the two steady states obtained in the hypothetical economy with only non-incentive contracts (A^*_{NIC}) and the economy with only incentive contracts (A^*_{IC}). The distorted economy lies in between these two benchmarks as a convex combination of the respective laws of motion. If $\hat{A}$ is growing fast enough in A_t, then the threshold level $\bar{A}$ is reached quickly. This allows for the possibility that the law of motion of asset endowment in the distorted economy is downward-sloping around the steady state ($h_{OSC}(A_t)$). If, on the other hand, the fraction of credit-constrained entrepreneurs is sufficiently low around steady state, then the distorted economy will converge monotonically to its unique steady state ($h_{MON}(A_t)$). We conclude that a sufficiently severe agency friction in the contracting stage can lead the dynamic economy to exhibit cycles of production growth and decline around its steady state.

3.3 Numerical Illustration: Damped Oscillations Around Steady State

Consider an economy in which $b(A_t) = \alpha A_t^\gamma$ with $\alpha = 2$ and $\gamma = 0.5$. Figure 5 shows both the asset endowment threshold $\hat{A}(A_t)$ above which entrepreneurs obtain incentive contracts as well as the corresponding fraction of entrepreneurs with access to incentive contracts, $\lambda(A_t)$, for this economy.

As the asset endowment A_t increases, the threshold $\hat{A}$ grows due to larger agency costs as a result of an improving business cycle. For $\hat{A} > 0$, some entrepreneurs will not have enough asset endowment to credibly commit to exerting effort, i.e. their pledgeable income is not high enough to obtain an incentive contract. These entrepreneurs will be excluded from incentive contracts (decreasing λ) and obtain non-incentive contracts instead. For a sufficiently high level of the business cycle, agency costs become so large that no entrepreneur will have access to incentive contracts ($\lambda = 0$), and all entrepreneurs obtain non-incentive contracts if they are feasible (which is the case for $A > 0.03$). Then,

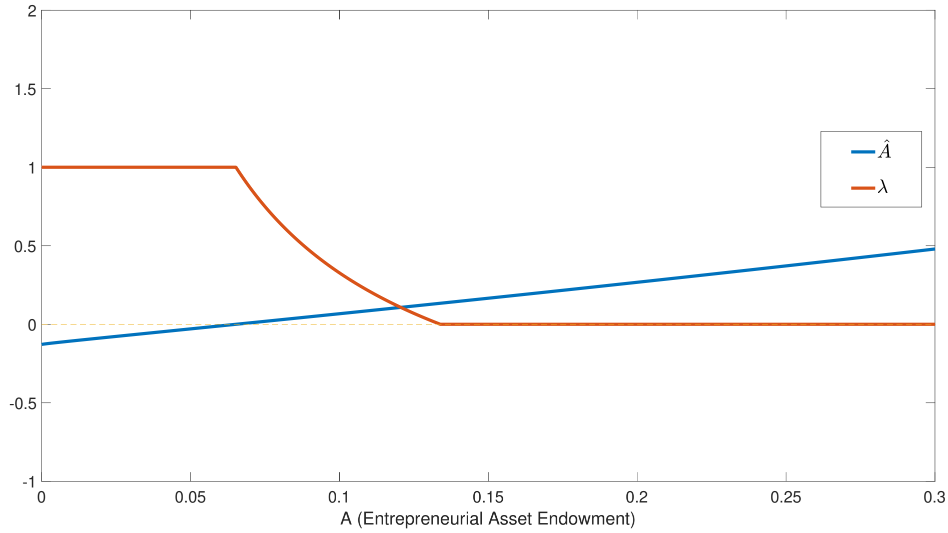

Figure 5: Asset threshold $\hat{A}$ and entrepreneurs with access to incentive contracts λ

every entrepreneur is 'riding the cycle'. Figure 6 shows the laws of motion for this economy.

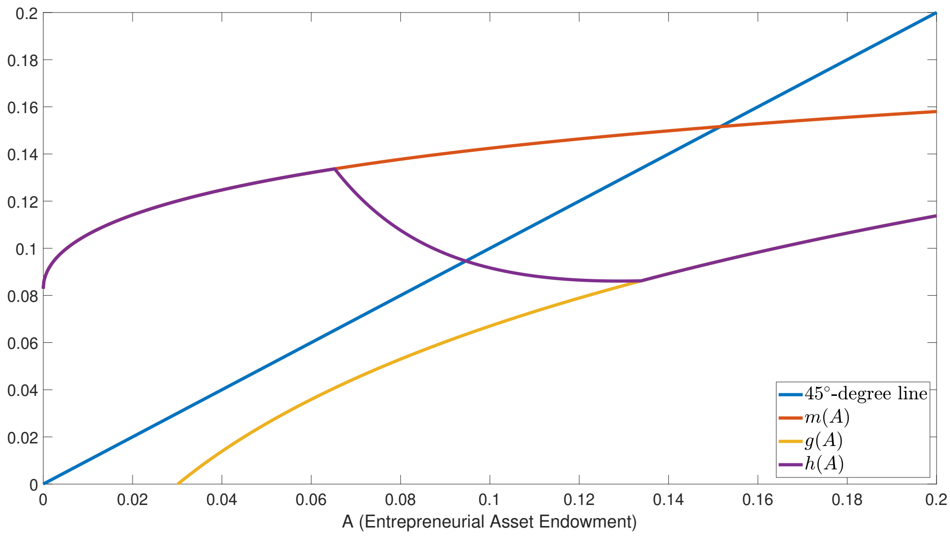

Figure 6: Laws of Motion

The red line indicates the law of motion for the undistorted economy in which each entrepreneur always obtains an incentive contract. The yellow line, on the other hand, shows the law of motion for the economy in which only non-incentive contracts are available.[3] The purple line represents the law of motion of the distorted economy which is in between these two extreme cases. We see that for $A < 0.0.065$, the distorted economy follows the law of motion of the undistorted economy. That is, the agency costs are sufficiently low such that each entrepreneur has access to incentive contracts. For $A > 0.0.65$, agency costs

[3]Note that in this example, the economy with only non-incentive contracts has no steady state. Further, non-incentive contracts are not feasible at $A = 0$.

are sufficiently high such that some entrepreneurs are excluded from incentive contracts and obtain non-incentive contracts instead. As a result, the law of motion for the distorted economy divorces from the law of motion of the undistorted economy as it becomes a strictly convex combination of the two benchmark law of motions. For $A > 0.1334$, agency costs are so large that no entrepreneur has access to incentive contracts, and the law of motion follows the law of motion of the economy with only non-incentive contracts.

The slope of the law of motion for the distorted economy is negative around steady state which implies that the economy converges to steady state with damped oscillations. Assume that the economy is in steady state at time t. Consider an exogenous shock to the business cycle such that the probabilities of success in period t are altered to $f(a, b-\epsilon)$ where $\epsilon > 0$. This leads to a decrease in output produced in period t and hence, an asset endowment in $t+1$ which is lower than its steady state level. The economy will then converge back to its steady state with damped oscillations. Figure 7 and Figure 8 show the evolution of asset endowment and the fraction of incentive contracts in response to a one-time (negative) shock to the business cycle, respectively. The shock is assumed to reduce the business cycle by 5% at $t = 3$.

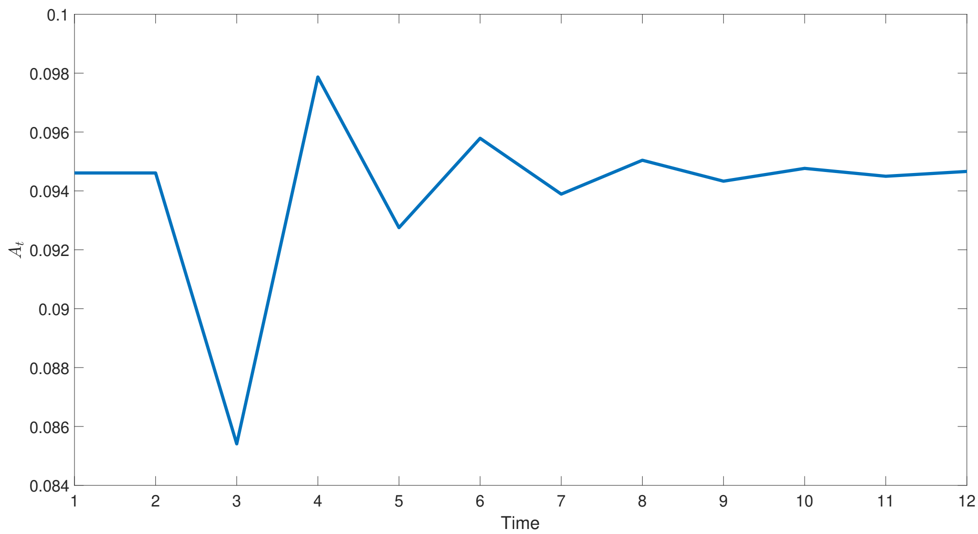

Figure 7: Impulse Response - Asset Endowment

As Figure 7 shows, the convergence of asset endowment back to stead state occurs in damped oscillations. The negative business cycle shock reduces production at $t = 3$ which reduces the asset endowment in the economy. As Figure 8 indicates, this reduces the agency friction in the next period implying that more entrepreneurs obtain access to incentive contracts. In the following period, this increase in incentive contracts leads to large production increases which boosts asset endowment above its steady state level. This increases agency costs and leads to a decrease in entrepreneurs with access to incentive contracts. This decrease reduces production next period which leads to a decline in the business cycle and hence reduces agency costs, and so on.

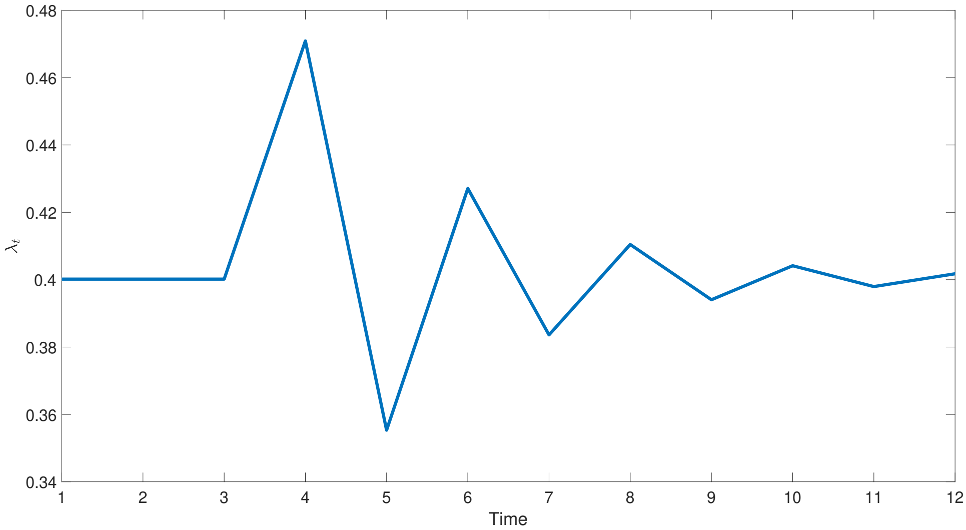

Figure 8: Impulse Response - Fraction of Entrepreneurs with Access to Incentive Contracts

4 Empirical Evaluation: Procyclical Agency Costs in the Data

Procyclical agency costs are at the heart of our theory. As aggregate conditions improve, entrepreneurs are more inclined to free ride on the business cycle which makes it harder for them to obtain outside funds. As we showed in the previous section, if this agency friction is sufficiently strong, it may be the case that as the business cycle improves, fewer agents will be able to credibly commit to exerting effort. As a result, more non-incentive contracts will be written at the expense of fewer incentive contracts. We derive the following two key predictions from our analysis:

1. Collateralization of credit is decreasing over the business cycle.
2. Leverage is increasing over the business cycle.

The first prediction rests on the observation that in the model, incentive contracts are 'collateralized' by the entrepreneur's asset endowment while non-incentive contracts imply that a subset of credit contracts written in our model economy is uncollateralized. Similarly, non-incentive contracts allow entrepreneurs with very little asset endowment to obtain the required funds to invest into the investment project. This increases leverage (debt-equity ratio) in the economy. We use these two model predictions to address the empirical relevance of our theory. In this section, we offer some preliminary empirical evidence for these two main hypotheses.[4]

Figure 9 (taken from Azariadis et al. [2015]) shows the evolution of secured and unsecured debt in U.S. data from 1981 to 2012 as well as corresponding business cycle data (recessions in grey).[5] Azariadis et al. [2015] report that the correlation between unsecured

[4]A more detailed empirical assessment is work in progress.

[5]The figure shows unsecured and secured debt for Compustat firms, and GDP multiplied by factor four (annual linearly detrended series, 1981–2012). Secured debt is obtained from the Compustat item "dm:

credit and GDP is given by 0.7. This is in line with our theoretical prediction that as the business cycle improves, more non-incentive contracts are being written. The authors also find that secured credit is weakly negatively correlated (-0.15) with contemporaneous GDP. Within our model, this observation is explained through procyclical agency costs which reduce the access to incentive contracts. As a result, improving aggregate conditions imply a shift from incentive to non-incentive contract. We interpret the data on secured and unsecured as roughly in line with this notion.

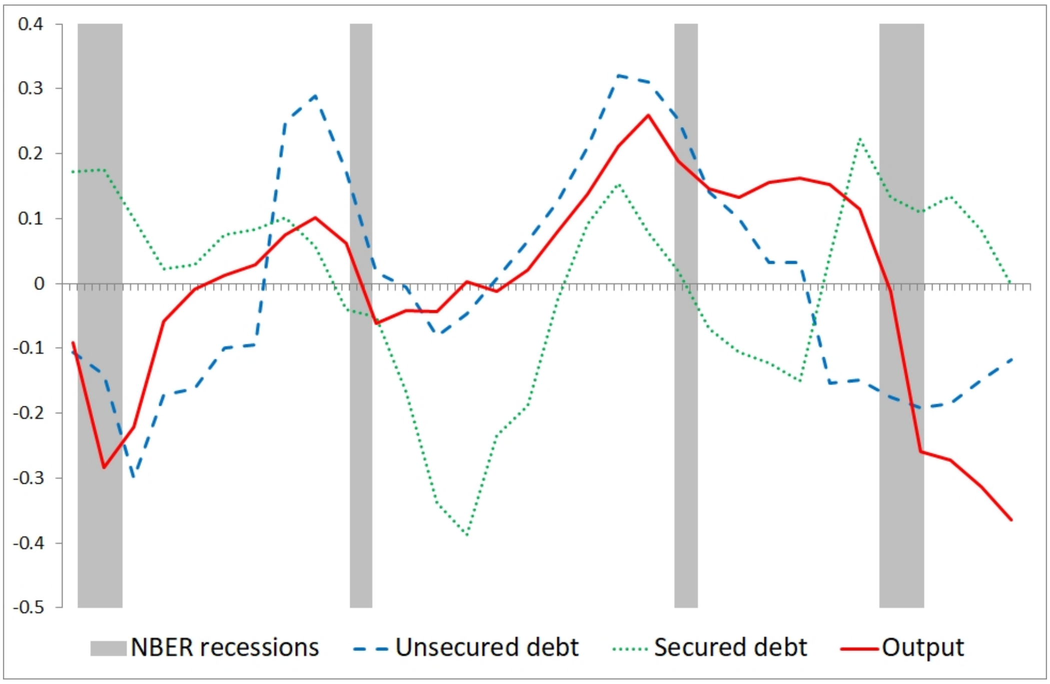

Figure 9: Secured and Unsecured Debt in the U.S. (source: Azariadis et al. [2015])

Non-incentive contracts allow the entrepreneur in our model to increase his leverage. More specifically, assume that $I = 1$ and that the entrepreneur has an asset endowment of $A < 1$. If the entrepreneur borrows $1 - A$ to invest into the production technology, then the margin or haircut is given by A/I=A%. The leverage is the reciprocal of the margin, i.e. $I/A = 1/A > 1$ (see Geanakoplos [2010]). That is, our model predicts that the existence of non-incentive contracts implies increasing leverage over the business cycle. Figure 10 shows data from the Senior Loan Officer Survey, conducted by the Federal Reserve Board.

Similar to Zhang [2019], we interpret the lending standards applied by banks when granting loans as a proxy for haircuts applied.[6] Figure 10 indicates that before and during recessions, banks increase their lending standards (or increase haircuts) which is equivalent to an increase in the asset endowment threshold $\hat{A}$ in our model. If the business cycle suddenly worsens, then non-incentive contracts may no longer be profitable. As a result,

debt mortgages and other secured debt" while unsecured debt is the residual from total debt to secured debt. See Azariadis et al. [2015] for a detailed description of the data.

[6]Geanakoplos [2010] and Gorton and Metrick [2012] provide similar evidence from repo markets.

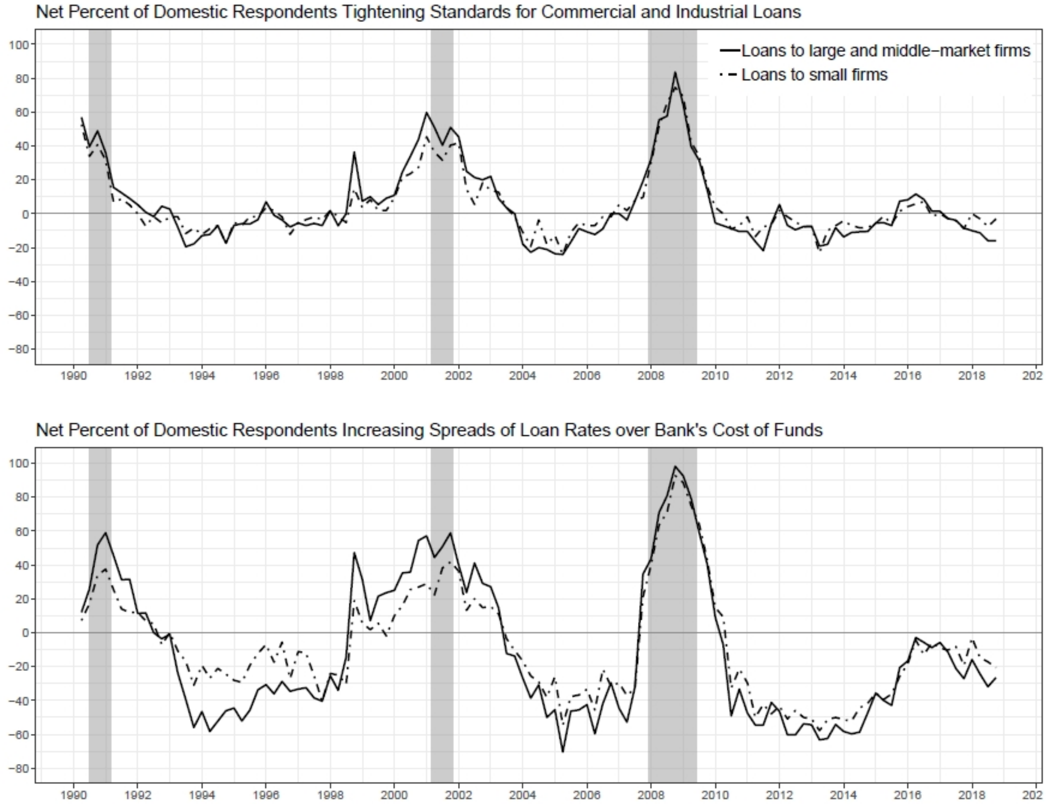

Figure 10: Senior Loan Office Survey (source: Zhang [2019])

these contracts will not be written and the business cycle will indeed worsen. This implies the negative correlation between haircuts and the business cycle indicated in the figure. Similarly, when the business cycle is improving, collateral requirements are reduced (lower haircuts) as non-incentive contracts become available. Our theoretical analysis implies that as the business cycle improves, agency costs rise and may eventually lead to a decrease in the business cycle. If this is the case, the economy may fluctuate between increasing and decreasing lending standards as in Figure 8. Assuming the economy is out of steady state, this results in endogenous ups and downs of lending standards. We conclude that our theory is in line with the observed correlation between lending standards and aggregate output.

5 Conclusion

We study the interplay between the business cycle and financial contracting. The key assumption we make is that both borrower effort as well as the state of the business cycle determine the probability of success of investment projects. This implies that borrowers are inclined to free ride on the business cycle. As a result, agency costs are procyclical which acts to decrease entrepreneurial access to credit contracts as the business cycle improves. At the same time, however, a higher business cycle improves the overall profitability of investment projects which facilitates entrepreneurial access to outside funds. The overall impact of the state of the business cycle on entrepreneurial access to funds then depends on the relative strengths of the agency effect and the profitability effect. We further find that if the business cycle is sufficiently high, a second type of financial contract arises: non-incentive contracts. These contracts allow entrepreneurs without access to incentive contracts to obtain external finance. Within non-incentive contracts, borrowers free ride on the cycle while still maintaining a positive net present value of investment. In a dynamic extension of our model, we find that as the business cycle increases, sufficiently high agency costs may imply a shift from incentive to non-incentive contracts. Thus, as the business cycle improves, more and more entrepreneurs free-ride on it. We find that the dynamic economy has a unique steady state. Convergence to this steady state may occur in damped oscillations, implying alternating ups and downs in aggregate production as a result to a one-time negative GDP shock. We conclude by relating our theoretical predictions to the observed cyclical patterns of secured and unsecured credit in the U.S. between 1981 and 2012. We interpret the strong procylicality of unsecured credit as a result of procyclical agency costs which imply a shift towards non-incentive contracts during times of high aggregate production.

The notion that the state of the business cycle is directly influencing the success probability of investment projects can be conceptualized in different ways. In this paper, we have studied a financial contracting model with moral hazard which results in procyclical agency costs. A different way of incorporating the business cycle into financial contracting is to assume that borrower type is hidden information, and that lenders learn about borrower type through performance. In such a setup, the business cycle interferes with the lender's learning from the borrower's performance. That is, poor borrower performance may be a result of bad borrower (or project) type or a poor business cycle realization. In such a model, the state of the business cycle influences the lender's willingness to terminate a credit relationship. More specifically, poor performance when the business cycle is high implies that the lender gets a bad signal about borrower quality which induces him to terminate the relationship. At the same time, however, if the business cycle has some persistence, the lender may expect the future business cycle to be high as well. This reduces the incentive to terminate the credit relationship. Studying the tension between these two effects gives a new understanding of banks' reactions to loan covenant violations (see Chodorow-Reich and Falato [2017] for a discussion of the importance of loan covenant violations during the financial crisis starting in 2008). Similarly, in such a setup, a high current or future business cycle is a substitute for information generated from screening and thus, reduces the lender's incentive to generate information about the borrower. This gives a new perspective on bank screening cycles.

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Appendix

A.1. Proof of Proposition 2

It holds that

$$h'(A_t) = \underbrace{\lambda'(A_t)}_{\lesseqgtr 0}\underbrace{[m(A_t) - g(A_t)]}_{>0} + \underbrace{\lambda(A_t)}_{>0}\underbrace{m'(A_t)}_{>0} + \underbrace{(1 - \lambda(A_t))}_{>0}\underbrace{g'(A_t)}_{>0} \tag{6}$$

and

$$\begin{aligned} h''(A_t) = \quad & \underbrace{\lambda''(A_t)}_{<0}\underbrace{[m(A_t) - g(A_t)]}_{>0} + 2\underbrace{\lambda'(A_t)}_{\lesseqgtr 0}\underbrace{\left[m'(A_t) - g'(A_t)\right]}_{<0} \\ & + \underbrace{\lambda(A_t)}_{>0}\underbrace{m''(A_t)}_{<0} + \underbrace{(1 - \lambda(A_t))}_{>0}\underbrace{g''(A_t)}_{<0} \end{aligned} \tag{7}$$

This implies that, if $A_t < \bar{A}$, then $h' > 0$ and $h'' < 0$, i.e. $h(A_t)$ is concave in A_t for $A_t < \bar{A}$. Hence, if $\bar{A} \geq A_{NIC}$, there is a unique steady state.

Consider $\bar{A} < A_{NIC}$. Then h may be increasing or decreasing, concave or convex. However, we know that $h' \leq g'$ for $A_t > \bar{A}$ and thus, there is at most one intersection of h with the 45°-line. □

A.2. Proof of Proposition 3

At the steady state A^*, the slope of h is given by

$$h'(A^*) = \lambda'(A^*)\,[m(A^*) - g(A^*)] + \lambda(A^*)m'(A^*) + (1 - \lambda(A^*))g'(A^*) \tag{8}$$

If $A^* \leq \bar{A}$, then $\lambda'(A^*) \geq 0$ and the slope is positive, implying monotone convergence to steady state.

If $A^* > \bar{A}$, then $\lambda'(A^*)$ is negative and the sign of the slope is ambiguous. We have that

$$\frac{\partial \lambda(A)}{\partial A} = \frac{\hat{A}}{A^2} - \frac{\hat{A}'}{A} \tag{9}$$

The value of $h'(A^*)$ is negative if

$$\frac{\hat{A}(A^*)}{A^*} > \frac{A^* m'(A^*) + \hat{A}'(A^*)(m(A^*) - g(A^*))}{m(A^*) - g(A^*) + A^*(m'(A^*) + g'(A^*))} \tag{10}$$

Since the fraction of constrained agents is bounded by 1, this condition can only be fulfilled if

$$(m(A^*) - g(A^*))\left[\hat{A}'(A^*) - 1\right] < g'(A^*)A^* \tag{11}$$

That is, convergence occurs in damped oscillations if, in steady state, the fraction of constrained entrepreneurs, $\frac{\hat{A}(A^*)}{A^*}$, is sufficiently close to but less than 1. □