The Lifecycle of the Financial Sector and Other Speculative Industries

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Abstract

Speculative industries exploit novel technologies subject to two risks. First, there is uncertainty about the fundamental value of the innovation: is it strong or fragile? Second, it is difficult to monitor managers, which creates moral hazard. Because of moral hazard, managers earn agency rents in equilibrium. As time goes by and profits are observed, beliefs about the industry are rationally updated. If the industry is strong, confidence builds up. Initially this spurs growth. But increasingly confident managers end up requesting very large rents, which curb the growth of the speculative sector. If rents become too high, investors may give up on incentives, and risk and failure rates rise. Furthermore, if the innovation is fragile, eventually there is a crisis, and the industry shrinks. Our model thus captures important stylized facts of the financial innovation wave which took place at the beginning of this century.

Keywords: Speculative industry, financial innovation, learning, moral hazard, rents, boom, crisis.

1   Introduction

Technical innovations can generate booms. Such developments are risky when the fundamental profitability of the innovation is unknown. Furthermore, the actions and performance of managers are particularly difficult to monitor in innovative industries, with which final investors are not familiar. This creates a moral hazard problem. As the industry spurred by the innovation grows, its potential value develops, but its riskiness and the agency problem can worsen. And if the risk eventually materializes, crises can take place. The goal of this paper is to model the equilibrium dynamics of such speculative industries.

A prominent example is the development of the financial sector at the beginning of this century. Technological advances in information technologies, combined with market liberalization, spurred many innovations, both in terms of techniques, e.g., securitization, and in terms of strategies and institutions, e.g., hedge funds and private equity funds. Innovation generated remarkable growth, in terms of capital invested, attraction of skilled workforce and market valuation. Significant profits were generated. Nevertheless, doubts remained. Were the financial innovations valuable enough to justify the allocation of so much financial and human capital? Did the fund managers and investment bankers really exert the right amount of effort and did they make the right decisions to ensure that investment would be valuable? Were the level of compensation to financial managers and their growth sustainable? Or would rents eventually absorb all the value creation in the industry?

We investigate these issues in the context of an agency model with rational expectations and learning. There are two sectors: the traditional one and the innovative one, which we refer to as the speculative industry. There is a continuum of competitive managers, who choose to work in the speculative industry if the wage it offers exceeds their compensation in the traditional sector. For simplicity we assume the traditional sector is well known, so that agency problems and uncertainty are not an issue there. Thus managers working in that sector receive wages equal to their known productivity. The speculative sector differs from the traditional sector, both in terms of opportunities

and in terms of challenges.

- First, there is uncertainty. The speculative sector can be strong and potentially very profitable. Alternatively it can be fragile and exposed to the risk of a crisis. Observing the dynamics of realized profits in the speculative sector, agents conduct Bayesian learning about the strength of that industry.

- Second, there is asymmetric information. In the speculative sector it is not easy to monitor how managers use the resources they have been entrusted with. The managers may be tempted to use these resources in ways that are not optimal for the final investors. Thus, this sector is plagued with moral hazard, which we model in the line of Holmstrom and Tirole (1997): when managers fail to exert effort, they earn private benefits from shirking, but the probability of success is lowered.

Our key assumption is that the nature of the moral hazard problem is related to the fundamental value of the innovation. We assume that if the innovation is strong managerial shirking does not reduce very much the probability of success, while if the innovation is fragile shirking significantly increases the risk of failure. To motivate this assumption consider the example of the innovation wave brought about by such techniques as securitization and credit default swaps. The initial uncertainty is about the extent to which these innovations would enable banks to reduce their exposure to the risk of defaults. A strong innovation is very effective at shedding this risk. A fragile one leaves banks exposed to high risks. In this context, consider the consequences of effort. If bankers exert high effort, they screen out most bad projects. In that case, whether the innovation is strong or fragile, they are exposed to limited default risk. In contrast, if banks shirk and fail to scrutinize loan applicants carefully, they remain relatively safe when the innovation is strong, but are exposed to high default risk when it is fragile.

Ironically, our assumption that the adverse consequence of shirking is greater when the innovation is fragile implies that the moral hazard problem is more severe when the industry is strong. Indeed,

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when the adverse consequences of shirking on success are limited, shirking is attractive for the manager. Hence agency rents are higher. In that context, our model yields the following equilibrium dynamics:

- **Boom:** In the early phase of the innovation wave, if there is no crisis, confidence builds up. Correspondingly the speculative sector attracts an increasing fraction of capital and labor.

- **Choking:** If performance continues, managers become very confident. Hence they demand large rents. These limit the net returns left to investors and slow down the growth of the speculative sector.

- **Risk–Taking:** At some point, the rents demanded by the managers become so high that investors give up on incentives. Consequently, managers screen projects lesss carefully, and default rates go up.

- **Bust:** At any point, if the industry is fragile, there can be a crisis.[4] When it occurs, agents revise downwards their expectations about the profitability of that sector. Consequently, investment, wages and employment in the speculative industry drop.

Thus, our model is in line with some of the major stylized facts of the financial innovation wave of the early 2000s and its eventual bust:

- **Uncertainty, learning and growth:** Before the crisis, some analysts claimed that securitization and risk management techniques had very significantly reduced (if not eliminated) the macro–risk associated with the financial sector. For example, A. Greenspan said in a speech delivered in 2005: "As is generally acknowledged, the development of credit derivatives has contributed to the stability of the banking system by allowing banks, especially the largest systematically important banks, to measure and manage their credit risk more effectively". In the

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[4]While the Boom, Choking and Risk–Taking regimes arise both for solid and for fragile innovations, crises take place only when the innovation is fragile.

language of our model, this corresponds to the belief that the speculative industry was strong. As in our model, such optimistic beliefs were motivated by a series of years with high profits and no large financial distress. As in our equilibrium, these developments were accompanied by an increase in the size of the financial sector.

- **Managers' rents and investors' net returns:** Our theoretical analysis implies that during the successful stages of financial innovation waves, managers operating in the speculative industry earn increasing rents. This is consistent with the empirical results of Philippon and Reshef (2008). They find that, during the recent financial innovation wave, the compensation of managers in the financial sector increased relative to other sectors. Furthermore, they estimate that part of that increase reflected rents. Our model also implies that, as long as there is no crisis, the relationship between the amount of money invested in the speculative sector and its past performance should be inverse U–shaped, which is constsient with the empirical results of Ramadorai (2008). The economic intuition we provide for this fact is that, initially, the increase in confidence due to good records attracts funds, while later confidence inflates managers' rents, which undermine net returns to investors.

Our analysis on the role of uncertainty and learning in booms and crashes is in line with the contributions of Zeira (1987, 1999), Rob (1991), Pastor and Veronesi (2006), and Barbarino and Jovanovic (2007). These papers offer rational expectations models where, in presence of uncertainty and learning, an industry can develop as long as good news are observed and then crash with bad news. Zeira (1999) shows that his theoretical model applies to the booms and crashes of 1929 and 1987. Pastor and Veronesi (2006), and Barbarino and Jovanovic (2007) show that their models offer insights into the boom and crash of the telecommunications and internet sector in the late 1990s.

One contribution of our analysis relative to these papers is to introduce moral hazard and study how it affects the dynamics of the innovative industry.[5] This enables us to generate new results relative

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[5]In that respect, while our analysis can shed some light on several innovation waves, including the internet boom, our

to the previous literature. We study the interaction between moral hazard and learning. We show how rents arise in equilibrium. We explain how the evolution of these rents affects the dynamics of the division of the value between managers and investors. We also show how moral–hazard can lead to excessive risk–taking at a systemic level.

Symmetrically, our paper also contributes to the literature by showing how the moral hazard problems arising in innovative industries are altered by learning. Thus, our model is in the line of Bergemann and Hege (1998). Yet the focus of the two papers is quite different. Bergemann and Hege (1998) offer an insightful analysis of long term Venture Capital contracts which is beyond the scope of our one–period contracting framework. But, while Bergemann and Hege (2008) study the interaction between two players only, we consider populations of investors and managers and characterize the lifecycle of the speculative industry, the allocation of human and physical capital to the innovative and traditional sectors, and the evolution of rents and risk–taking.[6]

Our work is also in line with Philippon (2008) who analyzes the interaction between the financial and non–financial sectors. But, in his model, agency problems plague the real sector, and monitoring by financial intermediaries mitigates the moral hazard problem facing manufacturing firms by monitoring them. In contrast, our analysis assumes moral hazard in the speculative industry. Finally, our analysis is also related to Lorenzoni (2008), who offers a model of credit booms with agency problems and aggregate shocks, where credit expansion can be followed by contractions. But his focus on pecuniary externalities differs from our focus on the interaction between learning and incentives.

The next section presents our model. Section 3 presents the benchmark case where effort is observable. It shows how booms and crashes can arise, because of uncertainty and learning, without

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emphasis on moral hazard makes our model particularly relevant for the recent evolution of the financial industry where agency problems were key.

[6]There is another, more technical difference, relative to the nature of the learning process in the two papers. In Bergemann and Hege (1998) there is learning about the probability of rare successes, so that no news is bad news. In contrast, in our model, there is learning about the probability of rare crises, so that no news is good news. This generates different learning dynamics.

moral hazard. Section 4 turns to the case where managerial effort is unobservable. It shows how moral hazard interacts with learning and gives rise to choking and risk–taking. Section 5 discusses the implications of our analysis and confronts them with empirical evidence on the financial sector. Section 6 concludes and briefly discusses some policy implications. Proofs omitted in the text are in the appendix.

2 The model

2.1 Agents and goods

Consider an infinite horizon economy, operating in discrete time at periods $t = 1, 2, ...$ There is a mass one continuum of competitive managers and a mass one continuum of investors. All players are risk neutral. The managers have limited liability and no initial wealth. At the beginning of each period, each investor is endowed with one unit of nonstorable investment good. At the end of each period, all agents consume the consumption good, produced, as explained below, by labor and capital. For simplicity, we focus on the simplest possible case, where managers and investors live only one period, and contracts are for one period.[7] Yet, the model is dynamic, to the extent that agents progressively learn about the state of the economy. Thus, the link between generations runs through the evolution of beliefs.

2.2 The two sectors

2.2.1 Managers and investors

Managers and investors are heterogeneous. Their types are denoted by ν and ρ respectively. The types of the manager are distributed over $[0, \bar{\nu}]$. Their cumulative distribution function is denoted by G. The types of the investors are distributed over $[0, \bar{\rho}]$. Their cumulative distribution function is

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[7]When palyers interact for several periods, shirking can crete a wedge between the beliefs of investors and managers. Bergemann and Hege (1998) and DeMarzo and Sannikov (2008) offer insightful analyses of this problem.

denoted by F.

There are two productive sectors, the traditional sector and the speculative one. Managers and investors choose in which sector to operate. For simplicity we asssume that, in the traditional sector, agents generate output equal to their type. Thus, ν is the productivity of the managers in the traditional sector. When the type ν manager operates in the traditional sector, he obtains, at the end of the period, ν units of the consumption good. Similarly, when investor ρ allocates her unit endowment of investment good to the traditional sector, she obtains ρ units of the consumption good at the end of the period.

The innovative technology requires one unit of investment as well as managerial effort. Capital is provided by the investors, who are endowed with the investment good at the beginning of the period. Managers are hired by investors.

2.2.2 Uncertainty

There is uncertainty about the speculative industry. Consider for example the securitization of sub-prime mortgages. It was not initially clear whether or not structured finance techniques could reduce exposure to defaults and improve the allocation of risk without generating perverse effects. Analogous securitization techniques had worked well previously for other types of assets, such as credit card receivables. But this new financial innovation wave had novel and yet untested characteristics, and there was uncertainty about how it could perform in the long run. While it could not have obviously been predicted that ex ante, it eventually turned out that the new securitization process involved intrinsic flaws, due to the interdependence between financial institutions, counterparty risk and its interaction with the real estate bubble.

We model this uncertainty by assuming that the speculative technology can either be strong, which is denoted by $\theta = 1$, or fragile, which is denoted by $\theta = 0$. If the industry is strong, it is immune from crises. But, if the industry is fragile, at each period, with probability $1 - p$, it can be hit by a crisis. In that case, all projects in the speculative sector generate 0 output. Thus, fragility implies that the

industry is exposed to the risk of a large crisis annihilating its profits.

2.2.3 Moral hazard

When there is no crisis, speculative sector firms generate R or 0. The distribution of output in that case depends on the effort of the managers. Managerial effort leads to an improvement in the distribution of output in the sense of first order stochastic dominance. This can be interpreted as an increase in the probability of success, e.g., in high–tech industries the manager can exert effort to increase the probability that a new patent will be obtained and a new product or service will be commercialized. Effort can also be interpreted in terms of risk prevention, e.g., in the financial sector managers can exert effort to screen investment opportunities, and avoid those with a large risk of default.

When there is no crisis, if a manager exerts effort, output R is generated for sure. But if he exerts no effort, there is a risk that output will be 0. When the industry is strong, the probability of default under shirking, denoted by $\underline{\Delta}$, is relatively small, but when the industry is fragile, the default rate under shirking can be is higher: with probability λ it is the same as for the solid industry (i.e. $\underline{\Delta}$), and with probability $1 - \lambda$ it is $\bar{\Delta} > \underline{\Delta}$. The expected default rate under shirking in the fragile industry $(\lambda\underline{\Delta} + (1 - \lambda)\bar{\Delta})$ is denoted by $\hat{\Delta}$.

To illustrate this consider the case of securitization of loans. Our assumption means that when the structured finance techniques is fragile (say in the case of subprime mortgages), there is a probability $1 - \lambda$ that shirking (i.e. not exerting due diligence in the screening and monitoring of borrowers) will result in higher default rates than for the solid industry, even in the absence of a crisis. By contrast if the industry is strong (as the securitization of credit card receivables) shirking is less damaging. Thus, when the industry is fragile not only is it exposed to crises (with probability $1 - p$ there is a crisis and all firms obtain 0 return), but also it is exposed to smaller micro–shocks (with probability $1 - \lambda$ the adverse consequences of shirking are greater than they would have been for the strong industry).

Managerial effort is not observable by investors, and, when the manager does not exert effort, she

obtains a private benefit from shirking, denoted by B. Hence there is a moral hazard problem.[8] The investor is the principal and the manager the agent. The extensive form of the game within a period is represented in Figure 1.

We now introduce our two key maintained assumptions. First, we assume

$$A_1 : p\hat{\Delta} > \underline{\Delta},$$

which means that the expected negative consequences of shirking on output are greater when the industry is fragile than when it is solid.[9] In other words, strong industries are more robust to shirking than fragile ones. Second, we assume

$$A2 : \underline{\Delta}R > B.$$

which, jointly with A1 implies that effort is socially optimal, and would take place in the first best, i.e.,

$$(\pi_t + (1 - \pi_t)p)R > (\pi_t(1 - \underline{\Delta}) + (1 - \pi_t)[1 - \hat{\Delta}]p)R + B, \forall \pi_t.$$

2.3 Learning

All the agents in the economy observe all returns realizations, and use these to conduct rational Bayesian learning about θ. At the first period, agents start with the prior probability, π_1, that $\theta = 1$. For $t > 1$, denote by π_t the updated probability that the speculative industry is strong, given the returns realized in the speculative sector at times $\{1, ...t - 1\}$. By the law of large numbers, aggregate default rates may reveal a lot of information. For example, Figure 1 shows that an aggregate default rate of either $\bar{\Delta}$ (large number of individual losses) or 1 (systemic crisis) can only come from a fragile industry. Thus the fragility of an industry is detected for sure (and π_t goes to 0) as soon as the

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[8] As in Holmstrom and Tirole (1994) we cast the problem in terms of private benefits foregone by the manager when exerting effort. One could equivalently consider a model without private benefits but where effort would be costly.

[9] Note that A1 implies that $\bar{\Delta} > \underline{\Delta}$.

average default rate strictly exceeds $\underline{\Delta}$.[10] Until this date, π_t remains strictly between 0 and 1. Thus if all projects succeed at date t, it implies that managers have exerted effort and the probability that the industry is strong has to be revised upward:

$$\pi_t = \frac{\pi_{t-1}}{\pi_{t-1} + p(1 - \pi_{t-1})} > \pi_{t-1}. \tag{1}$$

By contrast if the default rate is $\underline{\Delta}$,this shows that managers have shirked. Yet, the probability that the industry is strong increases even further:

$$\pi_t = \frac{\pi_{t-1}}{\pi_{t-1} + \lambda p(1 - \pi_{t-1})} > \pi_{t-1}, \tag{2}$$

since, in spite of shirking, the aggregate default rate has been limited. This is because,when the industry is fragile, shirking implies a positive probability of default rates in excess of $\underline{\Delta}$.[11]

Thus, as long as the average return of firms operating in the speculative sector is sufficiently good, beliefs about θ improve. But, when it is too low, confidence melts down and π_t suddenly falls down to 0.

2.4 Contracts

At time t, newly born investors and managers interact for one period. We assume however that they have access to the complete performance history of the industry, which implies that they share the updated belief π_t.

First consider the case where the contract stipulates that managers are to exert effort. If there is a crisis all projects fail, while otherwise all projects should succeed, and obtain return R. If the output of the project run by manager i is equal to 0, while others succeeded, it must be that manager

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[10]If a crisis could also occur when $\theta = 1$, while remaining less likely than for $\theta = 0$, the learning process would be smoother. But it would have the same major qualitative feature, i.e., π_t would increase after good returns and decrease after bad returns.

[11]If this property was satisfied with certainty (if λ was equal to 0) then the fragility of the industry would be inferred as soon as the managers would shirk, since it would lead to an aggregate default rate of $\bar{\Delta}$ incompatible with a strong innovation.

i shirked. It is optimal to set his compensation to 0 in that case. Also, it is weakly optimal to set managerial compensation to 0 when there is a crisis and all firms obtain 0 output.

Second, consider the case where the contract stipulates managers are not to exert effort. In that case, only the expected compensation of managers matter, not its allocation across states. Hence, it is weakly optimal to compensate the manager only when the output of his firm is R.

Accordingly, we consider contracts where managers are compensated only when their firm generates output R. We denote the value of this compensation at time t by m_t, which could be interpreted as the bonus, received by managers if and only if they succeed.

3   Equilibrium when effort is observable

Consider first the benchmark case where effort is observable. In that case, since effort is efficient, managers are simply instructed to exert it, and their compensation is set to clear the labour market. At time t, the expected output of firms operating in the speculative sector is:

$$S_t = [\pi_t + (1 - \pi_t)p]R, \tag{3}$$

and the expected compensation of the managers is:

$$M_t = [\pi_t + (1 - \pi_t)p]m_t,$$

while investors obtain $S_t - M_t$ in expectation. Managers with opportunities in the traditional sector below M_t prefer to operate in the speculative sector. Hence, the supply of managers for that sector is:

$$G(M_t). \tag{4}$$

Investors whose return opportunities in the traditional sector are below $S_t - M_t$ prefer to invest in the speculative one, and thus need to hire a manager. Hence, the demand for managers in the speculative sector is:

$$F(S_t - M_t). \tag{5}$$

Equating (4) and (5) the labour market–clearing condition is:

$$G(M_t) = F(S_t - M_t). \tag{6}$$

The supply of managers is continuous and increases from $G(0) = 0$ to $G(\bar{\nu}) = 1$, while the demand for managers is continuous and decreases from $F(S_t) > 0$ to 0. Consequently there exists a unique solution M_t^* to (6). In our simple model a natural measure of the size of the speculative sector is the number of managers, or equivalently the number of firms operating in that sector. Based on the discussion above, we state our first proposition (illustrated in Figure 2, Panel A):

Proposition 1: *When effort is observable, the equilibrium expected compensation of managers in the speculative sector is M_t^* (the solution of (6)) and the size of that sector is: $G(M_t^*)$.*

Suppose that, up to $t - 1$, there has been no crisis and the updated probability that the industry is strong is π_t. If during period t there is no crisis, then investors become more optimistic and the updated probability that the industry is strong goes up to $\pi_{t+1} > \pi_t$. Thus expected output in the speculative sector increases and the demand curve (5) goes up, while the supply curve (4) stays constant. Consequently, the equilibrium compensation of managers in period $t + 1$ is $M_{t+1}^* > M_t^*$. In contrast, after a crisis, the updated probability that the industry is strong goes down to 0 and the expected output in that industry goes down to pR. Consequently the size of the speculative sector shrinks. These remarks are summarized in the following corollary:

Corollary 1: *When effort is observable, as long as there is no crisis the size of the speculative sector goes up, along with the expected compensation of managers employed in that sector. When there is a crisis, the size of the speculative sector and the equilibrium expected compensation of managers suddenly drops.*

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4   Equilibrium under moral hazard

4.1   Incentive compatibility

When effort is not observable but requested, we must impose the incentive compatibility condition that the manager prefers to exert effort rather than consuming private benefits, i.e.,:

$$[\pi_t + (1 - \pi_t)p]m_t \geq [\pi_t\{1 - \underline{\Delta}\} + (1 - \pi_t)\{1 - \hat{\Delta}\}p]m_t + B,$$

or

$$m_t \geq \frac{B}{p\hat{\Delta} - \pi_t[p\hat{\Delta} - \underline{\Delta}]}.$$

This condition implies a minimum expected pay-off for the manager. Denote this minimum expected pay-off by R_t. We refer to it as the rent of the manager:

$$R_t = \frac{\pi_t + (1 - \pi_t)p}{p\hat{\Delta} - \pi_t[p\hat{\Delta} - \underline{\Delta}]}B. \tag{7}$$

The incentive compatibility condition can be rewritten as,

$$M_t \geq R_t, \tag{8}$$

which means that the compensation promised to the manager must be large enough to entice effort. Note that the rent R_t which must be left to the manager, varies with the beliefs about the strength of the speculative sector. Under $A1$, R_t increases with π_t. This is because, under $A1$, the strong industry is more robust to shirking than the fragile one. Hence, managers find shirking more tempting when they are confident that the industry is robust. Therefore, high rents are needed to provide incentives in that case.

Substracting the rent from the expected output yields the pledgeable income, i.e., the maximum expected revenue that can be pledged to the investors without compromising the incentives of the manager:

$$P_t = S_t - R_t. \tag{9}$$

Since both the expected output and the rent increase with π_t, the pledgeable income can be non–monotonic with the expected strength of the speculative sector. Combining the conditions stated above, we obtain our next proposition.

Proposition 2: *When effort is not observable but requested, the pledgeable income in the speculative sector is a concave function $P(.)$ of π_t. Moreover if*

$$p + (1-p)\frac{R\underline{\Delta}}{B} < \frac{p\hat{\Delta}}{\underline{\Delta}}, \tag{10}$$

$P(\pi_t)$ decreases when π_t is close enough to 1.

Condition (10) means that the expected negative consequences of shirking are substantially more important for a fragile industry than for a solid one.[12] This condition expresses that pledgeable income is decreasing at $\pi_t = 1$.

Proposition 2 implies the following dynamics for the pledgeable income when effort is requested. As long as high returns are observed, confidence in the speculative sector increases. This boosts expected output, but it also raises rents. Our assumptions imply that the marginal impact of increased confidence on pledgeable income decreases with π_t ($P(\pi_t)$ is concave). Moreover, under condition (10) the increase in rent ultimately dominates the increase in expected surplus, and pledgeable income starts decreasing.

4.2 Equilibrium with effort

When effort is requested from the agent, there are two possible regimes, depending on whether the incentive compatibility condition binds or not. In the first regime, the market clearing condition determines the equilibrium compensation of the managers, as in the previous section, i.e.,

$$M_t = M_t^* \text{ s.t. } G(M_t^*) = F(S_t - M_t^*)$$

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[12]Note that, under assumption *A2,* condition (10) is stronger than *A1.*

as in (6). For this to be the equilibrium, it must be that the incentive compatibility condition holds for M_t^*, i.e.,

$$M_t^* \geq R_t. \tag{11}$$

As illustrated in Figure 2, Panel A, in this regime the supply and demand curves on the labour market intersect above R_t, so that the incentive compatibility condition does not bind.

In the second regime, as illustrated in Figure 2, Panel B, the supply and demand curves on the labour market intersect below R_t. Thus, the incentive compatibility condition binds, i.e.,

$$M_t^* < R_t. \tag{12}$$

and the expected managerial compensation is

$$M_t = R_t. \tag{13}$$

Since this is above M_t^*, managers employed in the speculative sector earn greater expected compensation than in the observable effort case. Thus, although they are competitive, they earn a rent. Such rents make working in the speculative sector very attractive. Indeed the number of managers who want to work in that sector is above the demand for their services, i.e.,

$$G(M_t) = G(R_t) > F(S_t - M_t).$$

Thus there is rationing in the labour market, as in Shapiro and Stiglitz (1984).

For simplicity consider the case where ν is uniformly distributed over $[0, \bar{\nu}]$ and ρ is uniform over $[0, \bar{\rho}]$, i.e.,

$$G(\nu) = \frac{\nu}{\bar{\nu}}, F(\rho) = \frac{\rho}{\bar{\rho}}.$$

In that case the market clearing condition (6) defining M_t^* becomes:

$$\frac{M_t^*}{\bar{\nu}} = \frac{S_t - M_t^*}{\bar{\rho}}.$$

Thus:

$$M_t^* = \beta S, \tag{14}$$

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where:

$$\beta = \frac{\bar{\nu}}{\bar{\nu} + \bar{\rho}} \in [0,1].$$

The compensation of the manager is equal to a fraction (β) of the value created by the firm. This fraction reflects the relative values of the outside opportunities of managers and investors in the traditional sector. When managers' skills in the traditional sector are high, or the opportunities of the investors in that sector are poor, the market clearing compensation of the managers in the speculative sector is high.

The condition under which the incentive compatibility condition does not bind, (11), is equivalent to the condition that the pledgeable income be greater than the expected income of the investors in the first best

$$S_t - M_t^* \leq P_t. \tag{15}$$

After some manipulations, we obtain state our next proposition, which is illustrated in Figure 3.

Proposition 3: *Consider the case where effort is not observable, but is requested. If F and G are uniform ,there exists a threshold value $\bar{\pi}$ such that, for $\pi_t \leq \bar{\pi}$ the incentive compatibility condition is not binding and the compensation of managers is set by the market clearing condition (6).*

- *When*

$$B \leq \beta \underline{\Delta} R, \tag{16}$$

  then $\bar{\pi} \succeq 1$ and the incentive compatibility constraint never binds. The equilibrium outcome is the same as in the first best.

- *When*

$$\beta \underline{\Delta} R < B < \beta \hat{\Delta} p R, \tag{17}$$

  the threshold value $\bar{\pi}$ is interior $(0 < \bar{\pi} < 1)$.For $\pi_t > \bar{\pi}$, the compensation of managers is set by the incentive compatibility condition, (13).

Inequality (16) holds when the private benefit from shirking, B, is small. In that case, the moral hazard problem is not large and induces no distortion in equilibrium. Hence, the expected net cashflow obtained by investors in speculative sector firms is: $S_t - M_t^*$.

Inequality (17) holds when B is relatively large and $\underline{\Delta}$ relatively small. In that case, the agency problem is more severe and, when π_t is high enough, rents become so large that the incentive compatibility condition binds. Correspondingly, the expected net cashflow obtained by investors in speculative sector firms is: $S_t - R_t = P_t$.

4.3 Equilibrium without effort

Now turn to the case where effort is not requested from the agent in equilibrium. In that case the expected output from the project is:

$$\hat{S}_t = [\pi_t(1 - \underline{\Delta}) + (1 - \pi_t)p(1 - (\hat{\Delta}))]R,$$

and the expected wage earned by managers is

$$\hat{M}_t = [\pi_t(1 - \underline{\Delta}) + (1 - \pi_t)p(1 - (\hat{\Delta}))]m_t.$$

The demand for managers is: $F(\hat{S}_t - \hat{M}_t)$ while he supply of managers is: $G(\hat{M}_t + B)$. The market clearing expected wage without effort is $\hat{M}_t^*$ is such that

$$F(\hat{S}_t - \hat{M}_t^*) = G(\hat{M}_t^* + B).$$

Using this market clearing condition, the next proposition states equilibrium wage arising when effort is not requested.

Proposition 4: *Assume F and G are uniform. If effort is not requested in equilibrium, then the labour market for managers clear, the expected compensation of managers is*

$$\hat{M}_t^* = \beta\hat{S}_t - (1 - \beta)B,$$

and their total expected utility is $\beta(\hat{S}_t + B)$ while that of investors is $(1 - \beta)(\hat{S}_t + B)$.

When effort is not exerted, the total expected value created by each firm is $\hat{S}_t + B$. Since the agent does not exert effort no rent is needed and the market clears. Thus the share of the total value created obtained by managers and investors simply reflect their outside options in the traditional sector. Correspondingly, managers get fraction β of $\hat{S}_t + B$ while investors get the complementary fraction.

4.4   Is there effort in equilibrium?

We now investigate if effort is requested in equilibrium. Consider a candidate equilibrium, where effort is requested. Could a pair manager–investor be better off by deviating to a contract which would not request effort? If there is no such profitable deviation, then effort is requested in equilibrium. Symmetrically, consider a candidate equilibrium where effort is not requested. Could a pair manager–investor be better off by deviating to a contract which would request effort? Again, if there is no such profitable deviation, there exists an equilibrium without effort. The following proposition, illustrated in Figure 4, states the conditions on parameter values under which one of the candidate equilibria or the other prevails.

Proposition 5: *Assume F and G are uniform and (10) and (17) hold. If*

$$R[1 - (1 - \beta)(1 - \underline{\Delta})] < B[\frac{1}{\underline{\Delta}} + (1 - \beta)]. \tag{18}$$

there exists a threshold value $\hat{\pi} > \bar{\pi}$ such that effort is requested in equilibrium for $\pi_t \leq \hat{\pi}$, while equilibrium involves no effort for larger values of π_t.

The intuition of the proposition is the following: As long as $\pi_t < \hat{\pi}$, the rents which must be left to the managers are sufficiently small that the pledgeable income is greater than the expected income investors would get if effort was not requested. So, for these values of π_t, investors prefer to request effort, and it is implemented in equilibrium. (18) is the condition under which the threshold value $\hat{\pi}$ is

lower than 1. This condition states that for $\pi_t = 1$, the pledgeable income is lower than the expected income of the investors when effort is not requested.

5 Discussion and implications

5.1 The lifecycle of the speculative sector

Denote by $H(\pi_t)$ the fraction of the manager's population employed in the speculative sector. It is a measure of the size of the speculative sector. The above analysis, and in particular Propositions 3, 4 and 5, imply the following corollary.

Corollary 2: *As long as there is no crisis, the equilibrium dynamics of the size of the speculative sector, measured by the fraction of the managers employed in that sector, $H(\pi_t)$, is the following:*

- *For $\pi_t < \bar{\pi}$, $H(\pi_t) = F((1 - \beta)S_t)$,*

- *for $\bar{\pi} \leq \pi_t < \hat{\pi}$, $H(\pi_t) = F(P_t)$,*

- *and for $\hat{\pi} \leq \pi_t$, $H(\pi_t) = F((1 - \beta)(\hat{S}_t + B))$.*

Corollary 2 implies the following pattern for the lifecycle of the financial sector, illustrated in Figure 5.

- First, as long as there is no crisis, π_t grows (from π_0 to $\bar{\pi}$). This increase in the confidence placed in the speculative sector attracts managers and capital. Correspondingly the total output of the sector increases. This is the initial boom period following the introduction of the innovation.

- Second, if there is still no crisis, π_t continues to grow (from $\bar{\pi}$ to $\hat{\pi}$) and managers become so confident that investors must leave them rents to provide them with incentives. As confidence builds up, these rents absorb an increasing fraction of the returns realized in the speculative

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sector. This deters the allocation of capital to the speculative sector and slows down its growth, which can even become negative. This is the choking period.

- Third, if the crisis still does not occur, confidence continues to build up, as π_t goes from $\hat{\pi}$ towards 1. But the rents needed to incentivize effort have now grown so high that investors prefer not to request effort in equilibrium. Consequently, managers screen projects lesss carefully, and failures take place. As long as the rate of these failures remains as low as $\underline{\Delta}$, confidence still builds up. But as soon as the rate of failure exceeds $\underline{\Delta}$, investors realize the sector is fragile, and there is a crisis.

- At any point in time, if the industry is fragile, this can be revealed, either by a large crisis implying the failure of the entire speculative sector, or by a large average failure rate $\bar{\Delta}$ in the speculative industry. In both cases, confidence is destroyed and π_t drops to 0, where it remains. At that point, the size of the speculative sector and the wages in that sector undergo a sharp drop.

5.2   Risk and the speculative sector

There are two types of risk in our setting. First, there is the risk of a crisis affecting the whole speculative sector. Second, there is the micro–risk affecting an individual project when its manager shirked. We discuss them in turn.

First, consider the aggregate risk. The occurrence of the corresponding crisis is exogenous in our model. What is endogenous is the perception of that risk by agents, and their rational updating about the probability of crises. As the sequence of positive returns grows longer, risk is perceived to decline by all market participants. But in our simple framework, it takes only one shock for the confidence in the speculative sector to be entirely lost. It would be straightforward to extend our model to allow for a more gradual process. Suppose that the probability of a crisis is p when the industry is fragile and ϵ when it is strong, with $p > \epsilon > 0$. After the observation of a first shock, π_t would go down but

would not immediately reach 0. Then, after each crisis episode, market participants would become more and more pessimistic and π_t would progressively go to 0.

Second, consider the micro–shock, corresponding to the failure of one project. It is endogenous in our model, since when the agent exerts effort this risk is lower than when the agent shirks. In the case of the financial industry, effort can be interpreted as the hard work necessary to evaluate the creditworthiness of investment projects and screen out the bad ones. If bankers and fund managers don't exert this effort, it raises the risk that they allocate money to bad loans or unprofitable assets, and thus will fail. Thus, towards the end of the cycle, as π_t becomes larger than $\hat{\pi}$, the risk that many speculative projects fail increases in equilibrium. As it affects many firms simultaneously, this can be interpreted as systemic risk.

5.3   Empirical implications for the financial industry

In this subsection, we draw the empirical implications of our theoretical analysis for the financial industry. Our model is not relevant for all parts of the financial industry and all periods. It applies to segments and periods corresponding to our definition of a speculative industry: there is a significant innovation involving both risks and promises, it is quite uncertain whether the innovation is strong or fragile, and informational asymmetries between investors and finance sector managers are severe. Thus, our model does not apply to standard banking activities, such as loans to corporations, conducted in traditional ways, during periods with little financial innovation, e.g., the 1950s or the 1960s. In contrast, it is relevant to analyze the flow of financial innovations which took place at the beginning of this century or for previous waves of financial innovations, such as, e.g., that of the 1920s. To delineate the implications of our theoretical analyses for such situations, we rely mainly on the equilibrium dynamics illustrated in Figure 5.

Rents: Our model implies that during financial innovation waves, after the industry has acquired a good performance record, managers earn rents, i.e., their pay exceeds the market clearing wage they

would receive in a frictionless market. These rents arise in equilibrium, in spite of competition between managers, because of incentive constraints, in line with Shapiro and Stiglitz (1984).

This theoretical result is consistent with the empirical findings of Philippon and Reshef (2008). They observe that during the 1920s and after the 1980s, there was a burst of financial innovation, an increase in the complexity of financial jobs, and also an increase in the pay of managers in the finance sector increased. Philippon and Reshef (2008) estimate that, in the recent period, rents accounted for 30% to 50% of the wage differential between the financial sector and the rest of the private sector. They also find that this induced an increase in involuntary unemployment in the financial industry. Our theoretical analyses delivers results which are exactly in line with these facts.

Another implication of our model is that, as confidence in the financial innovation builds up, compensation contracts in the innovative financial sector should become more and more favorable to fund managers (at the expense of investors). This is a new implication, which has not yet been tested systematically. But it is consistent with anecdotal evidence from private equity funds that, at the beginning of this century, on top of the 2 percent annual management fee and the carried interest incentive fee, extra fees were progressively added, sometimes labeled portfolio fees. These fees progressively reduced the net performance earned by investors (see Phalippou, 2008).

Net returns and size: The equilibrium dynamics characterized above imply that, as long as there is no crisis, realized returns *net of management fees*, start at a high level and then go down with past performance. While realized net returns are non–increasing, *expected* net returns initially increase. This is because the increase in the probability of success outweighs the increase in fees. The corresponding increase in expected net returns attracts capital. Hence the size of the sector (measured, e.g., by assets under management or total open positions) initially increases with past performance. Thus, during that period, an increase in size coexists with a decrease in realized net returns, which can be interpreted in terms of decreasing marginal returns to size.[13] But, at some

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[13]This is reminiscent of the results of Berk and Green (2005), but obtains for different reasons. In the present model, decreasing returns to scale are not directly driven by the technology used by managers. They stem from the combination

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point the increase in agency rents can outweigh the increase in confidence and expected net returns themselves start decreasing. When that point is reached, investment in the speculative sector declines. Thus, overall, the relationship between the amount of money invested in the speculative sector and its past performance will be inverse U shaped. This implication from our theoretical analysis is in line with the empirical results of Ramadorai (2008). He studies the closed–fund premium in the hedge fund industry. This premium offers a proxy for the demand for hedge–fund management services. When it is large, it suggests that many investors are eager to delegate the management of their money to that segment of the speculative financial industry. Consistent with our models, Ramadorai (2008) finds that this premium is initially increasing and then decreasing with past performance.

Managers' skills: In our model, as the size of the speculative sector increases, it attracts better and better managers. This implication of our analysis is in line with the empirical findings of Philippon and Reshef (2008) that the average skill level of managers in the financial services industry rose at the beginning of this century.

Time– and money–weighted average returns: During the ascending phase of the cycle the size of the speculative sector goes up. Hence time–weighted average returns give more weight to early returns than do money–weighted averages. Now, as shown above, even if there is no crisis, realized net returns tend to decrease. Hence the time–weighted average net return is greater than the money–weighted one. And the former overestimates further returns more than the latter. Thus our model warns that investors should view past time–weighted average net returns with caution, and should not extrapolate them, since this would neglect the growth in agency rents.

Estimating risk: Our learning model is a good description of industries, such as the financial one recently, where until some rare event occurs there is no strong change in beliefs, and then when

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of learning, moral hazard and equilibrium effects. Also, managers in our model are identical, while they are heterogeneous in Berk and Green (2005).

the rare event happens, there is a strong decline in optimism. In such an environment, frequentist estimations of risk would be very misleading. Consider the case where, up to time t, there has been no crisis. The estimated default rate computed using past data is 0. This is lower than the rational Bayesian estimate of the risk of default which is

$$1 - (\pi_t + (1 - \pi_t)p) > 0.$$

This is in line with the analysis of the recent crisis offered by Brunnermeier (2009) and Rajan et al (2008). Brunnermeier (2009) notes that: "the statistical models of many professional investors and credit-rating agencies provided overly optimistic forecasts about structured finance products. One reason is that these models were based on historically low mortgage default and delinquency rates."

6   Conclusion and policy implications

Our model analyzes the lifecycle of speculative industries, exploiting innovations and characterized by uncertainty about the fundamental value of these innovations, as well as information asymmetry about the actions of the managers implementing them. These assumptions fit particularly well the evolution of the financial industry at the beginning of this century. And our theoretical analysis delivers a rich set of empirical implications, in line with the evolution of that industry and its eventual crisis. In particular our model shows how, in equilibrium, during the initial period of success, the industry grows, attracting human and financial capital, while the rents of the managers increase. Our model also shows how this increase in rents undermines the net returns obtained by investors and eventually makes incentives so expensive that excessive risk–taking prevails in the last part of the cycle.

In our analysis optimal contracts preclude large managerial compensation after failure. Thus, under our assumptions, the large compensations recently warranted to financial sector executives were suboptimal, and exacerbated agency and risk taking problems. Our analysis also implies that disclosure and transparency, to the extent that they reduce the private benefit from shirking, alleviate the moral hazard problem. Thus, they benefit investors and society by reducing rents and correspondingly i)

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increasing investors' net returns and ii) enlarging the set of parameters for which suboptimal risk–taking is deterred in equilibrium. Along with this advice to policy makers, our analysis also offers a warning: Even with the maximum possible level of disclosure and optimal contracts, rents and risk–taking are bound to remain prevalent issues in speculative industries.

References:

Barbarino, A., and B. Jovanovic, 2007, "Shakeouts and market crashes," *International Economic Review*, 385–420.

Berk, J., and R. Green, 2005, "Mutual fund flows and performance in rational markets," *Journal of Political Economy*.

Bergemann, D., and U. Hege, 1998, "Dynamic Venture Capital Financing, Learning and Moral Hazard," *Journal of Banking and Finance*, 703-735.

Brunnermeier, M., 2009, "Deciphering the Liquidity and Credit Crunch 2007–2008," *Journal of Economic Perspectives*, 77–100

DeMarzo,P., and Y.Sannikov, 2008, "Learning in Dynamic Incentive Contracts" Working paper, Stanford University.

Holmstrom, B., and J. Tirole, 1997, "Financial intermediation, loanable funds and the real sector," *Quarterly Journal of Economics*, 663–692.

Lorenzoni, G., 2008, "Inefficient credit booms," *Review of Economic Studies*, 809–833.

Pastor, L., and P. Veronesi, 2006, "Was there a Nasdaq bubble in the late 1990's ?," *Journal of Financial Economics.*, 81, 161–100.

Phalippou, L., 2008, "Beware of venturing into private equity," *Journal of Economic Perspective*, Volume 22, Number 4.

Philippon, T., 2008, "The evolution of the US financial industry from 1860 to 2007: Theory and evidence," Working paper, New York University.

Philippon, T., and A. Reshef, 2008, "Skill biased financial development: education, wages and occupations in the U.S. financial sector", Working paper, New York University.

Rajan, U., A. Seru, and V. Vig, 2008, "The Failure of Models that Predict Failure: Distance, Incentives and Defaults," Working paper, University of Michigan at Ann Arbor.

Ramadorai, T., 2008, "The secondary market for hedge funds and the closed hedge fund puzzle.",

Working paper, Saïd Business School, Oxford University.

Rob, R., 1991, "Learning and capacity expansion under demand uncertainty." *Review of Economic Studies*, 655–677.

Shapiro, C. and J. Stiglitz, 1984, "Equilibrium Unemployment as a Worker Discipline Device," *The American Economic Review*, 74, 433 – 444.

Zeira, J., 1987, "Investment as a process of search." *Journal of Political Economy*, 204–210.

Zeira, J., 1999, "Informational overshooting, booms and crashes." *Journal of Monetary Economics*, 237–257.

Appendix: Proofs

Proof of Proposition 2:

Substituting the values of S_t from (3) and R_t from (7), the pledgeable income at time t can be written as a function of π_t:

$$P_t = P(\pi_t) = [p + (1-p)\pi_t][R + \frac{B}{[p\hat{\Delta} - \underline{\Delta}](\pi_t - \pi^*)}],$$

where

$$\pi^* = \frac{p\hat{\Delta}}{p\hat{\Delta} - \underline{\Delta}}.$$

Note that, under $A1$:

$$\pi^* > 1.$$

The first derivative of the pledgeable income is:

$$P'(\pi_t) = (1-p)R - B\frac{p + (1-p)\pi^*}{[p\hat{\Delta} - \underline{\Delta}](\pi_t - \pi^*)^2},$$

while the second derivative is:

$$P''(\pi_t) = 2B\frac{p + (1-p)\pi^*}{[p\hat{\Delta} - \underline{\Delta}](\pi_t - \pi^*)^3}.$$

Thus, $P''(\pi_t) < 0$ for the relevant values of π_t, i.e., $\pi_t \leq 1 < \pi^*$. Thus the pledgeable income as a function of π_t is a hyperbola, concave for $\pi_t \in [0, 1]$.

Now,

$$P'(1) < 0 \Leftrightarrow (1-p)R < B\frac{p + (1-p)\pi^*}{[p\hat{\Delta} - \underline{\Delta}](1 - \pi^*)^2}.$$

That is:

$$(1-p)R < pB\frac{\hat{\Delta} - \underline{\Delta})}{\underline{\Delta}^2}.$$

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Or:

$$p + (1-p)\frac{R\underline{\Delta}}{B} < p\frac{\hat{\Delta} - \underline{\Delta})}{\underline{\Delta}}.$$

Hence the proposition.

QED

Proof of Proposition 3:

Substituting the market clearing managerial compensation (14) into (15), we obtain

$$(1-\beta)S_t \le P_t,$$

that is:

$$(1-\beta)[p + (1-p)\pi_t]R \le [p + (1-p)\pi_t]R - \frac{[p + (1-p)\pi_t]B}{p\hat{\Delta} - \pi_t[\hat{\Delta}p - \underline{\Delta}]}.$$

Simplifying both sides by $p + (1-p)\pi_t$ and rearranging terms, we obtain a much simpler condition:

$$\beta R \ge \frac{B}{p\hat{\Delta} - \pi_t[\hat{\Delta}p - \underline{\Delta}]}. \tag{19}$$

which is satisfied for π_t small enough. Note also that, if $B \le \beta\underline{\Delta}R$, condition (19) holds at $\pi_t = 1$, and therefore for all π_t. In contrast, if $\beta\underline{\Delta}R < B < \beta\hat{\Delta}pR$, condition (19) holds at $\pi_t = 0$, but not at $\pi_t = 1$.

QED

Proof of Proposition 4:

In the uniform distribution case, the market clearing condition without effort amounts to

$$\frac{M_t^* + B}{\bar{\nu}} = \frac{\hat{S}_t - M_t^*}{\bar{\rho}}.$$

That is $\hat{M}_t^* + B = \frac{\bar{\nu}}{\bar{\rho}}(\hat{S}_t - \hat{M}_t^*)$.Or

$$\hat{M}_t^*(1 + \frac{\bar{\nu}}{\bar{\rho}}) + B = \frac{\bar{\nu}}{\bar{\rho}}\hat{S}_t.$$

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That is

$$\hat{M}_t^* = \frac{\bar{\nu}}{\bar{\rho} + \bar{\nu}}\hat{S}_t - \frac{\bar{\rho}}{\bar{\rho} + \bar{\nu}}B = \beta\hat{S}_t - (1 - \beta)B.$$

Hence the expected total gain of the manager is $\hat{M}_t^* + B = \beta\hat{S}_t - (1 - \beta)B + B = \beta(\hat{S}_t + B)$. Similarly, the expected profit of the investors is $\hat{S}_t - M_t^* = (1 - \beta)(\hat{S}_t + B)$.

QED

Proof of Proposition 5:

The preliminary step of the proof is to compare the following three functions of π_t: $(1 - \beta)S_t$, $(1 - \beta)(\hat{S}_t + B)$ and P_t. Note the following:

- $(1 - \beta)S_t$ and $(1 - \beta)(\hat{S}_t + B)$ are linear and increasing in π_t .

- (17) implies that, at $\pi_t = 0$, $P(\pi_t = 0) > (1 - \beta)S(\pi_t = 0)$.

- A1 and A2 imply that $(1 - \beta)S_t > (1 - \beta)(\hat{S}_t + B)$.

- (10) implies that P_t is concave in π_t, increasing at 0 and decreasing at 1.

- By (10) and (17), there exists a threshold value $\bar{\pi} \in [0, 1]$ such that: $P(\pi_t) < (1 - \beta)S_t$ if and only if $\pi_t > \bar{\pi}$.

- $P(\pi_t) < (1 - \beta)(\hat{S}_t + B)$ holds for $\pi_t = 1$ if and only if $R - \frac{B}{\underline{\Delta}} < (1 - \beta)[(1 - \underline{\Delta})R + B]$, which simplifies to condition (18).

This implies that under condition (18) there exists a threshold value $\hat{\pi} \in [0, 1]$ such that: $P(\pi_t) < (1 - \beta)(S_t + B)$ if and only if $\pi_t > \hat{\pi}$. Also, since $(1 - \beta)S_t > (1 - \beta)(\hat{S}_t + B)$, we have that $\hat{\pi} > \bar{\pi}$. The functions $(1 - \beta)S_t$, $(1 - \beta)(\hat{S}_t + B)$ and P_t are plotted in Figure 4. The remainder of the proof consists in three steps, each one considering a candidate equilibrium and spanning the different possible values of π_t.

First, we consider the case where $\pi_t < \bar{\pi}$ and establish, that in that case, effort is requested in equilibrium. Since $\pi_t < \bar{\pi}$, the incentive compatibility condition does not bind. In the candidate

equilibrium, the total expected value created by the firm is S_t, and investors receive $(1-\beta)S_t$ while managers receive βS_t. If a pair manager-investor were to deviate to a contract without effort, this would generate total expected value equal to $\hat{S}_t + B$. Under A1 and A2, $\hat{S}_t + B < S_t$. Hence it is impossible to design a contract requesting no effort to which both the manager and the investor would prefer to deviate. Consequently, for $\pi_t < \bar{\pi}$, there is an equilibrium with effort.

Second, turn to the case where $\hat{\pi} > \pi_t > \bar{\pi}$. As in the previous case consider a candidate equilibrium with effort and take a similar approach: In that candidate equilibrium, the investor receives in expectation P_t and the manager R_t. The sum of the two is S_t. Could a manager and an investor both prefer to deviate to a contract with effort? In that deviation, the total value created by the firm would be $\hat{S}_t + B$. Under A1 and A2, this is lower than the total value created in the candidate equilibrium S_t. Hence, the investor could not both agree to such the deviation. Consequently, for $\hat{\pi} > \pi_t > \bar{\pi}$, there is an equilibrium with effort.

Third, focus on the case where $\pi_t > \hat{\pi} > \bar{\pi}$. Consider a candidate equilibrium without effort. In that candidate equilibrium, the investor receives in expectation $(1-\beta)\hat{S}_t$ and the manager $\beta\hat{S}_t$. Could a manager and an investor both prefer to deviate to a contract with effort? In that deviation, the investor could at most get $P(\pi_t)$. Now, by construction of $\hat{\pi}$, we have $P(\pi_t) < (1-\beta)\hat{S}_t, \forall \pi_t > \hat{\pi}$. Hence, the investor could not agree to such a deviation. Consequently, for $\pi_t > \hat{\pi}$, there is an equilibrium without effort.
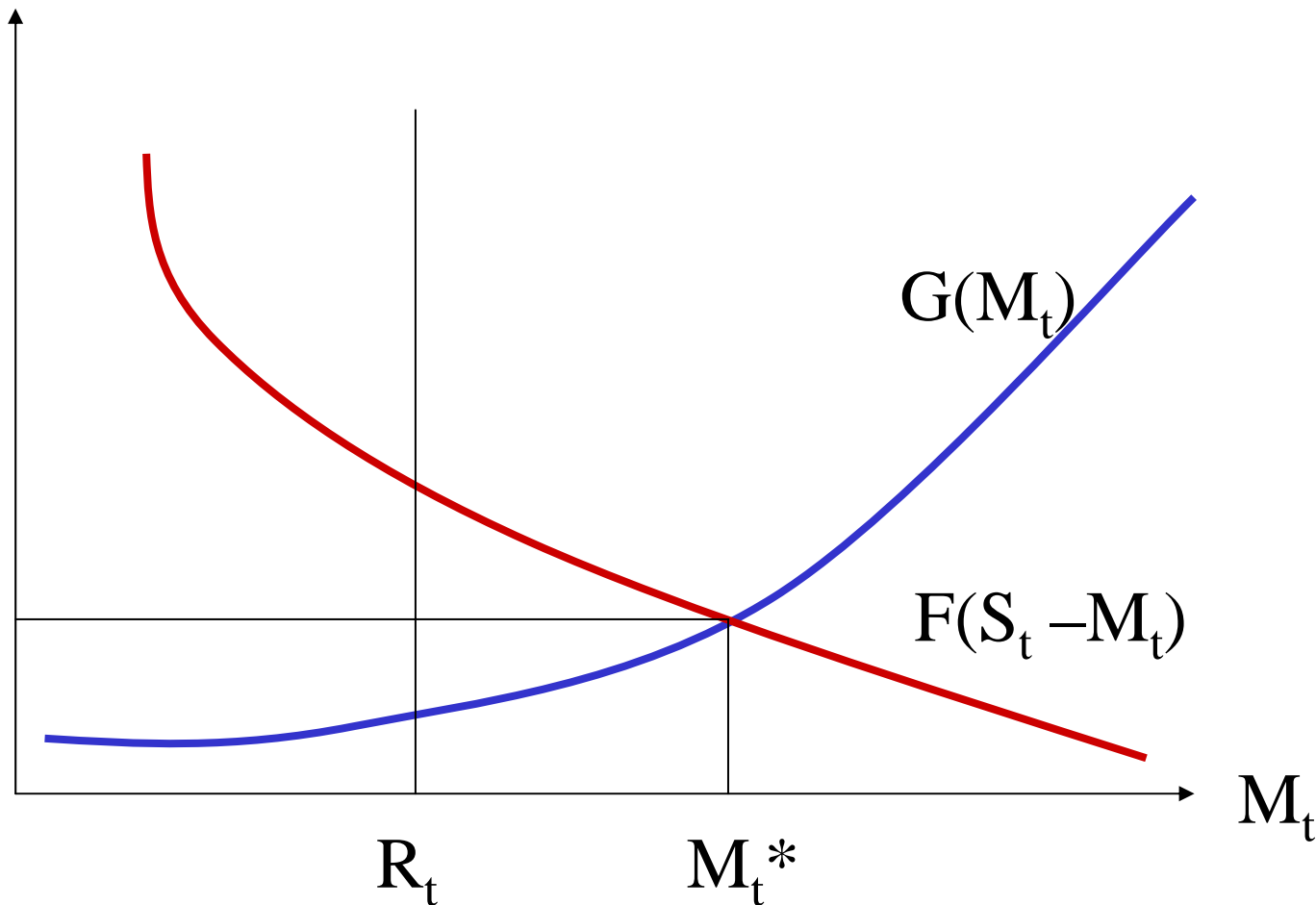
QED

Figure 1: The structure of uncertainty in period t
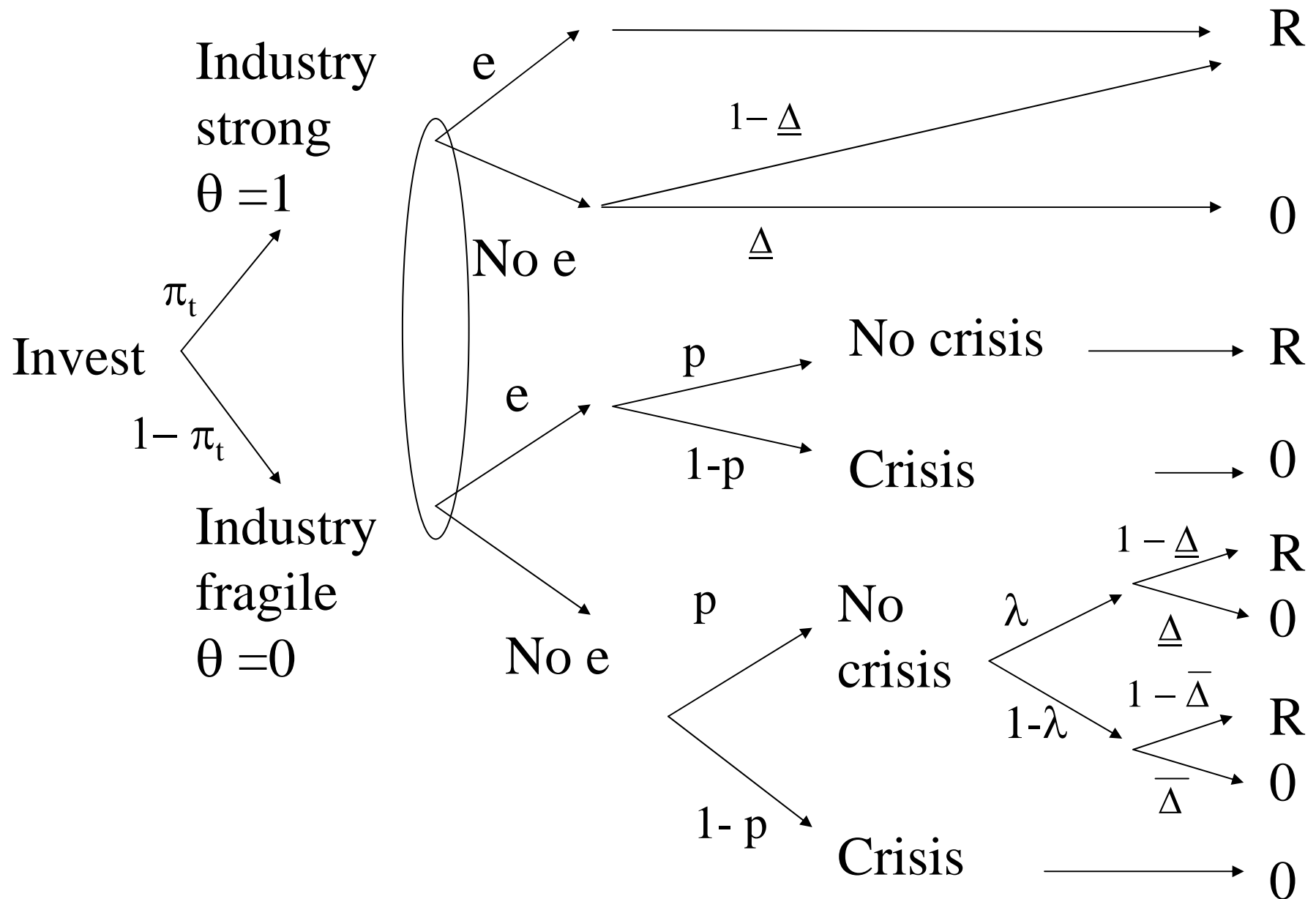
Figure 2, Panel A: Equilibrium without rationing

M_t is the expected compensation of the manager. $G(M_t)$ is the mass of managers who, given this compensation, prefer to work in the speculative sector, and $F(S_t-M_t)$ the mass of investors who also choose that sector. M_t^* is the market clearing expected compensation and R_t the rent which must be left to managers to incentivize effort. There is no rationing when $M_t^* > R_t$.

Figure 2, Panel B: Equilibrium with rationing

M_t is the expected compensation of the manager. $G(M_t)$ is the mass of managers who, given this compensation, prefer to work in the speculative sector, and $F(S_t\text{-}M_t)$ the mass of investors who also choose that sector. M_t^* is the market clearing expected compensation and R_t the rent which must be left to managers to incentivize effort. Since $M_t^* < R_t$ there is rationing.
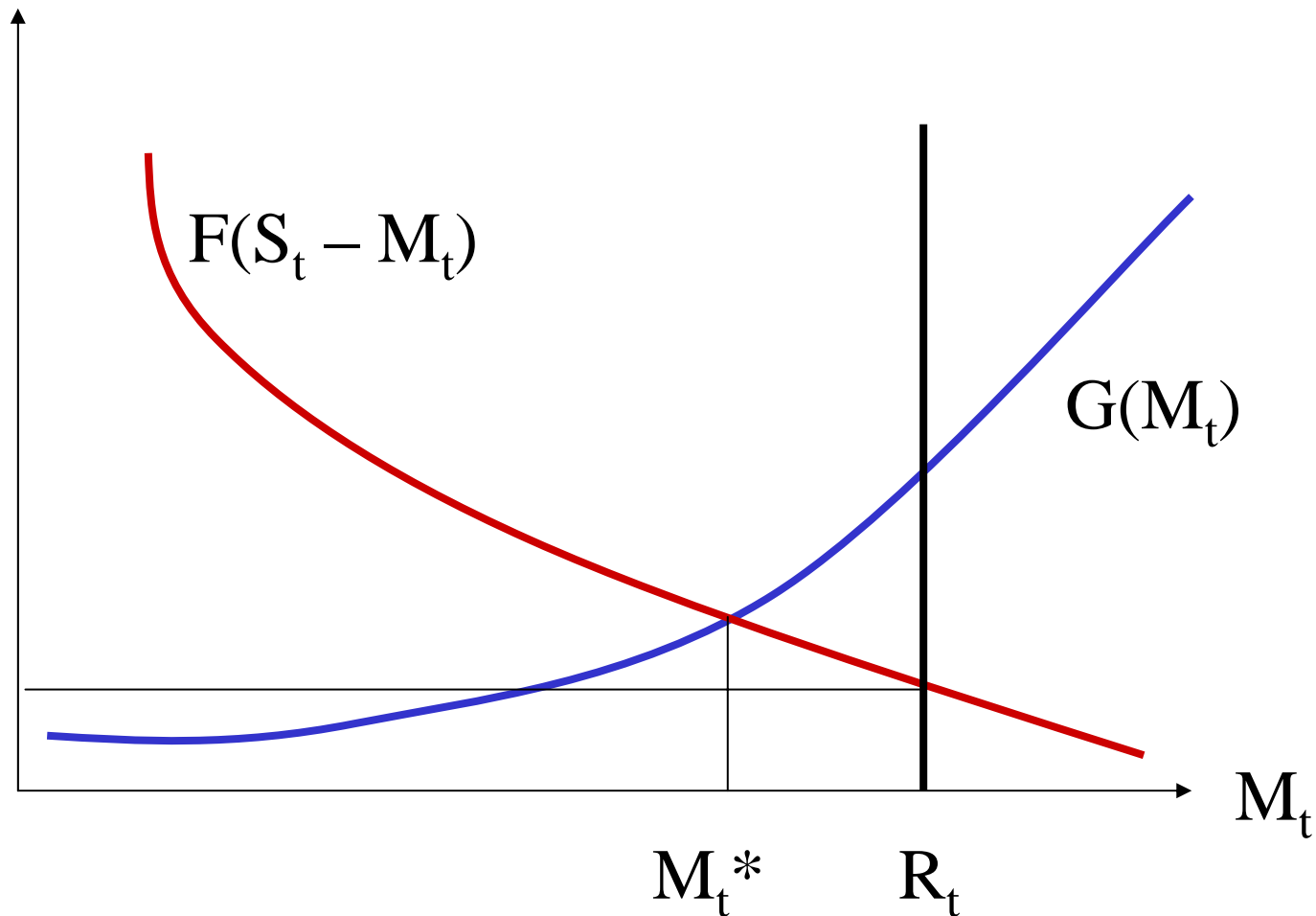
Figure 3: Equilibrium with effort

P_t is the pledgeable income. $(1-\beta)S_t$ is the equilibrium expected profit of investors if IC does not bind. When $\pi_t < \bar{\pi}$, the pledgeable income is above $(1-\beta)S_t$, so that the IC does not bind. In contrast when $\pi_t > \bar{\pi}$, the IC binds and investors earn the pledgeable income when effort is requested in equilibrium.
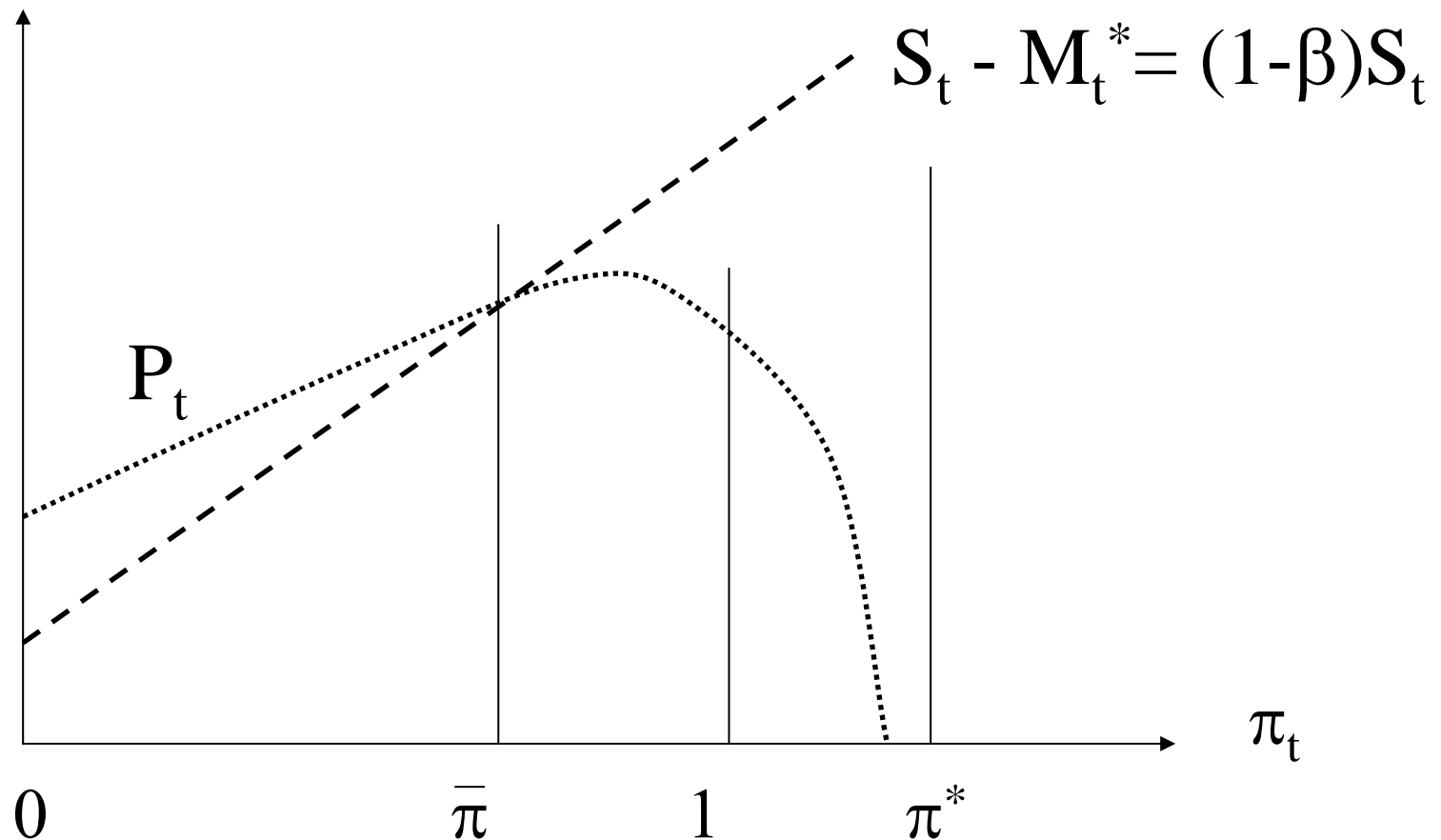
Figure 4: Equilibrium without effort

P_t is the pledgeable income. $(1-\beta)S_t$ is the equilibrium expected profit of investors if IC does not bind and effort is exerted. $(1-\beta)(\hat{S}_t+B)$ is the expected profit of investors without effort. When $\pi_t>\hat{\pi}$, investors, if they requested effort, would obtain the pledgeable income which is below $(1-\beta)(\hat{S}_t+B)$. Hence they prefer not to request effort.
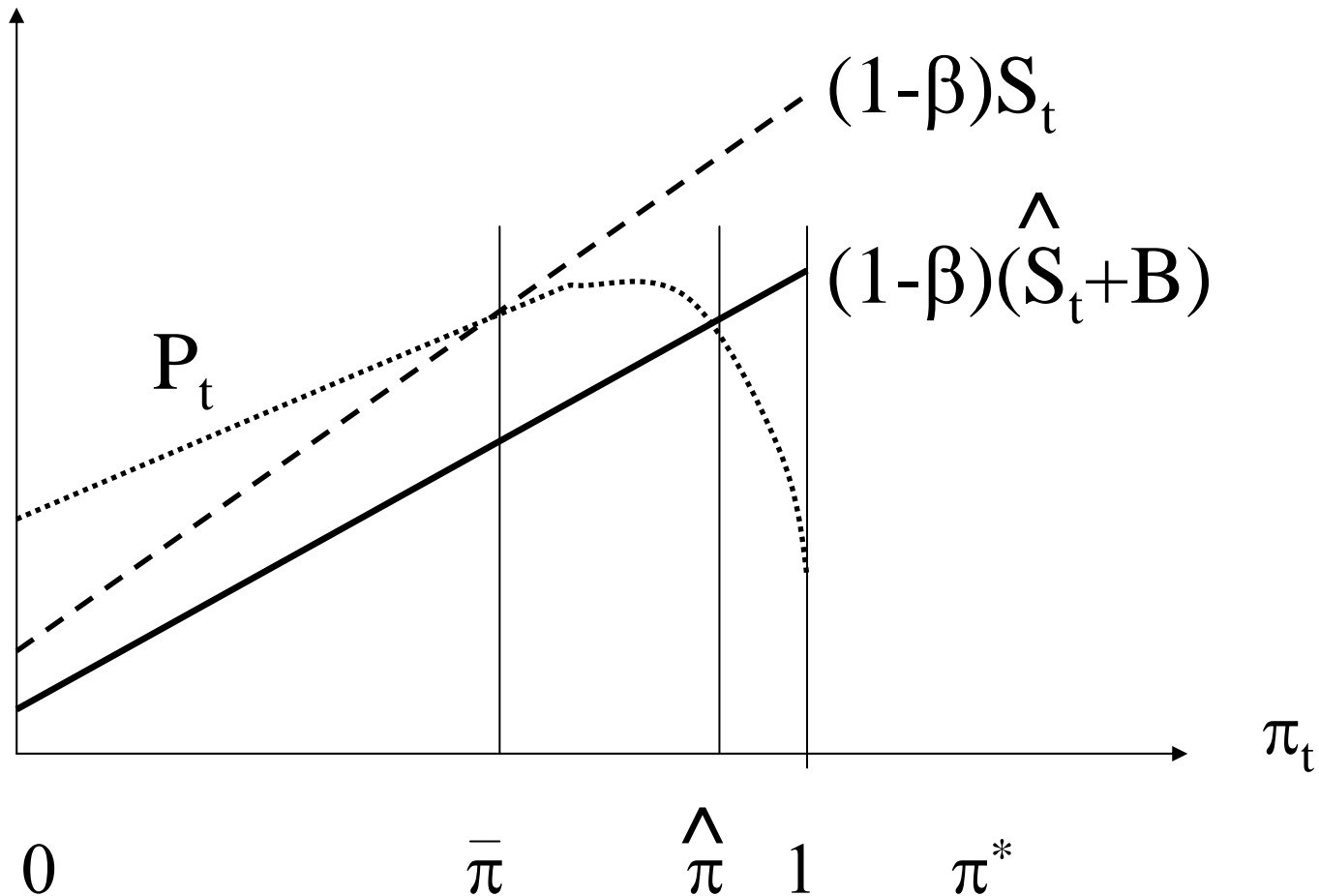
Figure 5: The lifecycle of the speculative sector

When the industry is solid, there is no crisis, π_t tends towards 1 and the figures below illustrate the evolution of the speculative industry. When the industry is fragile, at any point a crisis can occur, with probability p. In that case π_t goes to π_0 and remains at that point.

Size of the
speculative
sector

$0 \qquad \bar{\pi} \qquad \hat{\pi} \qquad 1$

π_t
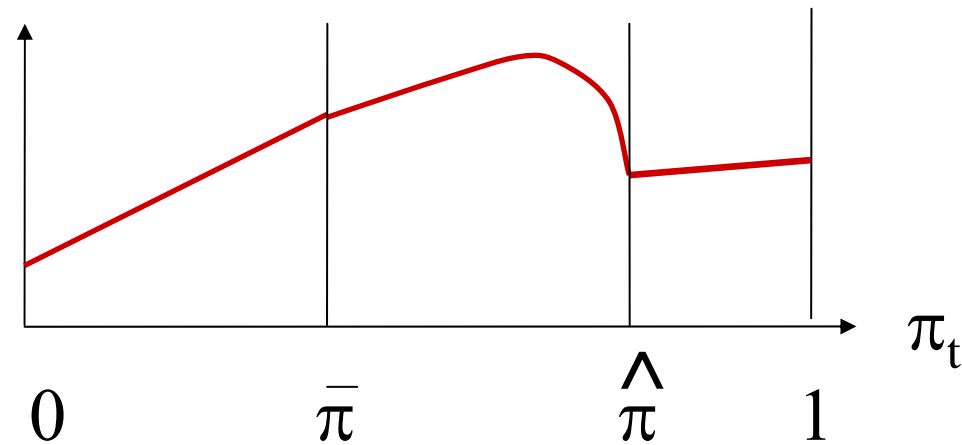
Realized return
averaged
across firms
in the
speculative
sector

Gross of managers fees

R

Net

$(1-\beta)R$

$R(1-\underline{\Delta})$

$(1-\beta)\,(R(1-\underline{\Delta})+B)$

$0 \qquad \bar{\pi} \qquad \hat{\pi} \qquad 1$

π_t