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Chapter 2

Inefficient securitization booms

2.1 Introduction

The recent financial crisis came as a surprise. The riskiness of securitized tranches and the underlying mortgages only came to light when U.S. house prices declined nationwide and foreclosures rapidly increased. A highly leveraged and interconnected financial sector propagated the mortgage losses which eventually resulted in a large recession. In hindsight, there arguably was a capital misallocation into securitized mortgages due to a lack of knowledge about their true risks.

To not repeat events, policy makers called for more transparency in securitization and money markets (which used securitized tranches as collateral) more generally. For example, the Dodd-Frank Act (2010) requires the disclosure of loan-level data as opposed to merely summary statistics. Some influential researchers however argue that it is the main purpose of money markets to be opaque so that they can provide liquidity by limiting informational asymmetries (Holmstrom, 2015). Indeed, also mortgage-backed securities themselves are designed to limit information production, which enhances their liquidity (Dang et al., 2015).

What is missing in the academic debate is the role of capital allocation. Even if their main purpose is to provide liquidity, a long history of banking crises shows that there is potential for massive capital misallocation in money markets. It is well known that capital allocation and liquidity provision do not go hand in hand, as information (asymmetries) or the lack thereof benefits the first and harms the latter. One would thus expect that markets produce an optimal amount of information, trading off the two. My contribution is to show that this is generally not the case when assets are correlated. Under laissez-faire, there is too much liquidity and too little information acquisition compared to what is socially optimal. This deteriorates capital allocation. At the heart of the inefficiency is a novel information externality originating from firms' securitization decisions. The implication for policy is that money markets may be too opaque, i.e., excessive in limiting information production.

To analyze the tension between liquidity and capital allocation, I consider a model where firms learn from security prices. As I mentioned, the effect of information production (by traders in the secondary market) is a double-edged sword: on the one hand it hinders liquidity provision due to adverse selection, and on the other hand some of it gets reflected in prices through the process of trading. The first effect harms the firms issuing the securities because the anticipated illiquidity in the secondary market raises investors' required rate of return in the primary market. The second effect benefits them because new information contained in prices improves firms' real investment decisions, an idea which goes back to Hayek (1945). For example, following a drop in the price of a firm's traded security, it may learn that its growth opportunity has a negative net present value, thus preventing inefficient investment. Here, the underlying assumption is that prices may reflect information that is new firms, for example because the market aggregates information by speculators which collectively may be better informed (Grossman (1976), Hellwig, 1980).[1]

Firms trade off the benefits and costs of information by actively managing their information environment. For example, by issuing securities which are more sensitive to fundamentals, firms increase outsiders' return to becoming informed by levering up their informational advantage (Dang et al., 2015). Or, when firms disclose more, for example by providing outsiders with detailed financial reports, then this decreases outsiders costs of estimating the value of the firm. In the model, firms choose their capital structure, but the results would also carry over to different contexts, such as choice of disclosure. What is important is that firms can fine-tune the informational tradeoff between liquidity and capital efficiency. Indeed, this way they can achieve an interior optimum.

I show that this tradeoff is distorted in a decentralized setting with multiple firms that face firm-specific as well as common risk. Firms may provide too little incentives for information production, which deteriorates capital allocation efficiency. There can also be too much information acquisition, excessively increasing firms' cost of capital.[2]

The mechanism works as follows. When firms make their securitization decision, their action has a direct and indirect effect. The direct effect is that issuing a more information-sensitive security increases their cost of capital, keeping constant the amount of information production (Myers and Majluf, 1984). The indirect effect is that this also increases information production, which further increases the cost of capital but also improves the informational content of prices, which benefits investment decisions.

The issue is that when it comes to information about common risks, firms do not internalize the indirect effect because they perceive information production as exogenous. When speculators become informed about the common risk factor, they trade on all firms' securities to take full advantage of their information. Thus their incentives to become informed depend on firms' joint decisions.[3] But this implies that each firms decision only has a marginal effect on information production about common risk factors.

When information production about the common risk factor has social value, meaning that the social benefits are larger than the social costs, then firms have incentives to

[1] This does not necessarily imply that firms are less informed about their investment opportunities than outsiders, but rather that outsiders can gather additional (or entirely different) signals.

[2] A concern with models of endogenous information acquisition is typically that noise traders do not have well-defined utility functions, precluding welfare analysis (Grossman and Stiglitz, 1980). Here, I endow them with utility functions and although they pay a passive role, they do have participation constraints. This allows me to do a full-blown welfare analysis.

[3] This does not necessarily imply that information about the common risk factor is cheap, since these risks are typically more difficult to analyze due to complexity (Coval et al., 2009a, 2009b).

excessively limit information production. The reason is that issuing risky securities to stimulate information production is privately costly due to their illiquidity. But more information production means more signals about the common risk factor, which increases indirectly also the option value of other firms' investment opportunities. Here, information about the common risk factor is a public good, the provision of which entails a private cost.

Firms thus free-ride by issuing too information-insensitive securities. This leads to ignorance about the common risk factor, related to when agents neglect risks due to their behavioral traits (Gennaioli et al., 2012a). There is an ignorance-fueled boom, which features over-investment relative to the social optimum where more information were produced. Information about the true risks only surfaces when they materialize.

Surprisingly, it is also possible that firms induce too much information production. When there is a lot of uncertainty about firm-specific risk (which is also learned through market prices), then firms have high-powered incentives to issue information-sensitive securities to learn from prices. This is because in contrast to the common factor, they fully internalize the costs and benefits of that information, since information production about their firm-specific risk only depends by their own action. However, when uncertainty about the common risk factor is low such that from a social perspective it is not worth learning about it, then firms may push it too far. By triggering information production about the common risk factor, this causes market illiquidity which also increases other firms' cost of capital. Here the externality is operating in the opposite direction. Where before the problem was that firms did not internalize the benefits of information about common risks accruing to others, here it is that they do not internalize the costs. Put differently, information is a public "bad". If firms could coordinate, they would issue information-sensitive securities so as to learn about firm-specific risk, but only up to the point where they do not induce wasteful information production about the common risk factor.

At the core of my paper is an information externality. Positive information externalities occur in different literatures due to the ease of duplication and common value. In Veldkamp (2006) and Veldkamp and Wolfers (2007), there is an efficient market for information due to certification and intellectual property rights protection. In contrast, I make the implicit assumption that information acquisition can not be certified and thus information can not be credibly sold. It must be revealed through privately optimal actions of the informed such as financial market trading. In the model of Veldkamp and Wolfers (2007), it is firms and not outsiders that produce information. They show that firms' labor market decisions may reveal this information, leading to free-riding by other firms. In these models there can not be an overproduction of information, because it only has a positive externality on other firms, not negative.

The herding literature uses information externalities to explain waves of financial innovations (Persons and Warther, 1997) and IPO's (e.g. Lowry and Schwert (2002), Benveniste et al., 2003). Going public reveals investors' information, which can trigger further IPO's. To the best of my knowledge, the positive information externality stemming from firms' capital structure decisions, with financial market trading as an information aggregation mechanism, has not been previously studied.

The implication of the information externality is that too little information is produced in booms, which has real consequences. In the model of Gorton and Ordonez

(2014), ignorance is optimal in a boom because there are no externalities. In related models, agents produce too little information in good times at the cost of inefficient market breakdowns in bad times when the scope for adverse selection increases (e.g. Pagano and Volpin (2012), Hanson and Sunderam, 2013). These models predict that that over time, market liquidity and thus investment should rebound as information asymmetries decrease. My theory implies that sudden halts to investments such as mortgages may be caused by more than financial frictions. Rather, under a state of large uncertainty, even moderate news can change expectations drastically. The release of adverse news is even ex post efficient, as then finally the veil of ignorance is lifted and further capital misallocation can be prevented. My theory implies that investment breakdowns should thus be very persistent, a testable empirical distinction. Also in terms of policy implications the theories differ. If investment breakdowns are only due to financial frictions, then ex post liquidity provision can alleviate the inefficiency. But limiting ignorance and overinvestment in booms requires ex ante policies.

On the methodological side, my model is related to a growing literature studying the feedback of information contained in asset prices on firms' real decisions.[4] There are only few papers featuring coordination failures on the firm side. In Subrahmanyam and Titman (1999) for example, there is a positive externality of having a large stock market due to more serendipitous information. Therefore in the good (bad) equilibrium, firms decide (not) to go public and the stock market is large (small). My model is closely related to a recent branch which incorporates multiple types of information (Goldstein Yang, 2014, 2015) and cross-learning via other firms' asset prices (Foucault and Frésard, 2018). Most related to the present approach are Huang and Zeng (2015), who also consider a model with multiple firms and a common risk factor. In their model, traders put *too much* weight on their information of the common risk factor relative to firm-specific risk factors when trading because real investment conforms more to the common shock due to informational spillovers, a reinforcing cycle. Other papers in the comovement literature share the idea that information about common risks crowds out information about idiosyncratic risk (e.g. Veldkamp and Wolfers (2007), Hoberg and Phillips, 2010). In my theory however it is the quality of information about common risks that is too low. While these two effects may even reinforce each other, there are also testable differences. According to comovement literature, in booms too many unproductive firms invest because of the lack of firm-specific information. Thus we should observe that real and financial busts should be concentrated among only a subset of firms in the industry. If during booms however it is the quality of information about industry risk factors that is poor, then in busts losses should be observed across the entire industry.

The rest of the paper is structured as follows. In section 2.2, I describe the model. In section 2.3, I solve for the equilibrium and study welfare. In section 2.4, I describe the private market inefficiency. Finally, I conclude in section 2.5.

[4] See Bond et al. (2012) for a survey.

2.2 The model

In this section I describe the model. There is a unit mass of firms indexed i, a large mass of investors, a large mass of speculators and a large masss of market makers. All are risk neutral and the discount rate is normalized to one. There are three dates t=0,1,2. At t=0, firms issue securities to raise cash for the purpose of making an investment. At t=1, before the firms invest, the securities are traded in the secondary market. This process aggregates the information endogenously acquired by speculators into prices. Then, upon inferring the signals contained in the prices of the securities, the firms decide whether to invest. At t=2, payoffs are distributed. This order of events allows firms to learn from market prices to guide their investment decisions. Importantly, the security design decision of firms influences how much information is acquired, which determines how much they can learn.

2.2.1 Investment

Firms are endowed with a project that can be undertaken at t=1 at cost K and generates cash flow $A_a A_i(x_H - x_L) + x_L$ at t=2. There is a safe return x_L and an excess return $x_H - x_L$. The factors A_a and A_i are two stochastic productivity shocks which determine whether the excess return will be realized. Specifically, shock A_a captures an industry-wide, common productivity shock and shock A_i captures a firm-specific, idiosyncratic productivity shock. The shocks are independently and binomially distributed. With probability q_a respectively q_I they are 1, otherwise they are 0.

I make two assumptions on firms' cash flows. First, investment is risky:

$$\text{A.1: } x_L < K.$$

Otherwise information would have no value, as investment is always NPV > 0. I also assume that the NPV of a project is positive under the prior:

$$\text{A.2: } q_a q_I(x_H - x_L) + x_L \geq K.$$

This is not a trivial assumption. Due to learning it is possible that even a negative NPV project becomes positive when there is good news at t=1, as in Dow et al. (2017). Rather, it restricts the amount of possible equilibria by ensuring that firms' default option is to invest.

2.2.2 Securities

Firms are penniless. At t=0, firm i raises capital K by issuing a security to investors by making them a take-or-leave offer. The security promises return $R_{H,i} \leq x_H$ at t=2 if the excess return is realized and $R_{L,i} \leq x_L$ if not, both conditional on investment being undertaken at t=1. In case the firm does not invest, the security pays out an amount R_i of the undeployed capital K.[5]

To be clear, I use simple binomial distributions to solve the model in closed form and to make a point about the information-sensitivity of the claims firms issue. The

[5] As in the securitization literature, I assume that $R_{L,i} \leq R_{H,i}$. Also, here it is not important that $R_{L,i}$ is different from R_i. In fact, we will see later that they are not uniquely pinned down in equilibrium as all that matters will be $R_{H,i} - R_{L,i}$.

aim of this paper is not to derive a general security design in a continuous state-space. We will see that the binomial structure nevertheless can capture the notion of information-sensitivity.

2.2.3 Information acquisition and trading

At t=1, a large measure of speculators are born who can acquire information about the two productivity shocks. The cost of becoming fully informed about the realization of the idiosyncratic risk factor of a unit measure of firms is c_I. Becoming fully informed about the common risk factor costs c_a. The informed trade on their superior information by submitting market orders to deep-pocketed, competitive and uninformed market makers in the spirit of Kyle (1985).

As in Foucault and Frésard (2018), I assume that there is "cross-asset learning".[6] That is, market makers observe the order flow in each security before setting their price. This assumption is natural because firms make their decisions at low frequency. Thus, by the time firms make their decisions, security prices are likely to reflect all order flow information. This implies that the price of firm i is a sufficient statistic for all information contained in order flow about the prospects of firm i. Therefore, firm i's investment decision will only depend on its own security price in equilibrium. I could assume that market makers can condition their price only on the order flow they receive themselves (no cross-asset learning). In this case, firm i optimally conditions its investment decision on all security prices. This does not change the implications of the model. The reason, intuitively, is that cross-asset learning is then performed by the firms rather than market makers.

For the speculators' information not to be fully revealed, the investors which funded the firms at t=0 experience unobservable liquidity shocks and are forced to sell their security. Their noisy supply of security i is $\ell_i = \frac{1}{2} + \Theta_a + \Theta_i$, where $\Theta_a \sim U[-\theta_a, \theta_a]$ and $\Theta_i \sim U[-\theta_I, \theta_I]$ are independently distributed.[7] The factor Θ_a is an aggregate liquidity shock which masks the speculators' trades who are informed about the common productivity shock A_a.[8] Θ_i is an idiosyncratic liquidity shock which masks the speculators' trades who about the idiosyncratic productivity shock A_i.

For completeness, next I specify a utility function for investors that is consistent with the noisy supply of securities just specified. It is a linear Diamond and Dybvig (1983) type utility function. I assume that each investor j holds only a small amount of securities issued by only one firm i. Then her utility is as follows:

$$U_{j,i} = l_{j,i} c_j^1 + c_j^2, \quad \text{where } l_{j,i} = \frac{1}{2} + \Theta_a + \Theta_i \tag{2.1}$$

where c^1 and c^2 is consumption at t=1 resp. t=2 and $l_{j,i}$ is the probability that she must consume early by selling the security in the market. $l_{j,i}$ depends on the realizations of Θ_a and Θ_i. If we add up the mass of securities of firm i at t=1, as required we get exactly l_i. The underlying assumption here is that liquidity risk is not diversifiable in the cross-section. Without this assumption, each investor would hold a diversified portfolio and there would be no trades in individual securities, and thus no informed

[6] See Pasquariello and Vega (2015) for evidence of cross-asset learning.

[7] I assume that $\theta_a + \theta_I \leq \frac{1}{2}$ to ensure that the noisy supply doesn't exceed the total supply of securities.

[8] Bernhardt and Taub (2008) elaborate further why this is required.

trades about individual firms. This is clearly at odds with reality.

Finally, placing unbounded orders would reveal the speculators' information even in the presence of noise trades, so I restrict them to buy or (short-) sell only up to one unit measure of each security.[9][10]

Recapping the sequence of events:

0.1 Each firm i raises cash K by selling a security ($R_{H,i}$,$R_{L,i}$, R_i) to investors.
1.1 Investors are forced to sell an unobservable fraction ℓ_i of each firms security.
1.2 Speculators choose to become informed about A_a and/or A_i.
1.3 Investors and speculators submit their orders and market makers set prices. Trades are executed.
1.4 Firms choose whether to invest.
2.1 Funded projects mature and payoffs are distributed.

2.2.4 Discussion

By assuming that all agents apart from firms are competitive, firms capture the entire social surplus. This allows me to isolate the inefficiency stemming from firms' decisions.

For simplicity I also assume that speculators don't participate in primary market. This has two reasons. First, if some informed speculators were forced to sell the securities they acquired in the primary market then they can not make use of their private information. The amount of informed capital would then be a random variable, and I would lose tractibility. Second, if they could also acquire information before they participate in the primary market, then this would lead to a complicated game in the primary market. What is important is that there is some way for information acquired by speculators to flow back to firms and that this information is aggregated and visible to all participants. Plus the fact that firms bear the costs of adverse selection, which is natural given that all other agents have participation constraints.

2.3 Equilibrium and social optimum

In this section, I solve for the competitive equilibrium of the model and the social planner's solution.

2.3.1 Trading strategies and investment decisions

Due to risk neutrality and perfect competition, each informed speculator trades the maximum size possible. Speculators thus go long one unit of security i when they receive a positive signal and short otherwise.

[9] As discussed in the survey by Brunnermeier and Oehmke (2013a), the specific size of this position limit is not essential for the results, as long as speculators can not take unlimited positions.

[10] Other papers show that monopolistic speculators would also spread their trades across multiple securities to camouflage their information (e.g. Bernhardt and Taub (2008)), so this is consistent. Moreover, competitive speculators would only trade the most information sensitive security when informed about A_a if they for example had a dollar constraint instead.

I assume that a single speculator can only acquire information about either firm-specific risk or common risk. Note that the two types of information are (partial) substitutes for learning the fundamental value of securities, because if either A_a or A_i are zero, then the realization of the other factor is irrelevant. Combined with the fact that signal costs are additive separable, this assumption is natural.

Total order flow X_i for security i is $\frac{1}{2} + \Theta_a + \Theta_i + (2A_a - 1)\phi_a + (2A_i - 1)\phi_i$, the sum of the liquidation shocks and speculators informed trades. Upon observing order flow, market makers update their beliefs. Due to cross-learning, all market makers have the same information set. Therefore there is a representative market maker who prices all securities.

Market makers infer speculators' information about the common shock A_a by calculating the average order flow over all the securities, $\bar{X} \equiv \int X_i \mathrm{d}i$. Define $\hat{q}_a \equiv \Pr(A_a = 1|\bar{X}, \phi_a, \{\phi_i\})$ as their updated belief that the common productivity shock is positive conditional on observed total order flow $\bar{X}$ and the equilibrium measure of informed speculators ϕ_a and ϕ_i for all i. By Bayes' rule,

$$\hat{q}_a = \frac{q_a \varphi_a(\bar{X} - \int \frac{1}{2} + \phi_a + (2A_i - 1)\phi_i \mathrm{d}i)}{q_a \varphi_a(\bar{X} - \int \frac{1}{2} + \phi_a + (2A_i - 1)\phi_i \mathrm{d}i) + (1 - q_a)\varphi_a(\bar{X} - \int \frac{1}{2} - \phi_a + (2A_i - 1)\phi_i \mathrm{d}i)},$$

where $\varphi_a(\Theta_a)$ is the density function of the uniform distribution of Θ_a. This yields

$$\hat{q}_a = \begin{cases} 1 & \text{if } \widetilde{X} \in [-\phi_a + \theta_a, \phi_a + \theta_a] \\ q_a & \text{if } \widetilde{X} \in [\phi_a - \theta_a, -\phi_a + \theta_a] \\ 0 & \text{if } \widetilde{X} \in [-\phi_a - \theta_a, \phi_a - \theta_a]. \end{cases}$$

where $\widetilde{X} \equiv \bar{X} - \frac{1}{2} - \int (2A_i - 1)\phi_i \mathrm{d}i$ is the normalized total order flow market makers use to infer A_a. Thus there are three possible contingencies. When aggregate order flow $\bar{X}$ (resp. $\widetilde{X}$) is very large (small), then speculators' positive (negative) signal about the common risk factor is fully revealed. When $\bar{X}$ is intermediate, their private information remains unknown and market makers' updated belief that $\Pr(A_a = 1)$ is equal to the prior q_a.[11]

To infer speculators' signal about the idiosyncratic factor A_i of firm i, market makers subtract total order flow $\bar{X}$ and a constant term from the order flow of security i. Define $\hat{q}_i \equiv \Pr(A_i = 1|X_i, \bar{X}, \phi_a, \{\phi_i\})$ as their updated belief that the productivity shock of firm i is positive. Then by Bayes' rule,

$$\hat{q}_i = \frac{q_I \varphi_I(X_i - \bar{X} + \int (2A_i - 1)\phi_i \mathrm{d}i - \phi_i)}{q_I \varphi_I(X_i - \bar{X} + \int (2A_i - 1)\phi_i \mathrm{d}i - \phi_i) + (1 - q_I)\varphi_I(X_i - \bar{X} + \int (2A_i - 1)\phi_i \mathrm{d}i + \phi_i)},$$

where $\varphi_I(\Theta_i)$ is the density function of the uniform distribution of Θ_i. This gives

$$\hat{q}_i = \begin{cases} 1 & \text{if } \widetilde{X}_i \in [-\phi_i + \theta_I, \phi_i + \theta_I] \\ q_i & \text{if } \widetilde{X}_i \in [\phi_i - \theta_I, -\phi_i + \theta_I] \\ 0 & \text{if } \widetilde{X}_i \in [-\phi_i - \theta_I, \phi_i - \theta_I]. \end{cases}$$

[11] The reason that their signal is either fully revealed or masked is due to the simplicity of the uniform distribution of liquidity shocks.

where $\widetilde{X}_i \equiv X_i - \bar{X} + \int (2A_i - 1)\phi_i \mathrm{d}i$ is the normalized order flow market makers use to infer A_i. The intuition is the same as for the inference about A_a. Firms' idiosyncratic productivity shock A_i is revealed to be 1 (0) if their securities order flow is large (small) compared to the aggregate. If it is intermediate, no information is revealed and the updated belief remains equal to the prior q_I.

To price the securities, market makers must also anticipate firms' investment decisions conditional on the information that will be contained in prices. The project is worth undertaking for firm i if the updated probabilities $\hat{q}_a$ and $\hat{q}_i$ are high enough. Since by assumption investment is NPV > 0 under the prior, firms' default option is to invest. Thus they forgo investment if prices signal that either A_a or A_i are 0, in which case the securities' payoff is just R_i. The pricing rule of security $(R_{H,i}, R_{L,i}, R_i)$ thus is[12]

$$P(X_i, \bar{X}) = \begin{cases} \hat{q}_i \hat{q}_a (R_{H,i} - R_{L,i}) + R_{L,i} & \text{if } \widetilde{X} > \phi_a - \theta_a \\ & \quad \text{and } \widetilde{X}_i > \phi_i - \theta_I. \\ R_i & \text{otherwise.} \end{cases}$$

2.3.2 Trading profits

To analyze the equilibrium amount of speculators becoming informed about each firms' idiosyncratic risk factor ϕ_i and the common risk factor ϕ_a we first must know speculators' expected profit if they become informed.

LEMMA 1. *The expected trading profit to becoming informed about A_i resp. A_a is*

$$\pi_i(\phi_i) = \left(1 - \frac{\phi_i}{\theta_I}\right) q_I(1 - q_I) q_a (R_{H,i} - R_{L,i}) \quad \forall i$$
$$\pi_a(\phi_a) = \left(1 - \frac{\phi_a}{\theta_a}\right) q_a(1 - q_a) q_I \int R_{H,i} - R_{L,i} di.$$

Proof: Appendix B.1.1.

Expected profits are made up of three terms. The first, $1 - \frac{\phi_i}{\theta_I}$ resp. $1 - \frac{\phi_a}{\theta_a}$ is the probability that speculators' information remains hidden. It depends inversely on how many speculators become informed relative to the noisiness of liquidity-driven trades. We can interpret $\frac{\phi_i}{\theta_I}$ resp. $\frac{\phi_a}{\theta_a}$ as a signal to noise ratio. The higher it is, the likelier the chance that the true state of nature will be revealed through trading and thus the lower speculators' profits.

In the second term, the cross-product $q_I(1 - q_I)$ is the difference in beliefs about $\hat{q}_i$ between the informed and uninformed (when no information is revealed). With probability q_I, $A_i = 1$ and thus the difference is in beliefs between knowing and not knowing is $1 - q_I$. Similarly, with probability $1 - q_I$, $A_i = 0$ and thus the difference is $q_I - 0$. q_a turns up because it affects the expected fundamental value of a security. Given that speculators can trade one security of each firm, this de facto allows them to make larger trades. For the profits from information about A_a the same logic applies.

[12] As discussed in Dow et al. (2017), there can also exist equilibria where market makers do not guide firms to make the right investment decision in expectation. Apart from being uninteresting, they do not survive a slight perturbation of the model where firms can observe order flow directly, so I rule them out.

The third term $R_{H,i} - R_{L,i}$ in the first equation is the excess return of the security. The larger it is, the more useful knowing what state will occur is. Note that the profits to becoming informed about firm-specific risk and the common risk factor are near mirror images except for the signal to noise ratio and the last term. For the latter, what matters is the excess return of *all* securities combined, because information about the common factor can be used to trade on *all* securities. Furthermore, this implies that the excess return $R_{H,i} - R_{L,i}$ of firm i's security on the margin has no effect on speculators' incentives to become informed about the common risk factor because it is atomistic. This is the source of the inefficiency in the competitive equilibrium described in setction 2.3.6.

Note that profits are independent of the payout R_i when firms do not invest. The reason simply is that the informed lose their advantage when firms choose to retain the cash that they raised.

One should also note the surprising fact that expected trading profits are independent of how many speculators become informed about the other productivity shock. That is, $\pi_i(\phi_i)$ is independent of ϕ_a and vice-versa. The intuition for this is as follows. Take for example an increase in the mass of speculators becoming informed about the common risk factor. This increases the probability that there is bad news about A_a, which decreases profits of being informed about the idiosyncratic risk factor because then the firm does not invest. But there is also a higher chance that there is good news about A_a, which increases the expected value of the security. This effect increases the profits of becoming informed about A_i because information can be "levered up more", as explained earlier. In this setup these two forces cancel each other out, which keeps things tractable.

2.3.3 Information acquisition in equilibrium

Speculators decide whether to acquire information by comparing the cost c_a and c_I to the profit $\pi_a(\phi_a)$ and $\pi_i(\phi_i)$, respectively. Denoting the equilibrium level of ϕ_a and ϕ_i by ϕ_a^* and ϕ_i^*, respectively, an equilibrium with interim level of information production $\phi_a^* \in [0, \theta_a)$ and $\phi_i^* \in [0, \theta_I)$ is obtained when, given that a measure ϕ_a^* resp. ϕ_I^* of speculators choose to produce information, a speculator who acquires information breaks even in expectation:

$$\pi_a(\phi_a^*) = c_a$$

Alternatively, there may be a corner solution for ϕ_a. An equilibrium with no information production $\phi^* = 0$ is obtained when, given that none of the speculators produce information, the cost of producing information is greater than the expected trading profit:

$$\pi_a(0) < c_a$$

The equilibrium amount of information production ϕ_a^* and ϕ_i^* can not exceed θ_a and θ_I, respectively, otherwise there is a Grossman and Stiglitz (1980) type of paradox. Information would be perfectly revealed, preventing the informed of recuperating their information costs. Solving the two conditions above for both aggregate and idiosyncratic information directly leads to Lemma 2:

LEMMA 2. *The equilibrium amount of speculators* ϕ_a^* *and* ϕ_i^* *becoming informed about the common shock* A_a *and firm-specific shocks* A_i *are*

$$\phi_a^* = \max\left[\theta_a\left(1 - \frac{c_a}{q_I q_a(1-q_a)\int R_{H,i} - R_{L,i}\,di}\right), 0\right] \tag{2.2}$$

$$\phi_i^* = \max\left[\theta_I\left(1 - \frac{c_I}{q_a q_I(1-q_I)(R_{H,i} - R_{L,i})}\right), 0\right] \forall i \tag{2.3}$$

To shorten notation, I define the excess return $\Delta R_i \equiv R_{H,i} - R_{L,i}$ each firm issues and the total excess return $\Delta R \equiv \int \Delta R_i \mathrm{d}i$. For the analysis later it is also useful to define the thresholds $\overline{\Delta R_I} \equiv \frac{c_I}{q_a q_I(1-q_I)}$ and $\overline{\Delta R_a} \equiv \frac{c_a}{q_I q_a(1-q_a)}$ for which speculators are just indifferent in acquiring information about that factor. In the knife-edge case where $\Delta R = \overline{\Delta R_a}$ resp. $\Delta R_i = \overline{\Delta R_I}$, the signal to noise ratios $\frac{\phi_a^*}{\theta_a}$ and $\frac{\phi_i^*}{\theta_i}$ are just a function of $\frac{\overline{\Delta R_a}}{\Delta R}$ and $\frac{\overline{\Delta R_I}}{\Delta R_i}$, respectively. If $\Delta R > \overline{\Delta R_a}$ resp. $\Delta R_i > \overline{\Delta R_I}$, then speculators acquire information about the common factor resp. idiosyncratic risk factor, otherwise not. These thresholds are important when I characterize the social planners problem problem and the competitive equilibrium.

2.3.4 Primary market underpricing

Investors are only willing to buy securities in the primary market if they are sufficiently underpriced because they anticipate liquidation losses in the secondary market due to the informed. The value investors attach to security ($R_{H,i}$, $R_{L,i}$, R_i) at t=0 must be at least K for them to be willing to finance:

$$\begin{aligned} &\overbrace{q_a q_I(R_{H,i} - R_{L,i}) + R_{L,i}}^{\text{Fundamental value under the prior}} + \overbrace{\left[(1-q_a)\frac{\phi_a^*}{\theta_a} + (1-q_I)\frac{\phi_i^*}{\theta_I}\left(1-(1-q_a)\frac{\phi_a^*}{\theta_a}\right)\right]}^{\text{Probability that firm does not invest}}(R_i - R_{L,i}) \\ &- \underbrace{\phi_a^*\left(1-\frac{\phi_a^*}{\theta_a}\right)q_a(1-q_a)q_I(R_{H,i}-R_{L,i})}_{\text{liquidation losses from informed trade about } A_a} - \underbrace{\phi_i^*\left(1-\frac{\phi_i^*}{\theta_I}\right)q_I(1-q_I)q_a(R_{H,i}-R_{L,i})}_{\text{liquidation losses from informed trade about } A_i} \geq K \end{aligned} \tag{2.4}$$

Their valuation can simply be written as the fundamental value of the security adjusted by a few terms. First, if there is bad news because the project will fail, firms forgo investment and investors receive R_i instead of $R_{L,i}$. Second, since trading is a zero-sum game and market makers break even, investors' losses are equal to speculators' gains from trade. Intuitively, with probability $1 - \frac{\phi_a}{\theta_a}$ resp. $1 - \frac{\phi_i}{\theta_I}$ market makers remain uninformed and there is over- or underpricing. The investors' curse is that many (few) of them must liquidate precisely when the firms' fundamentals are strong (weak), conditional on market makers not learning speculators' information. The difference between how many must liquidate when information remains hidden versus unconditionally is exactly ϕ, the first term in the liquidation losses in equation 2.4.

Now we have all the ingredients to set up the maximization problem at t=0. I will first characterize the constrained planner's problem as a benchmark before analyzing the competitive equilibrium.

2.3.5 The constrained planner's problem

The planner is constrained, i.e. he can neither acquire information himself nor have speculators report to him directly. He can only regulate firms capital structure. I focus on policies where all firms must issue the same security. This is a natural assumption given that firms are ex ante identical in this setup. It also implies that the same amount of firm-specific information is gathered for each firm, so I define $\phi_I \equiv \phi_i$ for all i.

The welfare criterion can simply be written as the ex ante surplus of firms, because investors, speculators and market makers all break even. The planner's objective function therefore is

$$\max_{R_H,R_L,R} W = \overbrace{(q_a q_I(x_H - x_L) + x_L - K)}^{\text{NPV under prior}} \quad \overbrace{-\phi_I^* c_I - \phi_a^* c_a}^{\text{real cost of information}}$$
$$+ \underbrace{\left[\frac{\phi_a^*}{\theta_a}(1-q_a) + \frac{\phi_I^*}{\theta_I}(1-q_I) - \frac{\phi_a^*}{\theta_a}(1-q_a)\frac{\phi_I^*}{\theta_I}(1-q_I)\right](K - x_L)}_{\text{value of information}},$$

subject to the break even constraint (2.4) of the investors for all firms and the equilibrium amount of speculators becoming informed about the common (2.2) and idiosyncratic factors (2.3).

The first term is simply the expected value of the project under the prior. The second term is the real cost of information acquisition born by the speculators, which is passed on to firms in the form of underpricing in the primary market. The third term reflects the gains of information. If there is bad news, this prevents firms from investing in a negative NPV project, which would produce a sure loss of $K - x_L$. The decision whether to invest can be interpreted as a call option, where K corresponds to the strike price and the signal to noise ratios $\frac{\phi_a^*}{\theta_a}$ and $\frac{\phi_I^*}{\theta_I}$ to the volatility.[13]

Note that the third term is decreasing in the signal to noise ratios. This is because there is a chance that bad information about both risk factors is revealed for a given firm, but only one of them is sufficient to deter investment. In other words, the two types of signals are (imperfect) substitutes for investment decisions.

It turns out that welfare only depends on the securities' excess return ΔR because information acquisition only depends on ΔR. The investor's breakeven condition pins down R_L and R.[14] ΔR thus is a sufficient statistic to characterize the optimal security. However, this also implies that the planner only has one choice variable and can not fine-tune the signal-to-noise ratios of the two risk factors independently from each other. We get the planner's first order condition (FOC) by plugging in the equilibrium mass of speculators becoming informed into the objective and taking the derivative

[13] In this simple model where firms' investment decisions are binary, in good states information has no value because by assumption A.2. firms' default option is to invest. This assumption is not crucial however.

[14] In fact, R_L and R are only pinned down jointly, thus they are indeterminate.

w.r.t. ΔR:

$$\left[\frac{\frac{\partial\phi_a}{\partial\Delta R}}{\theta_a}(1-q_a)\left(q_I+(1-\frac{\phi_I}{\theta_I})(1-q_I)\right)+\frac{\frac{\partial\phi_I}{\partial\Delta R}}{\theta_I}(1-q_I)\left(q_a+(1-\frac{\phi_a}{\theta_a})(1-q_a)\right)\right](K-x_L)$$
$$-c_a\frac{\partial\phi_a}{\partial\Delta R}-nc_I\frac{\partial\phi_I}{\partial\Delta R}=0. \quad (2.5)$$

The FOC sharpens our intuition to what extent the two signals are substitutes.[15] Take for example the marginal change in the signal-to-noise ratio of the common risk factor, $\frac{\partial\phi_a}{\partial\Delta R}/\theta_a$. For the fraction q_I of firms with good firm-specific realizations, bad news about the common risk factor can prevent them from making a NPV < 0 investment. Thus, for them a higher signal-to-noise ratio of the common risk factor has proportional efficiency gains, so the marginal value of information is constant. On the other hand, for the fraction $1-q_I$ of firms with bad firm-specific outcomes, more information about the common risk factor is only useful for those that do not learn about their firm-specific shock. The others that do learn forgo investment regardless. Thus, the marginal value of increasing ϕ_a^* is smaller the larger the firm-specific signal to noise ratio $\frac{\phi_I}{\theta_I}$ is for $1-q_I$ of firms.

The feasible range of ΔR is bounded from above and below. Define as $\Delta R_{\min}$ resp. $R_{H,\min}-R_{L,\min}$ the safest possible security that firms can issue. Since investment is risky, also securities must be risky, so $\Delta R_{\min}>0$. Due to limited liability, there is also an upper bound on ΔR, defined as $\Delta R_{\max}$ resp. $R_{H,\max}-R_{L,\max}$.[16] Thus for ΔR to be feasible, we need that $\Delta R\in[\Delta R_{\min},\Delta R_{\max}]$. To make the problem interesting, I assume that $\Delta R_{\max}$ is sufficiently large to incentivize information production, i.e. $\Delta R_{\max}>\max[\overline{\Delta R_I},\overline{\Delta R_a}]$.

PROPOSITION 1. ***(planner's solution)*** *If* $\left(\frac{c_a}{q_a}+\frac{c_I}{q_I}\right)(K-x_L)>c_I\frac{\theta_I c_I}{q_a q_I(1-q_I)}+c_a\frac{\theta_a c_a}{q_I q_a(1-q_a)}$, *then it is optimal to set ΔR maximal. Otherwise, an interior solution ΔR^{SP}_{Int} is optimal if it exists, where*

$$\Delta R^{SP}_{Int}=\frac{\overbrace{2\overline{\Delta R_a}(1-q_a)\overline{\Delta R_I}(1-q_I)(K-x_L)}^{\text{decreasing component}}}{\underbrace{\theta_I\overline{\Delta R_I}c_I+\theta_a\overline{\Delta R_a}c_a}_{\text{marginal cost}}-\underbrace{\left(\overline{\Delta R_I}(1-q_I)q_a+\overline{\Delta R_a}(1-q_a)q_I\right)(K-x_L)}_{\text{constant component}}}.$$

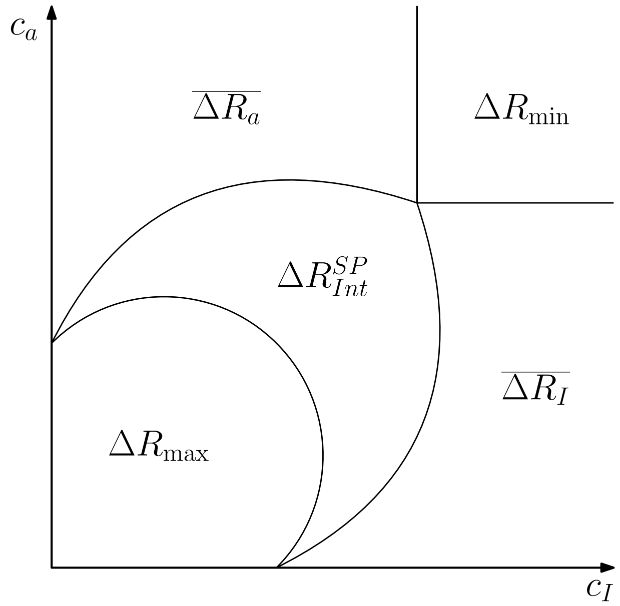
It exists as long as it profitable for speculators to acquire information about both risk factors, i.e. if $\Delta R^{SP}_{Int}>\max[\overline{\Delta R_I},\overline{\Delta R_a}]$. If not, then there are two possibilities. (i) If $\overline{\Delta R_I}>\overline{\Delta R_a}$, then $\overline{\Delta R_I}$ is optimal whenever $\frac{1}{\theta_a}(1-q_a)(K-x_L)>c_a$, otherwise ΔR_{min}. (ii) If $\overline{\Delta R_I}<\overline{\Delta R_a}$, then $\overline{\Delta R_a}$ is optimal whenever $\frac{1}{\theta_I}(1-q_I)(K-x_L)>c_I$, otherwise ΔR_{min}.

Proof: appendix B.1.2

[15] I normalize the FOC by multiplying it with ΔR^2 for the entire analysis. Then the marginal cost as well as part of the marginal value of information is a constant function of ΔR.

[16] There are three different configurations of R_H, R_L and R which maximize R_H-R_L, depending on the parameter values.

Figure 2.31: Socially optimal security.



This Figure shows the socially optimal security depending on the costs of information c_I and c_a about the firm-specific factor and common risk factor, respectively. ΔR is the difference in payoffs between the high and low state. Accordingly, $\Delta R_{\max}$ and $\Delta R_{\min}$ are the most and least information-sensitive securities, respectively. $\overline{\Delta R_a}$ and $\overline{\Delta R_I}$ are the most information-sensitive securities without triggering information production about the common and firm-specific factor, respectively. $\Delta R^{SP}_{\text{Int}}$ is the interior solution to the planner's problem.

Figure 2.31 illustrates the proposition. Speculators' cost of becoming informed about the idiosyncratic risk factor is measured on the horizontal axis, and for the common risk factor on the vertical axis. If the costs of information are sufficiently low, then maximizing information acquisition is optimal. The planner thus has firms issue $\Delta R_{\max}$ to learn as much as possible. If on the other hand the costs of information are sufficiently large, then $\Delta R_{\min}$ is optimal so as to limit information acquisition as much as possible. If the costs are intermediate, then there is an interior solution $\Delta R^{SP}_{\text{Int}}$ which trades off the value and cost of information.

In the off-diagonal regions, the costs of information are asymmetric, and information production about only one risk factor can be socially optimal. In the upper left region for example, from a social perspective the cost of inducing information about the idiosyncratic risk factor is sufficiently low compared to the value. Speculators also have more incentives to become informed about the idiosyncratic risk factor ($\overline{\Delta R_I} < \overline{\Delta R_a}$). Thus the planner can cherry-pick to some extent. He maximizes ΔR up to $\overline{\Delta R_a}$ to get as much firm-specific information as possible. Exceeding $\overline{\Delta R_a}$ however would induce wasteful information acquisition about the common risk factor.[17]

A figure with q_I instead of c_I and q_a instead of c_a as the axes would look very similar to figure 2.31. The higher the probability of success, the lower the value of knowing whether the bad state will occur, which is similar to increasing the costs. What matters is the value of information compared to the costs.

[17] The parametrization in the figure assumes that $\theta_a = \theta_I$ for simplicity. If $\theta_a \neq \theta_I$, then there is also a region where the planner can not cherry-pick and minimizes ΔR instead.

2.3.6 Competitive equilibrium

Now I characterize the competitive equilibrium. Each firm optimally chooses a security to issue in the primary market, taking the securities others issue as given. The objective function of firm i at t=0 is

$$\begin{aligned}\max_{R_{H,i},R_{L,i},R_i} \Pi_i &= q_a q_I\big(x_H - x_L - (R_{H,i} - R_{L,i})\big) + x_L - K \\ &+ \underbrace{\left[(1-q_a)\frac{\phi_a^*}{\theta_a} + (1-q_I)\frac{\phi_i^*}{\theta_I}\left(1-(1-q_a)\frac{\phi_a^*}{\theta_a}\right)\right]}_{\text{Probability that it does not invest}}(K - R_i - (x_L - R_{L,i})),\end{aligned}$$

subject to the break even constraint (2.4) of the investors and the equilibrium amount of speculators becoming informed about the common (2.2) and idiosyncratic factors (2.3). By plugging in investors breakeven condition, we can rewrite it as

$$\begin{aligned}\max_{\Delta R_i} \Pi_i = \overbrace{q_a q_I(x_H - x_L) + x_L - K}^{\text{NPV under prior}} & \overbrace{-\phi_i^* c_I - \phi_a^*\left(1-\frac{\phi_a^*}{\theta_a}\right) q_a(1-q_a)q_i(R_{H,i} - R_{L,i})}^{\text{primary market underpricing}} \\ & + \underbrace{\left[(1-q_a)\frac{\phi_a^*}{\theta_a} + (1-q_I)\frac{\phi_i^*}{\theta_I}\left(1-(1-q_a)\frac{\phi_a^*}{\theta_a}\right)\right](K - x_L)}_{\text{value of information}}.\end{aligned}$$

The problem is almost identical to the planner's except for the fact that the firm does not internalize it's effect on information acquired about the common risk factor, ϕ_a^*. Same in the planner's problem, the excess return $\Delta R_i \equiv R_{H,i} - R_{L,i}$ also is a sufficient statistic to characterize each firms optimal security. $R_{L,i}$ resp. R_i are pinned down by investors' breakeven condition. The first order condition of Π_i with respect to ΔR_i is

$$\frac{\partial \Pi_i}{\partial \Delta R_i} = \frac{\partial \phi_i}{\partial \Delta R_i}\left[\left(1-(1-q_a)\frac{\phi_a^*}{\theta_a}\right)\frac{1-q_I}{\theta_I}(K - x_L) - c_I\right] - \phi_a^*\left(1-\frac{\phi_a^*}{\theta_a}\right) q_I q_a(1-q_a). \quad (2.6)$$

The first term is the difference between marginal value and costs of increasing information acquired about the firm's idiosyncratic risk factor. In that respect firms face the same tradeoff as the planner. The second term however differs from the planners FOC, because firms do not internalize their impact on how many speculators acquire signals about the common risk factor. The implication is that they treat as exogenous the informativeness of prices and thus their impact on capital allocation and the premium demanded by investors (market illiquidity) per unit of excess return ΔR. What the second term reflects is that increasing the excess return of a security nevertheless depresses it's price in the primary market, keeping constant it's fundamental value.

PROPOSITION 2. ***(competitive equilibrium)*** *If $\frac{1}{\theta_I}(1-q_I)(K-x_L) < c_I$, then firm-specific information is not sufficiently valuable relative to the costs and in equilibrium firms issue ΔR_{min}. Otherwise there is a unique equilibrium with $\Delta R > \overline{\Delta R_a}$. If $\frac{\Delta R^{CE}_{Int}}{\Delta R_I} - 1 \geq$*

$1 - \frac{\Delta R_{min}}{\Delta R^{CE}_{Int}}$, *then each firm issues* ΔR^{CE}_{Int}, *where*

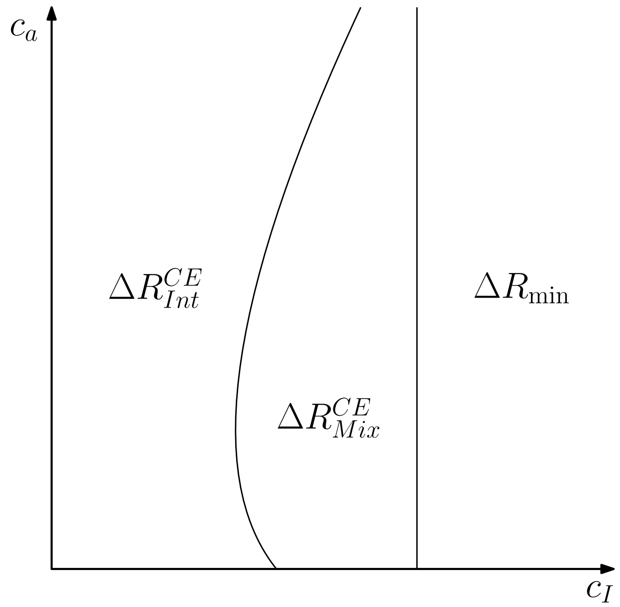
$$\Delta R^{CE}_{Int} = \frac{1}{2\theta_a c_a}\Bigg\{\overline{\Delta R_a} + \overline{\Delta R_I}(1-q_I)q_a(K-x_L) - \theta_I c_I + \sqrt{\left(\overline{\Delta R_a} + \overline{\Delta R_I}(1-q_I)q_a(K-x_L) - \theta_I c_I\right)^2 + 4(1-q_I)\overline{\Delta R_I}(1-q_a)\overline{\Delta R_a}(K-x_L)}\Bigg\}.$$

Otherwise, a fraction f^* *of firms issues* $\widetilde{\Delta R} \equiv \overline{\Delta R_I}\left(1 + \sqrt{1 - \frac{\Delta R_{min}}{\overline{\Delta R_I}}}\right)$ *and a fraction 1-*f^* *issues* ΔR_{min}. *The aggregate* $\Delta R^{CE}_{Mix} \equiv f^*\widetilde{\Delta R} + (1-f^*)\Delta R_{min}$ *is given by*

$$\Delta R^{CE}_{Mix} = \frac{1}{2\overline{\Delta R_I}[(1-q_I)q_a(K-x_L) - \theta_I c_I]} \Bigg\{\left[\theta_a c_a \widetilde{\Delta R}^2 - \overline{\Delta R_a}(1-q_a)\overline{\Delta R_I}(1-q_I)(K-x_L)\right] - \sqrt{\begin{array}{l}\left[\theta_a c_a \widetilde{\Delta R}^2 - \overline{\Delta R_a}(1-q_a)\overline{\Delta R_I}(1-q_I)(K-x_L)\right]^2 \\ -4\overline{\Delta R_I}[(1-q_I)q_a(K-x_L) - \theta_I c_I]\theta_a c_a \overline{\Delta R_a}\widetilde{\Delta R}^2\end{array}}\Bigg\}.$$

Proof: appendix B.1.3

Figure 2.32: Security issued in the competitive equilibrium.



This Figure shows the type of security firms issue in the competitive equilibrium, depending on the costs of information c_I and c_a about the firm-specific factor and common risk factor, respectively. ΔR is the difference in payoffs between the high and low state. $\Delta R_{\min}$ is the least information-sensitive security. $\Delta R^{CE}_{\text{Int}}$ and $\Delta R^{CE}_{\text{Mix}}$ are the securities where firms trade off the benefits and costs of information about their firm-specific risk factors.

Figure 2.32 illustrates the proposition. In the region to the right, the value of information about the idiosyncratic risk factor is smaller than the costs. There, firms issue $\Delta R_{\min}$ to minimize their cost of capital. In the other two regions the value of information about the idiosyncratic risk factor is larger than the cost, and firms have incentives to issue information-sensitive securities to learn about it. In the region to the left, firms are at an interior optimum where they trade off the gains from receiving firm-specific information against illiquidity coming from speculators being informed about A_i and A_a. In this region the information-sensitivity of the securities that firms issue is highest. In the middle region, the net benefit from learning about A_i is moderate. Here, some firms issue an information-sensitive security to learn about A_i and some issue an information-insensitive security to maximize the liquidity of their securities.

2.4 The inefficiency

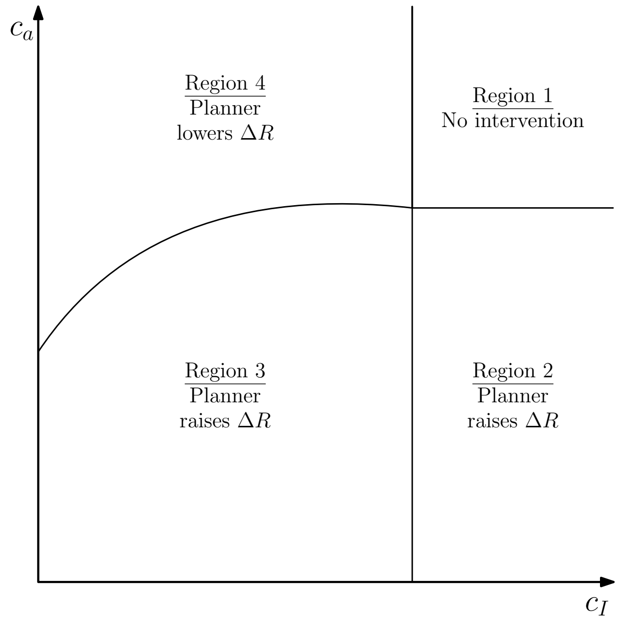
Next I analyze under which conditions the equilibrium is inefficient compared to the constrained planner's solution.

PROPOSITION 3. *For $\frac{1}{\theta_I}(1-q_I)(K-x_L) < c_I$, there are two possibilities. If $\frac{1}{\theta_a}(1-q_a)(K-x_L) < c_a$ or $\overline{\Delta R_a} > \overline{\Delta R_I}$, then there is no intervention (region 1). Otherwise the planner can increase total surplus by forcing firms to issue riskier securities (region 2). For $\frac{1}{\theta_I}(1-q_I)(K-x_L) \geq c_I$, there are also two possibilities. If c_a is small enough such that $c_a < \overline{c_a}$, then the planner can increase total surplus by forcing firms to issue riskier securities (region 3). If c_a is large enough such that $c_a > \overline{c_a}$, then the planner can increase total surplus by forcing firms to issue safer securities (region 4).*

Figure 2.41 illustrates the planner's intervention, depending on the costs of information production. In regions 1 and 2, firms have no desire to induce information acquisition (about the firm-specific risk factor) and thus issue $\Delta R_{\min}$. In region 1 on the top right, also the planner would like to limit information production, because learning about the common risk factor is not worthwhile either. Minimizing information production is optimal, both socially and privately, so there is no intervention. In region 2 on the bottom right, the planner however would like to induce information production about the common risk factor since it is cheap. This is in contrast to the competitive equilibrium, where firms issue information-insensitive securities because learning about A_i is expensive. He would therefore have them issue the most information-sensitive security up to the point where information production about A_i is triggered, $\overline{\Delta R_I}$.

In region 3, also firms would like to trigger information production, but they do so less than the planner because they only internalize the value of information about firm-specific, not common risk. The planner therefore makes them issue more information-sensitive securities. In region 4, we get the surprising result that firms induce too much information production. They like to learn about the idiosyncratic risk factor, but doing so triggers excessive information production about the common risk factor. The planner would make them be more conservative so that speculators do not waste resources learning about A_a.

Figure 2.41: The inefficiency.



This Figure illustrates how the planner intervenes, depending on the costs of information c_I and c_a about the firm-specific factor and common risk factor, respectively. ΔR is the difference in payoffs between the high and low state, and is positively related with the information-sensitivity of the issued securities.

2.5 Conclusion

I provide a model of capital misallocation due to an informational externality. Firms have incentives to limit information production to decrease their cost of capital. This comes at the cost of uninformative prices, which deteriorates capital allocation. The inefficiency arises because valuable information about risk factors common across firms is a public good from their perspective. Providing this public good entails a private cost in the form of issuing securities that will become illiquid in the secondary market, which increases firms' individual cost of capital.

This externality has implications not just for money markets, but also for non-financial industries during periods where there is large aggregate uncertainty, for example when there is an innovation that is broadly adopted or uncertainty about product demand. These industries may experience inefficient booms due to insufficient knowledge about the risks of the innovation. A social planner would incentivize more information production in such periods, for example by forcing firms to retain a certain amount of information-insensitive securities. This would force them to finance themselves with more information-sensitive securities, which would promote information production.