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Contents

The effects of capital requirements on shadow banking - A theoretical analysis

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1 Abstract

This article aims to provide insights on the considerations prompting banks to sell some of their risky assets to other less regulated entities and how their decision is influenced by regulatory risk-adjusted leverage ratios. Based on a framework by Guillaume Plantin, these aspects are discussed in a regime with mandatory asset ratings and compared to a state without these regulations. It will be shown that asset ratings might have a dichotomous effect on welfare.

2 Introduction

Banks are required by markets and regulators to finance a certain amount of their assets by equity. Owing to its low seniority, equity acts as a buffer and prevents bank runs at the first sign of financial distress. Since the banks' shareholders are the first who have to suffer losses, capital requirements might also discourage banks from excessive risk taking even in the presence of a government safety net (Berger, Herring and Szegö (1995)) . Aiyar, Calomiris and Wieladek (2014) argue that banks usually prefer debt

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and retained earning over equity as means of funding and that capital requirements come at a disutility for the bank, not least because raising equity sends out a negative signal about the situation of the bank which results in adverse selection costs.
One popular way to circumvent capital requirements is the shift of activities out of the regulated system towards the so-called shadow banking system[1]. This system of financial intermediation is not uniformly defined, which is why economists are in discord about the scope of the shadow sector.
Broadly speaking; a frequently used definition by Adrian and Ashcraft (2012) declares the shadow banking system to include all means of credit intermediations "without (...) direct and explicit [access to] public sources of liquidity and tail risk insurance" (Adrian and Ashcraft (2012), p.1). In the United States, these would be the Federal Reserve‘s (FED) discount window and deposit insurance by the Federal Deposit Insurance Corporation (FDIC).
Amongst investors in the shadow banking system are money market mutual funds (MMFs), which will be of importance in the following sections. Very roughly speaking, these funds purchase risky assets which were originated by traditional banks or securities issued by the government. Depositors can invest in MMFs by buying shares. Thus, they are equity-financed (Noeth and Sengupta (2011), p.10).
The MMFs' assets grew from almost \$77 billion in 1980 to \$3,800 billion in 2008, before they were hit by the financial crisis (Gorton and Metrick (2010), p.269).

Although the term 'shadow banking' might sound somehow disreputable, it is not semilegal or illegal in general. However, some entities in the shadow banking system were established to circumvent mandatory capital-requirements by holding assets off the balance sheet of traditional financial firms. As a consequence, regulators have to incorporate the effects of shadow banking in their considerations on capital requirements.
This article proceeds as follows: Section 2 will briefly present a model by Guillaume Plantin which examines the implications of regulatory risk-adjusted leverage ratios for banks on the transfer of risks towards the

[1] Noeth and Sengupta (2011) offer a concise overview of the major market players and the shadow banking credit intermediation chain.

shadow banking sector, represented by MMFs. Based on this framework, section 3 will introduce mandatory ratings for risky assets and discusses the changed constraints for the trading partners and three possible equilibria. Principal differences will be summarized in section 4.

3 The Basic Model

Section 2 summarizes, and thus is completely based on, "Shadow Banking and Bank Capital Regulation" by Guillaume Plantin (2014).

3.1 Unregulated Banking

In the basic model, there is a household which is endowed with W_1 dollar[2] at time t_1. The household wants to purchase a consumption good at t_2, which is produced by the entrepreneur. As opposed to the money, this consumption good is of use to the household only. It is assumed that the household does not prefer having money under its mattress. Therefore, it has to entrust a bank or a mutual money market fund (MMF) with its endowment.

The MMF has access to a storage opportunity with a yield of zero, meaning it simply preserves the value.
As opposed to this, the bank's shareholders have two investment opportunities:

a) they can invest an outlay of a fixed amount I in a loan portfolio, which is either of good quality with probability $p \in (0,1)$ or bad quality with probability $(1-p)$. At t_2, it generates a payoff of $L+l$, if it is of good quality and only L otherwise, where $0 < L < L+l$.

b) they can invest x dollar in an alternative investment opportunity, henceforth called 'the alternative'. With probability $q \in (0,1)$, it

[2] Plantin refers to a numéraire good instead of a specific monetary unit. This different representation was chosen in order to provide a summary as concise and illustrative as possible.

repays $x + f(x)$, while it repays x only with probability $(1-q)$. The function $f(\cdot)$ is assumed to fulfil the Inada condition. Thus, its marginal returns are decreasing.

The qualities of the loan portfolio and the alternative are independent of one another and the probabilities p and q are known to all agents. Hence, the bank can be one of four types:

	good alternative	bad alternative
good portfolio	Type-1	Type-2
bad portfolio	Type-3	Type-4

Since both bank and MMF are penni-less, they have to use the household's endowment to finance their investments at t_1. In order to collect enough money to fund the risky loan portfolio, the bank has to pledge all or a part of the portfolio's expected return to the household, whereas the alternative's expected payoff cannot be pledged by assumption. This pledging is modeled as the bank is issuing securities backed by the portfolio which are purchased by the household.

3.2 Equilibrium

All four agents are assumed to be risk neutral. Furthermore, the household does not discount future consumption. Therefore, as long as its expected payoff at t_2 is not smaller than \$1 per dollar invested, the household is assumed to be willing to entrust its endowment to the bank or the MMF. Due to its storage technology, the MMF cannot offer a payoff of more than \$1 per dollar invested to the household and therefore offers exactly \$1. Hence, the bank offers an expected return of \$1 per dollar invested as well. The security issued by the bank is backed by a fraction $\mu \in (0,1)$ of the safe return L and a fraction $\lambda \in (0,1)$ of the risky return l. Thus, the expected return of a security at t_2 is $\mu L + p\lambda l$. It is assumed that the household will store the expected return of the security with the bank and the rest of its endowment with the MMF and thus will make zero profit on average.

Hence, the household‘s endowment at t_2 is

$$W_2 = \begin{cases} W_1 - (\mu L + \lambda pl) + \mu L + \lambda l = W_1 + (1-p)\lambda l & \text{prob. } p \\ W_1 - (\mu L + \lambda pl) + \mu L = W_1 - \lambda pl & \text{prob. } (1-p) \end{cases} \tag{1}$$

To ensure that the bank has enough cash to fund the portfolio, it must be that

$$\mu L + \lambda pl \geq I. \tag{2}$$

If the outlay I is smaller than the expected return, that is $\mu L + \lambda pl - I = D > 0$, the bank uses this difference D to finance the alternative. Plantin refers to this difference as the dividend. Totalled up, the bank's expected utility at t_2 is

$$U_B = \mu L + \lambda pl - I + (1-\mu)L + p(1-\lambda)l + qf(\mu L + \lambda pl - I) \tag{3}$$

and is increasing w.r.t. to λ and μ. In the absence of a regulator, the bank would choose to pledge the whole return of the portfolio, that is $\mu = \lambda = 1$, in order to use the proceeds from selling the securities to fund the alternative.

3.3 The Prudential Regulation of Banks

Plantin introduces a regulator in the model who has the authority to issue banking licenses and whose objective is the maximization of total welfare. In order to obtain such a license, the bank has to obey the regulator's capital requirements.

As seen in the previous subsection, the utility of the bank would be maximized by pledging the whole expected return of the portfolio. However, the regulator has to take the utility of the entrepreneur into account as well[3]. It is assumed that the entrepreneur suffers costs from adjusting his production scale due to the unforeseeable endowment of the household at t_2, as shown in (1). Therefore, the larger the fraction of risky assets the

[3]Plantin discusses the welfare effects of regulatory leverage ratios for banks in much more detail. Although this aspect of the model is certainly of great importance, it is of no relevance for the discussion of the effects of rating agencies in the next section. For a more profound analysis, the reader is referred to Plantin (2014).

bank pledges, the more volatile W_2 is, resulting in higher adjustment costs for the entrepreneur. This depiction is representative for many kinds of negative externalities owing to high leveraging by banks.
On its balance sheet, the bank has L safe assets worth \$$L$ and l risky assets with a risk-adjusted value of \$$pl$. As mentioned, the household stores the expected revenue of the security, that is $\mu L + \lambda pl$, with the bank. Since a high leverage ratio of safe assets does not harm the entrepreneur, the regulator chooses $\mu = 1$ and all safe assets are financed by the household's deposit. By contrast, the regulator requires $\lambda^* \in (0,1)$ due to the negative externalities for the entrepreneur and the risky assets are only partially financed by the deposit. The rest of the risky assets, that is $(L+pl)-(L+\lambda pl) = (1-\lambda)pl$, is financed by equity. Plantin interprets the parameter λ as the risk-adjusted bank leverage ratio and it is the central policy tool for the regulator in the model and in practice.

3.4 Information Problematic Assets and Shadow Banking

It is now assumed that the bank privately learns the quality of its portfolio and its alternative at t_1. Furthermore, the regulator is not able to detect and prohibit transfers between the bank and the MMF. So far, the MMF had access to the zero-yield technology only. It is now able to invest the savings entrusted to it in up to $(1-\lambda)l$ risky assets. This transfer is supposed to model shadow banking.

Since only the bank knows the quality of its risky assets, the MMF will offer less than \$1 per risky asset. Knowing that all its l risky assets will have a value of \$1 at t_2, Type-2 will not offer risky assets at all. Thus, there remain three bank types on the shadow market and the MMF offers a constant price r per risky asset, so that it breaks even. This price is equal to the probability of purchasing a good asset, conditional on the asset being for sale, that is,

$$r = \frac{pq}{(1-p)+pq}. \tag{4}$$

Subject to this price, Type-1 calculates its optimal supply of risky assets λ':

$$\max_{\lambda' \in [0,1-\lambda]} (p\lambda + r\lambda')l + L - I + f\Big((p\lambda + r\lambda')l + L - I\Big) + (1-\lambda-\lambda')l. \quad (5)$$

Notice that both banks with bad portfolios have to imitate Type-1, otherwise they would disclose their real types. Therefore, the probability of purchasing a good risky asset, conditional on the risky asset being for sale, is constant and given by r. The first order condition of the maximization above yields

$$(p\lambda + r\lambda')l = \phi\left(\frac{1-p}{pq}\right) + I - L, \text{where } \phi = f'^{-1} \quad (6)$$

and shows that the optimal supply λ' increases, if the regulatory net-leverage λ is tightened.

In order to prevent all shadow banking activities, that is $\lambda' = 0$, the regulator can loosen capital requirements and choose

$$\bar{\lambda} = \frac{\phi(\frac{1-p}{pq}) + I - L}{pl} \quad (7)$$

Recapitulating, Plantin's model shows in an elementary way how higher capital requirements encourage banks to sell their risky assets on less regulated markets and thus partly circumvent the regulator's attempts to reduce negative externalities.

4 The Rating Agency

The basic model in the previous section is extended by a rating agency and the assumption that the regulator can observe transactions between numerous banks and several MMFs. Because banks use the revenues of asset sales to invest them into the welfare-enhancing alternative, there is no reason to generally prohibit banks from selling risky assets to MMFs. However, the regulator can oblige MMFs to purchase high-quality assets only. This assumption is in line with history, although, since September 2015, MMFs in the United States are required to invest in securities with minimal credit risks only:

> The money market fund rule 2a-7 currently requires money market funds to invest only in securities that have received one of the two highest short-term credit ratings or, if they are not rated, securities that are of comparable quality.
> The amendments will eliminate these requirements. Instead, a money market fund is limited to investing in a security only if the fund determines that the security presents minimal credit risks after analyzing certain prescribed factors.[4]

Alternatively, one could assume that the investors require the MMF to invest in investment-grade papers only. Whether an asset is of high quality or low quality, that is investment-grade or non-investment-grade, is assessed by a rating agency. As before, only a bank knows its type at t_1. Therefore, a rating agency cannot determine the quality with certainty. Following Bolton, Freixas and Shapiro (2012), it is assumed that the rating agency uses its technology to generate a signal $\theta \in \{good, bad\}$. The informational content about the true quality of the risky assets $\omega \in \{good, bad\}$ is

$$Pr(\theta = good|\omega = good) = Pr(\theta = bad|\omega = bad) = v. \tag{8}$$

This probability can be interpreted as the precision of the signal and is assumed to be known to all agents. It must be that $v \in (0.5, 1)$, otherwise a bank would do better by choosing the non-investment-grade assets. Since a fraction $(1 - v)$ of the bad assets is also categorized as investment-grade, the banks with bad portfolios have a chance to get rid of their assets and will not leave the market for certain.

If a bank wants to sell its risky assets, it has to pay a fee for the rating. This rating fee is modelled as a constant $F > 0$. To ensure that the banks always have enough cash to fund the rating, it is assumed that the dividends D are higher than the rating fee, hence

$$D = (p\lambda l + L - I) > F. \tag{9}$$

[4] U.S. Securities and Exchange Commission, (2015). *SEC Removes References to Credit Ratings in Money Market Fund Rule and Form*, online, available at: https://www.sec.gov/news/pressrelease/2015-193.html , accessed 7 May 2016.

The fact that the issuer has to pay for the rating is in line with reality. As White (2010) points out, the issuer pay model can constitute a conflict of interests. On the one hand, rating agencies are interested in a longterm relationship with the rated corporation or issuer, thus they might have an interest to enhance the rating. On the other hand, a rating agency, which systematically overestimates the quality of the assets, will loose its reputation. Sooner or later, no issuer will buy these ratings anymore, since they are not accepted by the investors. However, it is assumed that there is only one rating agency in this model and thus the problem formulated above can be neglected.

The effect of rating agencies on shadow banking activities is examined in two steps. First, the participation constraints for each of the four bank types are formulated. In a second step, the decision of the MMFs is discussed.
As in the basic model, it is assumed that all banks know their types at t_1 and it is still welfare-enhancing if the banks pledge all their safe assets, hence $\mu^* = 1$. Furthermore, the regulator compels all banks to pledge the same fraction $\lambda^* \in (0, 1)$ of their risky assets to the household.

4.1 Participation Constraints

After the banks have learned their types at t_1, all four bank types have two options:

a) Offer-Option: The bank pays the rating fee F and offers a fraction Λ of its risky assets for sale, provided that the assets are categorized as investment-grade.

b) Keep-Option: The bank keeps its risky assets on its own balance sheet and thus pays no fee. Good risky assets will have a value of \$1 at t_2, whereas bad risky assets will be valueless.

Especially for Type-3 and Type-4, the Keep-Option does not sound compelling. In order to find the profit-maximising option, the banks compare their expected revenues under the two options. Because the return of a risky asset at t_2 is either \$1 or \$0, the MMFs will offer a price $r \in (0, 1)$

per asset. For simplicity it is assumed that the return of the alternative follows a natural logarithm, that is $f(x) = ln(x)$[5].

Similar to section 2, the analysis starts with Type-2. It will choose the Offer-Option, if

$$\begin{aligned} p\lambda l + L - I - F + v\Lambda^* lr + (1 - \lambda - v\Lambda^*)l &\geq p\lambda l + L - I + (1-\lambda)l \\ \Leftrightarrow v\Lambda^* l(r-1) - F &\geq 0. \end{aligned} \tag{10}$$

The left hand side in the first line represents the expected profit of the Offer-Option, consisting of the dividend less the rating fee and the expected proceeds from selling the risky assets in addition to the value of the risky assets on its own balance sheet. If this type decides to go with the Keep-Option, it will end up with the dividend and a return of \$1 per risky asset for certain at t_2. It was not necessary to compute the optimal supply of risky assets Λ^* yet. Since $F > 0$ and $r \in (0,1)$, inequality (10) is never satisfied. Thus, as already seen before, Type-2 will never choose the Offer-Option in this framework. While it would never receive its reservation price of \$1 per asset, it would have to pay the rating fee, just to see that a fraction $(1-v)$ of its supply is mistakenly rated as valueless.

Type-1 determines the best option similarly to the previous bank type. It will offer risky assets for sale, if

$$\begin{aligned} & v \cdot \left[p\lambda l + L - I - F + \Lambda^* lr + ln\left(p\lambda l + L - I - F + \Lambda^* lr \right) + (1 - \lambda - \Lambda^*)l \right] \\ & \quad + (1-v) \cdot \left[p\lambda l + L - I - F + ln\left(p\lambda l + L - I - F \right) + (1-\lambda)l \right] \\ & \geq p\lambda l + L - I + ln\left(p\lambda l + L - I \right) + (1-\lambda)l \end{aligned}$$

[5] The fact that $f(x) = ln(x)$ is negative for $x \in (0,1)$ does not compromise the extension's insights. However, an upward shift by 1 would have been more appropriate with regard to the basic model.

if and only if

$$v \cdot ln\left(\frac{p\lambda l + L - I - F + \Lambda^* lr}{p\lambda l + L - I - F}\right) + ln\left(\frac{p\lambda l + L - I - F}{p\lambda l + L - I}\right) + v\Lambda^* l(r-1) - F \geq 0$$

Inequality (11) is basically composed of the same terms of the sum as condition (10), except that this bank type uses the remaining dividend and the proceeds from selling the risky assets to invest them in the valuable alternative. The bank sells a fraction Λ^* of its risky assets if the expected surplus is larger than the rating fee. For $r = r_1$, (11) holds strictly.

So far, the optimal supply was undetermined. Before Type-1 is actually able to compare the expected revenues of the two options, it has to calculate the optimal supply subject to the price. Thus, the bank maximizes (where $\Lambda \in [0, 1-\lambda]$):

$$\begin{aligned} v \cdot &\left[p\lambda l + L - I - F + \Lambda lr + ln\left(p\lambda l + L - I - F + \Lambda lr\right) + (1-\lambda-\Lambda)l\right] \\ &+ (1-v) \cdot \left[p\lambda l + L - I - F + ln\left(p\lambda l + L - I - F\right) + (1-\lambda)l\right] \qquad (11) \end{aligned}$$

As opposed to the basic model (see (4)), there is no unique price in this setting. The first order condition of the maximization-problem (12) solved for Λ^* reads:

$$\Lambda^* = \frac{\left(\frac{r}{1-r}\right) - \left(p\lambda l + L - I - F\right)}{rl} \qquad (12)$$

It is easy to see that Λ^* is decreasing in the regulatory risk-adjusted leverage ratio λ. Unsurprisingly, it can be shown that the optimal supply of risky assets increases, if the MMFs offer a higher price r.

Notice that the supply determined above would be optimal, if Type-1 chooses the Offer-Option. However, if the revenues of the Keep-Offer are still higher, meaning $r < r_1$, Type-1 would refrain from purchasing a rating. The difference in profits between the two options, as represented by (11), is simply called 'the surplus' henceforth.

Since the MMFs know that, for a given price r, Type-1 will not offer more than a fraction Λ^* of its risky assets for sale, Type-3 and Type-4 still have to imitate the former type. Otherwise, they would disclose their types. Therefore, the participation constraint for Type-3 reads

$$\begin{aligned}&v \cdot \ln\left(\frac{p\lambda l + L - I - F}{p\lambda l + L - I - F + \Lambda^* lr}\right) + \ln\left(\frac{p\lambda l + L - I - F + \Lambda^* lr}{p\lambda l + L - I}\right)\\ &\quad + (1-v)\Lambda^* lr - F \geq 0 \end{aligned} \tag{13}$$

and Type-4 will favour the Offer-Option, if

$$(1-v)\Lambda^* lr - F \geq 0 \tag{14}$$

respectively. Since the participation constraint for each bank type is known, the examination continues with the MMFs' decision making process. It is assumed that there are several MMFs on the market, which bid competitively for the assets, as long as their expected revenue is positive.[6] Hence, it must hold that

$$\begin{aligned}&Pr(\text{Type-1}|\text{afs}) l\Lambda^* 1 + \Big(1 - Pr(\text{Type-1}|\text{afs})\Big) l\Lambda^* 0 > l\Lambda^* r\\ &\Leftrightarrow Pr(\text{Type-1}|\text{afs}) > r\end{aligned} \tag{15}$$

where $Pr(\text{Type-1}|\text{afs})$ is the probability that the asset is good, conditional on the asset being for sale (afs). While this probability was constant in the basic model (see (4)), this is not necessarily true in the presence of a rating agency. As the following subsection will demonstrate, for a sufficiently high rating fee F or a high precision of the signal v, one or both banks with bad portfolio might prefer the Keep-Option and thereby alter the composition of the risky asset supply. This is the reason why there exists no unique price in the maximization problem (12). Under the assumption that the MMFs own enough funds, they determine their buying decision in the following way:

[6] The latter assumption is necessary to ensure that the price is slightly below \$1, in order to prevent divisions by zero.

1. Knowing Type-1's participation constraint (11), the MMFs have to offer at least a price $r \geq r_1$ per risky assets.
2. By controlling for conditions (14) and (15), the MMFs know whether Type-3 and/or Type-4 will offer their risky assets for $r \geq r_1$ as well.
3. The MMFs calculate Pr(Type-1|afs) by incorporating the participation of Type-3 and/or Type-4. If this conditional probability is higher than Type-1's reservation price r_1, the MMFs will purchase assets and outbid each other until condition (16) is no longer satisfied.

4.2 Equilibria

In this subsection some numerical examples and figures are used to demonstrate differences between the basic model and the extended model as well as some equilibria in the latter.
All three figures (see the appendix) are designed as follows: On the abscissa the prices r in the relevant range are shown. On the left axis of the ordinate, the reader can see the respective surpluses of all banks except Type-2's, as represented by (11), (14), and (15), for all prices. The exogenous parameters were chosen such that different equilibria can be simulated. A bank will prefer the Offer-Option, if its surplus is positive on average.
The solid line represents the optimal supply of risky assets $\Lambda^* \in (0, 1)$, as calculated in (13), with its values noted on the right axis of the ordinate. The grey vertical line represents the threshold probability Pr(Type-1|afs).

Figure 1 shows the case known from the basic model. For all prices $r > r_1 \approx 0.76$, both banks with bad portfolios prefer to choose the Offer-Option as well. Since $Pr(\text{Type-1}|\text{afs}) > r_1$, the MMFs will make a positive profit on average by purchasing risky assets. Although Type-1, and therefore both other types, offer their maximum supplies $(1 - \lambda)$ for a price below Pr(Type-1|afs), the MMFs will try to outbid each other until the price is slightly below the threshold probability.
Figure 2 shows the same situation as presented in figure 1, except that the regulatory net leverage was increased by 25 percentage points. Mainly due to the decreasing marginal returns of the alternative, Type-1 demands a much higher price in order to pay the rating fee and offer its risky assets,

conditional on that it is not mistakenly categorized as a bad bank with probability $(1-v)$. Since both banks with bad portfolios are willing to choose the Offer-Option for a much lower price, the threshold probability has not changed. Even so, due to $r_1 > Pr(\text{Type-1}|\text{afs})$, the MMFs would loose money on average and there will be no trade at all.
The effect of a very high precision of the signal v is presented in figure 3. Whereas the banks with bad portfolios had no money to loose in the basic model and always offered as many risky assets as Type-1, the high probability of getting recognized as bad makes it extremely unattractive for both banks to pay the rating fee. Thus, they will not enter the market and $Pr(\text{Type-1}|\text{afs}) = 1$. In the end, Type-1 will sell all its risky assets for a price slightly below $1.
There are also equilibria possible in which only one of the bad banks offers its risky assets.

5 Conclusion

It was demonstrated that mandatory asset ratings lead to another approach on the equilibrium, in comparison to the basic model. This model extension cannot give a general answer to the question whether a rating agency is welfare enhancing or not. On the one side, the rating fee and the imprecise categorization might discourage Type-1 to offer its risky assets on the market, although this would be welfare enhancing. On the other side, banks with bad portfolios might also be discouraged and leave the market entirely, resulting in higher proceeds for Type-1 and thus higher investments in the alternative.

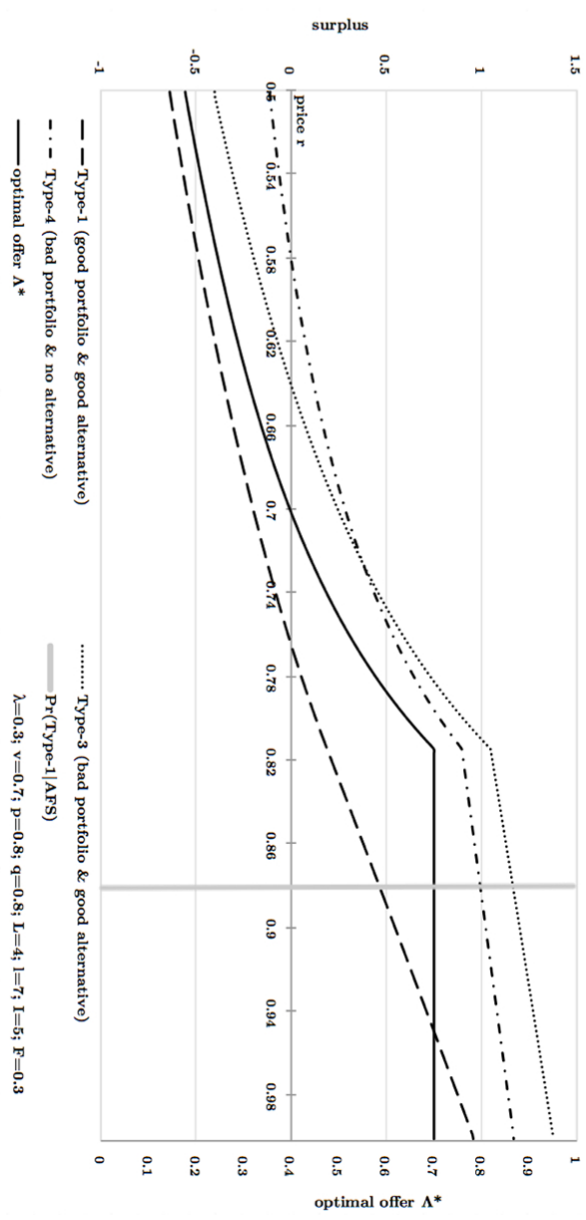

Figure 1.1: All three banks choose the Offer-Option

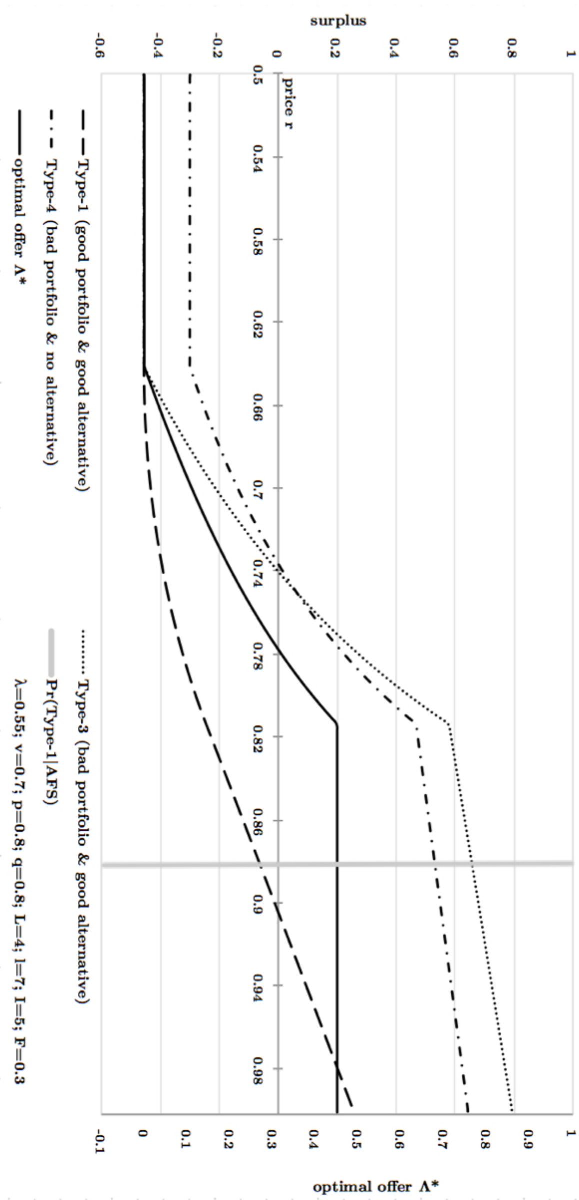

Figure 1.2: No bank chooses the Offer-Option

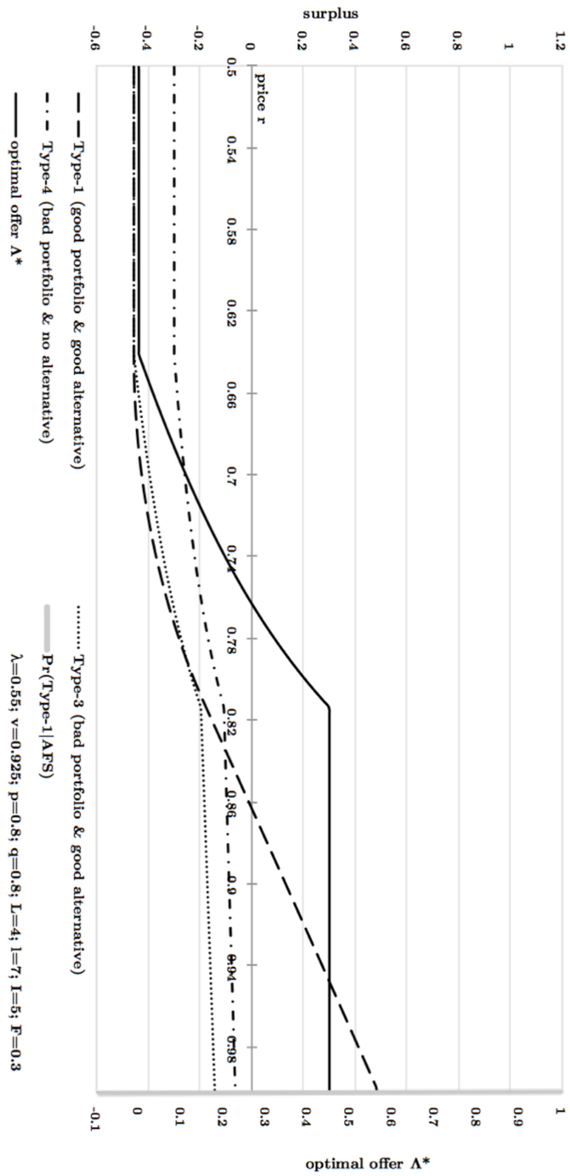

Figure 1.3: Only Type-1 chooses the Offer-Option

Team incentives and inequity aversion

Adrian Krywjak*

1 Abstract

In this Bachelor thesis, the behavior of inequity averse people is analyzed based on (Rey-Biel, 2008). Using an adjusted Fehr Schmidt utility function, an optimal contract for all kinds of inequity aversion can be derived. The main result is that employers prefer hiring inequity averse workers, as they always demand lower compensation in comparison with standard preference agents. The formal derivation of the results presented here can be found in the original Bachelor thesis.

2 Introduction

Starting from our birth we experience inequality every day. Sometimes we are favored and very often we are not. As I am the only child in my family, I never really understood why parents buy the same clothes for their twins in order to treat them equally. It never came to my mind that even such a *small and negligible* inequality can produce conflicts and can even damage the relationship between the parents and their children in the long run. We probably must learn how to cope with inequality first, and a growing person needs do it quickly, as such is nature - we are diversely talented, our parents earn different amounts of money and the destiny is

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also sometimes *unfair*. On the other hand, inequality producing envy is very useful in terms of motivation. When we see a reference point, for example, a beautiful house or a car of our coworker, it is much easier for us to put maximum effort into achieving the same or even more. Therefore, it is surprising that for a long period of time classical economics treated an individual as a homo oeconomicus. Such an individual maximizes his own utility and neglects the utility of people surrounding him or, in other words, he has no social preferences.

Several experiments brought some evidence to reconsider the homo oeconomicus concept. It is not surprising that employees are interested in the wealth of the coworkers. (Agell and Lundborg, 1999). Generally, the employees know approximately the productivity of each other, as they work together all day long and it is natural that they want to know the coworkers? salary level. Around 69% der of CEOs use standardized salary schemes, because they believe that it is the best way to implement equality. 78% of the CEOs stated that good working atmosphere depends on fair working conditions (Bewley, 1990). It must be the case that inequality is part of the workers? utility function and that inequality has a negative impact on their utility level.

The main purpose of this paper is to show that principals generally prefer inequity averse agents as workers with standard preferences are costlier for them. The results will be presented and explained intuitively. To see the formal derivation of the results, please have a look at the appendix or my Bachelor thesis. I used the modeling approach shown in *Inequity aversion and team incentives* by (Rey-Biel, 2008) to understand the behavior of inequity averse agents.

3 Model

We start with the slightly changed Fehr Schmidt utility function (Fehr and Schmidt, 1999). This function shows the utility of an inequity averse agent.

$$U_1 = \bar{w} + U_i - \alpha \times \max(U_j - U_i; 0) - \beta \times \max(U_i - U_j; 0)$$

The general utility of agent i consists of two parts. The first part is the basic salary $\bar{w}$ and his direct utility. The direct utilities are constructed this way:

$$U_i = b_i - c_i \text{ and } U_j = b_j - c_j$$

where b_i and b_j are bonuses, paid by the principal and c_i and c_j are costs of effort.

The second part of the utility function is the negative utility coming from the inequity aversion. There are two possible reasons why a worker could suffer this negative utility. Let us assume that worker i works as hard as worker j does or even less but he gets a significantly higher salary. As in real life, worker i feels envious and this brings him negative utility. The maximum function, which is discounted by α represents this case. The negative utility, which is discounted by β, shows the reverse situation, where I get higher salary even though I do *not deserve* it. In this case I feel guilty and get negative utility.

In our model with perfect information we have two inequity averse agents, who can either work hard ($c > 0$) and produce a higher amount of input or shirk ($c = 0$) and produce relatively small amount of input, and a principal with standard preferences. The project is always worth doing and the principal prefers both agents to work hard, to get higher profits. To reach this outcome, the principal implements bonuses and pays basic salary. Both must be nonnegative and have to be paid from the output returns. The agents are willing to work in the firm as the basic salary is always sufficient to break even. The reservation wage is normalized to 0.

4 Optimal contract

It is important to bear in mind that in standard principal agent models, the principal pays bonuses which are equal to the costs of additional effort of the employees. Higher bonuses do not bring any additional profit to the principal.

In our model, the principal has two mechanisms at his disposal to motivate the agents to work hard: he can impact the agent's utility by setting higher/lower bonuses. Furthermore, he can influence the proportion between their direct utilities, in order to find a use for the inequity aversion and consequently also change their general utility.

Proposition 1 Given an agent does not want to work hard, there is no need to pay him a positive bonus, as basic salary is already *enough*. In this case the direct utility of the shirking agent is 0, as he bears no costs. This proposition is quite intuitive and is widely observed in practice.

Now we need to apply some general concepts in game theory. The principal wants to set bonuses so that the strategy of working hard is a Nash equilibrium strategy for both agents. Given one agent wants to deviate from this equilibrium, the principal does his best to reduce the general utility of the shirking employee as strongly as possible. This can be reached by instrumenting inequity aversion. The idea is that he pays the highest / lowest possible bonus to the hardworking coworker depending on whether envy or guilt has a stronger impact.

Proposition 2 The shirking agent must be punished by setting his coworker's bonus as high as possible, if the impact of envy is higher (agent is envious). Consequently, such an agent has to be punished by setting his coworker?s bonus as low as possible, if the impact of guilt outweighs (agent is guilty).

There can be three possible combinations of different agent types:

1. envious, envious
2. envious, guilty
3. guilty, guilty.

The principal's optimal reaction to those combinations in terms of setting the bonuses level is of interest. We assume that agent j is more productive than agent i:

$$q_j - c_j \geq q_i - c_i$$

Previous propositions enable us to compute the highest utility punishment, given one agent deviates from the Nash equilibrium. Now the principal needs to compute the bonuses, such that agents are exactly indifferent between shirking and choosing higher effort. The solutions will be visualized in graphs. The formal derivation can be found in my thesis.

Proposition 3 The optimal solution is represented by the intersection of the indifference curves of the agents. a) In this case we have two envious agents. Given, one of them deviates from the Nash equilibrium, he receives a maximum *envy punishment*. Figure 2.1 shows all possible bonus payouts in the Nash equilibrium, where the agents are indifferent between shirking and exerting higher effort.

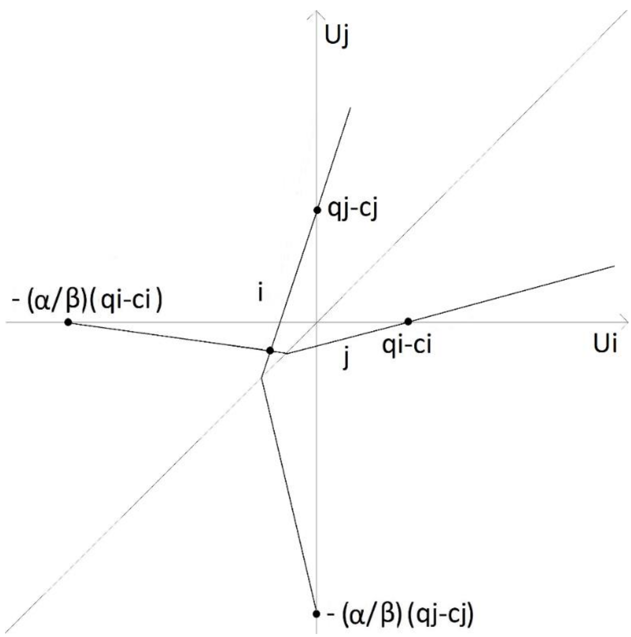

Figure 2.1: Indifference curves of the envious agents i and j

All incentive compatible bonuses schemes are represented by the area between both indifference curves in the right top corner of the graph. Optimally, the point with lowest possible bonuses is chosen (Rey-Biel, 2008). An important result is that the sum of bonus payments is always smaller than the sum of additional costs of higher effort.

b) There are two agents: one envious and one guilty agent. The ideas used in case a) stay the same: the shirking envious agent is punished with a maximum possible payment to his colleague. Accordingly, the hardworking envious agent receives a minimum bonus, given his colleague is not working properly, to induce maximum guilt. As previously, the intersection of the indifference curves in figure 2.2 below represents the optimal bonus level in Nash equilibrium. Again, the sum of bonuses is less than the sum of additional effort costs.

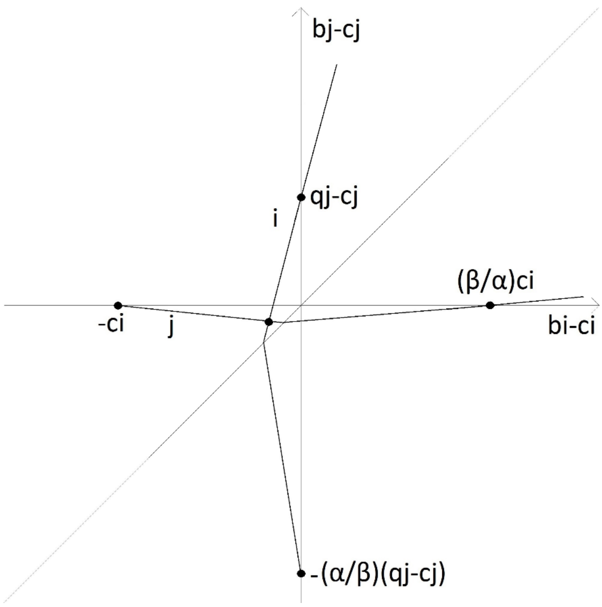

Figure 2.2: Equilibrium bonuses, if i is envious and j is guilty. Graph looks like this if: $\beta ci < \alpha(qj?cj)$

Another important aspect is that these solutions work only if there is no second Nash equilibrium strategy (shirk, shirk). This is not the case in situations a) and b). But this problem arises in case c), which is why the strategy of the principal needs to be slightly adapted.

c) In sections a) and b), both workers were motivated to choose higher effort in case the coworker shirks. That is why the strategy (shirk, shirk) could never be a Nash equilibrium. Here, we assume that there are two guilty agents. If we applied the same approach as previously, we would have to pay the hard-working agent, given his coworker shirks, a zero bonus in order to punish the shirking agent. Consequently, the hardworking agent relieves a negative general utility, even though he worked hard. Now observe the situation where one agent is always going to shirk. Another agent anticipates his negative general utility in case of working hard and chooses lower effort. This result is symmetric for both agents, which is why this approach is not working.

This is why we need to construct an incentive for at least one of the agents to work hard, given the colleague is shirking, in order to implement the same ideas as before (Rey-Biel, 2008). Once such an incentive exists, (shirk, shirk) is not an equilibrium any more. An extreme bonus is still needed to induce the highest possible punishment for shirking. Consequently, the shirking guilty agent is treated as an envious one, which leads to a maximum possible payment to the hardworking coworker.

One question arises: Who should be treated as envious? This depends on relative sensibility of both agents to envy and guilt. The exact explanation and derivation can be found in the appendix of my bachelor thesis.

As previously, the intersection of the indifference curves in graph 3 represents the optimal bonus scheme in equilibrium.

5 Conclusion: Inequity aversion profitable for the principal

In this section, the results of the models with inequity averse and standard agents are compared. It is common knowledge that in case of agents? standard preferences the principal lets the agents break even. This means that he pays bonuses, which are equal to costs of additional effort. This scheme also works out if agents are inequity averse. Their direct utility would be then 0 and, consequently, there is no inequity. But if $\bar{w}$ is high enough, the principal can pay them even less, as stated in previous sections.

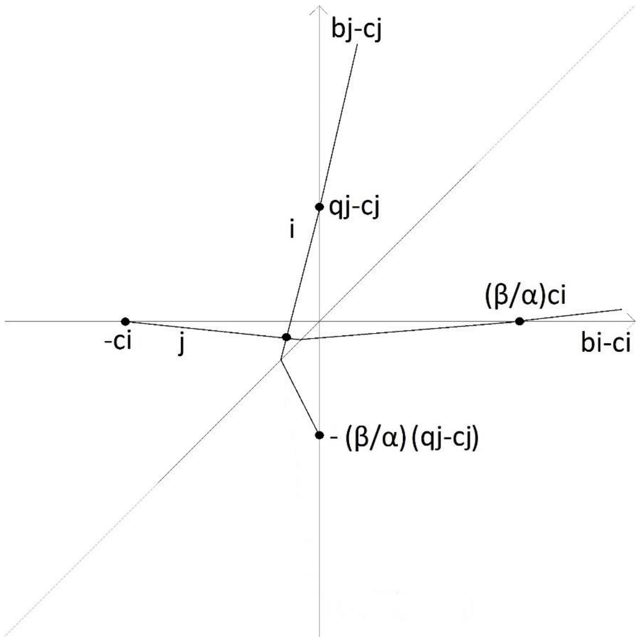

Figure 2.3: Equilirbium bonuses, if i and j are guilty.

This means that the principal is also interested to implement additional effort, even if the worker is very unproductive (c higher than the produced output) (Rey-Biel, 2008). Let us assume there are two workers (1 productive, and one not productive). When implementing the additional effort, the principal receives not only an additional output, which is less important for him. Much more important is the incentive for the other, more productive worker to exert additional effort, as he does not want to be punished. Such a situation is in the model with standard preferences agents not possible.

Online Appendix to: Team incentives and inequity aversion by Adrian Krywjak

Participation condition

In this model, we assumed that $\bar{w}$ is always high enough, such that the agents are always willing to stay in the firm. This means that the principal could hypothetically induce infinitely negative utility, in case of shirking. This assumption is a bit odd but to understand the incentive mechanisms it is necessary to make this assumption. Thus, we cannot oversee the real function of the basic salary.

Once we neglect this assumption and the basic salary is too small, the principal has no other choice as to pay the same bonuses as in the model with standard preferences agents. If $\bar{w}$ is too small, there is no way to use the inequity aversion instrument (Rey-Biel, 2008).

The reservation wage is normalized to zero, which means that our agents suffer from inequity only if they are in the firm (Rey-Biel, 2008). This assumption is unrealistic, as people tend to compare themselves with others no matter which situation they are in. However, it is unclear as to what the reference point might be if an agent leaves the firm. Hypothetically, the agents could compare themselves with both their former but also new coworkers.

Continuity of the effort levels

It is also unrealistic that there are solely two effort levels, which is why we now consider the model with continuous effort levels. In this case, the principal computes the optimal level of effort $\bar{e}$ and the corresponding output level $\bar{q}$ and implements the same strategy as previously. The result is that there is no impact on our model results, if we change the effort levels assumption (Rey-Biel, 2008).

At first glance, it appears that the principal could use the produced output, in case this output is smaller than the expected output ($q < \bar{q}$), to punish the shirking worker stronger. Unfortunately, this idea does not help him to reduce the equilibrium bonuses. To be able to reduce them, the agent has to be willing to produce the same output amount even after the principal?s strategy change, which is not going to be the case. The agent finds himself in the previous situation, where he had to choose between null and high effort. Consequently, such a strategy change cannot bring any additional profit for the principal and he would even *burn down a part of the output* (Rey-Biel, 2008).

Status and efficiency seeking preferences

The Schmidt Fehr utility function can be used to model other interesting types of social preferences. For example, there are very competitive firms, where coworkers could react to inequity differently (Rey-Biel, 2008).

$$U_I = \bar{w} + U_i - \alpha \times max(U_j - U_i; 0) - \beta \times max(U_i - U_j; 0)$$

The impact of envy would be the same as previously. On the other hand, we could assume that β is negative, whereas beta is smaller than 1. Once one agent is better off than others, he gets an additional utility. There is always an incentive to work hard, given the other agent shirks, which means that the optimal contract is comparable with the one in section a).

We could also think of another preference type - the efficiency seeking type (Rey-Biel, 2008). Agents of this kind would suffer from choosing the lower effort, or in other words of the reduction of the total pie. We assume that $\alpha < 0, 0 \leq \beta$ and $|\alpha| \leq |\beta|$. In this case it is optimal to pay nothing to the hardworking agent, in order to induce maximum punishment to the shirking one. Same as in case c) agents could both choose shirking strategy and this is an equilibrium. The solution here is to compensate the hardworking agent, who has smaller costs of additional effort, such that his direct utility is zero. Another coworker receives a zero bonus.

Limited liability and budget constraint

One of the central assumptions in our model is limited liability. Without this assumption, the principal would be able to implement negative bonus payments, which is in practice quite unrealistic (Rey-Biel, 2008). This means that infinitely negative utility levels of the agents would be feasible, as the basic wage according to our assumption is always sufficient for them to break even.

Secondly, we made an assumption that all bonuses have to be paid from the output returns. The argumentation behind this assumption is similar to the previous one (Rey-Biel, 2008). Without this assumption, the principal could hypothetically implement infinitely positive bonuses, to induce the maximum possible envy. This would also lead to problematic results. Such a strategy would not be credible, as only the biggest firms can afford such kinds of contracts. Even if there was enough cash to make this threat real, it would probably not work in practice.

To sum up, both assumptions make sense and contribute to better and plausible results, from which all the interdependencies in the model can be inferred.

Summary and conclusion

The purpose of my Bachelor thesis was to show that the principal can use the inequity aversion preferences of the agents to increase his profits. He should be careful when setting the bonuses, because it can happen that a second equilibrium exists, such that the incentives to work hard disappear. Taking this fact into account, the principal can implement high effort without even fully compensating the agents for their effort costs. This means that it can be profitable for him to hire an unproductive agent to create working incentives for the other agent. These results are valid for both binary and continuous effort levels. Although the assumptions in our models seem to be unrealistic, they are useful in terms of providing plausible results.

Generally, in the western and several other cultures the information about wage level of workers is not published, which is somehow weird, if we think about positive impacts on firm profits. On the other hand, employees must be happy about this social habit. The less the employees compare themselves with others, the smaller, according to our model, is the suffered negative utility off the equilibrium path. This results in higher equilibrium bonuses.

It is interesting in which direction our society develops in terms of using the phenomenon of inequity aversion. On the one hand, firms could start implementing more wage transparency in the firms to use the positive effects on the profits. On the other hand, this measure could lead to an image loss amongst potential employees, such that none of the firms dares to do the first step. Only firms with overcompetitive corporate culture might easily use this phenomenon. This thesis delivers several arguments why other firms could take some measures, which would enhance wage comparisons between coworkers, into consideration.

The Effects of Bail Ins on Interconnected Banks

Marco Reuter*

1 Abstract

As a result of the 2008 financial crisis and the immense costs for saving banks that took place on a global scale, banking regulation has changed from „bail out“ to „bail in“. The scientific discussion regarding implications of these new regulations is far from concluded. To add to this discussion, the thesis connects the topic of financial contagion and stability to the status quo in banking regulation. A theoretical model is developed which recognizes inter bank TLAC holdings as a channel for contagion and a possible threat to financial stability, as recognized in the most recent update of banking regulation by the Basel Committee on Banking Supervision.

2 Introduction

Prior to new regulations following the financial crisis there has been a large amount of research, both theoretical and empirical, to deepen the understanding of financial contagion caused by inter bank lending. However as a result of the bail outs that happened on a global scale as a result of the recent financial crisis in 2008 at the expense of tax payers, global

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leaders have been determined to end "too big to fail" and to switch from "bail out" to "bail in" in order to stabilize the financial sector.[1] This thesis tries to build a bridge between the idea of financial contagion that has been extensively researched prior to the financial crisis and the current situation in light of the new bail in regulations.

The new bail in regulations allow regulators to write down some of a bank's debt and to convert it into equity when a bank is in need of additional capital. This procedure is especially suited for the resolution of Global Systemically Important Banks (G-SIBs) that were previously deemed too big to fail. At its core the model in this thesis assumes inter bank holdings of such debt that can be bailed in and describes how a bail in can amplify losses throughout the whole banking sector. As the process of bail ins is still new it is being extensively discussed in current financial research. *Walther and White (2015)* show how asymmetric information can raise the value of commitment for regulators if a bail in can be understood as a signaling game between a well informed regulator and uninformed market participants. *Bolton and Oehmke (2016)* show that the resolution of a global bank by national regulators can lead to conflicts of interests across jurisdictions.

The literature this thesis most closely relates to however, is the idea of *Walther and White (2015)* to model the specific effects of a bail in decision for a bank, to connect them to a withdrawal game between short term depositors that is modeled after the classic model by *Diamond and Dybvig (1983)* and to connect it to the financial contagion literature, which was influenced theoretically by *Allen and Gale (2000)* and extensively researched empirically, for example by *Upper ((2004), (2007) and (2011))*.

[1] The Brussels G7 Summit Declaration, June 2014

3 The Model

3.1 Basic Model

Assume an economy that consists of 2 banks. There are three distinct points in time. In the beginning, at $t = 0$ the balance sheet for bank $i = 1, 2$ is described as follows:

Assets	Liabilities
v_i Asset	D_i Short Term Debt, due at $t = 1$
a_i Asset	B_i Long Term Debt, due at $t = 2$
	E_i Equity

The bank owns two different kinds of assets, v_i and a_i which will pay out their face value for certain at the final date $t = 2$. The bank is financed through three distinct forms of liabilities. It owes D_i in short term debt, which can be demanded at $t = 1$ for an arbitrarily small, non-pecuniary cost χ or at $t = 2$ without cost.[2] Also, the bank owes B_i in long term debt which is due at $t = 2$ and can not be demanded earlier. Finally, the bank is financed through E_i in equity. The combination of long term debt B_i and equity E_i is called *TLAC*, the bank's *Total Loss Absorbing Capital*. For the basic model, there is no difference between the assets v_i and a_i. Those will be added later. The banking system in the economy is overseen by a regulator. Banking regulation requires the bank's balance sheet to adhere to an equity quota.

$$\frac{E_i}{v_i + a_i} \geq K \tag{1}$$

where the ratio of equity to assets has to fulfill some quota $K < 1$. For simplicity suppose that this requirement is fulfilled with equality. Which means that there are no buffers or reserves which can absorb losses.[3]

[2] The idea of the non-pecuniary cost χ is borrowed from *Walther and White (2015)*
[3] The introduction of buffers does not qualitatively change the outcome of the model

Assume that at $t = 1$ both banks will suffer from an exogenous shock, reducing the value of the asset v_i by $l_i \in [0, l_i^{max}]$ where $l_i^{max} \leq v_i$. The post shock balance sheet then is as follows:

Assets	Liabilities
$v_i - l_i$ Asset - Exogenous Shock	D_i Short Term Debt, due at $t = 1$
a_i Asset	B_i Long Term Debt, due at $t = 2$
	$E_i - l_i$ Equity

The result of the shock is two fold: First it will decrease the value of each banks asset v_i. Second it will also result in a loss for each bank, which is absorbed by the bank's equity. Thus the post-shock equity to asset ratio equates to

$$\frac{E_i - l}{v_i - l + a_i} < K \tag{2}$$

To make sure that each bank adheres to the equity requirement at all times, the regulator is allowed to bail in a portion z_i of a bank's long term debt. A bail in means that the portion z_i of the long term debt is written off and will not be paid back to the debt holders, on the liability side it is effectively converted to equity. The debt holders on the other side are only entitled to being paid back the portion $1 - z_i$ of the initial debt. In addition they may also receive some equity shares to compensate for the bail in. Therefore, to compensate for the shock's effect on the bank's balance sheet the regulator has to bail in an amount z_i, such that

$$\frac{E_i + z_i B_i - l_i}{v_i - l_i + a_i} = K \tag{3}$$

$$\frac{(1-K) l_i}{B_i} = z_i \tag{4}$$

Where equation 4 follows by rearrangement and using equation 1. A bank which has the possibility of suffering a shock l_i such that it's $TLAC$ is not sufficient will be called *under-capitalized.* Therefore the regulator would have to force the bank to raise more loss absorbing capital until such a point where equation 4 yields a value smaller than 1.

3.2 Model with Inter Bank Lending

This section is going to introduce a link between the banks. The link is constructed as follows: in this section the asset a_i will differ from the asset v_i. The asset a_i is assumed to be long term inter bank debt that bank i owns and is owed by bank j. The asset v_i bundles all assets that are not inter bank lending. Therefore the value of the long term debt a_i will directly depend on a bail in which takes place in bank j.[4] Mathematically the interaction between bail in and the value of the inter bank assets is modeled as follows:

Assume that $a(z)$ is a function that maps from $[0,1]^2$ to R^2. The i'th entry of the function corresponds to the value of the asset for bank i. For $i = 1,2$ $a_i(0)$ is the initial face value of the long term debt, while $a_i(1)$ is the value of the long term debt for the bank which is holding it on the asset side if all of the debt is bailed in. Note that the function $a(z)$ does not only represent the value of the amount of debt that is not written off, but also the value of any equity shares that might have been received during the course of the bail in. Further, assume that $a_i(z_j)$ is strictly decreasing in z_j. When a bail in of bank j's long term debt takes place it decreases the asset value and forces the long term debt holders to bear at least part of the bank's losses.

This link between the banks creates a channel of contagion in combination with the bail in mechanic. Due to the fact that a bail in decision now not only affects the bank whose debt is being bailed in the regulator needs to be aware of the full extent that a bail in decision has on the sector as a whole. As in the basic model a shock occurs at $t = 1$ and reduces each banks asset v_i in value. However when a bail in takes place in bank j the value of the inter bank debt a_i is also reduced. The post shock and bail in balance sheet for bank $i = 1,2$ is as follows:

[4] Different interpretation of the model are also possible: a_i could represent derivatives such as Credit Default Swaps which have recently been modified to apply in the case of bail ins.

Assets	Liabilities
$v_i - l_i$	D_i Short Term Debt, due at $t=1$
$a_i(z_j)$	$(1-z_i)B_i$ Long Term Debt, due at $t=2$
	$E_i + z_i B_i - l_i - (a_i(0) - a_i(z_j))$ Equity

where $v_i - l_i$*=Asset-Exogenous Shock and* $a_i(z_j)$*=Post Bail In Asset Value*

The regulator has to anticipate the feedback effect that is caused by a bail in. The ratio of equity to assets after the shock and the bail in is accounted for equates to:

$$\frac{E_i - (l_i + a_i(0) - a_i(z_j)) + z_i B_i}{v_i - l_i + a_i(z_j)} \tag{5}$$

For $i, j = 1, 2$. The regulator is overseeing the banking sector and needs to make sure that the bank fulfills the asset to equity requirement after the shock has occurred. Therefore equation 5 needs to equal the equity to asset ratio K. Rearranging the equality and combining it with equality 1 yields the necessary bail in z_i.

$$z_i = \frac{(1-K)(l_i + a_i(0) - a_i(z_j))}{B_i} \tag{6}$$

Note that the bail in value in the equation above does not represent the equilibrium bail in value. As the feedback effect takes place in the economy the equation above can be seen as a reaction function and the final bail in levels that constitute an equilibrium are referred to as the *equilibrium bail in levels.*

The degree of feedback and contagion within the banking economy depends on a number of factors. The severity of the shock l_i that is immediately suffered by the the bank. The amount of inter bank lending within the sector represented by the function $a(z)$, the amount of loss absorbing long term debt which can be bailed in and the equity to asset requirement K which is enforced by the regulator. A lower value of K implies that a smaller percentage of the losses has already been absorbed by equity and therefore a higher amount has to be absorbed by the bail in. This can be seen as support for advocating stricter capital regulations. Among the proponents for stricter capital regulation are economists such as *Admati and Hellwig (2014)* who advocate for stricter capital regulation for a number of reasons. Further the research of *Nier, Yang, Yorulmazer and Alentorn (2008)* has shown that higher capitalization in the banking sector can make it more resilient when faced with shocks.

3.3 Large Banking Sectors

So far the analysis has been conducted in a highly stylized banking sector that consists of only two banks. In a next step the model will now be widened to consider a larger amount of banks. This section is going to extend the analysis to a banking sector of N banks. First off will be the introduction of the notation that is used for the N dimensional analysis. As there are multiple banks it is important to note how much a bank owes on the inter bank market and to whom, as the possibility for different network structures are plentiful. Previously the question of who the money is owed to did not arise as there was only one possible counter party.

For each bank denote $a^i(z_i)$ as the value of the total long term debt that bank i owes on the inter bank market (including the value of possible equity shares received during a bail in of severity z_i). Each bank $j \neq i$ owns a fraction $\alpha^i_j \geq 0$ of the inter bank debt long term debt which is owed by bank j where $\sum_{\substack{j=1 \\ j\neq i}}^{N} \alpha^i_j = 1$. Note that this only sums up the inter bank long term debt - not necessarily all of outstanding long term debt has to be owed on the inter bank market, a significant fraction of long term debt might be owed to non-bank entities. Therefore for a bail in of severity z_i bank j will own long term debt and possible equity shares in bank i worth $\alpha^i_j a^i(z_i)$. A majority of the analysis for the N bank case follows along the lines of the basic 2 bank model with the difference of considering more dimensions. A N dimensional shock vector l affects the economy where l_i describes the shock to each individual bank. The regulator then considers bail in needs and considers some initial bail in amounts. Analog to the analysis with 2 banks these events then have their repercussions for the whole banking sector. As a bail in takes place in one of the banks, all other banks whose assets are affected by the bail in suffer an additional loss. The new value of inter bank debt is given by a N dimensional function $a(z)$ where each element $a_i(z)$ is calculated as the sum of the value of outstanding long term debt and possible equity that bank i is entitled to after a bail in takes place in the other banks of the economy. The loss in inter bank assets for bank i is then calculated by

$$\sum_{\substack{j=1 \\ j \neq i}}^{N} \alpha_i^j (a^j(0) - a^j(z_j)) \tag{7}$$

The resulting reaction functions that describe the needed bail in for each bank i then equate to:

$$z_i = \frac{(1-K)}{B_i} \left(l_i + \sum_{\substack{j=1 \\ j \neq i}}^{N} \alpha_i^j (a^j(0) - a^j(z_j)) \right) \tag{8}$$

A bail in equilibrium then is a N dimensional vector z that if used as the initial bail in vector is a fixed point in the system. That means that all initial bail in values for each bank coincide with the value that the reaction function for each bank yields given all the other initial values for the other banks and their reaction functions.

Theorem 1 *A unique N dimensional bail in equilibrium z^* exists if $a(z)$ is Lipschitz continuous for a parameter λ_a such that $\lambda_a \sum_{i=1}^{N} \frac{1-K}{B_i} < 1$.*

Proof: See the appendix

4 Detailed Decision Making

4.1 The Short Term Debt Holders Decision

This section focuses on the decision of the short term debt holders and discusses the implications. The early withdrawal game between short term debt holders follows the idea of the classic model by *Diamond and Dybvig*

(1983). It is similar to Diamond and Dybvig in the sense that short term debt holders can withdraw early, at $t = 1$ or roll over the debt until $t = 2$ and that the decision to withdraw early can result in coordination problems which may lead to bank runs and the disorderly liquidation of banks.

To begin the analysis there will be assumptions to restrict the model parameters to the interesting cases. I.e. those cases where the bail in of inter bank debt makes the difference between a bank run or not. Suppose that at $t = 1$ banks have the option to liquidate their assets on a secondary market if they need liquidity to match the early withdrawals of short term debt. This liquidation on the secondary market comes at a cost however, which is represented by a discount factor $\lambda < 1$. Then the first assumption will ensure that without the interconnectedness in the banking sector, there will be no bank run equilibrium:

$$\lambda\left(v_i + \sum_{\substack{j=1 \\ j\neq i}}^{N} \alpha_i^j a^j(0) - l_i^{\max}\right) > D_i \tag{9}$$

for all $i = 1, 2, ..., N$. This assumption ensures that the liquidation value of the assets the bank holds minus the maximum possible shock that the bank can suffer is sufficiently large to pay out 100% of the senior, short term debt. Given the arbitrarily small early withdrawal fee χ it is strictly better for the short term debt holders to withdraw late to avoid this fee, as even if everybody decides to withdraw early the one debt holder who withdraws late will still be paid out in full. Therefore a bank run is not an equilibrium for the short term debt holders.

The next assumption is targeted at the interconnected case. To make the analysis interesting, suppose that there is the possibility for a bank run of short term debt holders, if the exogenous shock is sufficiently large. Assume that there is a vector $\tilde{l} \neq l^{max}$ where l^{max} is the vector where all individual shocks for the banks are maximal, such that:

$$\lambda\left(v_i + \sum_{\substack{j=1 \\ j\neq i}}^{N} \alpha_i^j a^j(z_j^*) - \tilde{l}_i\right) = D_i \tag{10}$$

for at least one $i \in \{1, 2, ..., N\}$ and

$$\lambda\left(v_i + \sum_{\substack{j=1 \\ j \neq i}}^{N} \alpha_i^j a^j(z_j^*) - \tilde{l}_i\right) \geq D_i \tag{11}$$

for the others.
Denote the set of all vectors who satisfy this property as $\tilde{L}$. Define the $>$ relation between vectors such that $x > y$ is equivalent to $x_i \geq y_i$ for all i with a strict inequality for at least one i. Now consider some vector l with $l > \tilde{l}$ and $\tilde{l} \in \tilde{L}$. Then for at least one bank i the liquidation value of assets is no longer sufficient to cover all of the outstanding short term debt, as a larger exogenous shock vector l implies larger equilibrium bail in amounts z^* and a larger direct loss for the bank. Therefore the asset value for all banks which are holding long term inter bank debt is decreased. That means there exists some $i \in \{1, 2, ..., N\}$ such that

$$\lambda\left(v_i + \sum_{\substack{j=1 \\ j \neq i}}^{N} \alpha_i^j a^j(z_j^*) - \tilde{l}_i\right) < D_i \tag{12}$$

The liquidation value of bank i's assets on the secondary market is not sufficient to pay out all the short term debt holders in case of an early withdrawal. If a short term debt holder was to withdraw at $t = 2$ instead of at $t = 1$ he would avoid the early withdrawal fee χ, however if everybody else withdraws early there would not be any money left to be paid back in $t = 2$. As χ can be chosen arbitrarily small, it will be optimal to withdraw early just like all the others. Therefore at least some of the banks in the sector are vulnerable to bank run equilibria, whenever $l > \tilde{l}$. The space of all possible exogenous shock vectors, $[0, l_1^{max}] \times [0, l_2^{max}] \times [0, l_N^{max}]$ can therefore be partitioned into areas where there are no bank run equilibria and areas where bank run equilibria are possible. An example of the two dimensional case can be visualized as seen in figure 1.

The dashed line represents the border for where bank runs can occur in bank 1. For a shock above the dashed line the liquidation value bank 1's assets smaller than the amount of short term debt. The dotted line represents the same feature for bank 2. This creates 3 areas above the

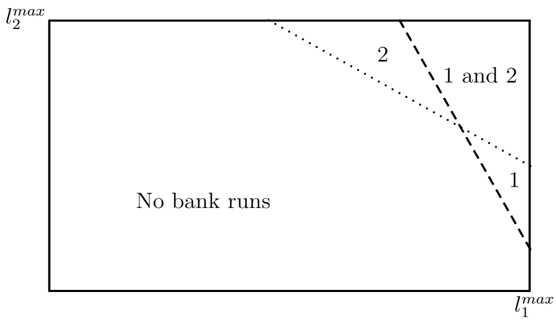

Figure 3.1: Partition of the space of possible exogenous shocks into bank run and non bank run areas

dashed and the dotted line. The area labeled "1" describes the shocks for which a bank run equilibrium is possible for bank 1 only. The area labeled "2" describes the shocks for which a bank run is possible for bank 2 only, and the area labeled "1 and 2" describes the shocks for which there are bank run equilibria for both banks. The exact shape of the border will depend on a number of factors. However only such borders are possible where for any vector belonging to the no bank runs partition all other vectors smaller also belong to that partition. The converse must be satisfied for the partition where bank runs are possible.

When the shock is sufficiently severe, that means it belongs to the bank run partition, the analysis has to be extended to cover the complex consequences of a bank run for the banking sector. As an immediate result of a bank run that takes place in bank i all assets are liquidated to pay out the short term debt holders. That means that the bank will not be able to pay back any of its long term debt, reducing its value to 0 and further since the bank is liquidated and all funds are fully used to pay back short term debt, the equity value of the bank is 0. Therefore the value of the inter bank debt holdings for all other banks j that hold some of bank i's debt decreases from $\alpha_j^i a^i(z_i^*)$ to 0. Applying theorem 1 to this reduced banking sector yields a new bail in equilibrium.

However for this remaining sector the danger of bank runs has to be reconsidered again. The liquidation value of the assets for the banks that still remains is calculated as

$$\lambda\Big(v_i + \sum_{\substack{j=1 \\ j\neq i,r}}^{N} \alpha_i^j a^j(z_j^*) - l_i\Big) \tag{13}$$

Where r represents all the index numbers of banks that have been subject to a bank run already. The liquidation value has decreased as a result of the bank runs that already have taken place. Therefore banks that had previously not been vulnerable to a bank run now have to be reassessed. If the remaining liquidation value as represented by the expression above is smaller than D_i for any of the remaining banks than a bank run equilibrium exists for those. The process of accounting for the new losses caused by the new bank runs and determining a new bail in equilibrium has to be repeated. The chain reaction that was caused by the very first bank run only stops, when either all the banks in the sector have been run, or if the remaining banks in the sector have a sufficiently high liquidation value to pay out all their short term debt holders despite the additional stress that has been put on them due to the bank runs that have taken place in the other banks. This procedure resembles the algorithm proposed by *Furfine (2003)* that is discussed in the empirical assessment of inter bank exposures in *Upper (2007)*.

4.2 TLAC Regulation

One of the model's key points dictating the regulator's decision was the capital regulation symbolized by the asset to equity ratio K. However to make sure that the new bail in regulation scheme is viable another important regulatory measure has emerged: TLAC regulation. In addition to the regular Basel III capital requirements banks have to adhere to further TLAC regulation. TLAC must be at least 16% of a resolution groups RWAs (risk weighted assets) by January 2019 and 18% by January 2022.[5] These requirements are supposed to ensure that banks have sufficient TLAC to offer the means for recapitalization through a bail in. In terms of the model the requirement ensures that there is no bank that is *under-capitalized*.

The new regulations also include support for the model's prediction towards contagion. As the theory of the model has shown there is the possibility of contagion when banks are holding TLAC issued by other banks (in the model's terms: long term debt). This danger has been recognized by the Financial Stability Board (FSB) and been included in regulations:

> *Authorities should place appropriate prudential restrictions on G-SIBs' and other internationally active banks' holdings of instruments issued by G-SIBs that are eligible to meet the Minimum TLAC requirement.*
>
> *To reduce the potential for a G-SIB resolution to spread contagion into the global banking system, it will be important to strongly disincentivise internationally active banks from holding TLAC issued by G-SIBs.*[6]

In terms of the model successfully reducing incentives to hold TLAC issued by other banks reduces contagion and leads to smaller bail in equilibria. As to how the FSB wants to achieve this they further elaborate:

> *In order to reduce the risk of contagion, G-SIBs must deduct from their own TLAC or regulatory capital exposures to eligible external TLAC instruments and liabilities issued by other G-SIBs in a manner generally parallel to the existing provisions in Basel III that require a bank to deduct from its own regulatory capital certain investments in the regulatory capital of other banks.*
>
> *The Basel Committee on Banking Supervision (BCBS) will further specify this provision, including a prudential treatment*

[5] FSB (2015) Section 4: Calibration of Minimum TLAC

[6] FSB (2015), Article (xii): Limitation of Contagion

> *for non-G-SIBs.*[7]

The Basel Committee on Banking Supervision just recently released the further specifications for this provision in October 2016.

> *Internationally active banks (both G-SIBs and non-G-SIBs) must deduct their TLAC holdings that do not otherwise qualify as regulatory capital from their own Tier 2 capital. This reduces a significant source of contagion in the banking system. Without deduction, holdings of TLAC could mean that the failure of one G-SIB leads to a reduction in the loss absorbency and recapitalisation capacity of another bank. Deducting TLAC holdings from Tier 2 provides a single treatment that can be applied consistently by both G-SIBs and non-G-Sibs, as well as providing sufficient disincentives for banks to invest in TLAC.*[8]

Therefore inter bank holdings for TLAC are disincentivised through the deduction of the holdings from Tier 2 capital, which means that if a bank wants to hold TLAC of another bank it will be expensive in terms of regulatory capital.[9] The recognition of the problem that is resembled in the newest regulations and the clear goal to disincentivise inter bank TLAC holdings can be seen as a sign that regulators share the view that is expressed in the model and are aware of the possibilities of contagion.

An interesting further research question that can be extrapolated from this point is whether or not the inter bank market has changed in light of the new regulations. If the regulation is effective in deterring inter bank TLAC holdings one might expect to see a reduction in long term inter bank lending and other inter bank TLAC holdings that are now disincentivised when comparing holding of such assets prior to the new regulations.

[7] FSB (2015), Section 15: Regulation of Investors
[8] Basel Committee on Banking Supervision (2016) TLAC Holdings, pp.1-2
[9] The Basel Committee also specifies more thresholds and details. For further information consult the publication on TLAC Holdings.

5 Conclusion

This thesis has built a model to describe the effects of a bail in on an interconnected banking sector. It has shown that inter bank holdings of long term debt can be a channel for financial contagion in the banking sector by making more severe bail ins necessary for interconnected banks compared to the absence of such connections between banks.

Concerning implications for regulatory policies, the model recognizes that significant amounts of inter bank holdings can be a source of financial contagion and instability. As the discussion in the section on TLAC regulation highlights, these hazards have recently been recognized by regulators and counter-measures have been implemented into the newest banking regulations in order to disincentivise inter bank TLAC holdings, by making them expensive in terms of regulatory capital. Whether or not these measures are effective in reducing the possible dangers of inter bank TLAC holdings is an open question which is left to future research.

Online Appendix to: The Effects of Bail Ins on Interconnected Banks by Marco Reuter

Proof of Theorem 1

The idea behind the proof is to establish a condition under which the function z is a contraction in order to apply the contraction mapping theorem. What needs to be shown is that there is some parameter λ_z such that $d(z(a(x)), z(a(y))) \leq \lambda_z d(x,y)$ and that the parameter $\lambda_z < 1$ if $\lambda_a \sum_{i=1}^{N} \frac{1-K}{B_i} < 1$. As a distance function to use in the proof consider the case of $p = 1$ of the general Minkowski distance.

$$d(x,y) = \left(\sum_{i=1}^{N} |x_i - y_i|^p \right)^{\frac{1}{p}} \tag{14}$$

Before beginning with the proof itself, remember that the reaction functions are always limited to a value of one. As a useful thought prior to the proof, consider

$$|\min\{x,1\} - \min\{y,1\}| \tag{15}$$

Then a couple of cases can occur. Trivially if $x \geq 1$ and $y \geq 1$ then

$$|\min\{x,1\} - \min\{y,1\}| = 0 \leq |x - y| \tag{16}$$

Now if $x \geq 1$ and $y < 1$

$$|\min\{x,1\} - \min\{y,1\}| = |1 - y| \leq |x - y| \tag{17}$$

If $y \geq 1$ and $x < 1$

$$|\min\{x,1\} - \min\{y,1\}| = |x-1| = |1-x| \leq |y-x| = |x-y| \tag{18}$$

And trivially if $x < 1$ and $y < 1$

$$|\min\{x,1\} - \min\{y,1\}| = |x-y| \tag{19}$$

As this covers all possibilities the general result follows that

$$|\min\{x,1\} - \min\{y,1\}| \leq |x-y| \tag{20}$$

To begin with the proof that the function z is a contraction consider the distance

$$d(z(a(x)) - z(a(y))) \tag{21}$$

and apply the proposed distance measure. This yields

$$d(z(a(x)) - z(a(y))) = \sum_{i=1}^{N} |\min\{z_i(a(x)),1\} - \min\{z_i(a(y)),1\}| \tag{22}$$

Using the result that was established in the beginning of the proof yields

$$d(z(a(x)) - z(a(y))) \leq \sum_{i=1}^{N} |z_i(a(x)) - z_i(a(y))| \tag{23}$$

Now substituting the definition of the reaction function yields:

$$d(z(a(x)), z(a(y)) \leq \sum_{i=1}^{N} \Bigg(\Bigg| \frac{1-K}{B_i} \Bigg(\sum_{\substack{j=1 \\ j \neq i}}^{N} \alpha_i^j (a^j(0) - a^j(x_j)) \tag{24}$$

$$- \sum_{\substack{j=1 \\ j \neq i}}^{N} \alpha_i^j (a^j(0) - a^j(y_j)) \Bigg) \Bigg| \Bigg) \tag{25}$$

$$= \sum_{i=1}^{N} \Bigg(\Bigg| \frac{1-K}{B_i} \Bigg(\sum_{\substack{j=1 \\ j \neq i}}^{N} \alpha_i^j (a^j(x_j) - a^j(y_j)) \Bigg) \Bigg| \Bigg) \tag{26}$$

$$\leq \sum_{i=1}^{N} \left(\left| \frac{1-K}{B_i} \left(\sum_{j=1}^{N} |a^j(x_j) - a^j(y_j)| \right) \right| \right) \tag{27}$$

Where equation 27 follows from 26 by taking the absolute value in the sum, adding the piece where $j = i$ to the sum and removing the parameters $\alpha_i^j \leq 1$. This can be rearranged to

$$\sum_{j=1}^{N} |a^j(x_j) - a^j(y_j)| \sum_{i=1}^{N} \frac{1-K}{B_i} \tag{28}$$

The first sum is equal to $d(a(x), a(y))$ under the used distance measure. Since a was assumed to be Lipschitz continuous for parameter λ_a it follows that

$$\sum_{j=1}^{N} |a^j(x_j) - a^j(y_j)| \sum_{i=1}^{N} \frac{1-K}{B_i} \leq \lambda_a \sum_{i=1}^{N} \frac{1-K}{B_i} \sum_{i=1}^{N} |x_i - y_i| \tag{29}$$

Now defining

$$\lambda_z = \lambda_a \sum_{i=1}^{N} \frac{1-K}{B_i} \tag{30}$$

establishes the result. If $\lambda_z < 1$ then the contraction mapping theorem applies since the function z maps from $[0,1]^N$ to $[0,1]^N$ by definition. Therefore the existence of the unique fixed point is established.

An Empirical Analysis of Market Manipulation in the USA

Kevin Roohnikan*

1 Abstract

In modern times, copious famous cases of market manipulation emerges, however the academic literature lacks on empirical studies on market manipulation. This thesis tries to investigate the effects of market manipulation on stock prices. It is shown that there are common problems while analyzing market manipulation, such as partial anticipation and incompleteness of disclosing market manipulation. The main focus lies on an event study, testing abnormal returns on significance. Additionally, further regression analysis is supplied to deepen the results of the event study.

2 Motivation

As the globalization of financial markets gradually continues, market manipulation has become more and more the focus of not only medial coverage but also within the academic literature. Especially in Germany, market manipulation gained more interest within the events of the Volkswagen emissions scandal. The Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin) charged Volkwagen's former CEO Martin Winterkorn with market manipulation, due to the fact that Volkswagen informed its shareholders

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not until September 22nd, 2015 (FAZ (2016)). They claim that Winterkorn informed the shareholders of Volkswagen too late about the upcoming expected financial damage concluding that Winterkorn has violated the ad hoc disclosure. Putnins (2012) argues that market manipulation is at least as old as trading on organized exchanges, nevertheless the effects of market manipulation are broadly unknown. This thesis empirically analyzes market manipulation, focusing on reported cases of market manipulation, which were pursued and punished by the Securities and Exchange Comission (SEC). By employing an event study as the main focus this thesis tries to understand, how changes in stock price (caused by market manipulation) can be explained by disclosing and punishing market manipulation. To deepen the comprehension of market manipulation further regression analysis is implemented. A cross-sectional Ordinary Least Squares (OLS) and a logit regression examine the relation between changes in stock price and changes in firm characteristics and how likely it is to disclose market manipulation on certain industries.

3 Literature Review

Putnins (2012) argues that there is no specific definition of market manipulation. He rather distinguishes between legal and academic definitions. In contrast to legal definitions, as they are typically imprecise, the academic literature coincides in certain aspects. According to Thel (1994) market manipulation is a trade with the intention to artificially manipulate stock prices up- or downwards resulting in a beneficial trade with market participants. Jarrow (1992) claims that market manipulation is a strategy to trade with uninformed participants to achieve a positive payoff with zero risk. According to Kyle and Viswanathan (2008), market manipulation is only a trading strategy that biases prices, reduces market liquidity and violates the efficiency of markets. By compiling these three definitions, market manipulation should be understood as the unfair trade with other market participants.

Putnins (2012) also shows that the theoretical literature of market manipulation provides a deep insight under which assumptions market manipulation is possible and profitable. The theoretical literature is advanced enough to differentiate between information-based, trade-based and action-based market manipulation. On the contrary, the empirical literature on market manipulation is not that extensive. Putnins (2012) argues that the main reason for that is obtaining suitable data which results in less knowledge about how often market manipulation arises or how the market reacts to regulations to prevent market manipulation. Another common problem is that it is likely that not all cases of market manipulation are disclosed by the SEC.

Aggarwal and Wu (2006) also empirically analyzed market manipulation concluding that during market manipulation security prices went up. After disclosing market manipulation, the stock prices dropped and volatility increased. However, there is less literature about the comparison between ex ante and ex post effects of market manipulation as there is specifically less known about the ex ante effects (Aggarwal and Wu (2006)).

4 Hypotheses

To conduct a proper empirical analysis, is it necessary to establish some hypotheses. Aggarwal and Wu (2006) argues that market manipulation is mainly a problem within Over The Counter (OTC) traded firms. Therefore, the first hypothesis is that market manipulation arises rather in inefficient markets, such as the OTC Bulletin Board or Pink Sheets. By continuing this argument, it must be more difficult to establish market manipulation in efficient and less volatile markets, resulting in fewer disclosures of market manipulation in such markets. If this is common knowledge, market participants can anticipate the likelihood of market manipulation in certain markets. This argument delivers the second hypothesis. If there is partial anticipation regarding market manipulation, an event study will deliver biased results as the crucial assumption of an event study will be violated. The third hypothesis is based on the expectation that disclosed market manipulation will change the firm value. Speaking in terms of an event study this means that abnormal returns (AR) and cumulative abnormal return (CAR) must be significant under the assumption that there are no other influences, such as partial anticipation, which will bias the results. The fourth hypothesis simply states that the logit regression must show what kind of firms are impacted with market manipulation if market manipulation is contractible on observable firm characteristics.

5 Empirical Design

5.1 Samples and Data

For the event study analysis, the sample uses a time frame between 1995 and 2013. In total, there are 214 pursued cases of market manipulation by the SEC within the sample. This study assumes that the day there the filing was submitted to the SEC, is the first day, where the market learns that market manipulation has occurred. As the first hypothesis differentiates between listed and OTC traded firms, two event studies are employed one for each type of firms.

From the entire 214 pursued cases, 348 manipulated stocks were identified. After matching the manipulated stocks to available data, 148 cases of manipulated stocks were available for the event study, whereby the main problem was the availability of price data for OTC traded firms. From these 148 cases, 125 firms were listed and 23 were OTC traded firms. For listed firms data from the Center for Research in Security Prices (CRSP) were collected from 1995 to 2015. The sample for OTC traded firms was used from the Wharton Research Data Services (WRDS) by the time frame from 2011 to 216. To determine the AR for the event study, the Fama-French three-factor model was used. The belonging data for that model are available on the website of Kenneth R. French.

5.2 Event Study

The event window for this study was ten days prior to the event (t_{10}^{-}) and 20 days after the announcement that the respective stock was manipulated (t_{20}^{+}). For an event study, it was necessary to estimate normal returns within the estimation window.

The normal return then showed how the firm could have performed if there had been no manipulation for that firm at all (Atanasov and Black (2015)). For the estimation of normal returns, an estimation window from 120 (d^-_{120}) to 30 (d^-_{30}) days prior to the event was used. With the estimated normal returns, it was now possible to calculate AR and CAR. The are AR the residual between actual returns and normal returns. The residual then indicated how the event influenced the stock price (Atanasov and Black (2015)). The CAR were defined as the cumulated AR over a certain window. For the empirical analysis of the event study, CAR were tested on statistical significance.

6 Empirical Approach

6.1 Parametric and Non-Parametric Test Statistic

To describe an overall effect of market manipulation, average abnormal returns (AAR) and cumulative average abnormal returns (CAARs)[1] were constructed. Within this cross-sectional analysis, it was possible to test for the overall effect of market manipulation. Typically studies tested whether AR are systematically distributed different from zero. If there is no influence of market manipulation on stock prices, the abnormal returns should be distributed overall around (Kothari and Warner (2004)). Thereby for moment t with N firms AAR are defined as:

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{i,t} \tag{1}$$

Depending on how much the market anticipates market manipulation or how fast it learns that a certain stock was manipulated, it could be interesting to test CAAR for different time intervals, as it is possible

[1] Kothari and Warner (2004) define AR as the mean residual.

to derive information about the market efficiency (Kothari and Warner (2004)). For the CAR and CAAR the following holds:

$$\mathrm{CAR}_{\mathrm{i},(\mathrm{t}_1,\mathrm{t}_2)} = \sum_{t=t_1}^{t_2} AR_{i,t} \tag{2}$$

$$\mathrm{CAAR}_{\mathrm{t}_1,\mathrm{t}_2} = \frac{1}{N}\sum_{i=1}^{N} CAR_{i,(t_1,t_2)} \tag{3}$$

The parametric test tests, as said before $H_0 : CAAR_{t1,t2} = 0$ versus $H_1 : CAAR_{t1,t2} \neq 0$. The test statistic is then:

$$\mathrm{t}_{\mathrm{CAAR}_{\mathrm{t}_1,\mathrm{t}_2}} = \sqrt{N}\,\frac{CAAR_{t_1,t_2}}{\sigma_{CAAR_{t_1,t_2}}}, \tag{4}$$

Thereby $\sigma_{CAAR_{t_1,t_2}}$ is the standard deviation of the CAAR. The standard deviation is defined as:

$$\sigma_{\mathrm{CAAR}_{\mathrm{t}_1,\mathrm{t}_2}} = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(CAR_{i,(t_1,t_2)} - CAAR_{t_1,t_2})^2}. \tag{5}$$

The literature additionally often uses non-parametric tests. Cowan (1992) argues that non-parametric test, should be preferred over parametric test as parametric tests need explicit assumptions over the distribution function of AR. Violating these assumptions could lead to biased results, resulting an incorrect analysis. According to Corrado and Zivney (1992), the central limit theorem implicitly says that the statistical power of the t-test depends (for large samples) on how the variance and the mean of the AR are distributed. Based on the approach of Corrado and Zivney (1992) this thesis used a rank test as the non-parametric test. The rank test used the samples from the event- and estimation window. For all AR in these two windows, ranks were matched and standardized for missing values:

$$K_{i,t} = \frac{\mathrm{rank}(AR_{i,t})}{1 + d_i + t_i} \tag{6}$$

Thereby d_i are the non-missing AR within the estimation window and t_i the non-missing values in the event window. D and T are the total observations for both, the estimation- and event window. For simplicity, the following is used: $N_t = d_i + t_i$. The non-parametric test tests also whether the AR are significantly different from zero. That means $H_0 : CAAR_{t1,t2} = 0$ versus $H_1 : CAAR_{t1,t2} \neq 0$. The rank test uses mean ranks, which are defined as the following:

$$\overline{K}_t = \frac{1}{N_t} \sum_{i=1}^{N_t} K_{i,t} \tag{7}$$

the test statistic is then:

$$\mathrm{t}_{\mathrm{rank}} = \sqrt{T} \left(\frac{\overline{K}_{T_1,T_2} - 0.5}{\sigma_{\overline{K}}} \right), \tag{8}$$

with

$$\sigma_{\overline{K}} = \sqrt{\frac{1}{T+D} \sum_{t=T_0}^{T_2} \frac{N_t}{N} \left(\overline{K}_t - 0.5 \right)^2} \tag{9}$$

and

$$\overline{K}_{t_1,t_2} = \frac{1}{L_2} \sum_{t=T_1+1}^{T_2} \overline{K}_t \tag{10}$$

Here $\overline{K}_{t_1,t_2}$ indicates the rank of the AR and CAR over the period (t_1, t_2). The results are presented in chapter 6.

6.2 Logistic Regression

For the logit regression, three different equations were estimated. The three regressions differ in the definition of the dependent variable. The dependent variable is a dummy, which takes the value of 1, if the firm was identified with market manipulation for the first regression and 0 otherwise. Subsequently this variable will be referred to as Manipulation_1. In the second regression the dependent variable only takes the value of 1 if the respective stock lies within a manipulation period of three years. Therefore the period consists of two years prior and one year after the announcement of market manipulation and 0 otherwise. This variable will be called Manipulation_2. For the last regression the dummy variable is 1 for the same conditions as in Manipulation_2. But it only takes the value of 0 if the stock was identified with market manipulation. This variable is a combination between the first two variables and will be now called $\mathrm{Manipulation}_3$. Especially the third variable will be a proxy on how well market manipulation can be observed on firm characteristics.

These three manipulation variables will be regressed on firm characteristics, which were often used in the academic literature before. The regression is then defined as:

$$\mathrm{Manipulation}_{\mathrm{i,t}} = \beta_{i,t} X_{i,t} + \epsilon_{i,t} \tag{11}$$

there $\mathrm{Manipulation}_{\mathrm{i,t}}$ contains the defined dummies. In the matrix $X_{i,t}$ are the firm characteristics. Outliers are winsorized on the 1% level. (99% and 1%).

Using the results of the logit regression, a new variable was calculated. This variable is defined as the estimated probability that the stock was identified with market manipulation. Respectively for the three different manipulation variables, three different estimated probability variables were computed. Therefore $(P(M_1))$ is defined as the probability, how likely market manipulation has occurred, given the definition of $Manipulation_1$. Following this logic, $(P(M_2))$ and $(P(M_3))$ are defined as the probability that $Manipulation_2/Manipulation_3$ take on 1.

6.3 Cross-Sectional Regression

For the cross-sectional regression the dependent variables are AR and CAR, whereby the period for the AR are t_1^- to t_3^+. For the CAR, the time periods are (t_1^-,t_1^+), (t_2^-,t_2^+), (t_3^-,t_3^+), (t_0,t_1^+) and (t_0,t_2^+).

These variables were regressed on the same firm characteristics before with the exception that the estimated probabilities and a CEO dummy variable are now included in the OLS regression. The CEO variable is 1 if the CEO of a specific firm was involved in the manipulation. The following regression is estimated:

$$Return_{i,t} = \beta X_{i,t} + \lambda CEO_{i,t} + \varphi P(M)_{i,t} + \epsilon_{i,t} \tag{12}$$

7 Main Empirical Analysis

7.1 Results for Publicly Traded Firms

The results of the test statistic are presented in table 1 panel A. Comparing the different values of the parametric result of the CAAR, it is noticeable that the values are higher if only days prior to the event are implemented. The values for the other three CAAR, are negative. It is also the case that none of the CAAR are significant, meaning that it was not possible to show that the CAAR are distributed different from zero inferring that there is no average effect of market manipulation in stock prices. The non-parametric results differ greatly as there are overall higher values for the CAAR. Additionally, there is now a significant result concluding that market manipulation might have an effect on stock prices.

It is important to understand, although there is no significance in the parametric test, that there still is an effect. It could be likely that other factors biased the results similar to the argument of partial anticipation. One crucial assumption is that no one knows about the manipulation before the SEC filing. Partial anticipation could be an explanation for the biased results as there might be a sufficient big number of market participations, which knows about the manipulation before. This would accompany with the first hypothesis that market manipulation is rarer in efficient markets or is less disclosed. Therefore, it would be more difficult to establish an effect of market manipulation. The results of the non-parametric test should also be interpreted with a sufficient caution. Combining these two results, it is likely that there is an effect of market manipulation on stock prices, but that there are unobserved factors which may bias the results. Significant results on the non-parametric test do not imply that there must be an effect.

7.2 Results for Over-The-Counter Traded Firms

The results for the OTC traded firms are represented in panel B from table 1. The CAAR are not positive for the intervals (t_1^-,t_1^+), (t_0,t_1^+) and (t_0,t_2^+). The parametric test shows significance for CAAR within

(t_2^-,t_2^+) and (t_3^-,t_3^+). Comparing this with the results before, it follows that even with the parametric framework, it was possible to show statistical significance. Considering the problems from before, the results suggest that there might be a greater effect of market manipulation for OTC traded firms than for listed firms. The results for the non-parametric test inherit also significant results going in the same direction as in the case for listed firms. However, these results need to be interpredted with caution.

Compared to listed firms, fewer observations were available. This is largely due to the availability of data for OTC traded firms. This should take a main point in the analysis. However, the results still accompany with the first hypothesis as market manipulation seems to have an bigger influence on stock prices in inefficient markets concluding for the OTC companies, this implies that market manipulation might have a bigger influence on stock prices. Still the small sample size indicates that it is not possible to verify or falsify the other hypotheses.

7.3 Firm Characteristics

The results for the logit regression are listed in table 2. For the logit regression it is important to take the coefficient sign into consideration. A negative coefficient means that variable X decreases the logarithmized chance of market manipulation and a positive coefficient increases this chance. Through this analysis it is possible to see which factor increases the likelihood of market manipulation.

For the first regression leverage, profitability and earnings per share seem to decrease the probability of market manipulation. For example the logarithmized chance for market manipulation decreases if the leverage is increased by one unit. Other firm characteristics are positive, but not significant at all, except for expenditures in R&D. These variables increase the probability of market manipulation.

For the second regression, lever loses in on explanatory power. The only significant variables are now R&D and Earnings per Share, whereby the coefficient of R&D is still positive and Earnings per Share are still negative. In the third regression, not a single variable is significant.

It seems that profitable firms have a lower risk of getting confronted with market manipulation explaining why profitability and earnings per share are significant within the regression analysis. It is notable that every coefficient in all three regressions are on a low level in absolute values. More importantly the logit regression indicates that firm characteristics are not an good source of explaining market manipulation. Assuming market manipulation can be completely explained by firm characteristics most of the coefficients should be highly significant. However, even the estimated probability $P(M_3)$ is that small that it is obvious that market manipulation depends on other factors . In fact, the estimated probability was roughly about 18.41%. For verification of this hypothesis, the estimated probabilities are no implemented within a cross-sectional regression.

7.4 Abnormal Return Regressions

The following six regressions only differ in the implementation of the estimated probabilities of market manipulation. The results for the AR regressions are represented in tables 3, 4 and 5. Table 2 shows that leverage, profitability and size are highly significant over all AR inferring that these variables might have an influence on market manipulation. However, the most interesting part is the interpretation of the estimated probabilities. These probabilities were multiplied by 100 as the initial values were to small. Due to the fact, that the probability is overall rather insignificant, it might be likely that the firm characteristics can not explain market manipulation as well as expected.

Table 3 shows that the influence of the estimated probabilities on market manipulation decreases even more. Apart from that, the results are overall the same as in the first regression.

Table 4 indicates that the probability becomes more influential. Still the difference between the first two and the last regression can be explained through the underlying definition of the third dummy variable. In the third case, it is analyzed how firm characteristics change during the time of manipulation given that only manipulated firms are observed. Non-manipulated firms were excluded from the sample for that case anymore.

The implementation of estimated probabilities served as an explanation why the abnormal returns were insignificant especially for the parametric analysis. When the estimated probability of market manipulation is significant, it could be that there was partial anticipation regarding market participants based on observable firm characteristics. For robustness CAR are also regressed on firm characteristics.

The robustness test shows how firm characteristics changed over a certain period of time. The results are represented in tables 6, 7 and table 8. The interpretation is analogously the same as before. The results seems to verify the analysis of the abnormal return regression.

8 Critical Evaluation

Especially for the regression analysis one must notice that the disclosure of market manipulation hits different firms in a different ways, meaning that one firm is heavily influenced by the disclosure of the fraud and the other not. This would bias the coefficients of the regression. Furthermore if there is partial anticipation, the coefficients will be even more biased. Eckbo et al. (1990) argue that other variables for instance an indicator for insider trading must be implemented, as market manipulation is likely depending on unobservable firm characteristics. Following Putnins (2012) it is also important to take the frequency of market manipulation into account. Especially when it is not known how many cases of market manipulation there disclosed by the SEC. To solve, for partial anticipation the approach of Malatesta and Thompson (1985) could be used. The authors used ex ante probabilities of an event as a proxy for partial anticipation. Lastly, the event study yields better results if the treatment - and control group are almost identical. Instead of focusing on normal performance of the stock it would be useful to increase the homogeneity of these two groups for better comparison.

9 Conclusion

This thesis provided a brief overview on market manipulation and its difficulties to analyze it empirically. An event study was conducted to determine the influence of market manipulation on stock prices for listed and OTC traded firms. The test statistics showed that AR do not seem to follow a distinct distribution, resulting imprecise parametric test statistics. A logit regression tried to explain market manipulation on observable firm characteristics, however the estimated probabilities of market manipulation indicates that market manipulation accrues on unobservable firm characteristics. Additionally, the AR and CAR were regressed on firm characteristics. This regression analysis is only possible for listed firms as there are certain difficulties in obtaining data for OTC traded firms. Analyzing the results, it became clear that there might be other factors influencing abnormal returns. One possible explanation is partial anticipation.

Future empirical studies that test for partial anticipation and the other problems occurring during the empirical analysis, whereby a approach like in Malatesta and Thompson (1985) can derive better results for the empirical analysis of market manipulation.

Online Appendix to: An Empirical Analysis of Market Manipulation in the USA by Kevin Roohnikan

Tables

Table 1.1: Publicly traded firms

Variable	Value	Parametric	Non-Parametric
$CAAR_{t_1^-,t_1^+}$	-1.1591773	-.2506046	3.1323595
$CAAR_{t_2^-,t_2^+}$	88.719719	1.1110487	4.0642481
$CAAR_{t_3^-,t_3^+}$	90.672081	1.1268792	4.3760581
$CAAR_{t_0,t_1^+}$	-1.5553517	-.3857336	1.9611934
$CAAR_{t_0,t_2^+}$	2.0737798	.27111393	3.1010876
Observations	123	123	122

Table 1.2: OTC traded firms

Variable	Value	Parametric	Non-Parametric
$CAAR_{t_1^-,t_1^+}$	6.8748	1.5067	2.6758237
$CAAR_{t_2^-,t_2^+}$	-5.1748	-2.2762	2.727627
$CAAR_{t_3^-,t_3^+}$	-9.1489	-4.4781	2.7616465
$CAAR_{t_0,t_1^+}$	7.9362	1.5514	2.7616465
$CAAR_{t_0,t_2^+}$	1.4098	2.417608	2.417608
Observations	23	23	122

Table 2: Results for the Logit-Regression

Variables	(1) $Manipulation_1$	(2) $Manipulation_2$	(3) $Manipulation_3$
Leverage (Bookvalue)	-0.000456	-0.000902	-0.000572
	(0.000378)	(0.000941)	(0.000736)
Leverage (Marketvalue)	-9.95e-05**	-2.66e-05	0.000105
	(4.26e-05)	(3.68e-05)	(7.50e-05)
Tobin's Q	0.0154	0.0125	-0.00350
	(0.0107)	(0.0318)	(0.0262)
R&D	0.0329**	0.0508**	0.0290
	(0.0129)	(0.0220)	(0.0277)
Profitability	-0.291**	-0.183	0.324
	(0.127)	(0.416)	(0.692)
Return on Assets	0.118	0.134	-0.0525
	(0.0839)	(0.293)	(0.551)
Size	0.0390*	0.0122	-0.0765
	(0.0224)	(0.0552)	(0.0820)
Market-to-Book ratio	0.00217	-0.00463	-0.0120
	(0.00270)	(0.00459)	(0.00804)
Earnings per Share	-0.140***	-0.122***	0.0648
	(0.0119)	(0.0329)	(0.105)
Constant	-5.401***	-6.989***	-1.207***
	(0.0946)	(0.229)	(0.333)
Observations	111,364	111,364	555

robust standard erros in parentheses. Variables are winsorized on the 1% level.
Die coefficient must be interpreted as logarithmized chances.
*** p<0.01, ** p<0.05, * p<0.1

Table 3: AR Regression I

Variables	(1) AR_1^-	(2) AR_0	(3) AR_1^+	(4) AR_2^+	(5) AR_3^+
Leverage (Book)	0.249***	-0.0287***	-0.0222***	0.252***	-0.100***
	(0.0396)	(0.00433)	(0.00371)	(0.0399)	(0.0157)
Leverage (Market)	-0.0125***	0.000515	0.00165***	-0.0125***	0.00490***
	(0.00391)	(0.000450)	(0.000420)	(0.00387)	(0.00159)
Tobin's Q	0.216	-0.216***	-0.121	0.0511	-0.190
	(0.462)	(0.0569)	(0.186)	(0.415)	(0.181)
R&D	3.277*	0.166	-0.268	3.099*	-1.151
	(1.705)	(0.201)	(0.316)	(1.653)	(0.702)
Profitability	-14.17*	-4.846***	5.460**	-14.10*	6.598*
	(8.476)	(1.714)	(2.165)	(8.349)	(3.699)
Return on Assets	-3.480	2.238**	-3.995*	-3.987	-0.315
	(4.019)	(0.909)	(2.162)	(3.925)	(1.952)
Size	5.340***	0.0143	-1.828***	5.632***	-2.584***
	(1.350)	(0.240)	(0.303)	(1.337)	(0.598)
Market-to-Book ratio	0.338**	0.0296	0.0925	0.327**	-0.142**
	(0.159)	(0.0292)	(0.0786)	(0.162)	(0.0719)
Earnings per Share	2.706	-0.674	0.123	2.706	-1.233
	(5.446)	(0.595)	(0.577)	(5.493)	(2.160)
CEO	-0.889	-0.266	0.870	1.810	0.685
	(1.767)	(0.630)	(1.078)	(1.775)	(1.392)
$P(M_1)$	-108.9**	-11.27*	8.651	-101.7*	37.12*
	(53.67)	(6.572)	(9.077)	(52.11)	(22.07)
Constant	37.98	7.187**	2.106	33.33	-8.324
	(23.93)	(3.346)	(4.575)	(23.17)	(9.990)
Observations	555	555	555	555	555
R^2	0.500	0.263	0.235	0.499	0.457

robust standard erros in parentheses. Variables are winsorized on the 1% level.
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Regression des AR auf Unternehmenscharakteristika II

Variables	(1) AR_1^-	(2) AR_0	(3) AR_1^+	(4) AR_2^+	(5) AR_3^+
Leverage (Book)	0.234***	-0.0305***	-0.0238***	0.237***	-0.0959***
	(0.0380)	(0.00447)	(0.00547)	(0.0380)	(0.0157)
Leverage (Market)	-0.0104***	0.000720**	0.00134***	-0.0106***	0.00414***
	(0.00314)	(0.000354)	(0.000407)	(0.00312)	(0.00126)
Tobin's Q	0.167	-0.219***	-0.0519	0.00882	-0.147
	(0.452)	(0.0506)	(0.134)	(0.408)	(0.155)
R&D	5.145*	0.383	0.127	4.870*	-1.563
	(2.661)	(0.325)	(0.859)	(2.625)	(1.046)
Profitability	-8.755	-4.325***	4.109**	-9.091*	4.372*
	(5.547)	(1.432)	(1.692)	(5.486)	(2.579)
Return on Assets	-0.232	2.585***	-3.999**	-0.941	-1.318
	(4.015)	(0.923)	(1.855)	(3.920)	(1.928)
Size	3.995***	-0.128	-1.794***	4.372***	-2.155***
	(1.031)	(0.224)	(0.295)	(1.015)	(0.482)
Market-to-Book ratio	-0.119	-0.0188	0.102*	-0.101	0.00288
	(0.208)	(0.0295)	(0.0524)	(0.214)	(0.0809)
Earnings per Share	2.674	-0.677	0.131	2.676	-1.220
	(5.420)	(0.596)	(0.579)	(5.469)	(2.153)
CEO	-0.547	-0.232	0.806	2.127	0.554
	(1.848)	(0.624)	(1.081)	(1.804)	(1.418)
$P(M_2)$	-648.4*	-70.06*	-15.64	-608.7*	193.4
	(333.8)	(41.23)	(101.5)	(330.4)	(131.0)
Constant	48.93	8.604**	7.757	43.87	-9.365
	(30.84)	(4.077)	(9.765)	(30.52)	(12.11)
Observations	555	555	555	555	555
R^2	0.501	0.263	0.234	0.499	0.457

robust standard erros in parentheses. Variables are winsorized on the 1% level.

*** p<0.01, ** p<0.05, * p<0.1

Table 5: AR Regression III

Variables	(1) AR_1^-	(2) AR_0	(3) AR_1^+	(4) AR_2^+	(5) AR_3^+
Leverage (Book)	0.116***	-0.0156***	-0.0148***	0.120***	-0.0440***
	(0.0366)	(0.00456)	(0.00417)	(0.0372)	(0.0143)
Leverage (Market)	-0.0187***	0.00163***	0.00197***	-0.0188***	0.00779***
	(0.00533)	(0.000586)	(0.000491)	(0.00545)	(0.00195)
Tobin's Q	-0.389***	-0.297***	0.0216	-0.374***	0.00500
	(0.114)	(0.0419)	(0.208)	(0.0923)	(0.0781)
R&D	0.00784	-0.0324***	0.00238	0.0178	-0.0118
	(0.0213)	(0.00546)	(0.00367)	(0.0217)	(0.00882)
Profitability	-0.155	-1.203***	0.242	-0.110	-0.699*
	(0.840)	(0.214)	(0.932)	(0.798)	(0.422)
Return on Assets	1.348***	0.807***	-0.208	1.158***	-0.0508
	(0.344)	(0.126)	(0.625)	(0.282)	(0.235)
Size	-8.379	0.913	-1.121*	-8.004	2.944
	(5.090)	(0.648)	(0.630)	(5.193)	(1.963)
Market-to-Book ratio	-0.00434***	0.000647**	0.00238***	-0.00432***	0.000659
	(0.00111)	(0.000280)	(0.000601)	(0.00113)	(0.000442)
Earnings per Share	-1.527	0.0797	0.244	-1.592	0.527
	(2.070)	(0.273)	(0.192)	(2.083)	(0.845)
CEO	0.242	-0.144	0.824	3.174**	0.259
	(1.608)	(0.621)	(0.947)	(1.401)	(1.414)
$P(M_3)$	-2,172**	179.9*	123.7	-2,135**	896.4***
	(868.6)	(98.26)	(83.06)	(887.3)	(321.3)
Constant	292.1**	-23.06	-10.47	286.2**	-116.4**
	(122.9)	(14.05)	(12.13)	(125.6)	(45.67)
Observations	555	555	555	555	555
R^2	0.578	0.273	0.226	0.573	0.529

robust standard erros in parentheses. Variables are winsorized on the 1% level.

*** p<0.01, ** p<0.05, * p<0.1

Table 6: CAR Regression I

Variables	(1) $CAR_{t_1^-,t_1^+}$	(2) $CAR_{t_2^-,t_2^+}$	(3) $CAR_{t_3^-,t_3^+}$	(4) CAR_{t_0,t_1^+}	(5) CAR_{t_0,t_2^+}
Leverage (Book)	0.135***	0.483***	0.382***	-0.0455***	0.138***
	(0.0257)	(0.0903)	(0.0728)	(0.00849)	(0.0257)
Leverage (Market)	-0.0230***	-0.0743***	-0.0615***	0.00323*	-0.0228***
	(0.00501)	(0.0179)	(0.0146)	(0.00175)	(0.00508)
Tobin's Q	-0.681**	-0.797***	-0.653***	-0.271	-0.665**
	(0.286)	(0.252)	(0.210)	(0.232)	(0.286)
Forschung und Entwickelung	-0.0375**	-0.0579	-0.0419	-0.0245***	-0.0274*
	(0.0165)	(0.0517)	(0.0422)	(0.00701)	(0.0153)
Profitability	-2.716**	-3.603***	-2.906***	-0.707	-2.638**
	(1.270)	(1.165)	(0.966)	(1.033)	(1.273)
Return on Assets	2.031**	2.533***	1.890***	0.583	1.840**
	(0.859)	(0.768)	(0.639)	(0.697)	(0.859)
Size	-2.029*	-3.691	-5.337*	-1.753***	-1.758
	(1.147)	(3.680)	(3.045)	(0.446)	(1.107)
Market-to-book ratio	0.000812	-0.000583	-0.000867	0.00274***	0.000779
	(0.000884)	(0.00133)	(0.00106)	(0.000755)	(0.000915)
Earpings per Share	-2.030	-6.996	-5.719	0.466	-2.080
	(1.752)	(6.006)	(4.799)	(0.482)	(1.760)
CEO	0.732	-1.299	-10.13***	0.579	3.675***
	(1.240)	(2.729)	(3.610)	(0.948)	(0.965)
$P(M_1)$	-590.6***	-1,841***	-1,554***	39.24	-576.0***
	(142.7)	(505.1)	(414.0)	(51.11)	(144.2)
Constant	337.8***	1,038***	887.8***	-13.32	328.6***
	(82.32)	(290.7)	(238.3)	(29.60)	(83.07)
Observations	555	555	555	555	555
R^2	0.510	0.531	0.522	0.337	0.512

robust standard erros in parentheses. Variables are winsorized on the 1% level..

*** p<0.01, ** p<0.05, * p<0.1

Table 7: CAR Regression II

Variables	(1) $CAR_{t_1^-,t_1^+}$	(2) $CAR_{t_2^-,t_2^+}$	(3) $CAR_{t_3^-,t_3^+}$	(4) CAR_{t_0,t_1^+}	(5) CAR_{t_0,t_2^+}
Leverage (Book)	0.179***	0.649***	0.523***	-0.0543***	0.182***
	(0.0308)	(0.104)	(0.0843)	(0.00917)	(0.0308)
Leverage (Market)	-0.00838***	-0.0276***	-0.0221***	0.00206***	-0.00858***
	(0.00256)	(0.00870)	(0.00716)	(0.000693)	(0.00254)
Tobin's Q	-0.103	0.241	-0.0154	-0.271*	-0.262
	(0.384)	(1.062)	(0.845)	(0.151)	(0.349)
R&D	5.655**	12.48*	10.13*	0.510	5.380**
	(2.438)	(7.062)	(5.798)	(1.066)	(2.403)
Profitability	-8.971*	-25.57*	-19.36	-0.216	-9.308*
	(5.044)	(14.69)	(12.53)	(1.820)	(4.969)
Return on Assets	-1.645	-0.932	-3.880	-1.413	-2.354
	(3.798)	(10.58)	(8.697)	(2.070)	(3.694)
Size	2.072**	9.859***	6.570***	-1.923***	2.449***
	(0.873)	(2.782)	(2.333)	(0.290)	(0.839)
Market-to-Book ratio	-0.0354	-0.278	-0.254	0.0837	-0.0173
	(0.176)	(0.577)	(0.480)	(0.0613)	(0.180)
Earnings per Share	2.129	6.481	5.025	-0.546	2.131
	(4.335)	(14.89)	(12.05)	(1.128)	(4.383)
CEO	0.0273	-3.348	-11.99***	0.574	2.701*
	(1.520)	(4.331)	(4.204)	(1.014)	(1.546)
$P(M_2)$	-734.1**	-1,648*	-1,355*	-85.71	-694.5**
	(300.7)	(891.1)	(730.7)	(127.9)	(297.1)
Constant	65.29**	128.6	115.1*	16.36	60.23**
	(28.03)	(82.10)	(67.45)	(12.15)	(27.71)
Observations	555	555	555	555	555
R^2	0.482	0.496	0.485	0.337	0.484

robust standard erros in parentheses. Variables are winsorized on the 1% level.
*** p<0.01, ** p<0.05, * p<0.1