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Jonas Kalb Psychology in Financial Markets – The Disposition Effect

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Contributions Prof. Dr. Matthias Kräkel On Optimal Tournament Contracts with Heterogeneous Agents

> **Prof. Dr. Urs Schweizer** Damages for Negligent Ratings

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Size Does Matter – Incentives in Heterogeneous Cartels

Max Engels^{*}

Introduction

Cartels cause harm to society by distorting prices and market allocation. As a remedy, Antitrust Authorities (AA) impose rules to enforce competition and programs to detect collusive acts of cartels. For an effective deterrence of cartel collusion, it is essential to understand how cartel members react to regulatory measures. This article sheds light on the incentives of cartel members to join a cartel and to stick to its agreement depending on the firms' size and on the Leniency Program (LP) the AA establishes.

To better understand the behavior of cartel members, I conducted a survey on 36 non-confidential cartel decisions published by the European Commission (EC) between January 1st, 2005 and January 1st, 2012.¹ Its pivotal data are the duration of the cartels, their estimated market share, the number of their members, the possibility of cartel entrance or exit during their lifetime and finally the relative size of the member who applied for the LP of the EC in the first place. The first applicant mostly obtains immunity from fines and is referred to as a whistle blower, since without his application the cartel might often be impossible

^{*} Max Engels received his degree in Economics (M. Sc.) from the University of Bonn in 2013. The present article refers to his master thesis under supervision of Dr. A. Wohlschlegel and Prof. Dr. U. Schweizer, which was submitted in September 2012.

 $^{^{1}}$ The detailed results of the survey are listed in Table 1 in the Appendix.

to detect. The relevant results of the survey are the following: The average cartel lasted nine years. Most of the cartels were subject to a fluctuation of cartel members, late entries occurred as well as exits prior to the cartel breakdown. They possessed an average market share of 80%, but only two of them covered the entire market.

The last but very interesting result is the fact that the whistle blower who applied at first for the LP was typically a large cartel member. The average number of cartel members was seven, the average "position" of the whistle blower was 2,53. In 15 cases the largest member was first, in five cases the second largest was first and in five cases the third largest was first to apply.

These empirical facts cast doubt on the perception of a static collusive equilibrium as developed in many economic models. Rather the collusive equilibrium occurs to be dynamic and may change over the periods. The cartel members alter with time and cartels do not last forever. The large cartel market share allows for two conclusions on the incentives of firms to join cartels depending on their size. Firms with a large market share seem to have high incentives to join a cartel. In only a few cases there were large free firms. On the other side there were almost always small firms competing besides the cartel. It seems the incentives of smaller firms to enter a cartel are rather low. Finally large firms seem to have high incentives to apply for leniency and hence to destroy the cartel, which seems to contradict their continuous participation in cartels in the beginning.

These empirical observations served as a motivation to set up a new model, which could possibly explain the observed firm behavior. Within the model, the following results turn out to be valid: There are small firms which will not join the cartel at all. The cartel will most likely consist of large firms. Given that the fines for a cartel engagement increase with the duration of the infringement, there exists a cutoff value beyond which the aggregate expected fines become too large to be compensated by the gains from joining the cartel. If the basic fine scheme depending on the firms' size is a convex function of a firm's capacity, the cutoff value is smaller for large firms.

Related Literature

The present paper touches upon the following topics: Cartel formation, cartel stability, corporate leniency programs as well as the treatment of cartel ringleaders under those leniency programs.

The topic of cartel stability in combination with corporate leniency programs has been extensively covered in the past decade. The first to mention would be Motta and Polo (2003). Motta and Polo (2003) examine the effect of a corporate leniency program on the stability of a cartel. They describe two effects which are accompanied by the introduction of a leniency program. On the one hand, cartel participation may become more appealing since the expected fines for the cartel engagement decrease. On the other hand, it creates larger incentives to deviate from the cartel agreement once involved in a cartel. Motta and Polo (2003) show that the second effect dominates if the leniency policy is optimally chosen. In recent years several articles were published which cover the topic of corporate leniency programs quite similar to Motta and Polo (2003) were published. Additional articles on this subject include Buccirossi (2008), Aubert, Kovacic, and Rey (2006) or Harrington (2008).

The work most closely related to this text is the paper by Bos and Harrington (2010). Bos and Harrington (2010) design a model which endogenizes the formation of a cartel. They assume a finite set of firms which compete in an infinitely repeated and capacity-constrained price setting game, where firms are heterogeneous in terms of their capacities. Within this setting the authors are able to show that stable non all-inclusive cartels exist with free-riders competing besides

of it. Further, they show that the firms not participating in the cartel are the small firms, while large firms form the cartel.

Bos and Harrington (2010), however, exclude the possibility of cartel detection by an AA in their model. This topic is added in the working paper by Bos and Wandschneider (2011). Bos and Wandschneider (2011) drop the cartel entrance decision and cover only all-inclusive cartels although their paper is built on the framework of the Bos and Harrington (2010) model. Their model studies the effects of a corporate leniency program on the cartel members' incentive compatibility constraint (ICC), which governs the companies' decision to remain in the cartel or to blow the whistle. They introduce a fine scheme which depends on the firm's capacity. On this background they study the effects of ringleader discrimination, that is cartel ringleaders being not or only partially eligible for the corporate leniency program. Their model reveals that ringleader exclusion may result in a higher collusive price, depending on the form of the fine scheme and the distribution of the cartel members' capacities.

Finally, the topic of ringleader exclusion has also been covered in a working paper by Herre and Rasch (2012). They impose some asymmetries on the cartel members, they exogenously choose one firm to be the cartel ringleader. The difference between the ringleader and the other cartel members is caused by the different amounts of evidence of the conduct the firms may offer to the AA. They then analyze the effect of ringleader exclusion on the stability of collusion. They find that ringleader discrimination does not play an important role if the relative amount of the ringleader's evidence is very high. It fosters collusion if its relative amount is moderate and has a deterring effect if its relative amount is low.

Capacities and Cartel Engagement

Our model setup follows Bos and Harrington (2010). Consider an economy consisting of a finite set of firms denoted by $N = \{1, ..., n\}$ which compete in an infinitely repeated capacity constrained Bertrand Competition with homogeneous goods. Firms have common knowledge, equal marginal costs c > 0 and discount future profits with equal δ . Each period they decide simultaneously on their price $p \in \{0, \epsilon, 2\epsilon, ..., c - \epsilon, c, c + \epsilon, ...\}$. The firms are heterogeneous with respect to their exogenously fixed capacity constraints k_i . Furthermore, denote $K = \sum_{i \in N} k_i$ as the total sum of the capacity constraints of all firms in the industry and let K_T be the sum of all capacity constraints of the cartel members. The firms face the demand function D(p).² The economy is assumed to have the following structure:

$$k_i < D(p^m)$$
 and $\sum_{j \neq i} k_j \ge D(c), \forall i$

Here, p^m denotes the price a monopolist would charge. These assumptions require that no single firm has sufficient capacity to supply market demand at monopoly price and that any collection of firms consisting of all but one firm has sufficient capacity to supply the quantity that would be demanded at marginal costs. In addition to these assumptions an AA is introduced. The basic fine structure follows Bos and Wandschneider (2011), but the present paper considers fine schemes that are more complex. The AA detects the cartel at the end of every period twith probability $\alpha_t \in {\underline{\alpha}, \overline{\alpha}}$. Every firm observes the detection probability at the beginning of every period. For all future periods the firms expect the high detection probability $\overline{\alpha}$ with probability γ and the low detection probability $\underline{\alpha}$ with probability $(1 - \gamma)$. For simplicity it is assumed that $\underline{\alpha} = 0$ while $\overline{\alpha} \in (0, 1)$. As in Bos and Wandschneider (2011), it is assumed that whenever a cartel is

 $^{^{2}}$ All further assumptions which are necessary to support the desired outcome are as in Bos and Harrington (2010).

detected, it is also convicted. In the case of detection, the cartel members face the basic fine F(k) as a function of a firm's capacity k with F(0) = 0, F'(k) > 0and F''(k) > 0. This basic fine is multiplied by the factor d, which stands for the duration of the firm's cartel engagement.

It is assumed that the AA offers a corporate leniency program similar to the program of the EC. The first applicant will receive immunity from fines, all later applicants may receive a fine reduction. Since deviating firms will be the first to apply for leniency, they expect ex ante to be granted immunity. For simplicity, it is assumed that ex ante all firms expect to receive immunity if they deviate from the agreement, even if they apply simultaneously with other firms in one period. Whenever the cartel is convicted, all participants who did not deviate apply for a LP which reduces their ex ante expected fine by an equal share of $\beta \in (0, 1)$. At last the total fine $(1 - \beta)dF(k_i)$, which has to be paid in the case of conviction may not be larger than a cap value $\overline{F_i}$.³ Henceforth, the fine firm *i* expects to pay in the upcoming period after *d* periods of cartel engagement is:

$$E[F(k_i, d)] = \alpha_t \min\{(1 - \beta)dF(k_i), \overline{F}_i\}$$

In case of a conviction all firms pay their respective fines in the next period, the cartel will be destroyed and can never be rebuild in any future period.

Similar to Bos and Harrington (2010), it is assumed that all cartel members charge the monopoly set the price in order to maximize the cartel's profit. The cartel members share the cartel's total demand according to a proportional sharing rule, depending on the capacity constraints of the members. In addition they all play the grim trigger strategy. Whenever a cartel member deviates from the cartel

³ With $\frac{\partial \overline{F_i}}{\partial k_i} > 0$ and $\frac{\partial^2 \overline{F_i}}{\partial k_i^2} > 0$

agreement, all firms return to perfect competition.⁴ This strategy implies that while it is possible to enter the cartel in later stages an early exit results in a complete break-down of the cartel.

The static game without collusion has two possible symmetric Nash equilibria. One in which all firms price at c, the other one in which all firms price at $c + \epsilon$. Since ϵ is very small, the difference between those two equilibria is negligible. All firms earn zero profits in both equilibria. Firms are only able to increase the price successfully if they cooperate in a cartel. The larger the market share of the cartel, the more they are able to do so. Hence, the cartel has always interest in expanding. In the model, some of the firms may choose not to join the cartel. This is most likely true for small firms. Assume a cartel exists in the economy and denote K_t as the cartels market share without the participation of firm i. The condition for firm i to enter the cartel is:⁵

$$E[F_i] < \{(p(K_t + k_i) - c) \frac{(D(p(K_t + k_i)) - K + K_t + k_i)}{K_t + k_i} - (p(K_t) - c)\} \cdot k_i \frac{1 + \delta(\gamma \overline{\alpha} - \underline{\alpha})}{1 - \delta(1 - \gamma \overline{\alpha})}$$

 $E[F_i]$ are the fines firm *i* expects to pay in all future periods of its cartel engagement. This term is simplified since it cannot be derived explicitly without the knowledge when $dF(k_i)$ exceeds the cap value $\overline{F_i}$. It can be shown that if the capacity of firm *i* is close to zero and one ignores the expected fines, then the condition boils down to:

$$\frac{D(p(K_t)) - K + K_t}{K_t} > 1$$

 $^{^4}$ Other equilibrium strategies might exist, but can be ignored within this context as the grim trigger strategy is sufficient to guarantee the desired equilibrium behavior.

 $^{^5}$ The cartel entrance conditions as well as the ICC are derived explicitly in the original master thesis.

This condition is never fulfilled. It follows that if a firm's capacity is very small, it will not enter a cartel even if it expects no fines for the infringement at all. If the fine scheme is not too convex, the cartel will most likely consist of the large firms. There will exist a cutoff capacity at which each firm will be indifferent between joining the cartel or remaining a free firm. This is consistent with the observation from the survey that small firms often do not participate in cartels. Moreover, the model is able to explain why large firms have the strongest incentives to apply at first for leniency once the cartel breaks down. Once a member of a cartel, the ICC of cartel member i according to the model setup looks as follows:

$$(p(K_T) - c) \cdot k_i < (p(K_T) - c)(D(p(K_T)) - K + K_T)$$
$$\cdot \frac{k_i}{K_T} \frac{1 + \delta(\gamma \overline{\alpha} - \underline{\alpha})}{1 - \delta(1 - \gamma \overline{\alpha})} - E[F_i]$$

The longer the cartel exists, the larger becomes $E[F_i]$ due to the multiplier d, the stricter become all ICCs of all cartel members. If one ignores the fines, the ICC would be the same for all cartel members. From this follows, since the fine scheme $F(k_i)$ as well as the cap value $\overline{F_i}$ are convex, it will be the ICC of the largest cartel member which is the strictest of all cartel members. Thus, it will be the first one which is violated.

Summing up, the model offers a possible explanation why large firms have strong incentives to engage in cartels in the beginning and then again strong incentives to end the cartel and to apply for the LP. The key to this explanation is the convex fine scheme and the increasing multiplier d. Strictly speaking, the model does not explain why large firms are the first to apply for leniency. It only explains why they have the strongest incentives to do so. Due to the fact that all firms have equal knowledge about the detection probability, all firms know whether any ICC of any cartel member is satisfied or not. Hence, all cartel members will deviate from the cartel agreement in the same period the largest cartel member does. One could solve this problem by the introduction of asymmetric information. In this article this possibility is not pursued.

Ringleader Exclusion

Cartel ringleaders are sometimes but not always excluded from the benefits of the LP. The LP of the EC, e.g., allows cartel ringleaders to apply for immunity, the LP of the German Federal Cartel Office does not.

In the following, I will discuss two countervailing effects of ringleader exclusion. Ringleaders play an important role for a cartels' structure, they often start the interaction between the firms or organize the cartel meetings. By excluding them from the LP, the role as a cartel ringleader becomes much less profitable because of the expected loss due to a possible cartel breakdown. Therefore, no firm is eager to earn the spot of the ringleader, the cartel interaction is then effectively impeded. On the other hand there exists an effect which fosters collusion. Once a firm has established itself as a ringleader, it is no longer able to apply for immunity. Hence, the effect of the LP as a whole diminishes. First, there is one firm less which may end the cartel by whistle blowing, which directly fosters the collusion. Second, the other cartel members who are still eligible to apply for the LP face a lower probability that the cartel is detected by whistle blowing, hence their ICC is less strict. Both effects may enhance the cartel duration.

In terms of the model, the deterrence as well as the fostering effect can be seen very clearly. Assume the largest firm engages as the ringleader and let it be unable to participate at the LP. ⁶ The deterring effect can be seen on the cartel entrance decision of this largest firm. Since not being able to apply for immunity,

 $^{^6}$ This assumption is likely to hold. Bos and Wandschneider (2011) conducted a survey on EC cartel decisions with focus on cartel ringleaders. They found 14 cases where ringleaders were explicitly named, 79% of them were the largest firms of the cartel.

its expected fines $E[F_i]$ are larger than in the non - discriminatory case. Hence the participation is less profitable. Consequently ringleader discrimination may even prevent cartel foundation under certain conditions. If the largest firm in an industry does not want to participate in the cartel, then a cartel foundation is unlikely to happen.

Nevertheless, if ringleader exclusion did not prevent the cartel foundation, then it will foster the collusion. Without the possibility of applying for leniency for the ringleader, the strictest ICC of all cartel members is now the one of the second largest firm. Thus, the cartel may endure longer than in the non-discriminatory case.⁷

Conclusion

In order to efficiently enforce cartel prosecution it is necessary to understand how cartels react to regulatory measures. The behavior of cartel members depending on their market share was described on the basis of an infinitely repeated capacity constrained Bertrand competition. It was shown that if the AA uses a fine scheme which is convex and increasing in the capacities of the cartel members and in the duration of the firm's cartel engagement, then i) there may exist a cartel consisting of the largest firms of the industry, ii) there are small firms which will not join the cartel even if they expect no fines at all for the infringement, iii) the incentive compatibility constraint of the largest cartel member will be the strictest of all cartel members, iv) as the duration of the cartel increases, the ICCs of all cartel members will become stricter, v) the ICC of the largest cartel member will be the first which will be violated.

The last part of the article covered the topic of ringleader exclusion from the corporate leniency program within the framework of the model. It was shown

 $^{^7}$ The same effect may be observed if the ringle ader was the smallest cartel member and the fine scheme was concave with respect to the capacity constraint of the firm.

that if the largest cartel member is the cartel ringleader and not able to apply for leniency, then ringleader exclusion may have a pro-collusive effect once a cartel is established. This effect occurs since the ICC of the ringleader may be slackened due to ringleader discrimination. Otherwise ringleader exclusion may be a good instrument to prevent cartels. If the fine scheme is convex and the largest firm expects to be the ringleader, it may prevent the largest firm from joining the cartel. Without the market share of the largest firm, the cartel may be unable to increase prices at all.

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Appendix

Tables

Avg.	2005	2005	2005	2005	2006	2006	2006	2006	2006	2007	2007	2007	2007	2007	2007	2007	2008	2008	2008	2008	2008	2008	2008	2009	2009	2009	2009	2009	2010	2010	2010	2010	2010	2011	2011	2011	Year
ı	37773	38281	38354	38443	38620	38645	38456	38121	38638	38899	38823	37755	38710	38432	39165	38629	38628	38543	38695	39180	39181	39188	39125	39406	39401	39396	39129	38589	38511	39092	38344	38866	39309	39579	39605	39600	Case Number
9,38	14	7	20	σ	6	57	œ	16	œ	16	9	ω	12	ω	1	9	2	18	σı	0,5	13	2	υī	19	25	ω	4	13	4	12	18	35	4,5	ω	6	3,5	Duration
1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Y_{es}	No	Yes	No	No	No	No	Y_{es}	Yes	No	Yes	No	Yes	Yes	No	Y_{es}	No	Yes	Yes	Y_{es}	Yes	Yes	No	No	No	No	Late Entries
,	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	No	No	No	No	No	No	Yes	No	No	No	Yes	No	No	Yes	Yes	Early Exits						
6,92	5	сл	16	4	7	σ	14	11	6	10	cπ	4	σ	4	4	σ	2	10	7	4	10	ω	4	6	2	7	7	11	10	17	17	σ	6	ω	4	ы	Cartel Members
81,26 %	95~%	n/a	77%	58 %	75~%	86%	60%	95%	87%	n/a	85%	%00	92~%	89~%	80%	100~%	55%	n/a	95%	n/a	100%	50%	95%	%00	n/a	75%	n/a	n/a	n/a	n/a	80 %	71~%	70%	n/a	n/a	n/a	Cartel Market Share
1	Clariant	Deltafina	Combipac	Flexsys	Degussa	Degussa	BP	Mueller	Bayer	ABB	Otis	InBev	BP	Fuji	Asahi	Bayer	Bayer	n/a	Akzo Nobel	Boliden Odda	Shell	Chiquita	Asahi	Yokohama	n/a	Akzo Nobel	Siemens	Chemtura	Micron	Masco	Saarstahl	Kemira	Samsung	Henkel	Samsung	Tecumseh	Whistleblower
2,53	2	1	1	1	2	1	ω	UT	1	1	1	2	ω	2	ω	1	1	n/a	1	4	4	1	ω	сл	n/a	ω	1	n/a	1	n/a	15	1	1	2	4	4	Position

Table 1: Statistics of the non-confidential decisions of the European Commission All cases are available on the homepage of the European Commission, listed under their case number. "Position" describes the market share of the whistle blower in comparison to the other cartel members. All numbers are estimations. Duration in years.

Psychology in Financial Markets – The Disposition Effect

Jonas Kalb^*

The Disposition Effect and Empirical Evidence

Using the term disposition effect, Shefrin and Statman (1985) describe the phenomenon, that investors in financial markets, if compared to an optimal trading strategy, tend to hold stocks that have lost in value too long, whereas they sell winnings too fast. Over the time a lot of essays about the disposition effect have been published and a bunch of theories and models in psychology and behavioral economics have tried to show if and why investors behave that way.

Genesove and Mayer (2001) were able to show a disposition effect in the real estate market and Odean (1998) shows a significant tendency for investors in financial markets to hold losers (i.e. stocks that have a price lower than the price it was bought for) longer than winners (i.e. stocks that have a higher price than the initial buying-price). With data from 10.000 discount-broker-accounts in the US from 1987 to 1993 he was able to compute the percentage of gains realized (PGR) and the percentage of losses realized.

 $PGR = \frac{realized \ gains}{realized \ gains + paper \ gains}$

^{*} Jonas Kalb received his degree in Economics (B. Sc.) from the University of Bonn in 2012. The present article refers to his bachelor thesis under the supervision of Dr. S. Ebert and Prof. Dr. H. Hakenes, which was submitted in April 2012.

$PLR = \frac{realized \ losses}{realized \ losses + paper \ losses}$

If the ratio $\frac{PGR}{PLR} > 1$, investors sell relatively more winners than losers, which is an indication for the disposition effect. Odean (1998) finds a significant indication for the disposition effect: $\frac{PGR}{PLR} = 1.51$ for the whole period.

One can argue that these outcomes do not necessarily indicate a psychological or behavioral phenomenon, because external effects could have made the trading strategy of keeping losers and selling winners optimal. Weber and Camerer (1998) conducted an experiment to obtain an isolated view on the disposition effect. Over several periods students had to decide whether to invest in different stocks and when to sell them. The stock prices followed a statistical trend, so that in each period the price went up or down by a known fixed amount, but with an unknown fixed probability that was different for each of the stocks. Therefore the investment's expected value is strictly positively correlated with the probability of the price going up. The best trading strategy is to invest in the stocks that had the best performance until a given moment, because these stocks have the highest chance to be those with the highest expected value. Note that this trading strategy is contrary to the disposition effect. If investors follow the disposition effect, they hold losers and sell winners. In this setting, following the optimal trading strategy is to hold winners and sell losers. Using this experimental design, Weber and Camerer (1998) were able to show a disposition effect for most of the probands. Why are investors unwilling to sell losers but sell winners? To detect a reason, Weber and Camerer (1998) had a second experiment that was different only in one aspect: if in the first experiment investors had to execute all trading activities by themselves, in the second experiment all stocks were sold after every period and could be rebought for the same price as they were sold. Without any transaction costs, economic theory predicts, that there is no difference in the behavior between both groups. But Weber and Camerer (1998) show that the group of "automatic sellers" had a smaller tendency to the disposition effect as those who had to execute sales by themselves. The difference between automatic and self-induced selling seems to be important in the investment decisions of investors.

The Disposition Effect and Theoretical Explanations

After pointing out that the disposition effect exists in the real market as well as in an experimental environment we now give the theoretical ideas to explain why investors act that way. The theory of regret aversion as defined by Bell (1982) and Loomes and Sugden (1982) says that individuals take future feelings into account when they make decisions. On the one hand they earn pride if an investment turns out to be good ex-post (i.e. if they gain sth.), on the other hand they feel regret if a decision is bad ex-post (i.e. they suffer a loss). In both scenarios, individuals compare the "is" state of the world with an antithetic "fictitious" state of the world (Muerman and Volkman (2006)). That means if one investment rises in price (i.e. is a winner), the individual compares his decision to buy the stock with the worst state of the world where he would have suffered a loss. The investor will now sell the stock to ensure the feeling of pride about having made the right decision. On the other hand, he will hold on to losers to avoid the feeling of regret about having made a false decision. As long as the loss is not realized, there is still a chance, that it turns out to be a winner. If investors act like that, the disposition effect is the consequence. The term "Regret Aversion" is also used by Thaler (1980) to describe that "[...] whenever choice can induce regret consumers have an incentive to eliminate the choice." This could explain the finding of Weber and Camerer (1998) that the disposition effect is more distinct if individuals have to take the selling-decision by themselves. For them, realizing a loss creates regret, so they try to avoid it if possible. A second approach for explaining the disposition effect is the mentalaccounting theory by Thaler (1985). He argues, that investors do not have their whole portfolio in mind when deciding to sell or buy stocks. For every position in their portfolio they have a separate mental account, each evaluated separately from the others. Together with the above mentioned theory of regret aversion the disposition effect can be explained. If the investor does not feel pride or regret regarding his whole portfolio, but separately for each position, he will keep losers and sell winners to avoid regret and seek pride. Positive effects rising from an optimal trading strategy are not taken into account.

Another way to explain why investors tend to hold losers and sell winners is the theory of self control. Hoch and Loewenstein (1991) as well as Thaler and Shefrin (1981) describe agents as an organisation and their decision-making as a conflict between two opposed preferences in that organisation. On the one hand there is a myopic "doer". He is able to take action and make decisions, but his utility function is only defined for one period. On the other hand there is a farsighted "planner" who lives for several periods but cannot take immediate action or decisions. His utility function is dependent on the aggregated utility of the doers in all periods. Combining this theory with the theory of regret aversion, a doer is not going to sell any losers because that would make him feel regret. That feeling is shifted into future periods which do not effect his utility function. On the other hand, winners are sold to feel pride. The only thing the planner can do is to set rules and restrictions such as buying stop-loss-options or predefine a fixed investment path. The doer is then forced to follow the predefined path.

That last theoretical framework for the explanation of the disposition effect that will be mentioned here is a prospect theory model defined by Barberis and Xiong (2009). Prospect theory was developed by Kahneman and Tversky (1979) as an alternative to expected utility theory. The aim was to predict the actual decision of agents. There are three main differences to expected utility theory: first, the argument of the utility function is the gain or loss from a particular decision rather than final wealth. Second, the utility function is divided in two parts around a reference point. In the area of losses the function is convex, mirroring that agents are risk-seeking for losses. As they are risk-averse over winnings, the utility-function is concave in the area of gains. Therefore the value function is S-shaped, as shown in Figure 1. The third difference takes into account, that in experiments probands showed a tendency to overestimate small probabilities and underestimate high and moderate probabilities. Therefore probabilities are weighted according a weighting-function. This feature is not used in the following model, because Barberis and Xiong (2009) argue that "[...] [one cannot] expect probability weighting to be central to the link between prospect theory and the disposition effect."

Let $\tilde{G} \sim (p_1, x_1; p_2, x_2; ...; p_n, x_n)$ be a lottery that pays x_i with the probability p_i (i = 1, ...n). If probability-weighting is not applied, the Prospect Theory utility from that lottery is

$$V(\tilde{G}) = \sum_{i=1}^{n} p_i v(x_i) = E[v(x_i)]$$

with the value-function $v(x_i)$

$$v(x_i) = \begin{cases} x^{\alpha} & \text{for } x \ge 0\\ -\lambda(-x)^{\alpha} & \text{for } x < 0 \end{cases}$$

defining the utility. Note that the reference point is zero for this function: $v(x_i = 0) = 0$. Barberis and Xiong (2009) define a model in which an investor with utility similar to $v(x_i)$ makes investment decisions over several periods. He can

either invest his initial wealth W_0 in a risk-free asset which pays no interest or in a risky asset whose price follows a path through a binomial tree. With the probability of 0.5 the price will rise (fall) at a fixed rate R_u (R_d). To ensure that there is an incentive to invest in the risky asset, assume that the expected return from the risky asset is higher than the return of the risk-free asset: $R_u + R_d > 2$. Two different approaches are considered. In the first approach, the agent gets utility from annual gains only,¹ i.e. from the winnings or losses he was able to earn through several periods until a predefined end-period. This model does not predict a disposition effect. In the second approach, the agent gets utility through every gain or loss he realizes.² That is, everytime he sells an asset with a win (loss), he receives utility (disutility). In this setting, prospect theory is shown to predict the disposition effect.

To analyse the first case, assume that the investor can make investment decisions from a starting period t = 0 until an end-period t = T. It can be shown that, to maximize his utility, the investor chooses an optimal wealth allocation for the period t = T. That means, that for every state of the world, he defines how much wealth he wants to have, given his budget constraint. It is not possible for the investor to have a negative wealth in any state of the world. Therefore there are three options to allocate wealth:

- I. Choose an investment path that gives a return that is higher than the risk-free return
- II. Choose an investment path that gives the same return as the risk-free return
- III. Choose an investment path that gives a return smaller than the risk-free return, but greater than or equal to zero

¹ "A Model That Applies Prospect Theory to Annual Trading Profits"; Barberis and Xiong

 $^{^{(2009)}}$ 2 "A Model That Applies Prospect Theory to Realized Gains and Losses"; Barberis and

It can be shown that the investor either chooses I or a special case of III where his wealth is zero. Furthermore he allocates a higher level of wealth to those nodes in the binomial tree in which the price of the risky asset is high. In the lowest parts of the tree he chooses the wealth allocation $W_T = 0$. From the last period backward one can compute the optimal trading strategy to reach the wealth allocations given a state of the world.³ In the beginning, the investor buys the risky asset because the expected return is high enough. Suppose now that the price of the asset falls. The agent is in the convex part of the value-function.⁴ The investor has to adjust his portfolio so that on the one hand, his losses are not too high if the price falls again. On the other hand he wants to keep the chance of earning a small gain. Keep in mind, that the expected return of the risky asset is positive. He will therefore sell some of his assets. If in the beginning the price of the risky asset rises, the investor will buy more assets and the mechanism is analogous. Even if the price falls, the investor wants to have a positive return. On the other hand he wants to earn as much as possible. To ensure both, he will buy more risky assets. This is a behavior that differs from the disposition effect: the investors hold winners and sell losers.

In the second approach Barberis and Xiong (2009) allow the investor to receive utility everytime he sells some of his assets. Doing so, they give the investor the chance to insure himself against falling stock prices and to let him hope for rising stock prices. Assume the price of the asset went up after the first period. The investor is now in the concave part of the value-function. If the price goes up again, the investor will receive relatively low extra-utility because of the diminishing marginal utility. If the price falls, his losses are relatively big. By selling some of the assets, he can ensure some utility. This explanation works the other way around in the area of losses.

 $^{^3}$ cf. Figure 2 4 cf. Figure 3

Connecting Empirical Evidence and Theoretical Explanation

There is a connection between the empirical findings and theories discussed. Weber and Camerer (1998) find a weaker disposition effect in the group where automatic selling applies. As described above mental-accounting in combination with regret aversion would usually lead to not selling at a loss. If in every period all positions in the portfolio are sold, no matter if at a gain or a loss, the investor can make an investment decision about his whole wealth in every period and mental-accounting is not present. One can argue that the feeling of pride or regret then applies on that whole wealth, because that is what the investor gets as a payout in every period.

The Prospect Theory model by Barberis and Xiong (2009) predicts no disposition effect if the investor receives utility from annual gains. Only if the investor can receive utility by realizing gains or losses a disposition effect can be shown. The agent then tries to avoid the realization of losses because he hopes, they turn into winners again. At the same time he realizes gains to ensure some utility. That connects to the theory of self control where a similar mechanism is at work. The doer tries to realize gains as fast as possible, whereas losses are shifted to future periods, hoping they become winners again. If the planner can restrict the doer through predefining an investment path, the disposition effect would vanish similar to the annual gains model of Barberis and Xiong (2009) where the investor defines different wealth allocations and then derivates his optimal investment path from that. If he once defined his investment path he has no incentive to deviate from it.

All in all, the disposition effect can be observed in real markets as well as in experimental settings. In all of the above mentioned theories, the disposition effect occures because the agent tries to avoid a negative feeling, either called disutility or regret. At the same time he seeks to receive a positive feeling (utility or pride). Selling winners works like an insurance against falling stock prices, whereas holding losers works like a gamble to get lucky and earn a gain. The main argument is that investors try to ensure utility by selling winners and shift disutility by keeping losers. Further experiments with an open time horizon may be interesting. One question is if subjects who are allowed to have utility from every sold asset realize their gains earlier than those with a predefined end-period like the model from Barberis and Xiong (2009) predicts. This could be investigated by giving probands the opportunity to leave the experiments whenever they want and give them a payment correlated to their earned returns.

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Appendix

Figure 1: Prospect Theory value function v(x)v(x) is concave in the area of gains and convex in the area of losses. The smaller α , the more curved is v(x)



Figure 2: Asset prices and trading strategy

One can see values for asset price, wealth and the number of assets an investor has. The investor maximizes his utility by choosing a wealth allocation for t = 4. The result is a trading strategy for every possible movement in the binomial tree. Marked in red is one possible path. Data: Barberis and Xiong (2009)



Figure 3: Wealth allocation and value function

The left side shows a possible wealth allocation for t = 2. The point A (C) refers to a situation in which the asset price rises (falls) in the first period. B' (D) refers to a situation in which the asset price rises (falls) two times in a row, whereas B and D' are situations in which the asset price first rises (falls) and then falls (rises). The right side shows the induced utility levels for each situation. One can see, that the investor has a negative utility only for the end-point D. For all others he has at least a slightly positive utility. Data: Barberis and Xiong (2009)

Debt Capacity for Short-Term Financing in Financial Crises

Katrin Kölker^{*}

Introduction

The following work analyzes the relationship between short-term financing and financial crises. Due to several financial crises in recent years, there has been an increasing amount of literature on short-term financing. Most of them question whether short-term financing is origin, accessory phenomenon or just the consequence of crises. Answering the question would exceed this paper. For this study it suffices to approve the fact that short-term financing and financial crises occur simultaneously.

The most likely causes of short-term financing are adverse selection and moral hazard problems. On the one hand this is because information can be handled more quickly and effectively. On the other hand lenders gain the power of retrieving capital from poor firms. Therefore, short-term debt is cheaper and more attractive to firms. However, short-term debt can lead to several problems concerning the amount of debt, which will be presented in the following work. Debt capacity is generally understood to mean the amount of money that can

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be borrowed against an asset using the very asset as collateral. Thus, it can be described as the amount of money the firm is able to raise at the maturity of the debt. The firm strives to estimate their debt capacity precisely in order to draw up long-term capital investment planning. Moreover, the creditor needs to know the debt capacity to determine the amount of money he is willing to borrow. Consequently, for both it is important to estimate the debt capacity, which will be shown in this paper.

There is a large volume of published studies describing different influences on debt capacity. Shleifer and Vishny (1992) endogenize the liquidation value and analyze the impact of agency problems. They find that illiquidity reduces the debt capacity by decreasing the optimal price of the asset. The work of Acharya, Gale, and Yorulmazer (2011) can be seen as a generalization of this. Martin and Scott Jr. (1976) show that higher risk of insolvency induces decreased debt capacity. This is intensified in times with low cash flow and in times of financial crises. Rampini and Viswanathan (2010) show that debt capacity is influenced by productivity and equity capital. Hence, firms have higher refinancing costs in financial crises. Debt capacity can also be increased by leasing capital instead of financing with collateralized loan (Eisfeldt and Rampini (2009)). Furthermore, Aivazian, Qiu, and Rahaman (2010) show that diversified companies have less capital costs and thus higher debt capacities.

This paper is organized as follows. A model of Acharya et al. is presented in section 2. A critical view and the inclusion of interest rates are shown in section 3. Section 4 concludes.

Maximum Debt Capacity

Acharya, Gale, and Yorulmazer (2011) present a model to explain the sudden drop in the debt capacity. A long-term asset, which is purchased at t = 0 with lifetime T = 1, is financed by short-term debt with maturity $\tau \ll 1$. Thus, the debt is to be rolled over frequently, namely $N = \frac{1-\tau}{\tau}$ times. Two states of nature are considered. State L indicates low information state, while state H means high information state. Depending on the state, the fundamental value of the asset is v_L or v_H at maturity (i.e. t = 1), where $v_L < v_H$.

States of nature are modeled as a stochastic process and can be determined completely with markov chains. The probability of transition from a high state at time t_n to a low state at time t_{n+1} is constant and indicated by p_{HL} . This probability is chosen very small, which means that the occurrence of a low state being in a high state, for example a financial crisis, is unlikely to happen. The other transition probabilities, p_{LL} , p_{HH} and p_{LH} , are defined in the same manner.

If the borrower has to default at some point, the collateral will be liquidated by the creditor with liquidation cost $(1 - \lambda)$ of the sale price.

To calculate the maximum debt capacity, note that the amount of money which is borrowed should not exceed the debt capacity of the next roll-over date. Otherwise the creditor would take unreasonable risk. It can be shown that in state L the optimal face value of debt D is always the fundamental value of the asset in state L. Therefore, the debt capacity in state L at time n, denoted by B_n^L , is constant in time:

$$B_n^L := v^L$$

If the economy is in the high state, the debt can be set to the expected value of next term's fundamental value:

$$B_n^H := p_{HH} B_{n+1}^H + p_{HL} \lambda v^L$$

Backward induction leads to:

$$B_n^H = (p_{HH})^{N-n} (v^H - \lambda v^L) + \lambda v^L$$

If the face value of debt is set to the future debt capacity, the debt capacity will be maximized over the whole time.

Acharya et al. use numerical examples to show that for sufficient small τ this strategy can result in a market freeze. Figure 1 shows the debt capacity and fundamental value in the different states. If economy changes to state L, the debt capacity will drop to a minimum rapidly, while the fundamental value does not change noticeably. Because of this, the lender cannot raise enough money and has to default. The market for short-term debt is frozen.

Acharya et al. present a model which shows the correlation between debt capacity and the expected fundamental value at maturity. The impact of interest rates on this model is analyzed in the next section.

Interest Rates

For the following study we assume that the creditor has refinancing costs and shifts these to the borrower. Thus, we define an interest rate r_n at time n. Since we have complete financing and do not want to generate income streams throughout the model period, we add the interest payment to the next period's debt. Therefore, the cash flow at time n, $CF_n = -(1 + r_{n-1})D_{n-1} + D_n$, is set to zero. This leads to:

$$D_n = (1 + r_{n-1})D_{n-1} = \dots = \prod_{u=0}^{n-1} (1 + r_u)D_0$$

In order to avoid payment at t = 0, D_0 is set to the acquisition value of the asset. Let V_n be the fundamental value at time t = n. The net present value can be calculated as follows:

$$NPV_n = \frac{V_{N+1} - r_N D_N}{(1+r_n)^{N+1-n}} = \dots = \frac{V_{N+1} - r_N \prod_{u=n}^{N-1} (1+r_u) D_n}{(1+r_n)^{N+1-n}}$$

We can now describe the fundamental value¹:

$$\begin{aligned} V_n^L &= p_{LL}(n) \cdot NPV_n^L + p_{LH}(n) \cdot NPV_n^{LH} \\ V_n^H &= p_{HL}(n) \cdot NPV_n^L + p_{HH}(n) \cdot NPV_n^H \end{aligned}$$

The fundamental value is to be compared to the debt capacity. The latter can be calculated as follows. The creditor anticipates the interest payment of the next period and the debt capacity is reduced by this. We get:

$$B_n^L = (1 - r_n^L) B_{n+1}^L = (1 - r_n^L) (1 - r_{n+1}^L) B_{n+2}^L = \dots = \prod_{t=n}^N (1 - r_t^L) v_L$$
$$B_n^H = p_{HH} (1 - r_n^H) B_{n+1}^H + p_{HL} \lambda v_L$$

If we assume low interest rates in financial crises and therefore in information state L and growing rates in state H, we can use the formulas for several numerical analyses. Let the debt maturity be one month. Figure 2 shows that after including interest rates the difference between the debt capacity and the fundamental value is significantly smaller than in the model without interest rates (figure 1). Therefore, if the information state changes to L, the default of the borrower is not necessarily occurring. This effect increases as the debt period is

$$\begin{pmatrix} p_{LL}(n) & p_{LH}(n) \\ p_{HL}(n) & p_{HH}(n) \end{pmatrix} = \begin{pmatrix} p_{LL} & p_{LH} \\ p_{HL} & p_{HH} \end{pmatrix}^{N+1-n}$$

¹ $p_{IJ}(n)$ is the transition probability that nature has state I at time n and at time N+1 it has state J and can be calculated as follows :

The net present value NPV_n^H , NPV_n^L and NPV_n^{LH} can be determined with the formula above, where all variables depend on the state of nature.

extended (see figure 3 and 4).

Longer periods imply an asset period of several months. However, extending debt period is equivalent to raising interest rates. This allows us to consider the situations to be realistic. It can be seen that the calculable interest rates compensate the risk of default. This is a result of lower fundamental values because, being financed with high interest rates, the asset has less value in the first periods. The liquidation value is rated higher as its value does not have to be discounted. This leads to a smaller difference between fundamental value and debt capacity in the low information state.

Furthermore, figures 5 and 6 present fundamental value and debt capacity if the debt has to be rolled over 200 times. During low states and early periods, the fundamental value exceeds the debt capacity. This difference is again higher if interest rates are considered. Comparing it to the results for N = 100 in figure 2, the difference increases with the number of periods. Figure 7 shows that a debt which needs to be rolled over 1000 times has less debt capacity even in high information state. This means that in case of a financial crisis the drop of the debt capacity is less crucial and, thus, might not lead to default. Notice that interest rates are not considered here.

A positive cash flow produced by the asset will also increase the sharp difference in debt capacity, which can be proven similarly.

Conclusion

The study was designed to determine the effect of interest rates on debt capacity. It shows that the default of a borrower using an asset as collateral while financing it with short-term debt depends on different aspects. The longer the asset period or the shorter the debt periods are, the smaller is the possibility of the default after a financial crisis is observed. This is caused by a smaller drop of debt
capacity. Furthermore, the study shows that including interest rates leads to decreased risk of default. The fundamental value has to be discounted and is closer to the estimated debt capacity. Taken together, this leads to the conclusion that the debt capacity of collateralized debt is positively correlated with the interest rates as well as with the length of the period and both must not be neglected when estimating debt capacity.

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Appendix

The data for the following figures is collected with a C++ program and the charts are designed with MS Excel.



Figure 1: Maximum debt capacity (B) and fundamental value (V) in low state L and high state H, ${\rm N}=100$



Figure 2: Maximum debt capacity (B) and fundamental value (V) in low state L and high state H with interest rates, N = 100, credit period = 1 month



Figure 3: Maximum debt capacity (B) and fundamental value (V) in low state L and high state H with interest rates, N = 100, credit period = 2 months



Figure 4: Maximum debt capacity (B) and fundamental value (V) in low state L and high state H with interest rates, N = 100, credit period = 3 months



Figure 5: Maximum debt capacity (B) and fundamental value (V) in low state L and high state H without interest rates, ${\rm N}=200$



Figure 6: Maximum debt capacity (B) and fundamental value (V) in low state L and high state H with interest rates, N = 200, credit period = 1 month



Figure 7: Maximum debt capacity (B) and fundamental value (V) in low state L and high state H without interest rates, $\rm N=1000$

News Shocks and the Business Cycle

Philipp Korfmann^{*}

Introduction

Expectations play an important rule within the business cycle theory. Households and firms decide whether to consume or to save using the information they receive (Blanchard, L'Huillier, and Lorenzoni (2009)). Pigou was one of the first to name news about future developments as a possible source for business cycle fluctuations. In 1927, he assumed that changes in output result from a change in firms' expectations about the profitability of their investments. Fluctuations happen not only because of real observable changes but also because of new information (Collard (1996)). News shocks are defined as expected future changes that affect business cycles. They contain information that is used by households and firms for their intertemporal consumption or their production decision (Rebelo and Jaimovich (2009), Beaudry and Portier (2004)). This paper will focus on news shocks to technology.

News shocks began to become more interesting partially motivated by the U.S. "boom-bust" cycle from 1999 to 2001. High expectations about the future productivity led to high growth rates in 1999 and 2000. In 2001, when those ex-

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pectations had to be revised, a recession occurred (Beaudry and Portier (2007)). Today, expectations about future changes are remarked as important sources of economic fluctuations. According to the article on business cycle research of Rebelo (2005) "news-shocks may be important drivers of business cycles." Several empirical papers suggest that business cycles are driven by a shock, which can be interpreted as a news shock. Beaudry and Lucke (2010), and Beaudry and Portier (2006) find that news shocks explain more than 50% of business cycle fluctuations. Schmitt-Grohe and Uribe (2010) mention that future changes are mostly anticipated and that more than half the variance of cycles is explained by those expected shocks.

However, it is very difficult to generate an upswing as a reaction to a news shock in a standard business cycle model. Beaudry and Portier (2004), and Cochrane (1994) show that many versions of a simple neoclassical model generate a recession today as a reaction to good news about future developments.

The paper proceeds as follows. First, in the following section I present a simple version of a neoclassical model. The next section will demonstrate the reactions of the model to a news shock by calculating impulse response functions, simulating the model and calculating stylized facts for the generated time series. Furthermore, I will analyze a "multi-shock" environment, i.e. a model driven by expected and unexpected total factor productivity shocks, and compare the calculated business cycle statistics. Finally, the last section concludes.

The Model

The closed economy is populated by a representative household and a representative firm. There is no government sector. The representative infinitely lived household maximizes the expected value of lifetime utility given by:

$$U = E_t \sum_{t=0}^{\infty} \beta^t (\ln(c_t) - \psi \frac{l_t^{1+\varphi}}{1+\varphi})$$

The function U(...) is concave in consumption (c_t) $(U'_c > 0, U''_c < 0), \beta \in (0, 1)$ is the factor by which future utility is discounted, and l_t are the number of hours the household works $(0 < l \leq 1)$. The parameter $\varphi \ge 0$ represents the wage elasticity of labor supply, $\psi \ge 0$ the degree of disutility from work. In each period t the representative firm produces output (y_t) using capital (k_t) and labour (l_t) . The technology for producing the homogenous good of this economy is described by a Cobb-Douglas production function with constant returns to scale:

$$y_t = A_t k_t^{\alpha} l_t^{1-\alpha}$$

where A_t represents the level of total factor productivity (TFP) which is specified further below.

The final good can either be consumed or invested (i_t) .¹ The capital stock evolves according to the following law of motion:

$$k_{t+1} = i_t + (1 - \delta)k_t$$

where δ represents the constant rate of capital depreciation.² The only exogenous variable in the model is A_t , following a stochastic process driven by two shocks.

$$A_t = \bar{A}e^{z_t}$$
$$z_t = \rho z_{t-1} + \epsilon_t^1 + \epsilon_{t-8}^2$$

 $^{1 \}quad y_t = c_t + i_t$ ² In addition, there are the nonnegativity constraints $l_t, c_t, k_{t+1} \ge 0$ and the transversality condition $\lim_{T \to \infty} \beta^T \lambda_T k_{T+1} = 0$.

The shocks are normally distributed with $\epsilon_t^1 \sim N(0, \sigma_{\epsilon_t^1})$ and $\epsilon_{t-8}^2 \sim N(0, \sigma_{\epsilon_{t-8}^2})$. The parameter ρ measures how persistent those shocks are. ϵ_t^1 represents an unexpected shock in period t. The news shock is represented by ϵ_{t-8}^2 , it has no contemporaneous effect on TFP. Following Barsky and Sims (2011), the news shock will inform the agents about a change of TFP two years in the future. Hence, one period in this model corresponds to a quarter year. \bar{A} represents the normal level of TFP and is normalized to 1. Agents have perfect information about the shock.

Analysis

The model is calibrated to U.S. data following primarily Cooley and Prescott (1995) and King and Rebelo (1999). Table 1 shows the value assigned to each parameter. Those parameter values are chosen by taking into account average long run observations from empirical data.

The following section will demonstrate that a news shock, saying that a one percent change in TFP will arise eight quarters in the future, leads to a recession today. Consumption will rise while investment, output and hours worked will decrease. After this section I will show, using business cycle statistics of a simulated version of the model, that news shocks do not lead to positive comovement between production and the other main aggregates. Finally, I will present business cycle statistics for a simulation of the model driven by an expected and an unexpected shock to TFP.

Impulse Response Functions

Impulse responses are the time paths of the model to a one time impulse in the technology shock, ϵ_t , ϵ_{t-8} , or both. The economy begins in the steady states, with all shocks to TFP set to zero. Figure 1 demonstrates impulse responses

for consumption, capital stock, wage, hours worked, production, investment, and the shock process z. Agents receive a news shock at period zero that TFP will increase by 1 percent at period eight. When receiving the positive news, the households experience a positive wealth effect and, as a reaction to this effect, reduce their hours worked and increase their consumption (Rebelo and Jaimovich (2009)). At period zero the capital stock remains unchanged. This leads, together with the decline in hours worked, to a decrease in output.

Since consumption increases and output decreases, investment, as the residuum of both, has to decline. The capital stock k declines during the first eight quarters, so that the household can consume more.³

As the impulse response functions show, changes in expectations about future TFP growth do not lead to positive comovement. Investment and hours worked rise, while consumption is decreasing. Good news about the future lead to a recession today. Only when the shock materializes in period 8 there is a boom.

Business Cycle Statistics

Comparing second moments between simulated and empirical data is another way of evaluating the model's ability to generate realistic business cycle fluctuations. Before calculating the second moments the time series is detrended using the Hodrick and Prescott filter (HP filter). For quarterly data the standard value chosen for the smoothing parameter λ is 1600.

Figure 2 shows the cyclical components of the simulation driven by a news shock, and Figure 3 displays those for the U.S. business cycle. The bright line represents the output, the dark line the respective variable. Table 2 presents a set of stylized facts computed for quarterly U.S. data for the time period from 1948 I to 2010 IV. The standard deviation represents the volatility of the time series, correla-

³ See also: Beaudry and Portier (2004) p. 1186.

tion represents comovement, and autocorrelation shows how persistent cycles are (Rebelo (2005)). Table 3 displays the stylized facts computed for a simulation of the model driven by a news shock.

Overall the model matches the U.S. second moments. In particular, investment has the highest volatility while consumption has lower volatility than output. For hours worked the data shows higher volatility compared to output, this fact is not replicated. The model also captures the high autocorrelations of all variables.

In addition, since comovement between the major aggregates is an important business cycle fact, and the model can not produce an upswing as an reaction to a news shock, I calculate the correlation of all main variables (Rebelo and Jaimovich (2009) and Barsky and Sims (2011)).

Table 4 demonstrates, that comovement is not generated by the model. The correlation between consumption and investment, and consumption and hours worked is negative. Because of this, news shocks, within a simple neoclassical model, cannot produce realistic business cycles and can be ruled out as an major source for economic fluctuations (Beaudry and Portier (2007)).

"Multi-Shock" Environment

Adding more shocks to the model and using them to generate comovement is another research area beside building models that generate comovement as a reaction to a news shock. Already Cochrane (1994) mentioned this idea: "The problem we are having is that it is hard to match a single shock model to a multiple shock world." The empirical papers of Cochrane (1994), Schmitt-Grohe and Uribe (2010), and Barsky and Sims (2011) identify more than one shock as sources of business cycle fluctuations.

Furthermore, Haertel and Lucke (2008) came to a similar result. They identify an unexpected as well as an expected shock to TFP: "Both types of shocks seem to account for important fractions of the total variance of macroeconomic variables." Following Barsky and Sims (2011) I will demonstrate that a model driven by both, an expected and an unexpected shock to TFP, can produce business cycles, that are even more realistic. Therefore the model is simulated two more times. Table 5 shows the corresponding correlations of the simulated time series. The first row displays the correlations of the U.S. main aggregates from 1948 I to 2010 IV.

The correlations for a simulation driven by a news shock and an unexpected shock to TFP are shown in row two, and the third row provides those for a simulation driven only by an unexpected TFP shock. Furthermore, Figure 3 shows the simulated time series driven by an expected and an unexpected shock.

As shown in the previous section, a news shock alone does not generate comovement between major aggregates. In contrast to this result, if expected and unexpected shocks to TFP are used as sources for business cycles fluctuations comovement occurs. Furthermore, within a "multi-shock" environment the correlations between output and the other main aggregates are much closer to U.S. data than those of the simulation driven by only an unexpected shock to TFP.

Conclusion

News shocks may be important sources for business cycle fluctuations. Empirical papers show that large fractions of the volatility of economic fluctuations is explained by anticipated shocks. Furthermore, news shocks can improve the quality of simulated data. They lower, if used together with expected TFP shocks, the correlations between all major aggregates, compared to model driven by a single unexpected TFP shock.

Within a simple neoclassical model news shocks do not lead to comovement between the main aggregates. Consequently developing models to do just that is an important research area. Beaudry and Portier (2004) were the first to present such a model that generates comovement between all major aggregates. Rebelo and Jaimovich (2009) produced an alternative to this model. They expanded a simple neoclassical model by adding non-time-seperable preferences, variable capital utilization and investment adjustment costs.

Especially the model of Rebelo and Jaimovich (2009) can replicate important business cycle facts. The assumption that agents have perfect knowledge about the future developments has to be revised. Rebelo and Jaimovich (2009) as well as Schmitt-Grohe and Uribe (2010) use real predictions of future GDP growth to define their shock processes, or allow baysian updating.

Overall, "searching for a deeper structural explanation for what has been empirically identified and labeled as 'news' is a promising avenue for future work." (Barsky and Sims (2011))

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Appendix

Figures



Figure 1: Impuls response functions (News-Shock)



Figure 2: Simulation (News-Shock)



Figure 3: Simulation (unexpected and news shock)



Figure 4: U.S. business cycle

Tables

Variable	Value	Description
β	0.99	Discount factor
δ	0.025	Annual depreciation of 10%
α	0.33	Capital share in output
φ	2	Wage elasticity of labour supply
ψ	24.28	Set labor effort in steady state $(l = 0.33)$
ρ	0.975	TFP shock persistence
σ_ϵ	0.007	TFP shock variance
\bar{A}	1	No technological progress

 Table 1: Calibration

Source: Cooley and Prescott (1995), and King and Rebelo (1999)

Var	std(x)(%)	std(x)/std(y)	corr(x, y)	$corr(x_t, x_{t-1})$
Output	1.7221	1.0000	1.0000	0.8483
Investment	8.1562	4.7361	0.8586	0.7974
Consumption	1.2685	0.7366	0.7898	0.8066
Hours worked	1.9277	1.1194	0.8724	0.9006

Table 2: Stylized facts (U.S. data 1948 I - 2010 IV)

HP filtered with smoothing parameter 1600. All time series are expressed in per capita terms, real terms, and in logs. Table 6 shows the corresponding sources.

Var	std(x)(%)	std(x)/std(y)	corr(x, y)	$corr(x_t, x_{t-1})$
Output	1.1289	1.0000	1.0000	0.7391
Investment	4.9682	4.4008	0.9910	0.7444
Consumption	0.2024	0.1793	-0.0934	0.6257
Hours worked	0.3885	0.3441	0.9849	0.7450

Table 3: Stylized facts (News Shock)

HP filtred with smoothing parameter 1600. We choose $\sigma_{\epsilon_t^1} = 0$; $\sigma_{\epsilon_{t-8}^2} = 0.007$ and $\rho = 0.975$.

Shock	corr(y,c)	corr(y, i)	corr(y, n)	corr(c,i)	corr(c,n)
U.S. Data	0.82	0.78	0.86	0.61	0.69
News shock	-0.0934	0.9910	0.9849	-0.2260	-0.2641

Table 4: Comovement (News shock and U.S. data)

All time series are HP filtered with smoothing parameter 1600. U.S. time series are expressed in per capita terms, real terms, and in logs.

Shock	corr(y,c)	corr(y, i)	corr(y, n)	corr(c,i)	corr(c, n)
U.S. data	0.82	0.78	0.86	0.61	0.69
Both shocks	0.63	0.98	0.96	0.47	0.41
unexp. shock	0.99	0.96	0.98	0.92	0.89

Table 5: Comovement (U.S. data and various shocks)

For both shocks we choose $\sigma_{\epsilon_t^1}, \sigma_{\epsilon_{t-8}^2} = 0.007$ and $\rho = 0.975$. For the simulation of the model driven only by an unexpected shock we choose $\sigma_{\epsilon_t^1} = 0.007$; $\sigma_{\epsilon_{t-8}^2} = 0$ and $\rho = 0.975$. All time series are HP filtered with smoothing parameter 1600. U.S. time series are expressed in per capita terms, real terms, and in logs.

Description	Source	Code
real GDP	St. Louis Fed - FRED	GDPC96
real private Investment	St. Louis Fed - FRED	GPDIC96
real private Consumption	St. Louis Fed - FRED	PCECC96
Population aged 16 and older	Bureau of Labor Statistics	LNU0000000Q
Hours worked (seasonal adj.)	Bureau of Labor Statistics	PRS85006033

Table 6: Sources for U.S. data

On Optimal Tournament Contracts with Heterogeneous Agents

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In practice, firms often use tournaments where employees compete for given prizes or the distribution of a fixed amount of bonuses. For example, managers are compensated via relative performance pay (Eriksson (1999)), workers compete in job-promotion tournaments to climb the hierarchy ladder (Baker, Gibbs, and Holmström (1994)), salesmen participate in sales contests (Murphy, Dacin, and Ford (2004)), and workers compete for higher shares in bonus-pool arrangements (Rajan and Reichelstein (2006)). These and similar tournament schemes occur if the relative performance of employees is linked to monetary consequences. Hence, forced-ranking or forced-distribution systems also belong to the class of tournament compensation schemes. Here, supervisors rate their subordinates according to relative performance given a fixed distribution of different grades that can be assigned to the employees (Boyle (2001)).

Three major advantages of corporate tournaments have been highlighted in the literature: (1) tournaments are applicable even in situations where performance information is only ordinal (Lazear and Rosen (1981)). (2) Contrary to individual incentive schemes like bonuses and piece rates, tournaments do work if the

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performance measure is not verifiable to a third party (Malcomson (1984)). This important self-commitment property of tournaments is based on the fact that tournament prizes or bonus pools are fixed in advance and that payment of these prizes is verifiable. Since, the firm must pay the high winner prize to one of the employees, it cannot save labor costs by misrepresenting the performance information. (3) Tournaments filter out common risk so that the firm may save labor costs without harming incentives (Green and Stokey (1983)). In this short paper, I will concentrate on advantages (1) and (2) to characterize optimal tournament contracts for heterogeneous workers under unlimited and limited liability.

The paper is organized as follows. The next section describes the model. In Section 3, I derive the optimal tournament contract for the case where agents are not protected by limited liability. Section 4 deals with the case of limited liability. Section 5 concludes.

The Model

Two risk neutral agents A and B are hired by a risk neutral principal P. The two agents have zero reservation values. The agents with observable abilities a_A and a_B ($a_A \neq a_B$) exert efforts e_A and e_B that lead to monetary output $\sum_{i=1,2} e_i + a_i$ for the principal. Following Gürtler and Kräkel (2010), I assume that P cannot directly observe efforts nor output but receives an unverifiable, ordinal performance signal s about the ranking of the two agents. This signal either equals $s = s_A$ indicating that agent A has performed better than B or $s = s_B$ indicating the opposite. The signal structure can be characterized as follows:¹

$$s = \begin{cases} s_A & \text{if } e_A + a_A - e_B - a_B > \varepsilon \\ s_B & \text{if } e_A + a_A - e_B - a_B < \varepsilon. \end{cases}$$
(1)

 $^{^1}$ Note that this kind of additive model has the same structure as the seminal paper by Lazear and Rosen (1981).

Hence, the realization of the relative performance signal depends on the agents' efforts, their abilities and the variable ε that describes an unobservable, exogenous random term (e.g., measurement error) with density g and cdf G. The density g is assumed to be unimodal and symmetric about zero. Intuitively, the higher agent i's effort choice and/or his ability the more likely the principal will receive the signal $s = s_i$. Based on this relative performance signal, P offers a tournament contract to the agents, consisting of winner and loser prizes. In the following we will differentiate between two cases. If agents are not protected by limited liability, tournament prizes are allowed to be arbitrarily positive or negative. However, if the agents are protected by limited liability, tournament prizes are not allowed to be negative.

Effort e_i entails costs on agent *i* that are described (in monetary terms) by the function $c(e_i)$ with $c'(e_i), c''(e_i), c'''(e_i) > 0, \forall e_i > 0$, and c'(0) = c(0) = 0 (i = A, B). To ensure the existence of pure-strategy equilibria in the tournament, I assume that²

$$\sup_{\Delta e,\Delta a} \Delta w \cdot |g'(\Delta e + \Delta a)| < \inf_{e>0} c''(e)$$
⁽²⁾

with $\Delta e := e_A - e_B$, $\Delta a := a_A - a_B$ and Δw denoting the spread between winner and loser prize. As a benchmark case, we can compute the efficient or first-best effort level for each agent. This effort maximizes welfare $\sum_{i=1,2} (e_i + a_i - c(e_i))$ and is implicitly described by e^{FB} with $1 = c'(e^{FB})$ for each agent. The timing is the typical one in moral-hazard models. First, the principal offers a contract to each agent. If the agents accept, they will take part in a tournament and simultaneously choose efforts. Then outputs are realized and payments are made.

 $^{^2}$ For a similar condition see Schöttner (2007). See also Gürtler (2011) on the existence of pure-strategy equilibria.

Unlimited Liability

Let (w_{1i}, w_{2i}) denote the tournament contract that is offered to agent *i*. According to (1), the winning probabilities of agents *A* and *B* are given by $G(e_A - e_B + \Delta a)$ and $1 - G(e_A - e_B + \Delta a)$, respectively, with $\Delta a = a_A - a_B$. The agents maximize

$$EU_A(e_A) = w_{2A} + \Delta w_A G(e_A - e_B + \Delta a) - c(e_A)$$

and

$$EU_B(e_B) = w_{2B} + \Delta w_B [1 - G(e_A - e_B + \Delta a)] - c(e_B)$$

with $\Delta w_i := w_{1i} - w_{2i}$ denoting the prize spread of agent i (i = A, B). The equilibrium (e_A^*, e_B^*) is described by the first-order conditions³

$$\Delta w_A g \left(e_A^* - e_B^* + \Delta a \right) = c' \left(e_A^* \right) \tag{3}$$

and
$$\Delta w_B g \left(e_A^* - e_B^* + \Delta a \right) = c' \left(e_B^* \right).$$
 (4)

When designing the optimal tournament contract, P chooses optimal prizes that maximize expected profits subject to the incentive constraints (3) and (4), the participation constraints $EU_i(e_i) \ge 0$ (i = A, B) and the principal's selfcommitment constraint

$$w_{1A} + w_{2B} = w_{1B} + w_{2A}.$$
(5)

Note that without condition (5), P would expost always claim the winner-loser combination that minimizes the collective wage bill since the signal s is unverifiable. As (5) implies $\Delta w_A = \Delta w_B =: \Delta w$, the equilibrium at the tournament stage will be symmetric. Since the agents are not protected by limited liability,

³ Recall that (2) guarantees existence.

P will choose $\Delta w = 1/g(\Delta a)$ to implement $e_A^* = e_B^* = e^{FB}$, and individualized loser prizes w_{2A} and w_{2B} to extract all rents so that both agents' participation constraints become binding. The following proposition summarizes the findings:⁴

Proposition 1. Suppose agents are not protected by limited liability. Although agents are heterogeneous, P implements $e_A^* = e_B^* = e^{FB}$ via the optimal tournament contracts (w_{1A}^*, w_{2A}^*) and (w_{1B}^*, w_{2B}^*) with

$$\begin{split} w_{1A}^{*} &= c\left(e^{FB}\right) + \frac{1 - G\left(\Delta a\right)}{g\left(\Delta a\right)} \quad and \quad w_{2A}^{*} &= c\left(e^{FB}\right) - \frac{G\left(\Delta a\right)}{g\left(\Delta a\right)}, \\ w_{1B}^{*} &= c\left(e^{FB}\right) + \frac{G\left(\Delta a\right)}{g\left(\Delta a\right)} \quad and \quad w_{2B}^{*} &= c\left(e^{FB}\right) - \frac{1 - G\left(\Delta a\right)}{g\left(\Delta a\right)}. \end{split}$$

The proposition shows that heterogeneity of agents is not a problem even in settings where handicaps are not applicable. Of course, for given tournament prizes equilibrium efforts decrease in the magnitude of agent heterogeneity, Δa , since g has a unique mode at zero, but the optimal prize spread can always be adjusted to induce efficient incentives. The principal is interested in implementing efficient effort since he can extract all efficiency gains via individualized loser prizes that satisfy the self-commitment constraint.

Limited Liability

Under limited liability, we can neglect the agents' participation constraints since each agent has a zero reservation value so that non-negative tournament prizes and c(0) = 0 guarantee that the agents cannot do better than accepting any feasible tournament contract. The principal now faces the two limited-liability conditions $w_{2A} \ge 0$ and $w_{2B} \ge 0$. Because of the non-binding participation constraints and the fact that loser prizes decrease incentives and increase implementation costs, the principal optimally chooses $w_{2A}^* = w_{2B}^* = 0$. The self-

⁴ See also Gürtler and Kräkel (2010).

commitment constraint (5) then implies $w_{1A}^* = w_{1B}^* =: w_1^*$. The uniform winner prizes together with the incentive constraints (3) and (4) imply that we have a unique symmetric equilibrium $e_A^* = e_B^* =: e^*$ with $w_1^*g(\Delta a) = c'(e^*)$. The principal thus maximizes

$$2e^* + a_A + a_B - w_1^* = 2e^* + a_A + a_B - \frac{c'(e^*)}{g(\Delta a)}.$$

The first-order condition yields⁵

$$e^* = A\left(2g\left(\Delta a\right)\right),\,$$

with $A \equiv c''^{-1}$ denoting the inverse function of c'', which is monotonically increasing since c''' > 0. Altogether, we obtain the following result:

Proposition 2. If agents are protected by limited liability, P will implement $e_A^* = e_B^* = A(2g(\Delta a))$ by choosing $w_{2A}^* = w_{2B}^* = 0$ and $w_{1A}^* = w_{1B}^* = c'(A(2g(\Delta a)))/g(\Delta a)$.

Proposition 2 shows that P optimally chooses uniform winner prizes although agents are heterogeneous. This result follows from the limited liability of the agents, which prohibits rent extraction by the principal via negative loser prizes. The best P can do is setting the loser prizes equal to zero. But then uniform winner prizes automatically follow from the self-commitment constraint.

The proposition also shows that implemented effort will no longer be first best due to limited liability as contractual friction. The implemented effort, $A(2g(\Delta a))$, decreases in the degree of agent heterogeneity, Δa , since density g falls to the tails. Intuitively, the more heterogeneous the agents the less intense will be tournament competition so that the principal would have to choose a high winner

⁵ The second-order condition is satisfied since c''' > 0.

prize – implying a large rent for the agents – to restore incentives. The principal therefore prefers low-powered incentives under large heterogeneity.

Note that the impact of uncertainty as measured by the variance of the distribution for ε depends on the degree of agent heterogeneity (see Kräkel and Sliwka (2004), Kräkel (2008)). If agent heterogeneity tends to zero (i.e., $\Delta a \rightarrow 0$), then increased uncertainty via a shift of probability mass to the tails and a corresponding decrease of g(0) would unambigously lead to a decrease of implemented effort. However, under strict agent heterogeneity, tournament competition may be fostered by higher uncertainty. Technically, $g(\Delta a)$ may increase by a shift of probability mass to the tails. The economic intuition is the following. Suppose, there is moderate uncertainty but considerable agent heterogeneity in the initial situation. In that case, equilibrium efforts (for given winner prize) would be quite low since there is a clear favorite and a clear underdog. If now uncertainty increase, the tournament outcome will be less clear, which balances competition. In other words, the underdog may now win by luck which results into higher incentives for both agents.

Conclusion

If the principal uses uniform tournament prizes for both heterogeneous agents, even under unlimited liability the tournament contract will result into inefficiently low effort since the principal has to leave a positive rent to the more able agent. However, if the principal optimally switches to individualized tournament prizes that satisfy the self-commitment constraint, the principal will be able to extract all rents. Consequently, he implements first-best efforts. Hence, Propositions 1 and 2 stress that heterogeneity is not a natural problem for the optimal design of tournaments, but that only the usual contractual frictions from individual incentive schemes (here, the agents' limited liability) apply for tournaments as well. In the last decade, severals extensions of the seminal tournament paper of Lazear and Rosen (1981) have been introduced in the literature. A considerable part of this new literature deals with issues that belong to behavioral economics. For example, Demougin and Fluet (2003) as well as Grund and Sliwka (2005) analyze the impact of inequity aversion in tournaments. In a recent paper, Gill and Stone (2010) investigate the implications of loss aversion for tournament competition. The three papers show that the consequences of the behavioral effects crucially depend on whether tournament prizes are exogeneously given (so that only the game between the contestants has to be considered) or endogenously chosen by the principal, who can adjust them optimally to possibly benefit from the behavioral effects.

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Damages for Negligent Ratings

Prof. Dr. Urs Schweizer^{*}

Law and Economics

Law and economics, L&E for short, refers to a broad area of research concerning legal institutions and making use of concepts and methods from economics. Competition law, e.g., governs market activities. It hardly comes as a surprise that even purely legal expositions have always made use of terms such as markets, competition and market power familiar from economic theory. But as a recognized research area of its own, L&E was born much later. Ronald Coase and Guido Calabresi are considered as founding fathers of the field. Coase (1960) famous paper entitled "The problem of social cost" is a pioneering contribution to the economic analysis of contract law. Calabresi (1961) "Some thoughts on risk distribution and the law of torts" is an equally pioneering economic analysis of tort law.

Contract law governs transactions among individual parties. In fact, modern market exchange would be unthinkable in the absence of contract law. Tort law concerns interaction among parties plagued by what economists call external effects. Therefore, contract and tort law, both deal with a subject that is as intrinsically of economic nature as competition law. In contrast to competition

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law, however, there still exists a vast legal literature on contract and tort law that does not borrow any notions and concepts from economic theory. Yet, following Coase and Calabresi, an increasing number of contributions to contract and tort law qualify as L&E today.

There is, of course, no sharp dividing line between the different approaches. In Germany, contributions of legal scholars referring to notions such as efficiency and welfare may qualify as L&E even if reference to these notions from economics may remain rather vague. In the United States, authors probably have to make more serious use of economic methods to be recognized as L&E scholars. Germany seems to lag behind. In fact, most German legal scholars are exposed to L&E for their first time (if at all) at that stage of their career where they might be heading for a LL.M-degree from a U.S. university, which means after having studied law in the more traditional way for years and passed the state exams at home without any reference to economics.

At the other end, your work may also qualify as L&E if you happen to be an economist applying his own methods to the study of legal institutions. The economic analysis of law in the strict sense is a subfield of L&E.

In the following, I provide an economic analysis of a topical problem from tort law. Rating agencies are blamed for having contributed to recent financial crises by assigning overly optimistic ratings to firms and financial assets. Lenders of money, allegedly being misled by such ratings, have suffered harm. Should rating agencies be required to pay compensation and, if yes, what amount?

Economists are mainly concerned with the right amount of effort spent by the rating agencies while rating institutions and assets. No doubt, damages regimes in place affect incentives. Agencies that anticipate higher damages claims will spend more effort as compared to those who do not face such claims. Nonetheless, investment requirements should remain "reasonable". From the economic perspective, "reasonable" may mean investments at the level that maximizes expected welfare. The present paper investigates damages rules that would provide efficient incentives for investments and compares them with those that are currently enforced by courts.

Compensation and Incentives

Let me quote from the basic norms of German tort law as laid down in the Civil Code (BGB, official translation):

"A person who [...] negligently [...] injures [...] the property of another person [...] is liable to make compensation to the other party for the damage arising from this." (§ 823 BGB) and "A person who, in a manner contrary to public policy, intentionally inflicts damage on another person is liable to the other person to make compensation for the damage." (§ 826 BGB)

Let me refer to "a person" as injurer and to "another person" as victim. For the above provisions to become relevant, the victim must have suffered harm, the injurer must have taken an action that has caused the harm and that must constitute the breach of a legal duty as laid down above.

The provisions explicitly require that the victim should be compensated. Punitive damages as known from the U.S., however, are not supported by German tort law. The victim should, after having received compensation, be equally well but not better off as compared to the hypothetical situation where the injurer had met his duty. I will refer to this requirement as the compensation goal of tort law.

If compensation would mean pure redistribution, economists had no normative criterion to offer. Yet, ex-post compensation if anticipated affects ex-ante precaution incentives of the injurer. Precautions, in turn, affect expected welfare. In this sense, ex-post redistribution affects ex-ante incentives. As a normative reference point, precaution investments are called efficient if they maximize the expected welfare. The missing link between the compensation goal of tort law and efficient precaution incentives consists of the due care level. In fact, the injurer's expected payoff is equal to expected welfare minus the victim's expected payoff. Suppose courts would follow the economists' advice to interpret due care at the level of efficient precaution investments. Then the injurer would have the incentive to meet such duty for the following reason.

By deviating, the expected welfare would be lower but, due to the compensation goal, the victim's expected payoff including compensation would not be lower. As a consequence, the expected payoff of the injurer would decrease with any deviation from an efficient duty. Put differently, the injurer has efficient precaution incentives indeed provided that the compensation goal is achieved relative to a (legal) duty that is efficient.

In the following, I confront these ideas and concepts from tort L&E with the case of a rating agency as the injurer and market participants as the victims of the agency's negligent behavior.

Duties of Rating Agencies

As it turned out, a rating agency was intentionally negligent in a manner contrary to public policy while assigning an unjustified positive rating to a given financial asset. Ratings concern likely performance of the asset at future dates. Predicting the performance for sure remains beyond reach. Therefore if, in spite of a positive ranking, the asset fails ex post, no negligent behavior of the agency need be involved. Predictions may fail even if based on careful investigations.

But, in my example, courts have discovered hard evidence that the agency's rating activity was grossly negligent indeed. Instead of a careful investigation, it had assigned ratings just by tossing coins.

In a second step, courts must then find out whether the agency's negligence has caused any harm to the victim at all. If it has then, as a final step, courts must specify the quantum of damages that compensates the victim for the harm caused by the agency's breach of its legal duty.

Harm is defined as the difference of the victim's hypothetical wealth position under non-negligent behavior and its wealth position under the actually negligent behavior of the rating agency. Quantifying damages is an intrinsically difficult task as it includes specifying the purely hypothetical wealth position of the victim if the agency had met its duty which, actually, it has not. The hypothetical wealth position may remain uncertain even from the ex-post perspective when courts are called in.

To illustrate the issues at stake, let me introduce a simple model. Real cases are more intricate than even sophisticated models as lawyers keep repeating again and again. Some legal scholars are even convinced that, exactly for this reason, there is absolutely no need to understand models, let alone to learn thinking in them. Such an attitude is not helpful for interdisciplinary research.

Economists concede that models are simpler than reality. Yet, models are more complex and possibly closer to reality than what would remain seriously tractable without formal model. Quite likely, effects uncovered in a suitable model by formal analysis remain present and, hence, relevant for the real case as well.

A Simple Model

Think of a market for a financial asset to which a rating agency has assigned the rating r = A out of the two possible ratings A and B. Rating A indicates a high value i = H for buyers. Based on this positive rating, a quantity of q_A units of the asset has actually been traded at a price p_A per unit.

Ex post, however, the value turned out to be low instead (i.e. i = L) such that,

from hindsight, rating r = B would have been more appropriate. Buyers complain and the court, in fact, detects that the agency has not spent any effort at all while issuing the positive rate A but just had intentionally tossed a coin, contrary to public policy indeed.

Hence, in a second step, courts have to quantify the harm that was caused by such a grossly negligent action of the rating agency. According to general principles of tort law, to quantify damages, courts should compare the actual with the hypothetical wealth position of the victims.

Insights from microeconomic theory are used to reconstruct the situation at the time when trade decisions, based on the actual rating, were taken. At that time, the true state i of the world was still uncertain. The duty of the rating agency consisted of reducing uncertainty. But remember, eliminating uncertainty entirely at tolerable costs was beyond reach.

Parties knew, by assumption, that the true but unknown state must either be high (i = H) or low (i = L). At known state *i* from $\{L, H\}$, the asset's market would be governed by a demand function $p = F_i(q)$ and a supply function $p = G_i(q)$. Think of a downwards sloping (inverse) demand and an upwards sloping (inverse) supply curve to be interpreted as marginal utility of the buyers and marginal cost of the sellers, well in line with microeconomic theory.

In the absence of ratings, parties would consider both states to be equally likely. A serious (non-negligent) rating, however, would allow updating beliefs as follows. At positive rating A, the high state i = H is expected to occur with a probability $x^* > 1/2$. At negative rating B, the low state i = L is expected to occur with, for simplicity, the same probability $x^* > 1/2$. Since ratings cannot entirely eliminate uncertainty the "incorrect" rating will still be assigned with probability $1 - x^* < 1/2$ even if the agency has met its duty.

Imagine for a second, market participants were aware of the fact that ratings
are resulting from tossing a coin. Then, of course, ratings would not affect the conditions of trade at all. But markets rely on the rating being carried out with due care x^* and, hence, the market outcome q_r and p_r will depend on the actual rating r. For simplicity, let me assume that the market is competitive, which means that the market outcome corresponds to the intersection of the appropriate demand and supply curves.

If parties are risk-neutral and the rating is A then the appropriate demand function is

$$f_A(q) = x^* \cdot F_H(q) + (1 - x^*) \cdot F_L(q)$$

whereas it is

$$f_B(q) = x^* \cdot F_L(q) + (1 - x^*) \cdot F_H(q)$$

if the rating B had been produced at due effort. The appropriate supply functions $g_r(q)$ are contingent on the rating r in a fully symmetric way. In any case, at rating r from $\{A, B\}$, the market outcome (q_r, p_r) satisfies $p_r = f_r(q_r) = g_r(q_r)$ as the market is assumed to be competitive.

Ex post when courts are called in, the true state i = L has become observable. Based on the true and, at that stage, known demand and supply functions $F_L(q)$ and $G_L(q)$, the social surplus $S_L(q)$ as a function of the traded quantity q amounts to the area between demand and supply function up to q. Social surplus is defined as the sum of consumers' and producers' surplus

$$S_L(q) = CS_L(q, p) + PS_L(q, p).$$

Recall, consumers' and producers' surplus depend on the traded quantity q as well as the price p at which the asset is exchanged. For further details, if needed, the reader should consult any microeconomic textbook.

With such machinery at hand, the harm caused by the agency's negligence can easily be determined as follows. The actual wealth positions amount to $S_L(q_A)$ (social), $CS_L(q_A, p_A)$ (buyers of the assets) and $PS_L(q_A, p_A)$ (sellers of the assets).

The corresponding hypothetical wealth positions remain uncertain. In fact, even at due care, the positive rating r = A would have been assigned with positive probability $1 - x^*$ to the asset. In this event, the same market outcome (q_A, p_A) would have resulted as under the actual tossing of a coin such that no harm was caused by the agency's negligence.

With probability x^* , however, the more realistic rating r = B would have emerged, leading to market outcome (q_B, p_B) as derived above. Hence, the social harm caused by the negligence of the agency in this event amounts to

$$\Delta S_L = S_L(q_B) - S_L(q_A).$$

Since market distortions have been ruled out, the social loss ΔS_L cannot be negative. In fact, unless the rating affects only the price but not the quantity, the social harm will be strictly positive, i.e. $\Delta S_L > 0$ unless $q_A = q_B$. Let me assume that buyers actually suffer harm, i.e.

$$\Delta CS_L = CS_L(q_B, p_B) - CS_L(q_A, p_A) > 0$$

is assumed to hold.

As far as capital markets are concerned, it is sometimes claimed that only one side of the market can suffer harm. This claim is certainly true, if the rating does not affect the quantity traded. If, however, the quantity (not just the price) is strictly contingent on the rating, the game no longer remains zero sum and, as a consequence, both sides may loose.

Yet, for illustration, let me assume that the sellers of the asset have actually gained from the optimistic rating A, i.e.

$$\Delta PS_L = PS_L(q_B, p_B) - PS_L(q_A, p_A) < 0$$

such that sellers would enjoy enrichment simply due the agency's mere tossing a coin. I cannot imagine that courts would classify this as unjust enrichment and, for that reason, I am definitely ruling out that the sellers would owe any compensation to the agency just for being lucky in tossing a coin.

Buyers, in contrast, suffer harm that is caused with probability x^* by the agency's negligence. Since hypothetical harm remains uncertain, I propose to award the expected harm

$$x^* \cdot \Delta CS_L + (1 - x^*) \cdot 0 = x^* \cdot \Delta CS_L$$

as damages to the buyers of the asset. From the ex-ante perspective at least, buyers would be equally well off as if the agency had met its duty. In this sense, the compensation goal would be met by my proposal.

To be sure, if the agency must compensate the buyers but the agency is denied compensation for the sellers' enrichment then the agency would owe damages in excess of social harm. At an efficient negligence standard, however, this would not distort the agency's incentives to meet its duty. In fact, the incentives would even be stronger to assign ratings with due care if winners can keep windfall gains for free.

My approach seems well in line with basic tenets of tort law as widely propagated

by textbooks on obligation law. Yet, as soon as uncertainty is involved, courts – in full agreement with the legal profession – quickly abandon such basic principles and, as a substitute, rather take resort to ad-hoc solutions. The lack of data usually serves as justification of such practice.

I admit, of course, that eliciting the demand and supply curves may be a difficult task in real cases. But, instead of trying hard enough, abandoning established principles right away does not seem satisfactory either.

In the next section, I report on some proposals from the legal side and examine their effects in terms of efficiency. My model allows to visualize these effects.

Legal Aftermath

German tort law as laid down in the civil code is a lame duck if the misbehavior of rating agencies is at stake. § 823 does not apply in the case of pure economic losses. But losses of that type are exactly the ones that are caused by negligent rating activities.

Some proponents of L&E think of pure economic losses as purely redistributive. While some parties may suffer harm, others enjoy enrichment such that, on balance, no social harm is caused at all. My model has shown that this view can hardly ever be correct. Financial crises, as we all know, come with severe real effects. A recession is a negative-sum, not a zero-sum game. As a consequence, if negligent rating has contributed to the downturn of the economy, social harm cannot be zero.

§ 826 BGB, in contrast, includes compensation of pure economic losses. Yet it requires intention of the injurer. In the strict sense, intention refers to a condition of the brain while taking a decision and, as such, can hardly ever be observed by courts. In legal practice, it proves difficult to receive compensation for pure economic losses because courts maintain high standards if proving intention is at stake. In contrast to tort law, under contract law, pure economic losses are recoverable. Therefore, if legal scholars feel of unease with conclusions from tort law, they may try to rule rating agency cases under contract law instead. But, sophisticated as their arguments may be, it remains difficult to argue why a (pseudo-) contractual relationship between the rating agency and the buyers of the rated asset should ever exist.

Given that general obligation law is not well suited to deal with negligent rating agencies, it might be appropriate to think of new laws that have a sharper focus. The EU, in fact, has enacted the Credit Rating Agency Regulation (VO 1060/2009) that spells out the duties of such agencies in greater detail. An explicit damages rule, however, is not part of that regulation. Currently, the commission proposes to extend the existing regulation to include civil liability explicitly.

Wagner (2013) proposes to lower the standard of due care (as compared with § 826 BGB, e.g.) below which rating agencies will be held liable even for pure economic losses but to put a legal ceiling on damages awards.

In my model, the effects of Wagner's proposal could easily be investigated. Suppose the due care standard is such that rating agencies have the incentive to keep it then the resulting outcome can only be efficient if the standard would be specified at the efficient level of precaution. If, however, the due care standard remains high enough such that it is not worth for agencies to meet it then the agency operates in a range where its expected payoff is the same as under strict liability. Under strict liability, however, precaution incentives would be insufficient provided that the legally imposed ceiling on damages binds and is lower than social harm. Only if the ceiling binds but is still higher than social harm, precaution incentives would become efficient. Such a situation would arise if the ceiling were equivalent to the sellers' enrichment being subtracted in part or in total from the buyers' harm. To ensure ceilings in that range would require a lot of fine-tuning by courts.

In any case, Wagner's proposal would remain difficult to implement. Courts would still have to estimate the victim's harm in order to find out wether the ceiling is binding or not. The issue of causality would also have to be addressed. Economic analysis rather suggests to include pure economic losses and to stick otherwise to the basic tenets of tort law. Negligence thresholds should be based on efficiency considerations and in a way predictable by rating agencies. A legal ceiling on liability could then be dispensed with as rating agencies always have the option to avoid damages claims by meeting (predictable) standards. For the same reason, there is also no need to compensate rating agencies for enrichment that may possibly have been caused by their negligent behavior.

Conclusion

This paper presents a short and rather incomplete economic analysis of a currently topical case from tort law. I have tried to convince the reader that economic methods are useful and worth being applied to questions concerning legal institutions. To be sure, the interaction between legal and economic scholars remains rather demanding. Even after having spent much time and effort on discussions with colleagues from the other department, I find it difficult to bridge the gap between the two disciplines. Lawyers think in cases, economists in models. Research topics, however, are overlapping and both sides would benefit from a more serious interdisciplinary discourse.

During the next two winter terms, I am planning to offer a module in the bachelor program on the economic analysis of law again. In class, I distribute a script to the participants. I am also planning to write a book on tort and contract law based on methods from applied game theory. If you have missed the class, hopefully, you can read the book in some not so distant future.

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