Essays on Credit Markets and Banking

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Umeå 2012

Umeå Economic Studies No. 840
ISSN: 0348-1018
ISBN: 978-91-7459-384-6
Cover picture: Copyright © Ulf Holmberg
Electronic version available at http://umu.diva-portal.org/

Printed by Print & Media at Umeå University
Umeå, Sweden 2012

To the memory of my grandparents

Abstract

This thesis consists of four self-contained papers related to banking, credit markets and financial stability.

Paper [I] presents a credit market model and finds, using an agent based modeling approach, that credit crunches have a tendency to occur; even when credit markets are almost entirely transparent in the absence of external shocks. We find evidence supporting the asset deterioration hypothesis and results that emphasize the importance of accurate firm quality estimates. In addition, we find that an increase in the debt's time to maturity, homogenous expected default rates and a conservative lending approach, reduces the probability of a credit crunch. Thus, our results suggest some up till now partially overlooked components contributing to the financial stability of an economy.

Paper [II] derives an econometric disequilibrium model for time series data. This is done by error correcting the supply of some good. The model separates between a continuously clearing market and a clearing market in the long-run such that we are able to obtain a novel test of clearing markets. We apply the model to the Swedish market for short-term business loans, and find that this market is characterized by a long-run non-market clearing equilibrium.

Paper [III] studies the risk-return profile of centralized and decentralized banks. We address the conditions that favor a particular lending regime while acknowledging the effects on lending and returns caused by the course of the business cycle. To analyze these issues, we develop a model which incorporates two stylized facts; (i) banks in which lending decisions are decentralized tend to have a lower cost associated with screening potential borrowers and (ii) decentralized decision-making may generate inefficient outcomes because of lack of coordination. Simulations are used to compare the two banking regimes. Among the results, it is found that even though a bank group where decisions are decentralized may end up with a portfolio of loans which is (relatively) poorly diversified between regions, the ability to effectively screen potential borrowers may nevertheless give a decentralized bank a lower overall risk in the lending portfolio than when decisions are centralized.

In **Paper [IV]**, we argue that the practice used in the valuation of a portfolio of assets is important for the calculation of the Value at Risk. In particular, a seller seeking to liquidate a large portfolio may not face horizontal demand curves. We propose a partially new approach for incorporating this fact in the Value at Risk and Expected Shortfall measures and in an empirical illustration, we compare it to a competing approach. We find substantial differences.

Keywords: financial stability, credit market, banking, agent based model, simulations, disequilibrium, clearing market, business cycle, risk, organization

Acknowledgements

Let me begin with expressing my deepest gratitude to my supervisor, Prof. Kurt Brännäs, who showed more confidence in my work than I initially deserved. This guy is a genius and he never fails to impress me with the widths of his knowledge. I would also like to thank my co-supervisor Prof. Jörgen Hellstöm for all the helpful comments (as well for teaming up with me in Uppsala so that we could beat the B-guys). Here, Prof. Tomas Sjögren deserves a special thanks for sharing my wide interest in economics, as well as for having (the most) awesome modeling skills. Working together with Tomas has been a pure pleasure!

I would like to thank Svenska Handelsbanken and the Graduate Industrial Research School at Umeå University for the financial support as well as for the opportunity to participate in a rather successful PhD student experiment that allowed me to have one foot in the "real world" (whatever that is) while keeping the other foot buried in sweet academic soil. I am grateful to Prof. Petter Gustafsson and Benkt Wiklund for organizing and managing the research school as well as for having the ambition and courage to try "something new". Here, I would also like to thank the Knut and Alice Wallenberg foundation for the travel grant.

Dr. Matias Eklöf at Svenska Handelsbanken deserves a thanks for introducing me to new (and complex) methods in economics as well as for giving me the opportunity to repeatedly present my work at the bank. The ideas that sprung from these meetings were most valuable. I am also grateful to the participants at the (sometimes wild) department seminars. I could not have done it without the comments from Prof. Karl-Gustaf Löfgren (who forced me to really understand what I was doing), Prof. Runar Brännlund (who gave me comments that I value almost as much as the occasional Belgian beer), Dr. Carl Lönnbark (who also deserves a thanks for the ease with which we have collaborated), Christian Lundström (who has a fresh businesslike take on the subject) and Emma Zetterdahl (who's comments tell a story about her in-depth understanding of the subject). In addition, I would like to thank Dr. Kenneth Backlund for his leadership and flexibility as well as Marie Hammarstedt for handling my employment with such ease. I would also like to thank my fellow PhD students as well as all the other researchers at the department for the awesome research environment as well as for giving the department a healthy mix between business and pleasure. I proudly consider the friends I have met here as my "pseudo family up north".

While on the subject, both the Holmbergs and Oldenburgs deserve a thanks for their support as well as for the wild discussions regarding my research. I now have a book on my side (even though I might have written it myself) and in the words of Henry Thoreau, "you should read the best books first...". Speaking of books, my brother Björn certainly deserves a thanks for dragging me into some random

bookstore in Guilford a long time ago. I blame my interest in social sciences on this particular event and for that, he owes my gratitude. Finally, I would like thank the "skull loving" Anna Ternow for all the good times as well as for putting out with my lengthily monologs and variable mind.

Stockholm, March 2012
Ulf the wolf

This thesis consists of a summary and the following four papers:

[I] Holmberg, U. (2012): "The Credit Market and the Determinants of Credit Crunches: An Agent Based Modeling Approach", *Umeå Economic Studies No 836 (revised)*.

[II] Holmberg, U. (2012): "Error Corrected Disequilibrium", *Umeå Economic Studies No 837 (revised)*.

[III] Holmberg, U., T. Sjögren, and J. Hellström (2012): "Comparing Centralized and Decentralized Banking: A Study of the Risk-Return Profile of Banks" *Umeå Economic Studies No 838*.

[IV] Lönnbark, C., U. Holmberg, and K. Brännäs (2011): "Value at Risk and Expected Shortfall for Large Portfolios", *Financial Research Letters*, 8, 59-68 .

1 Introduction

When the United States real estate market collapsed in the end of 2006, most market participants failed to predict the scale and consequence of the coming unfolding of events. The collapse lead to a sudden liquidity crisis in the United States banking system that forced the eruption of a global financial crisis, unprecedented in scale since the 1930s' Great Depression.[1] The crisis forced the collapse of large financial institutions and a downturn in stock markets all around the world, while a stream of national bank bailouts and stimulus packages were implemented. Why the financial markets suddenly behaved in such a way quickly became a scholarly subject and, consequently, a wide range of theories emerged explaining the cause and nature of the recent unfolding of events. Among other things, government deregulation was targeted as a cause, as well as the practices of banks and investors on the unregulated collaterized debt obligation and credit default swap markets. However, the cause and nature of the crisis is still under debate and as discussed by Lo (2012), scholars have yet to agree on a single narrative.

Even though the specific nature of the crisis may be disputed, most scholars do agree on that the onset of the crisis was somewhat related to the expansion of bank credit; and as discussed in Fratianni and Marchionne (2009), the financial crisis of the late 2000s carries many features of a Credit-Boom-and-Bust (CBB) crisis. In short, a CBB crisis tends to begin with an economic shock that brightens the economic prospects of the market participants (e.g., an increase in housing prices). Credit from banks tend to feed the boom such that households accumulate debt while firms increase leverage in order to fund suddenly profitable new projects. Such credit booms are often correlated with monetary expansion, further increasing the credit supplied by banks (Kindleberger and Aliber, 2005). These events tend to force an increase in the value of assets, feeding the prevailing optimism about the firms' future investment opportunities, and so forth. However, the boom is fragile and the credit bubble tends to burst if a negative shock hits the system. Such a negative shock may for instance be the reach of some unforeseen threshold of acceptable liability structures (Minsky, 1977) or a sudden stream of defaults on debt. Whatever its nature, such a shock will inevitably reduce the value of firms' future stream of cash flows, reducing the value of assets such that investors tend to become more risk averse (Minsky, 1977). With a higher proportion of risk averse investors active on the market, an unloading of assets is sure to follow, forcing the value of assets to plummet while firms seek to deleverage, giving asset prices an extra push downhill. A consequence of such a large scale debt liquidation is an un-

[1] In Reinhart and Rogoff (2009), the recession that followed the financial crisis of the late 2000s is referred to as "the second great contraction" where the 1930s' Great Depression is referred to as the "first great contraction".

intended decrease in inflation such that inflation falls below expected levels. This in turn forces the real value of debt to increase while debtors suffer a decline in net worth (Fisher, 1933; Fratianni and Marchionne, 2009) and the quality of debt decreases. In addition, a drop in the value of assets lowers the value of collateral. Thus, borrowers need to put up even more security for a given value of nominal debt (Fratianni and Marchionne, 2009), further highlighting the importance of lenders within the CBB crisis framework.

As such, if one seeks to understand the nature of a financial crisis of this scale, one needs to understand the workings of credit markets as well as why banks suddenly reduce the amount of credit supplied (Paper I). It is also important to have the correct tools if one seeks to model credit markets empirically (Paper II) since empirical research may give new insights into the causes of a credit crisis. In addition, since banks tend to be at center of a financial crisis (Allen and Carletti, 2008), insights concerning the risk-return profile of banks during the course of the business cycle are equally important (Paper [III]). Further, since asset market liquidity tends to dry up during financial distress (Brunnermeier and Pedersen, 2009); investors need the means of accurately measuring financial risk while accounting for the liquidity risk of an investment (Paper [IV]).

2 Credit markets, banking and financial fragility

As so accurately put in Allen and Carletti (2008), "banks are always critical to the financial system". Banks act as delegated monitors and allow for various information problems to be solved, contribute to financial risk sharing as well as to economic growth (Allen and Carletti, 2008). However, due to the maturity differences between the banks' assets and liabilities, banks may cause fragility in the financial system due to the possibility of bank runs (Mitchell, 1941; Kindleberger and Aliber, 2005; Bryant, 1980; Diamond and Dybvig, 1983; Chen et al., 2010) as well as due to the the possibility of contamination (Allen and Gale, 2000; Freixas et al., 2000; Dasgupta, 2004; de Vries, 2005; Brusco and Castiglionesi, 2007) such that banks are often found to be at the very center of a financial crisis (Allen and Carletti, 2008). Thus if one seeks to understand the cause and nature of a financial crisis, one needs to begin with the practices of banks. In addition, since the financial crisis of the late 2000s originated from a liquidity crisis in the United States banking system, i.e. from a credit crunch; a natural starting point is to research the determinants of such sudden contractions of credit.

In general, a credit crunch is defined as "a significant contraction in the supply of credit reflected in a tightening of credit conditions" (Udell, 2009). What causes banks to simultaneously coordinate their actions in such a way? As dis-

cussed in the previous section, the recent crisis shares many features with a CBB crisis in the sense that the quality of debt was lowered by some external shock; darkening the economic prospects of the market participants. This explanation is well in line with the asset deterioration hypothesis (Sharpe, 1995), i.e. the hypothesis that banks tend to reduce their supply of credit due to unpredicted losses in bank capital. Pazarbasioglu (1996) found early evidence supporting this hypothesis after studying the Finnish credit crunch in the early 1990s, but this hypothesis alone does not explain why lenders tend to reduce credit since it relies on the occurrence of some exogenous shock. Thus, we turn to the theoretical literature for answers and in particular, to the model developed by Suárez and Sussman (1997, 2007). They developed a rational expectations model in which cyclical contractions of credit are driven endogenously by a moral hazard problem between firms and the providers of credit. As such, a credit crunch may manifest itself solely due to the inherent imperfections of a credit market. Kiyotaki and Moore (1997), on the other hand, developed a real business cycle model of a credit market of collateralized debt. They find that a recession is amplified with a reduction in the value of collateral during an economic downturn, fully in line with the timing of events seemingly inherent in a CBB crisis. Another explanation is given by the Risk-Based Capital (RBC) hypothesis. According to the RBC hypothesis, the implementation of new risk-based regulatory rules governing financial intermediaries allocation of internal resources may in itself cause the eruption of a credit crunch (Berger and Udell, 1994). If, for example, firm debt suddenly requires more cash reserves, banks may reallocate resources to less risky debt (e.g., governmental securities), forcing a decline in the supply of firm credit. However, no new risk-based regulatory rules were enforced in the United States in direct relation to the recent financial crisis; even though it is possible that previously implemented regulations may have contributed to the magnitude of credit reduction.

Given the above, one may be tempted to conclude that sudden credit contractions are either caused by some exogenous shock or by endogenous problems caused by information problems between the borrowers and lenders. This may be true, but as is found in Paper [I], contractions of credit may also emerge spontaneously, even if credit markets are almost entirely transparent. We find that credit booms and busts may evolve naturally when lenders have adaptive expectations about the credit risk in their debt portfolio. Since we also find evidence in line with previous theories, it may be that external shocks, such as a sudden reduction in the quality of debt, increases the probability of a credit crunch, even though the shock per se is not its cause.

However, it's not always obvious whether an observed reduction in credit is due to a contraction of the supply or demand for credit. Firms may have gloomy economic outlooks such that they need less credit for their future investments.

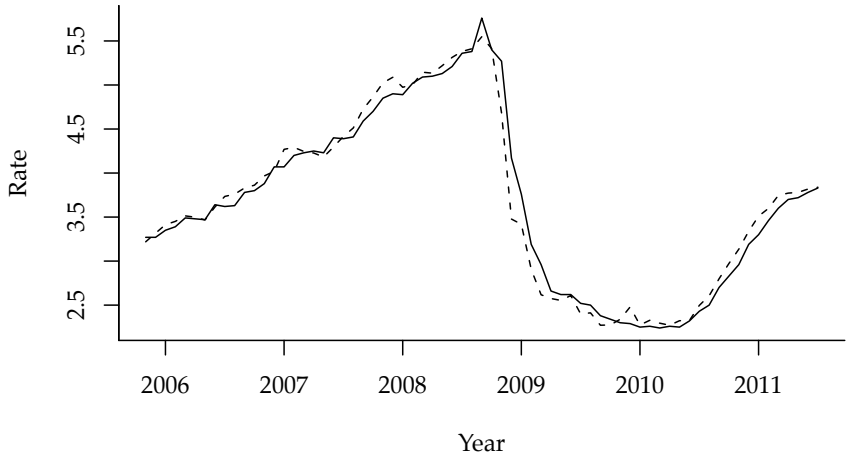

Figure 1: Actual average interest rate on short-term business loans in Sweden (solid line) and the long-run equilibrium interest rate (dashed line) as estimated as in Paper [II].

Thus, in order to determine if a credit market suffered from a credit crunch or not, one needs to use empirical models that separates between the demand and supply side of credit. In addition, since credit markets may be subject to some long-run excess demand for credit (Stiglitz and Weiss, 1981), one also needs to account for the possibility of a market in disequilibrium. Fortunately, a large bulk of literature have emerged, providing econometric methods for markets in disequilibrium (see Fair and Jaffee (1972); Amemiya (1974); Maddala and Nelson (1974); Goldfelfd and Quandt (1975); Quandt (1978); Bowden (1978); Gourieroux et al. (1980a,b); Maddala (1986) among others) and a recent stream of literature do in fact utilize the disequilibrium framework in credit market modeling (see Pazarbasioglu (1996); Perez (1998); Hurlin and Kierzenkowski (2003); Allain and Oulidi (2009) among others). However, the econometric methods used in these studies do not deal with the problems caused by spurious regressions in time series data, as first made explicit by Granger and Newbold (1974). Acknowledging this issue, Paper [II] derives a novel econometric model for markets in disequilibrium, suitable for time series data. Here, a distinction is made between a clearing market in the short and long-run while it is assumed that demand and supply of a good are co-integrated, i.e. the supply may not drift too far away from the demand and vice versa. By using the model on Swedish data, we find that the Swedish market for short-term business loans is subject to a long-run non-market clearing equilibrium; an equilibrium that determines the average interest rate on short-term business loans, as illustrated in

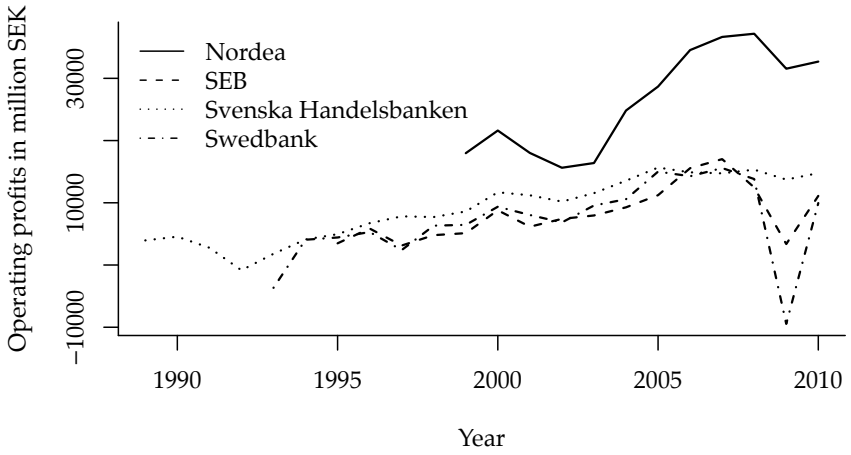

Figure 2: Operating profits for the four largest Swedish banks. Currency conversion based on the exchange rate on the last trading day of the year. Source: Annual reports.

Figure 1. In addition, we find a significant increase in the equilibrium interest rate, ceteris paribus, during the lowering of the Riksbanks prime rate during 2009. Since it is fairly unlikely that the lowering of the prime rate coincided with an increase in the demand for credit, this result implies that the supply of credit was reduced during this period. Thus, this result indicates that the Swedish market for short-term business loans suffered from a supply side driven credit crunch during 2009.

Even though lenders may suffer from credit losses during a crisis, it is important to note that there may be large differences in these losses as well as to the extent of which banks' balance sheets are exposed to risky credits/investments. For example, the reduction in operating profits, due to the recession of 2009, among the four largest Swedish banks (Nordea, SEB, Svenska Handelsbanken, Swedbank) varied from 10 percent (Svenska Handelsbanken) to 168 percent (Swedbank), as illustrated in Figure 2. Partially, these differences may reflect differences in risk culture between banks. However, since all banks are forced to deal with excessive asymmetry problems; such differences may also reflect the superiority of some banks in assessing the risk profile of their potential clients and investment opportunities.

One important factor within this context may be the lending technology used by banks. If, for instance, one bank engages heavily in transaction banking while another bank relies more heavily on relationship banking, the risks to which the two banks are exposed to are likely to differ (see Boot (2000) for an excellent review on relationship banking). Another potentially important factor is whether

the lending/investment decisions are decentralized (meaning that the lending decisions are taken at a low level in the bank hierarchy) or centralized (meaning that the lending decisions are taken higher up in the organization). Hierarchical banks may be better at utilizing hard information (e.g., data from credit scoring models and balance sheet data) while small and decentralized banks may be better at processing soft information (e.g., ability, honesty, etc.), as implicitly argued by Stein (2002). However, the arguments laid out by Stein (2002) originate from the internal capital markets perspective of firms. In banking, a decentralized bank may lack the ability to achieve a well diversified debt portfolio and the raising of lendable funds may cause externalities within the bank group. As such, there may be a trade-of between being effective in terms of selecting high-quality clients (which is achieved by having a decentralized decision-making structure) and being effective in terms of ending up with a well diversified portfolio of loans at the aggregate level (which is achieved by having a more centralized decision-making structure). In addition, the advantages of a certain lending technology may vary during the course of the business cycle, since the probability of firm default is highly dependent on the phase of the business cycle (see Helwege and Kleiman (1997); Fridson et al. (1997); Carey (1998) among others).

We develop a stylized model (Paper [III]) to study the differences between a centralized and decentralized bank in the case of an economic downturn. We find that whether one of these specific lending technologies outperforms another, largely depends on whether the proportion of high ability entrepreneurs (i.e. the expected default rate) differs between regions. If banks lend funds to entrepreneurs in regions with a similar proportion of entrepreneur types (i.e. a similar risk structure), a decentralized bank tends to outperform its centralized counterpart; since a decentralized bank more accurately assesses the risks associated with each debt contract. On the other hand, if the proportion of high ability entrepreneurs differs between regions, a centralized bank's ability to effectively diversify its debt portfolio between the regional markets makes this lending technology superior in the case of an economic downturn. Thus, our research adds an extra dimension to the understanding of credit markets in distress by acknowledging that the credit losses suffered by banks in an economic downturn depend on a bank's lending technology, in combination with the risk structure of markets.

The view that a bank only functions as a financial intermediary may be a simplified view. A bank is exposed to a wide range of risks, unrelated to lending. In particular, banks are often engaged in frequent trading and thus, exposed to the risks associated with holding large portfolios of assets. As such, a correct assessment of such risks are equally important in banking. Two popular risk measures within this context are the Value at Risk (VaR) and Expected Shortfall (ES) measures; where VaR is the industry standard way of quantifying the risk of adverse

price movements. It is defined as the maximum potential portfolio loss that will not be exceeded over a given time horizon with some probability (see Jorion (2007) for a survey). However, it is often assumed that the entire position can be sold at the market price, i.e. that the seller (buyer) of an asset face a horizontal demand (supply) curve. If this is not the case, such an assumption can be quite misleading, especially if the buyer (seller) is considering a large position of an illiquid asset. Thus, it is important to incorporate for price movements caused by illiquidity, i.e. liquidity risk, into industry standard risk measures (see Malz (2003) for a general discussion of liquidity risk). Within this strain of literature, Bangia et al. (1999) was the first to account for liquidity into the VaR measure using a spread based approach. In Paper [IV], we continue on their work and propose approaches of adjusting the VaR and ES measures for liquidity risk by using the average price per share, rather than the mid-price. Our proposed approaches for the VaR and ES measures rely on essentially the same idea as used for the VaR measure by Giot and Grammig (2006). They consider the average price per share that would be obtained upon immediate liquidation at the end of the horizon. Their VaR is volume dependent and it is based on the difference between the mid-price at the beginning of the horizon and the average price at the end of it. We argue that the relevant initial price is not the mid-price, but that the portfolio should be valued at the average price in the beginning of the period as well. By adjusting the risk measures with this insight, we find substantial differences.

3 Methodological approach

Since we use a wide range of tools to answer the research questions discussed above, many readers are likely to be unfamiliar with some of the methods. Thus, this section presents a brief introduction to the more unconventional methods used in the thesis, namely the methods used in order to answer the research questions in Paper [I] and Paper [II].

In Paper [I], we utilize a strain of computational economic simulation methods called Agent Based Models (ABMs) to find the determinants of credit crunches. To our knowledge, this method is new to the study of credit markets in economics and differs in essence from traditional analytical economic models. In traditional analytical economic methodologies, credit markets are often modeled as an economic system with equilibrium properties. Periodic patterns may then emerge around this equilibrium due to (say) some inherent imperfections of a credit market within a rational expectations framework (as in Suárez and Sussman (1997, 2007)). By adopting the ABM approach, the assumption that credit markets have some long-

run equilibrium may be relaxed together with other assumptions.[2] Instead, within the ABM framework, agents are equipped with a set of decision rules governing their actions on an artificial market. The decision rules may vary in complexity and the agents may be given a varying degree of intelligence. By simulating the model, the researcher may observe the choices made by the agents as well as the aggregate outcomes of the agents' interactions (e.g., the total indebtedness of firms) that may arise as a consequence of their actions. Thus, ABMs may be thought of as belonging to a set of "out-of-equilibrium" models since such models allow for the behavior of a system (a market) to be a caused solely as a consequence of the decisions made by its parts (the agents). Any equilibrium that may evolve is "natural" in the sense that there is no rule that forces the market towards an equilibrium per se. In addition, ABMs allow for the modeling of markets even when equilibria are computationally intractable or nonexistent (Tesfatsion, 2006). Thus, the findings in Paper [I], that a credit market may naturally evolve into a credit crunch, may be viewed upon as a "punctuation" of one possible equilibrium in which bank credit is constantly expanding.

ABMs have some drawbacks compared to traditional equilibrium analysis that are important to highlight. Most notably, results obtained from simulations of ABMs tend to be rather path-dependent. Thus, the initial conditions may highly influence the obtained result. One obvious remedy for this drawback is to simulate the ABM in different "states of nature". Such a sensitivity analysis increases the understanding of the system while providing simulated data from which a version of comparative statics can be obtained by the use of standard statistical techniques. Another drawback is the difficulty to validate ABM outcomes against empirical data since simulations often suggest the nonexistence of an equilibrium or the existence of multiple equilibria. However, this is a drawback that ABMs share with other theoretical approaches.

In Paper [II], we explore the concept of disequilibrium in econometrics. In pervious literature, disequilibrium is often referred to as a state in which the supply of some good does not equate its demand, i.e. a market in which the observed price differs from the theoretical Walrasian equilibrium price. Thus, an economic equilibrium, as it is addressed in previous disequilibrium literature, is not to be confused with some long-run equilibrium of stationary prices (as often studied using error correction models), even though such a state may exist. Indeed, it is possible that some markets suffer from a long-run "out-of-equilibrium equilibrium" in the sense that the stationary price does not force the supply to equate the demand.

In Paper [II], we acknowledge these issues and divide the clearing market hypothesis into a continuously clearing market hypothesis (a market in which de-

[2] See Tesfatsion (2006) for a more detailed discussion about the advantages of ABMs in economics.

mand equals supply at every instant) and a long-run clearing market hypothesis (the hypothesis that a market will clear at the long-run stationary price). In addition, by assuming that the demand and supply are co-integrated (i.e. that the demand of some good may not drift too far away from its supply), we "error correct" for deviations from the long-run equilibrium and derive an error corrected disequilibrium model in price differences. Since the error corrected model in price differences implies a stationary price series, we also find an empirical model for the long-run equilibrium price.

4 Summary of the papers

Paper [I]: The Credit Market and the Determinants of Credit Crunches: An Agent Based Modeling Approach

In this paper, we derive an Agent Based Model (ABM) of a credit market, based on a simplified banking model in which banks screen applicants in order to reduce their exposure to credit risk. Here, we let banks decide their acceptable level of firm probability of default such that they truncate the distribution of firm quality at the highest acceptable default probability. We let banks have adaptive expectations about the risk in their debt portfolio and find that sudden reductions in lending may emerge spontaneously, even if credit markets are almost entirely transparent, since credit markets may evolve into periods in which banks acquire riskier debt than what is specified by their profit maximising conditions. Such periods are swiftly followed by periods in which banks try to cut back on risky debt, making credit difficult to obtain. If such cutbacks are coordinated across banks, the market may experience the eruption of a credit crunch.

We simulate the model in different "states of nature" and apply a standard logit model on the simulated data. From the maximum likelihood estimates obtained from the logit model, we find that credit crunches are seemingly spontaneous but highly dependent on the level of conservatism practiced when banks pursue their internal credit risk goals. If banks tend to react slowly to new credit risk goals, i.e. have a conservative approach to new risky ventures, the probability of a credit crunch is reduced.

We also find that an increase in the debts average time to maturity, reduces the probability of a credit crunch since such an increase tends to reduce the probability that banks lend to a sequence of firms associated with a profit reducing level of credit risk. In addition, we are able to find evidence in line with the asset deterioration hypothesis as well as to confirm the importance of accurate estimates in the banks' screening procedures. Thus, by adopting the ABM approach, we are able to find the determinants of credit crunches through a simple mechanism linked to

the banks' own credit portfolio risk valuations while embracing the possibility of random spillover effects of counter party risk.

Paper [II]: Error Corrected Disequilibrium

In this paper, we relax the assumption of a clearing market and instead assume that the supply and demand for some good are co-integrated. In other words, we assume there is some process that drives the demand and supply towards a clearing market in the long-run, while relaxing the assumption that the markets clear at every instant. This assumption allows us to "error correct" the supply such that a model in price differences can be derived. This new "error corrected disequilibrium model" is suitable for economic time series data and it naturally separates between a clearing market in the short and long-run.

By studying the implications of the parameters of the model, we derive a test of the long-run clearing market hypothesis, related to a version of the augmented Dickey-Fuller test of a unit root with drift. In addition, we derive the implied long-run equilibrium (stationary) price from the error corrected disequilibrium model which allows us to estimate the effects on the long-run equilibrium price caused by changes in the exogenous parameters.

We apply the model on the Swedish market for short-term business loans and find that this market suffers from a long-run non-market clearing equilibrium. In addition, by estimating the long-run equilibrium effects, we find an increase in the equilibrium interest rate, ceteris paribus, during the lowering of the Riksbanks prime rate during 2009. Since it is fairly unlikely that the lowering of the prime rate coincided with an unexpected increase in the demand for credit, this result implies an unexpected reduction in the supply of credit; indicating that the Swedish credit market suffered from a supply-side driven credit crunch during 2009.

Paper [III]: Centralized or Decentralized Banking

In this paper, we argue that a potentially important factor contributing to the risk-return profile of a bank is whether the lending/investment decisions are decentralized (meaning that the lending decisions are decentralized) or centralized (meaning that the lending decisions are taken higher up in the organization). We derive a stylized theoretical model in which there is a trade-of between being cost effective in terms of selecting high-quality clients (which is achieved by having a decentralized decision-making structure) and being effective in terms of ending up with a well diversified portfolio of loans on the aggregate level (which is achieved by having a more centralized decision-making structure). In addition, we acknowledge that a possible consequence of decentralized decision-making is that the decision-

maker in one local branch may not take into account that his/her choices may affect the situation for the other local branches. As such, local decision-making may generate "externalities" within the bank group. Here we focus on financing externalities, which occur if the decision on how many loans to grant in one local branch effects the cost of raising funds in other branches within the bank group.

By simulating the model while purifying each effect, we find (among other things) that, in the presence of only the cost efficiency effect, decentralized banks will lend more funds and have lower risks than their centralized counterparts. We also find that if the pure cost efficiency effect dominates, then centralized banks tend to react stronger, in terms of reducing the amount of issued loans, in the wake of a recession. Second, when only the financing externality is present, then decentralized banks over-provide loans at the expense of "proper screening", in comparison with centralized banking. This implies that the pure financing externality produces lower profits and higher risks under decentralized banking. Third, the pure diversification effect also favors centralized banking in the sense that the client targeting is more efficient, the expected profit larger and risks lower, compared with decentralized banking.

We also simulate a model where the cost efficiency effect, the financing externality and the diversification effect are present simultaneously. This allows us to study how these three effects combine to jointly influence the comparison between the two banking regimes. Among the results, it is found that asymmetric markets (in terms of the proportion of high ability entrepreneurs) tend to favor centralized banking while decentralized banks seem better at lending in the wake of an economic downturn (high probability of a recession). In addition, we find that even though a bank group where decisions are decentralized may end up with a portfolio of loans which is (relatively) poorly diversified between regions, the ability to effectively screen potential borrowers may nevertheless give a decentralized bank a lower overall risk in the lending portfolio than when decisions are centralized.

Paper [IV]: Value at Risk and Expected Shortfall for Large Portfolios

In this paper we address the question of how to properly assess the risk in large financial portfolios. In risk assessment, it is usually assumed that the entire position can be sold at the market price (or mid-price), though one realizes that this can be a quite misleading valuation approach. The reason is that for large enough positions the seller (buyer) of an asset does not face a horizontal demand (supply) curve. Thus, there is an element of liquidity risk involved (see Malz (2003) for a general discussion of liquidity risk) and this should preferably be taken into account in risk assessment.

Here, the focus is on incorporating the liquidity risk in the Value at Risk (VaR)

and the Expected Shortfall (ES) measures. VaR is the industry standard way of quantifying the risk of adverse price movements and it is defined as the maximum potential portfolio loss that will not be exceeded over a given time horizon for some small probability (see Jorion (2007) for a survey). However, as highlighted by Artzner et al. (1999) the VaR suffers from deficiencies such as non-sub-additivity. As an alternative, they propose the ES that gives the expected loss given that the VaR is exceeded. We emphasize, as argued by François-Heude and Wynendaele (2001) and others, that it is implicitly assumed that the liquidation occurs in one block at the end of the predefined holding period when assessing the portfolio risk. The question of how to incorporate the liquidity risk into the VaR is a relatively old one and several alternative approaches have been proposed. Bangia et al. (1999) were the first to account for it, with their spread based alternative. Ernst et al. (2009) evaluates some alternatives empirically.

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