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Managing systemic risk in The Netherlands☆

Shuyu Liao [a], Elvira Sojli [a,*], Wing Wah Tham [a,b]

[a] Erasmus University Rotterdam, The Netherlands
[b] Tinbergen Institute, The Netherlands

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ABSTRACT

The paper investigates the effects on systemic risk of macroprudential capital requirements, which require banks to hold capital that is proportional to their contribution to systemic risk. We use a panel of correlated Merton balance sheet models combined with a network clearing algorithm, to measure systemic risk and how it changes with bank capital. The model explicitly incorporates the possibility of default through common exposures to macroeconomic factors and interbank linkages. We use five risk allocation mechanisms to allocate systemic risk to individual banks. Using a sample of Dutch banks, we find that macroprudential capital requirements deviate from the current observed capital levels by as much as 40% and they are positively related to bank size and interbank exposure. Furthermore, macroprudential capital requirements can reduce individual and multiple banks default probabilities by up to 26%. The results suggest that financial stability can be substantially improved by implementing macroprudential regulations for the banking system.

1. Introduction

The great recession of 2008–9 showed that defaults of large banks can trigger a chain reaction of insolvencies in financial markets. The severe damage caused to the global economy has opened a discussion about systemic risk, the risk of the collapse of the entire financial system as opposed to the risk of individual bank defaults. Systemic risk is created endogenously within the financial system due to bank's common exposures to macroeconomic factors and contagion through interbank linkages. However, current banking regulation is designed at the level of individual banks' balance sheets and does not account for the adverse effects that a bank's default imposes on other banks within the system, i.e. each bank's systemic risk contribution. Nonetheless, it is possible that although banks look healthy at the individual level, they may still present threats to the stability of the system, through interbank exposures. Therefore, there is an argument for banking regulations to be designed from a systemic perspective in order to improve the stability of the financial system (Crockett, 2000, Borio, 2003; and Hanson, Kashyap, and Stein, 2010). We investigate one possible regulatory framework, macroprudential capital requirements, which requires each bank to hold a buffer of capital that is consistent to the bank's contribution to the total risk of the system (Adrian and Brunnermeier, 2008 and Acharya, Pedersen, Philippon, and Richardson, 2010). In this way, banks are required to set up some buffer against their internally created risk and bear the insolvency risk they impose on the banking system.

In specifying macroprudential capital requirements, we break down the risk of the system across banks and reallocate bank capital within the financial system. Each bank's capital level is chosen to be proportional to its contribution to systemic risk, so banks that

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* Corresponding author at: T8-44 Rotterdam School of Management, Erasmus University Rotterdam, PO Box 1738, 3000DR Rotterdam, the Netherlands. Tel.: +31 104082824.
E-mail addresses: liaoshuyukylie@gmail.com (S. Liao), esojli@rsm.nl (E. Sojli), tham@ese.eur.nl (W.W. Tham).

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have a higher impact on the system are required to hold more capital (French et al., 2010).[1] This approach reduces the probability of a system breakdown and enhances the stability of the financial system. Redistributing required capital can change banks' default probabilities, default correlations, and each bank's risk contribution to systemic risk. Therefore, we follow an iterative procedure to solve for a fixed point at which each bank's capital level is proportional to its contribution to the overall risk of the system. Macroprudential capital requirements computed using the fixed point can explicitly account for the endogeneity of systemic risk.

We use five risk allocation mechanisms from the literature to derive macroprudential capital requirements: component Value-at-Risk (Jorion, 2007), increment Value-at-Risk (Berry, 2000), ΔCoVaR (Adrian and Brunnermeier, 2008) and two risk allocation mechanisms based on Shapley value (Shapley, 1953).[2] Each of these approaches maps the capital of each bank to its contribution to systemic risk.

There are two types of risk within the financial system. Asset devaluation risk arises when banks have similar asset exposures that push their solvency positions in the same direction, which leaves the system vulnerable to common shocks from asset markets and the macroeconomy. Contagion risk arises when the banking system is interconnected with interbank exposures. Insolvency of a single bank might trigger failures of other banks through the network of interbank exposures (Moussa, 2011, Forbes and Rigobon, 2002 and Bae, Karolyi, and Stulz, 2003). As a consequence, the size of losses in the system could exceed the size of the initial losses triggered by the shock.

To find a fixed point that corresponds to macroprudential capital requirements, we calibrate a Merton style network model which allows for the analysis of how the risk of the system changes when capital gets reallocated. In the spirit of Merton (1974), we adapt a panel of correlated Merton balance sheet models that are jointly estimated with bank equity returns. We extend the model by adding an interbank exposure clearing network algorithm designed by Eisenberg and Noe (2001). The Merton style network model captures two aspects of systemic risk: i) correlation between banks' assets that are exposed to common non-banking factors, and ii) occurrence of contagious defaults, due to losses from defaulted banks transferred through interbank exposures. To find macroprudential capital requirements, we start with a bad regime scenario under which the probability of default is high. Given the fixed amount of required capital currently observed in the system, we simulate equity losses for each bank, which are used to calculate each bank's risk contribution. We reallocate required capital across banks until they are consistent with banks' risk contribution.

Using the four largest publicly listed Dutch banks, we find that macroprudential capital requirements across all risk allocation mechanisms can reduce the average probability of individual bank defaults by up to 17% and the risk of multiple bank defaults by as much as 26%. Macroprudential risk allocations deviate from the current observed capital levels by up to 40%. In addition, they are positively related to bank size and interbank exposure, but not related to the probability of bank default or risk weighted assets. Although different risk allocation approaches lead to slightly different capital requirements, we find that all of them reduce systemic risk. Therefore, our findings suggest the need for a shift from the current regulation regime to a macroprudential regulatory framework.

In the literature, there are two main approaches to measuring and allocating systemic risk. One uses stock prices to calculate asset correlation and contagion among banks (Acharya et al., 2010). The other builds on a network model combined with an interbank clearing algorithm (Eisenberg and Noe, 2001). We extend the previous research by designing a Merton style network model that captures systemic risk from both asset correlation and contagion through interbank exposures.

This paper is strongly motivated by Gauthier, Lehar, and Souissi (2012), who conduct a study on designing macroprudential risk allocation mechanisms in Canada. Our work differs in three important dimensions. First, we calibrate different models of the banking system. Gauthier et al. (2012) use a network model that only accounts for asset correlation risk through fire sales. We use a Merton style network model that accounts for bankruptcies both through asset correlation and interbank contagion. Second, Gauthier et al. (2012) use data for Canada from 2006 to 2008, even though Canada did not have a banking crisis in 2007/08.[3] We use data from the Netherlands, where the banking system was heavily affected by the crisis, for the period 2006 to 2012. Third, they do not consider the time-variation in returns when calibrating the models, while we use a regime-switching Merton style network model, which accounts for time-variation in stock returns. In summary, our work is an extension of Gauthier et al. (2012) applied to the case of the Netherlands.

2. Macroprudential capital requirement measures

There are two fundamental concerns related to macroprudential capital requirements: 1) Is total capital in the system sufficient? 2) How to allocate a fixed amount of total capital according to each bank's risk contribution in order to enhance financial stability? The first is a policy related question that we do not address. We attempt to answer the second question using the total capital that is currently observed in the system, assuming it is adequate, and compare alternative risk allocation mechanisms on reallocating the current capital in the system.

If a bank holds more capital, it is less likely to default either due to direct losses or contagion.[4] Redistributing bank capital in the system through the new capital requirements can change a bank's probability of default and change total systemic risk, which in

[1] Similar to our work, Ho, Lai, and Lee (forthcoming) also study the effectiveness financial reforms and capital adequacy in Taiwan.

[2] These risk allocation mechanisms are closely related to risk measures widely used in the risk management literature. Bisias, Flood, Lo, and Valavanis (2012), McAleer, Jimenez-Martin, and Perez-Amaral (2013), Hammoudeh, Santos, and Al-Hassan (2013), Chang, Jimenez-Martin, McAleer, and Perez-Amaral (2013), and Hammoudeh and McAleer (2013) provide a comprehensive discussion on latest development of risk management literature.

[3] See various discussions by FT and NT Times on the issue: http://krugman.blogs.nytimes.com/2013/06/15/worthwhile-canadian-comparison/?_r=0, http://krugman.blogs.nytimes.com/2010/01/30/worthwhile-canadian-example/ http://www.ft.com/intl/cms/s/0/db2b340a-0a1b-11df-8b23-00144feabdc0.html?siteedition=intl#axzz2kLI0oz6Z.

[4] This is in the similar vein of Gorea and Radev (forthcoming), which examines the individual and joint default risk of euro area and relate sovereign default risk to individual country fundamentals and trade interconnection.