Financial Stability and Monetary Policy:

The Effects of Macroprudential Policy Instruments on the Goals of Monetary Policy and a Discussion of the Interaction of Instruments

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Abstract

Throughout modern history many different approaches to financial regulation have been tried. However, as the recent financial crisis of 2007 demonstrated, the existing rules and regulations were not enough to prevent a financial crash. The crisis spurred new thinking and one outcome was the idea of a broader use of time-varying macroprudential policy. The experience of many of these new policies is limited. However, since many of the proposed policy measures affects the credit market, it is not unlikely that some of the measures may slow down economic growth. Of the same reason, the question of whether these new policy measures have an effect on the efficiency of monetary policy has been posed.

This thesis is an extensive review of much of the literature concerning macroprudential policy with a special consideration to the literature concerning its interaction with monetary policy. Using a discussion between Lars Svensson and Michael Woodford as a backdrop, two different proposals onto how to best address systemic risk is discussed. Their discussion serves as a basis for an analysis of many of the issues addressed in the literature.

Until more empirical results about the effects of macroprudential policy is presented, it is difficult to make clear suggestions about how best to coordinate macroprudential and monetary policy. The term "macroprudential" must be concretized and more empirical results on the extent to which macroprudential instruments affects the efficiency of monetary policy is needed. If these results were to indicate that macroprudential policy does interact with monetary policy, some form of coordination of policy may be appropriate.

Contents

1 Introduction

"Macroprudential policy is roughly where monetary policy was in the '40s. If I were being charitable, that would be the 1940s, rather than the 1840s."[1]

The size and complexity of the global financial market have increased steadily over the last century. It is today hard to find areas of human activity (other than the most basic existence in the few remaining truly undeveloped areas of the world) which are not in some way connected to the global market for financial services. This development has accelerated over the last decades, as the globalization of the world economy has steadily opened new markets to foreign investments, trade and banking. A logical consequence of this is that the world economy has become more dependent on the infrastructure of financial markets. In turn, large disruptions in international finance reach further and affects more people than ever before.

The financial system comprises of countless assets and markets. The set of regulations, rules and laws meant to guard the public against adverse disruptions is just as diverse. Throughout modern history many different approaches to financial regulation have been tried. Some was implemented to reduce the probability or cost of the occasional breach of trust in banks. Most of them still applies (e.g. deposit insurance[2]). Other regulations have been discarded as they turned out to create to much frictions in the financial system and hence also impeded economic growth. For instance, national banks in the US were not allowed to extend mortgages until 1913 and then only under strict conditions[3]. Similarly, up until the middle of the 1980's, the credit market was controlled by the Norwegian government by way of the setting of interest rates.[4] However, as the recent financial crisis of 2007 demonstrated, the existing rules and regulations were not enough to prevent a financial crash. The enormous costs of a financial crisis has spurred new ideas. Some have advocated a new thinking in monetary policy. Others are contesting this and favors more targeted rules to reduce instability across the financial system.

[1] Andy Haldane, chief economist in the Bank of England (The Telegraph, 21 June, 2014)

[2] Introduced at the federal level in the US in the 1930s (Calomiris (1990) and Diamond & Dybvig (1983)).

[3] The National Banking Act of 1913 allowed national banks to extend farm mortgages, but only with a Loan-to-Value ratio of maximum 50 percent and for terms no longer than five years. (Elliott, Feldberg & Lehnert 2013).

[4] *Meinich, Per. (2014, 30. mai). Penge og Kredittpolitikk. Store norske leksikon.* https://snl.no/penge-_og_kredittpolitikk

Macroprudential policy is meant to mitigate and control systemic risk. There is, however, to this day no widespread consensus on either the kind of macroprudential measures are most efficient at reducing systemic risk or how such measures may affect other parts of the economy.

One way to categorize the different policy tools is presented in Elliott et al. (2013). There it is noted that systemic risk and hence macroprudential policy, can be divided into two categories. **Structural** risks are threats to the economy that are always present. Examples are the "too big to fail"-problem which may induce moral hazard and the implicit promise within money market mutual funds to repay investors at par on demand, which may make them prone to runs if uncertainty arise. **Cyclical** risks are threats that include asset price bubbles and rapid credit and leverage growth leaving the economy vulnerable to shocks. This type of risk and the countercyclical macroprudential policies which are measures that can be adapted to changing financial conditions, will be the main focus of this thesis.

The fact that the countercyclical macroprudential instruments are intended to be adjusted depending on the state of the economy makes the interaction with monetary policy an important factor when designing the policy framework for macroprudential policy. Some authors believe that the best approach is to coordinate monetary and macroprudential policy to optimize policy responses. Others, though acknowledging the potential gains of coordination, comments that political economy challenges may arise from such an organization. Some partially ascribes the recent financial crisis to a failure of the established doctrine of inflation targeting in monetary policy and suggests a re-thinking of this to also include financial risk as a determining element when deciding upon monetary policy. This divergence in conclusions may reflect the still limited empirical evidence on the efficiency of macroprudential policy. This thesis provides a review of this discussion.

This thesis is structured in three parts. First, a brief definition of macroprudential policy will be offered with a presentation of the prevailing thoughts in the literature addressing the economic frictions macroprudential policy is meant to mitigate. As several authors have pointed out, policymakers are in need of good metrics and measurement tools to get a reliable estimate of what the state of the financial system is to be able to make prudent policy actions. A number of suggested metrics and indicators for systemic risk will

therefore be assessed. Based on what is most discussed in the literature or already have been implemented and therefore also encapsulates more empirical research and results, six different macroprudential instruments will thereafter be discussed and compared with each other.

The second part of the thesis will discuss the interaction between monetary and macroprudential policy. This encapsulates both how their effects on the economy interact and a review of how the organization of the mandates of securing the traditional monetary policy goals and the goal of sustaining financial stability may affect policy decisions.

Thirdly, using a discussion between Lars Svensson and Michael Woodford in the *Sveriges Riksbank Economic Review* as a backdrop, two different proposals onto how best to address systemic risk will be discussed.

2 Literature Review

2.1 Macroprudential Policy

Lim, Columba, Costa, Kongsamut, Otani, Saiyid & Wu (2011) refer to IMF[5] when they characterize macroprudential policy based on three defining elements:

- Its **objective**: to minimize the impact on the real economy of widespread disruptions in the provisioning of financial services.
- Its **analytical scope**: the focus on the financial system as whole, including interactions between the real and the financial sector. As opposed to individual entities.
- Its **instruments**: it primarily uses prudential tools that have been designed and calibrated to target systemic risk, rather than risks in individual institutions.

In line with Lim et al. (2011), Elliott et al. (2013) refer to macroprudential regulation as an approach that can fill the gap between traditional macroeconomic regulation, such as financial and monetary policy, and the microprudential regulation, the purpose of which is to regulate individual financial institutions. In Galati & Moessner (2013) the differentiation between macro- and microprudential policy is done by examining their ultimate

[5]IMF, *Macroprudential Policy: An Organizing Framework* (2011)

objectives. That is, macroprudential policy is defined as policy designed to avoid macroeconomic costs stemming from financial instability. Microprudential policy, on the other hand, has as its objective consumer protection, both investors and depositors.[6] Jeanne & Korinek (2014) are in line, arguing that microprudential regulation aims to guarantee the stability of individual banks, and hence by definition is a form of bank regulation, with the goal of limiting moral hazard stemming from financial safety nets provided by the government, such as deposit insurance. These objectives often coincide with macroprudential goals, and that explains why many macroprudential tools are microprudential in nature. Though, as Elliott (2011) points out, risks that are common to many financial institutions, combined with a high degree of interconnections between these institutions can create systemic risk. That is, risk can evolve even though the individual institutions themselves are appearing safe and sound.

An example on this matter is the housing credit bubble that were building up prior to the financial crisis of 2008. Bullard, Neely & Wheelock (2009) explains that the rapid growth in housing prices and credit levels in the US persisted for so long because of low interest rates, rapid income growth and innovations in the mortgage market. These innovations made banks lower their underwriting standards[7]. By collateralizing mortgages and selling them off as bonds, financial intermediators could lend out funds without facing the risk attached to these loans. These initial lenders did not have strong incentives to make sure of the borrowers creditworthiness, before extending loans. Additionally, the collateralizing of the debt may have masked the true risk whereafter the bonds sold got a higher credit standard by rating agencies than what they perhaps should have had. The subprime loans[8] and the bonds and securities attached to them gave for long a high return in the US. A high growth in housing prices combined with low interest rates made the delinquency ratio on subprime loans low over a long period from the late 1990s. One reason was that these borrowers were able to refinance[9] or sell their house at a higher price than they bought it for, if they were unable to make their loan payments. If a widespread fall in housing prices were to occur, the subprime borrowers who were unable

[6](Galati & Moessner 2013) Table 1.

[7]See *Terms* for explanation.

[8]subprime loans is a term used on mortgage loans to borrowers with a bad credit score. That may imply a history of delinquency, bankruptcy or a high loan-to-value ratio (Bullard et al. 2009).

[9]Via "cash-out" refinance borrowers could withdraw accumulated equity from their homes, due the continuos increase in housing prices in the years before the crisis. In that way, borrowers were able to pay their loan payments if their income was not sufficient (Bullard et al. 2009).

to make their loan payments would no longer be able to sell or refinance their homes and thus be unable to make their payments (Bullard et al. 2009). The risk of such an event may have been underestimated. Bullard et al. (2009) comments that critics have charged rating agencies for having a conflict of interest when rating bonds and securities. As it was the bond issuers who paid for the ratings, rating agencies may have been inclined to give the debt products a better rating than they should have had. Further, Bullard et al. note that some investors may have relied too heavily on those ratings, when making their investment decisions. The expansion in credit, and buying and selling of the collateralized debt obligations (CDOs) caused high degrees of leverage in financial institutions and a common exposure to the housing market by these institutions. Both high leverage ratios and the common exposure are examples of factors that increase systemic risk. I will get back to both these features later in the thesis.

The acknowledgment that there are risks in the financial sector that under some circumstances are not internalized by investors and financial institutions has made the case for macroprudential policy. Before we go deeper in assessing possible policy measures, we need to further clarify the terms *financial instability* and *systemic risk*, as the existence of these features are what justifies policy interventions in the form of macroprudential policy.

2.2 Financial Stability and Systemic Risk

Theoretical research on financial frictions and systemic risk is developing fast after the recent financial crisis. In this section I refer to some of the mechanisms most discussed in the current literature. Bernanke, Gertler & Gilchrist (1999) introduced the financial accelerator, and by that a theoretical foundation for analyzing how frictions in the financial sector could affect the business cycle, primarily through amplification and propagation. Though, as Elliott et al. (2013) point out, their model does not include an independent role for the financial system as a source of shocks. Further Elliott et al. (2013) comment that the standard economic models used by central banks prior to the financial crisis of 2007-2009 suggested that finance was not an independent source of risk, but rather a "veil". Borchgrevink, Ellingsrud & Hansen (2014) are in line with Elliott et al. and argue that much of the literature explaining how financial frictions can amplify the real sector does not model shocks originating in the financial sector. Further, they note that there is no clear scope for macroprudential policy in the framework, as the literature does not

explain how a regulator should intervene to limit the impact financial instability may have through amplifying shocks in the real sector.

One aim of Borchgrevink et al. (2014) is to present an overview of the market failures in the financial system that causes the imbalances that in turn can be addressed and eliminated by macroprudential regulation. They observe that any regulatory intervention should be justified by market failures. So before one can assess potential instruments to target financial instability, one needs to identify the market failures that creates the systemic risk. Borchgrevink et al. (2014) have identified a number of categories of market frictions that can cause systemic risk, and hence give rise to the use of macroprudential regulation.

Asymmetric information (between lender and borrower) and limited enforcement by banks to collect outstanding debt, cause the need for collateral to get access to credit. As assets are used as collateral when taking on debt, asset price swings may have a direct effect on the amount of debt agents in the economy can get. In good times increases in asset values, and hence collateral, expands the credit constraint for borrowers. That implies that borrowers can take on more debt. The behavior of the credit institutions further accelerates the cycle. More specifically, Claessens, Ghosh & Mihet (2014) refers to recent research[10] who observes that banks' perception of risk is inherently procyclical. The reason is twofold. First, banks may prefer to keep their risk-weighted assets as a constant ratio to capital. Second, during a boom the banks' assessment of their "value at risk"[11] tends to decline. To keep the mentioned ratio constant when their weighted risk declines, banks are likely to expand the size of their assets rather than decrease their equity capital. The consequence is more lending and lending which carries higher risk (Claessens et al. 2014). This practice by credit institutions feeds into the asset price cycle, increasing collateral values and further decrease the value at risk.

When this **pecuniary externality** with a potential to cause "overborrowing" is not internalized, too much debt may be accumulated compared to the social optimum. Following a negative shock, this may have consequences on the real economy via debt deflation[12], which depresses aggregate demand. Another consequence is that sound investments may

[10] Adrian and Shin (2010) and (2014)

[11] Further explained in *Terms*

[12] see "Concepts" for definitions of fire sales and debt deflation

not get funding, due to the deteriorated values of collateral and an increase in the price of risk.

Another pecuniary externality in the financial sector may be associated with the widespread use of wholesale short-term debt by banks to finance their loans (Adrian, Covitz & Liang (2013) and Borchgrevink et al. (2014)). This may be a source of excessive maturity mismatches, as the banks debt constantly needs to be rolled over or paid back while the banks' assets are long-term, e.g mortagages. Short-term debt may be a cheap form of financing, and in a boom where the price of risk declines the interest spread between the short-term debt and the long assets is tempting for banks. As noted by Borchgrevink et al. (2014) however, banks may fail to internalize all of the cost when they are reliant on short term debt. In a crisis, banks may find it difficult to roll over their short term debt due to an increase in the demanded return by investors on that debt. To pay back the short term debt they might have to sell off assets, but as explained by Borchgrevink et al. the price of similar assets held by other banks may decline when one bank starts to sell these assets, and the value of their collateral and access to funding may be affected. This is the pecuniary externality. The failure of banks to internalize how these fire-sales in other institutions can affect their own assets may leave the financial system with excessive amounts of wholesale short-term debt, which creates systemic risk.

If banks have completely different portfolios, so investors do not question other banks' ability to oblige their short term debt when one institution is in distress, if banks are not connected to each other through lending, and investors and depositors are completely rational, the above mentioned externality might not pose a serious threat to the financial sector. That, however, seems unrealistic. This brings us on to another externality in the financial sector discussed in Borchgrevink et al. (2014). Namely **interconnectedness externalities**.

At the micro level, a banks' portfolio may look safe and sound in terms of risk. This might seem to mean that if the bank, in isolation is hit by a shock, the depositors and investors need not worry. Though at the macro level one needs to compare the banks' portfolio with the other institutions in the financial system to evaluate the aggregate risk. Cecchetti & Kohler (2014) states that a central externality within the financial system is joint failures of institutions, resulting from a similar exposure towards the real economy and interlinkages among institutions at a single point in time.

Borchgrevink et al. (2014) explains the two threats mentioned in Cecchetti and Kohler further, and adds a third element of interconnectedness externalities. **The first** is the risk arising from correlated portfolios. If a shock to the value of assets banks possess occur, and they all have the same exposure to those assets, all of them will be hit directly. The recent crisis, where many financial institutions in the US were exposed to the subprime mortgage market stands out as a good example. Individually, the banks thought they were diversified, but since they all were exposed to the same risk, collectively they were not. **Second**, systemic risk can arise from balance sheet interlinkages between banks. If a bank meets distress in isolation, it may still impose a threat to other entities if it is closely tied to other banks via debt. If one bank go bankrupt, it can drag other institutions down with it. This is what we may call direct contagion (Allen & Gale (2000) and Gai et al. (2011)). Indirect contagion is a mechanism closely tied to the pecuniary externality discussed earlier. A banks distress may impose a threat on other banks as asset prices fall when the troubled bank sells its assets in a fire sale to finance its obligations. A **third** externality stemming from interconnection is expectational spill-overs. The uncertainty arising within the financial system when some banks are in distress might arise questions regarding other, sound banks and their solidness. As a result, these financially sound banks may find it more difficult to get funding (see e.g. Caballero and Simsek (2009)). Eventually, expectations alone could lead to bank runs on sound banks as well as the banks who actually are in distress.[13]

Another market phenomenon is **strategic complementarities**. That is the tendency of agents to want to "do more when others do more". An often used example is bank runs, where depositors withdraw their deposits based on expectations that others will do the same. In Diamond & Dybvig (1983) bank runs are caused by a shift in expectations. The shift in expectations can can be caused by almost anything.[14]As depositors run to withdraw their deposits, banks must liquidate their assets. A widespread asset sale by banks cause the price of those assets to drop. As a result, even "healthy" banks might default. This may have real economic effects as banks recall loans and productive investments are terminated. Similar behavior have been observed by banks in the form of liquidity hoard-

[13]There were no bank-runs in Norway during the financial crisis in 2008-09. However, banks did experience a widening gap in the difference between the key policy rate and the Norwegian InterBank Offered Rate (NIBOR) during the crisis. One reason for that development may have been a growing uncertainty in the financial system as a whole.

[14] *"... a bad earnings report, a commonly observed run at some other bank, a negative government forecast, or even sunspots."* (page. 410 (Diamond & Dybvig 1983).

ing. This is the tendency of banks to hoard liquidity based on the expectation that it will be more difficult to get funding in the capital markets down the road. Inevitably, funding do get more difficult because the hoarding by some reduces the liquidity in the market and thus increases the incentive for other entities to hoard liquidity (Gale & Yorulmazer 2013).

The prospect of bailouts by the government, in the wake of a crisis, may induce banks to correlate their exposure. If a shock then occurs to the assets held by nearly all of the institutions in the financial sector, the likelihood of a bailout is far greater than if only an individual bank is hit by a shock. Policymakers will be more reluctant to intervene when only a minority of banks are hit by the shock (Borchgrevink et al. 2014). The same mechanism may be at work if bank managers are concerned with their short-term reputation (Rajan (1994)). The motivation is that capital markets will be more forgiving towards individual institutions if the whole financial sector is hit by an adverse shock. The incentive is therefore to correlate risk with other institutions and engage in excessive risk taking. If a shock does not occur, profits will be high. If the opposite happens, the shock will hit the whole sector, so the market will evaluate the individual banks more leniently. As explained earlier, correlated portfolios make the whole system more vulnerable to shocks.

2.3 Measuring Systemic Risk

Hannoun (2010) refers to the "paradox of financial instability". That is that the financial system looks the strongest precisely when it is at its most fragile. Relying on this paradox to decide when to increase capital standards would be foolish. We need better, and more accurate indicators of financial stability as a basis for developing macroprudential policy. Such policies might also need to be adjustable to be efficient. Considerable research on how to detect these fragilities have been done since the 2008 crisis. Here is a summary of some of the most prevalent views and results arising from this.

Adrian et al. (2013) defines **Systemically Important Financial Institutions (SIFIs)** as institutions whose distress could disrupt the functioning of the financial system. Being able to measure the degree of stability in these institutions is therefore crucial in order to decide when to implement macroprudential tools. Adrian et al. (2013) divides the indicators into **Standard and Market indicators**. Standard indicators include regulatory capital and leverage ratios, asset liquidity, wholesale short-term funding ratios and confidential supervisory assessments. They do pose the concern that these indicators often

are viewed as lagging in time, so that policy actions based on these indicators often are sub-optimally timed. When it comes to market indicators Adrian et al. (2013) mentions CDS (Credit Default Swaps) premiums, equity prices and expected default probabilities, but stress that these measures only indirectly measure systemic risk, as it is difficult to distinguish the overall pricing of risk and the riskiness of one institution. This is also a criticism taken up in Galati & Moessner (2013). They comment that these measures are backward looking, or at most contemporaneous as indicators of financial distress. They are also in line with Adrian et al. (2013) with regard to the second point, namely that the market indicators only to a certain degree measure systemic risk. However, Galati and Moessner are a bit more dismissive as they argue that the balance sheet indicators[15] and market indicators are micro in nature and thereby fail to highlight vulnerabilities at the aggregate level.

Adrian et al. (2013) also focuses on **supervisory stress test**[16], which are meant to project wether the largest SIFIs have sufficient capital to withstand a shock. The results from the stress tests have largely been viewed as informative on the resilience of individual firms to shocks, but these tests do, to some extent, also incorporate spill-over effects within the financial system. Adrian et al. (2013) comment that the stress tests do reveal some information regarding how firms would fare in a systemic event, when firms simultaneously are experiencing stress. As Adrian et al. (2013), and Galati & Moessner (2013) also argue, stress tests is a good instrument to highlight potential transmissions of shocks within the financial system. In line with Adrian et al. (2013), they point out, however, that such tests in practice fail to capture feedback effects between the financial system and the real economy. By that, the tests also fail to capture how small shocks can have substantial effects. However, the main advantage of stress tests, as opposed to other approaches, is that they are by nature forward looking. This is a factor emphasized especially in Galati & Moessner (2013). By forward looking we mean they have the potential of signaling systemic risk and highlight potential channels or areas of the economy that are particularly vulnerable, before an actual bust occur. This gives the market as well as policymakers the possibility to take actions to strengthen the system and potentially prevent a bust.

Vector autoregression models (VARs) are subjected to much of the same criticism

[15]Galati & Moessners term for *Standard indicators*

[16]See *Terms* for a more thorough explanation of stress tests.

as stress tests. According to Galati & Moessner (2013) VARs are a flexible tool for detecting the potential for financial distress, but as with stress tests they offer only a stylized description of the dynamics of the financial sector. Hence, they tend to fail to capture the full feedback to the macroeconomy that financial distress could impose.

Another line of research, commented on by both Adrian et al. (2013) and Galati & Moessner (2013), is the concept of **CoVaR, or Conditional Value at Risk**. This is meant to be an indicator for systemic risk, measuring the value at risk (VaR) of the financial system conditional on institutions being in distress. Adrian et al. (2013) comments that this measure is a direct attempt to uncover the systemic risk. They do point out the problem that this measure, as with all market-based measures, *"are not immune to confounding effects of overall risk pricing"*[17]. Galati & Moessner (2013) notes that though the CoVaR measure is appealing, due to its ability to capture spillover-effects across the financial system, there are several criticisms of the measure. First and foremost, the CoVaR is a measure on individual institutions and their individual contribution to systemic risk. However, the estimated CoVaR of institutions can not be added up so to get an aggregate measure of systemic risk for the whole financial system. Another issue is that the estimated correlations between institutions, which are measured in normal times, are likely to behave very differently in a crisis.[18]

A severe drop in **valuations of assets** may constitute a financial stability concern if the valuations have been supported by excessive leverage, maturity transformation, or lax underwriting standards, as defaults then may become extensive and trigger a crisis.
Adrian et al. (2013) stresses the importance of assessing asset valuations relative to fundamentals, and not relative to other asset prices. They claim that relative asset prices are not informative for financial stability purposes. *"If asset values are particularly rich relative to fundamentals by historical standards, asset prices are in danger of reverting abruptly, triggering the potential for financial instability"*.[19] It is stressed in Adrian et al. (2013) that mispriced assets, relative to fundamentals, must be considered in conjunction with investor leverage, maturity mismatch, degree of liquidity of the securities and underwriting standards before making any solid arguments regarding systemic risk. Galati & Moessner (2013) also focuses on asset market indicators. They claim that these, together

[17]page 14
[18]See *Terms* for a more detailed explanation on the CoVaR measure.
[19]page 22

with credit aggregates perform relatively well in predicting financial distress, even over longer horizons (1-4 years).

A financial crisis may have big effects on real variables in the economy. In their study, using data from 14 countries from 1870 to 2008, Schularick & Taylor (2012) finds an estimated cumulative impact on real output after five years following a financial crisis to be a drop of 7.9 percentage points, relative to trend (post-World War II). They also conclude that the single best predictor for financial crisis is past **credit growth**. This result is in line with several other studies.[20] Both Minsky (1977) and Kindleberger (1978, 2000) argued that a period of high credit growth and rising asset prices could lead to financial instability (Riiser 2012). The prevailing optimism during a boom deteriorates banks risk assessment and cause banks to issue loans that they probably would not have issued in other phases of the cycle. By ignoring the potentially high default rates by borrowers that could occur in a downturn, banks' behavior are creating systemic risk (Anh 2011). So, following this logic, credit growth should be a good indicator for measuring financial instability. The Basel Committee has also acknowledged this, and has recommended that the countercyclical capital buffer should be linked to the gap between the credit-to-GDP ratio and its long term trend (Riiser 2012).

2.3.1 The Credit-to-GDP Gap

The credit-to-GDP ratio consists of total private debt, as a fraction of total GDP. Riiser (2010) explaines that in the Norwegian Central Bank the measure of credit in the indicator for credit-to-GDP includes total credit to municipalities, non-financial enterprises and households. The ratios long term trend is calculated using a Hodrick-Prescott filter to isolate the trend in the credit-to-GDP growth.

In their publication on how to manage and implement the countercyclical capital buffer the Norwegian Central Bank (Norges Bank) lists four key indicators to measure financial instability (Norges Bank No.1 2013). The indicators are;

- The ratio of total credit[21] to mainland GDP
- The ratio of house prices to household disposable income
- Commercial property prices

[20] Anundsen, Gerdrup, Hansen & Kragh-Sørensen (2014) and Anh (2011).
[21] By total credit they refer to households and mainland enterprises.

- The wholesale funding ratio of Norwegian credit institutions

In the paper, Norges Bank argue that when financial crisis do occur they usually follow a period of strong increases in credit and property prices. Since real estate is both collateral and an asset, increases in credit and real estate prices are mutually reinforcing. They further argue that in periods where credit growth exceeds deposit growth, wholesale funding increase. They claim that a high and rising ratio of wholesale funding reinforce the increase in credit and prices. A high wholesale funding ratio may carry risk in turbulent times, as the financial institutions to a larger extent will be exposed to the risk of maturity mismatches and fire-sales. This, in turn, could lead to a sharp tightening in banks' lending (Norges Bank No.1 2013).

Drehmann & Tsatsaronis (2014) states that the credit-to-GDP gap is meant to inform, not to dictate policymakers' decisions regarding the capital buffer. They do however acknowledge the criticism expressed by some authors with regard to the lack of a theoretical foundation for the indicator to be able to correctly identify periods of "excessive" credit growth. For example, developing countries may experience periods of excessive credit growth, far above a trend estimate, that can be justified as a natural part of the developing process. Similarly, as explained in Schularick & Taylor (2012), eras of financial innovation, development and liberalization would see an expansion in credit to support real economic gains. This kind of expansion does not necessarily constitute a threat to financial stability. Referring to a study by the Bank of International Settlements (BIS), where it is argued that peaks in the financial cycle[22] are associated with banking crisis, Leeper & Nason (2014) point out that sharply distinguishing a financial cycle from the business cycle is not an easy task. It may well be difficult to separate real and monetary shocks from shocks to the financial trend. Leeper & Nason (2014) comment that we are not yet there where we can establish an exact empirical feature of the financial cycle.

Though the credit-to-GDP gap frequently are referred to as an indicator for systemic risk, several authors have commented on its technical weaknesses. Edge & Meisenzahl (2011) comments on two potential threats to reliability, both essentially tied to how the gap needs to be measured in real time to be informative for policy action. The first - that revisions of real time estimates of the gap are large, possibly as large as the measured gap itself. Second - even if the real time estimate is correct, the indicator includes the real

[22]The financial cycle is, by BIS, measured using statistical models based on credit aggregates and house prices.

time trend estimate, which also is prone to measurement error. The trend is constantly updated with new figures on total credit and total GDP. This means that the trend line can change considerably as new data becomes available, causing past measurements of the indicator to be wrong. This is a consequence of using a one-sided HP-filter and is called the end point problem. Edge & Meisenzahl (2011) further notes that the unreliability of the real time measures cause a tendency of "false positives" in the credit gap indicator, rather than "false negatives". This implies that the indicator seems to have a bias towards predicting excessively high credit levels, which later will be revised down, rather than the other way around. They explain that these revisions do not stem from adjustments of the underlying data on GDP or credit, but rather from the unreliability of the end-of-sample estimate of the trend of Credit-to-GDP. It can be argued that it can cause an unnecessary burden on banks if these estimates then were to dictate adjustments in the capital requirements, which later will have to be discarded, as measurements would be revised down. Edge & Meisenzahl (2011) finds that the potential costs, due to real time gap mis-measurements can be large.[23] Due to these uncertainties with the real time estimates, Hahm, Mishkin, Shin & Shin (2012) comments that using the credit gap in real time policy can be expected to present formidable political economy challenges. Increasing capital requirements, which will spill over on borrowers, could end up being difficult to justify when the policy action is based on the single indicator of the credit-to-GDP ratio gap.

Drehmann & Tsatsaronis (2014) challenge the criticism, arguing that many, while factually accurate, misinterpret the role of the credit-to-GDP gap. Specifically, the view that the indicator is to be used as a common reference guide for countercyclical capital buffer-decisions. Drehmann & Tsatsaronis (2014) notes that the end point problem of calculating trend values do not invalidate the credit-to-GDP gap ratio and its signaling ability. They do acknowledge that the indicator is not perfect, but they do claim that the credit-to-GDP measure is, on average, the best single indicator in this context.

One attempt to improve the predictive ability of the Credit-to-GDP indicator is done by Gerdrup, Kvinlog & Schaanning (2013). By augmenting the historical data with forecasts of the trend, the authors claim this may provide a more robust estimate and hence a more reliable early warning of a crisis. Based on historical data they find that by simply taking the average of the credit-to-GDP ratio for the last 4 quarters, and adding a 5

[23]The costs stems from curtailed lending, and not so much due to increases in interest rates on outstanding credit.

year forecast horizon to the data improves the properties of the gap indicator. In Norges Bank No.1 (2013) the authors observes that owing to this method, the trend is less sensitive to strong growth or an abrupt fall in the indicator at the end of the observation period.

2.4 Macroprudential Tools

As we now have established what separates macroprudential objectives from other macroeconomic objectives, we need to make some distinctions regarding the many types of prudential tools. As noted in the introduction there is, according to Elliott et al. (2013), an emerging consensus taxonomy that divides macroprudential policies into two. Namely structural and countercyclical policies. Elliott et al. (2013) choose to make their key distinction among countercyclical tools based on which side of the supply and the demand of credit they operate on. Limits on borrowers loan-to-value ratios and limits on loan maturities are examples on the demand side. Limits on deposit rates[24], limits on lending rates, restrictions on banks' portfolios, reserve requirements and capital requirements are examples of tools on the supply side. This taxonomy is also used by Claessens & Habermeier (2013), though they call it the banking and household sector, instead of supply and demand respectively. González-Páramo (2012)[25] use a different taxomony. Their focus is on the sort of tools whose calibration can be varied over the cycle, so called countercyclical instruments. They classify them into the following three kinds; Capital-based tools, (such as countercyclical capital buffers), liquidity-based tools, (like countercyclical capital requirements)[26], and asset-side-tools,(e.g. LTV- and DTI- ratio caps). This is also in line with Lim et al. (2011), though they refer to what in the BIS paper is called asset-side tools as credit-related tools.

Next, I present a number of macroprudential instruments that have been, or are being used to day. There is a whole range of instruments to chose from, but I have chosen to focus my attention on tools that are meant to mitigate the cyclical threats, in line with the classification in Elliott et al. (2013). Further, there are instruments in all of the three categories, following González-Páramo (2012). That is, capital-, liquidity- and

[24]Ceiling on deposit rates, to curb credit supply.

[25]A report submitted by a Working Group established by the Committee on the Global Financial System. Chaired by José Manuel González-Páramo, then European Central Bank.

[26]CCB make banks able to drain on equity as a shock occur which cause wide-spread defaults. CCRR make banks have a liquidity cushion, in case of a run.

asset-based instruments.

Loan-To-Value (LTV)- and Debt-To-Income (DTI) Ratio Caps

A Loan-to-Value (LTV) ratio is a well known measure used by financial institutions and other lenders to assess the risk of a loan, e.g. a mortgage. A high ratio implies that the borrower to a large extent finances a real estate transaction via lending. Hence, the lender is more leveraged. By imposing a cap on this ratio regulators restricts the degree of leverage borrowers may take The Debt-to-Income (DTI) ratio is the ratio of debt servicing to income over a certain time period (e.g. month). A cap on this ratio restricts potential borrowers to take on more debt, if they with the new debt will have a debt service to income ratio above the regulatory determined cap.

The LTV ratio cap is meant to mitigate systemic risk originating from excessive credit growth or inflation in asset prices, usually property prices. The introduction of LTV ratios, as well as Debt-service-To-Income (DTI) ratio caps[27], stems from boom-bust episodes and are particularly popular in Asian and European countries (Lim et al. 2011). Caps on LTV ratios, if implemented early in the cycle, may have a preemptive effect by limiting the broad leverage level in the housing sector, as it limits the value of loans to well below the current value of the properties. Lim et al. (2011) note that LTV ratio caps may restrict low income residents and first time buyers access to credit. Therefore, some countries[28] are planning to combine the implementation of LTV ratio caps with policies to help these residents into the housing market.[29] Lim et al. point out that there are differences between countries regarding to which degree the LTV ratio caps are broad-based or targeted[30]. The LTV ratio cap is not by itself an "automatic stabilizer", so the optimal use of the instrument may be to implement or increase the ratio cap in periods of high credit growth, to curb speculation and hence reduce systemic risk. In this way, the LTV ratio cap will be more potent in smoothing out the cycle (Lim et al. 2011). LTV ratios have already had some success in a number of countries, notably Hong Kong, Korea and Poland (Claessens & Habermeier (2013) and Lim et al. (2011)). In addition to LTV ratio caps, Hong Kong has also implemented DTI ratio caps to curb systemic risk. Hahm et al. (2012) comments that since the currency of Hong Kong are pegged to the dollar,

[27] According to Lim et al. (2011), these are usually used in combination.

[28] Canada, Chile, Hong Kong and the United States.

[29] Examples being government initiated social housing projects or the requiring of mortgage insurance for first-time borrowers.

[30] E.g. depending on the area or the value of the property.

monetary shocks from the US are directly transmitted into their economy. The use of additional tools to curb credit and asset price growth are therefore particularly important to Hong Kong.

Leakages

González-Páramo (2012) mentions the potential leakage of lending from domestic to foreign banks as well as into the unregulated banking sector as a consequence of an introduction of LTV- and DTI-ratio caps. Another concern raised in their paper is how an introduction of asset-side instruments may affect the number of transactions in the real estate sector, as less people would get access to the market. Especially in geographic areas with a low number of transactions, this may cause an unintended increase in price volatility in the real estate market.

When it comes to the impact on output of asset side macroprudential tools González-Páramo (2012) argues that an overall efficiency assessment is difficult to make. This is due to the fact that there is no empirical evidence of the costs of asset-side tools on the broader economy. Though it is noted that the costs could be more limited compared to other forms of macroprudential policy. The reason is that asset-side tools may only affect a specific proportion of borrowers. Also, the costs will probably be of the non-monetary sort, as the consequence for these specific borrowers may be that they do not get the opportunity to buy a house.

Empirical results on LTV ratio caps

Using panel data from 13 countries[31] Wong, Fong, Li & Choi (2011) examine how the mortgage delinquency ratio responds to changes in property prices and macroeconomic fluctuations, depending on wether LTV policies are present or not. They find that a one percentage point drop in property prices would increase the delinquency ratio for economies with LTV policies with 0.35 basis points. For economies without LTV policies, the result is 1.29 basis points.[32] A one percentage point decrease in GDP growth also gives a lower negative response in the delinquency ratio in economies with LTV polices than in those without. However this difference between policy choices is not significantly different

[31] Australia, Canada, Greece, Hong Kong, Korea, Malaysia, the Philippines, Portugal, Singapore, Spain, Thailand, the US and the UK

[32] The null hypothesis that the two estimates are equal can be rejected at the 10 percentage significance level.

from each other, statistically. The analysis in Wong et al. (2011) therefore suggests that a cap on LTV ratios is effective in dampening systemic risk, stemming from the property markets. Looking at the results across the countries that have adopted LTV policies, Wong et al. (2011) comment that although it seems clear that LTV caps in general will dampen household leverage, evidence that it will have a dampening effect on the activity in the property market are mixed. This suggests that the effect on systemic risk from LTV policies are direct, from lower household leverage, and not through a dampening in the property market.

Dynamic Loan-Loss Provisions

According to Saurina (2009) there is a general experience among banking supervisors that lending mistakes by banks are more prevalent during upswings. Overconfidence in investment projects by both borrowers and lenders may lead to lower lending standards and, in essence, a too low pricing of risk. This (irrationality) works the other way around in a recession, causing tight credit conditions and a high pricing of risk. This may have real economic consequences as good and economically well justified investment projects do not get funding. The realization that this sort of behavior, stemming from informational imperfections such as disaster myopia and herd behavior prevails, is also the main theoretical argument to rationalize an intervention (Saurina 2009). One way to counteract the procyclicality is by implementing the capital-based macroprudential instrument "dynamic provisioning"[33]. Dynamic provisioning encourages banks to set aside provisions based on expected losses, instead of the usual provisions based on incurred losses (Hannoun 2010). Through banks' balance sheets, this might make banks build up more capital in the form of provisions in upswings, which again makes them more resilient if a negative shock occurs. Also, following a bust, the expected future losses are low and credit should be looser than without dynamic provisioning. Smoothing banks' marginal cost of lending over the cycle will dampen credit growth in booms, and sustain justifiable lending in bust (Lim et al. 2011).

There are several existing systems with dynamic provisioning, but the most widely used is a system of countercyclical provisioning with discretionary rate adjustments (Lim et al. 2011). There are also systems where the provision rates are fixed, and set based on historical averages of default rates. With the countercyclical adjustments, the imposed

[33]It is also known as statistical or countercyclical loan-loss provisions

provisioning rate will be high during upswings, and reduced during downturns. According to González-Páramo (2012) there is clear evidence that dynamic provisioning improves the resilience of the whole financial system if it is implemented.

Fernández de Lis & Garcia Herrero (2010) have compared the effects and experiences from dynamic provisioning in Spain, Columbia and Peru. They conclude that dynamic provisioning pursues two goals: (i) to smooth credit growth and (ii) to allow for buffers to be build up in good times to be drained on in bad times. They find that when the boom is of a certain size, the effectiveness of provisions for the first objective in general is limited. However, they note for the second objective, dynamic provisions seems much more promising. Regarding the first objective, smoothening the credit cycle, González-Páramo (2012) is more specific, arguing that the research indicates that it has been effective for this purpose in Spain, but that it does not seem to have the same effect in Chile and Colombia.

Countercyclical Capital Requirements

In booms, asset values rise, this in turn supports further lending by banks (Hahm et al. 2012). A fixed regulatory capital requirement may therefore not be very difficult for financial institutions to fulfill in a boom. When a bust then hits the financial system, the value of the assets diminish, inducing banks to increase their capital buffers to be able to comply with the fixed capital requirements. This will potentially be at the expense of giving credit ((Hahm et al. 2012) and (Akram 2014)). So, a constant capital adequacy ratio could end up working against its purpose, being procyclical and exaggerate systemic risk. That is, even though they seem appropriate from a microprudential view, as the individual institutions appear more resilient with higher capital ratios (Jeanne & Korinek 2014). The basic idea behind the countercyclical capital requirements is therefore to require financial institutions to hold more capital in good times and lower the regulatory capital requirement in bad times (Hannoun 2010). In this way, during a boom, the tightening of the capital requirement will bolster banks' financial strength and at the same time potentially have a dampening effect on credit growth (Riiser 2012). A release of the imposed capital ratio in a downturn would mitigate pressure on financial institutions to deleverage, and thus mitigate the potential amplification mechanism forced deleveraging throughout the financial system can have on the real economy (Adrian et al. 2013).

Norges Bank No.1 (2013) discusses the general effects of an increase in capital require-

ments on bank behavior.[34] It is argued that banks, given that they do not already satisfy the regulations, roughly have two ways to meet them. Firstly, banks may increase their equity capital. This can be done by retaining earnings (as opposed to distributing these as dividends) and/or issue new shares. To the extent that it is more expensive to fund lending through equity than other sources (e.g wholesale funding) banks' cost for funding might increase. In turn, these higher costs may be passed through to borrowers, who will see a higher interest rate on their debt. So, an implementation or increase in the capital requirements on banks might dampen the volume of extended credit via higher interest rates, which may lower the demand for credit. Secondly, banks can reduce the denominator of the ratio, their risk-weighted assets. This can be done by either a reduction in overall lending and by that reducing credit supply, or by altering the composition of assets toward assets with less risk weight. This may decrease credit supply to only some sectors of the economy.

Leakages

Norges Bank No.1 (2013) notes that an important transmission mechanism for adjustments in capital requirements onto the economy is via changes in market interest rates faced by borrowers. However, the possibilities for arbitrage and leakages do exist (González-Páramo 2012). If capital requirements on banks are increased, the shortfall in credit due to a lower supply of credit by banks and increased interest rates could be taken up by non-bank institutions or internationally active banks. These international banks may not be subject to the increased requirements. Large borrowers might also substitute bank credit with the issuance of bonds, or similar instruments. In this way credit growth in the economy may not be significantly dampened. In González-Páramo (2012) the possibility of outright regulatory arbitrage is also discussed. It is noted that banks may try to dampen the impact of the requirements by adjusting their internal models, whereafter these models will generate lower risk-weights on their assets. This incentive may appear stronger the tighter the capital requirements are.

Empirical results on countercyclical capital requirements

Using a macroeconometric model which includes several relationships between financial and real variables, Akram (2014) investigates the impact on macro variables of an increase in capital requirements on banks using Norwegian data. Examples of interactions between

[34] See "Concepts" for further elaboration and details regarding the new capital requirements

financial and real variables are house prices and credit to households, and the correlation between lending rates and changes in the capital adequacy ratios. This latter interaction is, according to Akram, a novel feature of this model, as the implementation of capital requirements in macroeconometric models are rare. There are four main results Akram highlights in his analysis.

First higher capital requirements do have a mitigating effect on credit growth, real estate prices and other macroeconomic variables. Importantly though, these effects are not direct as the the direct effects are insignificant. The effects comes through higher lending rates, which is a response from the banks when higher capital requirements are implemented.

Second the effect on credit growth and real estate prices are considerable, while the impact on variables such as inflation and output are rather modest.

Third the model predicts that for most types of shocks, the optimal response in the countercyclical capital buffer is an increase of 2,5 percentage points. Depending on the persistence of the shocks, the optimal duration of the increase is between 1-12 quarters.

Fourth the countercyclical capital buffer that minimizes the variance in credit growth also minimizes a combination of the variances of credit growth and output. This shows that one should not encounter any big conflicts with regard to policy choices, if the variance of credit growth is included in the policymakers loss function. According to Akram (2014), this result is due to a strong correlation between credit growth, output growth and inflation. However, Akram (2014) notes that this outcome should be investigated by other models before any conclusions can be made.

Though the estimated effects on inflation and output are rather modest in response to an increase in capital requirements, Akram comments that the impact on these variables may be larger if Norway's trading partners were to implement higher capital requirements at the same time as Norway.

González-Páramo (2012) refers to a study by The Basel Committee, which estimates that a one percentage point rise in capital requirements leads to a 20-30 percentage point reduction in the annual probability of a systemic crisis (Long-term Economic Impact As-

sessment (LEI Basel Committee (2010))).[35] They do however stress that the marginal effect of increasing capital requirements is decreasing. The authors of the study comment that they do not try to gauge an optimal level of capital requirements, but they do claim that measured in output, there is considerable room to tighten capital and liquidity requirements while still getting a positive net benefit. Another study, by the Macroeconomic Assessment Group (MAG 2010) at The Bank for International Settlements, found that a one percentage point increase in the capital requirement on banks leads to decline in lending of 1-2 percentage points in the medium run, relative to a baseline forecast.[36] The results are estimated using a range of models and the estimate reported here is the median result.

The MAG study also estimated the impact a one percentage point increase in capital requirements would have on the growth in GDP. The results suggested that in the medium term, the annual GDP growth rate decreases with 0.04 percentage point, relative to the baseline forecast, for so to catch up towards baseline. The maximum decline in GDP was 0.19 percentage points below the baseline path. The LEI study found that a one percentage point increase in capital requirements decreases long-run output by 0.09 percentage points. It is important to note though, that the positive effects of a reduction in the severity and frequency of banking crisis has not been taken into account in either calculation.[37]

Another attempt to uncover the effects of capital requirements is done by Clerc, Derviz, Mendicino, Moyen, Nikolov, Stracca, Suarez & Vardoulakis (2012). They have developed a DSGE model to analyze how capital requirements affects the steady state and the transmission of various types of shocks in an economy. The model exhibit "three layers of defaults", as bankers, households and corporations all can end up defaulting on their debt. Bankers are financed by their own wealth (inside equity) and by deposits from saving households. Banks are lending to households and to corporations. As defaults have a material impact on the balance sheet of the lender in this model, the model display the impact of household and corporate defaults on the net worth of banks. Three main results stands out in their model. **First**, they find that there is an optimal level of capital requirements. Higher capital requirements reduce bank leverage and hence their risk of

[35] As an example, the LEI-study finds that increasing the capital ratio from 7 to 8 percentage points, decreases the annual probability of a systemic crisis from 4.1 to 2.8 percent.

[36] The baseline forecast is the forecast without an adjustment in capital requirements.

[37] LEI estimates that net results are positive for a range of increases in minimum capital ratios, relative to Basel II.

defaulting. An increase in capital requirements also reduce banks' implicit subsidy that a deposit insurance is.[38] Lower leverage means that banks, to a larger extent must be financed by equity, so banks funding costs increase with capital requirements. The higher funding costs may be passed on to borrowers. Hence, banks will extend less credit to a higher interest rate. This shows that there is an optimal level of capital requirements because too high levels imply that credit will be too restricted (Also, banking activities might be pushed into other, unregulated sectors). Clerc et al. (2012) do however not comment on what this optimal level of capital requirements is, or what it would be characterized by. **Second**, Clerc et al. (2012) find that the higher degree of leverage there is in banks, the more responsive is the economy to shocks. This may not surprise, but it implies that limited liability and deposit insurance constitute a potentially powerful channel of financial amplification. **Third**, countercyclical adjustments of capital requirements may improve the benefits of high capital requirements. Following a shock and the release of the accumulated capital, the buffer is meant to sustain credit supply and keep rates down even though defaults by borrowers are increasing. However, if the buffer is too low, banks may still see a rise in funding costs off-setting the intended impact the adjustment of the countercyclical capital requirement was meant to have. This issue is also commented on by Anil Kashyap[39], who notes that for regulatory capital requirements to matter, the level of capital in good times must be higher than the levels imposed by the market in bad times. Due to the often considerable uncertainty that prevails in periods of financial turmoil, the market might demand very high capital ratios in banks before their solvency are not being questioned. This brings to mind another mechanism the market exhibits in times of financial distress, namely the signaling effect interventions in the market may have on its participants. Could it be that simply releasing the regulatory buffer cause enough uncertainty to amplify the downturn, causing fire sales and ultimately lead to bank runs?

Reserve Requirements

Hahm et al. (2012) explain that reserve requirements is a traditional form of capital controls, where the central bank requires banks to deposit a certain fraction of their raised

[38]The existence of deposit insurance may make depositors less concerned with how leveraged their bank is. Because their deposits are insured, depositors will do not have the incentive to make sure their banks are solid. This mechanism may make banks take higher risk, in terms of a higher leverage ratio, if there is a deposit insurance.

[39]Lecture held in the *Northwestern Advanced Workshop for Central Bankers* in 2014

capital in the central bank. Reserve requirements is by Lim et al. (2011) characterized as a liquidity-related instrument. That means that the purpose of the instrument is to make financial institutions hold a certain amount of liquid assets. However classified as liquidity-related, imposing reserve requirements may also help build up capital buffers, as well as having a direct impact on credit growth. As such, reserve requirements may be effective both in terms of limiting expansions and mitigating declines.

One disadvantage of reserve requirements as a macroprudential tool is that it only applies to banks, rather than the wider group of financial institutions that use non-core liabilities for funding. As such, implementation of reserve requirements might push some of the bank-activity into other institutions than banks, creating systemic risk on their own (Hahm et al. 2012).

Lim et al. (2011) comment that reserve requirements usually are used in a quite targeted fashion. Examples being that they are differentiated by currency, maturity or types of liabilities the institution has. Further, reserve requirements are usually applied within a band, on a marginal basis or imposed if credit growth exceeds an official limit. For optimal use, Lim et al. (2011) note that reserve requirements should be increased during expansions and lowered, if not removed entirely during a bust. Brazil, China, Russia and Turkey are some countries that have introduced reserve requirements. For example, in 2011, Brazil imposed an unremunerated reserve requirement of 60 percent on all banks' short term debt in foreign currency, exceeding Tier 1 capital or $3 billion (whichever was lower).[40] As such, Hahm et al. (2012) argue that this sort of requirement also may be regarded as a tax on banks liabilities. Another example showing how reserve requirements are used on the margin is from Bulgaria. Prior to the EU accession, banks that exceeded the 6 percent per quarter credit growth by more than 2 percent had to set aside as much as 400 percent in reserves on these loans.

Empirical research on reserve requirements

Claessens et al. (2014) refer to a study on banks' response to a big and unexpected increase in reserve requirements in Uruguay in 2008, as an effort to try to find which effects reserve requirements may have on the financial sector. The study found that credit growth on the aggregate did go down as a response to the policy, but credit to more risky firms

[40]It is unremunerated as the reserves must be kept in the central bank, without yielding any interest.

increased. The conclusion was therefore ambiguous, as less credit not necessarily imply less systemic risk. When it comes to the impact on output, the LEI study find that meeting the liquidity standards[41] proposed by the Basel Committee will reduce steady state output by 0.08 percentage points. However, including the benefits of reducing the severity and frequency of banking crisis, the net benefit is calculated to be a net increase in steady state output of 0.68 percentage points.

Instruments Targeting Foreign Currency Borrowing

The macroprudential toolkit does also include measures to limit system-wide currency mismatches (Galati & Moessner 2013). This is especially relevant for emerging economies, as they tend to be more prone to high volatility in their currency valuations. Galati & Moessner (2013) note that large capital inflows may fuel domestic credit growth. Hence, policy measures meant to mitigate these capital inflows may be seen as a macroprudential tool, as they indirectly mitigate overall credit growth. This issue is highly relevant, as low interest rates in developed countries in the last years have triggered an increase in foreign currency borrowing by non-financial corporations in emerging market economies (EMEs) (Chui, Fender & Sushko 2014). Chui et al. report that private sector borrowers (other than banks) in major EMEs have more than doubled their foreign currency debt in the period 2009-12, compared to the four-year period prior to the financial crisis. They also refer to the recent development in Ukraine, who has seen a deterioration in the value of its currency, to illustrate how abruptly the economic situation in such countries may change. The risk arises when domestic borrowers who are paid in domestic currency take up loans in foreign currency. If a depreciation occur, as typically happens in a crisis, the debt relative to income and wealth spikes. If the practice of foreign currency borrowing is widespread, default rates might be high. In turn these defaults could drag banks down with them. Foreign currency debt can thus work as an amplification mechanism.

Lim et al. (2011) explain that several countries use macroprudential instruments to mitigate this form of risk. There are measures to limit foreign currency exposure and by that reduce the risk of amplification, and measures meant to build buffers so that if a crisis materializes, the system is more resilient. In the first category, measures include direct

[41] These standards can not directly be interpreted as an increase in reserve requirements. The proposition is that banks must meet a minimum level of the Net Stable Funding Ratio (NSFR), which is the ratio of stable funding to weighted long-term assets. This requirement is however to be regarded as a liquidity-based macroprudential instrument, in the same way as reserve requirements.

caps on exposures, debt service-to-income caps by currency and in extreme cases outright bans on foreign borrowing.[42] Examples of measures in the second category are higher risk weights[43] or higher capital requirements when lending foreign currency, and higher provision standards against foreign currency lending.

There are mixed evidence of the effectiveness measures on foreign exchange lending has on credit growth. Applied on its own, they seem effective at reducing credit growth, but this effect weakens when other measures are included (Lim et al. 2011). According to Lim et al., one measure that is effective is limits on net open positions on foreign currency exposure.[44] This reduces the whole domestic financial systems external indebtedness and by that reduce the overall risk.

The Pigouvian Debt Tax

The motivation for implementing a Pigouvian debt tax is that borrowers impose a pecuniary externality on the financial system, as they drive up collateral prices, fueling additional borrowing. Bianchi & Mendoza (2013) show that agents in a competitive equilibrium borrow "too much", because of this externality. Further, it is showed that by imposing a state-contingent tax on debt, this externality is internalized. Imposing the debt tax removes fat tails from the distribution of returns and reduce risk premiums. Bianchi & Mendoza (2013) further comment that varying the tax, depending on wether one are in an upswing or in a crisis is more effective than a fixed tax, as a fixed rate debt tax is less effective in reducing the severity of a crisis, compared to a varying one. Jeanne & Korinek (2010) come to the same conclusion and show that the optimal level of the tax should be dropped to zero in busts and rise to approximately half a percentage point, on total debt, in a boom. Here they differ from Bianchi & Mendoza (2013), who though agreeing that the tax should be reduced to zero in a crisis, find that the tax should be raised to as much as four and a half percentage point the year prior to the crisis.

Hahm et al. (2012) also discuss the possibility of a debt tax and refer to Korea, who in 2010 announced their *Macroprudential Levy* on banks' foreign exchange-denominated liabilities. Thus, Hahm et al. differs from other discussions of a debt tax, as they focus on banks. Specifically, they discuss a macroprudential tax on banks' non-core liabilities.

[42] Austria between 2008 and 2010, and Brazil since mid 2000s (Lim et al. 2011)

[43] In Croatia the risk weights are up to 150 percent (Lim et al. 2011)

[44] Limits on how much debt, net of assets one can be liable to in foreign currency.

For banks, non-core liabilities will be other liabilities than deposits, such as wholesale funding and debt to other institutions. The argument is that banks' non-core liabilities follow the stage of the financial cycle, because banks' non-core liabilities correlates with the under-pricing of risk which in turn follow the financial cycle. As explained in the section *Measuring systemic risk*, a high wholesale funding ratio in banks represents a risk because the banks are more exposed to the risk of fire-sales and maturity mismatches.This may also be why Norges Bank uses the wholesale funding ratio in credit institutions as an indicator for systemic risk. A tax on these liabilities can help to align incentives, much in the same way as other authors argue in favor of a debt tax on borrowers. By targeting non-core liabilities only, the levy/tax addresses the externalities associated with excessive asset growth. It is a Pigouvian tax as it reduces the systemic risk by aligning banks' incentives with the socially optimum. As such, the revenue raised by the tax is a secondary issue. Another desirability of the levy is that it, according to Hahm et al., do not need discretionary adjustments over the cycle. They claim that the base of the levy varies with the cycle, and hence bite hardest during the boom. This gives the tax the property of being an automatic stabilizer.

Comparative Empirical Results on Macroprudential Tools

Lim et al. (2011) presents a panel regression analysis which aims to contribute to the discussion of which macroprudential instruments are more efficient in limiting different sources of risk stemming from the financial sector. The regression uses data from 49 countries during a 10-year period, from 2000 to 2010. Specifically, eight instruments[45] are estimated to see if they have an impact on the procyclicality of leverage and credit. The degree of procyclicality is measured by the correlation between GDP growth and the growth rate in the aggregated measures for credit and leverage respectively. In the regression analysis, credit growth is measured as the logarithm change in aggregated claims on the private sector, held by financial institutions. Leverage is defined as assets over equity for financial institutions. By adding an interaction term of GDP and a dummy for the instrument, a negative coefficient implies that the instrument has a mitigating effect on the procyclicality. Additional regressions are also added. There the goals are to find out whether two other instruments[46] have any impact on risk stemming from common exposure by institutions. Proxies for two types of risk are the ratio of foreign liabilities

[45]Limits on credit growth, reserve requirements, dynamic provisioning, limits on foreign currency lending, counctercyclical capital requirements, restrictions on profit distribution, LTV- and DTI-ratio caps.

[46]Limits on net open positions and limits on maturity mismatch.

to foreign assets and total credit to total deposits, which are meant to reflect risk related to liquidity and capital flows respectively.

In all regressions it is controlled for the degree of economic development, exchange rate regime and the size of the financial sector. From the results of the regression analysis it is clear that the efficacy of the different instruments depends on where in the economy the risk stems from. The following general lessons are emphasized in Lim et al. (2011).

- Risk stemming from the procyclicality of credit is best addressed with credit-related instruments such as caps on LTV- and DTI-ratios. A LTV ratio cap nearly eliminates all of the procyclicality in credit growth, while a cap on DTI actually makes credit growth slightly countercyclical. This implies that quarterly credit growth decreases in response to an increase in economic growth. Additionally, reserve requirements and dynamic provisioning also seem to have an impact on mitigating credit growth.

- For risk arising from excessive leverage, capital-related instruments might be a good option. Countercyclical capital requirements, dynamic provisioning and reserve requirements can mitigate increases in leverage in booms and provide institutions with a buffer. As the effect of DTI-ratio caps on the procyclicality of credit, the effects of an implementation of countercyclical capital requirements, dynamic provisioning or reserve requirements are found to make leverage growth countercyclical. These effects are found to be significant on a one percentage point significance level. It is commented that in the regression, the instruments are only estimated as dummy variables. Hence, the results do not give any information regarding what levels these instruments needs to be set at, to eliminate the procyclicalities.

- To address systemic liquidity risk, liquidity-related instruments such as limits on foreign currency exposure, if the risk stems from foreign currency borrowing, and limits on maturity mismatch can be used. Though not covered in the regression analysis, the authors suggests that a levy on non-core liabilities, a Pigouvian tax on financial institutions' debt, also can be a good measure if wholesale funding is a significant source of funding for financial institutions.

Claessens et al. (2014) comment that most empirical studies on macroprudential policy takes an aggregate perspective. That is, they are investigating the impact of macroprudential policy on aggregated variables in the financial sector, such as total credit growth or

asset price growth. The above presented study by Lim et al. being one of them. Claessens et al. (2014), on the other hand, has a different approach. They study how policy measures might influence at the micro-level. That is, how macroprudential policies influence the build-up of vulnerabilities in individual banks' balance sheets. There are many channels through which banks can become vulnerable. In an upswing, where lending accelerates, banks become more leveraged. They finance the increased lending with an increase in non-core liabilities (such as wholesale funding) and can thus, to a larger extent, become exposed to foreign exchange risk and risk attached to maturity mismatches.

Using some 18,000 observations on approximately 2800 banks in 48 countries over the period 2000-2010, Claessens et al. (2014) analyze the effectiveness of various macroprudential tools in curbing asset growth. They divide the tools into four different categories and compare the results. The groups are; tools aimed at borrowers (debt service-to-income- and loan-to-value ratio caps), banks' assets or liabilities (limits on credit growth, foreign currency credit growth and reserve requirements), policies that encourages the build-up of countercyclical capital buffers (countercyclical capital requirements, dynamic provisioning and profits distribution restrictions) and a final group of miscellaneous policies, which has some overlap with the three other categories.

The results imply that policies aimed at borrowers are effective in reducing the build-up of vulnerabilities in the banking system. The policies aimed at banks' assets and liabilities, as well as the measures from the "other" group seems to be even more effective. However, the instruments meant to encourage the build-up of capital buffers are not effective, according to the authors.[47] One reason for this result could be that the dependent variable is banks' asset growth. Measures implemented to create capital buffers are not just meant to reduce the buildup of vulnerabilities, but also to mitigate a potential decline in financial intermediation following a bust. For the most part, these results are in line with the study in Lim et al. (2011). However, there are some interesting differences. The effect of countercyclical capital requirements and dynamic provisioning are in Lim et. al found to have a dampening effect on the total growth in leverage in financial institutions. The results in Claessens et. al, on the other hand, suggests that these instruments are not effective in mitigating their measure for bank risk. However, In Claessens et al.,

[47]The coefficient describing the effect of "financial institutions buffer-based instruments" (Reserve requirements, Dynamic provisioning and Countercyclical capital requirements) on mitigating banks' asset growth is not significantly different from zero at any reasonable sign.level

the dependent variable is asset growth in banks, while the dependent variables in Lim et al are quarterly growth in credit, measured as claims on the private sector, and quarterly leverage growth, measured as banks' assets as a ratio to their capital. So, these results can not be directly compared to each other.[48]

3 Monetary and Macroprudential policy

In 1952, Jan Tinbergen put forth what we now call the "Tinbergen principle". It states that policymakers need at least one independent policy tool for each independent policy goal (Tinbergen 1952). According to Hannoun (2010) monetary and fiscal policy are meant to stabilize prices and manage demand so, following the "Tinbergen principle", there is a need for additional tools to maintain financial stability. Hannoun does specify that it is not necessary that each policy tool are to be exclusively assigned to one objective alone, but he does claim that the number of tools must equal the number of objectives. It can be argued, as Hannoun does, that both monetary and fiscal policy can be used to sustain financial stability. Monetary policy by leaning against the credit cycle and fiscal policy through building up fiscal buffers that can be used to boost demand as a response to financial system stress. Accordingly, Hannoun believes fiscal and monetary policy should incorporate financial stability as a secondary objective, because financial stability contributes to the realization of their primary objective. With regard to monetary policy, which is the focus of this thesis, Woodford concludes, in Woodford (2012), that the prevalent inflation targeting framework should be adapted to take into account the risk of financial instability and react upon developments in the financial sector that may increase the risk of a crisis. However, Woodford states that it hardly can be argued that interest-rate policy can or should provide a "complete solution" to the problem of handling systemic risk. He notes that that assumption would only hold if one believes not only that monetary policy is very effective in dealing with financial distortions, but also that it would carry no costs to implement financial stability into the mandate of interest rate policy. According to Woodford, that last assumption would simply not hold.

With its implementation questions regarding how macroprudential policy will interact with other policy areas have arisen. I have looked more closely on how the interaction between macroprudential and monetary policy is discussed in the literature. Further, based

[48]It is commented in Claessens et al. (2014) that they in their study also analyzed the macroprudential instruments' and their effects on banks' leverage, but they did not find any strong results.

on a discussion between Michael Woodford and Lars Svensson, I discuss how their two alternatives for the role of monetary policy to address financial instability may impact the economy, in light of existing empirical and theoretical research.

3.1 The overlapping effect

Cecchetti & Kohler (2014) state that at the macroeconomic level, macroprudential and monetary policy have quite a bit in common when the goal is the conventional monetary policy objective of price and output stability. Their highlighted example is how the effect, on banks, of an increase in the key policy rate coincides with the effect of increasing the amount of capital banks are required to hold, as a ratio to their assets. When increasing the policy rate, the level of bank reserves and bank deposits decrease, resulting in a lowering of the supply of credit (Cecchetti & Kohler 2014). Increasing capital requirements may also have the effect of reducing aggregate credit. To increase their capital as a ratio to their risk-weighted assets, banks must either increase capital directly or they can reduce their holdings of assets. An increase in capital can be done by increasing lending rates, which have the consequence of lowering credit supply. Alternatively, banks can reduce their assets, which will also lower credit supply. Either way, credit will be reduced when capital requirements are increased. Additionally, the cost of financing through equity is higher than financing via debt (Billi & Vredin 2014). If the bank defaults, holders of equity are repaid after debt holders. Therefore, it is to be expected that holders of equity will demand a higher return than creditors, and hence the higher cost for banks to finance its assets through equity. To some extent the results in N'Diaye (2009) supports this notion. N'Diaye (2009) argues and shows that by implementing a countercyclical capital adequacy ratio, the central bank can obtain the same objectives, in terms of output and inflation, but with less adjustments in the policy rate. Thus, in an economic boom, where prices are increasing, raising capital requirements may mitigate price growth, via reduced credit, such that the policy rate do not need to be elevated as much as usual to meet the inflation target. This means that in a situation where the financial and business cycle are aligned, macroprudential and monetary policy can complement each other.

This line of thought confirms the theory and empirical results presented earlier showing that macroprudential policy may affect the goals of monetary policy. Specifically, credit growth is a determinant factor for the evolution in total economic activity and hence also affects price growth. As commented by Claessens & Habermeier (2013) this

can give rise to policy errors, as policymakers might wrongly estimate the extent to which for example an implementation or adjustment in reserve requirements may dampen aggregate demand and inflation, and thus make the wrong interest rate response. Claessens and Habermeier puts forth Turkey as a possible example. According to them, policymakers in Turkey overestimated the extent to which their increase in reserve requirements on banks would dampen aggregate demand and inflation, and thus did not increase the policy rate sufficiently in response to inflationary pressure.

3.2 The potential for conflict between Monetary and Macroprudential policy

In difference from the example presented in the last subsection, were the business and credit cycle were aligned, there may also be situations of the opposite. Then, due to the overlapping effect of macroprudential and monetary policy, responses might conflict. In this way, macroprudential policy may work in a procyclical way, with regard to the business cycle. The following example shows how macroprudential policy may interact with the transmission mechanism of monetary policy; Conditions in the macroeconomy require a looser monetary policy, but a regulatory countercyclical capital buffer is implemented to counter rising systemic risk. The looser monetary policy will lower banks' funding costs, generating an increase in bank capital via retained earnings. This is meant to foster an increase in the supply of credit, to boost the economy. But as a consequence of the implemented capital requirements, the increase in banks' capital, resulting from the looser monetary policy, might be directed into meeting the capital standards, rather than towards the economy as increased supply of credit (González-Páramo 2012)[49]. If the conditions in the economy are sufficiently poor and the implemented capital requirements have a negative effect on output and inflation, this may increase the probability of monetary policy being constrained by the lower bound on the interest rate.

Another line of thought, regarding the potential for conflict between the two policy areas is presented in Beau, Clerc & Mojon (2012). As in the example presented in González-Páramo (2012), the policy rate is lowered to meet downward pressure on the price level following an initial increase in capital requirements. Beau et al. (2012) comment that the lowering of the interest rate might sow the seed for new risk, through the "risk-taking

[49]page 60

channel" of monetary policy. Thus, paradoxically an initial tightening in macroprudential policy, to reduce risk, might then increase risk-taking by banks, due to lower interest rates. [50]

However, González-Páramo (2012) finds that because financial crisis' tends to occur with a lower frequency than the business cycles, conflicts are not necessarily very likely to happen on a regular basis. This is also emphasized in Beau et al. (2012). When evaluating their econometric results based on historical data (1985-2009) on the euro area, they conclude that episodes of conflict between monetary and macroprudential policy should be rather limited, on average, over the business cycle.

Nonetheless, if concluding that macroprudential policy does have an impact on the goals of monetary policy, either directly or through lending rates, and the policy rate affects financial stability, coordination of the two policies may make it easier to pursue all three objectives of price stability, output stability and financial stability (Hahm et al. 2012).

3.3 Organizing Monetary and Macroprudential policy

One might think that the division of policy mandates does not matter for the optimal conduct of macroprudential and monetary policy in combination. However, if the two policies influence each others goals, it may be economic gains from coordination. One way to coordinate policy would be to give both mandates (monetary and macropudential policy) to one institution. On the other hand, such a concentration of power may carry costs in itself.

At every level in policy, there are ponderations between different goals. Reaching one goal might go on accord with, or at least slow down the achievement of other goals. To illustrate, consider a state of a sudden increase in prices, due to imported inflation. The monetary policy response will be to increase the policy rate, to curb that inflation. This may have a negative affect on output through several channels, but also through the credit channel. The macroprudential regulator observes the fall in credit growth and respond

[50] According to Agur & Demertzis (2013), the main mechanisms through which the risk-taking cannel is thought to work are: valuation effects (collateral gains value from expansive policy such as a reduction in the policy rate, expanding credit-constraints), a search for yield (fund managers seek higher risk to maintain promised yields as the yield on safer assets decline with the interest rate) and cheaper short term debt (which raises incentives for increased leveraging).

with a release of the capital buffer imposed on banks and by lifting the Loan-To-Value ratio cap on lending. This easing in macroprudential policy is meant to increase credit growth. It may however also contribute to an increase in the very inflation the central bank is trying to curb. This example is in line with one of the main results in De Paoli & Paustian (2013). They find that if the macroprudential instrument used is too similar to that of the monetary authority, in terms of effect on the economy, the potential costs of lack of coordination between policy institutions can be considerable.

Next, I will present a very simple model[51] meant to highlight how different assumptions regarding monetary and macroprudential policy and their effectiveness in reaching their respective goals influence optimal policy actions. The model may also give some insights into how the use of instruments should be coordinated. The model may also offer some insight into how policy responses might differ, depending on whether policy is coordinated or not. A benchmark model is given by;

$$x_1 = -r - \beta b + u_1 \qquad 0 < \beta < 1$$

$$x_2 = -\alpha r - b + u_2 \qquad 0 < \alpha < 1$$

Here x_1 and x_2 are the functions whose value give the divergence from optima, for monetary and macroprudential policy respectively. r is the interest rate, b is the macroprudential policy tool and u_1 and u_2 are shocks to the monetary and macroprudential goals respectively. If one institution has the mandate to achieve both objectives of financial stability and price stability, then policy is more easily and naturally coordinated. The loss-function, where both objectives carry the same weight will be;

$$L = x_1^2 + x_2^2$$

Minimizing with respect to to b and r gives the following optimal policy reactions to the shocks;

$$r = \frac{1}{1 - \beta\alpha}(u_1 - \beta u_2)$$

$$b = \frac{1}{1 - \beta\alpha}(-\alpha u_1 + u_2)$$

[51] The model is a result of a conversation with Øistein Røisland.

As is clear from the solutions, monetary and macroprudential policy should move in opposite directions in response to shocks when there is full coordination, no uncertainty and no costs attached to the adjustment of the policy tools.[52] This is also found to be the optimal policy response in the model presented in Collard, Dellas, Diba & Loisel (2012). They find that in response to a shock in bank risk taking incentives, which would be the equivalent to a positive value of u_2 in the model presented above, optimal prudential policy is to increase the minimum capital requirement on banks. The optimal monetary policy response is to reduce the policy rate, in order to curb the increase in bank lending rates, which is the banks response to the initial increased capital requirements. In this way inflation are virtually unchanged and the overall effect on output is small.

With regard to the optimal organization of mandates, there are two main results from the model presented. **Firstly**, in a very simple framework separation of mandates and a dual-mandate institution yields the same optimal policy response function. We get this result because it is assumed that both policymakers know what the response of the other policymaker will be, and takes that response as a given when making their own decisions. Hence, the responses with no coordination will be equal as in the case of full coordination, as there is no uncertainty about either institutions' policy. **Secondly**, the result where separation of mandates yields the same optimal response functions only applies under certain conditions. If adjustment costs or uncertainty of the instruments effects are included, the optimal response functions under separation of mandates will differ from the dual-mandate organization. Cecchetti & Kohler (2014) have a similar analysis and compare the outcomes of three different organizations of the two policy tools. The two models do however part on central assumptions. For one, monetary policy in Cecchetti & Kohler (2014) wish to achieve two goals (price and output stability), in addition to financial stability. In the model presented above, monetary policy is only concerned with price stability in addition to financial stability. Cecchetti & Kohler (2014) evaluate "no coordination", which constitute a state of two different institutions only concerned with their individual goals of either financial or price stability. They look at "full coordination", where both institutions fully internalize the other instrument when adjusting their own instrument, like in a Nash equilibrium. Lastly they consider "partial coordination", which is two institutions with separate goals, but where one policymaker moves first, and the second takes the first made policy into consideration when conducting their response. They find that in the first case, no coordination, regardless of which instrument is assigned to which

[52]Results may be different if these assumptions do not hold.

objective, the first-best solution can not be achieved.[53] In the full coordination case, the first-best solution is attainable and this case is considered to be the optimal organization in Cecchetti & Kohler (2014). As in the "no coordination" case, partial coordination is always inferior to an organization of full coordination. Interestingly though, they find that the partial coordination case can cause higher losses than the no coordination case. The assumption is that macroprudential policy moves first and are within-period committed. Then monetary policy adjusts, taking the move from the macroprudential authority into consideration. By observing the macroprudential policymaker's choice, monetary policy may undermine the effect of the macroprudential response if the two policy objectives conflicts following a shock. The goal for the macroprudential instrument in Cecchetti and Kohler is to minimize the spread between lending and deposit rates. It follows from the solution of the model that a loosening of the macroprudential instrument will lower this spread. Following a demand shock the interest spread will increase due to higher demand for credit. The response will be a loosening of the macroprudential instrument. However, this conflicts with monetary policy which uses inflation as its indicator. If the demand shock creates higher inflation, monetary policy will raise the policy rate, which in turn may widen the interest spread. If macroprudential policy in Cecchetti & Kohler (2014) rather tried to minimize the credit gap instead of the interest rate spread, this conflict may have been avoided as the policy responses then might complement each other (macroprudential policy would be tightened in response to the demand shock), as explained in the chapter *The overlapping effect*.

So, both Cecchetti and Kohler, and the very simple model discussed above suggests that the optimal way of organizing macroprudential and monetary policy is by coordinating policy measures. That may be most easily implemented by giving one institution the mandate to control both the traditional monetary policy goals and financial stability, with the use of both monetary and macroprudential policy measures. Bryant, Henderson & Becker (2012) is in line when arguing that as a general principle, there are potential gains from coordination. On the other hand, it is commented that there may be "political costs" with an organization of coordinated policy. A system of decentralized decisions

[53]This is in difference from the result in the simple model inspired by Røisland, which found that the first-best solution was attainable, given certain conditions, also for the case of "no cooperation". It is the difference in the assumptions that cause this difference in the results. In Cecchetti and Kohler, monetary policy does not take into account how the macroprudential instrument might be adjusted, when different types of shocks occur.

without cooperation and information sharing may be justified with the arguments of increased accountability, improved specialization of function and the avoidance of an undue concentration of power in one institution. These political gains must however outweigh the economic benefits from coordinated policy decisions.

Giving one institution a dual-mandate could also create another problem, not covered by the broad political economy argument presented in Bryant et al. (2012). Specifically, a time-inconsistency problem might arise. Ueda & Valencia (2014) refer to Kydland and Prescott (1977) and Barro and Gordon (1983) when they present their model of a dual-mandate central bank, in charge of both price and financial stability. In their model, because the central bank has the incentive to create inflation following a financial shock, to reduce the real burden of debt (private sector leverage is a variable in the loss-function), a dual mandate central bank does not deliver the socially optimal solution. There will be an inflation bias following a bust in the financial sector. Though, this result hinges on the assumption that macroprudential policy can not be adjusted as frequently as monetary policy. Nevertheless, the result in Ueda & Valencia (2014) does contribute to the important question of how to formulate the mandate of securing financial stability.

3.4 "Leaning against the wind" in Monetary policy

The models discussed in section 3.4 assumed that monetary policy could have some effect on financial stability, but they abstracted from exactly how or what that effect would be. More research in this area is necessary in order to draw any conclusions. So far, there is some limited evidence.

The assumption is that an aggregated higher credit level in the economy increases the risk of financial instability, as described by Minsky and Kindleberger. Higher interest rates will dampen the demand for credit and hence mitigate credit growth and systemic risk directly. Also, as assumed in Woodford (2012), leverage in financial institutions might be positively correlated with output. Higher interest rates that dampen economic activity may then also reduce leverage levels in the financial sector and hence indirectly reduce systemic risk. If one also acknowledges the existence of a "risk-taking" channel of monetary policy, as described by Agur & Demertzis (2013), the case for directly including monetary policy as a part of the solution for handling financial instability may appear stronger.

3.4.1 Consequences of the risk-taking channel

Agur & Demertzis (2013) have studied the impact on monetary policy if financial stability is included as a factor in the monetary policy mandate. The difference between bank risk taking and socially optimal risk is a factor in the monetary authority's loss function, together with the economy's output gap. It is assumed that bank optimal risk taking is larger than the social optimum, that bank risk is procyclical and that risk-taking is persistent. They find that monetary policy may follow a more V-shaped path, compared to what the traditional Taylor-rule would recommend. That is, rates would be cut deeper, but for shorter periods during a downturn compared to a monetary policy regime without a financial stability objective. On the other hand, during upswings rates would be raised not just to limit output, but also to limit excess risk taking. This change of pattern is due to the assumption of a risk-taking channel. If hit by a negative demand shock, rates will be cut to get output back up. However, the policymaker is reluctant to keep rates low for too long since that may induce the financial sector to take too much risk, once the banking sector are done with their initial process of deleveraging. Therefore, rates are cut deeper, but for a shorter time, for so to be raised to curb increased systemic risk from the financial sector.

3.4.2 A longer horizon in Monetary Policy

However, one reason for why including financial stability explicitly into the central banks mandate may be problematic is highlighted by an example in Adrian et al. (2013). *"... policy makers would need to assess whether higher expected employment and higher downside risk would be preferred to lower expected employment and lower downside risk."*[54] In the *Monetary Policy Report* for July 2013, published by Sveriges Riksbank, this ponderation is discussed in light of the, at the time, growing domestic household indebtedness. It is argued that by lowering rates now the probability of a future crisis may increase. That, in turn, implies downward pressure on inflation and economic activity, looking past the usual medium term. It is stated that a monetary policy that takes account of financial stability would face a trade-off: *"A monetary policy that takes into account financial imbalances [will face] a trade-off between attaining the target in the short and long term: inflation's deviations from 2 per cent and unemployment's deviation from a normal level during the normal three-year period are weighed against the expected course of development beyond*

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the forecast horizon."[55]

Authorizing an independent institution with making this tradeoff is one challenge. Billi & Vredin (2014) comments that even if a broader mandate in monetary policy may have economic advantages, there is a potential for a lowered credibility of the price stability objective and a general weaker support for independence of monetary policy. Another challenge that will erupt if a broader mandate is given is addressed in the *Monetary Policy Report*. How should the benefits in the short term be weighed against the consequential buildup of risk in the longer term?

3.4.3 Leaning Monetary Policy versus Macroprudential Instruments

In their study, Lambertini, Mendicino & Punzi (2011) compare different interest rate rules and the use of a countercyclical macroprudential instrument. The instrument is a time-varying Loan-to-Value (LTV) ratio cap. The goal is to find the optimal policy for mitigating boom-bust cycles. In their model, expectations create booms that distort consumption and investments.The reversal of these expectations cause busts, which again have negative effects on economic and financial decisions. This may cause macroeconomic losses. Hence, the model incorporates expectations-driven cycles. The model also distinguishes between savers and borrowers such that there can be done a comparison of welfare outcomes between them. There are four important results that stand out from Lambertini et al. (2011). **First**, when only comparing policy rate rules they find that a strict inflation targeting policy rule is severely suboptimal to a more moderate policy rule. This is when it comes to stabilizing housing prices and the loan-to-GDP ratio over time. Strict inflation targeting is also detrimental to welfare, compared to a more moderate Taylor-type policy rule. **Second**, the authors find that an interest rate rule that leans against credit growth reduces booms and busts and is welfare improving, compared to the Taylor-type rule. **Third**, they compare different indicators for financial instability for the macroprudential instrument to be adjusted in response to. To find the optimal indicator they compare their effectiveness in reducing the volatility in debt-to-GDP and the welfare of the two types of agents in the economy. Lambertini et al. (2011) find that the only Pareto improvement, compared to the benchmark economy, is when they are using credit growth as an indicator for the macroprudential instrument. An increase in credit growth thus implies that borrowers face a tighter Loan-to-Value restriction. **Lastly**, They compare

[55]Monetary Policy Report, July 2013, page 48

the outcome of using macroprudential policy with the outcome from using an interest rate policy that targets the macroprudential goal of stabilizing credit growth. They find that using the LTV-ratio cap is better with regard to stabilizing debt-to-GDP levels, households' debt and inflation. However, the interest rate rule that targets financial variables is more effective in stabilizing investments, housing prices, consumption and GDP. When it comes to the welfare criterion, it is not possible to do an unanimous ranking of the two policy alternatives. This is due to the heterogeneity of agents in the model. Savers are better off with the interest rate rule that responds to credit growth, since this alternative to a larger extent stabilizes consumption. Borrowers, on the other hand are better off with the macroprudential policy, because this alternative creates more stable credit conditions.

Kannan, Rabanal & Scott (2012) present a DSGE model with housing where shocks in the financial sector and housing demand create boom-bust cycles. They construct four different policy rules for monetary and macroprudential policy. Then, they compare how efficient the different rules are at stabilizing key variables in the economy, in response to different shocks. In their simulations Kannan et al. (2012) find that a monetary policy that reacts with a tightened monetary policy in response to a positive financial shock may be beneficial. A positive financial shock is in the model to be regarded as a positive shock in credit growth, due to a lower mark-up from financial intermediaries. An interest rule that responds to credit growth combined with a macroprudential instrument[56] that is also tightened in response to credit growth is even better, as the increase in the policy rate then can be lower, since the instrument also mitigates credit growth. In response to a positive financial shock, the interest rate and the macroprudential instrument complements each other such that overall volatility in GDP, inflation and consumption is lower than in the case without the macroprudential instrument. Also, in response to a housing demand shock does a leaning tactic in monetary policy lead to a welfare improvement. Such a policy rule creates less volatility in key variables than what a policy rule only responding to inflation and output gap would do. Adding a macroprudential instrument to the leaning monetary policy does not change volatilities, and hence welfare, very much, compared to the "leaning only" tactic. Whether welfare improves or not depends, as in Lambertini et al, on the welfare criterion chosen. Using the macroprudential instrument creates more stability in consumption, while leaving it out are better with respect to stability in lending rates (but then consumption will be more volatile).

[56]The macroprudential instrument can be regarded as additional capital requirements or additional provisioning (Kannan et al. 2012).

However, the simulations show that in response to a productivity shock, which carries much of the same characterization as a housing demand shock, the use of the macroprudential instrument is not optimal. The macroprudential instrument puts downward pressure on credit growth and creates a significant increase in lending rates. In turn, this may give rise to considerable volatility in inflation and the output gap.

The general lesson from Kannan et al. (2012) is that it may be a good idea to give the central bank extra tools to address financial shocks, since these tools could reduce the need for aggressive monetary policy reactions. Hence, macroprudential policies may create less disruptions in the macroeconomy. However, rigid reactions to indicators may create policy mistakes, so judgement and the correct identification of the source of shocks is crucial.

4 Woodford and Svensson and the Goals of Monetary Policy

4.1 The Discussion

Inflation targeting, as now practiced, was intended to stabilize medium-term inflation expectations. Well anchored inflation expectations would allow monetary policy to, more aggressively, be used for stabilizing the real economy. If the price level is stable, due to the well anchored expectations, changes in monetary policy to control output could be done without any major sacrifice to price stability (Woodford 2012). According to Woodford, the policy of inflation targeting was meant to handle two specific sources of macroeconomic instability. The first being wage-price spirals, for example triggered by a shock in commodity prices. In the western world, the shock in the price of oil in the 1970's is an example that stands out. If agents expect monetary policy to react upon higher prices, there will be less pressure on wages and prices as a shock occur. Secondly, inflation targeting was meant to reduce the risk of self-fulfilling deflation, in the period following a crash. This was observed following the Great Depression in the 1930's. It is well known that a general belief of deflation itself can cause deflation, as saving is perceived to be profitable at the expense of spending. More specific, a drop in demand due to a belief that the value of money will increase leads to a drop in prices. A drop in prices confirms the ex-ante beliefs, and the dynamic continues. Well anchored inflation expectations will

prevent this dynamic, because agents know monetary policy will do whatever it takes to prevent deflation from happening. Woodford comments that, in this light, the regime of inflation targeting has functioned quite well. Following the recent crisis, which some have compared to the Great Depression, no economy has ended up in a deflationary spiral (yet). Also, even though we have seen massive volatility in the price of oil and other commodities, this has not caused any wage-price spirals of the same magnitude as in the 1970's.

However, Woodford asks, could an alternative monetary policy have prevented the recent crisis altogether? He is not alone in raising this question. In Leijonhufvud (2008) for example, it is commented that an important cause for the crisis itself was the failure of monetary policy in the US preceding the crash. Specific macroeconomical conditions, like import competition and exchange rate policy by the countries of origin of that import caused low inflation in the US in the years preceding the crisis. Monetary authorities in the US interpreted the low inflation as a confirmation of their low-interest rate policy being "right", following the dot.com bubble. However, the low rates may have caused very favorable conditions for bubbles to build up. According to Leijonhufvud (2008), monetary policy in the US was far to easy in the years preceding the crisis.

Lars Svensson[57], a known theorist of inflation targeting, does not agree with Leijonhufvud. In Svensson (2011) he states quite clearly that *"Easy monetary policy in the United States did not cause the crisis."*[58] In Svenssons view, it was the supervisory and regulatory failures as well as the house-financing policy in the US in combination with global imbalances that caused the massive imbalances which eventually caused the crisis. He further states that in his view flexible inflation targeting conducted in the right way, using all available information relevant for forecasting inflation and resource utilization including the conduct of financial stability policy, remains as the optimal monetary policy. Woodford, on the other hand, believes the crisis does justify a reconsideration of the doctrine of inflation targeting, specifically the notion that monetary policy is not to take into account the development in the financial sector. That is, the notion that monetary policy should take into account financial stability only insofar as it affects the outlook of inflation or real activity. Is such a view defensible, looking back at the experience of the

[57]Lars Svensson is a Swedish economist and a professor at Princeton University. He has also held the position as deputy governor at the Sveriges Riksbank (2007-2013).

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recent crisis? (Woodford 2012). Further, he asks, would an incorporation of financial developments in monetary policy require an abandonment of inflation targeting altogether? In Svensson (2012), the author argues that suggestions regarding an incorporation of financial stability into monetary policy is inappropriate. In his view, there are better and more efficient ways of addressing financial instability. He illustrates this, by adding a macroprudential instrument to the model in Woodford (2012).

Before presenting the model in Woodford (2012), for how an implementation of financial stability can be incorporated with the traditional inflation targeting, Woodford goes through some of the arguments that have been posed to set aside the question of financial stability in the conduct of monetary policy. Next, I will present these arguments and include Svenssons views where they conflict with Woodford.

Claim: Financial crisis' are not predictable enough for it to be any gains by adopting a "leaning against the wind" policy with regard to disruptions in the financial sector.

Svensson (2011) argues that it is too difficult to, in real time, distinguish what is an unsustainable situation, and hence, when to take action. There are costs, measured in output, associated with an increase in the policy rate. As it is difficult to detect when to take action, untimely policy responses to financial developments are likely to happen.

Looking at the alternative policy, "mopping up" after the crash, the recent crisis, even with its strong and unconventional policy responses, have not been able to hinder a sharp contraction in world trade and economic activity. So, one argument is that though it carries costs to use the policy rate in response to financial imbalances, it may certainly be costly not to (Woodford 2012). This is also emphasized in Hahm et al. (2012). Besides the obvious cost of a massive drop in output following a financial crisis, Hahm et al. lists three additional factors that might create long lasting costs on the economy. Firstly, financial crisis are usually followed by a prolonged period of slow growth, because the deleveraging process takes time. Secondly, the budgetary position of governments' deteriorates, as fiscal stimulus and bailouts coincides with a lower tax revenue. Greece, Spain, Portugal, Italy and Ireland are European examples of this effect following the recent crisis. This could potentially lead to a sovereign debt crisis, and eventually even sovereign defaults. Lastly, the central banks' nonconventional monetary policy may be difficult to exit from without also hindering the ability of the central bank to successfully manage the economy

in the future. Asset and securities purchases by central banks are crossing into the area of fiscal policy. This may lead to increased political criticism and questions could arise regarding the independence of central banks. The consequence could be that politicians limit the possibility for future nonconventional monetary policy (Hahm et al. 2012).

Woodford also argues that the claim is misleading as monetary policy, in his framework, is not meant to react upon the knowledge that a crisis will occur, but rather based on the identification of circumstances which will increase the *probability of a financial crisis*. He explains that it is not the case that central banks are to monitor and act upon what they perceive as over-valued assets. The criticism based on this notion, arguing that there is no reason to believe that the central bank should be better at forecasting asset price swings than other agents in the economy are correct, but miss at the target. The goal for the central bank is rather to detect extreme levels of maturity transformation and leverage in the financial sector, and act upon this. There are, as mentioned earlier in the thesis, many suggested indicators to measure systemic risk. One of the indicators regarded as most useful, is the credit-to-GDP gap. Woodford refers to Borio and Drehmann (2009) who finds that strong increases in credit and asset prices proves to have predictive value on banking crisis. Other references are Drehmann & Tsatsaronis (2014) and Schularick & Taylor (2012). However, there are also authors skeptical of the usefulness of the credit-to-GDP and other empirical measures of financial stability (e.g. Leeper & Nason (2014) and Edge & Meisenzahl (2011)) Both the technical reliability of such measures (Edge & Meisenzahl 2011) and the potential difficulty of separating unstable developments in the financial sector from natural developments in the economy (Leeper & Nason 2014) has been addressed.

<u>Claim:</u> Even if it is possible to detect a sharp increase in systemic risk, monetary policy will have limited influence on the build-up of risk in the financial sector.

Svensson comments that for the policy rate to have a noticeable impact on credit growth and house prices, the change in the policy rate will have to be considerable. This may have strong negative effects on resource utilization and inflation, also in sectors that is not experiencing any speculative activity (Svensson 2011).

Here, as with the former claim, Woodford argues that the argument is misplaced. What the central bank is to consider is excessive leverage in the system as a whole and extreme

levels of maturity mismatch in financial institutions. Addressing these issues, Woodford (2012) notes that even small changes in the short term interest rate may have an effect. Firms incentive to seek high degrees of leverage and borrow in the short term wholesale funding market may change considerably by even modest changes in the short term interest rate. This, in turn, can mitigate systemic risk, argues Woodford. He states that there is no ground to assert that interest rate policy is irrelevant to financial stability. This is in line with the theory of the "risk-taking" channel of monetary policy.[59]

Claim: Even given that monetary policy can influence the risk of a financial crisis, there are better policy tools to address the problem.
Svensson argues that by introducing macroprudential instruments, e.g. a countercyclical capital requirement on credit institutions, excessive leverage in the economy can be addressed more directly than if using the policy rate.

However, as noted in my chapter on *countercyclical capital requirements*, referring to González-Páramo (2012), macroprudential instruments such as countercyclical capital requirements may be vulnerable to leakages and arbitrage. Thus, even though macroprudential instruments might be more targeted in addressing excessive leverage in the economy, there are ways for financial institutions to circumvent the regulations. Monetary policy on the other hand, via the policy rate targets all financial intermediators in the economy, also the "shadow banking" system. Adjustments in the policy rate affects the cost of borrowing for all borrowers, including those who circumvents the macroprudential instruments (Spencer 2014).

On the other hand, the fact that it targets so widely is also used as an argument against using the policy rate to maintain financial stability. In Svensson (2011) it is commented that *"the interest rate is a blunt and unsuitable instrument for affecting financial stability."*[60] This is in line with Claessens & Habermeier (2013), who note that it is usually such that financial distortions are more acute in a few sectors, rather than in the economy as a whole. Thus, increasing the policy rate to control financial imbalances in a few sectors may be done at the expense of sound investments in other sectors. Due to this, Svensson claims it makes *"little sense"* to assign the objective of sustaining financial stability to monetary policy. He notes in Svensson (2012), "Monetary policy should be the last line

[59] See section 3.2
[60] Page 4-5

of defense of financial stability, not the first line".

Woodford does not reject the contribution other policy tools may have on maintaining financial stability. He comments that acknowledging that monetary policy is relevant to financial stability is no excuse for not improving bank-regulation and implementing macroprudential tools such as capital requirements. However, he comments that as long as macroprudential policy can not guarantee that there never will be any situations of financial instability, monetary policy will have to be a part of the solution. Hence, until it is clear that new tools and regulations have completely solved the problem of financial instability, Woodford argues that central banks should incorporate in their policy decisions how their actions affect the financial system (Woodford 2012).

Claim: There will be a conflict between the use of monetary policy to control risks to financial stability, and the use of it to maintain price stability and stable real activity.

Woodford agrees that there might be situations where the objectives demand conflicting policy measures, if financial stability is incorporated in monetary policy. However, he comments that there already is a tension in the standard inflation targeting policy. That is the tension between maintaing medium term inflation and stable output growth. This is well known and also acknowledged by the theorists of inflation targeting, such as Mervyn King, Ben Bernanke and Lars Svensson. The theory suggests it should be possible to use the short term key policy rate to mitigate short run instability of the output gap at the expense of the optimal policy for maintaining medium run inflation expectations. From the theory, it is well known that when the economy is hit by a positive "cost-push" shock, with the consequences of increased inflation and a drop in economic activity, optimal policy will not be a severe tightening of monetary policy, so that inflation returns to target as soon as possible. If some weight also are attached to keeping output close to its projected trend estimate, it is optimal to balance the two goals when adjusting policy. Woodford argues, and shows in his model, that financial stability should take a similar role in the traditional inflation targeting monetary policy as the output gap now has. He believes it is appropriate to introduce a new "flexible inflation targeting", where central banks should balance the objective of financial stability against the objectives of price stability and stability in output.

4.2 Woodfords Model

In Woodford (2012), it is presented a New Keynesian DSGE model, which is a simplified version of the model in Cúrdia and Woodford (2009). The key variable of the model is Ω_t which, at any time, is the gap between the marginal utilities of income of two different types of households.[61] The households differ in the way that some are credit-constrained, while others are not. An increase in Ω_t represents an increase in the gap of marginal utility of borrowers, compared to that of savers. This means that, to a greater extent, spending by borrowers is inefficiently low. Hence, it can be thought of as a variable that measures the distortion of expenditure, due to credit frictions. The IS equation takes the following form

$$y_t - g_t + \chi\Omega_t = E_t[y_{t+1} - g_{t+1} + \chi\Omega_{t+1}] - \sigma[i_t - E_t\pi_{t+1}], \qquad \chi,\sigma > 0 \tag{1}$$

Here y_t measures the output gap, g_t is a composite of various exogenous variables that shifts the relation between aggregate expenditure and marginal utility of income. One example is government purchases. i_t is the short term interest rate and π_{t+1} is the inflation rate from t to t+1. From this setup we observe that real aggregate demand not only depends on the expected real interest rate and government purchases, but also on the degree of credit frictions. Woodford refers to an increase in Ω_t as to what is sometimes called "financial headwinds".

The model's aggregate supply relation is also modified to include the state of the financial sector. It takes the form

$$\pi_t = \varkappa_y y_t + \varkappa_\Omega \Omega_t + \beta E_t\pi_{t+1} + u_t, \qquad \varkappa_y,\varkappa_\Omega > 0 \text{ and } 0 \leq \beta < 1 \tag{2}$$

Here, u_t is composite representing various exogenous "cost-push" shocks. There is a positive relation between the degree of credit frictions and inflation. Since a higher value of Ω_t effects real expenditure through restrictions on credit and by that an increase in the marginal utility of income, an increase in Ω_t for a *given* real expenditure, only corresponds to a *decrease* in the average marginal utility of income. A lower, on average, marginal utility of income creates upward pressure on wages, and hence inflation. In the model there are two states of Ω. It can either take a low value (the "normal" state), $\underline{\Omega}$, or a high value ("crisis" state), $\overline{\Omega}$. Woodford assumes that the probability of a transition from a normal to the crisis state is endogenous, and represented by γ_t, which is assumed to vary

[61] Could also be considered as the spread in interest rates between borrowers and savers.

with the degree of leverage in the financial sector of the economy. So, $\gamma_t = \gamma_t(L_t)$, where the function has the properties

$$\gamma_t(L_t),\ \gamma_t'(L_t),\ \gamma_t''(L_t) > 0$$

The idea behind these assumptions is that the higher the leverage rate in financial institutions, the less of an unexpected fall in asset values are needed for a change of state (from normal to crisis). In essence, higher leverage requires a smaller exogenous shock to trigger a crisis. Woodford comments that it is not just the degree of leverage that determines the probability of a change of state. The degree of maturity and liquidity mismatch between institutions' assets and liabilities are also crucial. In the model, however, these factors are also embedded in the function representing leverage. The law of motion for leverage (or financial risk-taking) is endogenous, and represented by

$$L_t = \varrho L_{t-1} + \xi y_t + v_t \qquad 0 < \varrho < 1,\ \xi > 0 \tag{3}$$

An increase in aggregate expenditure is assumed to have a positive relation with aggregate borrowing. As expenditure increases, borrowers expenditure also increases and it is assumed that borrowers expenditure increases by more than their increase in income. Hence, aggregate borrowing rises. v_t represents a variety of factors. Generally it represents a change in the degree of risk the institutions must take to finance their assets. A positive value of v_t could for instance represent an event that reduces banks' capital values. By including the objective of reducing the probability of a financial crisis, into the mandate of monetary policy, Woodford describes the loss-function the central bank is to minimize as

$$\frac{1}{2}E_0\sum_{t=0}^{\infty}\beta^t[\pi_t^2 + \lambda_y y_t^2 + \lambda_\Omega \Omega_t^2] \qquad \lambda_y,\ \lambda_\Omega > 0 \text{ and } 0 < \beta < 1 \tag{4}$$

In Woodford (2012), it is first shown what the optimal target criterion[62] would be, if γ_t is independent of leverage. In that case, changes in the state of the financial sector would be purely exogenous, and Ω_t will not be a part of the loss function. Woodford finds that the criterion then is

$$\pi_t + \phi_y(y_t - y_{t-1}) = 0 \tag{5}$$

[62]Compliance to the target criterion ensures an optimal evolution of output and inflation. It is optimal as this relation between inflation and the output gap minimizes the loss function each period, contingent on the state of the economy. Technically, the target criterion is the first order condition that must hold for policy to be optimal.

in every period $t \geq 1$,where $\phi_y \equiv \frac{\lambda_y}{\varkappa_y}$. This is the standard target criterion for a simple New Keynesian model. Alternatively, the first-order condition can be expressed as a constant price level target,

$$p_t + \phi_y y_t = p^* \tag{6}$$

So, if the change of state is purely exogenous, optimal policy is to balance price and output levels. However, policy must still take take the financial sector into consideration, because financial imbalances has a direct impact on output, as the mentioned "financial headwinds" in (1).

However, if γ_t does depend on leverage, as in (3), the solution becomes a bit more intricate. Now, Ω_t appears in the loss function. Woodford defines X_t as the "marginal crisis risk", and this factor is now one that monetary authorities must consider, additional to inflation and the output gap when they set the policy interest rate. X_t is a measure of the rate of increase in expected loss, when leverage increases by one unit.

$$X_t \equiv \gamma_t'(L_t) \times \Delta V_{t+1|t} \tag{7}$$

This is the value of X_t for $\Omega_t = \underline{\Omega}$, while $X_t = 0$, if the economy is in a crisis ($\Omega = \overline{\Omega}$). V_{t+1} is a function that represents the minimum attainable loss for the policymaker, looking from period t+1 and onwards. $\Delta V_{t+1|t}$ is defined as

$$\Delta V_{t+1|t} \equiv E[V_{t+1} \mid h_t, \Omega_{t+1} = \overline{\Omega}] - E[V_{t+1} \mid h_t, \Omega_{t+1} = \underline{\Omega}] \tag{8}$$

and gives the impact a crisis, in t+1, will have on value of the policymakers forward-looking loss function. h_t is the state of the world, known in t. Woodford finds the following criterion to describe optimal policy

$$p_t + \phi_y y_t + \phi_x E_t \sum_{T=t}^{\infty} (\beta \varrho)^{T-t} E_t X_T = p^* \tag{9}$$

Woodford shows that this equation, and conformity to it, is a necessary and sufficient condition for optimally policy commitment, under the assumption of an endogenous development in the probability of a financial crisis. The last term on the left-hand side of (9), the "marginal crisis risk", can not be negative. Hence, this rule implies that monetary authorities must let output and/or the price level undershoot values that normally would be regarded as appropriate when the financial risk is high. Thus, the model in Woodford (2012) recommends a "leaning against" a credit boom policy, even if that implies that

both output and inflation are below medium-run targets. Additionally, commitment to a price level target implies that periods of "leaning" against financial developments, which in turn may cause a fall in prices, will have to be followed by a period of high inflation to get prices back up when the financial sector no longer poses a high risk.

The disruptions in the financial intermediation observed in 2007-09 makes Woodford conclude that the inflation targeting framework needs to be reformed, and take into account the probability of financial crisis when conducting monetary policy. However, there is not necessarily a need for substantial changes in the already existing framework. Central banks and monetary policy are still to commit to preserve medium term price-stability. What he suggests should be changed, however, is the goal of preserving inflation-*rates*. Rather, monetary policy should focus on the cumulative ex-post realized increase in the price level, as a metric for price stability. In essence, Woodford suggests a transition from the focus on medium term inflation rates, to the medium term change in the price-level. Also, the focus on the *horizon* for when inflation are to return to target, should, according to Woodford, be replaced by a criteria for how large of a temporary *deviation from price stability* one can justify.

The risk of the zero lower bound and the possibility of using monetary policy to mitigate the risk of financial crisis justifies a re-thinking and evaluation of the traditional inflation targeting regime. Woodford comments that his proposition is an extension of, rather than an alternative to the inflation targeting regime that now are being followed by central banks.

4.3 Svenssons alternative

The fundamental disagreement between Svensson and Woodford is whether financial stability should be an objective of monetary policy or not. According to Svensson, monetary and financial stability policy are distinct and different, as monetary policy is the domain of the central banks while the responsibility of financial stability, in most countries, are shared between several institutions. He comments that monetary policy used for mitigating imbalances in the financial sector are bound to create confusion and inefficiency. Since the two policies have different objectives and different instruments to reach these objectives, they need to be conceptually distinguished from each other (Svensson 2011). The reasoning behind this view is that if monetary and financial stability policy are not

distinguished from each other, it will lead to both practical and conceptual confusion in policymaking. In turn, this may undermine the efficiency of policy as well as the policy institutions' credibility.

In response to Woodford proposition, Svensson (2012) introduces a macroprudential instrument in Woodfords model to show how financial stability may be obtained without altering the traditional monetary policy objectives of stable output growth and price stability. In this way, monetary policy and financial stability policy can be conducted separately, and thus, the conceptual and practical confusion that may occur, if financial stability is implemented as an objective in monetary policy, is avoided. Svensson introduces a macroprudential instrument, f_t in equation (3), which he argues could be regarded as cyclical capital requirements, like a countercyclical capital buffer.

$$L_t = \varrho L_{t-1} + \xi y_t + f_t + v_t \qquad 0 < \varrho < 1,\, \xi > 0 \tag{3a}$$

He comments that this will separate financial stability from monetary policy, whereafter the social loss function can be separated into two:

$$\frac{1}{2}E_t \sum_{\tau=0}^{\infty} \beta^\tau (\pi_{t+\tau}^2 + \lambda_y y_{t+\tau}^2) + \frac{1}{2}E_t \sum_{\tau=0}^{\infty} \beta^\tau \lambda_\Omega \Omega_{t+\tau}^2 \qquad \lambda_y,\, \lambda_\Omega > 0 \text{ and } 0 < \beta < 1 \tag{4a}$$

The first part of the social loss function may be assigned to monetary policy, and minimized by the use of the policy rate, i_t. The second part of the loss function may be assigned to financial stability policy, and minimized with the use of the instrument f_t. If the level of leverage in financial institutions can be controlled by the instrument, there is no longer a need for interest rate policy to step in to contract output in response to a rise in the risk of a crisis, an increase in $\gamma_t(L_t)$.

Like Woodford, Svensson assumes that there exists a level, $\underline{L}$, such that for levels of leverage beneath that value, the risk of a financial crisis is negligible. Svensson goes a bit further and assumes that for $L_t \leq \underline{L}$, γ_t is independent of leverage. That is

$$\gamma_t = \underline{\gamma} \text{ for } L_t \leq \underline{L}, \quad \gamma_t'(L_t),\, \gamma_t''(L_t) > 0 \text{ for } L_t > \underline{L}.$$

It is now clear that optimal macroprudential policy will be to make sure leverage is equal to or less than the critical value, $\underline{L}$. The optimal use of the macroprudential instrument is to adjust it every period, such that

$$f_t \leq f(y_t, v_t, L_{t-1}) \equiv \underline{L} - \varrho L_{t-1} - \xi y_t - v_t \tag{10}$$

An elevated risk of a financial crisis, due to an increased degree of leverage in financial institutions, will be neutralized if the macroprudential instrument is adjusted according to this rule. The capital requirements on institutions will be tightened in response to an increase in the output gap, if a negative shock to the institutions' capital occur and in response to lagged leverage. It is important to note that through the effect of monetary policy on the output gap, macroprudential policy needs to take monetary policy into account when making the adjustments.

5 Discussion and concluding remarks

The discussion between Svensson and Woodford in *Sveriges Riksbank Economic Review* (Nr 1, 2012) covers many of the topics reviewed in this thesis. I will, in the next section, revisit some of the issues they discussed. First, it is important to clarify the views of Woodford and Svensson so as to define the basis for the following discussion. As I see it, they both represent the view that some form of time-varying leaning in policy is an appropriate safeguard mechanism against systemic risk. However, the main difference between their positions is how they view the role of monetary policy. Svensson argues that monetary policy should remain focused on its traditional objectives, i.e. ensuring full employment and maintaining price stability, while macroprudential policy should be given the task of maintaining financial stability. Woodford, on the other hand, while not rejecting the contribution from alternative time-varying policy instruments, argues that monetary policy also should have a role in handling financial imbalances.

5.1 Measuring Systemic Risk

As described in the section *Financial Stability and Systemic Risk* above, a high leverage ratio in financial institutions may imply that a small shock could be enough to create situations of fire-sales on assets. This may, in turn, cause widespread bank defaults with major consequences for the real economy. Both Woodford and Svensson use the aggregate level of leverage in the financial sector as their indicator for systemic risk. Though it is generally believed that a high degree of leverage in the banking sector increases risk, this general measure has some limitations. Both Adrian et al. (2013) and Galati & Moessner (2013) comment that this kind[63] of measure for systemic risk, are lagging in time. Hence, they believe leverage as an indicator for risk will react too late to the fact that systemic

[63] Adrian et al. use the term *standard measures*, Galati and Moessner *balance sheet indicators*.

risk is rising. If so, policy actions might not be optimally timed and policy mistakes may occur.

Another issue arising from Woodford and Svenssons use of leverage as an indicator for systemic risk is that it is not particularly well specified. In general, the leverage ratio of an institution is defined as the ratio of its total assets to its core capital (Tier 1) (or equity). However, the value of this indicator may differ considerably depending on whether the assets are weighted by risk or not.

If assets are not weighted by risk, the leverage ratio being used to calculate the probability of a financial crisis in the policy rule may at times be misleading. As noted by *The Economist*, the result is that *"toxic junk [will be] treated the same as Treasury bonds"*[64].

In Woodford (2012), monetary policy responds to a higher aggregate level of leverage with an increase in the policy rate. A higher interest rate is meant to lower the output gap which in turn will lower the demand for credit and consequently the aggregate leverage level. It may be argued that the cost of this, i.e. lowering output, might not be justified if the financial institutions, for the most part, are exposed to safe assets (e.g. Treasury bonds).

It may, to get a better picture of the true risk at different levels of leverage, be better to weigh the financial institutions' assets based on their risk. However, establishing the correct risk weights for this purpose will be difficult. Interest rate policy conducted on the basis of subjective evaluations of risk may therefore be politically challenging.

5.2 The effectiveness of the instruments addressing systemic risk

Svensson argues that a countercyclical capital requirement on financial institutions or other macroprudential tools may be effective in controlling leverage in the financial system. The empirical results in Lim et al. (2011) do, in some ways, support this claim. In their study they find that countercyclical capital requirements do have a significant effect in mitigating the *procyclicality* in leverage growth[65]. In the model presented by Woodford and Svensson that would imply that the introduction of countercyclical capital requirements will reduce the value of ξ. Lim et al. (2011) do, however, not investigate

[64]The Economist, Volume 413 (22-28 Nov, 2014), pp 65-66

[65]In the study measured as the growth in assets over capital in financial institutions.

how countercyclical capital requirements affect the *level* of leverage in financial institutions. Because Svensson, in his model, assumes that countercyclical capital requirements will directly affect leverage, the result in Lim et al. on the effect of capital requirements on the procyclicality of leverage can not be used neither to discard nor to support that assumption.

Lim et al. (2011) try, in the same study, to establish how effective different instruments are at reducing the procyclicality of total credit growth[66]. As discussed earlier, a high level of credit may make an economy more vulnerable to shocks. Some even suggest that high credit levels in itself can cause financial crisis (Schularick & Taylor 2012). Lim et al. (2011) find no evidence to support the claim that countercyclical capital requirements have any affect on mitigating the procyclicality of credit growth.

Thus, countercyclical capital requirements may be a meaningful instrument to mitigate the procyclicality in leverage growth. However, as empirical studies show, there are other threats to financial stability not addressed by this instrument. If these other threats are to be addressed within Svenssons framework, additional tools may have to be implemented. In that case the coordination and combination of those tools may present a challenge.

With regard to Woodfords framework, his "marginal crisis risk" indicator may be broadened to include credit growth. Even though it may not change the conduct of policy very much, communication challenges may arise as more indicators for the interest rate to respond to are introduced. As an example, credit growth may challenge the trust in the central banks' commitment to deliver price stability.

5.3 Adverse effects of the instrument

As noted by Woodford, including financial stability as an objective in monetary policy is controversial. The fear among many is that an increase in the policy rate in response to increased systemic risk may tip the economy into a deflationary spiral. This may happen if inflation and output are on or below their target values, while the indicator for risk is high. If deflation grips, reducing interest rates might not be enough to restore stability or growth in prices, as the public no longer expects stable or growing prices. Persistent

[66]In the study measured as the log change in real credit. Credit is measured as total claims on the private sector.

deflation and economic depression may follow. Considering how costly and disruptive a period of prolonged deflation may be, the danger of deflation is a relevant argument against an adoption of a leaning against financial risk in monetary policy.

Woodford does address the danger of deflation and claims that with his interest rate rule, that leans against leverage, that danger may be reduced if monetary policy targets a price *level* rather than price *growth*. The reason is simple, as deflation prevails, prices will drift further away from the monetary authority's committed price level. In turn this will create expectations of above average inflation in order to get back to target. Woodford further comments that this change in expectations about future price growth may not occur if the monetary authority targets inflation. The reason is that they, in such event, will not allow excess price growth (above the target) in order to get the price level back up, not even to offset the past deflation. In this way, a price-level target brings more trust than an inflation target. More trust in the monetary authority's commitment to comply with its expressed target creates a profit. With a high degree of trust by the general public in the monetary authority's commitment to reach its goals, less adjustments in the policy rate may be needed to mitigate volatility in the price level. It follows that the risk of monetary policy of becoming constrained by the zero lower bound on the interest rate may be smaller.

Woodford may be right in his reasoning that the ex-post commitment to reach a certain price level might be easier for the public to understand and trust. Since expectations about decreasing prices is an important reason for deflation, targeting levels rather than growth in prices could therefore reduce the danger of deflation.

An aggressive response to financial developments through macroprudential policy initiatives may also increase the probability of tipping the economy into deflation. This is because macroprudential policy could impose a constraint on monetary policy. As discussed in the chapter *The overlapping effect* above, this may take the form of a tightening of macroprudential policy which will place direct pressure on inflation and economic activity[67] or by weakening the transmission mechanism of monetary policy.[68]

[67]The LEI- and MAG-study found that countercyclical capital requirements could have medium term negative effects on output

[68]González-Páramo (2012), Cecchetti & Kohler (2014) and Billi & Vredin (2014)

If tightened capital requirements cause a fall in the supply of credit and a subsequent decrease in economic activity and inflation, a drop in the policy rate may not have the intended effect of increasing economic activity and inflation. Rather, the financial institutions may be forced to maintain the interest rate faced by borrowers at a high level to comply with the increased capital requirements. In the model presented by Svensson and Woodford this would imply that the interest rate faced by borrowers (i_t^L), may be a function of the policy rate (i_t^{MP}) and the macroprudential instrument (f_t), such that;

$$i_t^L = i_t^L(i_t^{MP}, f_t)$$

Where $i_t^L{}'_1 > 0$ and $i_t^L{}'_2 < 0$. The lending rate will increase when the macroprudential policy instrument is tightened. (It follows from equation (10) that a tightening of the capital requirements implies a reduction in f_t)

This could potentially tip the economy into a deflationary spiral because monetary policy may have reached the zero lower bound on the interest rate as financial institutions were leveraging down. Though, the countercyclical capital requirement would be reduced and perhaps even removed in full before deflation settled. In turn, that may have increased credit availability and hence activity whereafter price growth will have turned positive. Nonetheless, these mechanisms of overlapping and potentially conflicting effects of macroprudential and monetary policy needs to be understood and accounted for when policymakers are considering how to optimally address financial instability.

5.4 Coordination

The general opinion in the current literature is that there may be potential gains from coordinating macroprudential and monetary policy. The reason is that most empirical and theoretical results suggest that monetary and macroprudential policy instruments affect either the other policy's goals directly or have an impact on the efficiency of the other policy's instruments. Most important is the overlapping effects monetary and macroprudential policy may have on the credit market. Specifically, one of the channels where an adjustment in the key policy rate may effect the economy is through changes in the price and supply of credit. In turn, this affects the level of investment and total output. Some macroprudential policies do also have an impact on the total credit level. Depending on the instrument, they may dampen credit levels by restricting access to credit (LTV- and DTI-ratio caps and restrictions on foreign currency borrowing), reduce the supply of credit (capital requirements, reserve requirements, dynamic provisioning) or by increasing

the cost of credit (capital requirements and debt-taxes).

There is differing opinions on how and to what extent monetary and financial stability policy should be coordinated. As I see it, the different views can broadly be divided into three areas. The **first** category is where monetary and financial stability policy share the social loss function and both instruments, the policy rate and the macroprudential tool, are chosen in conjunction to minimize that function. The **second** category is where the social loss function is divided into two and financial stability and monetary policy is conducted separately. However, policy is conducted taking the other policy into account as in a Nash equilibrium. The **third** category does also constitute a separation of the loss function and hence mandates. Though, in difference from the second category, policy is conducted without taking the other policy into account when choosing the response to changing economic conditions.

Woodford supports the notion that financial stability and monetary policy should be determined in conjunction. As shown in equation (4) in section 4.2, that implies a social loss function consisting of the traditional monetary policy variables, as well as a variable describing the state of the financial sector. Macroprudential policy is not explicitly included in Woodfords model. However, he comments that a macroprudential instrument, e.g. countercyclical capital requirements, could be included in the model. In his setup of joint optimization of policy, optimal policy would involve adjustments in both instruments in response to changing economic conditions. Woodfords' main argument in favor of full coordination of policy is that macroprudential policy has not yet proven to be capable of providing a complete solution to the challenge of achieving and maintaing financial stability. Hence, monetary policy has a part to play in maintaining this objective.

Another reason for why a shared loss function between monetary and financial stability policy could be beneficial rests on the assumption discussed in section 5.3. If monetary policy were to reach the zero lower bound on the interest rate and thus not be able to reach the goals for monetary policy, macroprudential policy may be used to increase price growth and economic activity. This may not happen if the mandates for financial stability and monetary policy is divided, as macroprudential policy then only is concerned with financial variables.

Svensson argues against a shared loss function for monetary policy that includes finan-

cial stability. I have repeatedly mentioned Svenssons statement regarding monetary and macroprudential policy as being distinct and different from each other. Svensson notes that his argument also applies with regard to the coordination of policy. In Svenssons view, monetary policy should be conducted taking macroprudential policy into account, and vice versa, as in a Nash equilibrium, rather than in a coordinated equilibrium. Hence, Svensson is an advocate for the second category as to how to organize monetary and financial stability policy. It should be organized this way, regardless of whether the central bank has the sole authority of the two policies, or if the responsibilities are shared between different institutions. Using monetary policy as a first line of defense to achieve and maintain financial stability is, according to Svensson, a second-best option. Macroprudential policy, applied in the right way should be given this task. Svenssons further argues that by not strictly dividing responsibilities and conduct of monetary and macroprudential policy, there is a risk that monetary and macroprudential policy may be confused with each other. In turn, this may lead to poorer outcomes for both policies and make it difficult to hold the different policymakers accountable.

This last point, regarding accountability, is also discussed by other authors. Billi & Vredin (2014) comments that the high degree of independence granted to many central banks might be put under pressure if financial stability policies where to become a part of the monetary policy mandate. In Billi and Vredin this is discussed in light of the notion that monetary policy are to "lean against the wind" with regard to the financial sector. This is not Svenssons point, as his comment is made with regard to coordination of the policy areas, rather than giving monetary policy the task of responding to financial developments. However, I believe the potential threat to central banks' independence if macroprudential policy is coordinated with monetary policy still is a valid argument against a full coordination of these.

Bryant et al. (2012) support the view that some form of coordination between macroprudential and monetary policy could have welfare gains and that decentralized decision making without coordination may cause inefficiencies. I believe that it needs to be pointed out again that the reason why many models discussed in this thesis do recommend coordinated responses by monetary and macroprudential policy is because these models are assuming that macroprudential policy affects the goal variables of monetary policy. In that way macroprudential policy overlaps with monetary policy. If that were not to be true, or only hold to a very limited extent, a full coordination of policies, as implied by

Woodford might not give large welfare gains. Rather, an organization of the third category may be optimal. Completely decentralized policy authorities with no information sharing who do not take each others policy responses into account may increase accountability. Additionally, as commented by Bryant et al. (2012), this type of organization of macroprudential and monetary policy gives little reason to fear an undue concentration of power in the central bank (which could threaten its independence), and may create a specialization of functions in both policy authorities/institutions.

There is a variety of macroprudential policies and they operate through many different channels. Todays knowledge about their impact on the wider economy is limited. It follows from this that it is difficult to make any general assessments about the extent to which policy should be coordinated. The term "macroprudential" must be concretized and we need more empirical results on the degree of overlapping the effects of the different instruments have with monetary policy, before we can reach any conclusions regarding how to optimally coordinate monetary and macroprudential policy.

However, if I were to comment on Svensson and Woodfords suggestions, I believe the notion that Svensson advocates in his extension of Woodfords model may be too simplistic. As available empirical and theoretical research show, there is good reason to believe that many macroprudential instruments, to at least some extent, affect economic activity and inflation through the cycle, via borrowing rates or access to credit. Because this may create situations were monetary policy reaches the zero lower bound on the interest rate, I believe some form of coordination of policy will be a necessity to reduce economic and financial instability.

6 Terms

There is a wide range of terms and concepts in the literature concerning macroprudential policy. In the following I will present a few chosen terms I believe needs further explanation.

A **pecuniary externality** is an externality that works through prices, when prices affect constraints in the economy. According to Holcombe & Sobel (2001) they occur when the action of one agent, for example by selling an asset, reduces the value of similar assets held by other agents. Price changes are not themselves a source of inefficiency. But when for example housing is used as collateral and the effect on collateral constraints of house price changes are not internalized when agents trade, a pecuniary externality is said to be present.

The **"Value at Risk (VaR)"** is a common measure of risk used by financial institutions. It is an estimate of the maximum potential numerical loss (e.g dollar) within a certain significance level for an individual institution in isolation (Adrian & Brunnermeier 2011). A VaR analysis also depends on the time frame, so the VaR analysis is meant to answer what the maximum potential loss could be, within a certain time frame, for different degrees of confidence. Adrian & Brunnermeier (2011) defines the **"Conditional Value at Risk (CoVaR)"** of an institution as the value at risk for the whole financial system if that institution is experiencing distress. The difference between the estimated CoVaR when the institution is under distress and the estimate for when it is in its "normal" state is the **"ΔCoVaR"**, and captures the marginal contribution to systemic risk, of that institution. Intuitively one might think that an institutions VaR and CoVaR gives the same outcome. Empirically that is not the case though (Adrian & Brunnermeier 2011). In a highly interconnected financial system, one company's distress can cause distress on other institutions and thereby cause higher total losses to the system than just the loss from the initial institution. If this is the case, the CoVaR will be higher than the VaR for that company.

The purpose of a **"macro stress-test"** is to measure and trace the response of the financial system if hit by a large exogenous shock. This may indicate how vulnerable the financial system is, and thereby be an indicator for policy actions. Using a macroeconometric model, one maps the consequences of an initial shock through multiple stages, often

including "satellite" models to include financial sector variables. The following example is from Foglia (2009), and gives a good insight into how a macro stress-test is conducted.

1. A simulated stress-event occur.

2. Link stress event to macroeconomic variables, such as GDP, interest rates and the exchange rate.

3. Use the outcome of the second stage in a satellite model to find effects on variables measuring banks' asset quality (typically housing prices).

4. Measure the impact on banks' balance sheet of the changes in asset quality and potential credit losses.

When the stress-test is done, one compares the estimated incurred losses with the capital and liquidity in the banks prior to the shock to see how well the banking sector would have done in case of an actual shock. A criticism of the macro stress test is that they, in practice, fail to capture the feedback effects from the financial sector on to the real sector, if a shock occur. In Foglias setup, this would translate into the effects of stage 4. back into the variables first calculated in stage 2.

"The Hodrick-Prescott filter (HP-filter)" was introduced by Hodrick and Prescott in 1997 and computes the permanent trend, TR_t in a time-series x_t (Carlo A. Favero 2002). That is, the HP-filter is derived by minimizing the following expression with respect to TR_t;

$$\sum_{t=1}^{T}(x_t - TR_t)^2 + \lambda \sum_{t=2}^{T-1}[(TR_{t+1} - TR_t)^2 - (TR_t - TR_{t-1})^2]$$

The value of λ is optional. A higher value gives a smoother trend, as deviations in trend from the previous value is penalized harder.

In 2010, the Basel Committee for Banking supervision recommended a new regulatory framework regarding capital and liquidity in the banking sector (Norges Bank No.1 2013). EU followed up a year later, and the **"Countercyclical capital buffer"** will also apply for Norway due to the EEA agreement. The new regulation consists of stricter capital requirements on banks, in terms of both quality and quantity.
The framework looks like the following;

- Banks must at all times satisfy a requirement of Common Equity Tier 1 (CET1), which will amount to 4.5 percentage point of the banks' risk weighted assets (RWA).
- On top of this, there is the buffer requirements. This comprises of the permanent conservation buffer of 2.5 percent of the RWA, and the time-varying component of the buffer. This time-varying countercyclical capital buffer comes on top of the permanent, and will be in the range of 0 to 2.5 percent of the RWA of the banks.

The capital ratios are calculated based on the following equation.

$$\text{CET1 ratio} = \frac{\text{CET1 capital}}{\text{RWA}} \qquad \text{RWA; Risk Weighted Assets}$$

For a financial institution, their **"leverage ratio"** consists of the fraction of their assets to equity. In essence, it is an indicator of the extent to which the institution is financing their assets with debt.

$$\text{Leverage ratio} = \frac{\text{Assets}}{\text{Equity}}$$

There are also other indicators used for measuring the degree of leverage. One example is debt-to-equity.

"Maturity mismatch" describes the situation where assets are illiquid and their maturity are long term, while financing are short term. For a bank this implies that it is financed by, besides deposits and equity, short term debt that constantly needs to be refinanced. In a state of financial instability where insecurity and panic erupts, it may be difficult for banks to get this short term debt rolled over. So to pay of outstanding and matured short term debt they might have to liquidate their long term assets. If the maturity mismatch is a widespread problem, widespread liquidation of long term assets may turn into a situation of Fire sale.

There is a broad consensus that a dramatic weakening of **"underwriting standards"** for mortgages in the US was one of the main causes for the recent crisis. Underwriting is the summarization of risk ex ante, and is evaluated when assessing a loan application (Bhardwaj & Sengupta 2009). Hence, the underwriting standard is the threshold of risk creditors are willing to make.

A **"Fire-sale"** is a forced sale at a dislocated price. It is forced in the sense that the seller can not wait to raise funds, typically because he needs to pay debt. The price is dislocated because the potential buyers are in the same position as the seller, namely sellers of the same type of assets. The assets are then sold to alternative buyers who are only willing to buy at a far lower value than its correct price (Shleifer & Vishny 2010). The fall in asset prices and hence in collateral values induces a **"Forced deleveraging"** process. The ratio of loan to value spikes, so asset owners must sell assets to manage their debt.

"Debt deflation" describes a situation where the real value of debt is increasing. Debt is nominal and hence its nominal value do not decrease when asset prices fall. Following a bust, with widespread fall in asset prices, paying off debt is difficult since liquidating collateral might not be enough to cover the nominal debt.

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