WP/16/87

IMF Working Paper

Mitigating the Deadly Embrace in Financial Cycles: Countercyclical Buffers and Loan-to-Value Limits

by Jaromir Benes, Douglas Laxton and Joannes Mongardini

INTERNATIONAL MONETARY FUND

 WP/16/87

IMF Working Paper

Research Department

Mitigating the Deadly Embrace in Financial Cycles: Countercyclical Buffers and Loan-to-Value Limits

Prepared by Jaromir Benes, Douglas Laxton and Joannes Mongardini

April 2016

Abstract

This paper presents a new version of MAPMOD (Mark II) to study the effectiveness of macroprudential regulations. We extend the original model by explicitly modeling the housing market. We show how household demand for housing, house prices, and bank mortgages are intertwined in what we call a *deadly embrace*. Without macroprudential policies, this deadly embrace naturally leads to housing boom and bust cycles, which can be very costly for the economy, as shown by the Global Financial Crisis of 2008-09.

JEL Classification Numbers: E32, E44, G38, L51

Keywords: lending booms, credit crunch, financial crisis, financial cycle, housing market, countercyclical buffers, loan-to-value limits, macroprudential policies

Author's E-Mail Addresses: jaromir.benes@gmail.com, dlaxton@imf.org, jmongardini@imf.org

Contents **Page**

I. INTRODUCTION

This paper assesses the effectiveness of countercyclical buffers (CCBs) and loan-to-value (LTV) limits for mitigating the risk and costs of financial crises. For this purpose, we use a version of the MAPMOD model augmented by an explicit housing sector.[1]

MAPMOD departs from the traditional loanable funds model. It assumes that bank lending is not constrained by loanable funds, but by the banks' own expectations about future profitability and banking regulations. In MAPMOD, the banking system may create purchasing power and facilitate efficient resource allocation when there are permanent improvements in the economy's growth potential. However, the possibility of excessively large and risky loans, not justified by growth prospects, also exists.[2] These risky loans can ultimately impair bank balance sheets and sow the seeds of a financial crisis. Banks respond to losses through higher spreads and sharp credit cutbacks, with adverse effects for the real economy. These features of MAPMOD capture key facts of financial cycles, like the correlations of bank credit with the business cycle and with asset prices (Brei and Gambacorta, 2014; Mendoza, 2010; Mian and Sufi, 2010; and Wong, 2012).

MAPMOD has significant non-linearities in the banks' response toward regulatory capital and individual borrowers' creditworthiness. At an overall balance sheet level, the pricing of loans increases exponentially as banks get closer to their minimum capital-adequacy ratios (loan portfolio supply curve). Via this mechanism, banks remain compliant with minimum capital-adequacy ratios (CAR), and thus avoid regulatory sanctions or supervisory intervention. At an individual loan level, banks charge increasingly higher interest rate spreads the higher the LTV ratio in order to compensate for the greater risk of default (individual lending supply curve). The interactions of these non-linearities can produce financial cycles and crises in line with the historical record. The most recent case in point would be the Global Financial Crisis of 2008-09 (Kindleberger and Aliber, 2011; Mian and Sufi, 2010 and 2015; Reinhart and Rogoff, 2009).

MAPMOD can account for good, as well as bad, credit expansions. As shown by Claessens, Ayhan and Terrones (2011), credit expansions may be justified by lower uncertainty or by future productivity improvements. Under these circumstances, banks' increased leverage may prove to be consistent with future fundamentals. Other credit cycles, however, may be based on a misjudgment about uncertainty or by excessive optimism about future productivity, forcing banks eventually to unleash a costly deleveraging process on the

---

[1] A full technical description of the structure and equations of the model will be documented in a forthcoming paper entitled "MAPMOD Mark II: Adding Countercyclical Buffers and Loan-to-Value Limits."

[2] The financial accelerator of Bernanke, Gertler, and Gilchrist (1999) and the leverage cycle of Geanakoplos (2010), Mendoza (2010) and Bianchi and Mendoza (2013) embody a similar process.

economy. This is consistent with the evidence that the recessions that follow financial crises have been especially damaging in terms of lost output (Cerra and Saxena, 2008; and Jorda, Schularick, and Taylor, 2012).

The MAPMOD Mark II model in this paper includes an explicit housing market, in which house prices are strongly correlated with banks' credit supply. This corresponds to the experience prior and during the Global Financial Crisis (Mian and Sufi, 2010 and 2015). This *deadly embrace* between bank mortgages, household balance sheets, and house prices can be the source of financial cycles. A corollary is that the housing market is only partially constrained by LTV limits as the additional availability of credit itself boosts house prices, and thus raises LTV limits. Conversely, during a downturn, the LTV limit tightens as house prices fall, thus accentuating the financial cycle. This result is similar in nature to the credit cycles of Kiyotaki and Moore (1997) and the leverage cycle of Geanakoplos (2010), Mendoza (2010), and Bianchi and Mendoza (2013). It differs, however, from the general equilibrium model developed by Goodhart and others (2012, 2013) as house prices in the latter are not endogenously determined and thus there is no externality arising from the interaction between mortgages, household balance sheets, and house prices.

From a policy perspective, our simulation results require a rethinking of LTV limits that takes into account their intrinsic procyclicality. We conclude that LTV limits should be based on a historical moving average of house prices over several years, rather than just on current market values to reduce such intrinsic procyclicality. We also analyze the interaction between CCBs and LTV limits during the financial cycle. While CCBs alone can be effective in reducing banks' credit expansion in an upturn and easing the credit crunch in a downturn, our simulations show that they are not sufficient in limiting the *deadly embrace*, given that they do not limit credit specifically to the housing sector. If used in conjunction with LTV limits, the use of a historical moving average of house prices to calculate LTV limits would help to reinforce the countercyclical nature of CCBs.

The rest of the paper is structured as follows. Section II discusses the current toolbox of macroprudential regulations, the experience implementing these regulations so far, and the rationale for MAPMOD as an analytical foundation to analyze the impact of these regulations on the behavior of banks and the macroeconomy. Section III sets out a non-technical summary of MAPMOD and its extension to the housing market. We present a partial equilibrium analysis of banks, households, and the housing market. We then bring the pieces together in a consistent general equilibrium framework. Section IV applies MAPMOD to two types of macroprudential policy, namely CCBs and LTV limits. Section V summarizes the policy conclusions.

II. MACROPRUDENTIAL REGULATIONS

The financial history of the last eight centuries is replete with devastating financial crises, mostly emanating from large increases in financial leverage (Reinhart and Rogoff, 2009).

The latest example, the Global Financial Crisis of 2008-09, saw the unwinding of a calamitous run-up in leverage by banks and households associated with the housing market (Mian and Sufi, 2010 and 2015). As a result, the financial supervision community has acknowledged that microprudential regulations alone are insufficient to avoid a financial crisis. They need to be accompanied by appropriate macroprudential policies to avoid the build-up of systemic risk and to weaken the effects of asset price inflation on financial intermediation and the buildup of excessive leverage in the economy.

The Basel III regulations adopted in 2010 recognize for the first time the need to include a macroprudential overlay to the traditional microprudential regulations (Appendix I). Beyond the requirements for capital buffers, and leverage and liquidity ratios, Basel III regulations include CCBs between 0.0 and 2.5 percent of risk-weighted assets that raise capital requirements during an upswing of the business cycle and reduce them during a downturn. The rationale is to counteract procyclical-lending behavior, and hence to restrain a buildup of systemic risk that might end in a financial crisis. Basel III regulations are silent, however, about the implementation of CCBs and their cost to the economy, leaving it to the supervisory authorities to make a judgment about the appropriate timing for increasing or lowering such buffers, based on a credit-to-GDP gap measure. This measure, however, does not distinguish between good versus bad credit expansions (see below) and is irrelevant for countries with significant dollar lending, where exchange rate fluctuations can severely distort the credit-to-GDP gap measure.

One of the limitations of Basel III regulations is that they do not focus on specific, leverage-driven markets, like the housing market, that are most susceptible to an excessive build-up of systemic risk. Many of the recent financial crises have been associated with housing bubbles fueled by over-leveraged households. With hindsight, it is unlikely that CCBs alone would have been able to avoid the Global Financial Crisis, for example.

For this reason, financial supervision authorities and the IMF have looked at additional macroprudential policies (IMF, 2014a and 2014b). For the housing market, three additional types of macroprudential regulations have been implemented: 1) sectoral capital surcharges through higher risk weights or loss-given-default (LGD) ratios;[3] 2) LTV limits; and 3) caps on debt-service to income ratios (DSTI), or loan to income ratios (LTI).

Use of such macroprudential regulations has mushroomed over the last few years in both advanced economies and emerging markets (IMF 2014b). At end-2014, 23 countries used sectoral capital surcharges for the housing market, and 25 countries used LTV limits. An additional 15 countries had explicit caps on DSTI or LTI caps. The experience so far has

[3] The LGD ratio is the share of the loan that is lost when a debtor defaults. The LGD ratios applied to different types of asset enter the calculation of risk-weighted assets. Thus, an increase in LGD ratios for a given loan portfolio would imply an increase in risk-weighted assets—and therefore an increase in required capital.

been mixed. Cerruti, Claessens and Laeven (2015) in a sample of 119 countries over the 2000-13 period find that, while macroprudential policies can help manage financial cycles, they work less well in busts than in booms. This result is intuitive in that macroprudential regulations are generally procyclical and can therefore be counterproductive during a bust when bank credit should expand to offset the economic downturn.

Macroprudential regulations are often directed at restraining bank credit, especially to the housing market. They do not, however, take into account the tradeoffs between mitigating the risks of a financial crisis on the one side and the cost of lower financial intermediation on the other. In addition, given that these measures are generally procyclical, they can accentuate the credit crunch during busts. More generally, an analytical foundation for analyzing these tradeoffs has been lacking, with the notable exceptions of Goodhart and others (2012, 2013), and Bianchi and Mendoza (2013). MAPMOD has been designed to help fill this analytical gap and to provide insights for the design of less procyclical macroprudential regulations.

III. A Non-Technical Presentation of MAPMOD

A. MAPMOD, Mark I

The starting point of the MAPMOD framework is the factual observation that, in contrast to the loanable funds model, banks do not wait for additional deposits before increasing their lending. Instead, they determine their lending to the economy based on their expectations of future profits, conditional on the economic outlook and their regulatory capital. They then fund their lending portfolio out of their existing deposit base, or by resorting to wholesale funding and debt instruments. Banks actively seek new opportunities for profitable lending independently of the size or growth of their deposit base—unless constrained by specific regulations.

This observation has significant repercussions for the role of banks in the economy. While banks in the loanable funds model provide passive intermediation between saving and investment, in MAPMOD they contribute directly to consumption and investment demand by providing the means to increase leverage in the economy on the expectation of future income and productivity growth. If banks' expectations materialize, the economy is better off and banks get paid back their loans. This we refer to as a good credit expansion. If, however, the economy does not produce the expected income and productivity growth, loans will turn non-performing, and banks will later need to cut bank on their lending through a process of deleveraging. We refer to this as a bad credit expansion. Ex-ante, however, banks (and other agents in the economy) do not know whether the economy is in a good or bad credit expansion. If banks' are especially over-optimistic during an upswing, their lending behavior can turn a bad credit cycle into a full financial crisis.

MAPMOD can capture the distinction between good and bad credit expansion. The model comprises sectors for households, local producers, exporters, banks, the central bank, and the rest of the world. Borrowers use bank loans to finance consumption and investment expenditures, using their assets (physical capital, housing, stocks) as collateral. Ex post, defaults are a function of asset prices, which are driven by both common and idiosyncratic risks. Banks cannot fully diversify these risks, which therefore remain in part on their balance sheet.

Banks' behavior is driven by their assessment of the risk/return tradeoffs, and subject to regulatory constraints. In particular, a bank's ability to expand its balance sheet is limited by its own capital and regulations. The bank needs to ensure that its regulatory capital will be above the mandated minimum capital-adequacy ratio (CAR), regardless of the potential risks to its balance sheet. Hence, banks seek ex-ante to establish sufficient capital buffers—over and above the minimum CAR—to avoid regulatory sanctions or supervisory intervention ex-post. In the limit, enforcement may involve closure of the bank.

In MAPMOD, a bank makes decisions at two levels. First, it decides the optimal size of its loan portfolio, given its own expectations about future profitability and the risk absorption capacity of the bank's capital. In the real world, this is equivalent to the bank's annual budget cycle where bank management sets growth targets for the loan portfolio, subject to the desired capital buffers. Second, the bank assesses each potential borrower (and his/her assets) for creditworthiness. The parallel in the real world is for the loan to be assessed against the bank's risk matrix, and then approved by a credit risk committee.

Decisions at both levels are driven by non-linearities. A bank chooses its *optimal loan portfolio curve* as a function of lending spreads and minimum CARs. The closer the bank's capital is to the minimum required, the higher is the lending spread for additional loans. At the same time, the bank chooses its *individual lending supply curve* as a function of the lending spread and the LTV ratio for an individual loan applicant. The higher the LTV ratio, the wider the lending spread charged to individual customers. Both the *optimal loan portfolio curve* and the *individual lending supply curve* are shown in Figure 1.

The bank's loan decisions critically depend on their expectations about the future. On the one hand, if a bank is overly conservative about the potential productivity improvements in the economy, it may lose market share against competitors. On the other hand, if a bank is overly optimistic about the future, it may experience a relatively larger increase in its loan portfolio during the upswing of the business cycle only to be faced later by a higher level of NPLs and a stronger requirement to deleverage during the downturn. If the whole banking sector is overly optimistic about the future, this induces a shift in the individual lending supply curves, and an underpricing of systemic risk in the banking sector (Figure 2). When banks eventually become aware of the extent of the risk on their balance sheets, they deleverage, causing a slowdown or contraction in economic activity.

Figure 1. Non- Linearities in Bank Lending Behavior

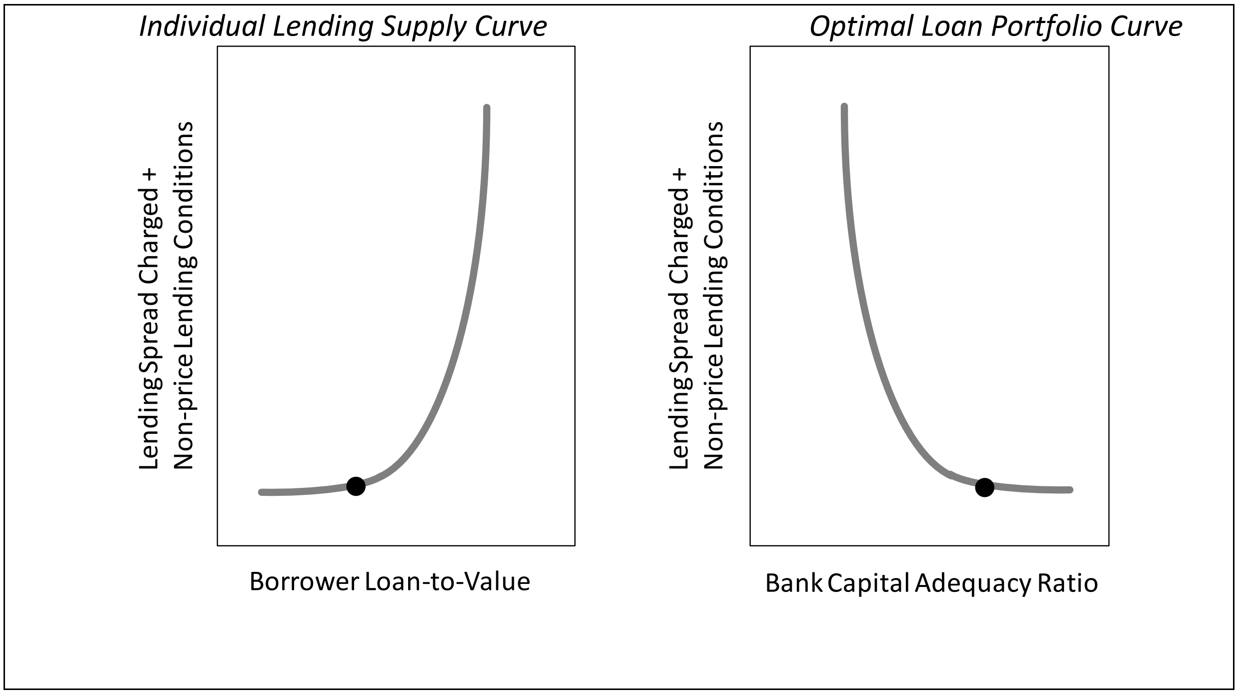
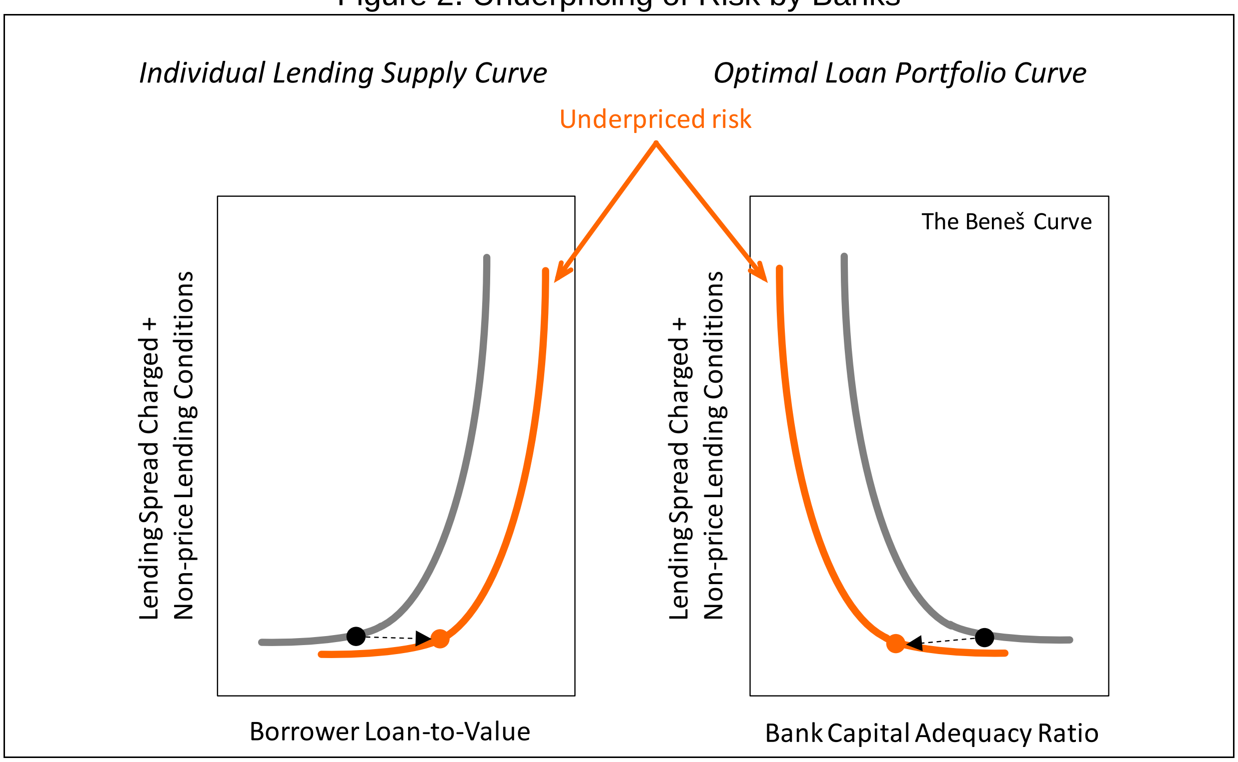


Figure 2. Underpricing of Risk by Banks



The good versus bad credit cycle in MAPMOD can best be demonstrated through a series of simulations (Figure 3). In these simulations, we assume that banks ex-ante expect a significant boost in productivity in the economy. As a result, they increase their lending at time 0. If the productivity boost is confirmed, the economy grows faster as a result and banks get repaid their loans over time (good credit expansion). If productivity, however, turns out lower than expected, banks will face higher NPLs (bad credit expansion). When the inevitable downturn arrives, banks are forced to deleverage to reestablish their optimal capital-adequacy ratio, and repair the capital losses associated with higher NPLs. In the worst-case scenario, where banks underprice the risk of their lending, the downturn can be severe and lead to a recession (bad credit expansion with overly optimistic banks).

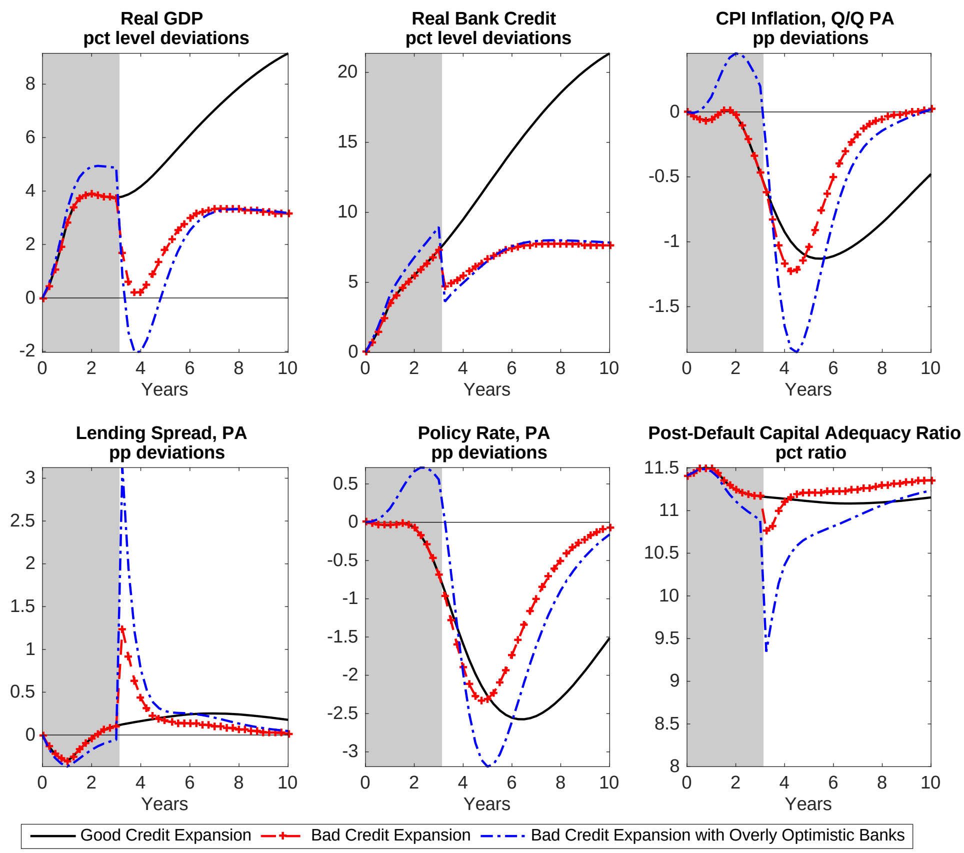
B. MAPMOD, Mark II

In MAPMOD, Mark II, we extend the original model by introducing an explicit housing market. We use the modular features of the model to analyze partial equilibrium simulations for banks, households, and the housing market, before turning to general equilibrium results. This incremental approach sheds light on the intuition behind the model and simulation results.

The housing market is characterized by liquidity-constrained households that require financing to buy houses. A house is an asset that provides a stream of housing services to households. The value of a house to each household is the net present value of the future stream of housing services that it provides plus any capital gain/loss associated with future changes in house prices. We define the *fundamental house price* households are willing to pay to buy a house the price that is consistent with the expected income/productivity increases in the economy. If prices go above the *fundamental house price* reflecting excessive leverage, we refer to this as an *inflated house price*. The supply of houses for sale in the market is assumed to be fixed each period. House prices are determined by matching buyers and sellers in a recursive equilibrium with expected house prices taken as given. We abstract from many real-world complications such as neighborhood externalities, geographical location, square footage or other forms of heterogeneity.[4]

[4] We are aware that this is a strong assumption that does not match the real world. In fact, Mian and Sufi (2015) provide ample evidence of entire neighborhoods in the United States being affected by foreclosures during the Global Financial Crisis. We plan to model a concept of neighborhood externality in future research.

Figure 3. Good vs. Bad Credit Cycles



Source: Authors' simulations.

Households with different and endogenously-determined down payments (and hence LTV ratios) apply for long-term fixed-interest rate mortgages.[5] Each household faces the individual lending supply curve of the financing bank, defining combinations of the lending rate and loan volumes. The household's own economic conditions define its point on the curve (i.e. an intersection of credit supply and credit demand curves).

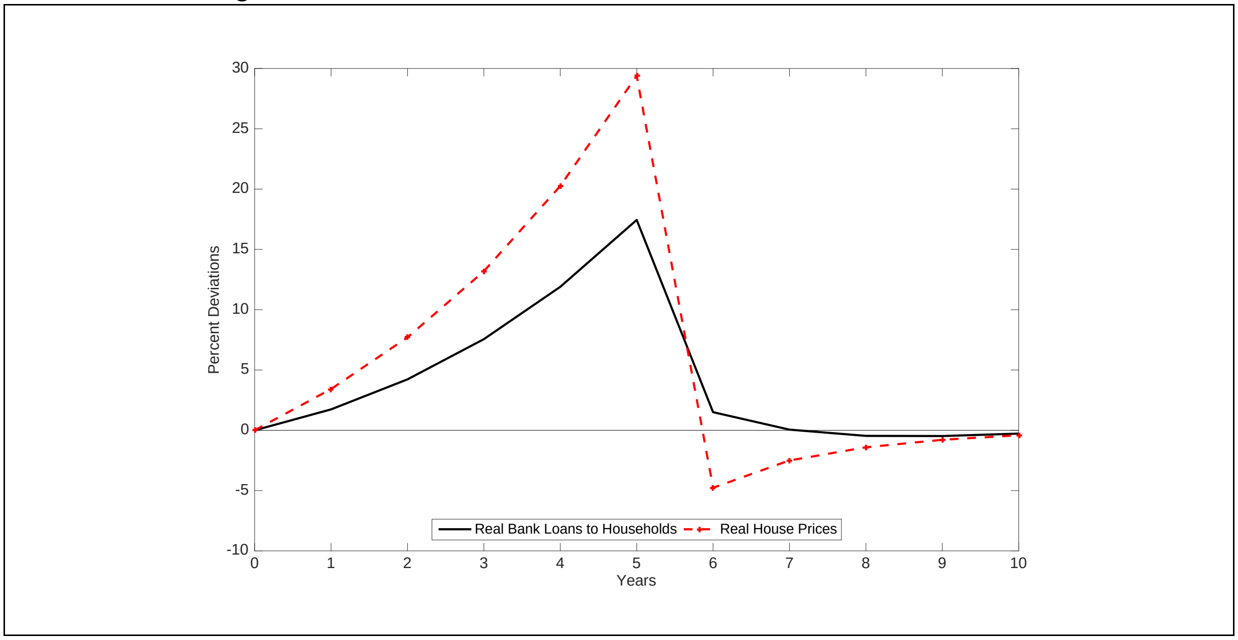
The probability of a household defaulting on the loan later into the lifetime of the loan is driven by a combination of the LTV and LTI ratios. These indicators therefore determine the riskiness of each borrower. Banks, aware of the market value of the house, are able to evaluate the probability of default for each mortgage and price it accordingly. They do not

[5] In this paper, we consider only fixed-rate mortgages for simplicity. In future research, we plan to apply the same model to variable-rate mortgages, where the interest rate risk is shifted from banks to households.

know ex-ante, however, whether any particular household will default on its loan. They only discover ex-post whether a borrower is able to repay. Cost of foreclosure is included in an LGD parameter, fixed at 0.25 in our simulations. So, if a borrower forecloses on a loan with outstanding balance of 100,000, the bank is only able to recover 75,000 in our baseline calibration.

Bank financing plays a critical role in the determination of house prices in the model. If banks provide a larger amount of mortgages on an expectation of higher household income in the future, demand for housing will go up, thus inflating house prices. Conversely, if banks reduce their loan exposure to the housing market, demand for houses in the economy will be reduced, leading to a slump in house prices. House prices therefore move with the credit cycle in MAPMOD, Mark II, just as in the real world, as shown in the simulation in Figure 4.

Figure 4. Co-movements in Bank Credit and House Prices



Source: Authors’ simulations.

Nonperforming loans and foreclosures in the housing market occur when households are faced with an idiosyncratic, or economy-wide, shock that affects their current LTV or LTI characteristics. Banks will seek to reduce the likelihood of losses by requiring a sufficiently high LTV ratio to cover the cost of foreclosure. But they will not be able to diversify away the systemic risk of a general fall in house prices in the economy. Securitization of mortgages in MAPMOD is not allowed. And even if banks were able to securitize mortgages, other agents in the economy would need to carry the systemic risk of a sharp fall in house prices. At the economy-wide level, the systemic risk associated with the housing market is therefore not diversifiable. The evidence from the Global Financial Crisis on securitization and credit default swaps confirms that this is the case, regardless of who holds mortgage-backed securities.

Partial Equilibrium Analysis for Banks

In this section, we look at the equilibrium for a single bank in the model, while keeping the rest of the economy unchanged. In particular, a bank does not internalize the effects of its lending behavior on house prices in the economy and thus takes house prices as exogenous.

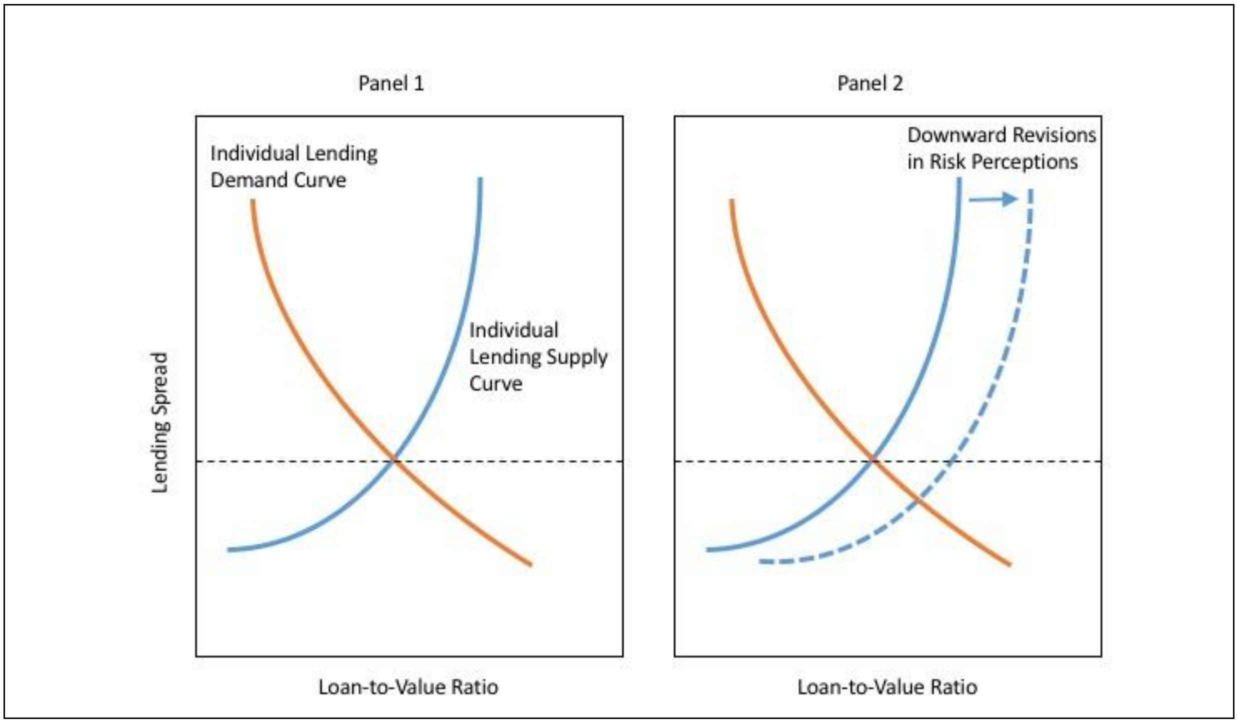
From a bank's perspective, the optimal choice is to lend to the housing sector as long as the expected return on an additional mortgage (conditional on the probability of default) is higher than the marginal cost of funds plus the marginal cost of maintaining the optimal capital adequacy ratio.[6] Value at risk is determined by the likelihood of default times the difference between the loan value and the recovery rate on the house price. As the LTV ratio rises, the bank will require higher spreads to approve a mortgage in order to offset the higher value at risk. This gives rise to the bank's own *individual lending supply curve* shown in Figure 1.

On the demand side, households apply for mortgages based on their choice of housing and their endogenously-determined down payments as explained above. They therefore demand mortgages based on different LTV ratios that make them more or less likely to default on their mortgages. In turn, they may reduce the spread charged on their mortgage by raising their down payment (reducing their LTV ratio). A bank's optimal lending will therefore be where demand and supply for mortgages meet in the LTV/spread space (Figure 5, Panel 1).

Missing from this partial equilibrium analysis is that, in a general equilibrium context, banks' own lending can affect house prices. As shown in Figure 4 above, if all banks increase lending to the housing sector at the same time, house prices will start rising. This will increase the incentives for banks to lend to the housing sector as mortgage demand rises on expectations of higher future house prices. Their internal calculations of the value at risk will fall. Banks may therefore be willing to shift their lending supply curve, with a higher LTV ratio for a given spread. If all banks do the same, house prices will become inflated and thus systemic risk in the economy increases (Figure 5, Panel 2). We will come back to this point in the general equilibrium analysis below.

[6] The marginal cost of maintaining the capital adequacy ratio can implicitly be thought of the opportunity cost of lending to other sectors of the economy on a risk adjusted basis. In future research, we plan to make this trade-off with other sectors of the economy explicit.

Figure 5. Bank Lending Demand and Supply



Partial Equilibrium Analysis for Households

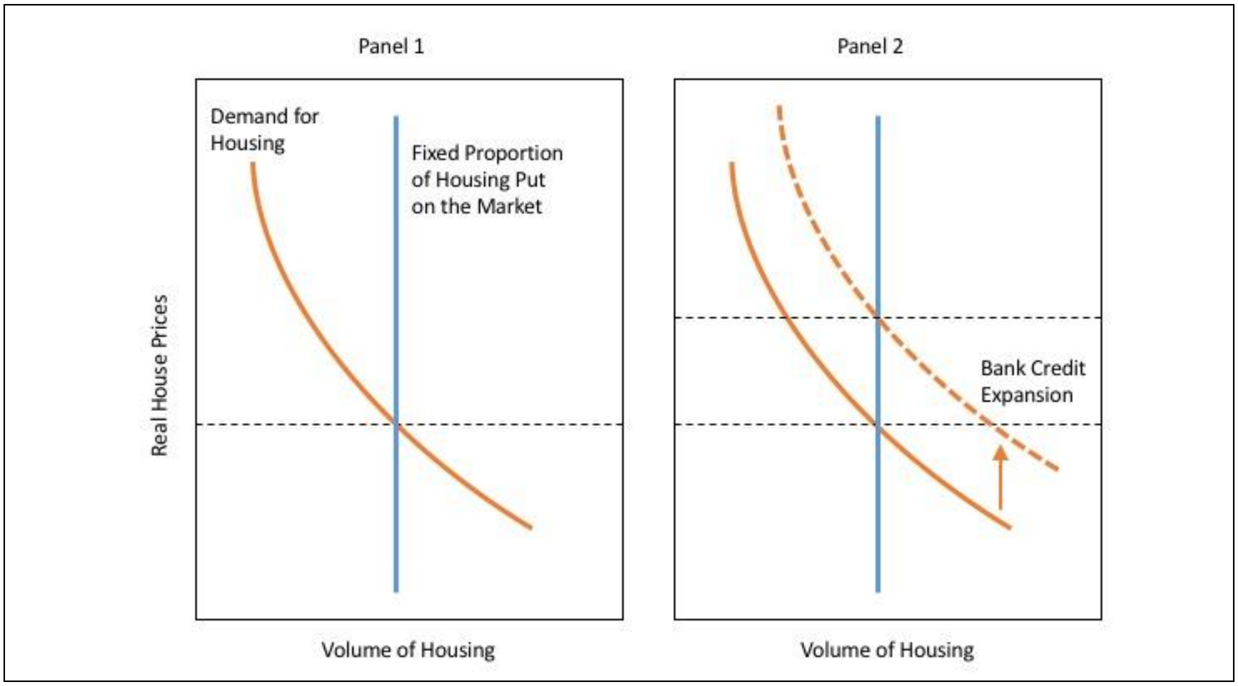
Households buy houses for the expected capital gains and the housing services they provide. The higher the expected increase in house prices in the future, the higher will be the house price that households are willing to pay today and thus the greater the demand for housing. Households may therefore be willing to buy houses at *inflated prices*, because of the expected capital gain in a house-price bubble scenario.

In MAPMOD, Mark II, we assume that expectations of house prices are rational, based on the limited time horizon that households use to make decisions in an uncertain environment. In forming their expectations, households take the banks' lending behavior as given, and do not take into account the impact of a potential bank deleveraging scenario on future house prices.

Household demand for housing is thus linked to banks' willingness to lend in two ways. First, households need mortgages from banks because they are liquidity constrained. Without mortgages, households would not be able to finance the purchase of a house. Second, household expectations for future house prices depend on expectations of bank lending to the housing sector. We call this symbiotic relationship between household demand and bank lending the *deadly embrace*—it creates the housing boom and bust that we will see later in the general equilibrium context.

In a partial equilibrium context, the intersection between the fixed vertical supply curve of housing and the downward sloping demand curve will determine the equilibrium price for houses (Figure 6, Panel 1). If banks increase lending to the housing sector, the expected future increase in house prices will rise (Figure 6, Panel 2), implying an increase in current demand for housing and thus a higher *inflated equilibrium price*. This correlation between bank lending, house prices, and demand for housing illustrates the *deadly embrace* discussed above.

Figure 6. Housing Demand and Supply

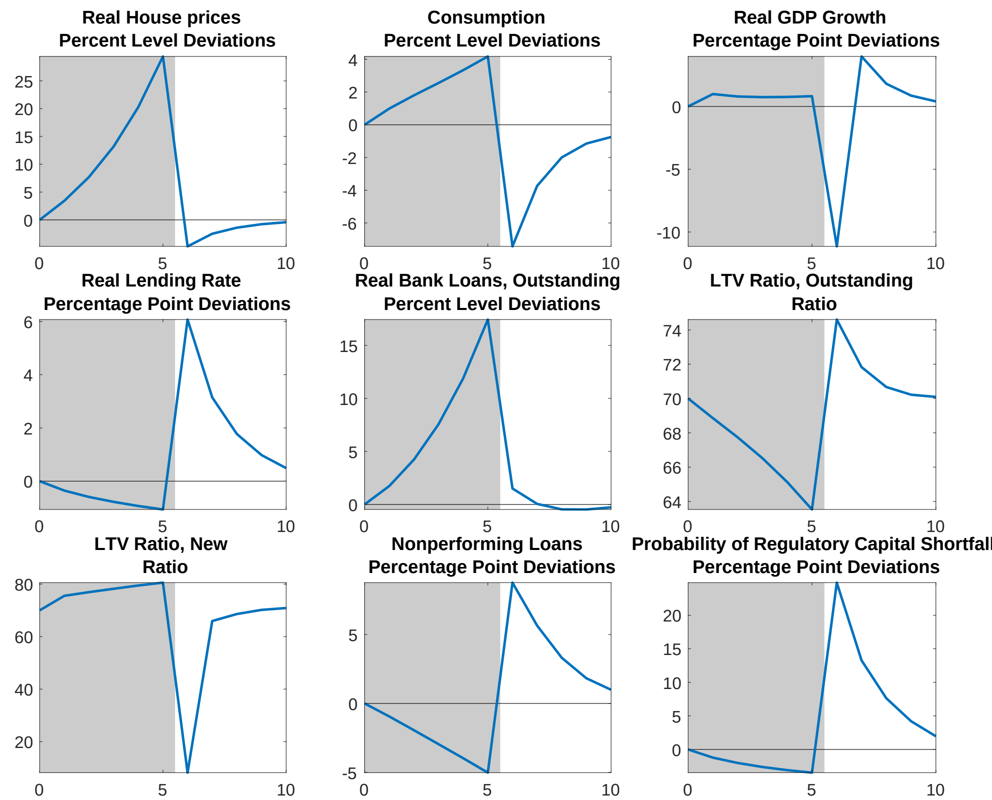


Putting the Pieces Together: The General Equilibrium Story

This *deadly embrace* becomes even more evident in a dynamic general equilibrium context. The interaction between bank lending behavior and household demand for housing has the potential to inflate house prices over time in a spiral unrelated to fundamental economic conditions. The bubble will ultimately burst when leverage in the economy reaches a point that is clearly excessive, and banks re-price the risk associated with housing market—perhaps at the behest of the regulators.

The starting point for this housing bubble can originate from a positive shock to the economy or a lowering of risk standards by banks. Whichever the culprit, demand for housing or bank lending to the housing sector will start rising relative to the initial steady state. As a result, *inflated house prices* will encourage households to increase their demand for houses, and banks to lend more to the sector. This positive feedback mechanism will reinforce the upward pressure on house prices, demand for houses, and bank lending. This process represents a self-fulfilling housing bubble. The model simulations in Figure 7 illustrate the process.

Figure 7. House Price Bubble and Burst



Source: Authors' simulations.

The bubble in these simulations would not be identified as such by standard financial soundness indicators. The increase in lending to the housing sector leads to a significant rise in real bank loans over the first five years of the simulations. This is accompanied by higher housing demand and thus an increase in real house prices over the same period. In turn, this increase in real house prices fuels private consumption through a wealth effect and thus growth in the economy. The increase in net lending is driven by what does not look like a more aggressive lending policy by the banks—indeed, the average LTV ratio for outstanding loans declines (although the LTV ratio on new loans rises). In addition, non-performing loans are declining, due to the large increase in new loans, which are by definition performing. Moreover, the capital adequacy of the banks is increasing through rising profitability. Banking supervisors would miss the increase in leverage in the economy if they looked just at these standard financial soundness indicators. The rapid increase in bank lending to the housing sector, and the consequent increase in prices, gives a more accurate warning signal. This is why the IMF is advocating the use of increases in mortgage credit and asset prices *jointly* as core indicators for the activation of LTV type measures (IMF, 2014b).

Once banks reassess their risk exposure to the housing sector, the impact on the economy can be severe. The reassessment in our simulations happens in year 5, when banks drastically cut their lending to the housing sector and hike their rate spreads. House prices collapse and new bank lending virtually stalls. This, in turn, leads to a severe recession, driven by the negative wealth effect on consumption of lower expected house prices in the future. Note also that standard financial soundness indicators jump, including NPLs and the average LTV ratios on outstanding loans. The losses from the jump in NPLs represent a decline in capital adequacy that will take time to restore through the process of deleveraging. Overall, these simulations show that the deadly embrace can be very costly for the economy.

IV. Macroprudential Policy to Mitigate the Deadly Embrace

Macroprudential policies that limit the *deadly embrace* between bank lending, house prices and household demand for housing would reduce economic instability. To the extent that neither banks nor households take into account the negative impact of their behavior on house prices, systemic risk slowly builds up in the economy during a housing bubble that can have devastating consequences for the economy when the bubble bursts. The existence of this externality provides an a priori case for appropriate regulatory controls.[7]
What specific controls would be effective? The answer would depend on specific circumstances for each economy. We focus on LTV limits and CCBs as ways to mitigate the risk of housing bubbles—but do not mean to imply that these are necessarily better than other options.

A. LTV Limits

In the simulations above, banks' underpricing of risk leads to an increase in LTV ratios for the same level of spreads. Such behavior has been widely documented prior to the Global Financial Crisis of 2008–09.

The rationale for LTV limits would be twofold. First, if they are sufficiently low, they would prevent banks from excessive exposures to individual borrowers. Second, they create an equity buffer against defaults, since house prices could fall by the equivalent of the equity buffer before the value of the house is underwater, namely below the loan value. The cost of LTV limits is that they limit mortgage lending to households that do not have a sufficiently

[7] Bianchi and Mendoza (2013) formally derive this externality as the difference between the decentralized equilibrium where agents do not internalize the impact of their actions on prices and a social planner optimization where the externality is taken into account. This leads the authors to argue for a state-contingent tax on borrowing as the optimal macroprudential policy. The authors, however, recognize the difficulty of implementing such a tax, given the uncertainty about the state of the economy.

large down payment to meet the limit. First-time house buyers, normally younger households, would be particularly affected.

Our simulations show that LTV limits based on the current value of a house can dampen excessive lending behavior by the banks, but they are highly procyclical (Figure 8). During the housing bubble, the LTV limit would reduce some of the increase in credit to the household sector compared with the no-policy scenario. However, as house prices rise, the limit becomes less binding on lending to the marginal borrower as the value of the house increases. Conversely, once the housing bubble bursts, the decline in house prices makes the LTV limit ever more binding, implying that banks cannot restore their lending as quickly as under the no-policy scenario. This implies that the recession induced by the bursting of the housing bubble is more prolonged.

The pro-cyclicality of the LTV limits could be substantially reduced by basing them on a moving average of house prices. In an alternative simulation, we base the LTV limit on the moving average of the last 5 years of house prices.[8] Using this moving average of the value of the house significantly dampens the procyclicality of the LTV limits, reduces the swings in house prices, bank lending, and consumption. More importantly, it leads to a faster recovery in lending and thus in consumption and growth once the housing bubble bursts. In fact, in our simulations, the cumulative consumption gap under the 5-year moving average LTV limit is always higher after ten years than under the standard LTV limit or the no-policy scenario (Figure 9).

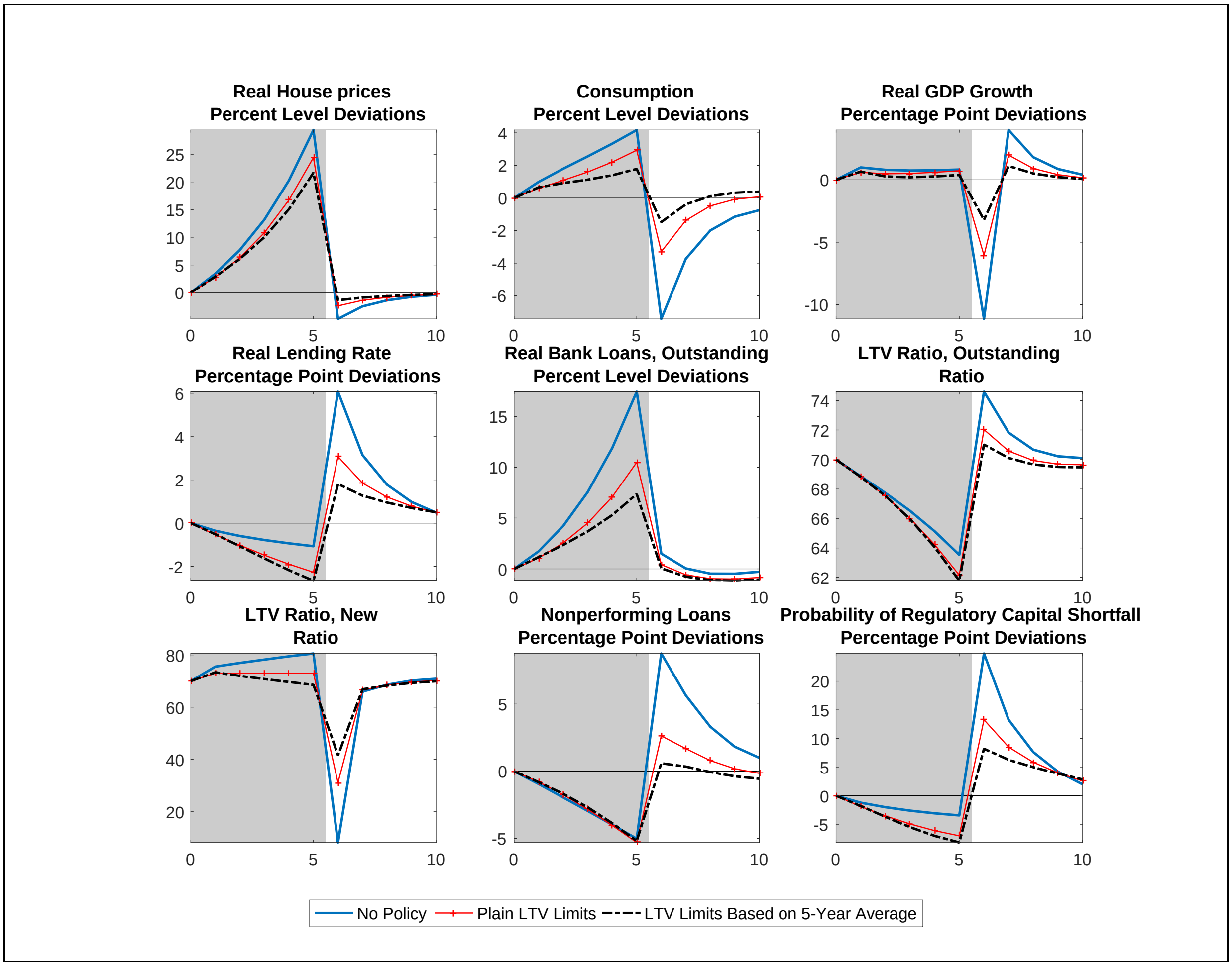
B. CCBs

CCBs can be another macroprudential policy to reduce the *deadly embrace*. If CCBs are raised during the upswing in house prices, banks would need to limit their lending in order to maintain the regulatory minimum capital buffer. Conversely, a reduction in CCBs after a housing bubble has burst would facilitate a recovery in credit, and make the post-bubble recession less severe. In our simulations, however, CCBs alone are ineffective at reducing bank lending during the upswing in real house prices, and they do little to dampen the positive impact on consumption and growth (Figure 10). The boom-crash cycle is only slightly moderated.

---

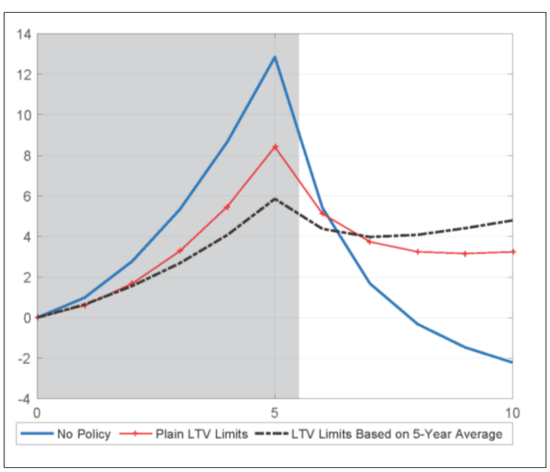
[8] This could easily be done in the United States where houses are subject to annual value assessments for the purpose of real estate taxes. In other countries, it may be more difficult for banks to have access to a time series of the price of the house being financed. However, this could be approximated by multiplying the current price of the house by the most relevant available index of house prices for the city or country where the house is located.

Figure 8. House Price Bubble and Burst with LTV Limits



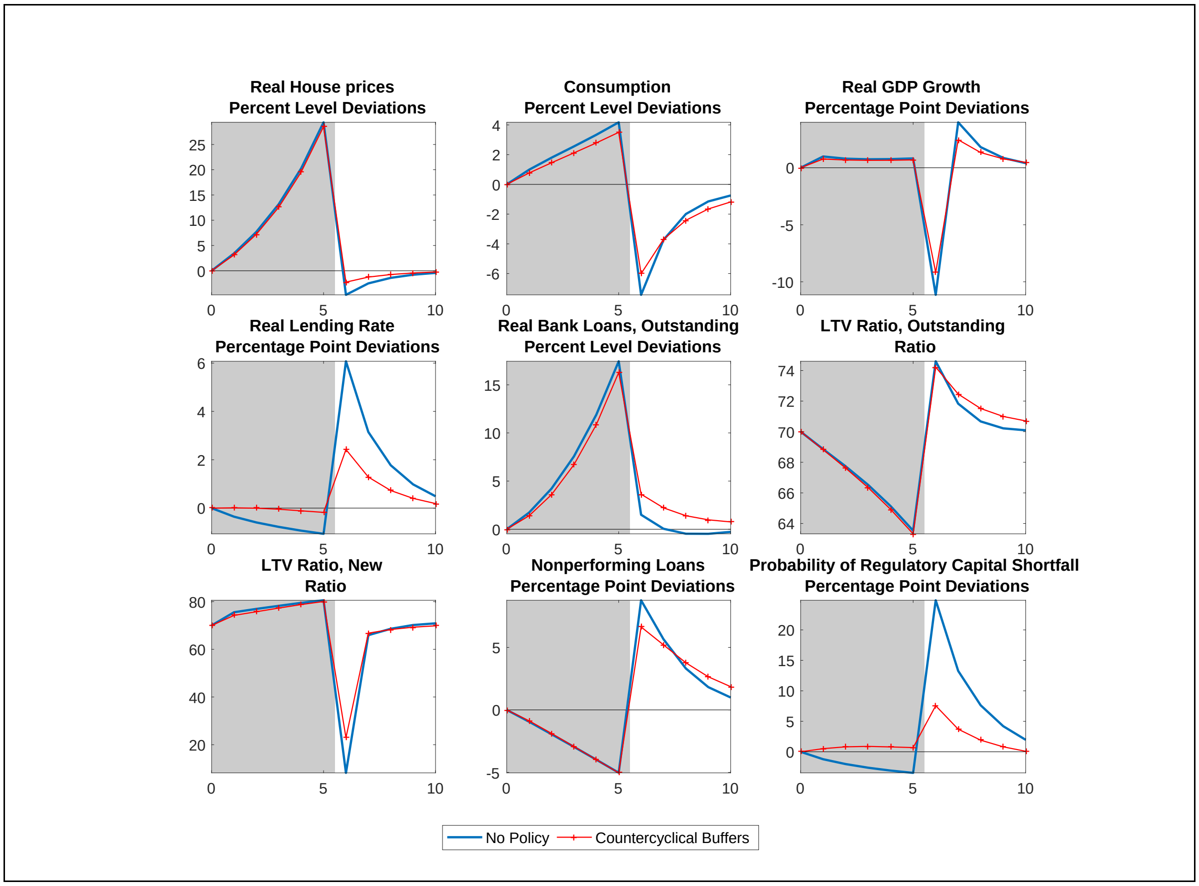
Source: Authors' simulations.

Figure 9. Cumulative Consumption Gaps
(Cumulative Percent Level Deviations)



Source: Authors' simulations.

Figure 10. House Price Bubble and Burst with Countercyclical Buffers



Source: Authors' simulations.

One problem with CCBs from the viewpoint of the model is that they are not sector specific. Whereas the problem of instability originates in the housing sector, CCBs impinge on all sectors. As a result, systemic risk could still build up in the housing sector at the expense of lower intermediation in other sectors of the economy, which would be the worst of both worlds. CCBs alone are therefore not necessarily the solution to resolve the *deadly embrace.* This result also confirms the empirical evidence that CCBs are insufficient to avoid future financial crises stemming from housing bubbles (IMF, 2014a and 2014b). This is why the IMF has been advocating additional "demand-side tools," such as LTV limits and DSTI caps.

C. A Combination of LTV Limits and CCBs

The problem with LTV limits is their procyclicality. Even if they are accompanied with CCBs, they may constrain the banks' lending in a downturn, such that the relaxation of CCBs becomes ineffective in increasing banks' lending. In fact, banks may not expand lending to the housing sector, because of the constraint originating from falling house prices. As such, the release of CCBs after a housing bust may aid other sectors, but would not directly mitigate the impact of lower lending on house prices. If LTV limits are to be used with CCBs, they would again have to be based on a moving average of house prices, so as to reduce their procyclicality as shown in the simulations. The release of CCBs would aid only to the extent that capital buffers were close to the regulatory minimum CAR as in the simulations.

Overall, a combination of LTV limits on mortgages based on a moving average of house prices and CCBs is likely to mitigate (but not eliminate) the *deadly embrace.* Additional macroprudential policies may also be needed, including DSTI or LTI caps. However, it is also important to recognize that all these macroprudential policies come at a cost of reducing financial intermediation. They therefore dampen both good and bad credit cycles in the housing market.

V. Policy Conclusions

This paper presented a new version of MAPMOD (Mark II) to study the effectiveness of macroprudential regulations. We extend the original MAPMOD by explicitly modeling the housing market. We show how lending to the housing market, house prices, and household demand for housing are intertwined in the model in a what we call a *deadly embrace*. Without macroprudential policies, this naturally leads to housing boom and bust cycles. Moreover, leverage-driven cycles have historically been very costly for the economy, as shown most recently by the Global Financial Crisis of 2008–09.

Macroprudential policies have a key role to play to limit this *deadly embrace*. The use of LTV limits for mortgages in this regard is ineffective, as these limits are highly procyclical, and hold back the recovery in a bust. LTV limits that are based on a moving average of historical house prices can considerably reduce their procyclicality. We considered a 5 year moving average, but the length of the moving average used should probably vary based on the specific circumstances of each housing market.

CCBs may not be an effective regulatory tool against credit cycles that affect the housing market in particular, as banks may respond to higher/lower regulatory capital buffers by reducing/increasing lending to other sectors of the economy.

A combination of LTV limits based on a moving average and CCBs may effectively loosen the *deadly embrace.* This is because such LTV limits would attenuate the housing market credit cycle, while CCBs would moderate the overall credit cycle. Other macroprudential policies, like DSTI and LTI caps, may also be useful in this respect, depending on the specifics of the financial landscape in each country. It is, however, important to recognize that all these macroprudential policies come at a cost of dampening both good and bad credit cycles. The cost of reduced financial intermediation should be taken into account when designing macroprudential policies.

References

Benes, J., Michael Kumhof, and Douglas Laxton, 2014a, "Financial Crises in DSGE Models: Selected Applications of MAPMOD," IMF Working Paper, 14/56

Benes, J., Michael Kumhof, and Douglas Laxton, 2014b, "Financial Crises in DSGE Models: A Prototype Model," IMF Working Paper, 14/57.

Bernanke, B., Mark Gertler and Simon Gilchrist, 1999, The Financial Accelerator in a Quantitative Business Cycle Framework, in J.B. Taylor and M. Woodford (Eds.), *Handbook of Macroeconomics*, Volume 1c, Elsevier Science, North-Holland, Amsterdam.

Bianchi, J. and Enrique G. Mendoza, 2013, "Optimal Time-Consistent Macroprudential Policy," NBER Working Paper No. 19704.

Brei, M. and Leonardo Gambacorta, 2014, "The Leverage Ratio Over the Cycle," BIS Working Paper No 471, available at http://www.bis.org/publ/work471.pdf

Cerra, V. and Sweta Chaman Saxena, 2008, "Growth Dynamics: The Myth of Economic Recovery," American Economic Review, 98(1): pp. 439–57.

Cerruti, E., Stijn Claessens and Luc Laeven, 2015, "The Use and Effectivess of Macroprudential Policies: New Evidence, IMF Working Paper, 15/61, available at http://www.imf.org/external/pubs/ft/wp/2015/wp1561.pdf

Claessens, S., M. Ayhan Kose, and Marco Terrones, 2009, "What Happens During Recessions, Crunches and Busts?," *Economic Policy*, 24, pp. 655–700.

Claessens, S., M. Ayhan Kose and Marco Terrones, 2011, "How Do Business and Financial Cycles Interact?," IMF Working Paper, 11/88, available at https://www.imf.org/external/pubs/ft/wp/2011/wp1188.pdf

Day, R., 1969, "Flexible Utility and Myopic Expectations in Economic Growth," Oxford Economic Papers, Vol. 21, No. 3, November, pp. 299–211.

Geanakoplos, J., 2009, "The Leverage Cycle," in NBER Macroeconomic Annual, Volume 24, University of Chicago Press, pp. 1–65.

Goodhart, C. A. E., Anil K. Kashyap, Dimitrios P. Tsomocos, and Alexandros P. Vardoulakis, 2012, "Financial Regulation in General Equilibrium," NBER Working Paper No. 17909, March.

Goodhart, C. A. E., Anil K. Kashyap, Dimitrios P. Tsomocos, and Alexandros P. Vardoulakis, 2013, "An Integrated Framework for Analyzing Multiple Financial Regulations," *International Journal of Central Banking*, Vol. 9, No. S1, January.

International Monetary Fund, 2014a, "Staff Guidance Note on Macroprudential Policy," Washington, D.C., December, available at http://www.imf.org/external/np/pp/eng/2014/110614.pdf

International Monetary Fund, 2014b, "Staff Guidance Note on Macroprudential Policy – Detailed Guidance on Instruments," Washington, D.C., December 2014, available at http://www.imf.org/external/np/pp/eng/2014/110614a.pdf.

Jorda, O., Moritz Schularick, and Alan M. Taylor, 2012, "When Credit Bites Back: Leverage, Business Cycles, and Crises, Federal Reserve Bank of San Francisco Working Paper 2011–27, October, available at http://www.frbsf.org/publications/economics/papers/2011/wp11-27bk.pdf

Kindleberger, C. P. and Robert Aliber, 2011, "Manias, Panics, and Crashes: A History of Financial Crises," Hoboken, New Jersey: John Wiley & Sons.

Kiyotaki, N. and John H. Moore, 1997, "Credit Cycles," *Journal of Political Economy*, Vol. 105, Chapter 2, pp. 211–248.

Mendoza, E. G., 2010, "Sudden Stops, Financial Crises, and Leverage," *American Economic Review*, Vol. 100, December, pp.1941–66.

Mian, A. and Amir Sufi, 2010, "The Great Recession: Lessons from Microeconomic Data," *American Economic Review*: Papers and Proceedings 100, May 2010, pp.51–56.

Mian, A. and Amir Sufi, 2015, "House of Debt: How They (and You) Caused the Great Recession, and How We can Prevent It from Happening Again," The University of Chicago Press.

Reinhart, C. M. and Kenneth Rogoff, 2009, "This Time is Different: Eight Centuries of Financial Folly," Princeton University Press.

Wong, Tak-Chuen, 2012, "Banking Procyclicality: Cross Country Evidence," Ph.D. Dissertation, University of Hong Kong, available at http://hub.hku.hk/handle/10722/161512

Appendix I – Basel III Regulations

This appendix summarizes the three pillars of the Basel III regulations, the liquidity standards and the phase-in arrangements approved by the Basel Committee on Banking Supervision of the Bank for International Settlements in 2010.[9] The main goal of the Basel III reforms is to strengthen microprudential regulation and supervision of the banks while adding a macroprudential overlay that includes capital buffers. In addition, Basel III regulations envisage higher capital buffers for global systemically important financial institutions (SIFIs) and domestic systemically important banks (DSIBs).

Pillar 1 – Capital and Risk Coverage

Pillar 1 of the Basel III regulations covers capital adequacy requirements, risk coverage and a leverage ratio. On capital adequacy requirements, the microprudential regulations mandated an increase to 4.5 percent of common equity as a percentage of risk-weighted assets by end-2014. In addition, a capital conservation buffer of 2.5 percent of risk-weighted assets is expected to be phased in over 2016–2019, bringing the total common equity to 7.0 percent of risk-weighted assets by 2019. At that time, the overall capital adequacy requirement will be 10.5 percent of risk-weighted assets.

The macroprudential overlay to these microprudential regulations is in the form of CCBs on top of the capital adequacy requirements. CCBs can range between 0.0 and 2.5 percent and can be adjusted at the authorities' discretion when they deem that excessive credit growth is resulting in an *unacceptable build up of systemic risk*. In other words, these buffers are expected to moderate excessive credit growth in boom cycles while mitigating the credit crunch during a downturn. Basel III regulations are silent, however, about the implementation of CCBs and their cost to the economy, leaving it to the supervisory authorities to make a judgment about the appropriate timing for increasing or lowering such buffers, based on a credit-to-GDP gap measure. This measure, however, does not distinguish between good versus bad credit expansions and is irrelevant for countries with significant dollar lending, where exchange rate fluctuations can severely distort the credit-to-GDP gap measure.

The Basel III regulations also envisage additional capital surcharges for SIFIs and DSIBs through a progressive common equity capital requirement of between 1.0 and 2.5 percent of risk-weighted assets. These surcharges are meant to protect the overall global and domestic financial system from a potential insolvency of a financial institution that could, by its systemic nature, affect the stability of the overall system.

---

[9] See http://www.bis.org/bcbs/basel3.htm

Pillar 1 of the Basel III regulations also changes certain aspects of the risk calculations and coverage of assets. These include the capital treatment for complex securitizations, higher capital charges for trading derivatives and securitized assets in trading books, more stringent requirements for counterparty credit risk, and a 2 percent risk weight for exposure to central counterparties (CCPs).

Finally, Pillar 1 also includes a leverage ratio to limit overall leverage of the financial institution. The leverage ratio, defined as tier 1 capital over total exposure, is required to be equal or above 3 percent. The leverage ratio is non-risk based and is calculated including off-balance sheet exposures.

Pillar 2 – Risk Management and Supervision

Pillar 2 adds to the regulations on risk management and supervision already introduced in Basel II, including the Internal Capital Adequacy Assessment Process (ICAAP). Basel III regulations require firm-wide governance and risk management capturing the risk of off-balance sheet exposures and securitization, managing risk concentrations, and providing incentives for banks to better manage risk and returns over the long term. They also introduce sound compensation practices, valuation practices, stress testing, and updated accounting standards for financial instruments, corporate governance and supervisory colleges.

Pillar 3 – Market Discipline

Pillar 3 covers market discipline as it pertains to financial disclosures. The disclosure requirements include securitization exposures and sponsorship of off-balance sheet vehicles, enhanced disclosures on the detail of the components of regulatory capital and their reconciliation to the reported accounts. They also require a comprehensive explanation of how a bank calculates its regulatory capital.

Liquidity Standards

Basel III regulations introduced two liquidity ratios for the first time as part of the new global liquidity standards: the liquidity coverage ratio (LCR) and the net stable funding ratio (NSF). The LCR is defined as the ratio of high quality liquid assets to total net liquidity outflows over 30 days. The LCR floor is being introduced incrementally starting at 60 percent in 2015 and reaching 100 percent by 2019. In addition, the regulations include a net stable funding (NSF) ratio, defined as stable funding (customer deposits plus long-term wholesale funding) over long-term assets. The proposal is to introduce a minimum standard by 2018, although there is no agreement yet on what that standard will be.

Beyond these two ratios, Basel III regulations introduce new principles for sound liquidity risk management and supervision, based on the lessons learnt during the global financial crisis, and a liquidity framework to assist supervisors in identifying and analyzing liquidity risk trends at both the bank and system-wide level.