The countercyclical capital buffer: A DSGE approach

Paulo Júlio
Banco de Portugal and CEFAGE

José R. Maria
Banco de Portugal

October 2019

Abstract
We address the stabilization performance of the Countercyclical Capital Buffer (CCyB) under distinct sources of expectation-driven business cycle fluctuations. Our environment is a Dynamic Stochastic General Equilibrium (DSGE) model for a small euro area economy. The model is endowed with a banking system where capital requirements and credit restrictions may trigger credit tightness and/or interest rate spread hikes. For fluctuation sources impacting a largely procyclical credit demand, the CCyB rule based on the credit-to-GDP gap is endowed with the proper stabilization timing and has important stabilization effects by alleviating the cost of credit of a fragile entrepreneurial sector. This is achieved at the expense of private consumption, depressed by the wealth reduction associated with the buffer build up. Under cycles affecting credit supply, the CCyB still plays a stabilization role but with milder effects as the entrepreneurial sector is more resilient and able to cope with interest rate spread hikes imposed by the banking sector. For fluctuation sources where credit is countercyclical the CCyB may have a destabilizing role, since the buffer is not released in the proper timing. (JEL: E32, E37, E44)

Introduction

The 2008 global financial crisis triggered a prolific debate on the interaction between the financial sector and the real economy. Undesirable loops associated with financial instability cast doubts on the quality of micro- and macro-prudential tools as a means to stabilize the business cycle. As a result, the economics profession started an extensive discussion on alternative ways to better cope with financial disturbances and ensure a more prominent macro-stability.[1]

Acknowledgements: We are grateful to Nuno Alves, João Amador, António Antunes, and to the Financial Stability Department of Banco de Portugal for precious comments and suggestions. Paulo Júlio acknowledges financial support from FCT—Portuguese Foundation for Science and Technology—within the project «UID/ECO/04007/2019». The analyses, opinions and findings of this paper represent the views of the authors, which are not necessarily those of Banco de Portugal or the Eurosystem.

E-mail: pfjulio@bportugal.pt; jrmaria@bportugal.pt

1. Policy challenges are often complex, multidimensional and with tradeoffs that are difficult to assess. For instance, there may exist a conflict between micro- and macro-prudential policies,

Policy goals also became more challenging as the zero lower bound on nominal interest rates rendered standard monetary policy reactions ineffective as a stabilization device. The new economic environment triggered a debate on how monetary and macro-prudential policies can interact with one another as a nationwide stabilizing device (Angelini *et al.* 2014; Clancy and Merola 2017). In small economies integrated in monetary unions, where official interest rates are effectively exogenous, macro-prudential policy can be an effective tool to mitigate credit supply shortages during periods of crisis.

At the policy-making level, the need to come up with macro-prudential mechanisms that are able to prevent or at least cushion the effects of financial disturbances led to major regulatory reforms, most notably the Basel III framework (Committee 2010).[2] One of the most important stabilization tools at the macro-prudential level proposed therein is the Countercyclical Capital Buffer (CCyB), whose main goal is to ensure as far as possible a regular supply of credit over the business cycle. This is achieved by establishing adequate capital buffers in periods when vulnerabilities accumulate above normal (*i.e.* when credit expansion is considered excessive *vis-à-vis* economic fundamentals), and to promptly allow for a buffer reduction in periods of credit shortage.[3]

Figure 1 plots the Gross Domestic Product (GDP) and the Gross Fixed Capital Formation (GFCF) growth rates for Portugal and the euro area since 1999. The plots depict high volatility levels, particularly for the Portuguese GFCF growth, and large slumps during the 2007–2009 financial turmoil and the ensuing euro area sovereign debt crises. The question that emerges is whether a CCyB rule could have mitigated the real effects during this period, by building up resilience in the banking sector prior to the crisis to cushion the effects from issues emerging in the banking and financial systems.

We contribute to the literature by evaluating the performance of the CCyB rule based on the credit-to-GDP gap under distinct business cycle fluctuations drivers. We make use of a Dynamic Stochastic General Equilibrium (DSGE)

since individual banks may not internalize costly spillovers that could harm the broader financial system (Liang 2017). Domestic incidents can easily become a multi-country problem, given the international banking system interconnection.

2. Under Basel III there exists not only national authority-specific guidances, but also multi-country institutional designs, namely a reciprocity regime in which domestic policy decisions have consequences on jurisdictions abroad.

3. The CCyB has already been implemented in many countries (Edge and Liang 2019). Pro-cyclical effects may emerge if banks have to improve their resilience by building up capital in crisis times (Kowalik 2011). Tightening capital requirements may have asymmetric effects on output, triggering a larger contraction in crisis times and slowing down growth in good times, while inducing risk taking (Jiménez *et al.* 2017). Identification problems—known as the "this time is different" fallacy—may also arise when managing capital requirements, particularly when cyclical events cannot be easily distinguished from structural changes (Bonfim and Monteiro 2013). The range of practices in implementing the CCyB has been evaluated in Committee (2017).

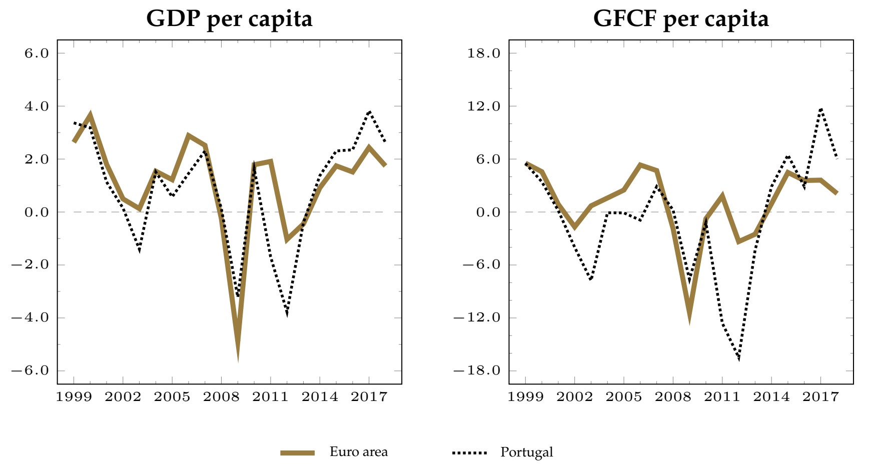

FIGURE 1: Key macroeconomic variables.

Source: Eurostat and Statistics Portugal.

Notes: both figures plot rates of change of real annual data, in percentage, since 1999; per capita refers to total population.

model, for a small euro area economy.[4] The model is endowed with a banking system where capital requirements and credit restrictions co-exist and may trigger credit tightness and/or interest rate spread hikes. Financial shocks—which spill over to the banking sector *via* bankruptcy losses hence depressing bank returns—and issues directly affecting the banking system, come into life in the form of larger spreads and credit restrictiveness. This has obvious feedback effects on the entrepreneurial sector, whose impact depends on their resiliency to absorb shocks, *viz.* their leverage. The interaction between real and financial variables builds up directly from capital demand and supply shifts, coupled with firms' need for external finance. This interaction rapidly spills over to the rest of the economy, deepening the slump. The CCyB rule features a buffer component that builds up whenever the credit-to-GDP ratio surpasses the steady-state value.

In our exercises, business cycles are solely driven by over-optimistic expectations about some future event such as in Lozej *et al.* (2018) and Clancy and Merola (2017). That is, fluctuations have no underlying economic fundamental, triggering an outcome characterized by excess credit.[5] Our analysis moves apart from the one in those articles along two key

4. That is, a structural model where nominal exchange rates are irrevocably unchanged and official interest rates are effectively exogenous.

5. Forward-looking models, which do not suffer from "this time is different" fallacies, are particularly suited to evaluate alternative policies under such circumstances.

dimensions. First, our banking system embodies due loans in conjunction with occasional binding credit restrictions, two important mechanisms to explain the dynamics of the banking sector and that affect the activation of the CCyB. Second, we carry out four distinct business cycle perturbations, on growth, investment efficiency, entrepreneurial risk, and bank returns. Each is endowed with unique features that drive the results. While under a growth perturbation credit is countercyclical, under the remaining credit is procyclical. Furthermore, while fluctuations in investment efficiency and entrepreneurial risk mostly impact the demand for credit, bank returns are an important driver of credit supply.

We show that, when the business cycle driver hinges on investment efficiency or on entrepreneurial risk, the CCyB rule triggers a buffer contraction during the crisis period that cushions the macroeconomic impacts of the downturn by alleviating the cost of credit, thus being able to achieve important stabilization effects. This is attained at the expense of lower private consumption, which suffers from a negative wealth effect associated with the buffer build up. When the business cycle driver hinges within the banking system but the entrepreneurial sector is resilient and hence able to cope with larger spreads, the CCyB still plays a stabilization role but with milder effects. The banking system recovers at the ride of larger spreads. When the business cycle driver hinges on a growth-driven perturbation, credit becomes largely countercyclical and the CCyB rule is generally ineffective or even destabilizing as it triggers a release of the buffer in the incorrect timing.[6]

A parallel discussion taking place in the literature relies on the costs and benefits of rules versus discretion (Kowalik 2011; Clancy and Merola 2017). Our focus herein is solely targeted to the effects of the CCyB rule under distinct underlying shocks. However, our byproduct that the rule may not be activated at the proper timing calls for some discretion for when to release the buffer.[7] In addition, we abstract from the housing sector and house price movements, from risk weights, and from specifics of the legislation in place, not included in the model to keep the key mechanisms sufficiently simple and tractable.[8]

6. The model used herein is an updated version of Júlio and Maria (2018a). The DSGE literature on this topic include Karmakar (2016), Clancy and Merola (2017), Lozej *et al.* (2018) or Faria e Castro (2019). The impact of macro prudential regulation has been examined both on empirical and theoretical grounds. A pioneer investigation with bank-firm-level Spanish data can be seen in Jiménez *et al.* (2017), and an evaluation of several CCyB rules using Portuguese data can be found in Bonfim and Monteiro (2013).

7. This is somewhat in line with Drehmann *et al.* (2010), who finds that the credit-to-GDP gap is the best performing indicator to signal in advance the build up of systemic risks in a wide set of crises and countries, but are unable to find any single variable that consistently signals when to release the buffer.

8. According to the legislation, changes in the CCyB are not the result of a linear mechanical rule. The business cycle and credit cycle indicators are guiding tools, but the macroprudential

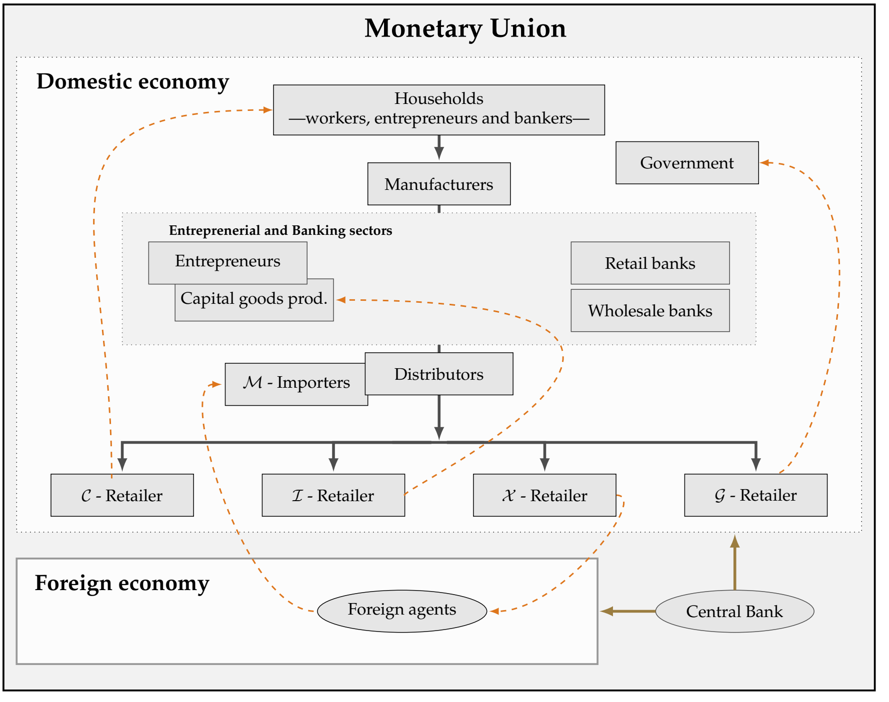

FIGURE 2: Interactions between agents.

Notes: Identifier $\mathcal{C}$ stands for consumption goods, $\mathcal{I}$ for investment goods, $\mathcal{G}$ for government consumption goods, $\mathcal{X}$ for export goods, and $\mathcal{M}$ for import goods. The financial accelerator mechanism comprises capital goods producers, entrepreneurs, and banks.

The non-financial block: households, production, and the foreign economy

The Portuguese economy is modeled as a stylized system of equations that can be solved to find equilibrium outcomes in labor, product and financial markets. The domestic economy is composed of nine types of agents: households, intermediate goods producers (manufacturers), final goods producers (distributors), retailers, capital goods producers, entrepreneurs, banks, the government and importers. The model embodies also foreign agents (the remaining euro area) and a Central Bank which sets the euro area's official interest rate. Key interactions between all agents is clarified in Figure 2.[9]

Households are composed of workers, entrepreneurs and bankers. Workers rent labor services to intermediate good producers (termed

regulator must provide the banks with a time to increase the CCyB, which can only change in multiples of 0.25 percentage points.

9. For details, see Júlio and Maria (2018a) and Júlio and Maria (2018b).

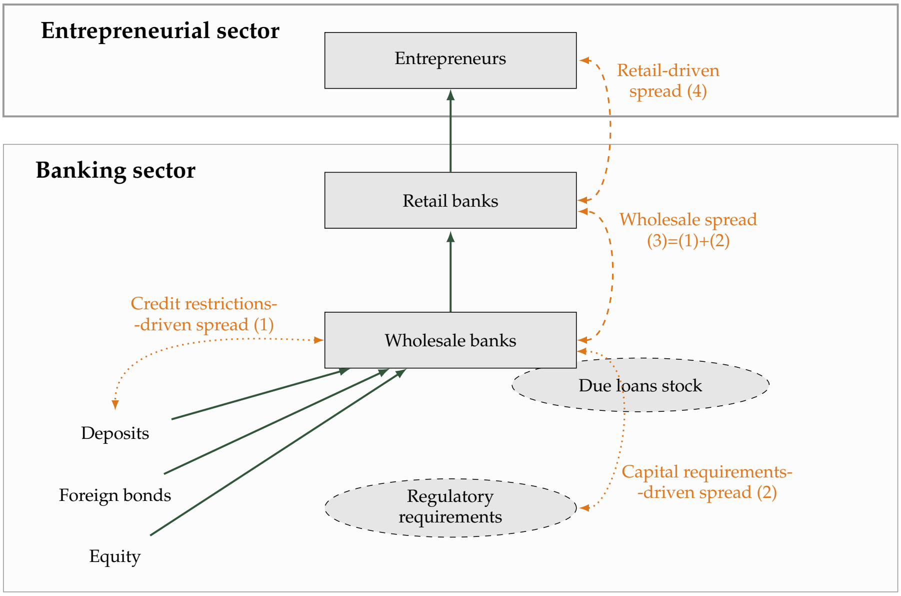

FIGURE 3: The financial sector.

Notes: The due loans stock is managed by wholesale banks. Before the end of each period, retail banks are assumed to transfer all their due loans to wholesale banks.

"manufacturers"). Final good producers ("distributors") combine domestic intermediate goods with imported goods to produce a final good, which retailers allocate to four different agents. Consumption goods are acquired by households, government consumption goods by the government, investment goods by capital goods producers, and export goods by foreign distributors. The interaction between capital goods producers, entrepreneurs and banks are assumed to capture key elements of the financial intermediation sector.

The financial sector: entrepreneurs and banks

Our financial and banking system brings together several strands of literature and adds a completely novel feature, *viz.* due loans management and endogenous write-offs. Figure 3 provides a simple diagram representing the financial sector of the model.[10]

The financial transmission mechanism is inspired on Bernanke *et al.* (1999), Christiano *et al.* (2010), and Kumhof *et al.* (2010). Entrepreneurs do not have

10. The exposition here is an improvement of the model presented in Júlio and Maria (2018a) and Júlio and Maria (2018b).

access to sufficient internal resources to finance desired capital purchases, but can borrow the difference from banks at a cost. They face an idiosyncratic shock that changes the value of the firm after decisions have been made. When hit by a severe shock, the value of assets collapses and the entrepreneur must declare bankruptcy, handing over the value of the firm to the bank. When hit by a milder shock, the entrepreneur survives but is unable to immediately reimburse the loan, which is reclassified by the bank as due.

The banking system builds on Benes and Kumhof (2015), and is composed of retail branches and wholesale banks. Retail branches operate in a perfectly competitive environment, celebrating loan contracts with entrepreneurs. These contracts set an unconditional, non-state contingent lending rate. Since entrepreneurs are risky, so are the individual loans of retail banks, who therefore charge a spread over the wholesale lending rate—the cost of obtaining funds from the wholesale bank—to cover the losses stemming from the mass of entrepreneurs that declare bankruptcy. Since a given retail branch lends to many entrepreneurs, by the law of large numbers the aggregate loan portfolio is risk-free, and hence *ex-ante* profits are zero. Retail branches are however exposed to non-diversifiable aggregate risk given the non-state contingent lending rate, and thus *ex-post* profits—to be transferred to wholesale banks—may differ from zero.

Wholesale banks finance their loans to retail branches and due loans through equity, deposits, and foreign funds. We assume that due loans accumulate on their balance sheet. Over time, some exogenous fraction of the total stock of due loans is recovered, while another fraction, endogenously decided, is written-off from the balance sheet. We term this latter fraction impairment rate and the corresponding costs impairment losses. Wholesale banks face two orthogonal idiosyncratic shocks, one affecting the return on their overall loan portfolio and the other specifically targeting the value of their due loans portfolio. These shocks, coupled with potential losses from retail branches, may trigger balance sheet effects and/or credit supply restrictions. Banks are subject to both regulatory capital requirements and due loans requirements, and non-compliance with either results in penalties and reputation costs. Banks therefore endogenously set buffers which allow them to cushion adverse shocks. For simplicity, we rule out bank failure.

Credit supply restrictions arise endogenously from a modified moral hazard/costly enforcement problem inspired in Gertler and Karadi (2011), Gertler *et al.* (2012), and Gertler and Karadi (2013). The banker has the option to divert a fraction of funds, though this only becomes attractive when the bank's value collapses well below the steady-state level (*i.e.* under bad financial shocks). Creditors recognize this fact and restrain the amount of funds placed at the bank until the banker's incentives to divert funds are aligned with their interests. In this way, wholesale banks become supply constrained with respect to the resources they can make available to the entrepreneurial sector.

Monitoring companies hire workers to perform three oversight activities. First, they help retail branches to repossess assets from bankrupted entrepreneurs. Second, they aid wholesale banks in recovering a fraction of the loans that are due. And finally, they supervise bankers when there is the risk of funds diversion, preventing any misreport of the banks' value.

The financing cost of wholesale banks corresponds to the costs of borrowing abroad, *viz.* the foreign interest rate plus a nationwide risk premium. An arbitrage condition matches this rate to the deposits rate. The premium between the wholesale rate and the deposits rate reflects both balance sheet risk—triggered by the probability of having capital or due loans outside regulatory thresholds—and moral hazard/costly enforcement problems. The former generates an expected cost for the bank—penalty, adjustment, or other—which is covered through a given spread. The latter triggers a quantity restriction in the amount of credit available—an upward shift in the supply of credit. Intuitively, households and foreign agents restrict the amount they deposit and foreign finance up to the point where the banker's incentives to divert funds are fully canceled out. This creates a wedge between the interest rate wholesale banks are willing to supply funds and the rate that creditors are willing to pay for funds. Finally, the retail rate is at another premium over the wholesale rate, to compensate for the fact that some entrepreneurs will declare bankruptcy and be unable to meet their debt obligations. We term this difference external finance premium. Naturally, the larger is entrepreneurial leverage, the greater are the unexpected losses of the banking sector. These are reflected into larger spreads, thus feeding back on the leveraged entrepreneurial sector which has to cope with even larger financing costs .

Due loans are associated with endogenous impairment recognition and management costs, which may depress bank equity and thus contribute to higher expected costs and hence spreads, under the umbrella of balance sheet risk. The optimality condition with respect to due loans balances, on the one hand, the cost of recognizing one unit of due loans as impairment loss net of the incentives to divert funds, and on the other, the expected cost of carrying-over that unit to the next period. The latter is composed of the opportunity, management and holding (penalty) costs—both direct and indirect, through their effect on the compliance of capital requirements. Larger impairment losses push down the gain from diverting assets, and thus the incentive compatibility condition becomes "less binding."

The occasionally binding nature of credit restrictions is able to generate powerful asymmetric responses to financial or banking shocks—those whose nature is endowed with important effects on the banking system. Under "good shocks" that expand banks' value, credit restrictions remain slack and play no role whatsoever. In contrast, under "bad financial shocks" depleting banks' capital negatively credit restrictions may become binding for some time and greatly affect the model dynamics, amplifying and increasing business cycle persistence.

Parametrization

We calibrate the model to match long-run data or studies for Portugal and euro area economies. Some parameters are exogenously set by taking into consideration common options in the literature, available historical data, or empirical evidence, whilst others are endogenously determined to match great ratios or other measures.[11]

We set the interest rate target at 3.2 percent per year, matching the pre-crisis average for the 3-month Euribor. Steady-state inflation is set at 2 percent per year, in line with the ECB's price stability target. The inverse Frisch elasticity is set to 2.5 and the discount factor to 0.996. The resulting net foreign asset position is around -50 percent of GDP. Household deposits amount to 40 percent of GDP.

Steady-state price markups are set at approximately 30 percent for wage setting, 20 percent for the intermediate goods sector, 10 percent for the final goods sector, and 5 percent for the import goods sector. The elasticity of substitution between capital and labor is close to 1, whereas the elasticity of substitution between domestic and imported goods is 1.5. The depreciation rate of capital is calibrated at 10 percent per year. Calvo parameters imply an average contract duration and intermediate goods average price duration of one year, and a final and imported goods average price duration of half a year. We assume no indexing.

On the entrepreneurial side, the model is endogenously calibrated to match a target leverage (net worth-to-debt ratio) of 1.2 and a yearly bankruptcy probability of 2 percent. The loss given bankruptcy is close to 40 percent and the retail-wholesale spread is 80 basis points.

For the banking sector, we set capital requirements to 8 percent and let banks build an endogenous capital buffer of 2.5 percentage points in line with the literature (*e.g.* Benes and Kumhof 2015; Clancy and Merola 2017), yielding a steady-state capital-to-loans ratio of 10.5 percent. The probability of non-complying with regulatory requirements is set at 2 percent per year, and the spread between the wholesale interest rate and the deposits rate is 1.2 percentage points. The sum of the retail and wholesale spreads matches the interest rate spread paid by non-financial corporations *vis-à-vis* the deposit rate. The fraction of bankers going out of business is 5 percent—the banker stays on the job on average around 5 years.

11. Here we provide only a brief sketch of the main calibration features. For further details see Júlio and Maria (2018a).

In the steady state, we set the due loans' threshold level to 5 percent of total credit, impose a buffer of 1.5 percentage points (and hence a due-loans-to-credit ratio of 3.5 percent), and a probability of non-complying with the threshold of 10 percent. The recovery rate is set to 6 percent and the resulting steady-state impairment rate is 7.7 percent. However, we let the threshold level along the dynamics deviate from the steady-state level, depending on both impairments and the total amount of due loans. The recovery cost is calibrated at 10 percent of the total stock of due loans. Agency problems are endogenously calibrated to be triggered in the presence of shocks with large negative impacts on banks' value. While important for the model, all these parameters play little influence on the main message of this article.[12]

The countercyclical capital buffer

Our aim in this article consists in addressing the stabilization effects of the CCyB for different fluctuation sources. For this purpose, we consider that the regulatory capital requirement, say γ_t, fluctuates according to a non-linear rule[13]

$$\gamma_t = (1-\rho)\gamma^{ss} + \rho\gamma_{t-1} + \mathrm{BUFFER}_t \tag{1}$$

where

$$\mathrm{BUFFER}_t = \max\left\{0, \rho_{rat}\left(\frac{\mathrm{CREDIT}_t}{\mathrm{GDP}_t} - \frac{\mathrm{CREDIT}_{ss}}{\mathrm{GDP}_{ss}}\right)\right\} \tag{2}$$

The subscript ss denotes steady-state figures, the element γ^{ss} is the steady-state value for the regulatory capital requirement, ρ is an autoregressive parameter that captures inertia, and ρ_{rat} is the sensibility of the buffer with respect to the credit-to-GDP ratio. The element CREDIT_t corresponds to total credit in quarter t and GDP_t is the Gross Domestic Product over the last four quarters. Note that the buffer builds up and is released gradually over time—*i.e.* there are no discrete jumps—and is capped from below at zero—implying that the regulatory capital requirement is capped from below at the steady state level γ^{ss}.[14] That is, banks are forced to accumulate larger amounts

12. Additional results are available from the authors upon request.

13. This is an option commonly found in the literature (*e.g.* Lozej *et al.* 2018)

14. Some authors (*e.g.* Drehmann *et al.* 2010) argue for prompt and sizable releases of the buffer instead of gradual releases. However, this remits to a parallel discussion of rules versus discretion, an issue besides the scope of this article.

of capital during (credit) expansions, to be used as a cushion device during downturns.

The autoregressive parameter ρ is set at 0.8, and the sensibility parameter ρ_{rat} at 0.2 for illustrative purposes. This implies a 2 percentage point increase in the buffer for a 10 percentage points deviation in the credit-to-GDP ratio from the steady-state level.[15]

A brief description of the exercise

We analyse the relative performance of the CCyB rule against the benchmark case of unchanged regulatory capital requirements, and plot selected impulse response functions under four representative boom-bust scenarios. All are based on overly optimistic expectations on some future event. Agents expect some shock with positive macroeconomic impacts to occur in the future (specifically within 3 years) and take that information into account immediately. This triggers a boom in the economy. When that moment arrives, they realize that no shock occurs, and revise expectations accordingly. This creates a subsequent bust as agents correct for their overly optimistic expectations. This is a common way in the literature to generate boom-bust cycles (*e.g.* Lozej *et al.* 2018; Clancy and Merola 2017).[16]

The four scenarios proposed herein intend to capture important drivers of expectation-driven business cycle fluctuations. The first is a growth-driven boom-bust cycle. The second consists of an expected increase in the marginal efficiency of investment. The last two are of financial nature—a decline in entrepreneurial risk and an increase in bank returns. All expected shocks have an half-life of around 1.5 years. We do not include any sensibility analysis in the article since the driving force of our results is basically of timing and of fluctuation sources, and not of magnitude. Changes in parameterization have little impact along these dimensions.

Expectation-driven boom-bust growth cycle

We start our analysis with a boom-bust cycle triggered by future growth expectations—a case depicted in Figure 4.[17] In this scenario, agents expect a

15. According to decisions taking place at the Basel Committee, transposed to European legislation through the Capital Requirements Directive (CRD IV), the buffer is capped from above at 2.5 percent. However, national authorities can implement a buffer in excess of 2.5 percent if it is deemed appropriate.

16. Similar conclusions would be achieved if one generates a boom-bust cycle through a materialized positive shock today, followed by some unexpected negative shock in the future.

17. Specifically, this shock corresponds to an expected increase in the growth rate of total factor productivity.

higher growth rate within three years, and this increases wealth and demand today. As a result, there is a boost in factor demand and prices, which raises the value of firms and diminishes the need for external finance on impact. Both credit and the corresponding spreads fall in the short run. The key feature driving this result is that the price of capital, *a.k.a.* the Tobin's Q, jumps on impact with agents' expectations, but capital takes time to accumulate due to real inertia. On the short run firms use the higher value of internal funds to finance the gradual increase in the capital stock and, simultaneously, diminish the degree of external finance. When agents realize they were making decisions based on wrong expectations, the reverse occurs: asset prices collapse due to fading demand and there is an increased need for external finance. This is accompanied by higher wholesale spreads so that banks are able to cope with the increased risk triggered by a more leveraged entrepreneurial sector.[18]

In this case, the CCyB has non-stabilizing effects and increases output volatility. In this simulation, the business cycle is not driven by a problem of credit nor of the financial/banking system. The collapse in asset prices when agents correct for their overoptimistic expectations decreases the value of firms' internal finance and contemporaneously leads to an increased need for external finance, despite the GDP drop. As a result, credit is countercyclical in this exercise. The banks' capital level is therefore not a major concern for the banking system. Hence, the buffer is only used when the credit market effectively fades, being unable to cushion the trough.[19]

Expectation-driven boom-bust investment efficiency cycle

The outcome is slightly different under a boom-bust cycle triggered by future investment prospects which do not materialize (Figure 5). In this case, there is an immediate increase in credit demand, so that firms can take advantage of a higher capital stock at the timing of the shock. The wholesale spread faces minor changes nevertheless, since leverage stays nearly constant, supported by identical increases in both external and internal finance. The latter is held up by higher asset prices following the boost in capital demand. When agents realize their expectational mistakes, asset prices and hence internal finance collapse, and the wholesale spread hikes while entrepreneurs strive to deleverage.

In this case, the CCyB has important stabilization effects. The main difference relative to the growth-based boom-bust cycle is that credit is

18. The hump-shaped pattern in the first three years of the simulation is explained by the dynamics of the trade balance, which declines only in the medium term due to real inertia.

19. Lozej *et al.* (2018) also find that credit is countercyclical under in some simulations.

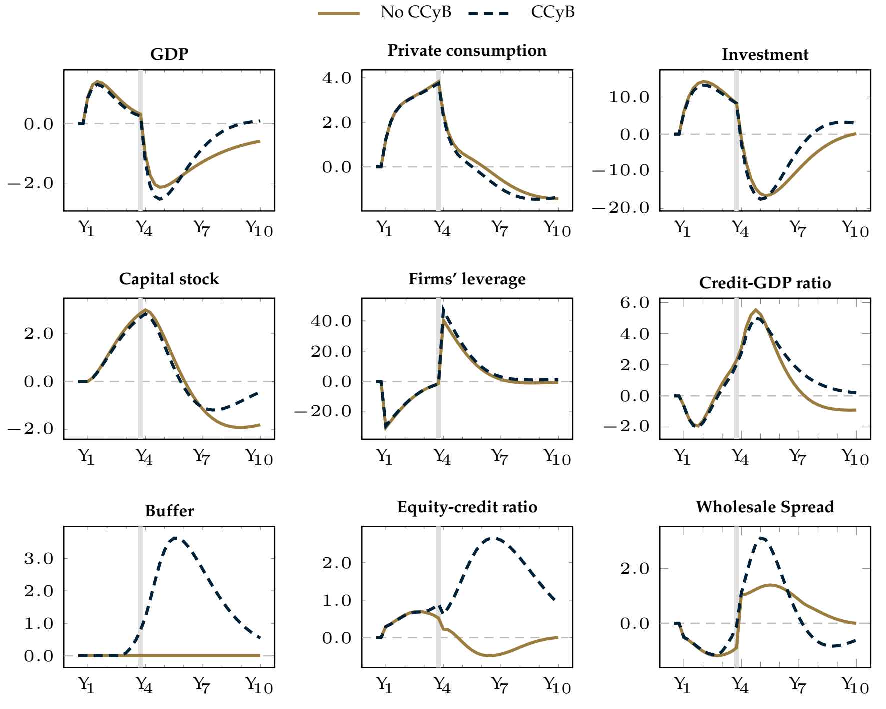

FIGURE 4: A boom-bust triggered by future growth expectations.

Notes: The figure represents an expected increase in growth of 1 percentage points to occur in the third year, which does not materialize. Vertical lines identify the period when agents revise their expectations. Variables are in percentage deviations from steady-state values except leverage, the buffer and the spread, which are in percentage points deviations. Notation Y_x refers to the first quarter of year x.

procyclical in this case, though with a lagged response. The expected future shock affects investment efficiency, which in turn determines firms' need for external finance. As investment prospects are directly related with the news, credit starts shrinking immediately after agents realize that they were overoptimistic about the future (i.e. around the third year). The decline in credit, coupled with the increased entrepreneurial risk due to excess leverage, pushes bank returns immediately downwards, affecting their equity level, to which banks responds through a spread hike. Using the accumulated buffer during this period cushions the decline in bank returns. This results in fewer costs for the banking system during the downturn and concomitantly in a smaller increase in the wholesale rate and a lesser decline in credit demand.

The stabilization effect works mostly through investment, which becomes less volatile. This comes at a cost, however: private consumption under the CCyB rule is always below that of the no rule case until the 8th year of the simulation. This is explained by the decline in wealth associated with the

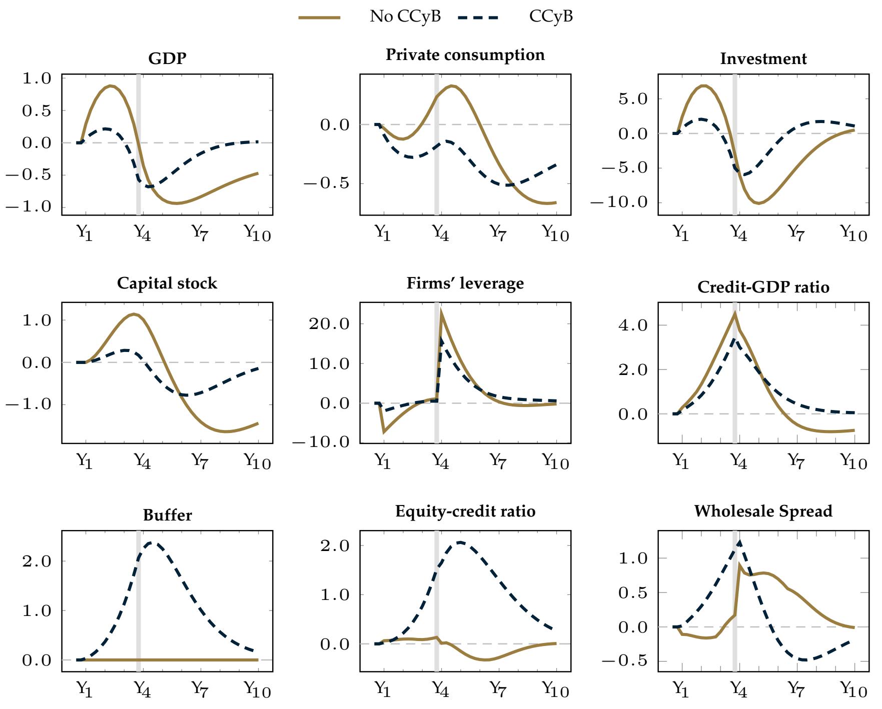

FIGURE 5: A boom-bust triggered by future investment efficiency expectations.

Notes: The figure represents an expected increase in investment efficiency of 10 percent to occur in the third year, which does not materialize. Vertical lines identify the period when agents revise their expectations. Variables are in percentage deviations from steady-state values except the buffer and the spread, which are in percentage points deviations. Notation Y_x refers to the first quarter of year x.

buffer accumulation. Specifically, as banks are required to increase capital levels during the expansion phase, the spread hikes and the cost of credit increases. As a result, there is a widespread increase in factor prices, pushing downwards the profitability of firms, a determinant of wealth. Households are only able to recover lost wealth when the buffer is close to depletion and the effects of the spread hike are fully reversed.

Expectation-driven boom-bust cycle triggered by financial risk

In this section we address the role of the CCyB in the case of a boom-bust cycle driven by expectational mistakes in the financial sector. Specifically, we consider that agents expect a decline in financial risk, to occur within three years. When the time comes they observe no change whatsoever and correct for their overoptimistic expectations. This generates a boom, supported by

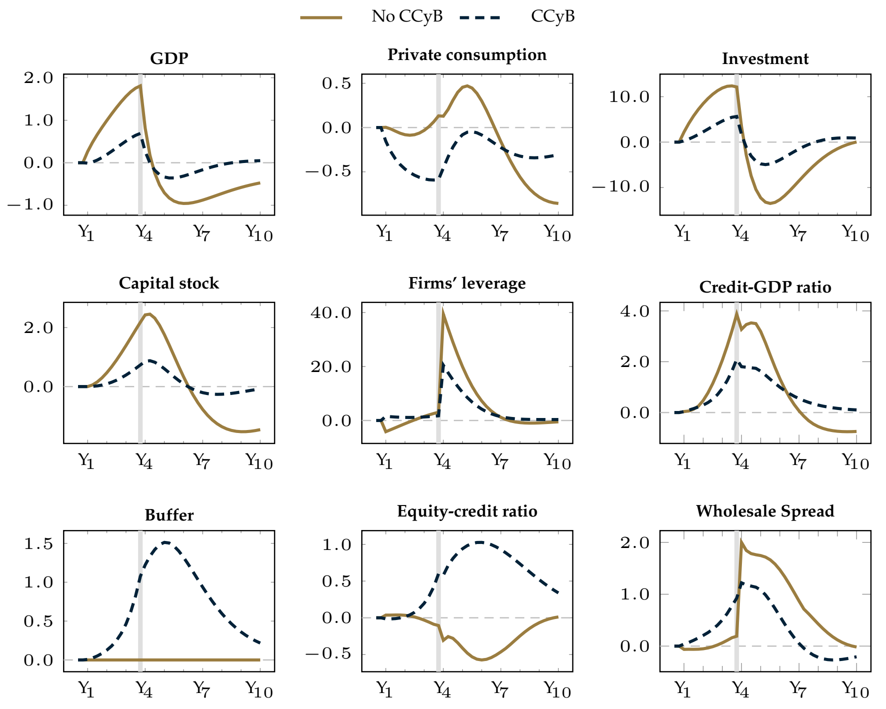

FIGURE 6: A boom-bust triggered by risk expectations.

Notes: The figure represents an expected risk shock of 20 percent to occur in the third year, which does not materialize. Vertical lines identify the period when agents revise their expectations. Variables are in percentage deviations from steady-state values except the buffer and the spread, which are in percentage points deviations. Notation Y_x refers to the first quarter of year x.

higher asset prices and consequently a more resilient entrepreneurial sector, followed by a bust (Figure 6). Asset prices and firms' value collapse when agents receive the updated news, and as a result leverage and bankruptcy probabilities hike. The banking sector is severely damaged by defaults and responds by restricting credit and charging a larger spread, as they cope with the downfall in their capital ratios.

As expected, the buffer plays a central role in this case, as it is well suited to address issues in the financial sector. Since credit is now procyclical and greatly coincident with GDP, the buffer accumulates during the credit expansion phase, providing a cushion for the banking system as it copes with the credit losses that emerge during the recession phase. As a result, credit restrictiveness becomes less severe and the wholesale spread faces a more moderate increase. This in turn cushions the feedback triggered by the losses in the banking system to a fragile entrepreneurial sector, taming the severity of the financial crisis.

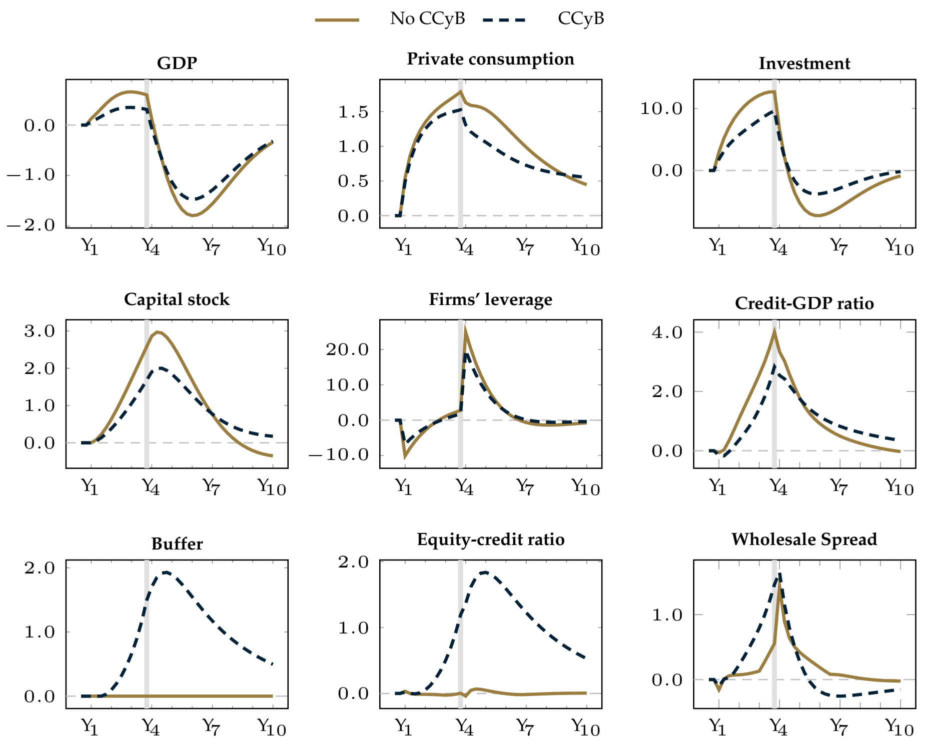

FIGURE 7: A boom-bust triggered by bank returns expectations.

Notes: The figure represents an increase in bank returns amounting to 1 percentage point to occur in the third year, which does not materialize. Vertical lines identify the period when agents revise their expectations. Variables are in percentage deviations from steady-state values except the buffer and the spread, which are in percentage points deviations. Notation Y_x refers to the first quarter of year x.

As in the previous simulation, the stabilization effect works mostly through investment, as private consumption is below the no buffer case until the 7th year of the simulation. The reason is identical: by requiring a spread hike, the buffer decreases the net income of firms and hence households' wealth, which takes time to recover.

Expectation-driven boom-bust cycle triggered by bank returns

In this section we address a boom-bust cycle emerging directly in the banking system and propagating to the rest of the economy through shifts in credit tightness and spread (Figure 7). In this scenario, agents expect an improvement in future bank returns, but when the time comes (in three years) they correct for their over-optimistic expectations. As in the previous section, this generates a boom, supported by higher asset prices triggered by an expected future decline in the interest spread. The entrepreneurial sector becomes less leveraged and more resilient, and concomitantly increases the demand for credit right away. In general equilibrium, the wholesale spread remains nearly unchanged, on the one hand pushed down based on future return prospects, and on the other hand pressed upwards due to the increased credit demand. When agents realize they were making decisions based on expectations which do not materialize, asset prices collapse and the entrepreneurial sector finds itself with excess leverage and hence too risky. The wholesale spread hikes as banks face a double hit. Directly because they revise their return expectations downwards and must generate higher interest income to cope with unexpected losses, and indirectly due to the increase in the bankruptcy rate of firms. In addition, credit restrictions emerge as banks must cap their leverage limit in order to finance their operations.

The tight relationship between credit, the latent shock, and the concomitant capital problems in the banking system, endow the CCyB with the proper stabilization features, while the contemporaneous correlation with GDP provide the correct timing dimension for the rule to be successfully activated. However, the stabilization dimension in this case is smaller than that from the previous two exercises. Since the shock impacts the supply of credit and not the demand, firms are able to better cope with the spread hike and still achieve reasonable levels of investment. This confines the spillovers triggered by the losses in the banking system to the rest of the economy as compared with our two previous simulations, and hence the effectiveness of the buffer as a stabilization device.

Concluding remarks

In this article we use a dynamic stochastic general equilibrium model for a small euro area economy to address the stabilization performance of the countercyclical capital buffer rule under different underlying fluctuation sources.

We conclude that the effectiveness of the rule greatly depends on the relationship between output and credit, and on whether the underlying shock affects the demand or the supply of credit. Fluctuations based on expectation-driven perturbations on investment efficiency or riskiness tend to generate credit movements which are largely procyclical, affecting mostly the demand for credit. In these cases the countercyclical buffer plays an important stabilization role, by limiting losses in the banking system and spread hikes when the entrepreneurial sector is fragile and the demand for credit low. However, this is achieved at the expense of private consumption, depressed by the wealth reduction associated with the buffer build up. In the case of a banking-based business cycle fluctuation, the countercyclical buffer is still effective although to a lesser extend. Since the source of fluctuation affects the supply of credit, firms are able to better cope with spread hikes generated within the banking system. Finally, under a growth-driven business cycle fluctuation, the countercyclical buffer is endowed with a destabilizing effect, due to the countercyclical relationship between credit and output. In this case, the buffer is not released in the proper timing, contributing to deepen the slump.

As it is common in the literature, an analysis such as the one performed herein has some caveats worth mentioning. First, we neglect micro prudential aspects. Second, we abstract from the housing sector and house price movements, which have important impacts on the banking system and may constitute a business cycle driver (sharp increases in house prices have also been pointed out as potentially useful indicators to activate the countercyclical capital buffer; see Bonfim and Monteiro 2013). Finally, the model does not feature international spillovers, balance sheet risk weights, nor takes into account the specifics of the legislation in place.

References

Angelini, Paolo, Stefano Neri, and Fabio Panetta (2014). "The Interaction between Capital Requirements and Monetary Policy." *Journal of Money, Credit and Banking*, 46(6), 1073–1112.

Benes, Jaromir and Michael Kumhof (2015). "Risky bank lending and countercyclical capital buffers." *Journal of Economic Dynamics and Control*, 58(C), 58–80.

Bernanke, Ben S, Mark Gertler, and Simon Gilchrist (1999). "The financial accelerator in a quantitative business cycle framework." *Handbook of macroeconomics*, 1, 1341–1393.

Bonfim, Diana and Nuno Monteiro (2013). "The implementation of the countercyclical capital buffer: rules versus discretion." *Financial Stability Report*, pp. 87–110.

Christiano, Lawrence, Roberto Motto, and Massimo Rostagno (2010). "Financial factors in economic fluctuations." Working Paper 1192, European Central Bank.

Clancy, Daragh and Rossana Merola (2017). "Countercyclical capital rules for small open economies." *Journal of Macroeconomics*, 54, 332–351.

Committee, Basel (2010). "Guidance for national authorities operating the countercyclical capital buffer." Basel Committee on Banking Supervision.

Committee, Basel (2017). "Range of practices in implementing the countercyclical capital buffer policy." Basel Committee on Banking Supervision.

Drehmann, Mathias, Claudio Borio, Leonardo Gambacorta, Gabriel Jiminez, and Carlos Trucharte (2010). "Countercyclical capital buffers: exploring options." BIS Working Papers 317, Bank for International Settlements.

Edge, Rochelle M. and J. Nellie Liang (2019). "New Financial Stability Governance Structures and Central Banks." Finance and Economics Discussion Series 2019-019, Board of Governors of the Federal Reserve System.

Faria e Castro, Miguel (2019). "A Quantitative Analysis of Countercyclical Capital Buffers." Working Papers 2019-8, Federal Reserve Bank of St. Louis.

Gertler, Mark and Peter Karadi (2011). "A model of unconventional monetary policy." *Journal of monetary Economics*, 58(1), 17–34.

Gertler, Mark and Peter Karadi (2013). "QE 1 vs. 2 vs. 3. . . : A Framework for Analyzing Large-Scale Asset Purchases as a Monetary Policy Tool." *International Journal of Central Banking*, 9(1), 5–53.

Gertler, Mark, Nobuhiro Kiyotaki, and Albert Queralto (2012). "Financial crises, bank risk exposure and government financial policy." *Journal of Monetary Economics*, 59, S17–S34.

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró, and Jesús Saurina (2017). "Macroprudential policy, countercyclical bank capital buffers, and credit supply: evidence from the Spanish dynamic provisioning experiments." *Journal of Political Economy*, 125(6), 2126–2177.

Júlio, Paulo and José R. Maria (2018a). “An integrated financial amplifier: the role of defaulted loans and occasionally binding constraints in output fluctuations.” Working Papers 13, Banco de Portugal, Economics and Research Department.

Júlio, Paulo and José R. Maria (2018b). “Interest rate spreads hikes: What lies behind them?” *Economic Bulletin and Financial Stability Report Articles and Banco de Portugal Economic Studies*.

Karmakar, Sudipto (2016). “Macroprudential regulation and macroeconomic activity.” *Journal of Financial Stability*, 25, 166–178.

Kowalik, Michał (2011). “Countercyclical capital regulation: should bank regulators use rules or discretion?” *Federal Reserve Bank of Kansas City Economic Review*, (Second Quarter), 59–80.

Kumhof, Michael, Dirk Muir, Susanna Mursula, and Douglas Laxton (2010). “The Global Integrated Monetary and Fiscal Model (GIMF) - Theoretical structure.” IMF Working Paper 10/34, International Monetary Fund.

Liang, J. Nellie (2017). “Financial Regulations and Macroeconomic Stability.” Keynote address at the International Finance and Banking Society, July 15-17, Oxford University.

Lozej, Matija, Luca Onorante, and Ansgar Rannenberg (2018). “Countercyclical capital regulation in a small open economy DSGE model.” Working Paper Series 2144, European Central Bank.