PRELIMINARY DRAFT

COMMENTS WELCOME

PRO-CYCLICALITY OF CAPITAL REGULATION: IS IT A PROBLEM? HOW TO FIX IT?

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Abstract

We use a macroeconomic model of the euro area featuring a bank sector to study the pro-cyclical effect of the capital regulation, focusing in particular on the extra pro-cyclicality induced by Basel II relative to Basel I. Our results suggest that this incremental effect is likely modest. While this result survives a series of checks based on alternative assumptions about specification and parameters of our model, its robustness remains to be tested under more radically alternative modeling choices. We also find that the regulator could offset the extra pro-cyclicality induced by Basel II via a countercyclical capital requirements policy. Our results also suggest that banks may have incentives to accumulate countercyclical capital buffers, making this policy less relevant. However, the latter result is found to depend on the nature of the shock hitting the economy.

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1) Introduction

Since the end of the 1980s, following the implementation of the so-called Basel rules on banks' capital requirements, G-10 countries have introduced capital requirements based on risk weighted assets. At the microeconomic level, the reasons for capital regulation include potentially excessive risk-taking by bank managers induced by flat-premium deposit insurance schemes[1] and insufficient monitoring of lending policies by small, dispersed depositors.[2] From a macroeconomic perspective, risk-based capital requirements are one of the tools available to reduce the externalities associated with bank failures (in terms, for example, of public funds needed in case of systemic crises or contagion across intermediaries).[3]

Against the rationale for their adoption, a potential drawback of risk-based capital requirements is that they may amplify the cyclical fluctuations of the economy (i.e. they may generate pro-cyclicality). In theory, in a frictionless economy they should not, but imperfections in capital markets do exist, and an accelerator mechanism may generate feedback from bank capital to the real economy (Adrian and Shin (2008)). Therefore, risk-based capital requirements may tend to generate pro-cyclicality, because risk itself is cyclical both in quantity and in value.[4] The debate on the additional pro-cyclicality generated by capital regulation is still open, though. To conclude that capital regulation has pro-cyclical effects one should check, first of all, that it induces pro-cyclicality in the minimum regulatory capital requirement under Pillar I, and next, that such pro-cyclicality survives the supervisory review process under Pillar II (in principle, the regulator could take steps to dampen it). Second, it should be ascertained that banks' response to the regulatory changes does not offset the additional pro-cyclicality (e.g. via voluntary accumulation of countercyclical capital buffers). Finally, one should check that any resulting additional pro-cyclicality in bank lending affect real activity.[5]

Although our knowledge about each of these conditions is very limited, as we argue below, in the aftermath of the current financial crisis a consensus has emerged that the Basel II capital rules should be amended. Widely discussed proposals, to be implemented

[1] See Kohen and Santomero (1980), Kim and Santomero (1988), Rochet (1992).

[2] See Dewatripont and Tirole (1994).

[3] See Kashyap and Stein (2004).

[4] The quantity of risk tends to rise during contractions, partly reflecting the process of accumulation during expansions (Borio *et al.* (2001)). Similarly, the price of risk – that is, investors' risk aversion – decreases during upswings and increases during downswings (Lowe (2002)).

[5] These conditions have been pointed out by several authors. See e.g. Taylor and Goodhart (2004).

once the crisis is over, focus on the level and the dynamics of bank capital. They include: strengthening the capital base of banks; implementing mechanisms to build capital buffers and forward-looking provisions in periods of buoyant growth, to be used in downturns; harmonising the definition of eligible capital and improving its quality; complementing Basel II rules with non-risk based limits to leverage (G20, 2009; FSF, 2009). Some of these proposals have been inspired by the experience of the few countries whose institutional frameworks already incorporate countercyclical mechanisms (e.g., the leverage ratio in Canada and the US, dynamic provisions in Spain). The challenge is not reaching an agreement on general principles, but translating principles into concrete measures, which can be applied consistently across jurisdictions.

The current state of the debate prompts the following considerations. First, the above mentioned proposals for reform are generally analyzed on a piecemeal, hands-on basis. So far, the policy debate has taken place in the absence of a consistent framework which would allow a more structured approach to the issue of capital regulation. Moreover, the proposals pursue the twofold objective of increasing the resilience of the financial system and of mitigating the pro-cyclical effects of capital regulation, at times without clearly distinguishing between these two objectives. Finally, in our view policy discussions have neglected the potential costs of the proposed measures; for example, scarce or no attention has been paid to potentially negative effects on economic growth (Kashyap et al. (2008)).

Moving from these considerations, the present paper represents a first attempt to address these issues in a systematic way. We believe that a comprehensive framework should address the following fundamental questions: (i) does the new Basel II regime really increase the pro-cyclicality of the banking system, and if so, by how much? (ii) higher capital requirements would clearly strengthen the resilience of the financial system; could they also help dampen the cyclical effects of credit on GDP, consumption, investment? (iii) what room there exists for a management of countercyclical capital requirements? (iv) what is the macroeconomic cost (e.g. in terms of GDP growth) of policies aiming at mitigating pro-cyclicality?[6]

To address these questions we cast the regulator problem within a macroeconomic model. Specifically, we build on the DSGE model developed by Gerali *et al*. (2009) to examine the functioning and possible shortcomings of risk-based capital regulation, and potential policy measures aiming at mitigating pro-cyclicality. Such model features a simplified banking sector with capital, capturing the basic elements of banks' balance sheets: on the assets side there are loans to firms and households; on the liabilities side there are deposits held by households and capital. We augment this model by introducing heterogeneity in the creditworthiness of the various economic operators. We also introduce risk-sensitive capital requirements and quantify the extent to which they induce excessive

[6] A fifth crucial issue, which we do not address here, concerns the systemic nature of certain risks: risk-based capital regulation that only refers to individual banks underestimates systemic risk by neglecting the macro impact of banks reacting in unison to a shock (Brunnermeier *et al.* 2009).

lending and excessive GDP growth in booms, and vice-versa in downturns. After reviewing some of the policy options that have been proposed to dampen pro-cyclicality, we assess the effectiveness of stylized countercyclical tools on the basis of the model. In particular, we look at the response of the key macroeconomic variables to higher capital requirements and passive and active countercyclical capital policies.

A final section is devoted to the practical aspects of the implementation of countercyclical capital rules. In particular, we focus on two tools: (i) the accumulation of Basel II capital buffers calibrated on downturn conditions (e.g., adopting simple correction factors based, for instance, on the ratio between downturn and current PDs); (ii) dynamic provisioning based on through-the-cycle expected losses. We argue that these tools may complement each other.

The paper makes two main contributions to the existing literature. First, the role of capital regulation is studied in the context of a macroeconomic model, which allows us to examine the general equilibrium effects of changes in bank capital regulation. The DSGE model employed throughout the paper belongs to a new class, which explicitly comprises a (simplified) financial sector and features a meaningful interaction between the latter and the real economy. It is worth recalling that the financial sector was entirely absent in DSGE models of the previous generation. The financial accelerator mechanism of Bernanke, Gertler and Gilchrist (1999) has been only recently re-considered in standard medium scale DSGE models. One possible reason why the empirical literature, in particular, has typically not considered this mechanism is that it does not significantly amplify the effects of monetary policy shocks.

Second, we try to integrate this simplified but rigorous framework with a discussion of the main policy proposals. This approach stands in sharp contrast, on the one hand, with existing literature on financial stability issues, typically based on reduced-form, partial equilibrium models; on the other hand, with the theoretical macroeconomic literature, typically not concerned with the practical implementation of policy proposals. The only other paper we are aware of, which studies the additional pro-cyclicality introduced by Basel II relative to Basel I in a similar macroeconomic framework, is Aguiar and Drumond (2009). They find that the amplification of monetary policy shocks induced by capital requirement becomes stronger under Basel II regulation.

2) The macro framework

Until recently, the financial sector was largely overlooked in macroeconomic modelling. Seminal contributions, starting from Bernanke, Gertler and Gilchrist (1999), have started to fill the gap by introducing credit and collateral requirements in quantitative general equilibrium models. More recently, models have begun to study the role of financial intermediaries in general and banks in particular (Christiano, Motto and Rostagno, 2007 and Goodfriend and McCallum, 2007). These models, however, emphasize mainly the demand side of credit. The credit spread that arises in equilibrium (called the external finance premium) is a function of the riskiness of the entrepreneurs' investment projects and/or his net wealth. Banks, operating under perfect competition, simply accommodate the changing conditions from the demand side.

Gerali *et al.* (2009) instead build on the idea that conditions from the supply side of the credit markets are key to shape business cycle dynamics. Starting from a standard model, featuring credit frictions and borrowing constraints as in Iacoviello (2005) and a set of real and nominal frictions as in Christiano *et al.* (2005) or Smets and Wouters (2003), they add a stylized banking sector with three distinctive features. First, banks enjoy some degree of market power when setting rates on loans to households and firms. Second, the rates chosen by these monopolistically competitive banks are adjusted only infrequently, i.e. they are sticky. Third, banks accumulate capital (out of retained earnings), as they try to maintain their capital-to-asset ratio as close as possible to an (exogenously given) optimal level. This optimal level might derive to banks because of a mandatory capital requirement (like those explicitly set forth in the Basel Accords) or, in a deeper structural model, might be the equilibrium outcome from balancing the cost of funding with the benefits of having more "skin in the game" to mitigate typical agency problems in credit markets. The model is estimated with Bayesian techniques using data for the euro area over the period 1998:1-2009:1.

Banks make optimal decisions subject to a balance sheet identity, which forces assets (loans) to be equal to deposits plus capital. Hence, factors affecting bank capital impact on the capital to assets ratio, forcing banks to modify leverage. Thus, the model captures the basic mechanism described by Adrian and Shin (2008), which has arguably had a major role during the current crisis.

In this paper we modify the model by Gerali *et al.* (2009) to study the role of capital regulation. More specifically, we assume that credit risk differs across categories of borrowers and introduce risk sensitive capital requirements. We then show how banks' optimal lending decisions, and hence the macro environment, are affected by different regulations. We refer the interested reader to the original paper for a more thorough description of the basic features of the model.

2.1 Main features of the model

The model describes an economy populated by entrepreneurs, households and banks. Households consume, work and accumulate housing wealth, while entrepreneurs produce consumption and investment goods using capital bought from capital-good producers and labour supplied by households.

There are two types of households, which differ in their degree of impatience, i.e. in the discount factor they apply to the stream of future utility. This heterogeneity gives rise to borrowing and lending in equilibrium. Two types of one-period financial instruments, supplied by banks, are available to agents: saving assets (deposits) and loans. Borrowers face a collateral constraint, tied to the value of collateral holdings: the stock of housing in the case of households, physical capital for entrepreneurs.

As mentioned above, the banking sector operates in a regime of monopolistic competition: banks set interest rates on deposits and on loans in order to maximize profits. The balance sheet is simplified but captures the basic elements of banks' activity. On the assets side are loans to firms and households. On the liabilities side are deposits held by households and capital. Banks face a quadratic cost of deviating from an "optimal" capital to assets ratio ν:[7]

(1) $$\kappa_b \left(\frac{K_{b,t}}{L_t} - \nu \right)^2 K_{b,t}$$

where $K_{b,t}$ is bank capital, L_t are total loans and κ_b is a parameter measuring the cost of deviating from ν. The latter can be thought of as a minimum capital ratio established by the regulator, plus a discretionary buffer. When the capital ratio falls below ν, costs increase and are transferred by banks onto loan rates:

(2) $$R_t^i = R_t - \kappa_b \left(\frac{K_{b,t}}{L_t} - \nu \right) \left(\frac{K_{b,t}}{L_t} \right)^2 + markup_t, \qquad i=H,\ F$$

where R_t is the monetary policy rate and the term "*markup*" captures the effects of monopolistic power of banks on interest rate setting.[8] Equation (2) highlights the role of bank capital in determining loan supply conditions. On the one hand the bank would like to extend as many loans as possible, increasing leverage and thus profits per unit of capital. On the other hand, when leverage increases, the capital-to-asset ratio falls below ν and banks pay a cost, which they transfer on the interest rates paid by borrowers. This, in turn, may reduce credit demand and hence bank profits. The optimal choice for banks is to choose a level of loans (and thus of leverage) such that the marginal cost of reducing the capital-to-asset ratio exactly equals the spread between R_t^i and R_t. The presence of stickiness in bank rates implies that the costs related to the bank capital position are

[7] The adjustment cost adopted in equation (1) is quadratic, and hence symmetric. An alternative, more realistic version should be asymmetric – the cost of falling below a regulatory minimum is arguably higher than the cost of excess capital. However, the first order approximation of the model which we use throughout the current version of the paper would make such alternative adjustment cost immaterial for the results. In a next draft we plan to introduce an asymmetric adjustment cost (see Fahr and Smets, 2008 for an application of to downward nominal wage rigidities) and look at a second order approximation of the model, or simulate the nonlinear model.

[8] In practice, a dynamic version of equation (2), in which bank rates are sticky, is employed in the model (see Gerali *et al.,* 2009). It is assumed that banks, at any point in time, can obtain financing from a lending facility at the central bank at a rate equal to the policy rate R_t. A no-arbitrage condition between borrowing from the central bank and from households by issuing deposits implies that in equilibrium a dynamic version of eq. (2) must hold.

transferred gradually to the interest rate on loans to households and firms. Bank capital is accumulated out of retained profits π, according to the following equation:

(3) $$K_{b,t} = (1-\delta_b)K_{b,t-1} + \Pi_{b,t-1}$$

where the term $\delta_b K_{b,t-1}$ measures the cost associated with managing bank capital and conducting the overall banking intermediation activity.

Monetary policy is modelled via a Taylor rule with the following specification:

(4) $$R_t = (1-\phi_R)\overline{R} + (1-\phi_R)\phi_\pi(\pi_t - \overline{\pi}) + \phi_y(y_t - y_{t-1}) + \phi_R R_{t-1}$$

The values of the parameters of the model are reported in Gerali *et al*. (2009).

2.2 *Key changes to the analytical framework*

We introduce a few changes in the basic framework of Gerali *et al*. (2009), to adapt it to our purposes. Specifically, we assume that loans to firms and to households are characterized by different degrees of riskiness captured, in a reduced form, by weights, w_t^F and w_t^H, which we use to compute a measure of risk-weighted assets.[9] The capital adjustment cost (1) is modified as follows:

(5) $$\kappa_b\left(\frac{K_{b,t}}{w_t^F L_t^F + w_t^H L_t^H} - v\right)^2 K_{b,t}\,,$$

where total loans L_t have been replaced by the sum of risk-weighted loans to firms (L_t^F) and households (L_t^H).

Note that setting w_t^F = w_t^H =1 expression (5) simulates the Basel I regime for loans to the private sector, whereas allowing the weights to vary over time captures the essence of the risk-sensitive Basel 2 mechanism. Under the latter mechanism, the inputs of the capital function can change through the cycle, reflecting either the rating issued by rating agencies or banks' own internal risk assessment models (the so-called internal ratings based, or IRB, approach). Under this second interpretation, we model the weights so as to roughly mimic their real-world setting by banks. We assume simple laws of motion of the form:

(6) $$w_t^i = (1-\rho_i)\overline{w}^i + (1-\rho_i)\chi_i(\log Y_t - \log Y_{t-4}) + \rho_i w_{t-1}^i \qquad i = F, H$$

[9] The model does not feature defaults, as they are ruled out as equilibrium outcomes (see Kyiotaki and Moore, 1997, and Iacoviello, 2005). However, the device we adopt mimics well the effect of capital requirements based on risk weighted assets.

where the lagged term w_{t-1}^{i} models the inertia in the adjustment of the risk-weights and the parameter χ_i (<0) measures the sensitivity of the weights to cyclical conditions proxied by the year-on-year growth rate of output.[10]

It is important to note that appropriate choices for the parameters in equation (6) also allow us to study the system dynamics under the two main rating systems allowed by the regulation: "point in time" (PIT) vs. "through the cycle" (TTC). In a nutshell, to assess borrowers' creditworthiness under Basel II, banks can either use ratings supplied by external rating agencies, or produce their own internal ratings. Regardless of the source, ratings can be attained via either a PIT or a TTC approach. PIT ratings represent an assessment of the borrower's ability to discharge his obligations over a relatively short horizon (e.g. a year), and so can vary considerably over the cycle. The TTC approach focuses on a longer horizon, abstracting in principle from current cyclical conditions. TTC ratings are therefore inherently more stable than PIT ratings, although their predictive power for default rates is lower.[11] Within our framework, the TTC approach could be approximated by choosing a large value for ρ and a small one for χ in (6). In the limit, in this simplified setting a pure TTC system coincides with the Basel I framework.

Summing up, the results in the following sections can be interpreted as a comparison between the Basel I vs. Basel II frameworks, but also as a comparison between the PIT vs. the TTC approaches of the Basel II framework. While in our comments we shall mainly refer to the first interpretation for brevity, the second should also be kept in mind.

A final remark concerns the interpretation of ν, the "optimal" capital/assets ratio appearing in equations (2) and (5). As mentioned above, ν can be thought as a minimum capital ratio established by the regulator, e.g. the 8 percent benchmark imposed by the Basel regulation, plus a buffer. The buffer captures the idea that banks tend to voluntarily keep their capital above the regulatory minimum, to avoid extra costs related to market discipline and supervisory intervention, or to meet market expectations (e.g., to maintain a given rating).[12] This twofold interpretation of ν, as a regulatory instrument and as a capital buffer held by banks, has a key role in the present paper and must be kept in mind for the interpretation of our results. We shall come back to it in the following sections.

3) The pro-cyclicality of the Basel II framework: is it a problem?

Whereas there is a relatively broad consensus that Basel I increased the pro-cyclicality of the financial system, the issue of how much additional pro-cyclicality Basel II

[10] The results illustrated below remain broadly unchanged if the business cycle is measured using the deviation of output from its steady state level.

[11] For a comparison of PIT and TTC components of default risk, see Löffler (2008).

[12] See Furfine (2001).

generates relative to Basel I is still open to debate.[13] This issue is problematic to address empirically, in view of the extremely recent application of Basel II (in Europe most banks deferred it to 2008). The scant available evidence available on the pro-cyclical effects of Basel II derives from counterfactual and simulation exercises or from comparisons with similar past experiences of regulatory change. Many authors argue that this extra pro-cyclicality may be substantial. However, the result often depends on the credit risk estimation techniques chosen. In addition, other authors observe that banks hold capital buffers in excess of the regulatory minimum, and that this could enable them to smooth or even eliminate the impact of the new regulation on lending patterns.[14] Overall, a tentative summary of the available literature is that Basel II may increase the pro-cyclicality of bank lending, but that this conclusion must be treated with caution. Furthermore, as we argued in the introduction, little if any evidence is yet available on the impact of the new regulation on the real economy – i.e. on GDP and its components, and lending – which is what ultimately matters to assess pro-cyclicality.

This section develops such analysis. Specifically, we use the model augmented with the estimated versions of (6) to compare the model dynamics under Basel I and Basel II, and assess whether Basel II induces extra swings in both bank variables and the key macro variables, and how large these swings are. To this end, we compute impulse response functions to various shocks. We focus on technology shocks, arguably the main drivers of the business cycle, but we also consider monetary policy and demand shocks.

We use the parameterization of the model reported in Gerali *et al* (2009). To make the model operational we need to estimate the parameters of (6). Taking this equation to the data presents several challenges, due to the fact that no historical time series for the weights, or the risk weighted assets, is yet available. To obtain estimates of the parameters of (6) we proceed as follows. We use data on delinquency rates on loans to households and non financial companies in the U.S. as proxies for the probabilities of default of these loans (similar data for the euro area were not available to us). We input these time series into the Basel II capital requirements formula, and using a series of assumptions concerning the other key variables of the formula (loss given default, firms' size, the maturity of loans) we are able to back out time series for the weights w_t^F, w_t^H. Next, we estimate equation (6) using these series. The regressions suggest that the sensitivity of the risk weights to the cycle (the parameter χ) is relatively large for commercial and industrial enterprises while it is not statistically different zero for residential mortgages. Details on the methodology used to obtain the weights are reported in the Appendix 1.

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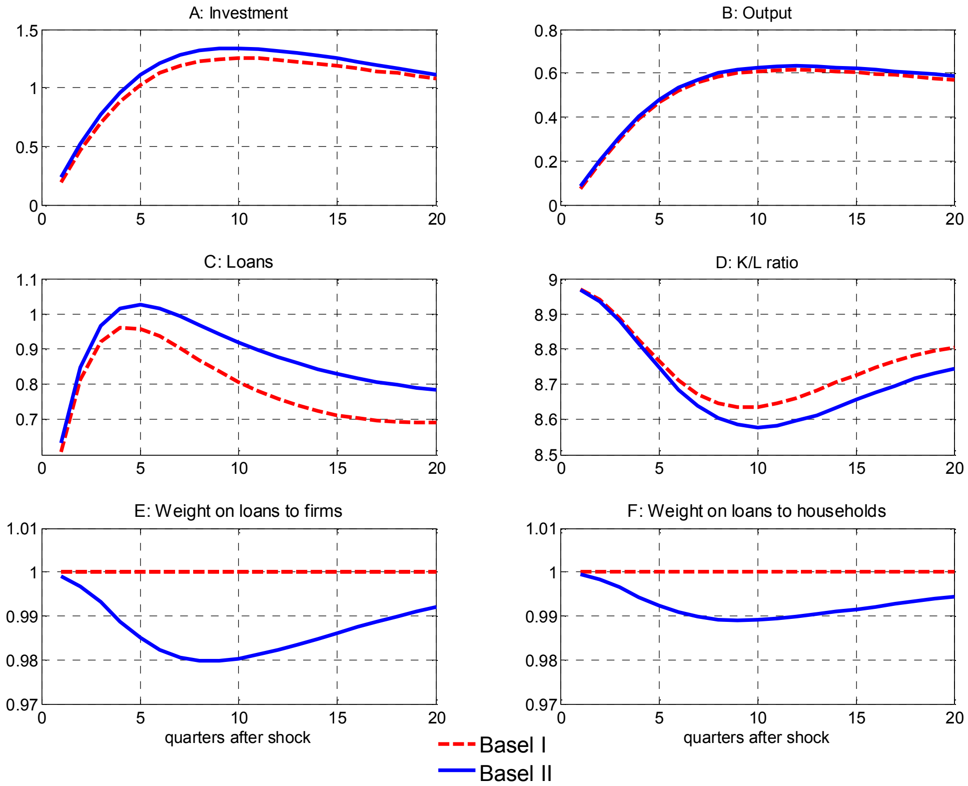
13 The Basel Committee was well aware of the potential pro-cyclical effects of the new regulations. The "through the cycle" philosophy that permeates the Accord, and several explicit provisions therein, were meant to contain pro-cyclicality. However, the evidence suggests that the implementation did not fully conform to the regulation's spirit. See Cannata and Quagliariello (2009).

14 See Panetta *et al.* (2009), Drumond (2008) for reviews of the literature on the pro-cyclicality of capital regulation, and for a summary of the debate on the pro-cyclicality induced by Basel I and Basel II.

3.1 Baseline results

Figure 1 shows the results for the technology shock, modelled as an unexpected increase in the total factor productivity (TFP). Consider the results under Basel I first (represented in the figure by the dashed red lines).

Figure 1 - Impulse responses to a positive technology shock: Basel I vs. Basel II



Note: the impulse responses are measured as percentage deviations from steady state, except for the *K/L* ratio (measured in percentage points) and the weights w^j (normalized to one and measured in levels).

The two top panels report the response of the key macroeconomic variables. The main effect works through investment: firms react to the positive technology shock by increasing investment by about 1.0 percent above its steady state level in the first year (panel A). The expansion of output is relatively more muted and delayed (panel B), reflecting a more gradual pick up in consumption. The increase in investment drives up the demand for loans, so that one year after the shock loan growth is about 0.9-1.0 percent above steady state (panel C).

The ratio between bank capital and assets declines over the first two-three years. The minimum value, close to 0.4 percentage points below the 9 percent steady state value, is reached after 10 quarters (panel D). The decline reflects the increase in loans in the denominator (panel C), as well as a contraction of bank profits, which affects the numerator via the bank capital accumulation equation (3). The decline in profits is related to the decrease of the policy rate by the central bank in response to the decline in inflation, and to the presence of a mark-up on the loan rates and a markdown on deposit rates. The mark-up and the mark-down are sticky. Hence, as the policy rate is reduced by the central bank, the interest rate margin falls and, since the price effect dominates the quantity effect, so do profits.[15] Notice that by construction the weights w_t^i in panels E and F do not move, as under Basel I they are fixed at 1.

Consider next the same exercise under Basel II (represented by the solid blue lines). In a nutshell, the system's responses are qualitatively similar, but slightly more pronounced than in the Basel I scenario. The reduction in the risk weights w_t^i is the key driver of the system's enhanced response. Both weights decline in the 2 years after the shock, reflecting improved macroeconomic conditions and the related decline in the riskiness of the loans. The sharper decline of w_t^F is due to its higher sensitivity to cyclical conditions (a higher χ_i in (6)). This drives the ratio between banks' capital and risk-weighted assets away from the desired value ν. To boost loans and reduce this gap, banks reduce interest rates on loans more aggressively than under Basel I.

The response of bank credit is always above the corresponding curve under the Basel I framework. The effect is relatively small, however. A similar reaction emerges for banks' capital/assets ratio.[16] The expansion in bank credit boosts investment growth: the deviation from steady state peaks about 2 years after the shock, at about 1.4 percent, vs. about 1.3 under Basel I. The effect on output is also magnified but muted.

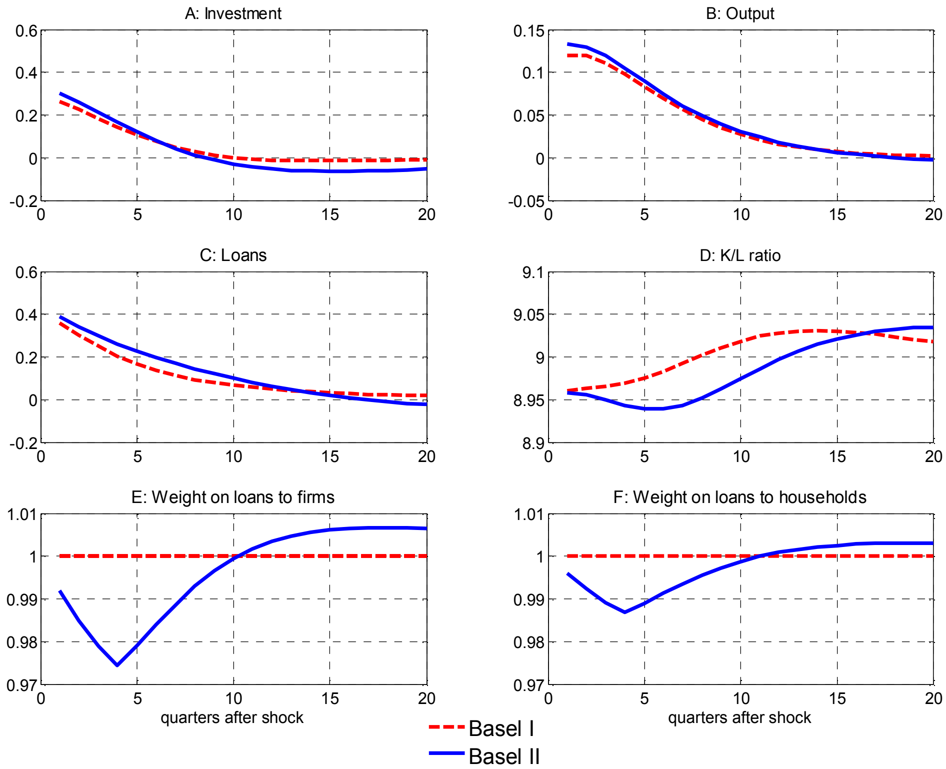
Figure 2 shows the results for an expansionary monetary policy shock. The effects on the macroeconomic variables are qualitatively analogous to those in figure 1: in the first 8-10 quarters the curves for Basel I are systematically below those for Basel II. However, the difference is negligible, as the curves virtually overlap. The limited impact of Basel II reflects the behaviour of the time varying weights w_t^i: whereas the technology shock described in figure 1 induced a large and persistent decline in the weights, the monetary policy shock causes a reduction of the risk weights that is too small and short-lived to alter significantly the dynamics of the bank and macro variables. In turn, this is due to the small and short-lived reaction of output to a monetary policy shock (a relatively common finding in the DSGE literature). The small additional pro-cyclicality induced by Basel II according to the exercises in figure 2 echoes several findings in the literature, according to which financial frictions do not significantly amplify the transmission of monetary policy shocks (see, among others, De Fiore and Tristani, 2009, De Graeve, 2008 and Iacoviello, 2005). At the same time, our result is in contrast with Aguiar and Drumond (2009), the only other paper which focuses on the Basel I vs. Basel II issue within a DSGE framework. They find

[15] Empirically, the differential between loan and deposit rates is countercyclical. See e.g. Aliaga-Diaz and Olivero (2008) for evidence on the U.S.

[16] This decline is also due to the fall of bank profits, which is sharper under Basel II.

that, in the case of a monetary policy shock, the impact of Basel on the model dynamics in general and on output in particular is larger than in our case (both for the effect of Basel I, and for the Basel II vs. Basel I differential).[17]

Figure 2 - Impulse responses to a positive monetary policy shock: Basel I vs. Basel II



Note: the impulse responses are measured as percentage deviations from steady state, except for the *K/L* (measured in percentage points) and the weights w^j (normalized to one and measured in levels).

As a third experiment, we examined a positive demand shock, modelled as a decrease in the intertemporal discount factor which induces both types of households to anticipate consumption and reduce savings. This type of disturbance, which affects directly households' intertemporal first order conditions, is commonly considered in estimated medium scale models (see Primiceri *et al.*, 2006 and Smets and Wouters, 2007). A feature of this type of shocks is that it typically generates opposite movements in consumption and investment. This does not match the pattern observed in reality, as the correlation, along the business cycle, between consumption and investment is strongly positive in most economies. Thus, the quantitative importance of these shocks for the business cycle tend to be relatively modest, and the positive correlation between consumption and investment may

[17] This difference may be due to alternative modelling choices. Aguiar and Drumond (2009) build on the Bernanke, Gertler and Gilchrist (1999) framework, whereas our model is based on the financial accelerator mechanism of Kyiotaki and Moore (1997).

reflect other, more important drivers of the business cycle (e.g. technology shocks, which push consumption and investment in the same direction).

The debate on this issue clearly lies outside the scope of the present paper. For our purposes, it is important to remark that following this type of demand shock investment falls, and so do bank loans; these movements are dampened (i.e. the contraction is more modest) under Basel II. Overall, output growth is (slightly) stronger under Basel II, as the growth in consumption offsets the fall in investment.[18] Thus, a strict GDP-based interpretation of the definition of pro-cyclicality proposed in the introduction (an arrangement is pro-cyclical if it amplifies the cyclical fluctuations of the economy), we can still conclude that adoption of Basel II produces a (modest) increase in pro-cyclicality. However, the muted contraction of bank loans (and investment) under Basel II makes one wonder whether simply looking at the behaviour of output is the proper thing to do.

Summing up, our findings suggest that the transition from Basel I to Basel II can amplify the dynamics of bank loans and capital/asset ratio and, ultimately, the fluctuations of the real economy. Furthermore, recalling that our exercises in figures 1 and 2 can also be interpreted as a comparison between the Point in Time (PIT) vs. Through the Cycle (TTC) rating approaches under Basel II, our evidence also suggests that the PIT approach introduces extra pro-cyclicality relative to the TTC. Our key finding, however, is that the magnitude of this amplification effect appears to be relatively small.[19]

This assessment must be qualified with the following two caveats. First, there are at least two reasons why, *ceteris paribus*, the above exercises may overestimate the extra pro-cyclicality induced by Basel II. One is that they only partially incorporate banks' optimal response to shocks and regulatory changes. As we discuss below, several authors contend that forward-looking banks will react to Basel II by holding voluntary countercyclical buffers. By contrast, we have assumed so far that ν (the parameter pinning down the steady state value of banks' capital/assets ratio) is time invariant. We shall address the issue of a time varying ν in section 5.1. Another potential source of overestimation is that our estimates of equation (6) are based on quarterly delinquency rates, and should therefore approximate a pure PIT approach.

Second, several shortcomings of the model may have an ambiguous impact on the magnitude of the Basel II vs. Basel I effect, thereby increasing the confidence interval

[18] The decrease in the households' discount factor makes them more impatient and causes an increase in consumption and output, and a reduction in savings (deposits fall by around 0.6%). The fall in deposits forces banks to reduce lending to firms (who cut investment spending) and to households. The initial increase in spending on capital goods reflects the large increase in the price of firms' installed capital stock. The fall in risk-weighted loans and the slow increase in bank capital, resulting from higher profits, raises the capital/asset ratio above the desired value ν. As for the technology shock, both weights decline in response to the demand shock. Profits increase under Basel I while they fall under Basel II. This difference reflects the response of loan rates, which increase more under Basel I than under Basel II.

[19] Our assessment of the pro-cyclicality of capital regulation may be affected by the parameter measuring the costs of adjusting the capital/assets ratio, κ_b ,in equation (1). We analyze the issue in section 3.2 below.

around our assessment. Other features yet are likely to generate an underestimation of this effect. We discuss them in section 5.

3.2 Robustness

Our results turn out to be sensitive, inter alia, to the estimated values of ρ and χ, whose point estimates are subjected to particular uncertainty, for the reasons just mentioned. Therefore, we now assess the sensitivity of our findings to alternative values for ρ^i and χ^i, the key parameters in equation (6). We gauge the impact of modifying these parameters on output and bank loans, the key variables that characterize the results of figures 1 and 2. We replicate the exercise underlying the figures under different values of for ρ^i and χ^i. These figures are judgmental – i.e., they are not estimated – and their only aim is to test the robustness of our results. In Table 1 we only report the results for the technology shock, as those for the monetary policy shock remain virtually unchanged.

Table 1 - Sensitivity of results to parameterization of eq. (6): technology shock

(*Maximum effect; % deviations from steady state*)

		Effect on output (0.6 under Basel I)			Effect on loans (1.0 under Basel I)		
		ρ^i			ρ^i		
		0.70	Baseline	0.97	0.70	Baseline	0.97
χ^i	Baseline	0.6	0.6	0.6	1.1	1.0	1.0
	Baseline * 5	0.7	0.7	0.7	1.9	1.4	1.1
	Baseline * 10	0.8	0.9	0.7	3.1	2.4	1.5

Note: the baseline values for χ^i and ρ^i (i=*F*, *H*) are those reported in the appendix, and used in figures 1 and 2. The estimated ρ is in the range 0.9-0.93 (i.e. larger than 0.7 and smaller than 0.97) for both households and firms.

For ease of comparison, the intersections of the row and columns labelled "baseline" report results from figure 1, Basel II scenario. For instance, consider the effect of the technology shock on output (left-hand side of the table). Using the baseline estimates of ρ^i and χ^i one obtains a maximum deviation of investment from its steady state value of 0.6%. This value is the maximum of the impulse response curve of output under the Basel II regime, reached after about 7-8 quarters (figure 1.B). Likewise, the maximum effect on loans, 1% of the steady state value, reached after 5 quarters, can be read off figure 1.C.

The other cells of the table report the results of three exercises. First, we keep the autoregressive parameters ρ^i fixed at their estimated baseline levels, and increase the sensitivity χ^i of the weights to the business cycle. Second, we move the autoregressive parameters ρ^j above or below their estimated baseline levels while keeping the χ^j at their baseline values. Finally, we allow both parameters to differ from the baseline. Note that the low ρ^j, high χ^j cells can also be interpreted as corresponding to a version of the Point in Time (PIT) rating approach more extreme than that under our Basel II baseline scenario in figures 1 and 2. Vice-versa, the high ρ^j, low χ^j cells could be viewed as capturing a Through the Cycle (TTC) less extreme than under our Basel I scenario in figures 1 and 2.

Overall, this robustness check confirms the results of figures 1 and 2. Consider first the effect on output (left-hand side of the table). In all cases the introduction of Basel II increases the pro-cyclicality relative to Basel I. Pro-cyclicality is also increased when moving from less to more PIT rating systems, i.e. moving from the upper right corner to the lower left corner of the table (although a slight non-monotonicity appears in the figures: the effect under ρ^j=0.7 is slightly larger than under the baseline value, which is above 0.9). The magnitude of the effects induced by the Basel II regulation is almost insensitive to the autoregressive parameter ρ^j, relatively more sensitive to the χ^H, χ^F parameters: assuming that the true values of these parameters are ten times larger than the estimated baseline, the pro-cyclical effect on output increases from 0.6 to 0.9 in terms of maximum deviation from the steady state value. Overall, the effects would remain modest even if we were to admit that our baseline χ^j were significantly underestimated.

Next, look at the effect on loans, on the right-hand side of the table. The above effects are confirmed from a qualitative viewpoint, but become more sensitive to the choice of ρ^j and χ^j. In reaction to the technology shock, loans grow up to a maximum of 2.3% of their steady state value when χ^j are ten times larger than the estimated baseline, vs. 1% when the baseline values are used.

We also check the sensitivity of the results to the estimated value of κ_b, the parameter measuring the cost of deviating from the optimal capital/assets ratio ν in (1). To this end, we increase this parameter up to 10 times its baseline value, and compute the impulse responses for technology, monetary policy and demand shocks. These simulations reveal that the effect of this parameter is relatively large if one focuses on the Basel I scenario (following a technology shock, the expansion of loans and investment is smaller if κ_b is larger); however, it is marginal if one looks at the Basel II-Basel I difference.

3.3 Summary

In this section we have shown that the shift from Basel I to Basel II increases the pro-cyclicality of bank lending, i.e. that the reaction of macroeconomic variables such as output and investment to shocks is relatively larger under the Basel II regime compared to Basel I. However, our results indicate that the magnitude of this amplification effect depends on the type of shock considered, and appears contained.

This conclusion is subject to a series of caveats. To begin with, the magnitude of this impact depends on a number of model features (discussed in section 5), which make our estimate particularly uncertain at this stage. In addition, admitting that the extra pro-cyclicality induced by Basel II is small does not entail that one should do nothing about it: if the cost of eliminating it were likewise small, then it would be optimal to address the problem. Finally, Aguiar and Drumond (2009), who employ a similar DSGE framework to address the issue, find that the amplification effect induced by Basel II is larger than suggested by our estimates.

Therefore, in the rest of the paper we consider possible remedies to the pro-cyclicality induced by the Basel II regulation, assessing their benefits and cost.

4) Assessing costs and benefits of countercyclical measures

In the current policy debate several proposals to reduce the pro-cyclicality induced by Basel II have been advanced. Section 6 of the paper reviews and discusses these proposals in some detail. In short, they can be grouped under the following headings: (*i*) smoothing the inputs of the capital function (for instance, banks could be required to mitigate the cyclicality of their PIT estimates of the PDs, or to move to TTC estimation methods); (*ii*) adjusting the capital function (for instance, some parameters such as the confidence level or the asset correlations could be appropriately changed over the cycle); (*iii*) smoothing the output of the capital function (i.e., allow capital requirements to move in an autoregressive or countercyclical fashion); (*iv*) adopting countercyclical capital buffers; (*v*) adopting countercyclical provisions.

For the purposes of this section, it is enough to remark that the model with which we work does not allow us to distinguish among these proposals (as it makes no distinction between capital and loss provisions, say). However, it does allow us to assess their macroeconomic effects if one is willing to overlook the (important) technical differences among these suggestions, and concentrate instead on their common denominator. In our view, such common denominator is the idea that capital (or provisions) should be adjusted in a countercyclical fashion.

In the next subsection we gauge the effects of implementing countercyclical (regulatory or voluntary) capital buffers on pro-cyclicality. In section 4.2 we assess the impact of higher capital requirements on pro-cyclicality.

4.1 Implementing a countercyclical capital

So far, we have worked under the assumption that the key parameter ν is time invariant. This is in keeping with the current policy framework, under both Basel I and II, and with the idea that banks like to keep voluntary capital buffers constant at the minimum possible value. However, a natural extension is to consider a time-varying ν. Within our framework, this represents the most straightforward way to assess the effect of countercyclical capital requirements. Consider the following equation:

$$\nu_t = (1-\rho_\nu)\bar{\nu} + (1-\rho_\nu)\chi_\nu(\log y_t - \log y_{t-4}) + \rho_\nu \nu_{t-1} \tag{7}$$

where the parameter $\bar{\nu}$ measures the steady state level of ν. In (7), we assume that ν_t adjusts to year-on-year output growth, our measure of the business cycle, with a sensitivity equal to the parameter χ_ν. Assuming that the latter is positive amounts to imposing a countercyclical regulatory policy: capital requirements increase in good times (banks hold more capital for given amount of loans they provide to the economy), and vice-versa.

Note that adding (7) to the model affects the cyclical pattern of the main variables but not their steady state levels, and is therefore neutral in this sense. The reason is that the steady state of the model is affected only by the value of $\bar{\nu}$ and not by the dynamics of ν, which are influenced by the sensitivity of capital requirements to output. Therefore, in what follows we focus on the effects of adopting (7) on the dynamics of the economy.

Recall from section 2 that ν has a twofold interpretation: as a capital requirement and as a buffer voluntarily held by banks. This interpretation carries over to ν_t and to equation (7): the regulator might decide to implement a countercyclical capital requirements policy; alternatively, banks might voluntarily choose to hold countercyclical capital buffers. In what follows we look at these two interpretations, in the order.

4.1.1 Countercyclical management of capital requirements policy

Is there room for countercyclical capital requirements? At first sight, the answer seems to be no, within our model as well as in general: the Taylor rule which closes the model is the natural countercyclical tool, and it would seem that any new instrument with such target should at best be collinear with monetary policy, and at worst conflict with it (e.g. if the responsibility of the new instrument were assigned to another authority and co-ordination between the two authorities were limited). However, models, including ours, feature several frictions, some of which are related to the presence of nominal rigidities (prices and wages) and others to the presence of borrowing constraints on households and firms. Therefore, an additional instrument might well improve upon the result attainable when only monetary policy is available.[20]

The literature has only very recently started studying optimal monetary policy in the context of models with financial frictions. Cúrdia and Woodford (2009) find that the in simple new Keynesian (NK) model with time-varying credit (arising because of financial

[20] Woodford (2003) shows that in a simple economy with one friction, optimal monetary policy is capable of restoring the first best allocation. However, Erceg, Henderson and Levin (2000) show that in an economy with staggered wage and price setting, strict inflation targeting can induce substantial welfare costs. This result suggests that when more than one friction is present, policy-makers may want to resort to multiple instruments to maximize society's welfare.

frictions) the optimal target criterion (i.e. the optimal monetary policy) remains exactly the same as in the basic NK model, that is the central bank should seek to stabilize a weighted average of inflation and output gap. In the context of a similar small-scale model, De Fiore and Tristani (2009) show that in the presence of a credit channel, near-full inflation stabilization remains optimal in response to specific shocks.

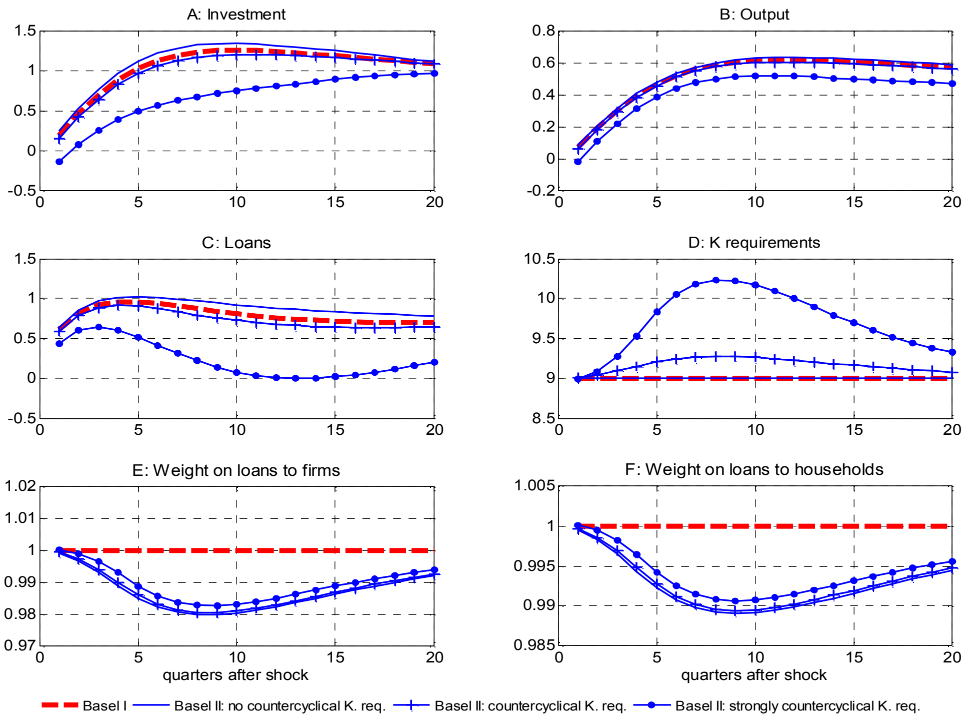
In this section we interpret equation (7) as a simple capital requirement reaction function, where the parameter $\bar{\nu}$ measures the steady state level of capital requirements ν_t and χ_ν>0 measures its sensitivity to the business cycle. As in section 3, we look at the effects of introduction of the capital requirement reaction function (7) on the dynamics of the model by examining the responses to various shocks. For comparison, the figures report the curves from figures 1 and 2 obtained under Basel I, a useful baseline since we have seen that its pro-cyclicality is a lower bound.

The results are in Figure 3. As usual, we start with a positive technology shock. Consider the responses of investment, in panel 3.1.A. The two top lines in the figure illustrate the reaction under Basel I (blue) and Basel II (dotted red). They are exactly those reported in figure 1, for ease of comparison. The two new lines are obtained with a countercyclical management of the capital requirement, i.e. simulating the model augmented with equation (7). Specifically, the solid blue curve labelled "Basel II: countercyclical K requirement" is obtained by setting ρ_ν= 0.90 and χ_ν= 20 in (7). The figure clearly shows that this policy can undo the extra pro-cyclicality induced by Basel II relative to Basel I, and indeed, to improve upon Basel I. How is this stabilization achieved? The basic mechanism is the same as illustrated in section 3. The stabilization policy dampens loans growth (panel C). In turn, this is due to the fact that the expansion of output drives up the capital requirement ν_t. The above parameterization for ρ_ν and χ_ν in (7) causes ν_t to gradually increase from its steady stage of 9.0 percent to a maximum of 9.3 percent after about 8 quarters (panel D).

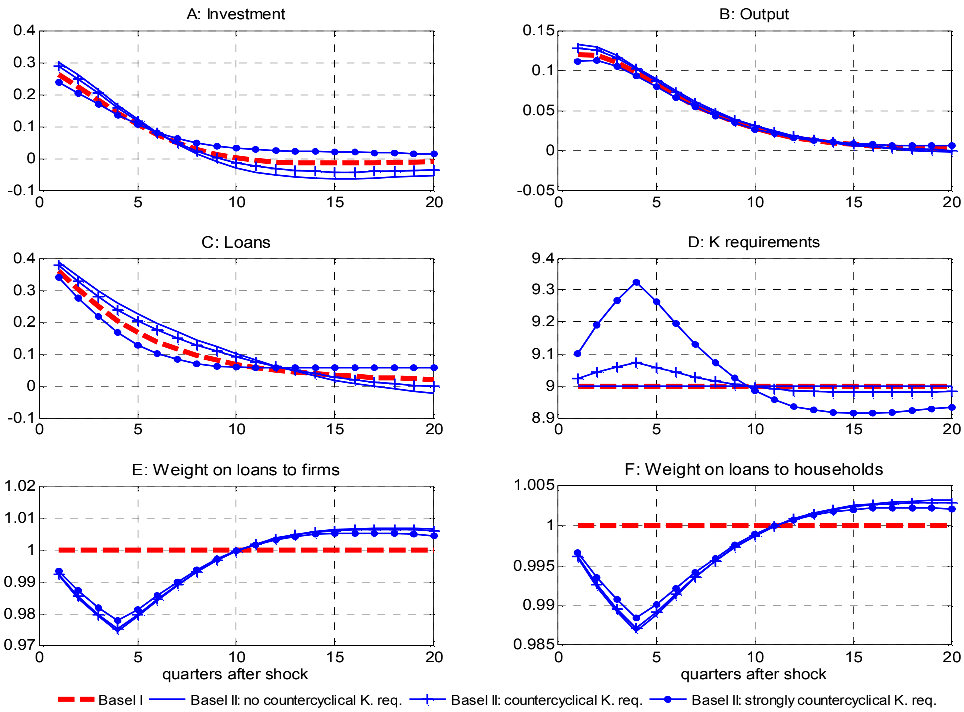
The response of output, in panel B, confirms this message from a qualitative viewpoint, although the small dimension of the effects, documented in section 3, causes the curves to be very similar. Notice that in this case, the risk weights in panels (E, F) are hardly affected, and consequently play a minor role.

Figure 3 – Impulse responses with passive vs. countercyclical capital requirements

3.1 Positive technology shock



3.2 Expansionary monetary policy shock



Note: the impulse responses are measured as percentage deviations from steady state, except for the capital requirement (measured in percentage points); the responses of weights w^j are normalized to one and measured in levels. To ease the interpretation, in panel (2) the curves have been computed using a value of χ^j in (5) five times larger than the baseline.

To assess the sensitivity of the results we simulated the model setting χ_v to 100. The resulting responses are labelled "Basel II: strongly countercyclical K requirement". A look at the usual sequence of panels in figure 5.1 reveals significant changes. The responses of investment and output are now well below the Basel I benchmark, pointing out that the dampening effect on pro-cyclicality is now relatively marked. This effect is obtained with a 1.2 percentage points increase of the capital ratio, from the steady state value of 9 percent to a peak of 10.2 after about two years. The order of magnitude of this increase does not look unreasonable.

According to the interpretation which we adopt in this section, equation (7) is a policy reaction function. Hence its parameters could be chosen optimally, so as to minimize pro-cyclicality, say, or maximize welfare. We leave this task for future research. The point of the simple exercise just described is to show that a countercyclical capital requirement policy can achieve relatively powerful results.

Panel 2 of figure 3 replicates the exercise for a monetary policy shock. Overall, the results of panel 1 are qualitatively confirmed. As in previous sections, the difference across the different regulatory regimes turn out to be small when this type of shock is considered. In this case, the "countercyclical K requirement" policy manages to improve on the passive policy, but still leaves more pro-cyclicality than under the Basel I framework. To improve on the latter, the "strongly countercyclical K requirement" policy should be adopted.[21]

Overall, our results suggest that introducing policy tools that allow building up and using buffers of resources in a countercyclical fashion may yield benefits, relative to an environment in which only the interest rate instrument is available to the policy-maker. The practical implementation of this countercyclical capital requirements policy is the subject of section 6. As we shall see, such policy need not be discretionary i.e., its implementation need not require periodic meetings of a Board, as it could be rule-based.

4.1.2 Would banks voluntarily adopt a countercyclical capital policy rule?

In our simplified framework, v_t can be thought of as comprising a buffer voluntarily held by banks (e.g. to face unexpected losses) because the current version of the model does not distinguish between capital and provisions. Therefore, one may view equation (7) as an admittedly rough way to let banks – not the regulator – choose a (possibly countercyclical) capital buffer. Indeed, as mentioned above, various authors (Repullo and Suarez, 2008 and Tarullo, 2008) argue that forward-looking banks will find it optimal to manage their excess capital buffers in a countercyclical fashion, and that this endogenous

[21] Like in previous cases, we consider also a demand shock. The results (not reported) confirm the analysis of the previous sections. Conditioning on this type of shocks, the success of the "countercyclical K requirement" policy is clearcut if one sticks to a strict definition of pro-cyclicality (output increases, and the increase is dampened under the countercyclical policy); it is ambiguous if one considers the entire economy (loans and investment decline, and the decline is enhanced under the countercyclical policy).

response has the potential to offset to a significant extent the extra pro-cyclicality induced by the new regulation.[22] If this were the case, regulatory intervention on capital requirements could turn out to be largely redundant.

A straightforward way to check whether this may be the case within our framework is to look at bank profits (the interest rate margin, more precisely) under Basel II, with and without the countercyclical capital policy (7). Clearly, if banks can increase profits by voluntarily adopting countercyclical capital buffers, they will not wait for the intervention by the regulator to implement such a policy.

Figure 4 reports the impulse response of bank gross profits (i.e. before capital depreciation) to the usual technology and monetary policy shocks under the four regimes discussed in the previous section: the Basel I and Basel II regimes underlying figures 1 and 2; the Basel II regime with the "countercyclical" and strongly countercyclical" policy (7) underlying figure 3.

Look at the first panel, reporting the response of bank profits to a technology shock. Gauged with the yardstick of bank profits, the worst regime is Basel II with fixed capital buffers; next comes the Basel I regime; then, the Basel II with time-varying, countercyclical capital buffers ("countercyclical K requirement"). The best is the Basel II with "strongly countercyclical K requirement". Thus, it seems that a countercyclical accumulation of voluntary capital buffers would be in the banks' own interest.

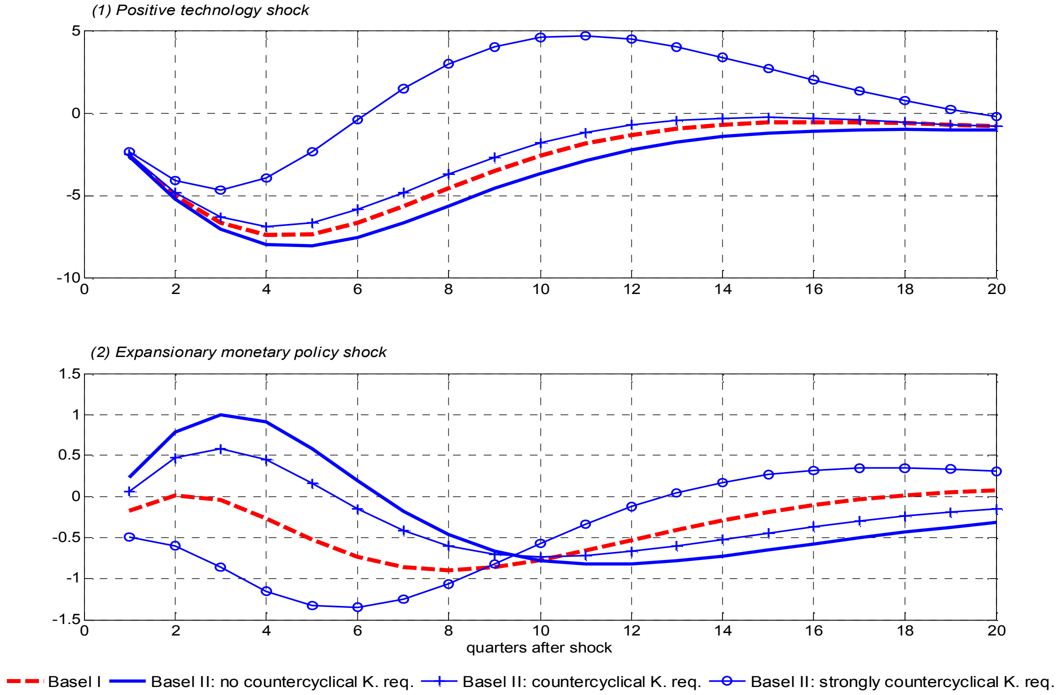
Next, consider panel 2, reporting the response of profits to the expansionary monetary policy shock. Here the results become ambiguous. Specifically, the ordering of the curves depends on the time horizon: a policy of countercyclical capital buffers accumulation would initially harm profits. When a countercyclical policy is implemented, capital requirements are increased exactly when the capital/assets ratio falls because of the expansion in lending. As a consequence, the fall in bank loan rates induced by the expansionary monetary policy is partly off-set by the increase in costs related to the bank capital position (see equation 2) and, consequently, profits fall by a larger amount. Overall, the figure suggests that banks would shy away from such a policy. As usual, we also considered a positive demand shock. The message emerging from the related figure (not reported) is in line with that of panel 1.

Summing up, several authors argue that, faced with the Basel II regulatory change, banks will find it optimal to (partly) offset the additional pro-cyclicality by appropriately choosing voluntary capital buffers. Our analysis provide only partial support to this argument. As is often the case within the context of analyses conducted with DSGE models, the optimality of certain economic actions is not uniquely determined, being conditional on the nature of the shock hitting the economy. As such, our results lends

[22] Repullo and Suarez (2008) suggest that these buffers would range from about 2% of total assets in recessions to about 5% in expansions.

support to the view that a policy of countercyclical management of capital requirement, enforced by a regulator, would not be redundant.

Figure 4 - Impulse responses of bank profits under alternative regulatory regimes



Note: the impulse responses are measured as percentage deviations from steady state. To ease the interpretation, in panel (2) the curves have been computed using a value of χ^j in (5) five times larger than the baseline.

4.2 Increasing banks' regulatory capital

Due to the current crisis, proposals to raise the regulatory minimum capital above 8%, or to improve capital quality, have recently come back to the fore. It is widely acknowledged that excessively low capital levels of financial institutions were a propagating factor of the current crisis. Relatively small losses, concentrated in time and affecting many intermediaries at once, triggered a de-leveraging whose consequences have been so far reaching. Clearly, the adjustment could have been much less dramatic if the capital base had been larger, i.e., if the leverage of the system had been lower. However, in the current policy debate proposals to increase banks' regulatory capital are seldom explicitly motivated with the need to reduce pro-cyclicality (see e.g. FSF, 2008 and 2009). This is probably due to the fact that the link between pro-cyclicality and the level of capital is not obvious. Intuitively, one could think that, as long as the cost borne for deviating from the minimum requirement is unchanged, it is immaterial whether the minimum is set at 8 or at a much higher level.[23]

Within our model an increase in ν does have an effect on the dynamics of the key macroeconomic variables.[24] In more intuitive terms, the effect of ν on the system dynamics may be seen as working through bank leverage: raising ν increases the steady state value of the capital assets ratio, reducing leverage. While this should univocally dampen the accelerator effect and therefore reduce pro-cyclicality, in practice we shall see that the result is ambiguous. Thus, we first assess whether higher capital requirements increase or decrease pro-cyclicality. Next, we look at the macroeconomic costs of higher capital requirements.

For the first task, we use the baseline parameterization of our model to compute impulse response functions of bank variables and key macroeconomic variables to different shocks, adopting several different, plausible values for ν. Figure 5.1, the counterpart of figure 1, reports the reaction to a positive technology shock. The curves labelled ν=0.09 are those of the baseline exercises in figure 1, reported for ease of comparison. The figure suggests that higher capital requirements dampen the reaction of the key bank variables: the curves for loans and the capital/assets ratio corresponding to higher ν are relatively closer to zero (panels C, D).[25] In turn, the dynamics of loans affect investment (panels B, C) and ultimately output.

Figure 5.2 replicates the same exercise for an expansionary monetary policy shock. Since under the baseline parameterization the curves virtually overlap in all the panels, we plot the responses obtained setting χ_j five times larger than the baseline; this magnifies the differences without altering their sign. The results appear now to be reversed, although they are not clear cut. The rate of growth of bank loans is higher in the first 6-7 quarters after the shock, but becomes lower afterwards. Increasing the capital requirement seems to have a pro-cyclical impact on investment and output, although the effects are negligible and short-lived.

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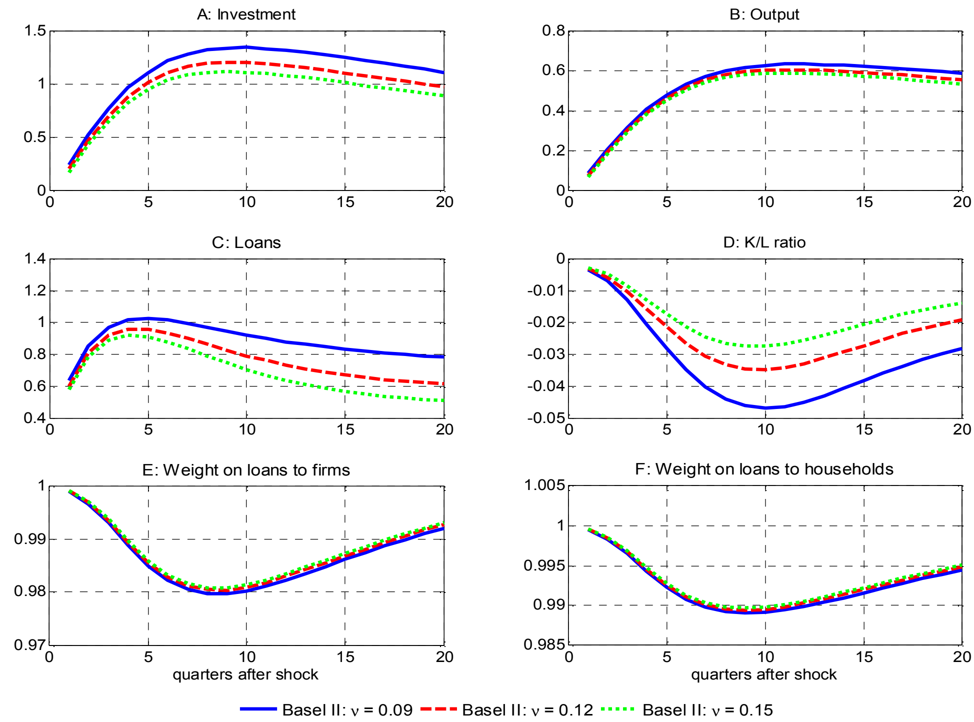
[23] This point is well summarized by Brunnermeier *et al.* (2009): "requirements based on minimum capital ratios do not provide resilience, since they cannot be breached. They represent a tax, not a source of strength". They thus suggest to introduce higher target levels of capital, with a specific, rule-based ladder of increasing sanctions.

[24] There are two indirect (and technical) effects. First, the depreciation parameter δ_b in equation (3) is determined by the parameter ν (via a series of conditions discussed in Gerali *et al.,* 2009, which we have omitted from section 2). Thus, increasing ν causes a decline in δ_b which affects the dynamics of capital accumulation via (3). Second, looking at the log-linear approximation to eq. (2) used to derive the impulse response functions presented throughout the paper, one can see that a higher ν implies that a given deviation of the capital/assets ratio has a greater effect on the interest rates set by banks.

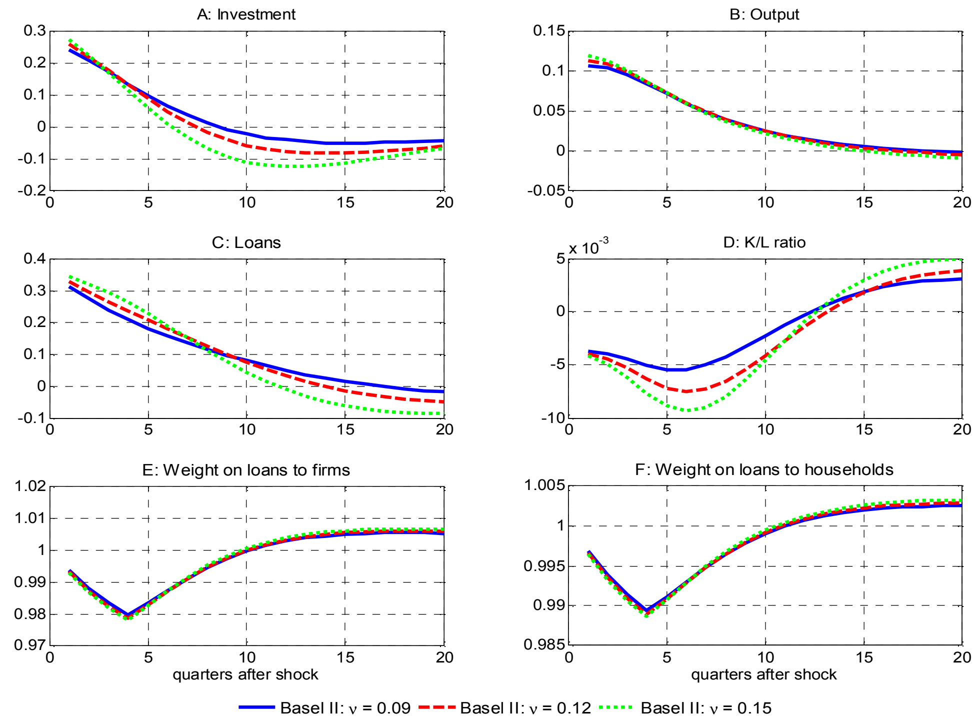
[25] The curves in figure 3 are derived from models with different steady states. They are comparable because they are expressed in terms of percentage deviation from the steady state.

Figure 5 - Impulse responses under different levels of capital requirements

(1) positive technology shock



(2) Expansionary monetary policy shock



Note: the impulse responses are measured as percentage deviations from steady state, except for the capital requirement (measured in percentage points); the responses of weights w^j are normalized to one and measured in levels. To ease the interpretation, in panel (2) the curves have been computed using a value of χ^j in (5) five times larger than the baseline.

As in section 3.1, we also considered a positive demand shock (figure not reported). The results obtained with the baseline parameterization of the model are somewhat ambiguous: the response of output is positive and increasing in v. Loans decline, reflecting the fall in investment. However, the fall is dampened for higher values of v. Overall, the difficulties of interpreting the outcome of this exercise mirrors those discussed in section 3.1.

Finally, we analyzed the robustness of these results to alternative choices of the key parameters in equation (6). For values of χ^j five or ten times larger than the baseline, the result of figure 3.1 vanishes: it is no longer true that higher values of v yield lower pro-cyclicality – indeed, they tend to produce higher pro-cyclicality. Figure 5.2 is already drawn under the assumption of χ^j five times larger than the baseline. Setting them to 10 times the baseline magnifies the pattern: higher values of v yield higher pro-cyclicality. The same holds true for the demand shock experiment: when χ^j are increased, higher v is associated with a larger response of output to the shock.

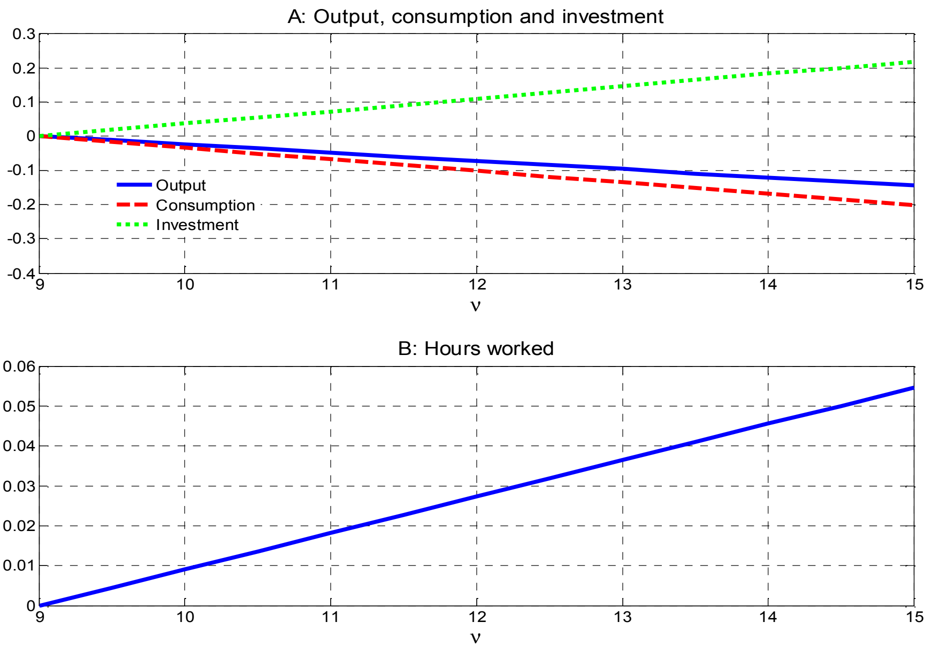
Summing up, the impact of higher capital requirements on pro-cyclicality is virtuous under the baseline parameterization of our model. However, it depends on the type of shock considered, and it is also somewhat sensitive to the model parameterization.

Next, we assess the effect of higher capital requirements on the steady state values of the key economic variables. Figure 6 reports some key results from this exercise. In each panel, values of ν ranging between 9 and 15 percent are measured on the horizontal axis. The figure suggests several interesting insights.

First, output monotonically decreases as ν is increased (panel A). This result appears intuitive: higher capital requirements should make the economy more stable, but at a cost, along an ideal efficiency-stability trade-off. Second, the decline in output is modest: the steady state level of output under ν=15 percent would be only 0.2 percent lower than under the baseline ν=7 percent. However, this effect must be qualified. To begin with, the decline in output takes place in concomitance with an increase in the equilibrium amount of hours worked: to prevent consumption from falling, workers choose to work more (panel B). This implies that a broader measure of welfare would signal that the cost of higher capital requirements are larger than suggested by simply looking at traditional measures, such as GDP and its components. In addition, the decline in output reflects diverging patterns for its components. Specifically, the steady state level of consumption decreases monotonically with the level of ν, while investment increases. In turn the increase in investment is driven by an increase in loans, which may be rather model specific and could not be robust to alternative modelling choices of the bank sector. Summing up, output, as well as the aggregate welfare of households and entrepreneurs, fall monotonically as ν is increased; the estimated decline is modest, but the caveats just given suggest that it could be a lower bound.[26]

These results suggest some policy implications concerning proposals to increase capital requirements. On the pros side, higher capital requirements increase the ability of the banking system to withstand shocks.[27] However, their effectiveness in terms of dampening pro-cyclicality is at best dubious: they may dampen or enhance the sensitivity of bank variables and the key macro variables to the business cycle, depending on the nature of the shock. On the cons side, higher requirements may well reduce aggregate welfare. Overall, with the usual caveats, these results suggest that policy options alternative to higher capital requirements may be better suited to limit pro-cyclicality.

Figure 6 - Increasing ν: effect on the steady state levels of key economic variables



Note: the graphs reports the percentage deviation from the steady state of the variables as ν is gradually increased from the initial value of 9 per cent. ν is measured on the horizontal axis. For output, consumption and investment, the deviations are expressed in annualised terms.

[26] The lower welfare caused by higher capital requirements at the aggregate level stems from opposite effects on savers and borrowers. In terms of consumption equivalents (a measure which is used in the literature when comparing welfare across different steady states), savers should be compensated when increasing capital requirements while borrowers (both households and entrepreneurs) would be willing to pay to move to a steady state with a higher capital requirement.

[27] It must be remarked that in our framework banks and firms never default in equilibrium. Thus, we overlook the fact that higher capital requirements reduce banks' probability of failure, an important factor of stabilization.

5) Technical Discussion

The results derived thus far are relatively clearcut, and reasonably robust to a series of alternative assumptions about certain model features and parameters. However, the amount of uncertainty surrounding our estimates is certainly much higher than for many other macroeconometric works. In what follows we list a series of technical issues which warrant this statement, or that may lead us to suspect a bias of some sort in our baseline estimates, and in particular, in one of our key results (that the extra pro-cyclicality injected by Basel II is small).

(i) The model used in the present paper belongs to a family which rules out firm and bank defaults in equilibrium. Models in this family include Kyiotaki and Moore (1997), and more recently Iacoviello (2005), Iacoviello and Neri (2009). Alternative models, in which defaults can and do happen are Bernanke Gertler and Gilchrist (1999), Christiano, Motto and Rostagno (2007). It remains to be seen whether a different macroeconomic environment could alter our conclusions.

(ii) The model does not differentiate between required capital and buffers voluntarily held by banks. As discussed in sections 3.2 and 4.1.1, there are reasons to believe that banks would at least in part offset the extra pro-cyclicality induced by Basel II via such buffers.

(iii) In Section 4.2 we saw that as ν is increased, so do investment and loans. This effect may be model-specific and could not be robust to alternative modelling choices of the bank sector.

(iv) Bank lending rates incorporate changes in the capital requirement via equation (2). However, they do not take into account potential changes in the idiosyncratic riskiness of households and firms. In principle, rates on loans to firms, say, should increase in reaction to an increase in the riskiness of firms (measured by w^F).

(v) In the current version of our estimated model, the steady state ratio between investment and output (defined as the sum of consumption and investment) is around 13 per cent. This compares to 26 per cent on average using euro area data. This is likely to induce an underestimate of true effects because in our environment Basel II works primarily through the effect on investment.

(vi) In our model bank capital has an implicit cost, given by the depreciation rate, but no explicit cost. Under alternative modeling choices, capital can be made a choice variable for banks and be assigned an explicit cost, possibly varying through the cycle.

Other things equal, features under (iii)-(vi) point to a potential downward bias in our estimate of the pro-cyclical effect of Basel II, whereas (ii) points in the opposite direction. The sign of the net effect is hard to tell.

6) The policy debate on countercyclical tools

The results of the previous sections may help financial regulators to give operational content to the recommendations of the G20 Leaders, published in April 2009. First, our analysis confirms that the transition to Basel II has to some extent enhanced the effects of banks' capital on the dynamics of loans and, ultimately, on the real economy. Our results suggest that the magnitude of this effect may have been overemphasised so far. However, they are consistent with the view that some correction to the current prudential framework is warranted, and that the policy-maker should eliminate potential pro-cyclical effects of capital regulation. Our analysis also suggests that this additional safeguard is better obtained through countercyclical buffers than with a simple, once and for all increase in capital requirements.

Our model cannot distinguish among the various proposals since they are too complex and detailed to be shaped in our simplified framework. Hence, in this section we review the main proposals for introducing countercyclical devices within and besides the Basel II framework, commenting on their pros and cons. We conclude with a discussion which expresses our own views.

6.1. Review of the main proposals

6.1.1 Smoothing the inputs of the capital function

Specification of more binding rules on how banks should estimate risk parameters. - Generally, in most rating systems, the PDs are assigned in a two stage process. First, a rating grade is assigned to a counterparty; next, a PD is assigned to an individual rating grade. Pro-cyclicality can result from (i) migrations (i.e., individual counterparties are assigned better or worse ratings as the cycle improves or deteriorates), and (ii) from recalibration of the mapping from rating grade to PDs (i.e., counterparties in a given rating grade will be assigned a different PD) or from a combination of the two.

In Point in Time (PiT) rating systems the role of factor (ii) above will typically be negligible, whereas factor (i) will be important: in a downturn a large number of borrowers will migrate to worse grades, resulting in higher capital requirements (and vice-versa in an expansion). By contrast, in Through the Cycle (TTC) rating systems migrations to different rating grades are rare and their role as a driver of pro-cyclicality tends to be negligible. In TTC systems some volatility of capital requirements can still derive from factor (ii).[28]

[28] It is difficult to quantify the impact of grade-PD changes, but it might be relevant after a period of unusual and prolonged crisis. For example, as the result of the current crisis, IRB banks are revising upward their grade-PD estimates in order to incorporate new credit conditions; this leads to an increase of risk-weighted assets.

Therefore, compulsory adoption of TTC systems can be seen as a straightforward way to reduce pro-cyclicality induced by capital regulation.[29]

6.1.2 Strengthening stress tests

Another option, which can go together with more TTC ratings, is to strengthen Pillar 2 provisions under Basel II, and particularly stress tests. Bank supervisors already have the responsibility to assess capital adequacy in the light of cyclical conditions and macro-prudential concerns. In particular, Pillar 2 gives supervisors the discretion to require banks to increase capital resources above the Pillar 1 minimum. While not limited to this purpose,[30] Pillar 2 rules have been designed also for reducing cyclicality (this is the reason why stress tests should consider, as a minimum, the impact of a recession on capital adequacy). Banks can be required, for instance, to run stress tests based on common recessionary scenarios set by supervisors and adjust their capital buffers according to the results of such simulations.

6.1.3 Adjusting the capital function

Time-varying confidence levels. - Kashyap and Stein (2004) note that the new prudential discipline aims at ensuring that the probability of default of a single bank stays below a given threshold, regardless of economic conditions. For example, if banks are required to hold enough capital to absorb unexpected losses that may emerge in a one-year horizon at a 99.93 per cent confidence level, the result is a probability of default of the bank over the same time-horizon equal to 0.07 per cent. The time invariance of this value implies that in recession the objective of reducing bank's probability of default is over-weighted and that of keeping sufficient credit flows to the economy is under-weighted (and vice-versa during expansions). Kashyap and Stein (2004) conclude that a policy-maker who cares about both objectives could adopt confidence intervals that change over the business cycle. This conclusion is supported by Repullo and Suarez (2008), who show that simple cyclical adjustments in the confidence level used to compute Basel II capital requirements may significantly reduce pro-cyclicality.[31]

Time-varying asset correlation. – Another option is the adjustment of the asset correlation parameter, which is either constant or dependent on PD levels for different asset

[29] Basel II expresses a favour towards TTC systems, but it does not force banks to adopt them. Indeed, in Europe, most banks implemented hybrid solutions, including both PIT and TTC components.

[30] The role of the supervisory authorities in Pillar 2 is to ensure that banks have adequate capital to sustain all the risks of their business, also in crisis times, and to push the banks to develop and use better risk monitoring and management techniques. The purpose of Pillar 3 (market discipline) is to complement the minimum capital requirements (Pillar 1) and the supervisory review process (Pillar 2).

[31] They propose to reduce the confidence level to 99.8 per cent during periods of high defaults and to raise it above 99.9 per cent during prosperous periods. They claim that this approach would achieve significant gains in terms of alleviating credit rationing without incurring major costs in terms of banks' solvency.

classes. The correlation would be adjusted downwards in bad times and upwards in booms. This approach appears consistent with the conceptual framework behind Basel II, where co-movements in credit risk are driven by a single systematic risk (i.e., the business cycle) which is captured in the model through asset correlation.

6.1.4 Smoothing the output of the capital function

Adjustments based on autoregressive mechanisms. - Gordy and Howells (2006) propose to smooth the output of the capital requirements formula, arguing that this will reduce pro-cyclicality while preserving the informative value of PiT ratings. They discuss an autoregressive filter to be applied to capital requirements of each individual banks, so that shocks are absorbed into the regulatory minimum over several years rather than all at once.[32]

Adjustments based on time-varying multipliers. – A second group of proposal envisage applying a non bank-specific, time-varying multiplier to the output of the regulatory formulae. The multiplier would be higher than one in good times and smaller than one in bad times. It should be announced in each period by national regulators and applied to all banks under their jurisdiction. Gordy and Howells (2006) mention, as an example, a multiplier tied to a moving average of the aggregate default rate for commercial bank borrowers. Repullo and Suarez (2008) propose a multiplier based on the deviation of GDP growth from trend. Goodhart and Persaud (2008) propose to use credit growth. Himino (2009) proposes equity prices.

6.1.5 Buffers based on risk-sensitive conditioning variables

An alternative approach for dealing with cyclicality is to rely directly on risk-sensitive variables. CEBS (2009), for instance, proposes a mechanism for measuring the gap between banks' capital needs in recession and in normal times. Since the probabilities of default are the most relevant source of cyclicality in banks' rating models, CEBS proposes to rescale the PDs estimated by banks in order to incorporate recessionary conditions. In practice, the proposal puts forth a scaling factor, given by the ratio between the current PD and the recession PD. By construction, this factor decreases in a recession and increases in expansionary phases. This scaling factor would be used to multiply the current PD in the regulatory capital formula. The approach can be applied at the portfolio-level (i.e., at the level of each asset class in the banking book).

The key element of the CEBS proposal is that the requirement obtained in this fashion should be used as a benchmark for supervisors when assessing the adequacy of Pillar 2

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[32] They assume that banks' rating systems are PIT. Let C_{it} be the unsmoothed output from the regulatory formula for bank i at time t, as a percentage of the exposure at default. The smoothed capital requirements C^* would be calculated according to an AR(1) filter: $C^*_{it} = C^*_{it-1} + \alpha(C_{it} - C^*_{it-1})$, where α is the degree of smoothing.

buffers. In other words, the adjusted PDs would only serve as a transparent way for identifying worst-case capital needs and, thus, for defining the adequate level of buffers, without altering in any way the current use of the IRB formula for determining the minimum capital requirement. More details can be found in Appendix 2.

6.1.6 Countercyclical provisioning

The proposals reviewed so far focus only on mechanisms to build up capital buffers. However, another possible way to accumulate resources in good times, to be used when the recession hits, is by changing loan-loss provisions.

The choice of the mechanism used for countercyclical provisioning is affected by accounting issues. In fact, current accounting standards allow banks to provision only at the very moment when losses are actually incurred. This can have a pro-cyclical effect, as losses accumulate in good times but emerge in bad times, when the increase in provisions would constrain banks' ability to lend.

A simple mechanism for correcting this pro-cyclical effect would be to align provisions to expected losses. This proposal has been sketched by IASB (2009), according to which provisions should reflect losses that banks estimate will be produced by a portfolio of loans, to be recognised in the income statement on an accrual basis or at origination. Such provisions would change through time to reflect updated estimates of expected losses. The model would require the calculation of the net present value of the expected cash flows (contractual cash flows less expected credit losses).

Another proposal has been put forward in the Turner Review (See FSA (2009a, 2009b)). The proposal links provisions to the stock of outstanding loans. The proportion of provisions to total loans is extrapolated from historical experience and aims at capturing latent losses in the overall loan portfolio. In order to avoid over-provisioning, a cap would be imposed to total provisioning.

So far, though, the only practical example of countercyclical provisions is the Spanish system of dynamic (or "statistical") provisioning. The Spanish approach links provisions to banks' historical loan loss experience. Each year, Spanish banks are required to charge their Income Statement specific provisions for incurred losses, and generic provisions, based on historical credit losses. Generic provisions are an increasing function of the flow of new credit, as well as of the stock of outstanding loans (the parameters of this function are set by the regulator). In good years, credit losses are typically low, and generic provisions are larger than specific provisions; thus, the difference between the two is added to the stock of provisions accumulated in previous years through the same mechanism. In recession years generic provisions will tend to be smaller than specific provisions; in this case, the difference is covered by drawing on the accumulated stock of provisions. A prolonged recession causes this stock to be gradually reduced, but bank capital remains unscathed until the stock of provisions is entirely depleted. The stabilization effect on bank capital is obvious. Spanish rules include upper and lower limits to the stock of general provisions. The cap prevents the accumulation of disproportionately large resources with countercyclical purposes, the floor avoids that such resources are entirely depleted. Both limits have been set by the Banco de España taking into account the impact of past severe recessions. Appendix 3 contains a more technical description of the system.

6.2. Critical assessment of the proposals

The model used in this paper does not help select an ideal system. However, we believe that an analysis of the pros and cons of the proposals just described provides arguments for ruling out some of the approaches.

Requiring banks to use TTC rating systems does not seem either feasible or desirable. As Gordy and Howells (2006) point out: i) TTC ratings would impair the comparability across time of the capital requirement and would make it difficult to infer changes in portfolio risk from changes in a banks' capital ratios; ii) they are poorly suited for internal pricing and risk-management purposes and may thus fail the "use test" provided for by the Basel II framework, which envisages that risk estimates used for the calculation of capital requirements are effectively employed for internal risk management purposes.

Reinforcing stress tests is certainly a promising avenue, but it would probably require longer implementation lags and may pose challenge in terms of international convergence of methods and approaches.

Conversely, the revision of the capital functions would hardly be able to provide the much needed prompt response to the limits of Basel II. The current calibration of the regulatory formulae is the result of a long process aiming at ensuring a consistent risk assessment across asset classes, so that changing it would likely require new, lengthy quantitative analyses.[33] We also note that the proposals for time-varying capital functions, while appealing in principle, is hardly workable in practice since it would rely on the correct identification of the phase of the business cycle by supervisory authorities. In addition, as cycles differ across countries, a common recalibration would be probably inappropriate and country-specific adjustments would need to be applied. This would significantly reduce the meaningfulness of cross-country comparisons of bank's solvency positions and increase the degree of discretion left to national authorities. Furthermore, implementation problems could be significant for large cross-border players: it would not be obvious how the conditioning variable (credit expansion, equity prices, etc.) should be defined, especially if host and home supervisors have different views[34] (Borio et al., 2001).

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[33] On the process that eventually led to the calibration of Basel II, see Cannata (2007).

[34] For instance, the former may wish to impose higher capital ratios on banks operating domestically because of local concerns; however, the latter may find unjustified imposing a higher capital ratio at the consolidated level if local developments have only a small effect on the bank's overall risk profile.

Similar criticisms apply to the proposal for adjusting the capital requirements based on time-varying multipliers, that would also need to be country specific to reflect local cyclical conditions. In turn, each variant for the definition of the multiplier has its own advantages and problems. First of all, market variables such as stock prices or CDS spreads are not necessarily robust indicators of credit cycles, especially for banks that are mainly involved in retail segments and loans to small and medium enterprises. Moreover, establishing a link between capital requirements and forward-looking measures of economic conditions, such as equity prices, would make capital requirement heavily dependent on the volatility of market conditions.[35] Using macroeconomic indicators (GDP growth) would have drawbacks due to publication delays and revisions.

Smoothing the output of the capital function through autoregressive mechanisms may create perverse incentives. A weak bank may be encouraged to increase portfolio risk rapidly (gambling for resurrection), because required capital would adjust only slowly. Moreover, the calibration of speed of adjustment would pose practical challenges. In fact, the timing of capital restoration after a crisis would largely depend on the choice of this parameter, which may be difficult to estimate.

More importantly, most of the variants discussed so far share a main drawback: as they define aggregate, system-wide adjustments, they do not capture the specific features of individual banks and may thus introduce distortions and raise level playing field issues. A bank with declining loans should not be required to increase capital due to the application of a rule linking capital requirements to aggregate credit growth. Furthermore, the proposed adjustments would fail to discriminate between banks with TTC and PiT approaches. Reliance on TTC estimates would thus be discouraged, as TTC banks would in any case be required to build up buffers just like banks using PIT measures of credit risk.

The proposal put forward by CEBS does not suffer from this shortcoming: it is bank-specific; it is based on risk-sensitive conditioning variables and meets therefore the incentive structure provided for by Basel II (TTC banks systems should be required to hold lower buffers than those adopting PiT systems, which have more pronounced cyclical fluctuations of capital requirements). These features reduce the risk of regulatory arbitrage, which is likely to arise if non-risk sensitive adjustments are applied.

Moreover, CEBS' proposal would preserve the informative content of regulatory capital, as advocated by Gordy and Howells (2006). More generally, the approach does not require any calibration of the buffer; in fact, each bank would be required to hold buffers consistently with the cyclicality of its capital requirements: if cyclicality is a small problem, the solution would be small and vice versa.

While we find the proposal sensible, there are some issues that should be pointed out. First, this approach addresses the pro-cyclicality of capital regulation, but does not lead to

[35] Other financial variables (such as spreads on credit default swaps) are likely to suffer from similar problems.

truly counter-cyclical capital buffers. In fact, the buffers will move through the cycle to compensate for the fluctuations of risk-sensitive capital requirements, bringing the Basel II framework close to Basel I. If counter-cyclicality were deemed desirable other tools should be introduced, that allow freeing capital in recessions. Second, the proposal might lead to wrong outcomes for banks that experienced significant structural changes in portfolio composition – e.g., through M&As – and would face requirements based on past measures of risk that are not significant anymore. This could be amended by leaving some flexibility in application, allowing banks to discuss with supervisors possible structural breaks in their time-series and, thus, the need to change the value of the downturn-PDs, if deemed appropriate. Third, CEBS suggests applying the mechanism under Pillar 2, the supervisory review process. This means that supervisors would enjoy some degrees of freedom in deciding if and how to take corrective actions in case the buffers are below the required level. Admittedly, the cross-country differences in applying Basel II are significant and may lead to some level playing field concerns: national supervisors may over-react in some cases and under-react in others; moreover, case-by-case adjustments may raise issues of supervisory forbearance. But if it does not look feasible to enforce the mechanism in a consistent manner under Pillar 2, it could always be considered as a true capital requirements under Pillar 1. In this case, banks would continue to use their internal estimates for borrowers' selection and pricing purposes, but they would be required to use the scaling factor mechanism for calculating the regulatory capital charge. This may weaken the use-test, but would preserve the informative value of PiT rating systems.

As to countercyclical provisioning, it does not directly amend the pro-cyclicality of capital requirements, but contributes to build up buffers in good times, to be used during recessions. The technical specification of the instrument is crucial, though. For instance, the proposal put forward in the IASB staff paper would be based on banks' internal estimates of expected losses. Such specification would risk being pro-cyclical, as it would generate more frequent changes in provisioning for banks relying on PiT estimates of credit risk: for those banks, provisions would indeed increase during downturns, thus restraining banks' lending capacity, while their low levels during upswings would contribute to sustained profits and lending booms. In case of TTC estimates the mechanism would work better, but would nonetheless limit the pro-cyclicality of provisioning, without really contributing to the building up of countercyclical buffers.

The Spanish dynamic provisioning mechanism does not seem to suffer from these drawbacks, as it is based on statistical, measures of loan losses and does not depend on the cyclical sensitivity of banks' internal models. It embodies both a flow and a stock measure of lending activity, thus allowing for a powerful mechanism for building up provisions in good times and using them up in bad times, without leaving any room for supervisory discretion. One potential problem with this system is that it blurs the distinction between expected and unexpected losses, which may generate risks of clashes with accounting rules. Alternative approaches, such as the one presented in the Turner Review (FSA, 2009a, 2009b), suffer the same shortcomings, since upper bounds are not linked to expected losses.[36]

6.3. Summary

Where does the above discussion leave us? The debate on this issue is ongoing and heated. As we have seen above, most proposals present pros and cons, which may help explain why no clear winner has emerged so far. With all due caveats, we believe that an agreement could be reached at least on some fundamental aspects of the problem. The current system deals with unexpected losses through capital requirements and with expected losses through provisions.

Let us look at the first aspect. It must be recognized that this aspect is the cornerstone of the entire Basel II framework. One may decide to scrap the system and start from scratch, or try to amend it. Our view is that the second option should be chosen, first and foremost because the system has several desirable features which could be lost under a radically different solution.

Concerning the second issue – management of expected losses through provisions – we believe that it is important to recognize that the concept of expected losses used thus far is probably too narrow, and that provisions should be accumulated vis-à-vis a broader concept. In this sense, all the above proposals grouped under the title "countercyclical provisioning" put the emphasis on the right spot. The Spanish system proved effective in the current crisis (an important advantage relative to other similar proposals, which have not been implemented and tested yet).

Assuming that an agreement could be reached on these two premises, we believe that the CEBS proposal would represent a viable option to address the first issue. It would be an effective mechanism for absorbing the fluctuations of Basel II capital requirements, bringing the cyclical properties of the Basel II framework closer to those of Basel I while preserving the transparency of banks' balance sheet and the information content of their capital requirement. Implementation through Pillar II would leave virtually unaltered the risk sensitivity of Basel II and the related incentives for banks.

As mentioned above, though, CEBS' proposal would not be sufficient to induce true counter-cyclicality in banks' resources. The introduction of dynamic provisions as a complement to capital buffers would cushion the cyclicality of losses, allowing to enjoy the welfare benefits of countercyclical buffers. Thus, capital buffers and dynamic provisions could work together. Preliminary work underway at the Bank of Italy simulates how Spanish dynamic provisions and buffers based on CEBS proposal would work together (see

[36] In order to avoid over-provisioning, the proposal envisages a cap on the total stock of provisions, based on a predetermined percentage of risk-weighted assets (in the range of 2-3 per cent). It is interesting to note that the proposal for dynamic provisions recently published by the EU Commission (2009) does not deal with the issue of a ceiling for the stock.

Burroni *et al.* (2009)). While simulations are based on fictitious data, they show promising results.

An important outcome of this work is that a system with a crystalline distinction between expected and unexpected losses would be preferable. Dynamic provisions should be aligned to long-term expected losses and should not be included in regulatory capital in order to magnify their countercyclical contribution.

7) Conclusions

In the aftermath of the current financial crisis, a consensus has emerged that the Basel II capital rules should be amended. Widely discussed proposals, to be implemented once the crisis is over, focus on the level and dynamics of bank capital. Much emphasis is placed on the need to reduce the pro-cyclical effects of the new regulation, although there is still much uncertainty as to the practical importance of this effect.

The present paper has moved from the consideration that the current policy debate lacks consistent measures of the benefits of the proposed amendments, as well as their costs. We set out to do such attempt. The regulator problem is cast within a macroeconomic model, which allows us to examine the functioning and possible shortcomings of risk-based capital regulation, and potential policy measures aiming at mitigating pro-cyclicality. Our results are relatively clearcut, and reasonably robust to a series of alternative assumptions about certain model features and parameters, although the amount of uncertainty surrounding our estimates is certainly higher than for most other macroeconometric work. The following answers to the four questions raised in the introduction must be read in the light of this important caveat.

First, our results confirm that Basel II can increase the pro-cyclicality of the banking system, relative to Basel I. Our simulations suggest that, following a technology shock (a key driver of macroeconomic fluctuations within our model) the deviation of output from steady state is 0.6 percentage points under the Basel II framework, vs. 0.5 under Basel I. A monetary policy shock yields an even smaller differential effect. Overall, these results suggest that the extra effect induced by Basel II vs. Basel I is modest, although this conclusion is subject to the caveats discussed in Section 5. The same conclusion, and the same caveats, apply to the comparison between the Basel II point-in-time vs. through-the-cycle approaches.

Second, we find that higher capital requirements (often advocated in the recent debate, although seldom motivated on grounds of reducing pro-cyclicality) may dampen the pro-cyclical effects of capital regulation. However, their effect depends on the nature of the shock hitting the economy: in a Basel II regime, the reaction of output to a technology shock or a demand shock is dampened by higher capital requirements, but the result vanishes under a monetary policy shock. Overall, our results provide only weak support in favour of adopting this measure to counteract pro-cyclicality.

Third, there does seem to exists room for a countercyclical regulatory policy. Simulation conducted with the model augmented with a simple regulatory reaction function which increases capital requirements during periods of buoyant growth, and vice-versa, can easily offset the pro-cyclicality induced by the move to Basel II, and even reduce it below the Basel I benchmark.

Would such a policy of countercyclical capital (or provisions) be spontaneously implemented by banks via voluntary accumulation/depletion during periods of boom/recessions? As above, our results suggest that the answer to this question depends on the nature of the shock hitting the economy: in a Basel II regime, a policy of countercyclical buffering is beneficial for banks (i.e. it increases profits) if it takes place in reaction to a technology or a demand shock; it reduces profits under a monetary policy shock. Thus, our analysis provides only partial support to the argument that, faced with the Basel II regulatory change, banks will find it optimal to offset the additional pro-cyclicality by appropriately choosing voluntary capital buffers. By contrast, results are in line with the view that a policy of countercyclical management of capital requirement, enforced by a regulator, could be non redundant, and in some cases beneficial. The practical implementation of this policy need not be discretionary. That is, its implementation could be rule-based, and need not require periodic meetings of a Board.

Fourth, we address the issue of the macroeconomic cost (e.g. in terms of GDP growth) of policies aiming at mitigating pro-cyclicality. Our findings suggest that a permanent increase of the capital requirement would have negative consequences on welfare. Bringing the requirement from 8 to 12% would cause a 0.1% fall of steady state output. This effect would be accompanied by an increase in the number of hours worked, so that, in terms of welfare, the loss could be larger than suggested by simply looking at output. By contrast, the adoption of a countercyclical capital policy would have no effect on the steady state of the model, and hence it would have no macroeconomic cost (at least, no cost measured in terms of steady state levels of the variables. This conclusion provides further support to the view that pro-cyclicality should be dampened via a countercyclical capital policy.

Indeed, the idea that capital (or provisions) should be adjusted in a countercyclical fashion represents the common denominator of many proposals currently being debated. Our model is unable to provide guidance on the practical implementation of this policy, as it cannot discriminate among the various important technical differences characterizing these proposals. However, it helps set the stage for our critical review of the available proposals, and provides some guidance as to the “strength” of the measures.

In sum, our review of the debate prompts the following considerations. The Basel II framework has desirable features which should not be discarded. The risk of pro-cyclicality should be contained through a package including countercyclical capital buffers and dynamic provisions. In our view, the proposal recently advanced by CEBS represents a reasonable option to address capital requirements volatility, bringing the dynamics of the Basel II framework close to Basel I while preserving the philosophy underlying the new regulation. Concerning dynamic provisions, a system inspired to the Spanish approach, which proved effective in the current crisis, would have desirable features. The approach could be simplified in order to make the distinction between expected and unexpected losses clearer. Provisions should be thus aligned to long-term expected losses and should not be eligible in regulatory capital in order to maximize their countercyclical potential.

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Appendix 1: The calibration of risk-weighted assets

The potential pro-cyclicality of Basel II depends on the cyclical behaviour of the risk parameters, particularly the probability of default (PD) and the loss-given-default (LGD), which affect the risk-weights via the regulatory formulae.

In the setting of the model used in the paper, the parameter χ in equation (6) represents the sensitivity of the Basel II risk weights to macroeconomic conditions (i.e., the degree of cyclicality of the Basel II capital requirements). Ideally, the calibration of χ should be based on the time-series of the risk-weights calculated according to the Basel II rules. Unfortunately, in most countries the new prudential framework has been implemented only in 2008 – if at all – so that no historical time series is yet available.

In principle, in order to analyze pro-cyclicality we could simulate our model for different values of χ and check the feedback effect from the financial sector to the real economy in each case. However, this methodology would not solve the issue of the *actual* degree of pro-cyclicality of the Basel II framework.

Without the ambition to provide the final answer, to examine the *true* pro-cyclicality of Basel II, we estimate χ starting from available proxies and exploiting the set of regulatory formulae provided for by the Accord.[37] In particular, we proceed as follows. First, we use US data on the delinquency rates on loans to households and firms as proxies for the probability of default of these loans.[38] Second, we input these time series into the Basel II capital requirements formulae, and using realistic assumptions concerning the other key parameters of the formula (the LGD, firm size, and the maturity of the loans) we estimate the time series of the risk weights w_t^F, w_t^H. This allows us to simulate the dynamics of risk weights for advanced IRB (AIRB) banks, under the hypothesis that the PD is the only source of cyclicality of the risk-weights. This is obviously an approximation, but a realistic one since AIRB banks are required to estimate downturn LGDs. Finally, we estimate equation (6) in the paper using the time-series for risk-weighted assets.

The second step is obviously the most difficult since it requires some judgment on the most appropriate figures for the key risk parameters. As mentioned, for the PDs we employ the delinquency rates for US loans. In other words, we assume that the behaviour of PDs goes hand in hand with that of credit losses. This is clearly an approximation – as forward-looking PDs do not necessarily exactly match backward-looking historical losses – but likely a reasonable one, as one would expect the PDs to be closely correlated with actual credit losses in the long term.

Since we have separate time series for firms and households' delinquency rates, we apply the method described above to each of these two categories.

For non-financial firms we use the corporate regulatory function with no size-adjustment. This is equivalent to assuming that firms have sales of at least 50 million euros.

[37] See Basel Committee, An Explanatory Note on the Basel II IRB Risk Weight Functions, 2004.

[38] Delinquency rates are provided by the Federal Reserve Board over the period 1991-2007 on a quarterly basis; they are annualized and seasonally adjusted. For households we used delinquency rates on single-family residential mortgages from banks ranked 1st to 100th largest in size (by assets). For firms we used delinquency rates on business loans from banks ranked 1st to 100th largest in size (by assets). To the best of our knowledge there are not similar data available either for the EU or the euro area.

This also means that we assume higher asset correlation and, thus, greater cyclicality than in a SME portfolio to some extent we are overestimating cyclicality. The loss-given-default is set at 40 per cent, consistently with the figures reported in the 5th Quantitative Impact Studies for G10 firms (the most recent publicly available information on the risk parameters of the Basel II framework).[39] The maturity of the loans is set at 2.5 years, as in the standardized approach.

For households, since data refer to mortgages, we use the residential mortgage function, with a LGD equal to 20 per cent, following the QIS5. Both functions include the 1.06 scaling factor. Using the regulatory formulae we obtain the capital requirements (as a percentage of the exposure at default), that are subsequently multiplied by 12.5 in order to obtain risk-weights .

The results of the regression estimated using these data are reported in the table below. The regression estimates the log-linear version of equation (6) since it is exactly in this form that it enters the model:

$$\hat{w}_t^i = (1-\rho_i)\chi_i\left(\log \hat{Y}_t - \log \hat{Y}_{t-4}\right) + \rho_i \hat{w}_{t-1}^i$$

where a hat denotes percentage deviations from steady state and the term in brackets measures output growth.

Table A1. Sensitivity of weights to cyclical conditions

Dependent variable	ρ	χ	R^2
Business loans	0.92 (0.03)	-14 (4.6)	0.97
Residential mortgages	0.94 (0.04)	-10 (8)	0.89

Note: Nonlinear least squares. In the case of households standard errors are corrected for heteroscedasticity and autocorrelation of residuals of order 2. Sample period: 1991:Q1 To 2007:Q4. For households we used delinquency rates on single-family residential mortgages from banks ranked 1st to 100th largest in size (by assets). For firms we used delinquency rates on business loans from the 100 largest banks (by assets). Data are taken from *the Federal Reserve Board* (http://www.federalreserve.gov/releases/chargeoff/deltop100sa.htm). Cyclical conditions are measured by year-on-year changes in real GDP (http://research.stlouisfed.org/fred2/series/GDPC96?cid=106). All data are seasonally adjusted.

Appendix 2: CEBS proposal for countercyclical buffers

CEBS (2009) proposal envisages a mechanism that takes into account the historical changes in PDs estimated by banks – the key and most cyclical driver of minimum capital requirements under the IRB approach – in order to build specific IRB buffers against recessionary conditions.

In practice, the mechanism is based on a quantitative assessment of the gap between current PDs and PDs corresponding to recessions (downturn PDs). In principle, the approach can be applied at different levels of aggregation. However, the less computationally burdensome approach works at the portfolio-level (i.e., at the level of the different asset classes in banking books).

[39] Basel Committee (2006), Results of the fifth quantitative impact study (QIS 5).

The approach is straightforward. First, the PD of the portfolio at time t is calculated as the average of grade PDs weighted by the number of counterparties in each grade:

$$\frac{\sum_{g=1}^{k} PD^g N^g}{\sum_{g=1}^{k} N^g}$$

where PDg is the PD of each grade "g" (1, … , k) and Ng is the number of counterparties in grade "g". The PD of the portfolio would obviously change over the cycle as the result of two different factors:

- transition of borrowers across grades (which is more pronounced in more PiT rating systems);
- change of grade PD (which is more pronounced in more TTC rating systems).

This methodology therefore aims at ensuring that the countercyclical adjustments are neutral with respect to the philosophy of the rating methodology.

Then, a scaling factor for the entire portfolio can be computed as: SFp = PDdownturn / PDcurrent which is close to 1 in a recession and assumes values higher than 1 in expansionary phases. The final step is to adjust grade-PDs (PDg) using the scaling SFp and compute the buffer as the difference between the regulatory capital requirements based on the adjusted PDs and those based on the unadjusted PDs.

Appendix 3: The Spanish Dynamic provisioning system

In Spain, each year, banks are required to charge their Income Statement: i) flow of specific provisions (s) for covering incurred losses, ii) flow of general provisions (g), based on historical credit loss information.

Specific provisions are a percentage (γ), determined by each bank, of the flow of non-performing loans (ΔP) emerged in a given year:

$$\mathbf{s = \gamma \Delta P}$$

General provisions (g) are calculated according to the following formula:

$$\mathbf{g = \alpha \Delta L + \beta L - s,}$$

where α is the average estimate of the credit losses; ΔL is the change in total loans; β is the historical average of specific provisions, L is the stock of total loans. Both parameters are estimated for six different risk classes (ranging from negligible risk to high risk).

By comparing βL with the current level of specific provisions, the bank can assess the speed at which incurred but not identified losses evolve into specific losses: i) in upturns, βL is higher than s, banks are under-pricing the actual risk they have in portfolio (latent risk not captured by specific provisions); ii) in downturns, βL is lower than s, banks are over-pricing the actual risk they have in portfolio.

In upturns, s is lower than $\alpha\Delta L + \beta L$ and the flow of general provisions is positive; thus, the stock of general provisions (G) is built up. In symbols, when $\alpha\Delta L + \beta L > s$,

$$\mathbf{g = \alpha\Delta L + \beta L - s}$$

and

$$\textbf{Total provisions} = \mathbf{g + s = \alpha\Delta L + \beta L - s + s = \alpha\Delta L + \beta L}$$

In downturns, s is higher than $\alpha\Delta L + \beta L$, the flow of general provisions is set to zero and G is run-down. Using the same notation, if $\alpha\Delta L + \beta L < s$, then $g = 0$. Clearly, if $G > s$, the new $G = G - s$; if $G < s$, the new G goes to zero and banks record losses $(s - G)$.

Spanish rules also include upper and lower limits to the stock of general provisions. In particular, it is required to remain within the range: $0.33*\alpha L \leq G \leq 1.25*\alpha L$. The cap prevents the accumulation of disproportionately large resources with countercyclical purposes, the floor avoids that such resources are entirely depleted.