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Abstract

We use a dynamic general equilibrium model of the euro area to study banks' possible responses to the stricter capital requirements called for by the Basel III reform package. We show that the effects of tighter capital requirements on output depend, inter alia, on the strategy banks adopt in response to the reform, and that banks tend to prefer some strategies over others. Specifically, an increase in loan spreads minimizes banks' costs and induces the sharpest contraction in real activity and investment, in the immediate as well as long term. A recapitalization, or restrictions on dividends, have more modest effects on output, but are less likely to be preferred by banks. We also find that the undesired macroeconomic effects of the reform during the transition phase are significantly mitigated if the reform is announced well ahead of its actual implementation – as was done for the Basel III package.

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Keywords: Basel III, capital requirements, macroprudential policy, banks.

Contents

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1. Introduction

The macroeconomic effects of Basel III are the subject of a hot debate. In setting the new capital requirements, the regulator has faced a trade-off. High capital requirements increase banks' resiliency to exogenous shocks. However, forcing banks to abide by higher capital ratios may make them reluctant to expand credit, potentially undermining the recovery. Some parties involved in the debate have emphasized the latter aspect, arguing that forcing banks to abide by stiffer capital requirements could have dire effects for the world economy (see e.g. IIF (2010)); other commentators have countered that capital is not expensive, and that the trade-off between capital and economic growth, if at all present, is very mild (see e.g. Admati et al. (2011)). Policymakers have made their decisions in the light of their own estimates of the economic costs and benefits of the new regulation (see BCBS (2010), MAG (2010)).

The present paper lies in the latter strand of work – indeed, it originates from work that was conducted to contribute to BCBS (2010), MAG (2010). It is worth emphasizing that our focus is on the costs of the new regulation, as our methodology is unable to capture the main benefits, which should arguably accrue in terms of reduced likelihood and severity of financial crises and hence of increased financial stability. A similar focus on the costs side is in MAG (2010), whereas BCBS (2010) also considers the benefits side.

With this important caveat in mind, we address the following key questions: (1) What is the cost of higher capital requirements on economic performance, both in the transition to the new regime and in the long-term? (2) Is the adoption of countercyclical capital buffers going to have a significant dampening effect on economic fluctuations? (3) Do the answers to the above questions depend on the strategies that the banking system is going to adopt in reaction to the reform? (4) Are there some implementation strategies – among the various alternatives available to the regulator – that can reduce the burden of the reform for the financial sector and ultimately for the economy?

Questions (1) and (2) have been addressed by several papers, including some of those mentioned above. The main new pieces of evidence that we bring to the debate on capital reform concern the third and fourth questions. Faced by higher prudential standards, banks are liable to resort to an entire array of countermeasures: resort to capital markets; speed the capital build-up by reducing dividends, or enhancing profits (via cost reduction, efficiency gains, rent-seeking behaviour, …); reduce lending with low expected returns; find new ways to elude risk-based regulation; etc. Some of these potential bank reactions to the reform can be captured in our model. Specifically, we assess the consequences of the following: (a) an injection of fresh capital; (b) a reduction in distributed dividends; (c) an increase in interest rate spreads – the differential between a lending and a deposit rate. We find that, under reactions (a) and (b) the macroeconomic losses generated by higher capital requirements are negligible, whereas under (c) they become more sizeable, although still quite small. Moreover, the analysis suggests that the banks' "pecking order" over these strategies run in exactly the opposite direction, since under (c) they are better able to preserve their profitability.

Regarding the fourth question, we find – in line with previous studies – that a longer phase-in period can reduce undesired short-term effects on output growth; the novel result is that the regulator can further reduce potential adverse macro effects by announcing the reform well in advance of the start of the phase-in period. In an economy with real and nominal rigidities, an advance announcement allows banks to prepare for the change and to considerably smooth out potential undesired side effects. This result rationalizes the approach chosen in the Basel III package for the increase in capital requirements, announced in September 2010 but due to be phased in gradually between January 2013 and January 2019.

For our analysis we build on the DSGE model for the euro area developed and estimated by Gerali *et al*. (2010) (GNSS from now on), which incorporates a (simplified) financial sector into an otherwise standard New-Keynesian framework, so as to generate a meaningful interaction between the financial and the real sectors of the economy. On the assets side of banks' balance sheets there are loans to firms and households while on the liabilities side there are deposits held by households and capital. We slightly amended the model to include a role for bank dividends and to analyze the different ways in which banks can respond to the change in the regulatory framework.

From a methodological viewpoint, it is worth emphasizing at the outset that we do not try to pin down the "optimal bank reaction strategy" in response to the regulatory reform. For instance, within our framework an increase in banks' interest rate margins (option (c) above) can be modeled only via an increase in banks' market power, which cannot be treated as a choice variable. Our more modest aim is to use the model as a disciplining device to study the macroeconomic costs of the reform, looking at the effect on banks' profits under each assumed reaction strategy. This allows us to assess how banks are likely to respond, and to obtain a measure of the range of macroeconomic effects that can be expected from the new regulation.

While much of our analysis focuses on changes in levels of macroeconomic aggregates after the reform, we also look at the average fluctuations around these levels. We find that the reform tends to dampen the fluctuations of the main macro variables (consumption, investment and output), and that this effect is reinforced by the adoption of countercyclical capital buffers. Thus, even if we are forced to overlook the benefits of the reform in terms of reduced likelihood of financial crises, we can conclude that its welfare implications are not unambiguously negative: on the one hand, agents incur utility losses because of lower mean output and consumption; on the other hand, lower volatility benefits risk-averse consumers.

The rest of the paper is structured as follows: Section 2 outlines the model and illustrates the amendments introduced to include a role for bank dividends and to analyze different banks strategies. Section 3 presents the main results of the paper, analyzing both the short-term and long-term impact of the reform on the levels of the key variables, under each proposed bank reaction strategy. Section 4 looks at the effect on second moments, i.e. on economic fluctuations, both under a fixed capital rule and using countercyclical capital rules. Section 5 studies whether certain features of the reform's implementation – specifically, altering the length of the phase-in period, or announcing the new rules well ahead of their implementation – may change the results. Section 6 concludes.

2. The macroeconomic framework

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; entrepreneurs produce consumption and investment goods using capital and labour supplied by households.

Households are of two types, who 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. In particular, patient households supply loanable funds which are then channelled by banks to impatient households and entrepreneurs. Banks offer one-period deposits and loans. Borrowers face a borrowing constraint, which ties the amount of debt that can be obtained to the value of their collateral holdings: the stock of housing in the case of households, physical capital for entrepreneurs. In particular, the collateral constraint for households reads as follows:

(1) $$(1+R_{h,t})L_{h,t} \leq m_H E_t[q_{t+1}h_{t+1}(1+\pi_{t+1})]$$

where q is the price of housing, h is the stock of existing homes, L_h the amount of borrowing, R_h the interest rate on loans and π is the inflation rate. The parameter m_H measures the loan-to-value (LTV) ratio for mortgages, the amount of credit that banks make available to households for a given (discounted) value of their housing stock.

Banks' balance sheet is simplified but captures the basic elements of their activity. On the assets side are loans to firms and households. On the liabilities side are deposits held by households and capital. With respect to market structure, the banking sector operates in a regime of monopolistic competition: banks set interest rates on deposits and loans to maximize "profits" Π_b (net interest income, the only source of profits in this model):

$$\Pi_b = L_{h,t}r_{h,t} + L_{f,t}r_{f,t} - D_t r_{d,t}$$

subject to the balance sheet identity $L_{h,t} + L_{f,t} = D_t + K_{b,t}$. L_f and r_f represent, respectively, the amount and the interest rate of loans granted to firms, while D and r_d and deposits and interest rate on deposits. The degree of monopolistic competition is parameterized by ε_l, the elasticity of substitution between varieties in the demand for loans, which maps directly into the size of the spread that banks apply on top of marginal costs when setting the loan rates (see equation (3) below). Bank capital ($K_{b,t}$) is accumulated out of retained earnings according to the following equation:

(2) $$K_{b,t} = \left(1-\delta_b\right)K_{b,t-1} + (1-DIV_b)\Pi_{b,t-1}$$

where the term $\delta_b K_{b,t-1}$ measures the cost associated with managing bank capital and conducting the banking intermediation activity. The parameter DIV_b summarizes the dividend policy prevailing in the banking industry. Dividends are distributed to households; only the retained portion of net interest income goes into capital accumulation. Furthermore, banks are assumed to face a (quadratic) cost of deviating from an "optimal" capital-to-assets ratio (ν) established by regulators. When the ratio between capital K_b and risk-weighted assets (RWA) falls below ν, costs increase for the bank and this impacts on the rates charged by banks on their loans, as shown by the rate-setting equation in the model:[1]

(3)
$$R_{i,t} = \left(\tfrac{\varepsilon_l}{\varepsilon_l - 1}\right)\left[R_t - \varphi\left(\frac{K_{b,t}}{RWA_t} - \nu_t\right)\right], \qquad i = h, f$$

where $R_{i,t}$ is the interest rate on each type of loan, $\left(\tfrac{\varepsilon_l}{\varepsilon_l - 1}\right)$ is the markup capturing the effects of monopolistic power of banks and the term in squared brackets represents the rate at which banks can obtain financing, which is equal to R_t – the monetary policy rate – plus the adjustment associated with the bank's capital position, which induces banks to lower lending rates when the ratio between capital and risk-weighted assets exceeds the regulatory minimum, and vice-versa.[2] Hence, factors affecting bank capital impact on the capital-to-assets ratio and, through equation (3), force 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 recent financial crisis. Monetary policy is modeled via a Taylor rule with the following specification:

(4)
$$R_t = (1-\rho_R)\bar{R} + (1-\rho_R)\left[\chi_\pi(\pi_t - \bar{\pi}) + \chi_y(y_t - y_{t-1})\ \right] + \rho_R R_{t-1}$$

Finally, we introduce some changes with respect to the published version of the model, to adapt it to our purposes. In particular, when we evaluate the effects of countercyclical capital requirements we change the nature of the parameter ν, held fixed in GNSS, turning it into a time-varying variable that adjusts according to the cyclical conditions of the economy. In particular we assume that a macroprudential regulatory authority (see below) sets capital requirements according to the equation:

(5)
$$\nu_t = (1-\rho_\nu)\bar{\nu} + \chi_\nu X_t + \rho_\nu \nu_{t-1}$$

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1 We distinguish between total loans ($L_t = L_{f,t} + L_{h,t}$) and the sum of risk-weighted loans to firms and to households (RWA_t) to account for the risk-sensitive regulation of capital. In particular, the empirical specification assumes that the risk weights depend on the yearly output growth rate: $w_t^i = (1-\rho_i)\bar{w}^i + (1-\rho_i)\chi_i(y_t - y_{t-4}) + \rho_i w_{t-1}^i$, where w^i is the risk weight of agent type I, $\bar{w}^i \equiv 1$ is its steady value, y is output, ρ_i =0.94 and χ_i=50. See Angelini *et al.* (2011a) for a description of the estimation method. Note that adding this equation to the model affects the cyclical pattern of the main variables but not their steady state levels, and is therefore neutral in this sense.

2 In practice, a dynamic version of equation (3), in which bank rates are sticky, is employed in the model (see GNSS). The only difference is an additional term to the right side of equation (3) that summarizes the effects of the adjustment costs associated to rate stickiness.

where $\bar{\nu}$ denotes the steady state level of ν_t. Based on (5), ν_t adjusts to the macroeconomic variable X_t with sensitivity equal to the parameter χ_ν. Many choices for the variable X_t are possible. In the simulations that follow, we assume that X_t is the ratio of total loans to output in deviation from its steady-state level. Thus, a positive value for χ_ν amounts to imposing a countercyclical regulatory policy: capital requirements increase in good times (banks hold more capital for given amount of loans) and vice-versa.[3]

Several features of our model need to be considered when interpreting the results. First, the model belongs to a family that precludes firm and bank defaults in equilibrium (see Kiyotaki and Moore (1997), Iacoviello (2005) and Iacoviello and Neri (2010)). Alternative models in which defaults can and do happen are Bernanke, Gertler and Gilchrist (1999) and Christiano, Motto and Rostagno (2010). Clearly, such alternative environment could allow a proper modeling of the key benefits of the new regulation (reduced likelihood of bank default) and could alter our conclusions. Second, the model does not distinguish between required capital and buffers held voluntarily by banks. There are reasons to believe that forward-looking banks would at least in part adopt such buffers on a voluntary basis (Repullo and Suarez 2008 and Tarullo 2008).

2.2 Modeling banks' reaction to a capital tightening

We perform the following experiment: starting from a pre-reform equilibrium in which ν=9 percent (the steady state value estimated in GNSS), we increase the value of this "regulatory" parameter and then look at the characteristics of the ensuing (post-reform) equilibrium. In this subsection we describe the modifications of the original setup needed to perform the simulations.

In the original model the parameter values were chosen so as to ensure that the ratio between capital and RWA was equal to ν in steady state. Since we model the reform as a shift in ν, we wish to ensure that this equality holds both before and after the reform. To do this, we impose the following extra condition on the post-reform steady state:

$$K_b \equiv \nu^* RWA \tag{6}$$

Adding an extra equation implies that, to close the model, we need to endogenize a formerly free parameter. Different parameters can be used for the same purpose, and each

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[3] Furthermore, with respect to the estimated parameter values in GNSS, we increase the stickiness of bank deposit rates relative to that of loans rates. This was done to avoid an implausible increase in bank profits (i.e. interest rate margins) immediately after the start of the reform. See Table 1A in the Appendix for a list of parameter values used in this version of the model.

choice has a clear resemblance with a real-life decision that banks will likely face in the aftermath of the reform. This gives us the opportunity to analyze the effects of different reactions that banks might have to the reform.[4] Looking at the steady state version of the bank capital accumulation equation (2):

$$K_b = (1 - DIV_b)\frac{\Pi_b(\varepsilon_l)}{\delta_b}, \tag{2*}$$

we see that the long-run level of bank capital K_b depends on three parameters: (a) the bank capital "depreciation" rate δ_b; (b) the dividend policy parameter DIV_b; (c) the degree of monopolistic competition ε_l in the loan market, which pins down long-run profits Π_b.

Depending on which parameter we choose to endogenize, the model can be used to compare the effects of three different, non-mutually exclusive reactions to the reform. For example, endogenizing DIV_b means that bank dividends are adjusted downward until the model reckons that banks will have enough equity to fulfil the higher capital requirements in the long run, i.e. until equation (6) is satisfied. For the other two parameters a similar reasoning holds. Once a parameter choice is made, the model calculates the size of the required adjustment and the impact on other macro variables.

Each parameter choice has a natural economic interpretation that speaks directly to the ongoing debate which suggests that among the most plausible banks' responses to higher capital requirements are the following (see e.g. MAG (2010a)):

(a) Raising more equity – Banks can raise fresh capital essentially in two ways: either by tapping the equity market or through some form of government intervention. Within our framework, these options can be captured either by adding an extra term to the right-hand side of the capital accumulation equation (2) or by lowering the value of δ_b. To see this, note that the main effect of lowering δ_b is to leave, *ceteris paribus*, more capital in the balance sheet of banks. Since operating revenues are unchanged, this change entails a decrease in RoE. Therefore, this scenario is reminiscent of a fresh capital injection (which

4 Technically, one might dispense with equation (6) and perform simulations using the original model, thus giving up the possibility of "different reactions" by banks. In such scenario banks would try to balance the benefits of expanding loans with the costs of remaining partially under-capitalized (and having to pay the penalties according to the capital cost function). For any plausible cost function, the equilibrium would feature an internal solution with the observed capital ratio strictly smaller than the regulatory requirement ν. The results from this scenario would be qualitatively very similar to those obtained under our "more profits" scenario (see below), the more so the more the observed capital ratio is close to ν (i.e. the steeper is the cost function).

ceteris paribus decreases RoE).[5] Note that this scenario is subject to the criticism that the resources needed for this capital inflow into the banking sector come literally from "outside the model" (since the change in δ_b benefits banks but does not represent a cost for any other agent in the model), and thus probably misses important tradeoffs involved in the choice of raising funds in the capital markets.

(b) Reducing dividends paid out to shareholders – Within our framework, this option translates into a lower value of DIV_b, which allows the banks to accumulate more capital through retained earnings. Again, operating revenues and total profits are unchanged and therefore the RoE decreases. Therefore this scenario encompasses all those "real life" strategies in which banks in one way or another react to the regulatory change by lowering the return paid on their equity.

(c) Increasing profits by raising the loan spreads – This option is to be thought of as any strategy (or public aid) aimed at boosting the profitability of the banking sector. In our model, these options are captured by a lower value of ε_l, i.e. an exogenous increase in banks' monopoly power in the loan market. This raises loan spreads (see equation (3)) and allows the bank to increase operating revenues, and thus profits. In this case the additional capital accrues to the banks since they are making higher profits, but the ratio between capital and profits remains unchanged and the RoE is unaffected in the long run.

3. Impact on economic performance

In this section we assess the impact of higher capital requirements on economic performance, both in the transition to the new regime and in the long-run, distinguishing between the different strategies available to banks to comply with the reform.

The regulation allows banks to adjust to the new regime over a long transition period (until the end of 2018; see BCBS (2010)). Accordingly, our baseline results are derived under the assumption that the capital requirement grows linearly over a period of 7 years from the estimated steady state value of 9 percent to 10 percent.[6] We work with a one percentage points increase because the results turn out to be approximately linear with respect to the increase. Thus, in the end our exercises yield elasticities – percentage changes in key variables for a one percent change in the capital requirement – which can be

[5] One would be tempted to interpret a decline in δ_b as an increase in bank "efficiency". However, this interpretation is inconsistent with the fact that a decline in δ_b reduces RoE.

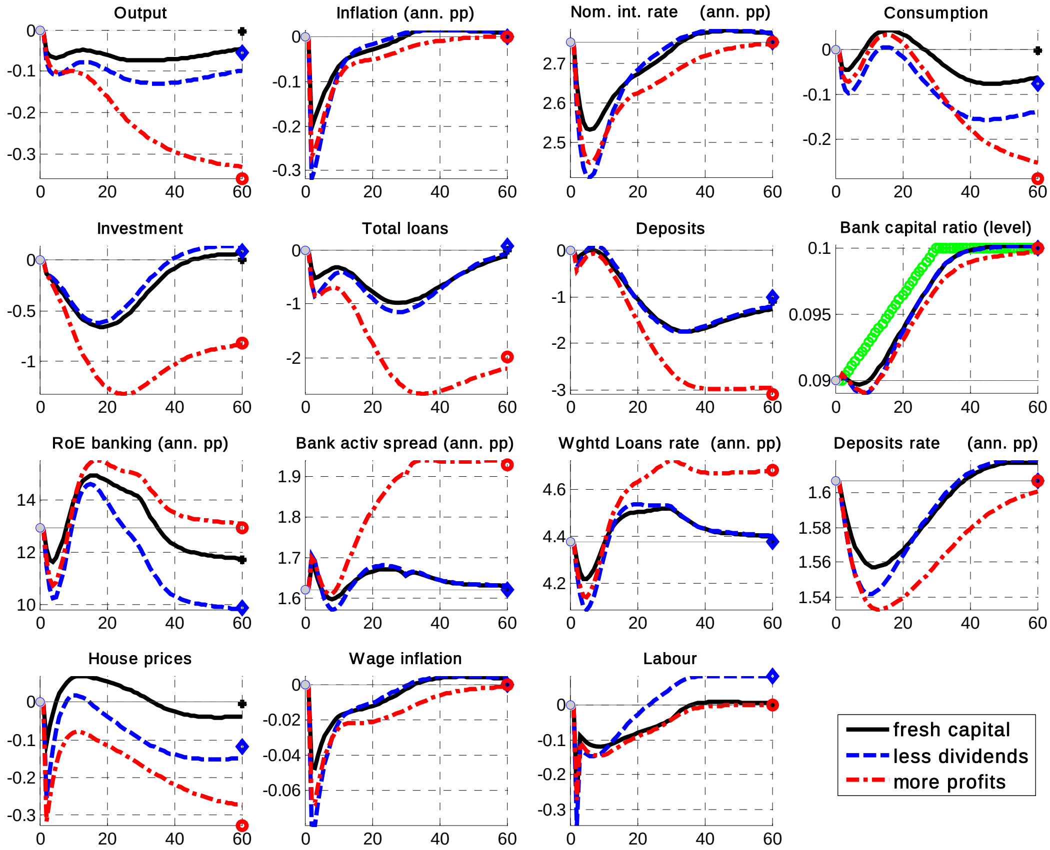
[6] In reality the reform's implementation path is not linear. We assume linearity for simplicity and for comparability with previous work on the subject. We discuss this issue in detail in section 5.

used to assess the impact of more ambitious reform scenarios. We implement the different recapitalization scenarios by letting each parameter of interest increase linearly in exact lockstep with the capital requirement.[7]

Figure 1 reports the paths for the key variables over the first 60 quarters (15 years) of the simulation. It also reports the "final" steady state values toward which the variables are converging using dots, diamonds and circles plotted in correspondence of the final quarter shown. For ease of reference, these final steady state values are also reported in Table 1. The assumed path for the regulatory capital ratio is shown in green in the corresponding panel in the figure.

Figure 1 – Short term economic dynamics following a one p.p. increase in the capital requirement

(percentage deviation from initial steady state unless indicated; quarters on abscissas)



Note: Banks' capital requirement is assumed to increase linearly from 9 to 10 percent over a horizon of 7 years (28 quarters) starting from quarter 2 (see green circles). Final steady state values are shown at quarter 60th using black dots (fresh capital), blue diamonds (less dividends) and red circles (more profits).

7 For numerical reasons, the simulations are conducted using a linear approximation of the model around the initial steady state, instead of running deterministic simulations of the original non-linear model. While being free from approximation errors, the latter method turned out to be numerically unstable except for very small changes in capital requirements. The former method, on the other hand, is not guaranteed to drive the system at exactly the values corresponding to the new steady state. Therefore, we checked ex-post that the approximated dynamics did move the system very close to the final steady state, thus bounding the size of the possible error.

Table 1 – Long-run effects of a one p.p. increase in the capital requirement
(percentage deviation from initial steady state unless indicated)

	banks' reaction strategy:		
	(a) (fresh capital)	(b) (less dividends)	(c) (more profits)
Output	0.00	-0.05	-0.36
Inflation	0.00	0.00	0.00
Consumption	0.00	-0.08	-0.29
Investment	0.00	0.08	-0.82
House prices	-0.01	-0.12	-0.33
Total loans	0.00	0.08	-1.96
Deposits	-1.09	-1.02	-3.03
Bank capital	11.12	11.20	8.94
Loans to output ratio	0.01	0.14	-1.60
Loans rates (ann. pp)	0.00	0.00	0.31
Deposit rates (ann. pp)	0.00	0.00	0.00
Return on bank equity (ann. pp)	-1.23	-3.07	0.00
Percentage change in the instrument	-9%	-16%	7%

The short run dynamics of the three scenarios, i.e. a drop in output and consumption, and a more substantial and protracted contraction of investment in the first couple of years, are driven by a common mechanism. Due to the reform K_b needs to rise, and/or loans need to fall. But banks cannot freely adjust bank capital, as it accumulates slowly as the resources needed flow in, so their best course of action is a temporary raise in the loan spread, i.e. a cut in the supply of loans. The reduced amount of loans granted helps them to meet the capital ratio while the increase in spreads boosts profits and helps to build up capital in subsequent periods. But the tightened credit conditions force indebted households to shrink consumption and firms to curtail investment, thus inducing a costly reduction in the pace of economic activity. Finally, the common short-term dynamics includes the reaction of monetary policy that, faced with the slowdown of growth and inflation, loosens its policy stance thus mitigating the initial increase in loan rates and helping cushion its contractionary effects on investments.[8]

[8] In the model, banks' interest margin depends positively on the level of nominal rates. This introduces an additional transmission channel of monetary policy. The drop in policy rates after the first few quarters has two opposite effects: on the one hand, it mitigates the effect of the financial squeeze on the real economy (the standard channel); on the other hand, it depresses banks' interest margins and profits (as deposits rates are more sluggish than loans rates and thus decline more slowly), yielding lower growth of bank capital. Therefore, the overall effect of a monetary policy easing on banks' RoE and the real economy is ambiguous; for the parameterization adopted in the paper, it turns out to be mildly negative.

A glance at the various panels reveals that the economic impact of tighter capital requirements is overall modest, with the long run reduction in GDP ranging from a minimum of zero to a maximum of 36 basis points. It is also evident that the impact can vary substantially depending on assumptions about banks' reaction strategies.

Under scenario (a) ("fresh capital") the reaction of output is negligible: following the short-lived credit tightening output drops by about 10 basis points in the first year, but then recovers gradually to the baseline steady state level. The small macroeconomic impact of the new regulation is hardly surprising: we saw above that under this scenario the additional capital comes from outside the model and economic agents bear only second-order adjustments. As fresh capital flows in, banks can gradually raise their supply of loans, reduce rates charged and satisfy loans demand by firms and borrower households at the level of interest rates prevailing before the reform. As a result, in the new steady state credit is virtually unaffected: the reform does not cause a reduction in the size of banks' balance sheet. Saving households hold fewer deposits in transition as well as in steady state, but the effect on their consumption is mild since the reform simply changes the composition of their revenues: they earn less interest on deposits (R_dD) but receive higher dividends from banks.

Under scenario (b) banks curtail dividends paid out to patient households to increase capital. The macroeconomic impact is more pronounced than under scenario (a): output drops by up to 10 basis points over the phasing in period, and then recovers somewhat below the baseline in steady state. Similar to scenario (a), banks manage to keep the size of their balance sheet virtually unchanged, but the cut in dividends causes the dividend ratio to fall from 0.4 to 0.34. The ensuing negative wealth effect on patient households forces them to reduce consumption, buy less housing and increase their labour supply, during the transition as well as in the steady state. Incidentally, this lowers house prices and indirectly benefits impatient households who can afford cheaper housing.

Scenario (c) yields the most pronounced effect: output falls by about 20-30 basis points over the phasing in period, and by about 30-40 in steady state; investment drops by over 1 percent over the phasing in period, and 0.8 percent in steady state. In this case the reform ends up increasing *permanently* the loans rates, i.e. a lower amount of credit in

We checked this by running an alternative scenario featuring a constant policy rate. Under this "passive" monetary policy, banks' RoE experiences no initial drop, gradually increasing instead, loans drop much less on impact and, as a result, the initial fall in output dynamics is about half as large. Obviously these differences are short-lived (about two years), as any difference with the active monetary policy scenario must vanish in the long run.

equilibrium (a shrinkage in banks' balance sheets). All agents are negatively affected by the reform, although borrowers obviously suffer the biggest hit. Entrepreneurs cut consumption and investment in physical capital, while impatient households reduce consumption of goods and housing services. The ensuing contraction in real activity depresses wages, spreading the damage to patient households as well.

Table 2 – Effects of a 1 p.p. increase in the capital ratio on output growth
(percentage points)

	banks' reaction strategy:		
Years since start of reform	(a) (fresh capital)	(b) (less dividends)	(c) (more profits)
year 1	-0.06	-0.10	-0.09
year 2	0.00	0.00	-0.01
year 3	0.01	0.02	0.00
year 4	0.00	0.00	-0.02
year 5	-0.01	-0.01	-0.03
year 6	-0.01	-0.02	-0.04
year 7	0.00	-0.01	-0.03
year 8	0.00	-0.01	-0.03
year 9	0.00	0.00	-0.02
year 10	0.00	0.00	-0.02
year 11	0.00	0.00	-0.01
year 12	0.00	0.01	-0.01
year 13	0.01	0.01	-0.01
year 14	0.01	0.01	-0.01
year 15	0.01	0.01	0.00

Summing up, our results suggest that the macroeconomic cost of higher capital is likely modest. If we translate the dynamic path of output shown in Figure 1 into *annual* growth rates (Table 2) and exploit the quasi-linearity in the response to the reform, we can reckon that, for example, a five percentage points increase in bank capital requirements (a not unlikely outcome of the reform for some European countries) would reduce output growth between 30 and 50 basis points in the first year, depending of the scenario considered, and have additional non negligible negative effects in subsequent years only under the worst-case scenario (c).

This finding is in line with previous literature, both with the contributions that have attempted to estimate the impact of stiffer capital requirements on the key macro variables ((BCBS (2010), MAG (2010), Angelini *et al.* (2011b), Roger and Vlcek (2011)) as well as with those that examine the impact on lending spreads (Elliot (2009, 2010), Hanson, Kashyap and Stein (2011) for the US, Schanz (2010) and Osborne *et al*. (2010) for the UK).[9]

Next, we look at the financial sector. Banks' profitability, proxied by RoE, declines on impact in all scenarios, and settles to its steady state value after a rebound. The short-run evolution of RoE reflects mainly the dynamics of official rates, as banks' interest margin depends positively on the level of nominal rates. Therefore, the initial drop in official rates squeezes interest margins while, as inflation and economic activity starts to spring back, the increase in official rates boosts profits and brings temporarily the RoE above its steady state.

Under scenarios (a) and (b) RoE settles at a lower steady state value, relative to its pre-reform level of 13 percent (minus 1.2 and 3.1 percent, respectively). Under (c) steady state RoE stays at its pre-reform level. In this case, in fact, the increase in the denominator of RoE triggered by higher capital requirements is exactly offset by the increase in interest rate margins. These effects on RoE establish a ranking of the three options from the banks' viewpoint. Banks' reaction to the reform would entail, in declining order of preference, an increase in lending spreads, a recapitalization, and a cut in dividends.

How to interpret these results? That banks would prefer option (c) is obvious, as this scenario amounts to an increase in their market power. Indeed, there are reasons to believe that banks' market power may have increased recently, due to the wave of consolidation in the banking sector that took place worldwide due to the crisis. At the same time, it is doubtful that banks would be able to shift the cost of the reform entirely on their customers. Banks' preferences over scenarios (a) and (b) are not obvious. From equation (2*), it is easy to see that steady state *RoE* can be written as the ratio $\delta_b/(1\text{-}DIV_b)$. Hence, adjusting δ_b (scenario (a)) or *DIV* (scenario (b)) should have an equivalent direct effect on *RoE.* In practice, therefore, banks' preferences over the two options must depend on their indirect effect on the economy. Figure 1 shows that, relative to scenario (a), a dividend cut has a stronger effect on output via consumption. This happens because households reduce their spending due to the reduced dividend inflow, whereas under the "free capital injection", as we have mentioned above, capital comes from outside of the model, and hence its macroeconomic effect is much more muted. Altogether, the ranking that we detect between options (a) and (b) may be model-specific. In a more realistic model, in which the

9 These papers argue that the effects of higher capital on lending spreads are modest, especially if banks are able to offset the increase in funding costs, e.g. through a reduction in banks' required return on equity and a decrease in borrowing costs, as banks become safer.

recapitalization costs are borne by households, the cost of option (a) in terms of output and foregone consumption might as well be larger than documented in figure 1, and banks' preferences over the two options might change.

The robust result emerging from our analysis is the following. The macroeconomic costs (in terms of lost output) of a regulatory reform aimed to increase the capital held by banks may be negligible, especially if banks resort to direct recapitalization manoeuvres (either dividend cuts or seasoned equity offerings). Under the alternative scenario, in which banks manage to raise lending spreads and shift the bulk of the adjustment to the private sector, these costs are somewhat bigger, on impact as well as in the long-run. The analysis further suggests that, lacking some incentive (government transfer or other policies) banks are unlikely to choose the first two options, as their economic convenience points toward the alternative course of action. With the due caveats, this result lends support to policies aimed at restricting banks' dividend distribution in the presence of capitalization problems, such as those envisioned in the Basel III package, and may help rationalize why banks do not voluntarily adopt them.

4. Impact on economic fluctuations

In this section we investigate the potential of the proposed reform (an increase in the capital requirement) to dampen cyclical fluctuations. We start in section 4.1 with the standard case discussed so far, in which the capital requirement is a fixed parameter, in line with the spirit of both Basel I and II, and the dampening effect, if any, comes from its higher level. Then in section 4.2 we move to a modified model in which the capital requirement is a function of the cyclical position of the economy, in the spirit of the countercyclical capital buffer introduced by the new Basel III regulation.

4.1 Impact on fluctuations of higher capital requirements

As a measure of the cyclical fluctuations of the main macro variables in each scenario we compute the unconditional standard deviations implied by the solution of the model and use them to judge whether the reform actually reduces (or magnifies) these fluctuations. Table 3 gives the percentage reduction in the standard deviation of the key variables relative to their steady state values under the no reform scenario. As the effects are non-linear with respect to the size of the reform, we look at three different reform scenarios: 2, 4 and 6 p.p. increase in capital requirements. Concerning shocks, we assume that the economy is hit by a (stationary) technology shock, which is a typical source of business cycle fluctuations in general equilibrium models such as ours.

Several results emerge. First, the reform decreases the cyclical volatility of all variables under all scenarios, except for investment and inflation. Second, the effects are nonlinear in the size of the reform. A substantial fraction of the stabilizing effect enjoyed by output and consumption already accrues under the minimal increase of the capital requirement considered (2 percentage points). For investment, larger (4 and 6 percentage points) increases tend to increase volatility.

Third, financial variables (loans, deposits, capital) seem to benefit relatively more from the reform than real variables. Looking at the "minimal" (2 p.p.) reform, output and consumption volatilities decrease between 2 and 4 percent, while loans and deposits volatility decreases by more than 11 percent in all cases, and in the case of bank capital the reduction is even greater, between 22 and 34 percent.

Fourth, looking across scenarios, the first two seem to be better options from the point of view of policymakers, since the reductions in volatility in macro variables and financial quantities are bigger and always increasing with the size of the reform. Under the "more profits" scenario, benefits are relatively more pronounced only for loans and deposits rates.

Table 3 – Change in the volatility of key variables under different banks' reactions to the reform
(technology shock)

	Size of capital ratio increase *(% points)*	banks' reaction strategy (a) (fresh capital)	(b) (less dividends) *(percentage changes)*	(c) (more profits)
Output	2	-3.5	-3.1	-2.3
(std dev under no reform: 2.88%)	4	-4.6	-4.1	-3.5
	6	-4.7	-4.3	-4.2
Inflation	2	4.8	8.5	5.0
(std dev under no reform: 0.58%)	4	8.4	14.4	8.7
	6	10.9	18.2	11.3
Consumption	2	-3.7	-3.4	-2.7
(std dev under no reform: 2.72%)	4	-5.4	-5.2	-4.5
	6	-6.3	-6.2	-5.7
Investment	2	-0.7	0.4	1.7
(std dev under no reform: 4.12%)	4	3.4	4.6	5.2
	6	8.3	8.1	8.6
Total Loans	2	-13.5	-13.7	-11.2

(std dev under no reform: 9.27%)	4	-20.0	-18.2	-17.2
	6	-22.8	-18.5	-20.3
Deposits	2	-14.6	-14.7	-11.4
(std dev under no reform: 5.37%)	4	-17.4	-18.7	-14.6
	6	-14.1	-17.6	-13.2
Bank Capital	2	-33.5	-21.8	-34.5
(std dev under no reform: 14.64%)	4	-49.5	-33.8	-50.6
	6	-55.8	-39.7	-56.7
Loans rate	2	-2.4	-2.8	-14.2
(std dev under no reform: 50.24%)	4	-1.7	-5.2	-23.8
	6	1.6	-6.4	-29.8
Deposit rate	2	-0.2	1.1	-0.9
(std dev under no reform: 45.09%)	4	-0.3	1.8	-1.8
	6	-0.4	2.3	-2.9

Note: Volatility is measured by the unconditional standard deviation of each variable. The percentage reduction/increase in the standard deviation is measured with respect to the value under the no reform case, reported in parenthesis under the name of the variable of interest.

As a robustness check, we recomputed the cyclical fluctuations including all thirteen shocks present in the estimated model. Bringing into the analysis such diverse shocks ("nominal" shocks to price and wage rigidities, "real" shocks to preferences and investment, "financial" shocks to loans rates, deposits rates and loan-to-value ratios) sensibly clouds the picture and the policy message that emerges from the analysis. As each shock impacts differently on each variable and thus induces co-movements among variables that are possibly different, the compound effect crucially depends on the relative size of the various shocks. Overall, when looking at all shocks, financial variables enjoy a similar degree of stabilization as the one computed under the technology shock, while real variables seem to somewhat increase their volatility, especially in the case of investment. Moreover, the effects continue to be nonlinear in the size of the reform, especially in the financial sector.

4.2 Effect of a countercyclical capital rule

In this section we modify the original model to investigate the effect of the adoption of countercyclical capital buffers. We posit the existence of a macroprudential authority that sets capital requirements ν_t according to the following equation:

$$\nu_t = (1-\rho_\nu)\bar{\nu} + \chi_\nu X_t + \rho_\nu \nu_{t-1}$$

where the parameter $\bar{\nu}$ measures the steady state level of ν_t and X_t is an indicator of cyclical conditions. Thus, a positive value for χ_ν means that capital requirements increase in good times (banks must hold more capital for given amount of loans) and fall during recessions. Having introduced this change we investigate two issues: first, whether this rule performs better than the fixed ν at the pre-reform level of $\bar{\nu}$; and second, whether the introduction of a capital reform that increases the steady state level $\bar{\nu}$ (by 2, 4 or 6 p.p.) has sizeable dampening effect on economic fluctuations. Depending on the definition of "financial stability", many choices for X_t are possible; in what follows, X_t is the ratio of total loans to output in deviation from its steady-state level.[10] The parameters ρ_ν and χ_ν have been chosen so as to magnify the countercyclical effect of the policy rule while at the same time avoiding an unrealistic amount of cyclical variation in the instrument.[11]

Table 4 reports the percentage increase/reduction in volatility in the main macro variables when the countercyclical capital rule is implemented. In particular, the "no increase" rows report the changes in standard deviations from the introduction of the countercyclical capital rule at the 9% capital ratio level. The rows labelled 2, 4 and 6 show the effect of compounding a change in the level of capital requirements together with the implementation of a countercyclical rule around the new level.

The main results are the following. First, the addition of the countercyclical rule dampens cyclical fluctuations: all output figures have a negative sign, both in the "no increase" row and in the reform scenarios (rows "2", "4" and "6"). The biggest decreases in volatility, and this is the second result, are recorded under the "more profits" scenario, while in the other two scenarios the gains are smaller and sometimes even negative, for example for investment and bank capital. Third, looking across variables, the main effect of the countercyclical rule seems to be to stabilize loans, as they always record the biggest stabilizing effect, which suggests how effective in this model is the transmission channel from the supply of loans to the real economy.

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[10] Angelini et al. (2011a), who run a similar exercise, set X_t equal to the loans/output ratio. For robustness, the exercises have been replicated with X_t equal to the annual growth rate of output, or to the deviation of total loans from their steady state; the results are qualitatively similar.

[11] After a numeric search, we set ρ_ν = 0.99 and χ_ν = 2.0. The implied standard deviation of ν_t means that, under normality, 95% of the cyclical values taken up by the policy parameter ν_t will be at most 3 percentage points away from the steady state. So if the steady state is 11 percent, the oscillations will be between 8 and 14 percent.

Table 4 – Change in volatility of key variables under a countercyclical capital rule

(technology shock; percentage changes in unconditional standard deviations)

	Size of capital ratio increase *(% points)*	banks' reaction strategy (a) (fresh capital)	(b) (less dividends)	(c) (more profits)
		(percentage changes)		
Output	no increase	**-2.0**	**-4.9**	**-12.9**
	2	-6.1	-8.0	-17.0
	4	-7.8	-9.0	-19.9
	6	-8.5	-9.3	-22.2
Inflation	no increase	7**.4**	**4.1**	**6.4**
	2	13.0	13.5	12.6
	4	17.1	20.0	17.2
	6	19.9	24.4	20.5
Consumption	no increase	**-1.7**	**-5.3**	**-9.0**
	2	-6.0	-9.2	-13.1
	4	-8.4	-11.5	-16.2
	6	-9.8	-13.0	-18.6
Investment	no increase	**1.9**	**2.2**	**-23.6**
	2	7.2	9.2	-18.2
	4	16.2	17.2	-11.3
	6	24.7	23.0	-4.9
Total Loans	no increase	**-11.5**	**-14.7**	**-24.2**
	2	-29.3	-29.9	-40.0
	4	-39.3	-34.6	-49.7
	6	-44.7	-34.5	-55.6
Deposits	no increase	**2.7**	**-0.9**	**-3.2**
	2	7.6	4.6	5.0
	4	23.0	16.9	17.8
	6	41.0	30.2	31.0
Bank Capital	no increase	**7.7**	**5.3**	**3.9**
	2	-9.2	1.5	-18.2
	4	-13.5	1.4	-25.6
	6	-13.6	2.1	-27.8
Loans rate	no increase	**12.8**	**8.0**	**11.0**
	2	18.2	13.7	3.1
	4	28.7	20.7	-0.4
	6	42.5	28.3	-1.3
Deposit rate	no increase	**1.4**	**-8.8**	**0.3**
	2	1.7	-9.3	-0.9
	4	2.0	-10.3	-2.2
	6	2.4	-11.7	-3.5

Note: The percentage changes are with respect to the standard deviations of the no reform case (reported in Table 3).

5. The timing of implementation of the reform

In what follows we investigate whether alternative ways to implement the reform may change the short-term dynamics of the key model variables outlined in section 3. Recall that so far we have assumed that the move to the new capital requirement starts at the beginning of the simulation period and takes place linearly in seven years. In what follows we explore two alternative implementation strategies. The first assumes a phasing-in period lasting only 3.5 years (shorter implementation). The second regime assumes that the phasing-in period still lasts 7 years but is announced 3.5 years in advance of its beginning (pre-announced or 'anticipated' implementation). This scenario is meant to gauge the effect of an announcement made ahead of the effective start of the reform, which should allow economic agents to plan their compliance strategies. This scenario is interesting because several parts of the Basel III package are designed with this characteristic. In particular, the key features of the new standards were announced in September 2010, but the announcement made clear that the implementation would begin in January 2013 and would be gradually completed by January 2019.[12] [13]

In Figure 2 we compare the transitional dynamics under the "more profits" scenario (taken from the baseline simulation; black solid lines) with the shorter implementation (blue dashed lines) and the anticipated one (red dotted lines). These scenarios only differ in terms of dynamics; their steady state values are the same.

The figure suggests that a shorter implementation period has detrimental macro effects: the transitional drop in output and investment is larger than under the baseline. This is due to the fact that banks, in the attempt to sustain RoE, increase the spread charged on loans more sharply than under the baseline scenario (almost 20 basis points on impact, against 8), causing a more severe fall in loans on impact (-1.4 percent, against -0.8). Such tighter credit conditions negatively affect investment and economic activity.

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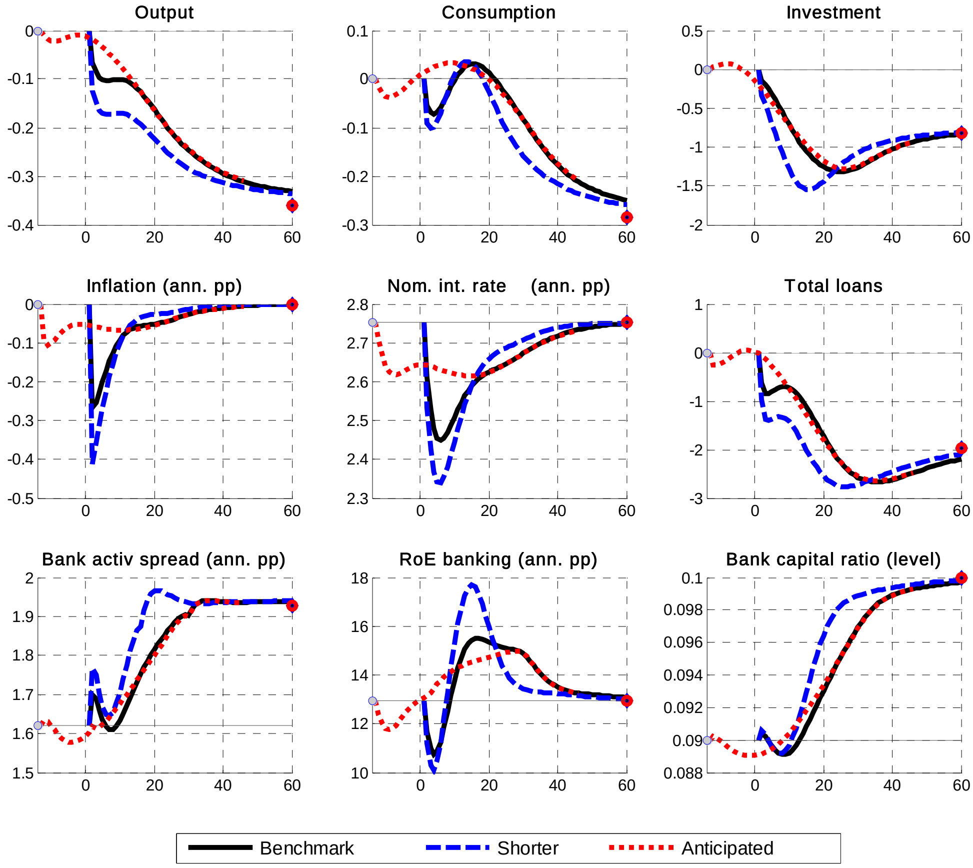
12 See the press release "Group of Governors and Heads of Supervision announces higher global minimum capital standards", available at http://www.bis.org/press/p100912.htm.

13 Perhaps because of the intense market pressure, it appears that most big systemic banks in the Euro area have effectively used the period between the announcement and the effective start of the reform to frontload most of the adjustment.

Figure 2 – Alternative implementation strategies for the reform

(percentage deviation from initial steady state unless indicated.
Quarters on abscissas; the zero denotes the start of the phase-in period)



Note: "Benchmark" denotes the "more profits" scenario presented in the previous sections. In this scenario banks' capital requirement increases linearly from 9 to 10 percent over a horizon of 7 years starting from quarter 1 (black solid line). In the "Shorter" implementation scenario (blue dashed line), the capital requirement is increased in half the time (3.5 years). In the "Anticipated" scenario (red dotted line), the implementation period is 7 years, but it is announced 3.5 years before its start.

By contrast, in the 'Anticipated' scenario the transitional macroeconomic effects are dampened. The required adjustments – an initial increase in loans rates and a reduction in loans granted – are qualitatively similar to those of the baseline case. However, thanks to the announcement effect, they are anticipated by 3.5 years and are much smaller than before. Now banks can afford to raise profit, and thus capital, at a much slower pace and thus the initial increase in loan rates is very small. As a consequence, the capital ratio is depressed below the initial steady state for longer, but, crucially, this is not too costly, as the regulatory requirement is not moving immediately after the announcement. As a result, the initial negative dent in output is almost entirely gone.

The nominal price, wage and interest rate rigidities embedded in the model are clearly a crucial determinant of this result. These rigidities imply that banks prefer to move loan rates as smoothly as possible. This constrains their ability to raise new profits and fresh bank capital.[14] Thus for banks it is beneficial to be able to begin adjusting well ahead of the actual start of the reform.

Overall, it seems that the modalities with which the reform is implemented – length of the phase-in period, advance announcement – are crucial to minimize its short-term macroeconomic costs: a more rapid implementation impairs the ability of the financial sector to provide credit to the real economy; allowing for a "planning period" before the start of the reform allows banks to better prepare for the change ahead.

6. Conclusions

The macroeconomic effects of the Basel III reform have been the subject of a hot debate. In setting the new capital requirements, the regulator has faced a trade-off: high capital requirements increase banks' resiliency to exogenous shocks, but may hamper their ability to finance viable investment projects, stifling economic growth, especially during the adjustment phase. The positions expressed in this debate have covered the entire spectrum: some argue that stiffer capital requirements could have dire effects for the economy, whereas others have countered that such effects are very small, if at all present. This heterogeneity of views is partly due to the lack of adequate analytical tools: a banking/financial sector was entirely missing from standard macro models until very recently, and modeling efforts aimed at filling this gap are currently in their early stages.

The present paper has used a macro model with a financial sector to investigate the mecroeconomic consequences of higher capital requirements. It is important to remark once more that our methodology is unable to capture the benefits of the reform in terms of reduced likelihood and severity of systemic crises, which are arguably its main drivers (see BCBS (2010) for a quantification of the benefits). Bearing this in mind, our main results can be summarized as follows.

Concerning the first two questions raised in the introduction, we find that the macroeconomic costs of the reform are modest. A 1 p.p. increase in capital requirements trims a few basis points off annual GDP growth in the first few years after the start of the reform (although this effects varies depending on banks' reaction to the reform, as we discuss shortly). We also find that a capital rule which raises the requirement in periods of

[14] Another crucial rigidity is introduced by the way we implement the experiments. The parameters of interest in each scenario do not jump to their final value on impact but instead adjust in exact lockstep with the gradual increase in capital requirements. Apart from being the only model-consistent way to implement the experiments, this assumption is consistent with the idea that it takes time to engineer, implement and derive resources from any plan or course of action in response to the reform.

buoyant economic growth and lowers it during downturns has the potential of reducing the procyclicality of the financial system, thereby dampening economic fluctuations. Overall, these results confirm the evidence in previous studies.

Our main contributions relative to the existing literature lie in the analysis of various strategies that banks might adopt in reaction to the regulatory tightening, and of the implementation strategy to be adopted by the regulator. Concerning the former, we have considered three widely debated options available to banks: (a) raising more equity, either on the market or through some form of public subsidy; (b) reducing dividends paid out to shareholders, i.e. accumulating capital through retained earnings; (c) raising the interest rate spread on loans. Our results suggests that the macroeconomic consequences of the capital tightening may vary to a non negligible extent, depending on how banks react to the tightening. Specifically, under reactions (a) and (b) the output loss generated by higher capital requirements is negligible, whereas under (c) it becomes more sizeable, although still quite small. Perhaps not surprisingly, our results also show that banks' preferences run it the opposite direction: Banks' RoE is negatively affected by the capital tightening, with the effect strongest under scenarios (a) and (b), and mildest under (c). This suggests that, if left to their own devices, banks would shift the burden of the new regulation entirely onto their customers, in the form of higher rates on loans and/or lower deposit rates. With the due caveats, this result lends support to policies aimed at restricting banks' dividend distribution in the presence of capitalization problems, such as those envisioned in the Basel III package.

Our second new result concerns the reform's implementation strategy. We show that by announcing the reform well in advance of the beginning of the phase-in period (for given length of the latter), the regulator can reduce the burden of the reform itself for the financial sector and ultimately for the economy. This is because, in the presence of real and nominal frictions, an announcement made ahead of the effective start of the reform allows banks to plan their compliance strategies. This result rationalizes several parts of the Basel III package designed with this characteristic.

Appendix

Table 1A – Model parameters

Parameter	Description	Value
	Basic parameters	
β_P	Patient households' discount factor	0.996
β_I	Impatient households' discount factor	0.975
β_E	Entrepreneurs' discount factor	0.975
a	Habit persistence in the utility function	0.86
ψ	Inverse of the Frisch elasticity	1.0
μ	Share of patient households	0.8
ε_h	Weight of housing in households' utility function	0.2
α	Capital share in the production function	0.25
δ	Depreciation rate of physical capital	0.025
m_H	Households' LTV ratio	0.7
m_E	Entrepreneurs' LTV ratio	0.35
ε_y	$\varepsilon_y/(\varepsilon_y-1)$ is the markup in the goods market	6.0
ε_d	$\varepsilon_d/(\varepsilon_d-1)$ is the markdown on deposit rate	−1.4
κ_p	Price stickiness	28.65
κ_w	Wage stickiness	99.90
κ_i	Investment adjustment cost	10.18
κ_d	Deposit rate adjustment cost	200.0
κ_{bE}	Entrepreneurs' loan rate adjustment cost	9.36
κ_{bH}	Households' loan rate adjustment cost	10.09
φ	Bank Capital adjustment cost	11.0
	Initial values of parameters used in the experiments	
v	Target capital-to-loans ratio	0.09
δ_b	Cost for managing the bank's capital position	0.049
DIV_b	Dividend yields in the banking sector	0.4
ε_l	$\varepsilon_l/(\varepsilon_l-1)$ is the markup on loans rate (households & firms)	2.7
	Monetary policy and countercyclical rule	
ρ_R	Monetary policy: inertia	0.77
χ_v	Monetary policy: response to inflation	1.98
χ_y	Monetary policy: response to output growth	0.35
ρ_v	Countercyclical rule: inertia	0.99
χ_v	Countercyclical rule: response to cyclical conditions	2.0

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