The Macroeconomic Effects of Anti-Cyclical Bank Capital Requirements: Latin America as a Case Study

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Abstract

The recent financial crisis has focused attention on credit booms and busts and bank credit procyclicality. The recently agreed Basel III attempts to improve the quality of bank capital and explicitly includes a capital buffer to address cyclicality. In this paper we study the potential for cyclical capital rules in a stochastic dynamic general equilibrium model. Our results suggest that introducing anti-cyclical bank capital requirements are welfare improving since they make consumption more stable, although they may actually make investment more volatile. The quantitative results are sensitive to the size of the capital buffer (over actual requirements) optimally held by banks. We consider Latin America as a case-study and find that given the large buffer of total capital held by banks over Basel requirements, an aggressive cyclical capital rule would be required to have significant impact. On the other hand, a cyclical capital rule specified on tier 1 capital would indeed lower consumption volatility significantly in the region. We suggest that rules on anti-cyclicality and on the quality of capital should be considered jointly.

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1 Introduction

The recent financial crisis has focused attention on pro-cyclicality in the financial sector and boom and bust credit cycles. Moreover, it has been frequently argued that finer risk-based capital requirements, as advanced in Basel II, would induce further pro-cyclicality as assessments of individual borrowers' risks are likely to rise in economic downturns and fall in upturns. In an attempt to address these concerns, Basel III, apart from higher requirements especially on tier 1 capital, has now introduced a capital buffer to be built up in good times and that may be reduced in economic downturns. This buffer along with the other stricter tier 1 requirements will be phased in over an extended period as the global economy recovers. Pro-cyclicality in banking has been a recurrent theme in the academic finance literature. In economic downturns banks' non-performing loans will rise and even in the absence of regulations banks may choose to raise new capital or reduce their lending to ensure their costs of funds do not rise and their solvency is not put at risk. If groups of banks attempt to recapitalize at the same time, recapitalization may become expensive or may simply not be possible. If so, a reduction in bank credit will occur exacerbating the economic downturn. In such a context, the imposition of capital and provisioning requirements may amplify these effects and thus have further consequences for the rest of the economy, especially if the reduction in bank credit effectively impacts investment and production for bank-dependent firms.

In part for these reasons, the case has been made for anti-cyclical capital requirements such that in good times banks are subjected to a higher minimum required capital-to-assets ratio, building a buffer of capital that will then be available and would be allowed to be reduced, thus potentially maintaining lending in bad times. This buffer may then be used to partially offset the effects of aggregate shocks on bank-dependent borrowers, helping to alleviate recessions.

Banking regulations and their macroeconomic implications have been studied in various recent academic papers; see in particular Furfine (2000), Van den Heuvel (2007 and 2008). In particular, one theme has been to test whether increased capital requirements might reduce the supply of credit and itself cause something of a credit crunch. Aliaga-Díaz and Olivero (2011), henceforth ADO, develop a theoretical model and then calibrate that model, bridging a gap in the literature between the theory and previous empirical work. They then use the model to study the financial accelerator effect of fixed bank capital requirements. Here we extend the model in ADO to allow for time-varying capital requirements and we apply the model to consider the particular situation of Latin America.

Specifically, we build a model where banks are subject to capital requirements that vary endogenously with the economic cycle. We then embed this model into a dynamic, stochastic general equilibrium setting to address the role of these regulations in the transmission of aggregate shocks. Two crucial general equilibrium elements are needed in the model for capital requirements to potentially have effects on the economy. First, the demand for bank credit must change endogenously with economic conditions. Second, in the model investment and production for bank-dependent firms must be endogenous to the supply of bank credit, so that bank credit can independently drive business cycles.

We find, from our general equilibrium analysis, that constant bank capital requirements (i.e.: ones that do not change through the cycle) cause a type of financial accelerator. In other words, after an adverse aggregate productivity shock, key macroeconomic variables are more adversely affected compared to a no-regulation environment. The intuition is that after an adverse aggregate shock, bank profitability declines, bank equity decreases, and banks must cut-back on the supply of credit to be able to meet the minimum required capital-to-assets ratio imposed by the regulator. This indirect effect of the shock, working through the supply of bank credit, amplifies a direct effect on the demand for credit, investment and production. Hence, standard constant capital requirements amplify the pro-cyclicality of macroeconomic variables.

In this environment, introducing anti-cyclical requirements is indeed welfare improving. In particular, they may make consumption less volatile, which is preferred by risk-averse households. However, they may make investment more volatile which might not be desirable to firms in the production sector. However, the results are sensitive to the buffer that banks' hold above minimum requirements. The explanation is the following: banks' optimal response to a capital requirement is to accumulate capital in excess of the minimum required as a buffer against future shocks. Depending on the parameters of the model, banks will maintain a sizeable capital buffer in the stochastic steady state. If now an anti cyclical rule is introduced banks will anticipate capital requirements falling in economic downturns. This may reduce the optimal buffer held by banks above the requirements and the effect of anti-cyclical capital rules may be smaller than previously thought. If the parameters of the model are such that the optimal buffer held by banks above requirements is fairly small, this is then when the effects of an anti cyclical rule are found to be strongest. In this case, consumption volatility falls with the anti cyclical rule but investment volatility may even rise as banks trade off the cost of hitting the capital requirement and contracting credit.

We consider Latin America as a case-study. Latin America survived the recent global financial crisis reasonably well and avoided any major financial crisis. No doubt the high buffers of total capital that banks held above capital requirements played a role. One might speculate that these substantial buffers are themselves a reflection of Latin America's economic volatility and turbulent financial history and the impact of previous crises. Calibrating the model to Latin

America, we find that the high buffers banks maintained over the requirements diminish the impact of introducing an anti-cyclical rule based on total capital. Such a rule may however still be justified. However, it suggests that if a rule is to have a significant bite it would have to be an aggressive one. On the other hand Basel III also introduces new rules regarding the quality of capital. Depending on how these rules are implemented in Latin America, and whether the anti cyclical rule operates on total capital or on only higher quality capital (tier 1 capital or core tier 1 capital), we find an anti cyclical rule may have greater impact.

We should however make certain caveats regarding these results. First we assume that banks behave optimally and maintain buffers over capital requirements to diminish the probability that they hit the requirement. We rule out what might be labeled as perverse behavior or gaming; for example the case of a bank speculating that the regulator may forebear or even reduce requirements in the case of bank capital falling below the required capital levels. In this same spirit we consider actual Latin American bank capital levels and moreover we focus mostly on *average* or median capital levels. As some banks will have lower buffers above the requirements than others, we are then likely underestimating the effects of an anti-cyclical rule.

The structure of the paper is as follows. The model is laid out in Section 2. Section 3 discusses the numerical solution and calibration. Section 4 discusses the calibration of the model to Latin America and includes a discussion of two sets of the results, (i) an analysis of impulse responses and (ii) simulating the model with alternative assumptions regarding the strength of the anti cyclical rule. Section 5 presents a policy discussion and conclusion.

2 The Model

In this paper, we develop a competitive stochastic general equilibrium model that includes a banking sector that provides loans to firms. The model builds on Aliaga-Díaz and Olivero (2011) (hereafter ADO) but we extend their framework in two significant ways. First, we will allow for capital requirements that vary over the economic cycle. This allows us to simulate an anti-cyclical capital requirement rule where the requirement is increased during periods of economic growth and reduced during economic downturns. Secondly, following Furfine (2000), we model a minimum capital regulation as a cost that banks are subjected to if they have capital that is less than the required level, and where the cost is related to the extent of their capital deficiency. This allows us to extend the model in the first direction while still maintaining tractability.

Since other than these two extensions the model is exactly as in ADO, we refer the reader to that paper for the formal and full presentation of the model. Here we limit ourselves to presenting the main elements of the model in a mostly verbal fashion.

2.1 Banks

Banks are perfectly competitive. They choose their optimal dividend payout policy (Δ_t) and retention of earnings (RE_t) to maximize the present value of the expected stream of dividend payments to their owners discounted at the households intertemporal marginal rate of substitution (q_t). The choice of Δ_t and RE_t pins down the optimal plans for equity (e_{t+1}), demand deposits (D_{t+1}) and bank loans (L_{t+1}).

The bank is subject to a corporate income tax with tax rate τ and with interest payments on deposits being exempt, which in turn determines a tax-advantage of using debt rather than equity to finance loans. Profit maximizing banks balance this benefit against the cost related to the capital regulation of using more debt and less equity. The introduction of this tax guarantees that the bank problem is stationary and that the financial structure does not drift towards an all-equity financing steady state (see Aiyagari and Gertler, 1998). Since by assumption firms only source of financing is bank lending, the bank is the only claim holder of the firm and thus it earns the firm's profits (π^{firm}).

$$e_{t+1} \geq \gamma_{req} L_{t+1} \tag{1}$$

$$\gamma_{req} = 0.08 A^{\gamma} \tag{2}$$

Finally, equations (1) and (2) introduce the capital adequacy regulation, which indicates that at least a fraction γ_{req} of bank lending has to be financed with the bank's own equity. This share is specified as an exponential function of the total factor productivity index (A) in the economy. In this paper, we follow Furfine (2000) and we state that if banks have capital less than a fraction γ_{req} of their loans, then they are subject to a cost. This improves the tractability of the model.[1] These costs are increasing in the distance between the actual capital-to-assets ratio $\frac{e_{t+1}}{L_{t+1}}$ and the required one γ_{req}.

This allows us to solve the model using standard log-linearization techniques around the stochastic steady state. Specifically, the cash flow equation, the law of motion for bank equity and the balance sheet equation now become equations (3)-(5):

$$(1-\tau)\left(i_t L_t + \pi_t^{firm} - r_t D_t\right) - L_{t+1}\left(\eta_0 - \eta_1 log\left(\frac{e_{t+1}}{L_{t+1}} - \gamma_{req}\right)\right) = \Delta_t + RE_t \tag{3}$$

$$e_{t+1} = RE_t + e_t \tag{4}$$

$$L_{t+1} = D_{t+1} + e_{t+1} \tag{5}$$

[1] The alternative of an actual occasionally binding constraint would complicate tractability enormously with seven state variables and with several alternative calibrations to be performed.

Plugging (4) and (5) into (3), we can obtain the following FOCs:

$$1 - \frac{\partial \left(L_{t+1} \left(\eta_0 - \eta_1 log \left(\frac{e_{t+1}}{L_{t+1}} - \gamma_{req} \right) \right) \right)}{\partial D_{t+1}} = E_t \left[q_{t+1}(1 + (1-\tau) r_{t+1}) \right] \quad (6)$$

$$1 + \frac{\partial \left(L_{t+1} \left(\eta_0 - \eta_1 log \left(\frac{e_{t+1}}{L_{t+1}} - \gamma_{req} \right) \right) \right)}{\partial L_{t+1}} = E_t \left[q_{t+1}(1 + (1-\tau) R_{t+1}) \right] \quad (7)$$

Euler equations (6) and (7) describe the optimal inter-temporal decisions of the bank as regards deposits and loans, respectively.

2.2 Households

The representative household in the economy maximizes its lifetime utility by choosing the optimal lifetime profile of consumption (c_t), labor (l_t), bank deposits (D_{t+1}) and bank shares (s_{t+1}) priced at p_t. Households also have access to a storage technology (Z_{t+1}) that pays no return, and that provides no service to households other than being an alternative way to smooth consumption[2].

2.3 Firms

Firms are perfectly competitive. The representative firm chooses the optimal level of investment (I_t), labor demand (l_t) and bank borrowing (L_{t+1}) to maximize the expected present discounted value of lifetime cash flows. The discount rate used here is the opportunity cost of funds for the firms' owners (the banks), given by the rate on deposits.

The inequality constraint in equation (8) imposes the need for bank financing in the model. It states that net investment must be entirely financed with new debt (i.e. $L_{t+1} - L_t$), while capital depreciation must be paid out of the firm's cash flow.

$$L_{t+1} \geq K_{t+1} \quad (8)$$

3 Numerical Solution

The system of equilibrium conditions describing this economy is highly non-linear. Therefore, the set of optimal policy functions cannot be obtained analytically, and it has to be approximated numerically. For this purpose we log-linearize the system of equilibrium conditions around the stochastic steady state. We calibrate the model at a quarterly frequency to match standard RBC

[2] This asset is introduced into the model to guarantee a non-negative equilibrium real interest rate.

statistics and bank capital holdings in Latin American economies. We then simulate the model numerically to examine the qualitative dynamics of the system in response to exogenous shocks to TFP. The parameter values used are presented in Table 1.

The households utility function is of the constant relative risk aversion (CRRA) type over an aggregate of consumption and leisure. To be able to abstract from wealth effects on labor supply, this aggregate is assumed to be of the Greenwood, Hercowitz and Huffman (GHH) type. Thus, $u(c_t, l_t) = \frac{\left(c_t - \frac{l_t^{\omega}}{\omega}\right)^{1-\theta}}{1-\theta}$. A Cobb-Douglas specification is assumed for the production technology $A_t F(K_t, l_t) = A_t K_t^{\alpha} l_t^{1-\alpha}$.

The autocorrelation parameter in the TFP process is set to $\rho = 0.765$ and the standard deviation of TFP shocks to $\sigma = 0.027$, in both cases following García-Cicco, Pancrazi and Uribe (2010). The parameter α is set to match a capital share of 0.67 in Latin American economies, β is set to match a quarterly interest rate of 4%, δ to match a 2.5% capital depreciation rate. The parameter ω is set to 1.7, to match an elasticity of labor supply of 1.5, and the parameter σ is set to 10 following the standard practice in the RBC literature. The corporate income tax rate τ is set to 29% using the data provided by Cetrángolo and Gómez Sabaini (2007)[3]. The parameter η_0 in the cost function associated to the capital adequacy regulation is set so that the costs of abiding by the capital adequacy regulation amount to around 1% of GDP in the deterministic steady state. To calibrate the parameter η_1 we use bank-level data on the Colombian banking sector (see Fogabin (2010)). In the benchmark parameterization, the parameter η_1 is calibrated to match an excess bank capital over tier 1 capital (capital buffer) of 2.1% for the median bank in Colombia. As a robustness check, η_1 is set to match an excess capital of 5.5% which is the average for all Colombian banks. We also run an alternative simulation to calibrate the model to the Basel II Accords and a buffer of capital of 7.75% (average 15.75% capital holdings), which is consistent with the IMF data presented in Table 2.

The required capital-to-assets rule is set to match an 8.5% ratio in the deterministic steady state.

All results are robust to the choice of parameter values. Sensitivity analyses are available from the authors upon request.

[3] Table A2 in Cetrángolo and Gómez Sabaini (2007) provides the average corporate income tax rate for 2006 for the following countries: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Perú, Republica Dominicana, Uruguay and Venezuela.

4 Results

In this section we use the model to consider whether endogenously time-varying capital requirements may mitigate pro-cyclicality and, if so, how. Given banks normally hold significant "excess capital" over requirements, in our view it is essential for any model that considers capital requirements and financial accelerator effects to be able to explain this behavior. A model that by construction has capital requirements always binding will likely find accelerator effects as a direct result of that assumption but will not then adequately explain bank behavior and may then misinterpret the potential effect of anti cyclical rules. Our model is indeed able to explain why the representative bank finds it optimal to hold "excess capital". The capital regulation operates as a restriction on net asset holdings (i.e. $\frac{e_{t+1}}{L_{t+1}} \geq \gamma_{req}$ is equivalent to $(1-\gamma_{req})L_{t+1} - D_{t+1} \geq 0$). In the context of aggregate uncertainty and with the capital-to-assets ratio falling below γ_{req} being costly, banks acquire self-insurance. They do that by over-accumulating capital above the regulatory limit; in other words they build up buffers of equity above requirements.

In our model it is clear from the representative bank's Euler equations that when deciding on the optimal level of debt financing, the bank balances its benefit (debt financing is tax-exempt) against its cost (higher debt implies a higher probability of hitting the capital constraint and the costs that the bank then has to pay). The bank, however, does not resort to an all-equity financing strategy because in equilibrium the return on equity obtained by the bank falls short of the cost of funds (which is approximately equal to $(1 + r) = 1.04$ in the deterministic steady-state). Note that a return on equity lower than $(1+r)$ is consistent with a risk-premium on bank shares. Given that bank deposits are risk-free, risk-averse households will hold bank shares only if they are compensated for risk.

In the simulations, typically the excess capital is large enough for the probability of a binding regulation constraint to be relatively small; i.e. the bank tries to minimize the cost associated to the capital adequacy regulation. The explanation for this is that for a lower level of excess capital (i.e. one in which the probability of hitting the constraint is positive) it is not guaranteed that the bank will be able to meet the regulatory constraint in every state of nature. Therefore, in some states of nature the constraint would not be met. Since these events are costly, the bank builds up enough excess capital to avoid this from happening.

In terms of calibrating the model it is then critical to choose appropriate parameters such that bank capital buffers resemble those that are actually found in practice. Table 1 gives the calibration parameters that we use in the simulations. Table 2 gives details of actual bank capital levels across Latin America. As can be seen in this table average bank capital levels are high, with a simple average across countries well in excess of 15% of assets at risk and this ranging from an average level of 12.5% in Ecuador to almost 19% in Uruguay and notably 18.5% in Brazil. Capital requirements vary in the region. Argentina, Mexico and Peru maintain capital requirements for credit risk of 8%, the Basel recommended minimum, while other countries have somewhat higher requirements. Brazil has one of the highest requirements in the region at 11% of assets at risk for credit risk. The bottom line is that compared to Basel requirements Latin American banks on average hold significant excess capital. We estimate excess average total excess capital relative to a Basel II 8% standard of some 7.75%.

However, Basel III suggests enhancements to bank capital. Basel I rules (unchanged in Basel II) call for a minimum of 8% of total capital in relation to assets at risk with tier 1 capital not falling below 4% of assets at risk. Basel III calls for a minimum of 4.5% of a new concept, namely core tier 1 capital and a minimum of 6% of total tier 1 capital and an absolute minimum of 8%. However, on top of this 8%, Basel III adds a capital conservation buffer which should be at least 2.5% of assets at risk and that should be made up of the same type of capital as tier 1. If banks do not comply with a total minimum of 10.5% of capital with at least 8.5% of that being tier 1 capital, then they should not be allowed to distribute dividends to shareholders. On top of these requirements Basel III also introduces an anti cyclical buffer. This buffer should be built up in the good times when credit growth is strong and may be drawn down at times of economic downturns. Basel III calls for at least a further 2.5% of capital to be built up as a consequence of the anti cyclical buffer rule.

It is not clear as yet how Basel III will be implemented in the region. To date no country in the region has implemented a definition of core tier 1 capital. Countries do define tier 1 and tier 2 and here we analyze bank by bank data for Mexico, Colombia and Brazil as examples.

The Mexican Comisión Nacional Bancaria y de Valores publishes bank by bank ratios of tier 1 and tier 2 capital to assets at risk, see Comisión Nacional Bancaria y de Valores (2010). Calculations reveal that some 50% of the Mexican financial system operates with a tier 1 capital to assets at risk ratio of under 14% or with a buffer of tier 1 capital of under 5.5% relative to Basel III's 6% minimum plus 2.5% capital conservation buffer.

In the case of Brazil we consider data from Bankscope which in this case has good coverage. This data reveals that well over 50% of the Brazilian financial system operates with excess tier 1 capital of 5.5% or below relative to a Basel III standard of 8.5% (6% plus 2.5% capital conservation buffer).

Colombia's deposit insurance agency (Fogafin) recently published an interesting note regarding the quality of bank capital - see Fogafin (2010). The note argues that Colombian rules on the quality of capital should be adjusted towards a Basel III standard. Unlike the Mexican and Brazilian data, the banks are not named and we do not know the size of the banks, however the analysis is restricted to the 18 deposit taking banks which are the main financial institutions in the country. Among the set of interesting statistics presented it is revealed that the median buffer among Colombia's banks over a Basel III total tier 1 requirement of 8.5% (6% minimum plus 2.5% capital conservation buffer) is about 2.1%. Or in other words the median bank has tier 1 capital of some 10.6% of assets at risk.

While we do not have hard statistics regarding tier 1 and tier 2 capital as a percentage of assets at risk in other countries of the region, we suspect that banks in other countries in the region may be between the higher levels of tier 1 capital for banks in Mexico and Brazil and the lower tier 1 capital ratios of Colombia.

Given the above statistics we decided to present three calibrations of the model in this paper. The first calibration is intended to represent that of a Basel II standard and hence we set the capital requirement to 8% and we calibrate the parameters of the model such that banks have excess capital of some 7.75% over that requirement. The second is intended to represent a Basel III standard calibrated to Basel III's tier 1 requirements with an excess capital of 5.5% of tier 1 capital. As discussed above, this is roughly the excess tier 1 capital of some 50% of the Mexican financial system and a little over 50% of the Brazilian financial system. Finally we present a calibration with an excess capital of 2.1%. This accords to the level of excess capital of the median Colombian bank.

4.1 Impulse Responses to TFP Shocks

In this sub section, we analyze the economy's response to a negative TFP shock under a no-regulation scenario (i.e. $\gamma_{req} = 0$). Then, we compare the dynamic paths in this economy to those of an economy with bank capital requirements.

When there are no capital requirements, tax-exempt deposits are cheaper, so that banks will choose to hold no equity. The model then collapses to a standard closed-economy RBC model with firms making investment and production decisions and households making consumption-saving decisions. Banks are completely redundant in this setting, and since they are perfectly competitive, the interest rate spread is zero. As usual in standard RBC models, after a negative TFP shock, the marginal product of capital and therefore, the interest rate fall. Output, consumption, labor and investment all fall following the drop in TFP. They are all positively linked to TFP, which is the only source of fluctuations in the model.

Figure 1 displays banks' optimal responses in the regulated environment derived by perturbing the system with a one standard deviation negative TFP aggregate shock for alternative values of the excess capital buffer optimally held by banks. It corresponds to a calibration of a capital rule á la Basel II (i.e. $\gamma_{req} = 0.08 \times A^{\gamma}$) and with a 7.75% capital buffer.

After a negative shock, bank equity falls. The intuition for this drop in equity is the following: Firms profits (π_t^{firm}) fall after a negative TFP shock. With the banks being the only claim-holders to the firm (by $K_{t+1} = L_{t+1}$), firms profits are rebated to the banks. Therefore, the fall in profits has a negative impact on banks' retained earnings and profitability, so that bank equity falls (see the relationship between earnings and equity described by equations (3) and (4).

If capital-to-assets ratios fall below the regulatory minimum as a result of this reduction in equity, banks find themselves needing to pay the costs of violating the capital adequacy regulation or to recapitalize. They do so by retaining earnings up to the point where the constraint on dividends becomes binding. After this, further adjustments to the capital-to-assets ratio have to be achieved by curtailing the supply of loans. Thus, credit availability is restricted in the model relative to a standard model that lacks capital requirements, and the interest rate spread optimally charged by banks rises. This induces borrowers to further lower employment and investment, which amplifies the standard effects of a negative TFP shock making the recession deeper and longer. Furthermore, the higher the required capital (i.e. the larger γ_{req}), or the less anti-cyclical the capital requirement (i.e. the less positive γ), the more likely it is that a bank will need to cut its loan supply, and therefore the stronger the financial accelerator.

4.2 Simulating the Model

We now simulate the model 500 times with each simulation of length of 100 periods. We do this for a constant capital requirement (γ=0), and for several alternative measures of capital requirement cyclicality. Under Basel II, a concern is that capital requirements will exacerbate pro-cyclicality as default probabilities may rise in the good times and fall at times of economic downturns. In our model this would be akin to an assumption that $\gamma_{req} < 0$. Hence we consider negative values of γ to be one way to think about a pro-cyclical Basel II type capital rule. On the other hand Basel III requires the building up of an anti-cyclical capital buffer in the good times. In terms of our model this is akin to having $\gamma_{req} > 0$. In this case capital requirements rise in the good times and are reduced in times of economic downturns. The results of these simulations are detailed in tables 3-5 and figures 2-4, again for the three calibrations with different levels of excess capital as discussed above.

Table 3 and Figure 2 correspond to the calibration using a Basel II standard of an 8% capital requirement and a 7.75% level of excess capital above those requirements. The first graph in figure 2 displays the capital requirements across the 500 simulations for each value of γ. Note that with γ equal to zero capital requirements are fixed at 8% and hence do not vary across the simulations.

At positive (negative) values of γ requirements rise (fall) with positive productivity shocks and hence requirements vary across the simulations. As can be seen the maximum requirement is about 12% and the minimum about 5% given the range of γ we adopt. To be consistent with Basel III's objective of an increased requirement of 2.5% in good economic times this would accord to a value of gamma of about 4, as given this value of γ, under the most positive economic scenario the capital requirement rises to about 10.5%.

Note that as γ rises, the volatility of both consumption and investment fall. However the effects are relatively small. As can be seen in Table 3, consumption volatility falls from 50.3% of that of total output with gamma equal to zero to 48.8% of that of output when gamma is equal to 4. This is a 3% reduction in consumption volatility. Due to the specification of the model, total output volatility does not change. Our interpretation is that as banks have such a large excess capital buffer under this calibration anyway, the gain from an anti-cyclical capital rule is relatively small. Note that as can be seen in the penultimate graph in Figure 2, the level of bank excess capital falls as gamma rises. As forward looking banks anticipate that their capital requirements will fall in economic downturns, banks tend to hold less excess capital. However, again under this simulation this effect is relatively small.

However, if the anti-cyclical capital buffer is implemented in the region in relation to Basel III's tier 1 capital rules rather than using total capital, then the anti-cyclical regulations have more bite. First note that as the capital regulations get tighter and hence banks' excess capital buffers fall, output volatility rises. This makes sense as if the regulations are more binding then the financial accelerator effect of the capital regulations rises. Now, as the capital regulation becomes more cyclical, consumption volatility is reduced more significantly. For example when the excess capital buffer is set at 5.5%, consumption volatility falls from 46.3% to 44.3% of the (higher) output volatility. This is a fall of some 4.4% in consumption volatility. When the excess capital buffer is set at 2.1%, then consumption volatility falls by some 5% (see Tables 4 and 5 and Figures 3 and 4).

Note however that while consumption volatility falls, under the Basel III calibrations (with 5.5% and 2.1% of excess capital over requirements), investment volatility actually rises. As described above, along the stochastic steady-state, banks keep a buffer of excess capital to cushion the effect of negative aggregate shocks. An unexpectedly large shock may make equity fall enough to make the constraint bind on impact. Banks will first try to restore the buffer of capital to its normal level by an increase in their equity holdings and only if the capital deficiency is large will cut back significantly on lending. As a result, when the excess capital is large, the financial accelerator effect of the model is small. As the capital rule becomes more cyclical (γ more positive) two opposing effects come into play. On the one hand capital requirements rise in the good times and fall in economic downturns; this will tend to reduce investment volatility. However, as noted above banks anticipate the reduction in the requirement during the downturns and hence tend to hold less excess capital. This effect operates in the opposite direction and may actually increase investment volatility as the rule becomes more cyclical. However, when excess capital is large the first effect dominates and investment volatility falls as the rule becomes more cyclical. Now, as the excess capital buffer is smaller, the effect goes the other way and the reduction in the excess capital over the requirement implies banks will cut back on lending more frequently, the financial accelerator effect of the model is therefore greater and investment volatility actually rises as the rule become more cyclical.

The main conclusions from this analysis are then as follows: If an anti-cylical capital rule is calibrated to levels of overall bank capital in Latin America subject to an overall requirement of 8% and such that banks are expected to build up 2.5% of further capital in good times, such a rule is likely to have little effect. The reason is that banks already have substantial overall capital buffers in the region in relation to Basel II's 8% minimum requirement.

If Latin America implements Basel III's stricter rules on the quality of capital and specifies that the anti-cyclical rule applies to tier 1 capital, then there would be a more significant impact. On levels of excess tier 1 capital that accord to Colombia's median bank or that accords to some 50% of the Mexican financial system, an anti cyclical rule might be expected to reduce consumption volatility by some 5%.

As consumption volatility is reduced, while we have not modeled this explicitly, an anti cyclical rule would be expected to increase welfare. However, at the same time we find that the rule may actually reduce the excess capital banks hold over capital requirements (as they anticipate such requirements will fall during economic downturns) and may increase investment volatility.

5 Conclusions

In this paper we studied the effects of endogenously time-varying capital requirements in a stochastic dynamic general equilibrium model. We find that constant capital requirements intended to protect society from bank insolvency do have a financial accelerator effect and hence exacerbate both economic booms and economic downturns.

Our results also suggest that an anti-cyclical capital rule could be used to smooth out business cycles. A set of simulations provides qualitative and quantitative support to this idea for Latin America. However, if the rule follows Basel recommendations and is applied to overall levels of bank capital, the smoothing effect of anti-cyclical capital requirements is rather weak. The reason is that banks already maintain significant capital buffers over Basel requirements. Introducing an anti-cyclical rule calibrated such that requirements rise by some 2.5% of assets at risk (as specified in Basel III) is then estimated to have a very minor effect in terms of reducing consumption and investment volatility. It is also found that forward looking banks anticipate that the capital requirements will fall in bad times. Therefore, they choose to adopt a smaller average buffer over the requirements compared to the case of constant capital requirements. A more aggressive rule would be needed to have a significant impact in smoothing business cycles in the region.

However, if the anti-cyclical buffer rule is applied to tier 1 capital and combined with Basel III's new requirements regarding the quality of capital then anti-cyclical capital rules would indeed have more bite. Using data available from selected countries on the current levels of tier 1 capital relative to Basel III recommendations, calculations reveal that excess capital buffers are lower than overall capital buffers. Hence applying a counter cyclical capital rule then has a greater impact. In particular we find a Basel III type rule might be expected to reduce consumption volatility by some 4%-5% using data calibrated to median banks in Brazil, Colombia and Mexico. Larger effects would result from more aggressive rules.

The results of course should be interpreted with several caveats due to unavoidable assumptions in the modeling exercise. However, our overall conclusion is that Basel III's anti cyclical rules on bank capital would be welfare improving in Latin America but may have very little impact depending critically on how they are implemented. If they are to be implemented on the overall levels of capital, then the conclusion from this analysis is that a much aggressive rule than the one contemplated in Basel III would likely be appropriate. On the other hand, if they are to be implemented on tier 1 capital and in conjunction with Basel III's rules on tightening the quality of capital, then the anti cyclical rules could have a significant and a beneficial impact. Naturally given more detailed information on the actual levels of bank capital and the quality of that capital in different countries in the region, we would be able to refine further these results.

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Table 1: Calibration

Standard RBC Parameters	**Parameters of the Cost Function**
$\beta = 0.955$	$\eta_0 = 1\text{e-}5$ (implies total costs of 0.95% of GDP in the benchmark)
$\delta = 0.025$	$\eta_1 = 0.275$ e-3 (excess capital = 2.1% over 8.5% requirement)
	$\eta_1 = 0.71$ e-3 (excess capital = 5.5% over 8.5% requirement)
	$\eta_1 = 1$ e-3 (excess capital = 7.75% over 8% requirement)
$\alpha = 0.67$	
$\omega = 1.7$	
$\sigma = 10$	
$\tau = 0.29$	
$\rho = 0.765$	
$\sigma_\epsilon = 0.027$	
Implied Steady State Interest Rates	**Implied Steady State Ratios**
$r = 0.0466$	$\frac{K}{Y} = 8.6691$
$R = 0.0502$	$\frac{C}{Y} = 0.7653$
$(R - r) = 0.0036$	
	$\frac{I}{Y} = 0.2167$

Table 2: Bank Regulatory Capital to Risk-Weighted Assets Ratios in Latin America

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**Average**
Latin America	**15.71**	**15.89**	**15.58**	**15.06**	**14.47**	**14.55**	**15.32**	**15.23**
Argentina	14.5	14	15.3	16.8	16.9	16.8	17.6	15.99
Bolivia	15.3	14.9	14.7	13.3	12.6	13.7	13.9	14.06
Brazil	18.8	18.6	17.9	18.9	18.7	18.4	18.5	18.54
Chile	14.1	13.6	13	12.5	12.2	12.5	13.6	13.07
Colombia	13	14.2	14.7	13.1	13.6	13.4	14.8	13.83
Costa Rica	16.5	19.1	20.6	18.8	16.1	15.1	15.4	17.37
Dominican Republic	8.9	12.9	12.5	12.4	13	13.4	14.5	12.51
Ecuador	12.2	12	11.6	12	12.5	13	14.2	12.50
El Salvador	12.8	13.4	13.5	13.8	13.8	15.1	16	14.06
Guatemala	15.6	14.5	13.7	13.6	13.8	13.5		14.12
Mexico	14.2	14.1	14.3	16.1	15.9	15.3	15.2	15.01
Panama	18.1	17.6	16.8	15.8	13.6	14.4	15.2	15.93
Paraguay	20.9	20.5	20.4	20.1	16.8	16.2	15.2	18.59
Perú	13.3	14	12	12.5	12.1	11.9	12.9	12.67
Uruguay	18.1	21.7	22.7	16.9	17.8	16.7	18.5	18.91
Venezuela	25.1	19.2	15.5	14.3	12.1	13.4	14.3	16.27

Source: IMF Global Financial Stability Report.

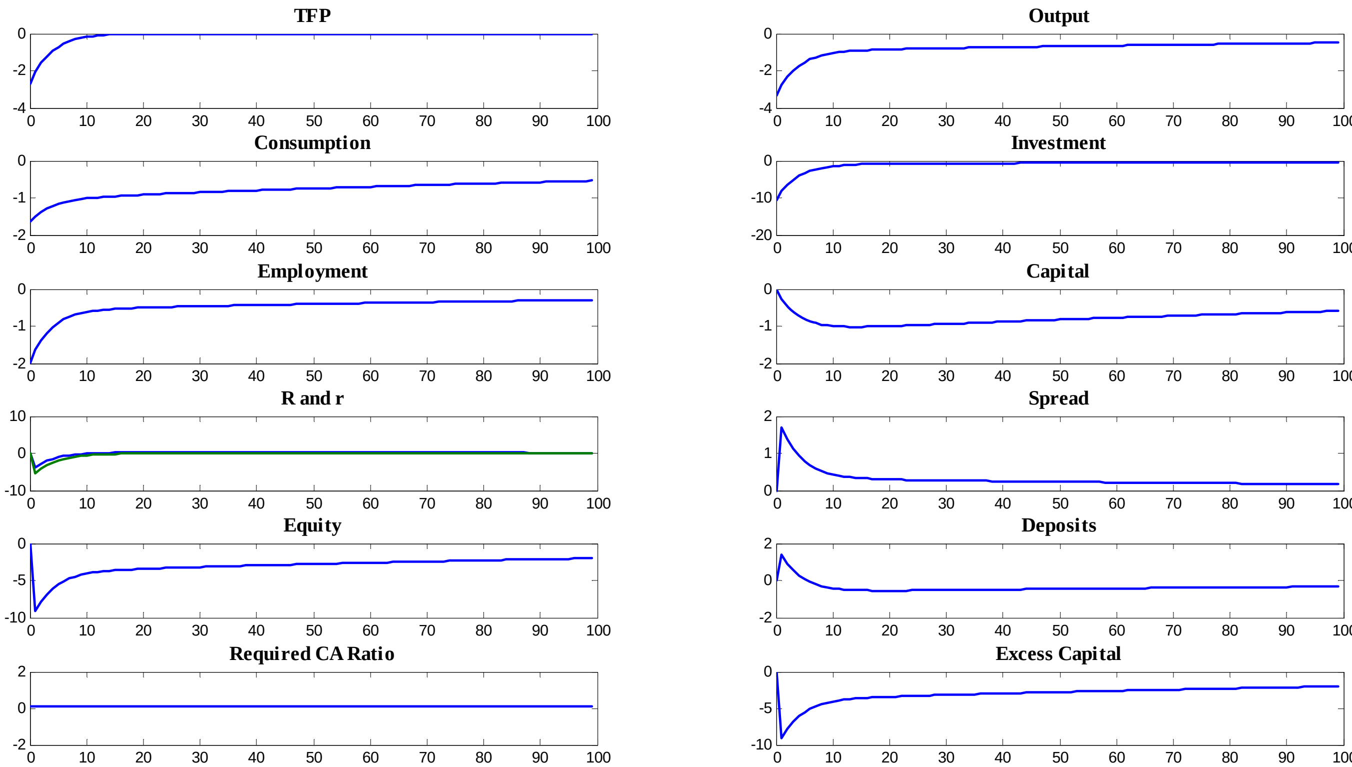

Figure 1: Impulse Response Functions - Basel II - $\gamma = 0$ **- Average** $\frac{e_{t+1}}{L_{t+1}} = 0.1575$

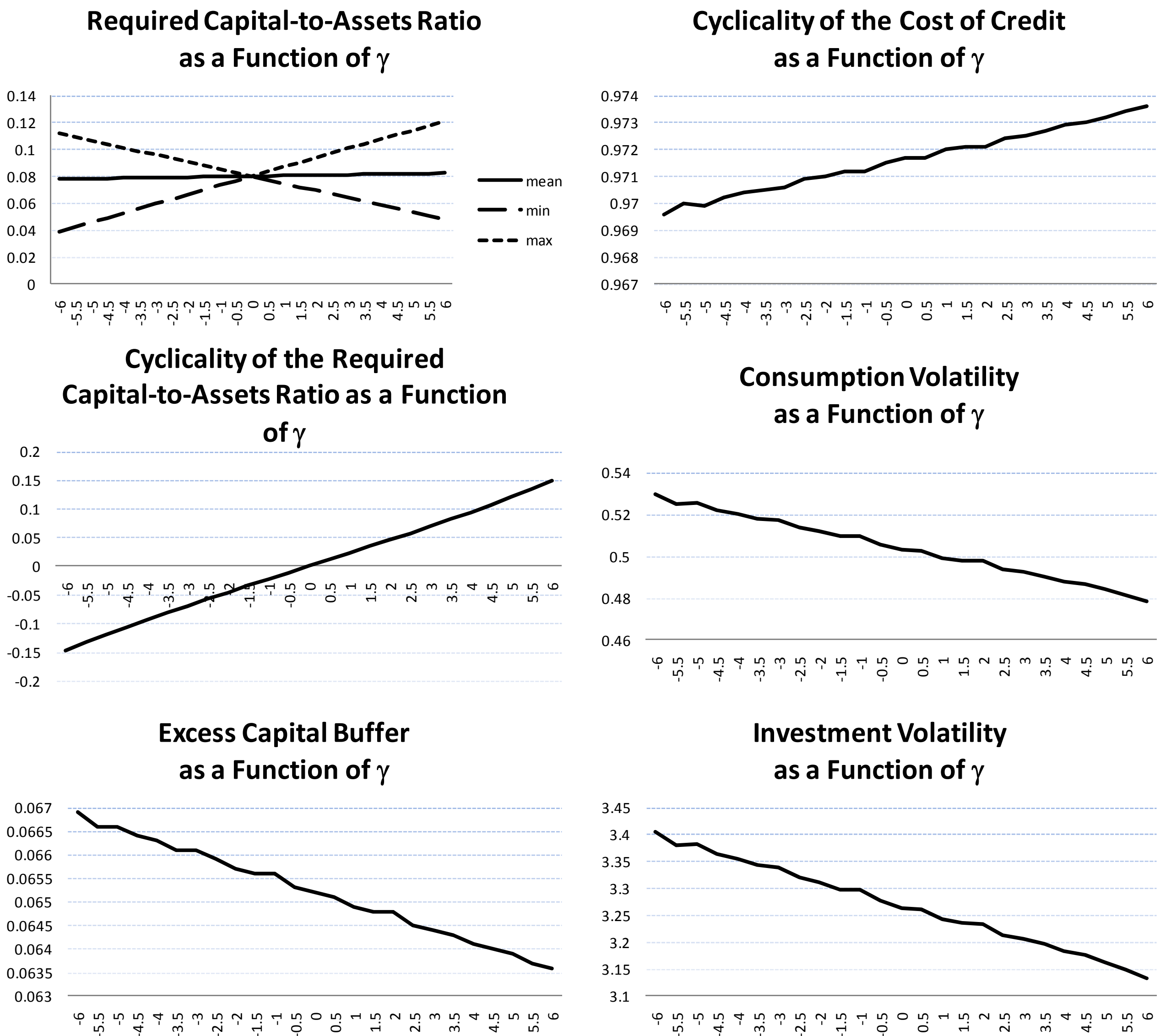

Figure 2: Simulation Results. x-axis shows γ parameter in $\gamma_{req} = 0.08 \times A^{\gamma}$ when average $\frac{e_{t+1}}{L_{t+1}} = 0.1575$ - Basel II

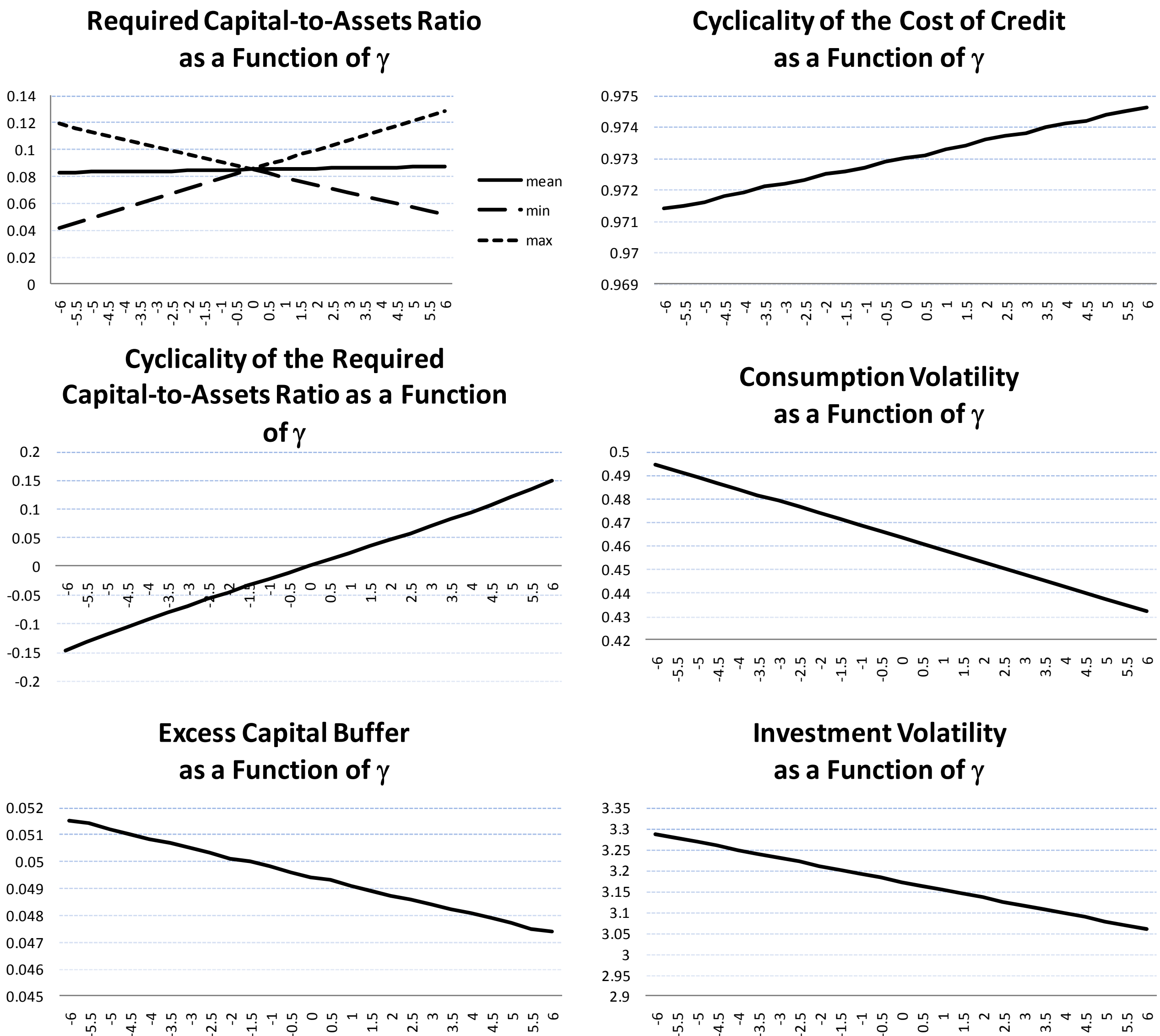

Figure 3: Simulation Results. x-axis shows γ parameter in $\gamma_{req} = 0.085 \times A^{\gamma}$ when average $\frac{e_{t+1}}{L_{t+1}} = 0.14$ - Basel III

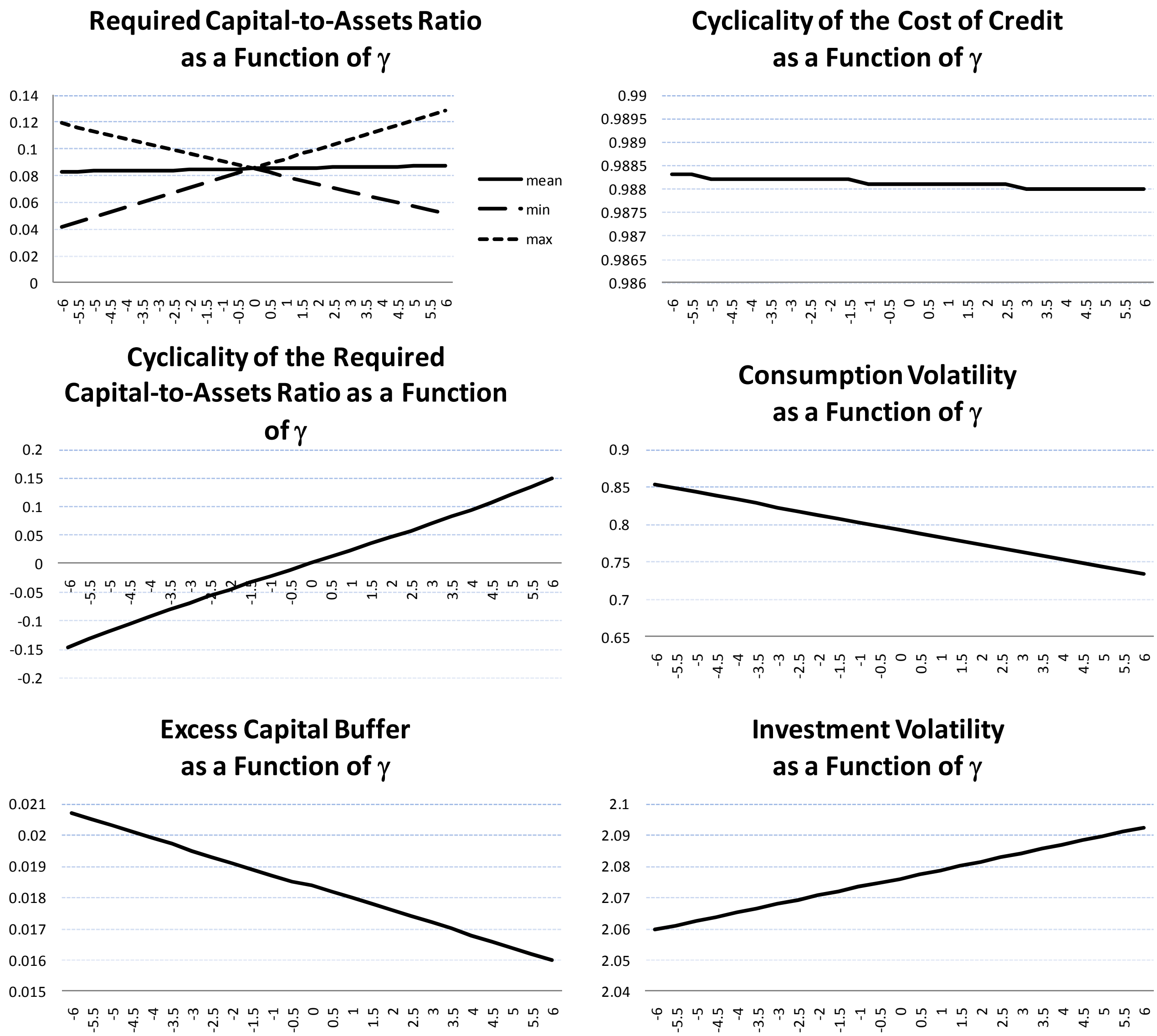

Figure 4: Simulation Results. x-axis shows γ parameter in $\gamma_{req} = 0.085 \times A^{\gamma}$ when average $\frac{e_{t+1}}{L_{t+1}} = 0.106$ - Basel III

Table 3: Simulation Results for Alternative Capital Rules in Basel II (Excess Capital = 7.75%)

	$\gamma=-6$	$\gamma=-4$	$\gamma=-2$	$\gamma=0$	$\gamma=2$	$\gamma=4$	$\gamma=6$
	Standard Deviations Relative to that of Output $\frac{\sigma(x)}{\sigma(Y)}$						
Y	0.0388	0.0388	0.0388	0.0388	0.0388	0.0388	0.0388
C	0.5296	0.5199	0.5119	0.5029	0.4976	0.4878	0.4784
I	3.405	3.3534	3.3105	3.263	3.2334	3.1822	3.1332
h	0.5865	0.5865	0.5866	0.5866	0.5866	0.5866	0.5866
w	0.4104	0.4104	0.4104	0.4104	0.4104	0.4105	0.4105
Δ	45.2818	44.8486	44.836	44.849	45.373	45.2591	44.8811
RE	48.4839	48.4426	48.4313	48.4092	48.3655	48.5505	48.429
π^F	48.0367	48.0407	48.0438	48.0469	48.0486	48.0514	48.0538
p	3.1958	3.0122	3.0256	2.9476	3.2317	3.0595	2.8645
γ_{req}	5.4422	3.393	1.6449	0	1.6434	3.3899	5.5098
K	0.2209	0.2178	0.2153	0.2125	0.2107	0.2076	0.2047
e	3.3602	3.1387	3.1356	3.025	3.3307	3.1222	2.9488
D	0.4976	0.4679	0.4691	0.4531	0.5015	0.4707	0.4474
R	1.1311	1.1313	1.1315	1.1316	1.1317	1.1319	1.1321
r	2.1869	1.9927	1.8237	1.6426	1.5114	1.3211	1.1373
A	0.8175	0.8176	0.8177	0.8177	0.8177	0.8178	0.8178
$(e-\gamma_{req}*L)$	19.2673	15.1844	11.8183	8.9118	8.5785	7.2478	7.1559
	Contemporaneous Correlation with Output $\rho(x,Y)$						
C	0.9801	0.9792	0.9784	0.9775	0.977	0.976	0.975
I	0.9863	0.9868	0.9873	0.9878	0.9881	0.9886	0.9891
h	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
w	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996
Δ	-0.1194	-0.1221	-0.121	-0.1229	-0.1073	-0.1125	-0.1145
RE	0.0026	0.0019	0.0021	0.002	0.0034	0.0021	0.002
π^F	-0.0019	-0.0019	-0.0019	-0.0019	-0.0019	-0.002	-0.002
p	0.9839	0.984	0.9843	0.9847	0.985	0.9856	0.9872
γ_{req}	-0.146	-0.0929	-0.0455	0	0.0458	0.0941	0.149
K	0.3902	0.3879	0.386	0.3838	0.3825	0.3802	0.3779
e	0.9813	0.982	0.9823	0.9825	0.9827	0.9831	0.9844
D	-0.9047	-0.9007	-0.9031	-0.9018	-0.9135	-0.9099	-0.9072
R	0.9696	0.9704	0.971	0.9717	0.9721	0.9729	0.9736
r	0.9798	0.9806	0.9813	0.982	0.9824	0.9831	0.9837
A	0.5258	0.5269	0.5277	0.5287	0.5293	0.5303	0.5313
$(e-\gamma_{req}*L)$	0.6037	0.6366	0.6162	0.5149	0.3142	0.0055	-0.321

For output, the measure is the absolute standard deviation.

Table 3 (ctd.): Simulation Results for Alternative Capital Rules in Basel II (Excess Capital = 7.75%)

	$\gamma=-6$	$\gamma=-4$	$\gamma=-2$	$\gamma=0$	$\gamma=2$	$\gamma=4$	$\gamma=6$
			Autocorrelation Coefficients at Lag 1 $\rho(x_t, x_{t-1})$				
Y	0.6046	0.6042	0.604	0.6037	0.6035	0.6032	0.6029
C	0.6422	0.6427	0.643	0.6435	0.6437	0.6442	0.6448
I	0.5904	0.5906	0.5907	0.5908	0.5909	0.591	0.5911
h	0.6047	0.6043	0.6041	0.6038	0.6036	0.6032	0.6029
w	0.6046	0.6043	0.604	0.6037	0.6035	0.6032	0.6029
K	0.9202	0.9202	0.9202	0.9202	0.9202	0.9202	0.9202
			Autocorrelation Coefficients at Lag 5 $\rho(x_t, x_{t-5})$				
Y	-0.1552	-0.1555	-0.1558	-0.156	-0.1562	-0.1565	-0.1568
C	-0.1221	-0.1217	-0.1214	-0.1211	-0.1209	-0.1204	-0.12
I	-0.1651	-0.1651	-0.1651	-0.1652	-0.1652	-0.1652	-0.1652
h	-0.1556	-0.1559	-0.1561	-0.1564	-0.1566	-0.1569	-0.1572
w	-0.1558	-0.1561	-0.1563	-0.1566	-0.1568	-0.1571	-0.1573
K	0.1033	0.1033	0.1033	0.1033	0.1033	0.1034	0.1034
			Autocorrelation Coefficients at Lag 10 $\rho(x_t, x_{t-10})$				
Y	-0.1987	-0.1985	-0.1983	-0.1981	-0.198	-0.1978	-0.1976
C	-0.2237	-0.224	-0.2242	-0.2245	-0.2247	-0.225	-0.2253
I	-0.1906	-0.1907	-0.1907	-0.1908	-0.1908	-0.1908	-0.1908
h	-0.1984	-0.1981	-0.1979	-0.1977	-0.1976	-0.1974	-0.1972
w	-0.1982	-0.1979	-0.1977	-0.1975	-0.1974	-0.1972	-0.197
K	-0.416	-0.416	-0.416	-0.416	-0.416	-0.416	-0.4159

Table 4: Simulation Results for Alternative Capital Rules in Basel III (Excess Capital = 5.5%)

	$\gamma=-6$	$\gamma=-4$	$\gamma=-2$	$\gamma=0$	$\gamma=2$	$\gamma=4$	$\gamma=6$
	Standard Deviations Relative to that of Output $\frac{\sigma(x)}{\sigma(Y)}$						
Y	0.0387	0.0387	0.0387	0.0387	0.0387	0.0387	0.0387
C	0.4945	0.4841	0.4738	0.4634	0.4531	0.4428	0.4325
I	3.2867	3.2486	3.2107	3.1728	3.135	3.0974	3.0599
h	0.5865	0.5865	0.5865	0.5866	0.5866	0.5866	0.5866
w	0.4104	0.4104	0.4104	0.4104	0.4104	0.4104	0.4105
Δ	3.9304	4.0938	4.4827	4.9542	5.5919	6.3404	7.3069
RE	47.9951	47.9872	48.0987	48.1152	48.1734	48.1851	48.2142
π^F	48.0352	48.0372	48.039	48.0407	48.0421	48.0433	48.0443
p	0.6854	0.6903	0.6984	0.7047	0.7119	0.7189	0.7265
γ_{req}	5.4483	3.3967	1.6466	0	1.6451	3.3932	5.5151
K	0.2138	0.2115	0.2093	0.207	0.2047	0.2025	0.2002
e	0.7323	0.7271	0.725	0.7209	0.7177	0.714	0.7109
D	0.1793	0.1775	0.176	0.1743	0.1726	0.171	0.1693
R	1.1405	1.1406	1.1407	1.1408	1.1409	1.141	1.1411
r	1.986	1.7744	1.5651	1.3567	1.1497	0.9436	0.7384
A	0.8185	0.8185	0.8185	0.8186	0.8186	0.8186	0.8186
$(e-\gamma_{req}*L)$	14.9098	8.6928	4.1744	1.7184	2.5311	5.1706	9.7225
	Contemporaneous Correlation with Output $\rho(x_t, Y_t)$						
C	0.981	0.9798	0.9786	0.9772	0.9758	0.9743	0.9727
I	0.9883	0.9886	0.989	0.9894	0.9897	0.9901	0.9904
h	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
w	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996
Δ	-0.7761	-0.6606	-0.5343	-0.4178	-0.3144	-0.2269	-0.1542
RE	-0.0023	-0.0022	-0.0028	-0.0028	-0.0023	-0.0027	-0.003
π^F	-0.0019	-0.002	-0.002	-0.002	-0.002	-0.002	-0.0021
p	0.8805	0.8861	0.8929	0.8985	0.9042	0.9094	0.9146
γ_{req}	-0.146	-0.0929	-0.0455	0	0.0458	0.0941	0.149
K	0.3796	0.3779	0.3762	0.3745	0.3727	0.371	0.3693
e	0.8982	0.8986	0.9003	0.9012	0.9025	0.9035	0.9048
D	-0.0759	-0.0808	-0.0892	-0.0954	-0.1027	-0.1095	-0.1171
R	0.9714	0.9719	0.9725	0.973	0.9736	0.9741	0.9746
r	0.9778	0.9782	0.9785	0.9785	0.9784	0.9779	0.9769
A	0.5279	0.5287	0.5295	0.5303	0.531	0.5318	0.5326
$(e-\gamma_{req}*L)$	0.7844	0.9002	0.9281	0.4918	-0.6937	-0.87	-0.8374

For output, the measure is the absolute standard deviation.

Table 4 (ctd.): Simulation Results for Alternative Capital Rules in Basel III (Excess Capital = 5.5%)

	$\gamma=-6$	$\gamma=-4$	$\gamma=-2$	$\gamma=0$	$\gamma=2$	$\gamma=4$	$\gamma=6$
			Autocorrelation Coefficients at Lag 1 $\rho(x_t, x_{t-1})$				
Y	0.6031	0.6029	0.6027	0.6024	0.6022	0.602	0.6018
C	0.6384	0.6393	0.6403	0.6414	0.6425	0.6437	0.645
I	0.5907	0.5908	0.5909	0.591	0.5911	0.5912	0.5912
h	0.6032	0.603	0.6028	0.6025	0.6023	0.6021	0.6018
w	0.6032	0.603	0.6027	0.6025	0.6023	0.602	0.6018
K	0.9202	0.9202	0.9202	0.9202	0.9202	0.9202	0.9202
			Autocorrelation Coefficients at Lag 5 $\rho(x_t, x_{t-5})$				
Y	-0.1565	-0.1567	-0.1569	-0.1571	-0.1573	-0.1575	-0.1577
C	-0.1255	-0.1247	-0.1238	-0.1229	-0.122	-0.1209	-0.1199
I	-0.165	-0.165	-0.165	-0.165	-0.1651	-0.1651	-0.1651
h	-0.1569	-0.1571	-0.1573	-0.1575	-0.1577	-0.1579	-0.1581
w	-0.1571	-0.1573	-0.1575	-0.1577	-0.1579	-0.1581	-0.1583
K	0.1033	0.1033	0.1033	0.1033	0.1034	0.1034	0.1034
			Autocorrelation Coefficients at Lag 10 $\rho(x_t, x_{t-10})$				
Y	-0.1978	-0.1976	-0.1975	-0.1973	-0.1972	-0.197	-0.1969
C	-0.2211	-0.2217	-0.2224	-0.2231	-0.2238	-0.2246	-0.2254
I	-0.1908	-0.1908	-0.1909	-0.1909	-0.1909	-0.1909	-0.191
h	-0.1974	-0.1972	-0.1971	-0.1969	-0.1968	-0.1966	-0.1965
w	-0.1972	-0.197	-0.1969	-0.1967	-0.1966	-0.1964	-0.1963
K	-0.4158	-0.4158	-0.4158	-0.4158	-0.4158	-0.4158	-0.4158

Table 5: Simulation Results for Alternative Capital Rules in Basel III (Excess Capital = 2.1%)

	$\gamma=-6$	$\gamma=-4$	$\gamma=-2$	$\gamma=0$	$\gamma=2$	$\gamma=4$	$\gamma=6$
			Standard Deviations Relative to that of Output $\frac{\sigma(x)}{\sigma(Y)}$				
Y	0.0396	0.0396	0.0396	0.0396	0.0396	0.0396	0.0396
C	0.8532	0.8329	0.8128	0.7927	0.7728	0.753	0.7334
I	2.0598	2.0652	2.0706	2.076	2.0814	2.0869	2.0923
h	0.5868	0.5868	0.5868	0.5868	0.5868	0.5868	0.5868
w	0.4105	0.4105	0.4105	0.4105	0.4105	0.4105	0.4105
Δ	40.0749	40.1818	40.2256	40.0822	39.7772	39.6585	39.5361
RE	43.2846	43.329	43.3665	43.2923	43.2584	43.3017	43.3492
π^F	46.9661	46.9643	46.9625	46.9607	46.9589	46.9571	46.9553
p	11.7099	11.9476	12.0352	12.0099	12.1617	12.2901	12.1701
γ_{req}	5.3241	3.319	1.6089	0	1.6071	3.3147	5.3872
K	0.1318	0.1322	0.1325	0.1329	0.1332	0.1335	0.1339
e	12.3158	12.4631	12.5365	12.7304	12.677	12.7225	12.7405
D	0.5062	0.5074	0.5085	0.5097	0.5109	0.512	0.5132
R	1.1251	1.125	1.1249	1.1248	1.1248	1.1247	1.1246
r	3.0084	2.6457	2.307	1.9923	1.7061	1.4579	1.2644
A	0.7998	0.7998	0.7998	0.7997	0.7997	0.7997	0.7996
$(e-\gamma_{req}*L)$	29.0876	28.1872	27.4533	27.7092	28.6158	30.4366	32.0948
			Contemporaneous Correlation with Output $\rho(x,Y)$				
C	0.9673	0.9647	0.9619	0.9589	0.9556	0.9519	0.9479
I	0.9673	0.9672	0.9671	0.967	0.967	0.9669	0.9668
h	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
w	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
Δ	-0.2253	-0.2342	-0.2434	-0.2535	-0.2629	-0.2711	-0.2818
RE	-0.0111	-0.0112	-0.0114	-0.0115	-0.0114	-0.0115	-0.0116
π^F	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003
p	0.2719	0.273	0.2731	0.2753	0.2764	0.277	0.2782
γ_{req}	-0.146	-0.0929	-0.0455	0	0.0458	0.0941	0.149
K	0.4986	0.4988	0.4991	0.4993	0.4995	0.4998	0.5
e	0.2747	0.2745	0.2729	0.2714	0.2727	0.2722	0.2723
D	-0.3917	-0.391	-0.3903	-0.3896	-0.3889	-0.3882	-0.3875
R	0.9883	0.9882	0.9882	0.9881	0.9881	0.988	0.988
r	0.9473	0.9333	0.9105	0.8738	0.8134	0.7125	0.5463
A	0.5601	0.56	0.56	0.5599	0.5598	0.5597	0.5596
$(e-\gamma_{req}*L)$	0.1008	0.0809	0.0545	0.0168	-0.0226	-0.0501	-0.0833

For output, the measure is the absolute standard deviation.

Table 5 (ctd.): Simulation Results for Alternative Capital Rules in Basel III (Excess Capital = 2.1%)

	$\gamma=-6$	$\gamma=-4$	$\gamma=-2$	$\gamma=0$	$\gamma=2$	$\gamma=4$	$\gamma=6$
			Autocorrelation Coefficients at Lag 1 $\rho(x_t, x_{t-1})$				
Y	0.6105	0.6105	0.6106	0.6107	0.6107	0.6108	0.6108
C	0.6782	0.6814	0.6849	0.6885	0.6923	0.6964	0.7008
I	0.5783	0.5783	0.5783	0.5783	0.5783	0.5783	0.5783
h	0.6102	0.6103	0.6104	0.6104	0.6105	0.6105	0.6106
w	0.6101	0.6102	0.6102	0.6103	0.6103	0.6104	0.6104
K	0.9143	0.9143	0.9143	0.9143	0.9143	0.9143	0.9143
			Autocorrelation Coefficients at Lag 5 $\rho(x_t, x_{t-5})$				
Y	-0.1524	-0.1523	-0.1523	-0.1522	-0.1522	-0.1521	-0.1521
C	-0.0993	-0.0969	-0.0943	-0.0915	-0.0886	-0.0855	-0.0823
I	-0.179	-0.179	-0.179	-0.179	-0.179	-0.179	-0.179
h	-0.1526	-0.1526	-0.1525	-0.1525	-0.1524	-0.1524	-0.1523
w	-0.1528	-0.1527	-0.1527	-0.1526	-0.1526	-0.1525	-0.1525
K	0.0675	0.0675	0.0675	0.0675	0.0675	0.0675	0.0675
			Autocorrelation Coefficients at Lag 10 $\rho(x_t, x_{t-10})$				
Y	-0.2035	-0.2036	-0.2036	-0.2036	-0.2037	-0.2037	-0.2038
C	-0.2535	-0.2559	-0.2584	-0.2611	-0.2639	-0.2669	-0.2701
I	-0.1797	-0.1797	-0.1797	-0.1797	-0.1797	-0.1797	-0.1797
h	-0.2031	-0.2031	-0.2032	-0.2032	-0.2033	-0.2033	-0.2034
w	-0.2029	-0.2029	-0.203	-0.203	-0.2031	-0.2031	-0.2032
K	-0.4289	-0.4289	-0.4289	-0.4289	-0.4289	-0.4289	-0.4289