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The Macroeconomic Implications of the New Banking Capital Regulation in Emerging Markets: A Duopoly Model Adapted to Risk-Averse Banks

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Abstract. In order to analyze the impact of the new banking capital regulation (Basel II) on the business cycle in an emerging economy, I develop a duopoly model composed of domestic and foreign banks. The principal results are: by the conduct of new banking capital regulation, the assessment of credit risk carried out by an international bank in a given country not only affects the *total* loans in that country but also the *total* assets supplied in other countries. Second, analyzing risk-averse banks, as portfolio diversification increases, the change in loans allocated in a given country by an international bank as a proportion of the original investment and the *total* level of loans for that country can be harshly affected by the behavior of a foreign bank following only "news" through the new capital regulation. Finally, even in the case that portfolio diversification increases without limits, the macroeconomic implication of a change of credit risk estimation, via the new capital regulation, is larger when banks are risk-neutral than risk-averse.

JEL classification: D43, E51, G11, G28.
Keywords: Market imperfection, Credit, Portfolio choice, Banking regulation.

Resumen. Con el propósito de analizar el impacto de la nueva regulación de capital de bancos (Basilea II) sobre el ciclo económico de una economía emergente, desarrollo un modelo de duopolio compuesto por bancos locales y extranjeros. Los principales resultados son: por medio de la nueva regulación de capital, la evaluación del riesgo crediticio realizada por un banco internacional en un país, no sólo afecta a los préstamos *totales* de ese país sino también a los activos *totales* otorgados en otros países. Segundo, cuando los bancos son aversos al riesgo y a medida que la diversificación del portafolio aumenta, el cambio en los préstamos concedidos en un país por un banco internacional como proporción de la inversión inicial, así como el nivel de los prestamos *totales* de ese país, pueden resultar fuertemente afectados por el comportamiento de un banco que sigue sólo "noticias" a través de la nueva regulación de capital. Finalmente, incluso cuando la diversificación del portafolio crece sin límite, la implicación macroeconómica de un cambio en la estimación del riesgo crediticio debida a la nueva regulación de capital, aumenta a medida que los bancos son menos aversos al riesgo.

Clasificación JEL: D43, E51, G11, G28.
Palabras clave: Imperfección de mercados, Crédito, Diversificación de portafolio, Regulación de bancos.

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1. Introduction

The most important justification that is often presented for regulating banks is the threat of a systemic risk due to a bank run and the inability of depositors to monitor banks. With the purpose to ensure a secure banking system for depositors and to encourage banks to invest in healthy projects, there are a number of specific instruments to regulate the banking industry.

One of the most predominant and employed instruments in the regulation of banking is the deposit insurance contract offered by the government. There exists a vast literature about the determination of the price. Starting with Merton (1977), he shows that deposit insurance can be viewed as a put option with a strike price equal to the promised maturity value of its debt. However, the arbitrage pricing method assumes that, among other things, financial markets are complete and the provider of deposit insurance can value accurately bank's assets because he has perfect information about the risk of banks' assets (and then moral hazard is ruled out). Under these conditions, however, deposit insurance is not necessary because there is no risk of bank panics. To that extent research was developed to specifically address the issue of the feasibility of fairly priced deposit insurance with the existence of asymmetry information. Chan, Greenbaum and Thakor (1992), for example, consider a setting where there is asymmetry of information and the insurance provider offers a menu of contracts, each requiring the bank to hold a certain capital–to–assets ratio and charging it a given insurance premium per unit of deposits. The authors find that it is generally impossible to implement incentive-compatible fairly priced deposit insurance. The reason is that the high–risk institution always prefers the menu of contracts chosen by the low–risk institution as long as this one chooses some positive level of deposits. Freixas and Rochet (1995) consider also the issue of incentive-compatible fair pricing of deposit insurance. They show that fair pricing is feasible but is not desirable from a welfare point of view. The reason is that it entails a subsidization of the less efficient banks by the more efficient ones. This cross-subsidization prevents the less efficient banks from mimicking the more efficient ones, thus improving the allocation of deposits, but there is a distortion because it leads to inefficient entry and exit decisions.

When the insurance provider observes bank risks only with error, risk-based premiums mechanisms are no longer equivalent (Flannery (1991)). It is then advantageous to consider jointly the design of deposit insurance and capital requirements to ensure that the government's option is "out of the money". More precisely, Giammarino, Lewis and Sappington (1993) consider this issue in a model where the banker knows the quality of the loans but the regulator does not, and the banker can influence that quality through an unobservable effort choice. The regulator provides a deposit insurance maximizing social welfare, which it is defined by the difference of

bank's profit and government's cost. For that, the regulator has to manage between the social costs from default and of avoiding default. By using a capital requirement policy, the government can observe the *realized* total quality of the loan portfolio (by periodic inspection of banks assets) and then motivate banks to improve their portfolios. Under the socially optimal deposit insurance system, the insurance premium needs to be adjusted for the quality of the bank's portfolio of loans, and higher-quality banks are allowed a relatively larger asset base and face lower capital requirements. Because in this model, banks are risk-neutral, the deposit insurance contract produce that banks behave as risk lovers (taking mean preserving spread in the projects) and then it is necessary the presence of capital requirements. Additionally, Bensaid, Pagès and Rochet (1993) consider both the presence of an adverse selection and moral hazard problem and found that optimal regulation can be decentralized by offering banks a menu of solvency and quality requirements. Solvency requirements are risk-adjusted and quality requirements are defined in terms of interim information, measured for instance by ratings performed by independent agencies.

Freixas and Gabillon (1998) consider again banks with private information on the initial value of their portfolio of loans, but this value follows Merton formula for pricing the deposit insurance premium. Using this framework, they characterize the optimal mechanism that maximizes the social surplus, constraining to be incentive compatible and individual rational. They obtain that if loans have a positive net present value, banks will never hold reserves (risk-free assets), and the deposit insurance premium will have to be decreasing with the bank's capital. In general, in these models based in imperfect information, there exists a trade-off between capital standards and insurance premium in order to extract information and minimize the cost of inducing the low-quality banks to mimic the high-quality ones.

When banks are regulated by a flat-capital requirement, this may lead to an increase in the bank's probability of failure because the banker may choose to compensate the loss in utility from the reduction in leverage with the choice of a riskier portfolio. Regulators can eliminate this adverse effect by using a risk–based capital requirement approach (Kim and Santomero (1988)). But this conclusion can be questioned. Rochet (1992) studies the case in which banks are protected by limited liability and then the objective function becomes the difference between the expected utility under no-bankruptcy and the expected bankruptcy cost. If the bank is undercapitalized (i.e. having a capital below the inverse of the absolute risk aversion index), the convexity of preferences due to limited liability may dominate risk aversion, and the bank will behave as a risk lover. In this case, even a risk–based capital regulation that makes use of market–based risk weights may not be enough to restrain the bank's appetite for risk. It may be necessary to impose an additional regulation, for example, to require banks to operate with a minimum capital level. In that context, the operational risk established

in the New Basel Capital Regulation (known as Basel II) can be considered as an additional capital required that accomplishes this function.[1]

Another common rationale for banking regulation builds on the problems of corporate governance (Dewatripont and Tirole, 1993a, 1993b). Because depositors that hold bank debt are not in a position to monitor management, as they are small and uninformed, they need to be represented by a regulator. Capital standards may be an important instrument to implement the optimal governance of banks because they can be used to define the threshold for the transfer of control from shareholders to the regulator.[2]

The review of contemporary banking theory has illustrated that there are differences in opinion regarding the market failures that justify banking regulation as well as in the conclusions of the research on the optimal design of capital regulation. Despite the progress in the theory of banking in the last two decades, there are still many relevant questions that remain unanswered. For example, as noted by Santos (2000), theoretical research on the macroeconomic implications of bank capital regulation is still limited (Blum and Hellwig (1995), Thakor (1996), and Krainer (2002)). The present article discusses the role of banking capital regulation in this context, analyzing in particular the behavior of foreign banks in emerging economies.

The remainder of this article is organized as follows. Section two analyzes the research that has been done on the relationship between banking capital regulation and the business cycle. Section three presents the different channels of the procyclicality of the financial system, and evaluates both capital accords, Basel I and II. Section four analyzes procyclicality in emerging financial markets, with emphasis in Latin American countries. Section five develops a duopoly model composed of a domestic and an international bank, in order to study the implications of Basel II in emerging markets, first under the assumption that they are risk-neutral and second that they are risk-averse. Section six concludes and presents the main results of the model.

2. Banking a Theory of the Business Cycle

Blum and Hellwig (1995) have studied the macroeconomic implications of The Basel Accord of 1988, known also as Basel I;[3] more precisely, they studied the impact of a variation in the bank equity on bank lending and industry investment. They found that, given a binding capital adequacy requirement, an additional unit of bank profits induces an increase of more than one unit of bank lending, showing that the multiplier effect of bank profits on investment demand is higher with a binding capital adequacy requirement than

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[1] See footnote 6 for an overview of this accord.

[2] See Part IV of Bhattacharya, Boot and Thakor (2004) for a more detailed review of the regulation of financial intermediaries.

[3] See annex 1 for an overview of this accord.

without one. Thakor (1996) investigated the impact of "risk-based" capital requirement on aggregate bank lending. In particular, he showed that because an increase in the risk-based capital requirement increases a bank's loan-funding cost (competition limits the bank's ability to pass this cost along to borrowers), therefore a small rise in the risk-based capital requirement for banks elevates the endogenously determined probability that a borrower will be denied credit by the entire banking system, thus reducing aggregate lending.

More recently, Krainer (2002) presents a partial equilibrium model of portfolio decisions of non-financial and financial enterprises. This model analyzes an agency problem between relatively more risk-averse bondholders and relatively less risk-averse stockholders. In the case of a non-financial enterprise, the solution of this problem takes the form of a "shared decision-making authority specified in an up-front contract". In the case of financial enterprises, the Basel Accord of 1988 was analyzed to question whether or not it is a particular application of this contract.

Can Basel I be a countercyclical contract? When banks shift the composition of their portfolio from safe assets[4] (e.g., categories 1 and 2 assets) into more risky assets (e.g., categories 3 and 4 assets) as they do in periods of general economic expansion, they are required by the Basel Accord to increase their tier capital thereby reducing their financial leverage. Similarly when they shift from risky assets into more safe assets (the so-called flight to quality) as they do in recessions, they are allowed to reduce their capital thereby increasing their financial leverage.

However, Krainer (2002) notes that the four categories are based on the legal classification of the financial asset.[5] Thus, a shock-induced reduction in the risk aversion of bank shareholders that raises bank stock valuations in the stock market is the signal for these intermediaries to put riskier investments in their portfolios. Part of this portfolio adjustment takes the form of risk deepening within category 4 assets, and no new capital is required. For this reason, the capital cushion or the "counter-cyclical capital" as computed now would at some times be inadequate. Concerning the New Basel Capital Accord (Basel II),[6] for the author it is doubtful that it can prevent capital arbitrage. Indeed, others studies have shown[7] that it is possible for a bank to reduce its regulatory capital requirements while at the same time increasing the standard deviation of its portfolio.

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4 See annex 1 for a best comprehension of this point.

5 Indeed, no distinction is made between investment grade business loans and low grade debt.

6 In 1999 the Basel Committee proposed a revised capital adequacy standard to replace the 1988 Accord. Two important aspects are considered in this new accord. First, it develops more risk-sensitive methodologies in calculating the regulatory capital. Indeed, in contrast to the present accord, credit risk measurement is taking into account and operational risk is included. Second, to contribute to a higher level of safety and soundness in the financial system, two aspects have been added to the minimum capital requirements. Indeed, the New Accord consists of three pillars, minimum capital requirements, supervisory review of capital adequacy and market discipline. However, in spite of the importance of the two last pillars, the new accord has been concentrated largely in the first one. This accord is supposed to start in 2006.

7 See Alexander, G., and Baptista, A. (2001).

3. Procyclicality of the Financial System: from Based I to Basel II

3.1. *An analysis of the numerator of the solvency ratio: provisions and capital*

First, it is important to make the distinction between expected and unexpected losses. The expected losses refer to the average or mean losses anticipated over a particular period, while unexpected losses refer to a measure of the dispersion, or degree of uncertainty that surrounds that outcome. The second notion of risk is closer in spirit to classical definitions of risk and it is related to the concept of diversification. Graphically, it is easy to understand the difference between these two concepts.

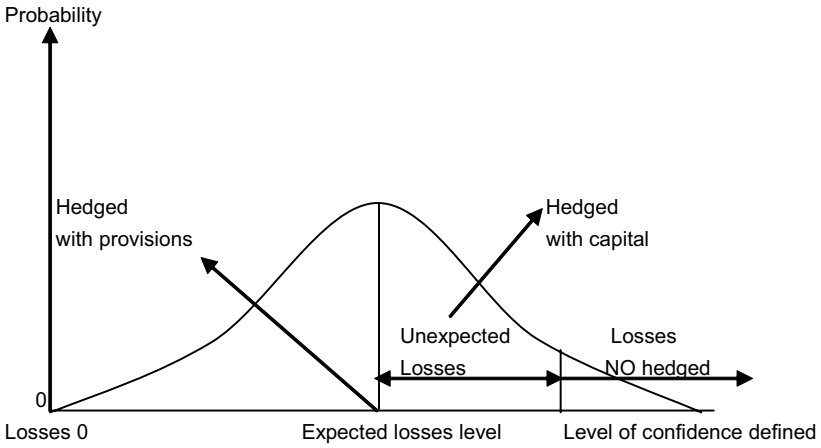

Figure 1. Expected Losses and Unexpected Losses

It is widely accepted that the role of capital is to provide protection against *unexpected* losses and of the role of provisions is to provide cover against *expected* losses. This distinction is important for at least two reasons. The first is that having provisions against expected losses (properly measured) is likely to reduce fluctuations in recorded bank profitability at business cycle frequencies. The second is that because the balance sheet must represent the true value of both gross and net assets of the bank, then gross assets values need to be recorded net of expected losses.

Concerning capital regulation, the 1988 Capital Accord established that difference between capital and provisions, although provisions are included in the capital. Moreover, in a large part of the countries in the world, the regulatory system distinguishes between specific and general provisions. With respect to Basel II, in the January 2001 proposal, regulatory capital charges have been calibrated to cover both expected and unexpected losses (with the expected losses defined as the probability of default over the next year multiplied by the losses in the event of default). In contrast, in January 2004, the Basel

Committee announced its intention to move to an Unexpected Losses (UL)-only risk weighting construct. In summary, for the internal approach, expected losses will be removed from the risk weight functions. However, banks will be required to compare their actual provisions with expected losses. Any shortfall should be deducted equally from Tier 1 and Tier 2 capital and any excess will be eligible for inclusion in Tier 2 capital subject to a cap. Therefore, the current treatment of general provisions will be withdrawn from the internal approach. Concerning the standardized approach, the Committee is not intending to make any related changes.[8]

The final expression of the capital ratio would then become in the New Basel Capital Accord as:

$$\frac{\text{Tier I + Tier II (without GP) + GP for Std part + (-) excess (shortfall) for IRB part}}{\text{Credit RWA for Std part + Credit RWA for IRB part + Market RWA + Operational RWA}} \geq 8\%$$

where,

GP: General Provisions

RWA: Risk Weighted Assets

IRB: Internal Rating Based Approaches

From an analytical point view, as it is noted by Borio, Furfine and Lowe (2001), the need to create provisions arises because the loans are not recorded at market value. A current value of a loan can be thought of as being equal to the present value of the expected future cash flows generated by the loan. Moreover, these expected cash flows are given by the contracted interest and principal payments on the loan less the expected value of losses. Then the current value of a loan will equal its face value plus the present value of expected default premiums minus the present value of the expected losses. Defining the provisions as the difference between face and current values of a loan, then provisions are the difference between the present value of expected losses and the present value of expected default premiums, that is:

$$Provisions = F_t - V_t = \sum_{i=t}^{T} \frac{E(l_i)}{(1+r)^{T-i}} - \sum_{i=t}^{T} \frac{E(d_i)}{(1+r)^{T-i}} \quad (1)$$

where F is the face value, V is the current value of a loan, r is the discount rate, d is the default premium and $E(l)$ is the expected loss from non-repayment.

[8] Concerning credit risk measurement, the Committee proposes a two-layer system. The first, named the standardized approach, establishes fixed risk weights corresponding to each supervisory category and makes use of external credit assessments provided by rating agencies. The second is an approach where the risk weights would be based on the bank's internal model of risk assessment. This internal approach has two variants, a "foundation" and an "advanced" approach. The first approach is for banks that are available to measure the probability of default. However, estimates of additional risk factors, such as loss incurred by the bank given a default and the expected exposure at default, will be derived through the application of standardized supervisory estimates. In contrast, the "advanced" approach will be available for banking organizations that all the risk components mentioned above will be estimated internally by the bank.

Two important points follow from this formulation. The first is that the entire future profile of expected losses and default premiums is relevant, not just the outcomes over the next year. The second is that if the default premium adequately compensates the bank for the expected non-repayment of principal and interest there is no need to make a provision.

It is sometimes claimed that a provision should be created even in cases in which overall expected losses are zero. Then, when the deterioration eventually occurs, and defaults increase, the provisions built up in good times are drawn down, so that profits are not adversely. The end result is stability in bank profits despite the cycle in defaults.

Concerning the capital, unlike provisions, the relevant time horizon is not the entire life of the loan, but rather depends upon the time taken for a bank to raise additional capital or to remove risks from its balance sheet. Furthermore, the amount of capital depends on the *variability* of expected cash flows over the chosen horizon. This variability would depend on the correlation between exposures.[9]

An alternative approach of capital would be for regulators to set the minimum level of bank capital with the explicit goal not of protecting depositors, but of protecting the stability of the financial system as a whole. If institutions were large and/or correlations high, a much higher level of capital would be required.

There are two distinct reasons why capital should change over time. The first is to reflect the changing riskiness of the relevant portfolio to maintain constant the target probability of failure. The second relates to reduce the costs of raising capital under different conditions and hence its impact on financial distress. Both of these arguments suggest that capital should be raised in booms. From the perspective of the system as a whole, raising capital in good times to be drawn upon in bad times has the additional benefit of limiting the amplification of the financial and business cycle.

3.2. *Procyclicality of provisions and capital*

Taking some OECD's countries during the period 1980-2000, Borio et al. (2001) show that bank provisions are strongly procyclical, being highly negatively correlated with the business cycle. In large part, the behavior of provisions translates into a clear procyclical pattern in bank profitability, which further encourages procyclical lending practices. This pattern appears to be strongest in those countries that experienced banking system problems

[9] Unfortunately, the New Basel Capital Accord does not take into account a good measure of correlation between exposures.

in the 1990s. For instance, for the case of Spain there is a strong correlation (0.84) between profitability and GDP that confirms the necessity of a counter cyclical provisions policy.[10]

On the other hand, there does not appear a robust relationship between measured capital ratios and the business cycle. Additionally, the task of detecting any relationship is made difficult by the introduction of the Capital Accord in 1988, which has caused a structural change in capital ratios. Further, the cycle in the ratio of capital to risk-weighted assets was much more pronounced than the cycle in the ratio of capital to total assets. This reflects the fact that, in the aftermath of the banking crises, risk-weighted assets fell more strongly than total assets, as banks shifted their portfolios away from commercial lending towards public sector securities.

3.3. *Credit risk and procyclicality*

A first explanation for the procyclicality of the financial system has its roots in information asymmetries between borrowers and lenders. When economic conditions are depressed and collateral values are low, information asymmetries can mean that even borrowers with profitable projects find it difficult to obtain funding. The reverse is also present. This explanation of economic and financial cycles is often known as the "financial accelerator".

However, as noted by Borio et al. (2001), while the financial accelerator probably plays a role in all business cycles, it is not sufficient to generate the spread of financial instability. They argue that an additional material source of financial procyclicality is the difficulty in measuring the time dimension of risk. The measurement difficulties often lead to risk being underestimated during booms and overestimated during recessions. These measurement biases can arise from a variety of sources. One such

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[10] A third category of provisions has been created in Spain, the so-called statistical provision. There are two approaches to comply with this provision. First, banks can use their *own internal models* in order to determine the statistical provision. Alternatively, there is a *standard approach* based on a set of coefficients, noted *s*, established by the regulator. Each coefficient corresponds to a different level of credit risk in the portfolio and reflects the average net specific provision over the economic cycle. Taking the latent risk measure ($LR = s \cdot L$) as a percentage of loans, the annual statistical provision is $\mathrm{StP} = \mathrm{Lr} - \mathrm{SP}$ with SP being the specific provision.

If $SP < Lr$: low problem loans => StP > 0 : building up of the statistical fund.
If $SP > Lr$: high problem loans => StP < 0 : depletion of the statistical fund.

Then, the statistical provision was designed not to substitute but to complement the specific provision (see Fernández de Lis, Martínez and Saurina, 1999). Hence it has a counterbalancing effect on the strong cyclical behavior of loan loss provisions. Unfortunately, as noted by Borio et al (2001), this profit stabilizing mechanism is, however, limited. If loan defaults are high and unusually large specific provisions are required, the statistical fund could be exhausted, and specific provisions would need to be made directly from the current year's profit. Conversely, once the statistical provision fund has reached three times the annual charge, no further charges to profit are required.

source is the complexity in forecasting overall economic activity and its link with credit losses. This contributes to excessively short horizons and to an unwarranted extrapolation of current conditions into the future.

More direct evidence of this idea can be obtained from the evolution of credit risk assessments in both approaches of the New Basel Capital Accord.

Analyzing the standardized approach, the evidence suggests that credit rating agencies fail to predict changes in the probability of crises, with downgrades occurring during a crisis rather than before.[11] The impact of external ratings migration on capital requirements has also received some attention recently. For example in the case of the United States there is very little cyclical impact of the Standardized approach relative to the existing capital regime. A possible explanation of this small impact is that rating agencies are some stable over time compared to other credit risk indicators such as spreads on bonds.

Concerning the internal approach of Basel II, banks use a one-year horizon for measuring the probability of default (PD). As it is noted by Borio et al (2001), the nature of internal rating systems means that the average rating of a bank's loan portfolio is likely to change over the course of the business cycle. When economic conditions are strong, loans are likely to move up the rating scale (to lower-risk ratings) given that the PD in the next year is relatively low. Conversely, in an economic downturn the average rating is likely to decline, given the increased PD in the short run. As a result, measured risk, as revealed by average internal ratings, is likely to be negatively correlated with the economic cycle.

The figure 2 shows the relationship between PD and the risk weight for loans to corporate borrowers (in the internal and standard approach). It illustrates the Foundation Internal Ratings-Based (IRB) approach as indicated in the Basel Committee's April 2003 proposal. The use of internal ratings makes capital requirement considerably more sensitive to the rating of the borrower than in the case under the Standardized approach. This degree of sensitivity is however lower under the modified IRB proposals than it was under the original proposal.[12]

An important consideration to evaluate the possible consequences of the new regulatory framework for the procyclicality of capital requirements in both industrialized and emerging market countries is the way that banks assign grades to individual borrowers. Unfortunately, many banks have only developed comprehensive ratings systems over recent years and the data are generally not available for research. One exception to this is the data provided by a large Swedish bank to the Swedish Central

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[11] Moreover, Ferri, Liu and Manjnoni (2001) show that, compared to developed countries, there exists a lack of accuracy in credit risk assessment for emerging countries.

[12] See Lowe and Segoviano (2002) for a comparison between the IRB approach of January 2001 and the modification realized in November 2001.

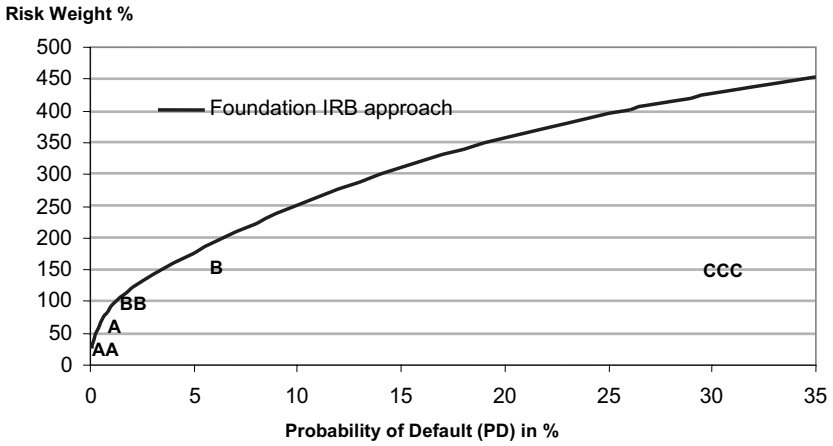

Figure 2. Risk weights and grades

Bank. These data include the ratings of over 50.000 borrowers over the period from 1994 to 2000 and show a significant amount of loan migration (see Carling et al, 2002). In particular, during the mid-1990s when the Swedish economy was recovering from recession, many loans were rerated to lower risk rating classes. Carling et al (2002) estimate that for this bank the required capital ratio under the Foundation IRB approach would have fallen from somewhere around 20% in 1994 to around 1-2% in 1999!.

The internal approach could be then more exposed to the possibility of procyclical risk assessments than the standard approach which is based in external ratings. The reason is that, in addition to the two aspects studied before,[13] the capital charge depends not only on the probability of default, but also on the loss given default.[14] If in periods of strong economic growth, collateral values become inflated, required capital may fall, when in fact the reverse should be the case.

Finally, an important remark is that the denominator of the solvency ratio established in the 1988 Capital Accord does not have a strong cyclical component. Indeed, capital requirements change over time only if the structure of a bank's assets changes. In contrast, the New Basel Capital Accord implies that capital requirement for a given portfolio will change over time as bank's assessment of the riskiness of that portfolio changes.

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[13] First, external ratings are more stable over time than bank internal ratings, and second the use of the internal approach makes capital requirement more sensitive to the rating of the borrower than the standardized approach.

[14] In the last version of the New Basel Capital Accord, the loss given default (LGD) is fixed at 45% instead of 50% for unsecured loans in the Foundation IRB approach, while in the Advanced IRB approach banks are permitted to estimate the LGD for each loan. Moreover, the risk weight formula assumes that the PD and the LGD are independent.

4. An empirical analysis of emerging markets: the Latin American countries

In this section I analyze the relationship between capital regulation and procyclicality for emerging economies. This is important for two reasons. First, risk-based capital requirements are likely to be procyclical. In particular, while this concern is generally expressed with reference to the wealthiest countries, perhaps it is even more relevant to emerging market economies, where assessments of risk can change quickly and by a significant degree. Second, even if in the beginning only developed countries will adopt Basel II (i.e., the members of the Basel Committee), this does not mean that emerging markets will not be affected. In fact, most of the questions for future research concern the impact of this accord on developing countries. For instance, how will Basel II impact banks domiciled and/or operating in emerging markets? How do the impacts differ between standardized and internal approaches in emerging markets? And, can the new banking capital regulation amplify the business cycle in emerging markets?

The purpose of this section is to study the variation in the required minimum level of capital we might see in the Latin American economies following the implementation of Basel II. For that, I present Lowe and Segoviano (2002) and Powell (2004). The objective of Lowe et al. (2002) is to calculate how the average risk weight would have moved in Mexico over the second half of the 1990s under both the standardized approach and the foundation IRB approach. Central to this exercise is the calculation of annual transition matrices. These matrices tell us the likelihood of a borrower having a specific rating in one year's time, conditional on its current rating. From these transition matrices they obtain default frequencies for each grade. They interpret these frequencies as the ex ante probabilities of default (PDs).

To calculate the amount of capital required under the standardized approach they assume that all loans had an external rating, by mapping the calculated ex ante PDs into Standard & Poor's (S&P) ratings.

Analyzing capital requirements under the internal approach, the authors found that they peak in December 1996 (more than 16%!) and then they subsequently decline, so that by December 1999 the capital requirements have returned to the levels broadly consistent with those in March 1995 (close to 10%).

Capital requirements under the IRB approach are volatile. Regulatory capital requirements are clearly larger during the period of highest loan defaults and when economic conditions are most depressed, although the requirements increase only gradually after the devaluation rather than in one large step. As Borio et al. (2001) show, the standardized approach with pseudo-risk-weighting produces capital requirements that are lower and less cyclically sensitive than those under the IRB approach. However this result must be viewed with prudence because, first, few corporate borrowers in Mexico have external ratings, and second, it is inappropriate to compare ex-ante PD with PD observed by S&P for purposes of calculating the capital requirement under the standard approach.

While the extreme nature of the Mexican crisis provides perhaps an upper bound on the likely increase in capital requirements in a downturn, a much smaller increase could conceivably cause stress and a reduction in credit supply. As noted by the authors, one way of avoiding such problems is for banks to hold adequate buffers above the regulatory minimum in good times, so that deterioration in the economy does not mean that new capital has to be raised. For that, banks need to take a multi-year view when deciding capital levels, and integrate macroeconomic considerations into their risk assessments. Supervisors can play a role here, by requiring banks to undertake sensitivity stress tests to see how their regulatory capital ratios might move with changes in economic conditions.

More recently, Powell (2004) studied the possible implications of Basel II in Latin America. Assuming perfect competition between banks, he establishes for a group of Latin American countries[15] whether capital requirements (Basel I and Basel II) are binding for banks. His principal findings are that countries with an "investment grade" rating, as with Chile and Mexico, the capital requirement under the internal approach is smaller than under the standard approach, and it is not binding. By contrast, in countries with a poor rating (Venezuela and Ecuador), the capital requirement under the internal approach is higher than under the standard, and Basel II is binding. Despite its useful results for policy-makers, the study has several limitations. First, it quantifies capital requirements in a fixed period of time (only for 2003) without taking into account the entire business cycle. Second, the empirical analysis assumes that bank loans are only designated for the sovereign. Third, the economic capital or endogenous capital is determined on the assumption that banks are risk-neutral and that Latin American banking systems are perfect.

5. The model

In this section, I develop an imperfect competition model composed of two banks, a domestic bank that continues to employ Basel I to determine capital requirements and an international bank that implements Basel II. I use a Monti-Klein model[16] adapted for banking capital regulation, first with the assumption that banks are risk-neutral and second that they are risk-averse. Because I consider only the impact of banking capital regulation through credit-risk measurement at the level of loans, I simplify this regulation by leaving market risk and operational risk out of account.

5.1. *Risk-neutral banks*

The balance sheet of each bank is composed only of loans L on the asset side and of capital K and deposits D on the liability side. Indeed, the model assumes that there are

[15] Argentina (before 2001 crisis), Brazil, Chile, Colombia, Ecuador, Mexico, Panama, Peru and Venezuela.

no open positions between international and domestic banks in the interbank market. For simplicity I also assume the same constant marginal costs *c* for deposits and loans. By contrast with the standard Monti-Klein model, there is no remuneration for deposits. This assumption can be justified by the fact that I am interested in the effect of capital regulation on the supply of loans, and minimum capital requirements do not depend on the level of deposits.[17] Consequently, the profit function is written as follows:

$$\pi(L,D,K) = r_L(L)L - r_K K - c(D+L) \tag{2}$$

where, $r_L(L)$ is the inverse demand function for loans and r_K is the capital remuneration determined exogenously by the equilibrium in the capital markets.

By matching assets and liabilities in the balance sheet: $L = K + D$ (3)

I obtain that: $\pi(L,K) = r_L(L)L - r_K K - c(2L-K)$ (4)

Denoting the capital requirement per unit of loans by β, capital regulation under Basel I requires that:

$K \geq \beta \cdot L$ where β is a fixed percentage determined by the regulator. (5)

In order to determine whether the capital requirement is binding, the value of loans *L* must be calculated as follows:

$$L = \min\left[\frac{K}{\beta}, \max_L \pi(L,K)\right] \tag{6}$$

Substituting the capital regulation structure (eq. (5)) into equation (4) and assuming that all capital is needed to cover unexpected losses ($K = \beta L$),[18] the bank's profit function becomes:

$$\pi(L) = r_L(L)L - r_K \beta L - cL(2-\beta) \tag{7}$$

From now on, I assume linearity in the demand function for loans which I write as:

$$r_L(L_i) = r_L(L_i^d + L_i^f) = a - b(L_i^d + L_i^f) \tag{8}$$

where L_i^d are the loans supplied by the domestic bank *d* and L_i^f are the loans supplied by the foreign bank *f* in country *i*.[19]

Combining equations (7) and (8), I obtain in the case of the domestic bank that:

$$\pi^d(L_i^d, L_i^f) = \left[a - b(L_i^d + L_i^f)\right]L_i^d - r_K \beta_i L_i^d - c_d L_i^d (2-\beta_i) \tag{9}$$

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16 See chapter 3 of Freixas and Rochet (1997) for a detailed review of this model.

17 Alternatively, the marginal cost can be viewed as the remuneration of deposits.

18 It is important to note that in some Latin American countries, national banking capital regulation is stricter than Basel I, where the solvency ratio must be at least equal to 8%. For example, in Venezuela, Argentina, Brazil, Peru and Colombia the capital requirements are respectively 12%, 11.5%, 11%, 9% and 9% instead of 8%. See IADB (2004).

19 Using equation (6) and assuming linearity in the demand function for loans, the problem to determine whether the capital requirement for the domestic bank is binding can be written as : $L_i^d = \min\left[\frac{K}{\beta_i}, \frac{a-2c}{2b} - \frac{L_i^f}{2}\right]$ and at equilibrium: $L_i^d = \min\left[\frac{K}{\beta_i}, \frac{a-2c}{3b}\right]$.

In order to determine the optimal amount of loans maximizing benefits for the domestic bank, when capital regulation is binding, I compute the first order conditions (assuming that π is concave) thus:

$$\frac{\partial \pi^d(L_i^d, L_i^f)}{\partial L_i^d} = 0 \leftrightarrow L_i^d = R_i^d(L_i^f) = \frac{a - \beta_i(r_K^d - c_d) - 2c_d}{2b} - \frac{L_i^f}{2} \tag{10}$$

This expression can be interpreted as the reaction or best response function of bank *d* to the loans supplied by bank *f*.

- Foreign Bank invests only in one emerging country

I start with the simplest case in which the foreign bank only invests in country *i*. As we have seen before, in the New Basel Capital Accord (Basel II), β depends on the credit risk estimation of assets calculated by banks or external agencies. Because this estimation depends on the accuracy of the credit risk model employed, I note β for Basel II by $\tilde{\beta}$.

Thus, under Basel II regulation we have: $K \geq \tilde{\beta} \cdot L$ (11)

Because foreign banks must calculate their capital requirement under the host country regulation (Basel I) and under the home country regulation (Basel II), the level of loans *L* given in country *i* is determined by:

$$\tilde{L}_i^f = \min\left[\frac{K_i}{\beta_i}, \frac{K - \tilde{\beta}_h L_h}{\tilde{\beta}_i}, \max_{L_i^f} \pi(L, K)\right] \tag{12}$$

where $\tilde{\beta}_h$ denotes the credit risk estimation of assets allocated in the home country (L_h).

Combining equations (7) and (8), and assuming that home regulation is binding in equation (12), I write the reaction function of bank *f* to the loans supplied by *d* as:[20]

$$\frac{\partial \pi^f(L_i^d, L_i^f)}{\partial L_i^f} = 0 \leftrightarrow \tilde{L}_i^f = R_i^f(L_i^d) = \frac{a - \tilde{\beta}_i(r_K^f - c_f) - 2c_f}{2b} - \frac{L_i^d}{2} \tag{13}$$

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[20] I assume for simplicity that credit risk in the home country is 0 ($\tilde{\beta}_h = 0$). A more interesting case, in which the foreign bank invests in a variety of countries, is developed in the next section.

[21] In this model I assume that the participation of foreign banks is as important to the host countries as the participation of domestic banks. Empirical evidence shows that for some Latin American countries (Argentina, Chile and Peru), the market share of foreign banks is around 50%. However, it might be interesting for future research to analyze cases in which the participation of foreign banks is larger (or smaller) than for local banks. For example, in Mexico the market share of foreign banks is more than 70%, while in Brazil it is less than 30% and in Colombia less than 20%. In these cases, it might be advantageous to develop a Stackelberg model instead of a Cournot model.

As usual in a Cournot duopoly model, the quantity supplied by each bank is a decreasing function of the loans determined by the other bank.[21] Additionally, as the credit risk estimation increases for a given country *i*, the quantity supplied by the foreign bank decreases. This is not the case for a domestic bank that follows the current regulation.[22]

From the intersection of the best response functions (equations (10) and (13)), I determine the quantities supplied at equilibrium for this market to be:

$$\tilde{L}_i^d = \frac{a - 4c_d + 2c_f - 2\beta_i(r_K^d - c_d) + \tilde{\beta}_i(r_K^f - c_f)}{3b} \tag{14}$$

$$\tilde{L}_i^f = \frac{a - 4c_f + 2c_d - 2\tilde{\beta}_i(r_K^f - c_f) + \beta_i(r_K^d - c_d)}{3b} \tag{14'}$$

These two equations yield our first results. Higher credit-risk estimation by a foreign bank decreases its quantity supplied while on the other hand induces an increase in the quantity of loans supplied by the domestic bank. However, the increase provided by the domestic bank does not compensate the decrease from the foreign bank, resulting in a decrease in *total* loans.

The idea behind this result is that credit risk estimation affects only the reaction function of the foreign bank (see eq. (13)) and more precisely a higher estimation shifts this best-response function downward, decreasing at the equilibrium the quantity supplied by this bank. In contrast, the domestic bank's reaction function is still the same and does not compensate the reduction of the foreign bank because, as usual in a reaction function, its slope is smaller than 45º. Indeed, the corner solutions for this function are the cases in which the bank is 1) perfectly competitive, and 2) a monopoly (in which case a lower quantity is supplied).[23]

The same finding is for the marginal cost of each bank and for the capital requirement per unit loan of the domestic bank which it is constant across time.[24]

Note that a change in the level of loans supplied by the foreign bank due to a new estimation of credit risk is given by:

$$-\frac{\partial \tilde{L}_i^f}{\partial \tilde{\beta}_i} = \frac{2\left(r_K^f - c_f\right)}{3b} \tag{14"}$$

This equation gives the macroeconomic implication of a change of credit risk assessment by the foreign bank.

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[22] Additionally, as it is often assumed in the literature I suppose that a > 2c and that capital remuneration is higher than marginal cost.

[23] See Chapter 12 of Mas-Colell, Whinston and Green (1995) for a detailed review of the Cournot model.

[24] Assuming that the asset allocation between the categories defined by Basel I (see annex 1) is constant.

- Portfolio diversification in *N* countries by the foreign bank

In this more realistic scenario, the profit function of the international bank is as follows:

$$\tilde{\pi}^{f}(L^{f},L^{d}) = \sum_{j=1}^{N-1} r_{L_j}(L_j)L_j^f + r_{L_i}(L_i)L_i^f - r_K^f \sum_{j=1}^{N-1} \tilde{\beta}_j L_j^f - r_K^f \tilde{\beta}_i L_i^f - c_f\left[\sum_{j=1}^{N-1} L_j^f(2-\tilde{\beta}_j)\right] - c_f L_i^f(2-\tilde{\beta}_i) \tag{15}$$

where $j \neq i$, and noting that the total amount of loans provided by bank *f* is L^f, I have:

$$\sum_{j=1}^{N-1} L_j^f = L^f - L_i^f \tag{16}$$

Assuming that the inverse demand function for loans and the credit risk measurement are the same in all countries $j \neq$ i, I can rewrite (15) as follows:

$$\tilde{\pi}^{f}(L^{f},L^{d}) = r_{L_j}(L_j)(L^f - L_i^f) + \left[a - b(L_i^f + L_i^d)\right]L_i^f - r_K^f \tilde{\beta}_j (L^f - L_i^f) - r_K^f \tilde{\beta}_i L_i^f - c_f(2-\tilde{\beta}_j)(L^f - L_i^f) - c_f L_i^f(2-\tilde{\beta}_i) \tag{17}$$

Again, in order to determine the optimal amount of loans given by the international bank, I calculate the first order conditions thus:

$$\frac{\partial \pi^f(L_i^d, L_i^f)}{\partial L_i^f} = 0 \leftrightarrow \tilde{L}_i^f = R_i^f(L_i^d) = \frac{a - r_{L_j}(L_j) - (\tilde{\beta}_i - \tilde{\beta}_j)(r_K^f - c_f)}{2b} - \frac{L_i^d}{2} \tag{18}$$

Comparing this expression with the case of investment in only one emerging country (see equation (19)), the quantity supplied in country *i* depends also on the inverse demand for loans and on credit risk measurement in countries other than *i*.

Obviously, the domestic bank reaction function is still the same as in the case of investment in only one emerging country, so that, from equations (10) and (18), I determine the quantities supplied at equilibrium thus:

$$\tilde{L}_i^d = \frac{a - 4c_d + r_{L_i}(L_j) - 2\beta_i(r_K^d - c_d) + (\tilde{\beta}_i - \tilde{\beta}_j)(r_K^f - c_f)}{3b} \tag{19}$$

$$\tilde{L}_i^f = \frac{a + 2c_d - 2r_{L_j}(L_j) - 2(\tilde{\beta}_i - \tilde{\beta}_j)(r_K^f - c_f) + \beta_i(r_K^d - c_d)}{3b} \tag{19'}$$

In addition to the findings noted by equations (14) and (14'),[25] there are two corollaries. First, as inverse demand for loans increases in countries other than *i*, the

[25] In particular, note that the change in portfolio composition of the foreign bank due to a new estimation of credit risk given by equation (14") is still in the same magnitude.

total amount of loans given in country *i* decreases. Second, the quantity supplied in country *i* increases as the credit risk measurement in other countries also increases. This fact implies that, by the conduct of capital regulation, an assessment of credit risk made by an international bank *f* in a given country not only affects the quantity supplied in that country but also the *total* of loans made in other countries in which this bank has a presence. These two results are found because domestic banks do not totally offset the variation caused by international banks in the domestic loan market.

5.2. *Risk-Averse Banks*

- No information about countries

I start with the case in which the foreign bank makes a poor estimation of credit risk in all countries and does not spend resources to learn more about a specific country. Then, capital requirement per unit loans under Basel II is identically and independently distributed with mean ρ and variance σ^2. I note that:

$$E(\tilde{\beta}_i) = E(\tilde{\beta}_j) = \rho \tag{20}$$

$$V(\tilde{\beta}_i) = V(\tilde{\beta}_j) = \sigma^2 \tag{21}$$

By the same token, because there is no information about countries, inverse demand for loans is also supposed to be the same across countries. Thus, the optimal amount of assets to be invested in each country must be the same:

$$L_i^f = \frac{L^f}{N} \tag{22}$$

By using eq. (15), the expected profit is:

$$E(\tilde{\pi}^f) = E\left[\sum_{i=1}^{N} r_{L_i}(L_i)L_i^f - r_K^f \sum_{i=1}^{N} \tilde{\beta}_i L_i^f - c_f \sum_{i=1}^{N} L_i^f (2 - \tilde{\beta}_i)\right] \tag{23}$$

Taking into account the assumptions presented above, the expected profit becomes:

$$E(\tilde{\pi}^f) = r_L \cdot L^f - r_K^f \rho L^f - c_f \cdot L^f (2 - \rho) \tag{24}$$

and the variance of profits is:

$$V(\tilde{\pi}^f) = \frac{L^{f2}}{N}\sigma^2 (c_f - r_K^f)^2 \tag{25}$$

We note the benefits of diversifying the portfolio for the foreign bank. In fact, as *N* increases, the variance of the return decreases, while the expected profit is independent of *N* (eq.(24)).[26]

[26] Because in this model, I assume that credit risk estimation is independently distributed, $\text{cov}(\tilde{\beta}_i, \tilde{\beta}_j) = 0$. In reality, because of contagion between emerging markets (due to current account links or to similar macroeconomic conditions) this covariance must be positive, decreasing the benefits of diversification.

- Rumor in country *i*

The main purpose of this sub-section is to show that, given diversification, risk-averse banks would have no incentive to use an accurate risk measurement for these markets, something it can contribute, by the conduct of banking capital regulation, toward a major procyclical effect in an emerging economy. As in Calvo (1998),[27] I now consider the case in which there is a rumor or "news" in country *i*. This rumor gives a new mean value γ different from ρ for the capital requirement per unit of loans. Then, for country *i* and countries *j* different than *i*, the expected capital requirements per loans are respectively:

$$E(\tilde{\beta}_i) = \gamma \quad (26) \quad \text{and} \quad E(\tilde{\beta}_j) = \rho \tag{27}$$

However the variance of credit risk estimation is still equal to σ^2 as in other countries and its distribution is independent.

By using equation (23), the expected profit for bank *f* is:

$$E(\tilde{\pi}^f) = \left[r_{L_j}(L_j) - r_K^f \rho - c_f(2-\rho) \right] \cdot \left[L^f - L_i^f \right] + \left[r_{L_i}(L_i) - r_K^f \gamma - c_f(2-\gamma) \right] \cdot L_i^f \tag{28}$$

And because the expected value and variance of credit risk estimation are identical in countries other than *i*, and additionally since I am assuming that countries other than *i* have the same inverse demand for loans, I obtain the result that the allocation invested in these countries must be constant across them:

$$L_j^f = \frac{L^f - L_i^f}{N-1} \tag{29}$$

Moreover, the variance of the total portfolio of the foreign bank is then:

$$V(\tilde{\pi}^f) = \sigma^2 (c_f - r_K^f)^2 \cdot \left[\frac{(L^f - L_i^f)^2}{N-1} + L_i^{f2} \right] \tag{30}$$

Again, as *N* increases the volatility of the foreign bank's portfolio diminishes, while the expected profit is independent of *N*.

Assuming that the Von Neumann-Morgensten utility *U* is a quadratic function where α is the Constant Absolute Risk Aversion (CARA), the expected utility can be represented from a mean–variance criterion (equations (28) and (30)) as follows:

$$EU = E(\tilde{\pi}^f) - \frac{\alpha}{2} V(\tilde{\pi}^f) \tag{31}$$

[27] Calvo (1998) shows that the cause of a balance of payments crisis can be explained by lenders' behavior. In fact, even if both diversification and information are desirable features for an investor, there may be a significant trade-off between them, which can provoke a balance of payment crises. Calvo (1998) has shown two important facts. First, investment into or away from a given country can be highly sensitive to news in a world in which investors are highly diversified. Second, highly diversified investors have lower incentives to learn about individual countries than investors with few diversification opportunities. These characteristics of highly-diversified investors tell us that diversification can encourage ignorance and, in that context, rumors can result in massive capital flows from the perspective of an individual country.

As before, in order to determine the optimal amount of loans given by the international bank, I calculate the first order conditions (from eq. (31)) thus:

$$L_i^f = R_i^f(L_i^d) = \frac{a - r_{L_j}(L_j) - (\gamma - \rho)(r_K^f - c_f) + \frac{\alpha}{N-1}\sigma^2(c_f - r_K^f)^2 L^f - bL_i^d}{2b + \alpha\sigma^2(c_f - r_K^f)^2 \frac{N}{N-1}} \tag{32}$$

Note that in addition to the variables found for the reaction function of risk-neutral banks, this depends also on the risk-aversion coefficient α, on the number of countries N, and on the variance of credit risk assessment σ^2.

Noteworthy, the domestic bank reaction function is still the same as before. From equations (10) and (32), I determine the quantities supplied at equilibrium:

$$L_i^d = \frac{(a - 2c_d)}{2b} - \frac{\beta_i(r_K^d - c_d)\left[4b + 2\alpha\sigma^2(c_f - r_K^f)^2 \frac{N}{N-1}\right]}{2b\left[3b + 2\alpha\sigma^2(c_f - r_K^f)^2 \frac{N}{N-1}\right]}$$
$$\frac{-(a - 2r_{L_j}(L_j) + 2c_d)b + 2(\gamma - \rho)(r_K^f - c_f)b - b\frac{2\alpha}{N-1}\sigma^2(c_f - r_K^f)^2 L^f}{2b\left[3b + 2\alpha\sigma^2(c_f - r_K^f)^2 \frac{N}{N-1}\right]} \tag{33}$$

$$L_i^f = \frac{a - 2r_{L_j}(L_j) + 2c_d - 2(\gamma - \rho)(r_K^f - c_f) + \frac{2\alpha}{N-1}\sigma^2(c_f - r_K^f)^2 L^f + \beta_i(r_K^d - c_d)}{3b + 2\alpha\sigma^2(c_f - r_K^f)^2 \frac{N}{N-1}} \tag{33'}$$

In addition to the variables obtained for the case of risk-neutral banks, I find that the total level of loans in country *i* depends also on the risk aversion of the bank, α, on the accuracy of the assessment of credit risk, σ^2, and on the number of countries in which the bank *f* is investing, *N*. In particular, I find that an increase (decrease) in the expected risk estimation for country *i* (for countries *j*) decreases the *total* level of domestic loans in country *i* due to the fact that the variation of the loans given by the foreign bank are offset only by half by the domestic bank (as it was for the case of risk-neutral banks).

A more interesting result is the change in the portfolio composition of the foreign bank due to a new estimation of credit risk. This is computed as the derivative of the level of loans in country *i* with respect to the expected capital requirement per loan γ in equation (33'), i.e.,

$$-\frac{\partial L_i^f}{\partial \gamma} = \frac{(N-1)2(r_K^f - c_f)}{(N-1)3b + N2\alpha\sigma^2(c_f - r_K^f)^2} \xrightarrow[N \to +\infty]{} \frac{2(r_K^f - c_f)}{3b + 2\alpha\sigma^2(c_f - r_K^f)^2} \tag{34}$$

Note that as N increases, the impact of a new credit risk estimation on the amount of loans given by the foreign bank in country i is higher.[28] Therefore, by making N sufficiently large, the change in the amount of loans allocated to country i by bank f as a proportion of the original investment (from eq. (22), prior to new information, investment in country i was L/N) could be arbitrarily large following new information. Thus, I obtain the same conclusion as Calvo (1998): "As the opportunities of diversification increase, the impact of "news" on the allocation of investment funds (relative to initial allocation) grows without bound".

There are two additional findings. First, from a macroeconomic point of view, as portfolio diversification increases, the *total* level of loans in a given country can be harshly affected by the behavior of a foreign bank following "news" and obeying the new capital regulation. Indeed, domestic banks do not compensate the variation of international bank loans: thus new banking capital regulation and "rumors" can greatly diminish the *total* level of domestic loans, and consequently investment and economic growth.

Second, analyzing banking behavior, by comparing equations (14") and (34), I obtain that the change in portfolio composition following a new credit-risk estimation in a given country is smaller for risk-averse banks than for risk-neutral banks, since the risk-aversion coefficient, α, and the lack of accuracy of credit risk assessment in other countries, σ^2, are higher. Consequently, even in the case in which portfolio diversification increases harshly, the macroeconomic implication of a change in credit risk estimation, via the new banking regulation, is greater when banks are risk-neutral.

6. Conclusions

In this article I first considered the main aspects discussed in the theoretical literature on bank capital regulation. In particular, we noted that the research already undertaken has produced some useful insights into the design of capital standards. Because of banks' informational advantage, incentive compatibility calls for a scheme of regulation that encompasses a menu of different instruments. Another development in research related to capital standards is the implementation of the optimal governance of banks, to define the threshold for interference in management and for transfer of control from shareholders to the depositor's representative, the supervisory authority.

However, as noted by Santos (2000), there are still many relevant questions that remain unanswered. For example, theoretical research on the macroeconomic implications of bank capital regulation is still very scarce (Blum and Hellwig (1995), Thakor (1996), and Krainer (2002)).

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[28] More precisely we have that: $-\frac{\partial^2 L_i^f}{\partial \gamma \partial N} = \frac{4\left(r_k^f - c_f\right)^3 \alpha\sigma^2}{\left[(N-1)3b + N2\alpha\sigma^2(c_f - r_k^f)^2\right]^2} > 0$.

Concerning the procyclicality of the financial system, an important source of the amplification by the financial system of swings in the macro-economy is the inappropriate measurement of changes in the absolute level of risk over time by financial market participants, especially in its systematic component. This miscalculation arises from the short horizons that underlie most risk measurement methodologies and from insufficient attention being paid to the correlations across borrowers and institutions. The consequence of this is that risk is often underestimated in booms and overestimated in recessions.

The credit risk structure of the 1988 Capital Accord does not have a strong cyclical component. Indeed, capital requirements change over time only if the strategy of a bank's asset portfolio changes. By contrast, the New Basel Capital Accord implies that the capital requirement for a given portfolio will change over time as the bank's assessment of the riskiness of that portfolio changes. If measured risk falls in booms and increases in recessions, then this would have implications for the procyclicality of the financial system. Financial stability would be enhanced by provisions and capital ratios increasing in economic booms.

The model developed in this article uses an adaptation of the Monti-Klein model to the banking capital regulation. In order to determine equilibrium in the loan market (which is composed of foreign and domestic banks), I took on the assumption first that banks are risk-neutral and second that they are risk-averse. From a theoretical point of view, this model is useful for two reasons. First, it analyzes a duopoly model for risk-averse banks and second, it is an additional contribution to the research on the relationship between banking capital regulation and the business cycle. In particular, I determined the impact that an international bank might have on an emerging economy (through the loan market) when adopting Basel II, and assuming that the Accord is binding for this bank.[29] The main results are:

1. A higher credit risk estimation by a foreign bank decreases its quantity supplied, and on the other hand increases the quantity supplied by the domestic bank. However, the increase in the credits by the domestic bank does not offset the decrease by the foreign bank, resulting in a decrease of the *total* loans. This is because, while the best-response function of the foreign bank shifts downward, the domestic bank's reaction function is still the same and its slope is smaller than 45º. Indeed, the corner solutions for this function are the cases in which the bank is 1) perfectly competitive, and 2) a monopoly (in which case a lower quantity is supplied).
2. The *total* quantity supplied in a given country increases as the credit risk estimation for other countries also increases. This implies that, by the conduct of the new banking capital regulation, the assessment realized by an international bank in a

[29] I assume that Basel II regulation is binding for the bank with respect to its strategy and host country banking regulation (Basel I).

given country not only affects the quantity supplied in that country but also the *total* loans in other countries where the bank has a presence.

3. Analyzing risk-averse banks, I obtained the same results presented above. Additionally, I showed that, as diversification increases, the change in loans allocated in a given country by an international bank as a proportion of the original investment and the *total* level of loans (and consequently investment and economic growth) in a given country could be harshly affected by the behavior of a foreign bank following new information and employing the new banking capital regulation.

4. Even in the case where the opportunities for diversification increase harshly, the change in portfolio composition following a new credit risk estimation in a given country is smaller for risk-averse banks than for risk neutral banks, as risk aversion and the lack of accuracy in credit risk assessment are higher. Therefore, the macroeconomic implication of a change in credit risk estimation, via the new banking regulation, is greater when banks are risk-neutral than when they are risk-averse.

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Appendix 1 Basel capital accord 1988 (Basel I)

This annex presents an overview of the current solvency ratio. This ratio must be equal to or higher than 8% and can be written as follows:

$$SR = \frac{Tier1 + Tier2}{\sum_{i=1}^{4} RW_i \cdot Assets_i} \geq 8\%$$

where:

- Tier 1 is defined as common stock, retained earnings, and perpetual preferred stock. It must correspond at least at 50% of the whole capital.
- Tier 2 is defined as fixed maturity preferred stock, loan loss reserves, and subordinated debt.

RW stands for the Risk Weight. There is a RW for each category:

1. In category 1, the RW is 0% and corresponds to risk-free assets (e.g., cash, reserves, and government securities).
2. In category 2, the RW is 20% and corresponds to slightly more risky assets (e.g., interbank deposits, fully backed mortgage bonds, general obligations of state and local governments, and securities issued by government agencies).
3. In category 3, the RW is 50% and corresponds to yet riskier assets (e.g., revenue bonds of state and local governments and residential mortgages).
4. In category 4, the RW is 100% and corresponds to the riskiest assets (e.g., commercial paper, business and household loans, and various fixed assets).