THE IMPACTS OF CAPITAL ADEQUACY REQUIREMENTS ON EMERGING MARKETS

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Summary

We investigate the macroeconomic impacts of changes in capital adequacy requirements, as developed in the Basel Capital Accords, on Brazil and Mexico. Changes in the capital adequacy requirements of international and domestic banks are considered, since the former adopted the Basel Capital Accord in 1988 and the latter in the mid-90s. Unlike most papers in the budding literature on the effects of the Basel Capital Accords on developing countries, we adopt an empirical approach, grounded in a general equilibrium macroeconomic model, which allows us to examine indirect transmission mechanisms. We first estimate a reduced financial block for Brazil and Mexico, which we integrate into the National Institute's General Equilibrium Model (NiGEM). We then simulate a shock to domestic and international capital adequacy ratios.

The simulations show that an increase in capital adequacy ratios—either domestic or international—has adverse impacts on Brazilian and Mexican GDPs. A moderate credit crunch occurs in both cases and in both countries and is accompanied by a rise in lending rates. However, there are important differences in banks' reaction to tighter solvency ratios in each country. In Brazil, international and domestic banks adjust their portfolios by switching from higher-risk loans (private sector) to zero-risk loans (sovereign and public sector), instead of increasing their capital provisions. Sovereign lending, and hence government spending, thus rises sharply in Brazil. This offsets the negative impacts of the fall in private investment that follows the credit crunch. In Mexico, sovereign lending from domestic banks remains largely unaffected by changes in capital adequacy ratios, whereas foreign loans to the Mexican public sector decrease. In both cases, the Mexican private sector bears the bulk of the adjustment of domestic and foreign banks to the new regulatory rules. These findings suggest the existence of a financial "crowding-out", where government borrowing replaces private sector borrowing in domestic banks loans portfolios.

Household borrowing including housing loans represents around 5 per cent of GDP in Mexico and about 8 per cent of GDP in Brazil, on average over 1997-2004. These ratios are considerably lower than those of countries such as the UK and the US. In 2000, for instance, total consumer credit in the UK and the US amounted to 73 and 78 per cent of GDP respectively (see Byrne and Davis, 2003). This may account for our finding that consumer credit in both countries is not sensitive to changes in solvency ratios. Nonetheless, our simulations show that household consumption in Brazil and Mexico drops following a rise in capital adequacy ratios. The transmission mechanism is carried out through household net wealth. Higher solvency ratios lead to higher interest rates, which, other things unchanged, increase net interest payments of households and thus their net financial wealth. In our model, lower financial wealth results into lower consumption. Overall, given an increase of 1/2 percentage point in solvency ratios, we found that GDP falls by 3.5 per cent in Brazil, and by 2.2 per cent in Mexico.
1 Introduction

In 1988 the Basel Committee on Banking Supervision introduced an international standard of banking regulation, founded on a single measure of regulatory capital provisions for credit risk and straightforward credit risk categories. Its main objectives were to encourage international banks to boost their capital positions and to reduce competitive inequalities. The 1988 Capital Accord was originally designed for internationally active banks incorporated in the 13 member countries of the Basel Committee (the G-10). These are Belgium, Canada, Germany, France, Italy, Japan, Luxembourg, Netherlands, Spain, Sweden, Switzerland, United Kingdom and United States.

Until the late 1990s there was little concern amongst international regulators about the impacts Basel I could have on emerging markets, although some of the risk categories of the Capital Accord concerned directly loans to non-OECD countries. Two events contributed to this change. First, the disproportionate amount of one-year and interbank loans that flowed to Asia in years preceding the 1997 Asian Crisis led the Committee to investigate whether its simple credit risk structure was to blame for the crisis. Second, since the mid-1990s many developing countries have been adopting its regulatory framework. And after the Asian Crisis, this happened with the support of the Basel Committee.

The analysis presented in this paper focuses primarily on the macroeconomic impacts of changes in capital adequacy requirements on Brazil and Mexico. Changes in the capital adequacy requirements of international and domestic banks are considered, since the former adopted the Basel Capital Accord in 1988 and the latter in the mid-90s. Unlike most papers in the budding literature on the effects of the Basel Capital Accords on developing countries, we adopt an empirical approach, grounded in a general equilibrium macroeconomic model, which allows us to examine indirect transmission mechanisms. We first estimate a reduced financial block for Brazil and Mexico, which we integrate into the National Institute’s General Equilibrium Model (NiGEM). We then simulate a shock to domestic and international capital adequacy ratios.

There is ample macroeconomic evidence that a reduction in domestic bank lending has negative impacts on the real economy (see Bernanke, 1983; Bernanke and Lown, 1991, amongst others). However, an industry-wide fall in domestic credit must occur for this to affect the real economy and it is difficult to see how all banks would be uniformly affected by the introduction or tightening of capital adequacy ratios. Even if some capital constrained banks cut back lending, the reduction must not be fully offset by increased lending either by better capitalised banks or by other financial intermediaries or by credit markets. In a paper examining the impacts of the 1988 Basel Capital Accord on the G-10, Jackson et al. (1999) find evidence of imperfect substitution between bank lending and alternative sources of finance in the US and Japan, which may have led to a credit crunch in the early 1990s. Regarding emerging markets, three factors indicate that tighter regulatory capital requirements are likely to cause a domestic credit crunch. First, it is a well documented fact that capital markets are quite shallow in these countries (Caprio and Honohan, 1999; Barth, Caprio, and Levine, 2001; Powell, 2004). Consequently, cor-
porate debt and equity issuance do not constitute a realistic alternative to domestic or international bank lending. In Mexico, for instance, debt issuance represented less than 6 percent of total private sector finance in 2000. This contrasts with the proportion of bonds in the liabilities of North American companies. Byrne and Davis (2003) report that in 2000 bonds constituted 13 per cent of corporate liabilities in the US and 17 percent in Canada. Second, the banking sector in emerging markets is usually quite concentrated. Data from the Central Bank of Brazil show that in 2004 50 percent of domestic credit in that country was provided by five banks. The 10 largest banks supplied 71 percent of total domestic credit. Clearly, the reduction of credit by a few capital constrained banks is likely to have a significant impact on domestic credit to the private sector. Finally, in most emerging markets, there is a marked presence of the government in the real economy, in the form of state-owned banks and state-owned companies. Under the rules of the 1988 Capital Accord and of the standardised approach of the 2004 Revised Framework, public sector entities may be included in the zero credit risk category, along with the central government and the central bank. In this context, a private bank subject to tighter capital requirements in an emerging market has several alternatives for increasing its capital ratios without raising additional capital. It may substitute its risk-weighted loans (to the private sector) by zero-risk loans to the central government, state-owned firms or state-owned banks.

Griffith-Jones, Spratt, and Segoviano (2002a), Weder and Wedow (2002), Griffith-Jones, Spratt, and Segoviano (2002b), and Gottschalk and Sodré (forthcoming) are some the few papers assessing the impacts of the Basel Capital Accord on emerging markets. With the exception of the last paper, their main focus is on international capital flows. Gottschalk and Sodré (forthcoming) investigate whether the adoption of Basel I led to a private credit crunch in Brazil. This literature is reviewed in Section 2.2.

Two recent papers examine the risks to financial stability from a macroeconomic perspective, Benito, Whitley, and Young (2001) and Catalán and Ganapolski (2005). Catalán and Ganapolski (2005) integrate a financial sector within a dynamic stochastic general equilibrium framework to investigate whether capital requirements should be loosened during recessions. The prevalent view, based on partial equilibrium analysis, suggests that tightening capital requirements during recessions provokes a credit crunch to firms, which intensifies the economic downturn. The authors found, amongst other interesting results, that tightening capital requirements during a recession has a positive impact on households’ savings decisions. Since their savings are the main source of corporate finance, via banks loans, an increase in capital requirements ultimately leads to a faster economic recovery.

Benito, Whitley, and Young (2001) build a detailed model of the UK financial sector that is incorporated into a macroeconometric model, the Bank of England’s medium-term macroeconometric model (MTMM). Two distinct analyses of risks to financial stability are presented in the paper. The first consists of deriving probability distribution functions for key financial variables, e.g., corporate debt, and then evaluating the chances of these variables assuming crucial values. For instance, in the case of corporate debt,
the paper concludes that the odds of it becoming as high as in the early 1990s are less than 5 percent. The second approach investigates the sensitivity of the financial sector to unanticipated shocks, and is characterized by the authors as a "stress test". The first shock is a fall in UK house prices, the second an increase in UK interest rates.

Our approach in this paper is closer to Benito, Whitley, and Young (2001), although our results cannot be directly compared to theirs. We estimate the behaviour of several financial variables, and incorporate the resulting equations into a macroeconometric model. We then simulate a positive shock in the international and domestic capital adequacy ratios, and analyse its impact on GDP and its components. Our main results are reported in the Summary and differ significantly from those of Catalán and Ganapolski (2005) for two reasons. First, household debt is non-existent in their model. Increases in interest rates translate exclusively into increases in household wealth. Here, household debt incurs interest payments that offset the interest paid on savings. Second, in Catalán and Ganapolski (2005) banks are price-takers. The interest rate that remunerates deposits/savings is determined by the market. The lending rate is modelled as being state-contingent and tied to firm productivity. If the productivity of the firms banks lend to rises, the return on the loans also rises, and banks then increase their loans to firms. In Brazil and Mexico, banks are price-makers and we found that they increase their lending rate when capital adequacy requirements are tightened.

This paper is organised as follows. After this Introduction, Section 2.1 summarizes the Basel Capital Accords and Section 2.2 surveys the literature on the impacts of capital adequacy regulation in developing countries. Section 3 presents the financial models of Brazil and Mexico, and section 4 shows the results of our simulations of these models. Section 5 concludes and precedes the Notes and the Data Sources appendix.

2 The Basel Capital Accord and its impacts on developing countries

2.1 The Basel Capital Accord

The Basel Committee was created in 1974 in the wake of the liquidation of the German Bank Herstatt, a small bank, whose failure had an unanticipated disruption of international foreign exchange markets for about a year. The original purpose of the Basel Committee was thus the coordination of the supervision of national banks with international activities, in order to prevent negative consequences of the failure of a national bank on the international financial system. In 1975 the Basel Committee published its founding document setting out the guidelines for international cooperation of banking supervisors, the Basle Concordat (see BIS, 1975). This short document attempted to allocate the supervision of internationally active banks between host and home countries. The responsibility for the solvency and liquidity of the subsidiary of a foreign bank would rest on the host country. The liquidity of foreign branches -which are considered an integral part of the parent bank, unlike the subsidiary- would be the responsibility of the parent bank. The Concordat also strongly emphasized the need for coordination and cooperation between national regulators, in order to ensure that no bank escaped supervision.
Table 1: Main activities of the Basel Committee

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 1975</td>
<td>Basel Committee establishes guidelines for international cooperation of banking supervision of international banks. This document is known as the Basel Concordat.</td>
</tr>
<tr>
<td>July 1988</td>
<td>Adoption of the Accord on the International Convergence of Prudential Ratios (&quot;Capital Accord&quot;). The 1988 version of the Accord is known as Basel I.</td>
</tr>
<tr>
<td>December 1992</td>
<td>Deadline for full implementation of Basel I.</td>
</tr>
<tr>
<td>January 1996</td>
<td>Amendment to extend the Accord to include market risk.</td>
</tr>
<tr>
<td>September 1997</td>
<td>Publication of the Core Principles for Effective Banking Supervision.</td>
</tr>
<tr>
<td>April 2003</td>
<td>Publication of third consultative document finalizing propositions for the reform of Basel I.</td>
</tr>
<tr>
<td>June 2004</td>
<td>Publication of revised Accord (&quot;Basel II&quot;)</td>
</tr>
<tr>
<td>December 2006</td>
<td>Deadline for full implementation of Basel II</td>
</tr>
</tbody>
</table>

However, the fraudulent failures of the German bank Schröder, Münchmeyer und Hengst (SMH) and of the Italian bank Ambrosiano SpA in 1983 prompted the revision of the 1975 Concordat, as these two cases highlighted the weakness of the division of supervisory responsibilities outlined in that document. The failure of Ambrosiano SpA in particular was a clear illustration of the regulatory loopholes that could be created by differing national definitions of banks. The 1983 amendement of the Concordat, BIS (1983), proposed that banking authorities disclose whether the branch/subsidiary of a foreign bank is actually subject to their supervision. Following the publication of the 1983 Concordat, the activities of the Basel Committee concentrated mainly on the establishment of international capital adequacy standards, with great emphasis on the quantitative aspects of banking regulation. These culminated in 1988 with the adoption by the G-10 countries of the Accord on the International Convergence of Capital Measurements and Capital Standards (Capital Accord), whose cornerstone is a capital adequacy measurement framework.

The 1988 Basel Capital Accord (Basel I) instituted a target ratio for capital provisions, a thorough description of the constituents of capital, and a set of risk weights that should be used to calculate the overall risk of a bank’s loans portfolio. The minimum capital requirements for a bank are defined by the ratio of its capital provisions to its risk-weighted loans portfolio. This solvency ratio-sometimes referred to as the Cooke ratio—must be at least equal to 8 per cent. Capital provisions are composed by core capital, or Tier 1 capital, and supplementary capital, also known as Tier 2 capital. Tier 1 capital comprises
the bank’s basic equity - ordinary shares/common stock and perpetual non-cumulative preferred stock- and published reserves from post-tax earnings. The core capital element of the ratio must represent at least 4 per cent of risk-weighted assets. Tier 2 capital includes undisclosed and revaluation reserves, general loan-losses reserves, and hybrid debt capital instruments. Clearly, the archetype of bank in the Basel Accord is an institution that has access to the stock market to raise capital and whose private shareholders own the equity. This accounts for the emphasis placed on stock market shares as a measure of core capital, and as the foundation of financial regulation. As shareholders risk losing their capital, they are thus interested in the solvency of the bank, and consequently do not allow the bank managers to take excessive credit risk.

The calculation of the risk-weighted loans portfolio is best illustrated by an example. Suppose a bank lends to the government of its home country, to a foreign government, to foreign banks, to domestic or foreign private firms, and to households. Households hold unsecured loans and mortgages. Loans to governments are usually bonds. Each type of loan has an intrinsic credit risk. It is generally accepted that loans to the bank’s government in the bank’s domestic currency are risk-free. Loans to foreign governments incur exchange rate risk, which can lead to default. The loan and its repayments are usually in the bank’s domestic currency. The foreign government’s income, from which repayments are made, is not in the bank’s domestic currency. A devaluation of the foreign government’s national currency can increase the value of repayments to the point of default. Loans to private firms and unsecured loans to households have approximately the same degree of default risk. Finally, mortgages have a lower level of credit risk because properties can be repossessed in the event of default.

Under the rules of Basel I, the overall credit risk incurred by the bank is the sum of these loans, weighted by their respective levels of risk. The risk associated with domestic and OECD governments’ loans is 0 per cent. The risk of non-OECD foreign government and private sector loans (domestic or foreign firms and households) is 100 per cent. The risk weight of inter-bank loans depends on the origin of the bank and the maturity of the loan. If the borrowing bank is incorporated in an OECD country, the risk weight of its loan is 20 per cent, irrespective of its maturity. If the borrowing bank operates in a non-OECD country, loans that have to be repaid in less than one year (short-term) incur a 20 per cent risk. Longer term loans to be repaid in more than one year are subject to 100 per cent risk weight. The rationale underlying this rule is that the longer the repayment period, the higher the probability of default. The risk of mortgages is 50 per cent. The capital provisions of this bank will thus have to be at least 8 per cent of the following sum:

$$0\% \times (\text{domestic government bond} + \text{OECD government bond}) + 100\% \times (\text{non-OECD government bond} + \text{non-OECD interbank long-term loans} + \text{loans to firms} + \text{unsecured household loans}) + 50\% \times (\text{mortgages}) + 20\% \times (\text{OECD interbank loans} + \text{non-OECD interbank short-term loans})$$
2.1.1 The risk weight structure of Basel I

The main objective of Basel I was the establishment of a set of principles and commonly agreed definitions of regulatory capital. The Basel Committee opted for a framework that was straightforward and easy to implement, based on the 8% ratio and on a small number of risk categories. Its implementation could be adapted at the discretion of national regulators, e.g., the zero risk-weight could become 20% or 50%. However, as a direct consequence of the simplistic risk weight structure banks could engage in regulatory capital arbitrage and thus take risks uncovered by their capital provisions.

First, the regulation of credit risk was considered but not that of market or operational risks. Market risk refers to the risk caused by changes in market prices, e.g., equity prices, interest and exchange rates, commodity prices. This omission could lead to a misapprehension of risk. For instance, an OECD 30-year bond (with a 0 percent risk weight) carries a higher interest rate risk than a one year loan to a private firm (with a 100 percent risk weight). The 1996 Amendment of Basel I covered market risk specifically (see BIS, 1996). Second, Basel I overlooked the risk-reducing benefits of portfolio diversification in its assessment of credit risk weights. So, although risk diversification of a loans portfolio can bring a reduction in actual risk, it does not imply a reduction in capital provisions under Basel I. A bank lending £1 million to 500 private firms incurs less credit risk than a bank lending to £500 million to 2 firms. The risk weights used to compute capital provisions, however, are identical. A similar remark can be made regarding geographical risk diversification, which is also not rewarded under either Basel I or Basel II, as will be seen below.

Finally, risk weights under Basel I were determined rather crudely according to membership to the OECD or loan maturity. Loans to Mexico and Turkey would entail a 0 percent risk weight, since both are members of the OECD, whereas loans to Brazil and Venezuela would incur a 100 percent risk weight. However, in terms of country risk, as measured by risk rating agencies, all countries are in a similar risk category. In 2002 Moody’s classified Mexico’s and Brazil’s foreign bonds as B2 and Baa2, respectively, while Turkey’s and Venezuela’s foreign bonds were rated B1 and B3. Short-term loans maturing in less than 1 year were given a 20 percent weight, irrespective of the nationality of the borrower, whereas loans to non-OECD borrowers with a longer maturity fell into the 100 percent category.

The 1997 Asian Crisis exposed the intrinsic weakness of Basel I’s fixed risk weights structure in such a spectacular way that the Bureau of International Settlements (BIS) set up a working group led by R. Bonte in 1998 to investigate the causes of this financial crisis. One of its specific task was to determine the extent to which the crisis could be attributed to the Basel Capital Accord. The ensuing publication, BIS (1999), found disturbing evidence of a very high proportion of interbank and short-term lending to Asia. From December 1993 to June 1997, loans from banks reporting to the BIS to the 5 worst affected countries, Indonesia, Korea, Malaysia, Philippines and Thailand, rose by 134%. In June 1997, 64% of the loans to Indonesia, Korea, Malaysia, Philippines and Thailand
and 77% of the loans to these countries plus China, Hong Kong, Singapore and Taiwan had a maturity of less than a year. 61% of the loans to these 9 countries were interbank. These facts prompted suggestions that the lending pattern of the G-10 banks were influenced by the rules of the 1988 Capital Accord. The authors of BIS (1999) ran several tests of this hypothesis but could not find conclusive evidence in its favour.

2.1.2 Basel II

In 1999, the BIS published a consultative paper introducing a revised capital adequacy framework. The ensuing negotiations by the G-10 countries concluded with the adoption of the Capital Accord of 2004 (Basel II). The final version of the proposed capital framework rests on three pillars: minimum capital requirements, which seek to refine the standardised rules set forth in the 1988 Accord; supervisory review of an institution’s internal assessment process and capital adequacy; and effective use of disclosure to strengthen market discipline as a complement to supervisory efforts. We summarize the main aspects of each pillar, with emphasis on the capital adequacy requirements.

Pillar 1: Minimum capital requirements

Basel II introduced a flexible risk-weight structure, whose aim is to closely match regulatory and actual risks. First, market and operational risks had to be covered for by 0.4 percent and 1.6 percent of the sum of Tier 1 and Tier 2 capital, respectively. Credit risk would have to be covered by 6 percent of the sum of Tier 1 and Tier 2 capital. Second, Basel II allowed two basic approaches to calculate risk weights, the standardized and the internal ratings (IRB). The first is quite similar in essence to Basel I, in that it consists of fixed weights to be applied to each category of credit risk. The novelty under Basel II is that the weights depend more on the borrower credit rating, as defined by rating agencies such as Standard&Poor or Moody’s, than on membership of international organisations. Table 2 shows the weights under the standardized approach, which we reproduce from BIS (2004). In its documents the BIS used Standard&Poor ratings for illustrative purposes.

In Table 2 we only show the risk weights for sovereigns and banks under Option 2. Under Option 1, inter-bank loans are subject to the same risk weights of loans to the sovereign of the country where they are operating. So, under Option 1, a loan to a bank whose main branch is in an OECD country would be subject to a zero risk weight. A loan to a bank in a country whose sovereign bonds are rated BBB+ to BBB-, would be subject to a 50% risk weight.

The great innovation of Basel II is the possibility of capital adequacy requirements varying more closely with the changes in a bank’s portfolio risk. To achieve this flexibility, banks are required to explicitly estimate the determinants of a loan’s riskiness. They then have to compute their own risk weights and thus their own regulatory capital provisions, within a pre-defined framework (internal ratings based or IRB approach). The IRB is then subdivided into two options, foundation and advanced.
Table 2: 2004 Basel Capital Accord-Standardised Approach

<table>
<thead>
<tr>
<th>Credit assessment</th>
<th>Claims on sovereigns and their central banks</th>
<th>Claims on banks Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AAA to AA-</td>
<td>A+ to A-</td>
</tr>
<tr>
<td>Risk weight</td>
<td>0%</td>
<td>20%</td>
</tr>
<tr>
<td>Risk weight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long term</td>
<td>20%</td>
<td>50%</td>
</tr>
<tr>
<td>Short term</td>
<td>20%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Sources: BIS (2004, p. 15), and BIS (2004, p. 18)

The risk weights under the IRB approach are based on the borrower’s probability of default ($PD$), which in turn depends on the maturity of the loan ($M$). The IRB also introduces two new elements in the calculation of risk weights. First, the exposure at default ($EAD$), which is the amount the bank may lose if the borrower default, and second, the loss given default ($LGD$), i.e., the percentage of the amount actually lost if a default occurs. $LGD$ is equal to 1 minus the recovery rate. All these variables are inserted into a fixed formula yielding the necessary regulatory capital (see BIS, 2005).

Under the foundation option of the IRB, banks only calculate their own $PD$, whilst the regulator provides the corresponding risk weights. The Annex 3 of BIS (2004) presents an illustrative table showing the risk weights for different categories of borrowers, for a loan with a maturity of 2.5 years, and several $LGD$s (45 percent, 85 percent, and 25 percent). Individual countries’ regulators are expected to produce analogous tables for the use of their domestic banks. Under the advanced option of the IRB, banks calculate the probabilities of default, the loss given default and the exposure at default. In addition, an estimate of loan maturity should be given.

A bank will have to satisfy minimum conditions to be allowed to use the internal ratings approach. They must have at least 2 years of data on probabilities of default ($PD$), and at least 7 years of data for loss given default ($LGD$), although they would be encouraged to consider a data covering a whole business cycle. This condition attempts to tone down the criticism that Basel II is more pro-cyclical than Basel I. Moreover, banks may use $LGD$ data from credit rating agencies, which, according to claims of these agencies, are immune to influences from business cycles. Finally, BIS (2004) recommends that banks develop a whole risk management system before being allowed to use foundation IRB. BIS (2005) is a non-technical note presenting the mathematical formulae of the IRB approach, which are reproduced in the Appendix A.

Pillar 2: Supervisory surveillance
Pillar 2 summarizes the extensive guidelines set up in BIS (1997) into four key principles. The following responsibilities of national regulators are identified in BIS (2004, p.159):

1. Encourage banks to develop the appropriate methodology to determine and the strategy to maintain capital adequacy ratios.

2. Evaluate banks’ internal assessments of their overall risks.

3. Evaluate the activities and risk profiles of individual banks to determine whether those banks should have higher/lower levels of capital than the minimum requirements in Pillar 1.

4. Ensure that banks operate above the minimum capital requirements.

No explicit detail on how supervisors should behave were proposed in BIS (2004). However, the Basel Commitee has recently emphasised the importance of stress testing for banks adopting the IRB approach. During the consultative process, the Basel Committee published several stress testing exercises carried out by its members. A stress test computes how much a bank’s portfolio would lose under different scenarios. In a test carried out by the Bank of England, for instance, the scenarios are a decline of 35 percent in world and UK equity prices, a decline of 12 percent in UK commercial and house prices, and a 15 percent depreciation in trade-weighted sterling exchange rate (see Hoggarth, Logan, and Zicchino, 2005). A study by the Central Bank of Brazil, Barbedo, Araújo, Moreira, and Clemente (2005), evaluates the impact of exchange rate risk on banks’ portfolios in Brazil under the Basel II standardised approach and the IRB assessment. The latter considers 4 risk assessment models. Regarding the comparison between the two approaches proposed in BIS (2004), the paper concludes that the capital requirements of Brazilian banks would be lower under the VaR (Value at Risk) model.

**Pillar 3: Market discipline**

The third pillar concerns mostly banks’ public reporting. Banks should provide frequent and transparent information on their risk exposure, their capital adequacy levels and their methods for computing capital requirements.

### 2.1.3 Evaluation of Basel II

The deadline for full implementation of the revised regulatory rules for the G-10 countries is December 2006. It is thus not possible to evaluate its impacts on the G-10 financial sectors. However, we can mention several criticisms that were made to the revised accord during the 5 years consultative process. Most related to the adverse impacts the new capital requirements would have on small and medium firms, emerging markets, banking sector competition and business cycle. And most were either hypothetical or inferred from the Basel I experience.
Jackson et al. (1999) investigated the impacts of Basel I on the banking sectors of the G-10 countries. This paper found evidence of an increase of capital ratios between 1988 and 1996 in most countries, with the exception of France, Germany, Japan, Netherlands and Switzerland. In these three countries capital ratios tended to remain relatively stable over the whole period. The greatest increments were observed in Belgium, Canada, Italy, Luxemburg, Spain, Sweden, UK and US. Jackson et al. (1999) noted that the rise in capital ratios resulted from a combination of banks raising new capital and reducing the volume of riskier loans. A credit crunch for riskier borrowers, i.e., small firms and countries rated BB and below is thus expected.

Two more serious criticisms relate, first, to the oversight of the risk-reducing effects of portfolio diversification on the calculation of capital adequacy requirements, and second, to the fact that Basel II’s capital adequacy framework is inherently pro-cyclical. The first was mentioned above, in the context of Basel I, but it remains regarding Basel II. As most of the literature on this topic is related to developing countries, we will develop this point below.

The essentially pro-cyclical nature of Basel II permutes all the aspects of its capital adequacy framework. The standardised approach is explicitly based on credit ratings, which are suspected of moving with the economic cycle. Although credit rating agencies deny this fact, Amato and Furfine (2004) find evidence that the creditworthiness of firms tend to be downgraded during economic downturns and upgraded during economic booms. More specifically, the authors find that although ratings are not systematically downgraded during recessions, a downgrade is more likely than an upgrade when a rating revision coincides with an economic downturn. Under Basel II, a downgrade will immediately imply an increase in risk weights and hence of capital requirements. Since raising capital is costly, banks prefer to minimise their capital requirements. This can lead to a restriction of credit for downgraded firms, which in turn can intensify the economic downturn. An analogous argument applies to internal ratings, which are constructed on probability distributions of defaults that depend on credit ratings. Goodhart and Segoviano (2004) conducted simulations of the changes in hypothetical portfolios of 1000 banks for the U.S., Norway and Mexico from 1982 to 2003. Their results strongly suggest that the adoption of the IRB framework over this period would have raised the pro-cyclicality of bank lending in those countries.

On a more general note, it should be mentioned that capital adequacy ratios are not universally viewed as the cornerstone of financial stability. Some, such as Stiglitz (2001), argue that a bank subject to higher regulatory capital requirements will look for higher returns to offset its higher costs, and in the process engage in increased risk-taking. There is also a consensus among policy analysts that creating effective regulatory institutions in developing countries would have a greater impact on their financial stability than introducing capital adequacy requirements. We survey this literature in section 2.2 below. A literature review on the issue of regulation and risk-taking can be found in Stolz (2002) and Jackson et al. (1999).
2.2 Impact of the Basel Capital Accord on developing countries

The Basel Capital Accord was mainly aimed at internationally active banks, few of which can be found in developing countries and emerging markets. However, an increasing number of countries are adopting the Basel capital standards, with direct consequences on their domestic provision of credit. For the most part, developing countries are affected by the Accords through their effects on international capital flows.

Regarding the macroeconomic impacts on countries adopting Basel I or II, there is a belief among some researchers that capital requirements will not improve the stability of domestic financial sectors, and may even deteriorate it. de Juan (1996), for instance, remarks that although most Latin American countries adopted Basel I capital standards in the 1990s, some also experienced severe banking crisis during that decade. Rojas-Suárez (forthcoming), on the other hand, shows that changes in equity—the core of capital adequacy requirements under Basel I and II—are a poor indicator of the occurrence of a banking crisis. Real net equity increased by nearly 20 percent in Malaysia, Mexico and Thailand in the year preceding the Mexican and Asian Crisis, whereas real net equity decreased by approximately 20 percent in Norway and Sweden in 1991, a year before the Nordic financial crisis.

Caprio and Honohan (1999); Barth, Caprio, and Levine (2001); Powell (2004), amongst others, thus see deficient regulation as a more important determinant of banking crisis than the lack of adequate capital provisions. Caprio and Honohan (1999) argue that in all countries supervisors are generally less well-paid than bankers, but that it is markedly so in developing countries, where the problem of retention of skilled supervisors in regulatory agencies is particularly acute. In this context, as Powell (2004) suggests, adopting the more sophisticated risk weight measurements proposed in Basel II will allow banks to easily bypass supervision. Powell (2004)’s main conclusion is that compliance with the so-called ”Core Principles” should be a pre-requisite for the adoption of Basel II.

The ”Core Principles” are guidelines for the regulation of banking activity. They were put out in an intricate document published by the Basle Committee, BIS (1997), and were meant to be a set of supervisory principles that could be adopted by any country, irrespective of the sophistication of its banking industry. Some were summed up in Pillar 2 of the 2004 Capital Accord. A recent empirical study by Podpiera (2004) examines the relationship between banking sector performance and the quality of regulation and supervision, as measured by compliance with the Core Principles. The basic question the author addresses is whether following the Core Principles creates a regulatory and supervisory environment that helps improve banking sector performance. Two of the common measures of banking sector performance are used: nonperforming loans (NPL) and net interest margins (NIM). A high level of NPLs is usually considered an indication of serious problems in the banking sector. Net interest margins are interpreted as a measure of efficiency, since they are an indicator of the cost of banking intermediation paid by customers. An econometric model for NPL and an econometric model for net interest margins are estimated as panels of 65 countries from 1998 to 2002. Podpiera (2004) finds
that compliance of Basel Core Principles decreases the share of nonperforming loans in total loans and decreases the net interest margins. Nonetheless, a recent survey of financial standards of the member countries of the IMF and the World Bank indicates that only 50 percent of them comply with 1/3 of the Core Principles set up in BIS (1997) (see International Monetary Fund and World Bank, 2002).

A very incipient research focuses on the effects the adoption of the Basel Capital Accords could have on the provision of domestic credit for the private sector in developing countries. Barajas, Chami, and Cosimano (2005) investigate whether the adoption of Basel I in Latin America caused a reduction of lending throughout the continent between 1987 and 2000. 22 out of the 24 Latin American countries adopted Basel I between 1991 and 1997. Their empirical results show that most countries of the region experienced a credit slowdown during that period, and that there is evidence-albeit weak- that Basel I was a contributing factor. Segoviano and Lowe (2002) show that the adoption of internal ratings by Mexican banks would have sharply increased the capital requirements for corporate credit risk in the 1990s. A recent investigation of the compliance of financial prudential regulation in Brazil, Gottschalk and Sodré (forthcoming), indicates that the adoption of Basel I in 1994 has lead to a credit crunch in the private sector. Brazilian banks appear to have adjusted their capital requirements by increasing their risk-free, 0 percent risk weight loans to the federal government, in detriment to financing private firms.

There have been more studies on the impacts of Basel II on capital flows to developing countries, some of which is surveyed in Daoud (2003). This growing literature points to the negative effects the adoption of the new risk weights could have on international capital flows to these countries. Griffith-Jones, Spratt, and Segoviano (2002a), Griffith-Jones, Spratt, and Segoviano (2002b) and Weder and Wedow (2002) argue that Basel II could lead to an international credit crunch for developing countries and emerging markets, due to a combination of reduced volumes of credit and the increase in the pricing of loans, as regulatory capital requirements may feed through international lending rates.

The new risk weights presented in Table 2 have direct consequences for Mexico and Turkey, for instance. As members of the OECD, the governments of both countries were subject to a 0 per cent risk weight under Basel I, but now incur a 100 per cent risk weight, since their sovereign bonds are rated Baa2 in Moody’s Investors Services (2003)\(^5\), which corresponds to BB+ in the Standard&Poor’s classification used in BIS (2004). The second aspect highlighted by Table 2 is that at all levels of credit ratings except AAA to AA- long-term bank loans are subject to higher risk weights than short-term loans. Since most developing countries are normally rated below BBB (Moody’s Investors Services, 2003), an immediate implication of the new rules is that international banks may choose to increase their capital ratios in detriment to long-term financial commitment in developing countries. Long-term investments are universally considered more conducive to economic development than short-term, speculative investments.

Few would argue that international financial instability is beneficial to economic development. In addition, few would reject the proposition that Basel I’s fixed risk weights
structure may have induced a risk-taking behaviour by international lenders. However, Griffith-Jones, Spratt, and Segoviano (2002a) and Griffith-Jones, Spratt, and Segoviano (2002b) show that the capital adequacy frameworks of the second Capital Accord require internationally active banks to make higher capital provisions than would be theoretically justified. This criticism applied to Basel I as well, since both versions of the Capital Accord fail to take into consideration the risk-reducing effects of portfolio diversification. Since investing in different assets reduces the overall risk of a portfolio, it should be expected that an internationally diversified loans portfolio has less risk exposure than a portfolio concentrated in one geographical area. Hence, according to Griffith-Jones, Spratt, and Segoviano (2002b), the regulatory capital associated with a diversified portfolio should be lower.

The latest publication of the Basel Committee, BIS (2005), rejects any suggestion that regulatory capital should be sensitive to portfolio diversification. The following excerpt, taken from (see BIS, 2005, p. 4), illustrates the point,

The model should be **portfolio-invariant**, i.e., the capital required for any given loan should only depend on the risk of that loan, and must not depend on the portfolio it is added to. Taking into account the actual portfolio composition when determining capital for each loan-as is done in more advanced credit portfolio models- would have been a too complex task for most banks and supervisors alike. [..] As a result, the Revised Framework was calibrated to well diversified banks.

The arguments supporting the Basel Committee’s decision are interesting. First, as Kjersti (2005) remarks, the model underpinning the Basel II IRB approach is far less sophisticated than the credit risk models currently in use in the banking industry. Second, the proposition that bank-level diversification can be a substitute for portfolio diversification is unusual. However, as the Basel Committee itself acknowledges that the IRB is a work-in-progress, its position on portfolio diversification may change in the future (BIS, 2004, see).

### 3 The model

In section 3.1 we present the key elements of the Brazilian and Mexican financial sectors, which will be included in the existing NiGEM models of these two countries. The financial equations for the two countries will be described in section 3.2. The National Institute’s Global Econometric Model, NiGEM, is presented in detail in Barrell, Dury, Hurst, and Pain (2000), Barrell and Dury (2000), Barrell, Byrne, and Dury (2003), Barrell and Pina (2004), and Barrell, Holland, Choy, and Gottschalk (2002), amongst others.

#### 3.1 Financial sector in Brazil and Mexico

Figure 1 shows the solvency ratios of Brazil, Mexico and the OECD average, excluding Mexico. We have included for comparison the Basel solvency ratio. Clearly, the capital
requirements of all the countries considered in the figure are well above the Basel minimum. The solvency ratio for the OECD rises sharply from 9.5 percent in 1991 to 12.5 percent in 1992, and fluctuates around this value over the sample period (1991-2001). It declined slowly from 1992 onwards to about 11 percent in the year of the Asian Crisis (1997) and has been increasing ever since. The ratio for Mexico was below the Basel minimum in 1991, and increased steadily until 1999. A very sharp rise occurred right after the Mexican Crisis, from 9.5 percent in 1994 to approximately 13 percent in 1998, and again right after the Russian Crisis, when the capital adequacy ratio reached 16 percent.

The minimum solvency ratio for Brazil was set at 8 percent by the Central Bank after the adoption of Basel I in 1994 and to 11 percent in 1997. A 1996 amendment required banks to make capital provisions for interest rate and exchange rate risk, with consequent changes to be implemented until 2000. In 1999 the Brazilian Central Bank published an official classification of credit into nine risk levels with associated risk weights. Figure 1 reflects these developments. First, it should be noted that the data prior to 2000 concern only the 5 biggest Brazilian banks, whose assets represent 24.75 percent of the assets of the whole sector. Data on solvency ratios for the whole banking sector are only available from March 2001. In 1995 these 5 banks had a solvency ratio of 10 percent. It increased to 17 percent in the aftermath of the Mexican Crisis, but declined steadily thereafter. A new step change occurs from 2001 onwards, partly because the 1996 amendment mentioned above came into force. Banks started making capital provisions for interest rate risk and the capital adequacy ratio of the whole sector increased as a result. The recapitalization
of failing state-owned banks by the government started in 1996, which may also account for this rise in capital adequacy ratio (Salviano Junior, 2004).

Brazil

Figure 2 shows the spread of Brazilian sovereign bonds over US Treasury bonds, along with the annual inflation rate calculated quarter-on-quarter, and the short-term interest rate. The spread is in percentage points and graphed on the right-hand y-axis, whereas the interest and the inflation rates are graphed in percent against the left-hand y-axis. A spread on sovereign bonds is the difference in percentage points between the interest rate paid by the issuing government and the interest rate paid by the US government. Since US government bonds are considered risk-free, spreads on sovereign bonds are thus a measure of the risk inherent to a certain country. Figure 2 shows a weak declining trend in the spread over the decade 1995-2005, from 1500 percentage points in 1995 to less than 500 in 2004. This indicates that the “Brazil risk” has declined over this period. Several explanations can be offered. The stabilisation plan of 1994 has been successful in reducing annual inflation rate from 2084 percent in 1993 to 403 percent in 1994q1 (not shown on the figure) and 81 percent in 1995q2. The main macroeconomic indicators for the period, shown in Table 3 point to moderate GDP growth, around 4 percent over 1996-2004, and government deficit was kept below 4 percent of GDP. The Russian Crisis in 1998 had a strong impact on the perception of the ”Brazil risk”, with a surge in the spread in the third quarter of the year. The huge increase in spread in the last quarter of 2002 can be accounted for by the results of the presidential election of November 2002, which brought to power a left-wing political party. The newly-elected government pursued a moderate policy, and guaranteed the independence of the central bank in the management of the inflation target regime. This reassured international investors and sovereign spread declined accordingly.

Finally, the interest rate decreased noticeably over the decade, from around 60 percent per annum in 1995 to less than 20 percent per annum in 2004. This fall reflects the success of the inflation moderation policy. The short-term interest rate rose sharply in 1997 and 1998, as a result of the Asian and Russian Crisis and their consequent speculative attacks on the Brazilian exchange rate, and again in 2003, following an acceleration of inflationary pressures. The annual average change in private consumption deflator shown in Table 3 reached 10.6 percent in 2003-2004, from an annual average of 8.5 percent in 2002.

Figure 3 presents the evolution of domestic credit in Brazil, by category of borrowers, as a ratio of GDP, from 1997 to 2005. Total domestic credit rises from 50 percent to 80 percent of GDP. Most of the rise can be attributed to the increase in government lending, which took off in the second half of 1997. After the Russian Crisis, lending to central government rose rapidly to 30 percent of GDP, but slowly increased to 40 percent of GDP from then onwards. Private sector credit, which includes household borrowing, fluctuated around 30 percent of GDP over the period. The participation of state-owned firms in banking finance remained very low over the period, with a declining trend.
Figure 2: Interest rate, inflation and spread - Brazil

Figure 3: Recipients of domestic credit - Brazil
Table 3: Main macroeconomic variables (1997-2004)- Brazil

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(a): percent of GDP. (b): in percent. NA: not available. Sources: See Appendix B.

Mexico

Figure 4 shows the spread of Mexican sovereign bonds over US Treasury bonds, along with the annual inflation rate calculated quarter-on-quarter, and the short-term interest rate. As above, the spread is graphed against the right-hand y-axis, whereas the interest and the inflation rates are graphed in percent against the left-hand y-axis. Unlike the spread on Brazilian bonds, the spread of Mexican bonds presents a very strong declining trend over the decade 1995-2005, with the exception of the surge in 1998, which resulted from contagion during the Russian Crisis. Interestingly, the Asian Crisis has very little impact, if any on the risk of Mexican bonds.

Figures 5 and 6 highlight several aspects of the credit sector in Mexico between 1997q1 and 2004q4. Figure 5 presents two complementary views of domestic and foreign credit to the private sector, as a percentage of total credit and as a percentage of GDP. The former is graphed on the left-hand y-axis, the latter against the right-hand y-axis. Total
Figure 4: Interest rate, inflation and spread - Mexico

Figure 5: Sources of loans to private sector - Mexico
Table 4: Main macroeconomic variables (1997-2004)- Mexico

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(a): percent of GDP. (b): in percent. NA: not available. Sources: See Appendix B.

Credit to the private sector represented approximately 30 percent of GDP over the period, a much lower ratio than in Brazil. This discrepancy illustrates the difference between the development of the financial sectors in these two countries. Legal restrictions were placed on the expansion of the Mexican banking sector in the 1980s, whereas the Brazilian banking sector was encouraged to develop by the government. Foreign loans amounted to less than 10 percent of GDP and remained largely unaffected by the Asian crisis. Moreover, the share of foreign credit in total credit rose noticeably over the period, from 20 percent in 1997 to 30 percent in 2004, reflecting the continuous increase in the confidence of international investors. Nonetheless, the bulk of banking credit to the private sector was provided by domestic institutions. Data from the Central Bank of Mexico not shown in the figure suggest that firms were the major recipient of banking credit, receiving about 79 percent of total loans over the period. Household borrowing amounted to approximately 21 percent of total loans to the private sector, and to 5 percent of GDP. Figure 6 cast some light on the institutional sources of loans in Mexico. The participation of commercial banks decreased from around 80 per cent in 1997 to 55 per cent in 2004q1, to the benefit of financial intermediaries like savings-and-loans institutions or cooperatives...
("non-banks" in Figure 6). Issues of debt instruments increased in recent years, whilst financing from development banks decreased concomittantly.

3.2 Financial equations of Brazilian and Mexican blocks in NiGEM

This section presents the financial equations of the Brazilian and Mexican blocks of NiGEM, and those that have been modified to include financial variables, in particular, private investment and consumption, government consumption and government investment. The current version of the two blocks is a backward-looking aggregate-demand aggregate-supply model. Expectations are treated implicitly by the inclusion of current and lagged values of the variables. In NiGEM, all national accounts variables are in constant prices, whilst personal sector variables are in current prices. This setting was kept for the model of Mexico. However, this was not possible for the Brazilian model. As was mentioned above the Brazilian inflation rate plummeted from 2084% per annum in 1994 to 400% per annum in 1995, and averaged 7% per annum in 2004. Given these wide fluctuations in the past 10 years, we opted for eliminating the effects of price changes in the model. So, national accounts, personal sector and financial variables were deflated in the Brazilian model. For instance, the change in the log of domestic credit to firms, $\Delta \ln b_{\text{sf}}$, should be read as the change in the log of $b_{\text{sf}} / b_{\text{cred}}$. The exceptions were the spread on Brazilian sovereign bonds, and, naturally, the nominal interest rates. The main implication of this modelling choice was that the inflation rate was not used as an independent variable in the equations of the Brazilian block.
As was seen above, the spread on sovereign bonds is used by international investors as a measure of the riskiness of a country. As such, it has a direct impact on international credit to Brazil and Mexico. There is a vast literature on the determinants of emerging market spreads that is reviewed in Rowland and Trespalacios (2004). Their follow-up paper, Rowland (2004), estimated a panel of 49 emerging countries rated $B^-$ or higher. Their results show that GDP per capita, GDP and the inflation rate were the main explanatory variables of sovereign spreads. Eichengreen and Mody (1998) found that variables such as high credit quality, foreign reserves, debt service and GDP growth contribute to lower the spread of sovereign bonds. Government deficit on the contrary has a negative impact on spread.

We have estimated the sovereign spreads of Brazil and Mexico individually, as functions of the inflation rate, the interest rate, and dummies for the Mexican and Asian Crisis. A variable capturing economic growth was included. In the case of Mexico, we found that an increase in export volumes reduces sovereign spread. It should be remembered that the sovereign spreads of emerging markets’ bonds reflect country risk. So, variables indicating an increase in country risk such as higher inflation or lower GDP growth, are expected to raise the spread.

$$
\Delta \text{brrsprd}_t = 4.5443 - 0.68265 \times [\text{brrsprd}_{t-1} - 1.9768 \times \text{brrr}_{t-1}] \\
+ 16.6614 \times \Delta \text{brced}_{t-1} + 0.86898 \times \Delta \text{bry}_{t-1} - 0.36514 \times \text{d97q4} + 0.6779 \times \text{d98q3} \\
- 0.4978 \times \text{d0301} \\
$$

(1)

$$
\Delta \text{lmxsprd}_t = 3.8318 - 0.71145 \times \text{lmxsprd}_{t-1} + 0.03346 \times \text{mxr3mt}_{t-1} \\
- 4.9817 \times \Delta \text{lmcxced}_{t-1} - 0.86146 \times \Delta \text{lmcxxvol}_{t} + 0.86472 \times \text{d95q1} \\
+ 0.59044 \times \text{d98q4} \\
$$

(2)

$$
R^2 = 0.32, \sigma = 0.3, DW = 1.69, LM(4) = 2.08. \text{ Sample: } 1996q1-2003q4. \text{ r}_{rt} \text{ is the real short-term interest rate, } \Delta \text{brced}_{t-1}, \text{ the consumer expenditure inflation, } \Delta \text{bry}_{t}, \text{ real GDP growth rate. The terms in brackets are the t-ratio tests, in this and in all equations below.}

\text{ r}_{3mt} \text{ is the nominal short-term interest rate, } \Delta \text{lced}_{t-1}, \text{ the consumer expenditure infla-}

\text{22}
tion, $\Delta lxvol_t$, the growth rate of exports.

Loans

Foreign loans to firms

$$
\Delta lbrlnsf_t = 0.731 - 0.20214 \frac{lbrlnsf_{t-1}}{bry_{t-1}} + 0.36585 \Delta lbrxvol_t - 0.11272 \Delta lbrssprd_{t-1} + 0.093586 d97q4 \\
- 0.20214 \frac{lbrlnsf_{t-1}}{bry_{t-1}} (2.63)
$$

$R^2 = 0.66$, $\sigma = 0.1$, $DW = 2.52$, $LM(4) = 5.30$. Sample: 1996q1-2001q4.

$lbrlnsf$ is the log of the foreign loans to private firms, $lmxy$ the log of GDP, $lbrxvol$, the log of export volumes, $wdkindex$, the capital adequacy ratio of OECD banks and $brssprd$ the spread of Brazilian sovereign bonds.

$$
\Delta lmxlnsf_t = 11.45 - 0.26816 \frac{lmxlnsf_{t-1}}{lmxy_{t-1}} - (-0.64922) wdkindex_{t-4} - (-5.5092) lmxvol_{t-1} - (-0.0033264) mxssprd_{t-1} \\
- (-0.023547) bry_{t-1} (3.33) - (-0.0086556) bry_{t-1} (2.68) (3.35) (3.58) (1.68) (1.89)
$$

$lmxlnsf$ is the log of the foreign loans to private firms, $lmxy$ the log of GDP, $lmxvol$, the log of export volumes, $wdkindex$, the capital adequacy ratio of OECD banks and $mxssprd$ the spread of Mexican sovereign bonds. Equations 3 and 4 reflect the fact that in equilibrium foreign loans to firms as a ratio of GDP should grow in line with exports, which we use as a proxy for the performance of the private sector. As a direct consequence of the Basel Capital Accord, foreign loans should be negatively affected by the capital adequacy requirements of lending banks, and by sovereign risk.

Domestic loans to firms

$$
\Delta lbrlnsdf_t = 2.0352 - 0.45514 \frac{lbrlnsdf_{t-1}}{bry_{t-1}} - (-0.023547) brkindex_{t-4} - (-0.0086556) brsprda_{t-1} \\
- (-0.0086556) brsprda_{t-1} (3.35) (3.58) (1.68) (1.89)
$$
$lbrlsnd$ is the log of the domestic loans to private firms, $lbrip$ the log of industrial production, $lbrmvol$, the log of import volumes, $brkindex$, the capital adequacy ratio of Brazilian banks.

\[
\Delta lmlxnsdf_t = 1.2387 - 0.14352 * \left( \frac{lmlxnsdf_{t-1}}{mxy_{t-1}} \right) - (-0.12563) * mxkindex_{t-4} \\
- (-0.70705) * lmxmvol_{t-1} + 0.39399 * \Delta lmxip_{t-2} - 0.056241 * d^{99q3}
\]

$lmlxnsdf$ is the log of the domestic loans to private firms, $lmxip$ the log of industrial production, $lmxmvol$, the log of import volumes, $mxkindex$, the capital adequacy ratio of Mexican banks. In equations 5 and 6 we see that in equilibrium domestic credit to firms as a ratio of GDP is mainly geared towards financing imports of intermediate inputs. Industrial production is included in the equation as a measure of economic performance of private firms. Capital adequacy requirements of domestic banks clearly affect domestic credit negatively.

Loans to households

\[
\Delta lbrlnsh_t = 1.8796 - 0.45097 * \left( \frac{lbrlnsh_{t-1}}{bry_{t-1}} \right) - (-0.000958) * brsprda_{t-1} \\
+ 0.094443 * \Delta lbrnw_{t-1} + 0.030877 * d^{95q1}
\]

$lbrlnsh$ is the log of the domestic loans to households, $lbrnw$ the log of net wealth. The banking spread, $brsprda$, is the difference between the lending and the deposit rate. The inclusion of the banking spread was prompted by the results of a 4-year research programme on banking costs developed by the Central Bank of Brazil. Details of this research can be found in Koyama and Nakane (2002).

\[
\Delta lmlxnsnh_t = 1.7739 - 0.087395 * \left( \frac{lmlxnsnh_{t-1}}{mxy_{t-1}} \right) - (-3.07) * mrxpdi_{t-1} \\
+ 0.3673 * \Delta lmxced_{t-1} + 0.18961 \Delta lmlxnsnh_{t-2} + 0.054278 * d^{95q1}
\]

$lmlxnsnh$ is the log of the domestic loans to households, $lmxrpdi$ the log of real disposable income, and $lmxced$ the log of the consumer expenditure deflator, the change of which

24
measures inflation. Capital adequacy requirements have no impact on personal credit in both countries, as could be expected from the fact that household borrowing as a ratio of GDP was relatively low in the 1990s. Personal income and wealth are significant variables for household credit in both countries.

Foreign loans to government

\[
\Delta \text{brlnsf}_{g_t} = 1.2245 - 0.12562 * \left( \frac{\text{lbrlnsf}_{g_{t-1}}}{\text{bry}_{t-1}} \right) - (-0.04) * \text{wdkind}_{t-1}
- (-0.018972) * \text{brssprd}_{t-1} - 0.56855 * \text{brrr}_{t-1}
- (9.8335) * d98q4 + (9.1346) * d97q1
\]

(9)

\[
\Delta \text{mxlnsf}_{g_t} = 1.7562 - 0.53179 * \left( \frac{\text{lmxlnsf}_{g_{t-2}}}{\text{mxyn}_{t-2}} \right) - (-0.04) * \text{wdkindex}_{t-2}
- (-0.54504) * \Delta \text{wdkindex}_{t-4} + (6.3129) * \Delta \text{mxssprd}_{t-1}
- 0.90844 * \Delta \text{mxlnsf}_{g_{t-2}} + (7.3994) * d98q4
\]

(10)

\text{brlnsf} and \text{mxlnsf} are foreign loans to the Brazilian and Mexican governments. This variable is the foreign component of the central government’s net borrowing necessities, which we use as a proxy for foreign lending to government. An alternative variable would be the value of the government bonds held by foreigners and foreign loans to government. The former is not available, the latter is published by the Bank for International Settlements (BIS). As expected, foreign lending to the public sectors of both countries is a negative function of the respective spreads on sovereign bonds \text{brssprd} and \text{mxssprd}.

Domestic loans to government

\[
\Delta \text{lbrlnsdg}_{t} = -16.8868 - 0.14977 * \left( \frac{\text{lbrlnsdg}_{t-1}}{\text{bry}_{t-1}} \right) - (0.99069) * (\text{brgc}_{t-1} + \text{brgi}_{t-1})
- (-0.3722) * \text{brrr}_{t-1} - (0.62871) * \text{brkindex}_{t-1}
- 0.43273 * \Delta \text{brlnsf}_{g_{t-4}} - (0.69969) * \Delta \text{brkindex}_{t-4} + (39.9065) * d97q1
\]

(11)
\[ \Delta \text{lnsdg}_t = -31.5097 - 0.98511 \left( \frac{\text{lnsdg}_{t-1}}{\text{mx}_{t-1}} \right) - (-0.0011491) * (mxgc_{t-1} + mxgi_{t-1}) \]
\[- (0.38632) * mxrr_{t-1} + 0.42887 * \Delta \text{lnsf}_{t-4} \] 

(12)

Total loans to firms and total loans to government are defined as simple algebraic sums of foreign and domestic loans.

Cost of capital

Lending rate

\[ \text{brcc}_t = 32.4997 + 1.8401 * (brkindex_{t-1} - wdkindex_{t-1}) + 0.52661 * \text{brrr}_{t-1} \]
\[- 1.0534 * (brr3m_{t-1} - usr3m_{t-1}) \] 

(13)

\[ \text{brcc}_t \] is the lending rate, \( \text{brkindex}_t \) and \( \text{wdkindex}_t \) as the equations above, and \( \text{brdepr}_t \) the deposit rate paid by Brazilian banks on domestic demand deposits.

\[ \text{mxcc}_t = 18.0964 - 0.7007 * \text{mxcc}_{t-2} + 0.8749 * \text{mxdepr}_{t-1} + 42.8434 * d95q1 \] 

(14)

where \( \text{mxcc}_t \) is the cost of borrowing, \( \text{mxkindex}_t \) the capital adequacy ratio of Mexican banks, and \( \text{mxdepr}_t \) the deposit rate paid by Mexican banks on domestic demand deposits.

User cost of capital

\[ \text{bruser}_t = 33.1408 + 3.7363 * (brkindex_{t-1} - wdkindex_{t-1}) + 0.01974 * \Delta \text{brssprd}_t \] 

(15)

where \( \text{bruser}_t \) is user cost of capital, \( \text{sprdus}_t \) the interest rate differential between Brazil and the US, \( \text{brssprd}_t \) is the spread of Brazilian sovereign bonds over US Treasury bonds, and \( d95q1 \) is a dummy equal to 1 in 1995q1.
\[
mxuser_t = -70.1956 - 0.31654 \cdot [mxuser_{t-1} - (-1.9589) \cdot sprdus_{t-1} \\
- 4.7217 \cdot mxkindex_{t-4} - 0.5141 \cdot mxssprd_{t-1}] - 7.4787 \cdot d95q1
\] 

(16)

where \(mxuser_t\) is user cost of capital, \(sprdus_t\) the interest rate differential between Mexico and the US, \(mxssprd_t\) is the spread of Mexican sovereign bonds over US Treasury bonds, and \(d95q1\) is a dummy equal to 1 in 1995q1.

GDP components

Capital requirements have a direct impact on two components of GDP, private consumption and investment. We assume that private sector investment is a function of GDP, the user cost of capital and loans. For the sake of simplicity, we exclude the emission of debt instruments, such as corporate bonds from the investment equation. The Basel capital requirements can affect investment by reducing the loans to firms, or by increasing the cost of capital.

Investment

\[
\Delta lbrpsi_t = 3.1911 - 0.09552 \cdot [\frac{lbrpsi_{t-1}}{bry_{t-1}}] + 0.47669 \cdot bruser_{t-1} \\
- (-0.0098458) \cdot brkindex_{t-1} - (-0.16464) \cdot lbrloansf_{t-1}] + 0.22957 \cdot \Delta lbrpsi_{t-2} \\
+ 0.048065 \cdot \Delta lbrloansf_t + 0.076104 \cdot d00q1
\]

(17)

where \(lbrpsi\) is the log of the capital stock, and \(lbrloansf\) are total loans to firms, i.e., the sum of domestic and foreign loans.

\[
\Delta lmxpsi_t = -0.40438 - 0.20248 \cdot [\frac{lmxpsi_{t-1}}{mxy_{t-1}}] + 0.47669 \cdot mxuser_{t-1} \\
- (0.59539) \cdot lmxloansf_{t-1}] + 1.1823 \cdot \Delta lmxvol_{t-1} + 0.051862 \cdot d95q1
\]

(18)
where $\text{lmxpsi}$ is the log of the capital stock, and $\text{lmxloansf}$ are total loans to firms, i.e., the sum of domestic and foreign loans.

Consumption

Consumption depends on real disposable income and the wealth of households. We define real disposable income as the sum of wages, transfers from government, other personal income, less income taxes, deflated by the consumer expenditure deflator. Other personal income is the sum of distributed dividends and net interest payments to households on their investments. Here, we may consider banking deposits and savings accounts as being households’ main investments. Although it may be considered simplistic, this actually captures the financial investments of most households in developing countries. Net interest payments are thus given by the interest rates paid to deposits and savings net of the interest applied to loans. Capital requirements can affect households’ net interest payments by increasing the interest rate on loans, by reducing the amounts lent to households, or by reducing the interest rates paid to deposits and savings.

\[
\Delta \text{lbrc}_t = -0.044703 -0.46632 \times \left[\frac{\text{lbrc}_{t-1}}{\text{lbrpdi}_{t-1}}\right] \\
- (-0.015522) \times (\text{lbrc}_{t-1} - \text{lnrw}_R) + 0.30212 \times \Delta \text{lbrpdi}_{t-3}
\]

(19)

$\text{lbrpdi}_t$ is the log of real disposable income, and $\text{lnrw}_t$ is the deflated net financial wealth. Household income is defined as the sum of mixed income ($\text{bri}$), compensation ($\text{brcomp}$), wages and social payments), government transfers ($\text{brtran}$), and other personal income ($\text{bropi}$). Those are the sum of dividends paid by firms to households ($\text{brdivd}$), net interest payments by households ($\text{brnip}$) and rent from land and insurance policy. The last two components of other personal income are aggregated into $\text{bropic}$. The net interest payments are the difference between interest paid by households on their domestic loans and the interest received on their domestic deposits and savings. For the sake of simplicity, we have aggregated demand deposits and savings, and the same interest rate is applied to both. These relationships are identities in the model. As mentioned above, all components of household income have been deflated by the consumer expenditure deflator.

\[
\Delta \text{lmxc}_t = -0.55172 -0.21668 \times \left[\frac{\text{lmxc}_{t-1}}{\text{lmxrpd}_{t-1}}\right] \\
- (-0.0042073) \times (\text{lmxc}_{t-1} - \text{lnxnw}_{t-1} - \text{lmxced}_{t-1})] + 0.56998 \times \Delta \text{lmxrpd}_{t-1}
\]

(20)
$lmxrpdi_t$ is the log of real disposable income, $lmxced_t$ the log of consumer expenditure deflator, and $lmxnw_t$ is net financial wealth. As above, household income is defined as the sum of mixed income ($mxi$), compensation ($mxcomp$, wages and social payments), government transfers ($mxtran$), and other personal income ($mxopi$). Those are the sum of dividends paid by firms to households ($mxdivd$), net interest payments by households ($mxnip$) and rent from land and insurance policy. The last two components of other personal income are aggregated into $mxopic$.

\[
mxpdi_t = mxi_t + mxcomp_t + mxopi_t - mxtax_t
\]
\[
mxopi_t = mxdivd_t + mxnip_t + mxopic_t
\]
\[
mxnip_t = mxcc_t \ast mxloansh_t - mxdepr_t \ast mxdepoh_t
\]

$brpdi_t = bri_t + brcomp_t + bropi_t - brtax_t$
\[
bropi_t = brdivd_t + brnip_t + bropic_t
\]
\[
brnip_t = brcc_t \ast brloansh_t - brdepr_t \ast brdepoh_t
\]

$mxdepoh_t$ are the deposits made by households. The interest rates $mxcc_t$ and $mxdepr_t$ are in decimal form rather than in percentage. The net financial wealth of households is by definition the sum of households financial assets (demand and time deposits, savings, gold) net of the sum of households financial liabilities (consumer credit and mortgages). Data on Mexican household financial position are quite difficult to obtain before 1993. We have thus used two proxies. Net wealth ($nw$) was proxied by the monetary aggregate $M_4$ and liabilities were proxied by total domestic credit. The model equation for household net wealth is also an identity. It is the sum of net foreign assets converted into domestic currency ($mxrx \ast mxna$) and household deposits, net of liabilities ($mxliabs$). Analogous definitions apply for equations (22).

We have assumed for the sake of simplicity that government consumption and investment follow the change on total loans to government ($brloansg_t$).

\[
brgc_t = brgc_{t-1} * \frac{\Delta brloansg_t}{brloansg_{t-1}}
\]
\[
brgi_t = brgi_{t-1} * \frac{\Delta brloansg_t}{brloansg_{t-1}}
\]
Finally, the capital requirements of national and international banks are the only exogeneous variables in the model.

4 Simulations of the model

This section presents the results of the simulations of a shock to domestic and international capital requirements on Brazil and Mexico. From the discussion in Section 2.2 and following Griffith-Jones, Spratt, and Segoviano (2002a), Weder and Wedow (2002) and Griffith-Jones, Spratt, and Segoviano (2002b), we simulate an increase rather than a decrease in solvency ratios. The results are presented either as a percent difference from base, or absolute difference from base (percentage points), if the variable is in percent, e.g., interest rates. The base for the Brazilian and Mexican blocks is the value of the variables on the last available quarter, which is flattened forward to 2010q4. As most financial variables and the components of GDP are quarterly, the base is their value in 2004q4. Personal sector variables, such as net interest payments, dividends, non-wage personal income, are annual variables. Their base value is that of 2003. For the Mexican and OECD solvency ratios, the base is 2001. For Brazilian solvency ratios, it is 2004q4. The base for all other country blocks in NiGEM is the April 2005 forecast published in NIESR (2005).

4.1 Shock to national capital adequacy requirements

Figures 7 to 10 show the results of a positive shock of 0.5 percentage points in domestic capital adequacy ratios. The user cost of capital in both countries rises, by 0.15 percentage points in Mexico and by 0.35 percentage points in Brazil (Figure 7). Since this is the cost of lending for private firms, it follows immediately that domestic loans to firms will decline, as can be seen in Figures 8 and 13. Domestic lending decline by less than 1 percent in Brazil and approximately 1 percent in Mexico. The impact on government lending in each country differs markedly. Domestic loans to government in Mexico remain unaffected by changes in domestic capital adequacy ratios, as can be expected from the Basel capital adequacy rules. However, as was seen above, banks have reacted to the implementation of capital adequacy rules by increasing lending to lower risk-weight borrowers, which in most cases, are the government and the Central Bank. This fact was documented in Brazil by Gottschalk and Sodré (forthcoming), and we found empirical evidence of it in the period 1997-2004, as can be seen in equation (11). The corresponding equation for Mexican government lending, equation (12) also shows no direct relationship between the domestic capital adequacy ratio and government lending. Figure 8 shows that domestic loans to the Brazilian government would rise by approximately 2 percent above
Before we examine the impacts on foreign lending, it is worth looking at Figures 9 and 10. Clearly, GDP and consumption rise in both countries, whereas exports tend to fluctuate around base. The fall in GDP relative to base reaches 3.5 percent in Brazil and about 2 percent in Mexico, owing to the sharp decline in private investment. Equations (17) and (18) show a strong negative statistical relationship between total lending to firms and private investment. Finally, although capital adequacy ratios do not directly feed into household borrowing, equations (5) and (6), the net interest payments by households depend on them through the lending rate, as can be seen in equations (22) and (21). Consequently, the rise in the lending rate seen in Figure 7 increases households’ net interest payments, which decreases their disposable income and hence reduces household consumption.

It is interesting to note that changes in domestic capital adequacy ratios have negative impacts on foreign lending to firms and government. This is an indirect effect, stemming from the fall in GDP. As can be seen in equations (3) and (4), foreign lending to Brazilian and Mexican firms are sensitive to the overall economic performance of the private sector, which is proxied by the growth rate of exports in the Brazilian equation and the level of exports in the Mexican equation. Consequently, since exports remain around base in Brazil, foreign loans to its private firms also fluctuate around base. In the Mexican case, we found that foreign loans are statistically extremely sensitive to changes in export
Figure 8: Impacts of domestic shock: Loans - Brazil

Figure 9: Impacts of domestic shock: GDP - Brazil
performance, which account for the strong decline in foreign loans to Mexican firms when exports fall. An analogous argument applies to foreign lending to government, which depends on GDP.

4.2 Shock to international capital adequacy requirements

Figure 11 summarizes the impacts of an increase of 0.5 percentage points in capital adequacy ratio on Brazilian GDP, consumption and on foreign loans to Brazilian firms and government. GDP and household consumption fall by more than 3.5 percent relative to base and slightly less than 2.5 percent from base respectively. As above, the decline is household consumption results in the rise of the lending rate, which depends on the differential between domestic and foreign capital adequacy ratios, as can be seen in equation (14). Foreign loans to Brazilian firms are found to be irresponsive to changes in foreign capital adequacy ratios, which accounts for its fluctuations around base. Moreover, foreign loans to firms are inversely related to the Brazilian sovereign risk, proxied by the spread of sovereign bonds, which declines slightly in the 8 quarters following the shock. Foreign loans to the Brazilian government, on the contrary, are sensitive to changes in foreign banks’ capital requirements and decrease to by approximately 1/2 percent below base three years after the shock.

A comparison of the impacts of a shock on domestic and foreign capital requirements (Figure 12) shows that the negative effects of the latter are larger than that of the former. The decline in GDP resulting from a foreign shock is about 2 percentage points bigger
the fall in GDP resulting from a domestic shock. This difference can be accounted for by the fact that an increase in foreign capital adequacy requirements leads to a fall in private investment and government expenditure, whereas a rise in domestic capital adequacy ratio decreases private investment but increases government lending and hence government spending (equation 23).

Table 5 and Figure 13 show the impact of an increase in OECD capital requirements on foreign loans to Mexican firms, total loans to the Mexican economy and on Mexican private investment. It is clear that even a small increase in capital requirements will have negative impacts on the Mexican economy in the short-term. Total loans will decline by approximately 1.7 per cent in less than a year, whilst loans to private firms will decline by 2 per cent in the first quarters following the shock. The impact of a rise in foreign banks’ capital requirements on Mexican private investment is rather mitigated, since foreign loans constitute a smaller proportion of Mexican firms’ loans.

Finally, Figure 13 compares the shocks on domestic and foreign solvency ratios on Mexican loans to firms. The foreign shock has larger negative impacts on total loans and foreign loans, whereas the domestic has a bigger impact on domestic loans than on foreign loans. The decline in total loans resulting from a shock in foreign capital requirements is quite pronounced, and reaches more than 6 percent below base.

As we found in the case of Brazil, changes foreign capital adequacy ratios may have a
Figure 12: Comparing domestic and foreign shocks - Brazil

Figure 13: Comparing domestic and foreign shocks - Mexico
potentially more damaging effect on the Mexican economy than changes in their domestic equivalent. Foreign lending may be reduced to a greater extent, which lead to a larger decline in private investment, consumption and ultimately GDP.

5 Conclusion

The Basel Capital Accords came to light as a response to the increasing vulnerability of the international financial system to disruptions in national financial markets. As these became increasingly integrated from the late 1970s onwards, it became more and more likely that failures of national financial institutions with international activities could build up into global crisis. The main objectives of the Capital Accords were thus the promotion of international cooperation of national supervisors and the implementation by its members of common prudential rules, and, in particular, of a common solvency ratio.

As the Capital Accords were originally designed to strengthen the solvency of internationally active banks, developing countries and emerging markets were not-and still are not-bound by its capital adequacy rules. However, countries such as Brazil, India and Mexico, have adopted the Basel prudential rules to regulate their domestic financial sectors in the late 1990s. Since the implementation of capital adequacy rules in emerging markets is quite recent, there has been very little research into the impacts of capital adequacy requirements on their financial systems and their economies.

This paper investigates the potential impacts of the adoption of capital adequacy rules from a macroeconomic standpoint. We show that changes in capital adequacy ratios in
Brazil and Mexico may negatively affect households, firms and government, by rising lending rates and decreasing banking loans. We found that public sector finance in Brazil may rise as a result of an increase in domestic capital adequacy requirements in detriment to private sector lending. Moreover, our results suggest that changes in foreign capital adequacy ratios may have a potentially more damaging effect than changes in their domestic equivalent. This can be accounted for by a portfolio redistribution effect. As government lending tends to increase with a rise in domestic solvency ratio, government expenditure rises, which helps sustaining GDP.
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Notes

1 More precisely, the risk weight of public entities may be 0, 10, 20, or 50 percent at the discretion of the regulator under Basel I.

2 The bank Ambrosiano SpA controlled an investment holding in Luxembourg, Banco Ambrosiano Holdings (BAH), which engaged in illegal transactions with its branches in Nassau and Peru, in order to sustain the stock price of its parent bank in Italy. BAH’s default led to the failure of Ambrosiano SpA. The Italian regulator, rescued the Italian main bank and refunded its depositors. However, the depositors of its Luxembourg and other foreign subsidiaries were completely ignored by the Italian and Luxembourg regulators. The former argued that they were outside its jurisdiction, whilst the latter argued that BAH was not registered as a bank in Luxembourg and hence not subject to banking regulation in this country. The failure of the German bank Schröder, Münchmeyer und Hengst (SMH) illustrates the risks of credit concentration and the benefits of supervisory cooperation. A single firm, IBH, concentrated loans with SMH amounting to 800 per cent of the bank’s core capital, in blatant breach of German regulations which stipulated a loan concentration limit of 16 per cent of core capital. To bypass this regulation, part of the loans were officially conceded by SMH Luxembourg subsidiary, as the Luxembourg banking authorities did not set limits to loan concentration. IBH bankrupted, and so did SMH immediately. However, unlike the case of Ambrosiano SpA, the German banking authorities coordinated the rescue of the parent bank and its subsidiary with the Luxembourg authorities.

3 In most documents published by the Basel Committee what we call loans portfolio are referred to as assets or claims. In a bank’s balance sheet, its loans are its assets, since they are money legally owned by the bank. Loans also constitute a claim a bank holds against its borrowers. Deposits and equity capital, on the contrary, are considered the bank’s liabilities towards the depositors and the shareholders, respectively.

4 The Basel Capital Accord applies to European banks with strictly domestic activities, unlike domestically active U.S. banks, which represent the vast majority of the 8000 American banks. The U.S. regulators announced in 2004 that few internationally active banks operating in their country would adopt Basel II. This number was later estimated to 10 to 20. The rest would comply with the domestic prudential system based on the Cooke ratio and national regulations. See Circular 11620 of the Federal Reserve Bank of New York, available at http://www.ny.frb.org/banking/circulars/11620.html

5 We use Moody’s classification published in Moody’s Investors Services (2003), since Standard& Poor’s credit ratings are not freely available.

6 According to the national definition of M4, as in International Monetary Statistics (2004), it comprises bills and coins outside banks, checking and current account (M1), other demand and time deposits, federal and private securities held by the private sector and other instruments held by pension funds (M2), demand and time deposits of non-residents in domestic banks and government securities held by non-residents (M3) and finally deposits of residents and non-residents held in branches abroad of domestic banks.
A The mathematics of Basel II

The new capital adequacy ratio—the McDonough ratio—is given by

\[
\frac{\text{core capital (Tier1)} + \text{complementary capital (Tier2)}}{\text{weighted risks}} \geq 8\% \quad (25)
\]

where the weighted risks are

\[
\frac{\text{core capital (Tier1)} + \text{complementary capital (Tier2)}}{\text{credit risk}} \geq 6\% \quad (26)
\]

\[
\frac{\text{core capital (Tier1)} + \text{complementary capital (Tier2)}}{\text{market risk}} \geq 0.4\% \quad (27)
\]

\[
\frac{\text{core capital (Tier1)} + \text{complementary capital (Tier2)}}{\text{operational risk}} \geq 1.6\% \quad (28)
\]

IRB risk weights

The risk weights under the advanced IRB are determined by the following formulas.

\[
K(LGD, PD, R, M) = LGD \cdot \mathcal{N}[(1 - R(PD))^{-0.5} \cdot G(PD) + \left(\frac{R(PD)}{1 - R(PD)}\right)^{0.5} \cdot G(0.999 - PD \cdot LGD) \cdot (1 - 1.5 \cdot b(PD))^{-1} \cdot (1 + (M - 2.5) \cdot b(PD))]
\]

where \(\mathcal{N}[.\) is the Normal distribution, \(G(.)\) the inverse of the Normal distribution, \(b(PD) = (0.08451 - 0.05898 \cdot \log(PD))^2\) is the maturity adjustment. \(M\) is the maturity of the loans and \(R(PD)\) the correlation

\[
R(PD) = 0.12 \cdot \frac{1 - e^{-50 \cdot PD}}{1 - e^{-50}} + 0.24 \cdot 1 - \frac{1 - e^{-50 \cdot PD}}{1 - e^{-50}} \quad (30)
\]

\(PD, LGD, \) and \(M\) are provided by the banks, which are known to rely on models such as CreditMetrics and CreditRisk+ to calculate the probability distributions of default \(PD\) and by extension the loss given default \(LGD\). See Gupton, Finger, and Bhatia (1997) and Credit Suisse First Boston (1997) for details.
B Data sources

B.1 Brazil


- IBGE: National accounts data. (1) GDP and its components (GDP, consumption, private investment, government investment, government consumption, export volumes, import volumes, inventories); (2) National accounts by institutional sector: Households (distributed dividends, interest income, tax, compensation, transfers). All variables available annually for the period 1990-2003.


- IMF: deposit rate (average rate offered by banks on 60-days deposits), cost of borrowing (weighted average of rates charged by banks on loans with fixed interest rates and with own funds to individuals and firms. Weights are loan amounts), 3-month interest rate (money market rate, which is the average rate on loans between commercial banks). (see International Monetary Statistics, 2004, p. 30-32). All variables available for the period 1991q1-2004q4.


- Thomson Datastream: Spread of Brazilian sovereign bonds (JPMorgan EMBI) over US Treasury bond. 1994q3-2005q2

B.2 Mexico

- Central Bank: total loans to non-financial private sector, total domestic loans, loans from domestic banks to private firms, loans from domestic banks to individuals, total loans from banks. Total deposits and savings. All variables available for the period 1996q4-2004q4.

- INEGI: National accounts data. (1) GDP and its components (GDP, consumption, private investment, government investment, government consumption, export volumes, import volumes, inventories); (2) National accounts by institutional sector: Households (net wealth of households, distributed dividends, interest income, tax, compensation, transfers; liabilities); (3) depreciation, GDP deflator. All variables available for the period 1993-2001.

- IMF: Average cost of funds (banks), deposit rate (weighted average rate payable to individuals on 60-day time deposits. Weights are deposit amounts), cost of borrowing (lending rate). Both variables available for the period 1980q1-2005q2.
