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Working Paper

On Endogenous Risk, the Amplification Effects of Financial Systems and Macro Prudential Policies

IDB Working Paper Series, No. IDB-WP-276

Provided in Cooperation with:

Inter-American Development Bank (IDB), Washington, DC

Suggested Citation: Majnoni, Giovanni; Powell, Andrew (2011) : On Endogenous Risk, the Amplification Effects of Financial Systems and Macro Prudential Policies, IDB Working Paper Series, No. IDB-WP-276, Inter-American Development Bank (IDB), Washington, DC

This Version is available at:

<https://hdl.handle.net/10419/89039>

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November 2011

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Inter-American Development Bank

2011

Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Majnoni, Giovanni.

On endogenous risk, the amplification effects of financial systems and macro prudential policies /
Giovanni Majnoni, Andrew Powell.

p. cm. (IDB working paper series ; 276)

Includes bibliographical references.

1. Financial Risk Management. 2. Financial crises. 3. Finance. 4. Economic policy. I. Powell,
Andrew. II. Inter-American Development Bank. Research Dept. III. Title. IV. Series.

<http://www.iadb.org>

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Abstract¹

The recent global financial crisis has put the spotlight on macro-prudential policies to protect firms and households from problems emanating from the financial sector. This paper proposes an analytical framework that combines exogenous and endogenous risks, the latter seen as stemming from frictions in financial markets. Arguing that endogenous risks may be systemic and costly, the paper employs a database of emerging market corporate bond spreads and finds evidence that endogenous risks are present and have amplified the effects of financial crises. Larger financial systems are found to exacerbate the impact of crises, and weaker financial systems are found to exacerbate particularly the impact of banking crises. The results suggest that policymakers should monitor time-varying systemic risks using both price and quantity signals and take actions in good times to mitigate potential amplifying effects at times of stress.

JEL Classifications: E32, E44, E58, F30, G01, G30

Keywords: Macro-prudential policies, Financial crises, Systemic risk

¹ All opinions expressed in this paper are of the exclusive responsibility of the authors and do not necessarily reflect the opinions of the Banca d'Italia or the Inter American Development Bank. We wish to thank Oscar Becerra for invaluable research assistance and participants in an IDB Policy Seminar on macro-prudential policies for valuable comments. Contact: Giovanni Majnoni, giovanni.majnoni@bancaditalia.it

1. Introduction

Central Bankers have long known that financial stability depends on the health of the financial system as a whole and not necessarily the stability of each and every financial institution. Indeed, Central Bankers have frequently stressed that individual institutions may fail and that the possibility of failure of individual institutions is a necessary part of a healthy financial sector.² It is often commented that the Basel standards have stressed microeconomic or individual institution risks. The standards neither consider how risks might develop within financial institutions nor how they are transmitted from one institution to another. In fact, Basel II's advanced approaches focus on the risk of each institution, assuming each has a diversified credit portfolio—as if all risks were both exogenous and fully diversified.

At the same time, a quite different mindset appears to have dominated the regulatory policies of the emerging world. While policymakers in the developed world (albeit with notable exceptions) allowed financial institutions to push leverage to unprecedented limits under a shared optimism regarding the capacity of capital markets to supply an almost infinite amount of liquidity, policymakers in developing countries have tended to focus on policies to protect the frequently lower levels of liquidity in their financial markets. We posit that this thinking has developed precisely because liquidity problems have been greater in emerging economies. Notable examples of this thinking appear around the time of the Tequila crisis that hit Latin America in late 1994 and early 1995, then after the Asian crisis of 1997.

To make progress in our analysis we first need to assess the relevance of different sources of risk and of the regulatory approaches devised to control them. In particular, we develop a conceptual definition of macro and micro-prudential oversight. To this end we move from the current debate—which sees the micro and macro-prudential approaches as offspring, respectively, of the partial and of the general equilibrium paradigms—and develop an empirical criterion to detect the presence of systemic spillovers and, accordingly, the need for macro prudential oversight.

We argue, drawing on Majnoni (2010), that appropriate policies will depend on the sources of financial volatility. In general micro-prudential policies will be appropriate for the management of exogenous volatility while macro-prudential policies should be targeted to manage endogenous volatility. Moving from the conceptual framework we then consider

² See Crockett (2000) and Borio (2003) commenting on the aftermath of the Asian crisis.

empirical evidence for the existence of endogenous risks. We employ a database of corporate bond spreads across emerging markets. We choose non-financial corporates to show the spillover effects from the financial sector to the cost of the capital to the economy in general. We then investigate whether during a crisis (and for different types of crises), the size and the quality (as measured by standard regulatory ratios) of the financial system affects the extent to which the effect of the crisis is amplified. Employing the analytical framework and empirical results, we then discuss the policy implications of our results, suggesting that they underline the need for macroprudential policies in emerging economies.

The paper starts with a characterization of exogenous and endogenous risk in Section 2 and, in Section 3, how their contribution to total returns covariance should be reflected by the two oversight approaches (micro and macro). We then turn to a quantification of the exogenous and endogenous risk in the market for corporate bonds in emerging countries (Section 4) with a view to provide a first assessment of the size of market spillovers faced by emerging economies and the relevance of the challenge faced by macro prudential policies in these countries. Section 5 concludes and details suggestions for future work.

2. Endogenous and Exogenous Risk in Financial Asset Returns

The micro and macro prudential approaches aim at controlling two different forms of financial risks. Looking in greater detail at these risks helps define their measurement and detect their determinants, a task to which the second part of this paper is devoted. But as the saying goes, “what can be measured can be controlled,” and therefore it is to be expected that better measures of the different sources of risk will help define the relative importance and features of the two prudential approaches.

The micro-prudential approach deals with risk from the perspective of standard financial asset pricing and treats individual intermediaries as portfolios of assets. In this approach the role of financial intermediaries is to manage risks that come from outside the financial system. Risk is exogenous.

The macro-prudential approach looks instead at risk from the perspective of dynamic macro-financial models. Risks are related to macroeconomic volatility, which in turn is generated by cyclical factors or by multiple equilibriums associated with frictions due to imperfect information and incomplete markets. In this approach financial intermediaries’ actions

generate further waves that affect the real economy and feed back to the financial sector. Risk is endogenous.

The characterization of the two risks reveals a partial equilibrium ascendance in the case of the exogenous risk and a general equilibrium one in the case of the endogenous risk. Moreover, the description of exogenous risk is mindful of traditional asset pricing models, while that of endogenous risk appears linked to the literature on bank instability in general equilibrium models developed in the last couple of decades. Moving from these elements, we shall define a functional form for the two types of risk that may help understand their interaction with a view toward disentangling and estimating their separate influence on asset returns and more generally on macroeconomic volatility.

2.1 Exogenous Risk: A Partial Equilibrium Formulation

The partial equilibrium ascendance may not be obvious in the case of the micro approach because asset pricing is part of a construct—that of modern finance—that fits into a general equilibrium framework. However, taking a closer look, it becomes apparent that asset pricing is largely based on individuals’ underlying preferences and endowments and—as a result of finance separation theorems—financial decisions remain independent of individuals’ risk aversion and endowments.³

It is precisely a consequence of the partial equilibrium approach that risk—in terms of both quantity and price—is taken as exogenous in finance: the quantity of risk (e.g., shocks to aggregate wealth) being generated by shocks of natural or technological origin, and the price of risk being originated in the “real” side of the economy and therefore “outside” financial markets.

According to the partial equilibrium approach, asset returns are a function of the vector of risk factor loadings β and risk factors, x , as in equation (1). If the risk factor is unique and approximated by the “market” excess return over the riskless rate, then equation (1) reduces to the CAPM.

$$(1) \quad r_{i,t} = \alpha + \beta x_t + \varepsilon_{i,t} \quad \text{where} \quad \varepsilon_{i,t} \text{N.I.D.}(0, \sigma_\varepsilon^2) \\ \text{and} \quad x_t \text{N.I.D.}(\bar{x}, \sigma_m^2)$$

³ See Majnoni (2010) for a broader discussion of the partial equilibrium features of the finance approach.

In this approach the co-movement of asset returns depends uniquely on the systemic component (σ_m) and on exposure to exogenous common risk factors. On average, the correlation of asset returns must therefore be rather stable and increase if the idiosyncratic risk decreases.

$$(2) \quad Cov(r_i, r_j) = \beta^2 \sigma_m^2; \quad \sigma^2(r_i) = \beta^2 \sigma_m^2 + \sigma_\varepsilon^2; \quad \rho(r_i, r_j) = \frac{\beta^2 \sigma_m^2}{\beta^2 \sigma_m^2 + \sigma_\varepsilon^2}$$

Exogeneity puts risk beyond regulators' responsibility and equates its extreme manifestations with "acts of God." In policy terms, risk exogeneity implies that financial regulators' main task is to prevent financial intermediaries from piling up an excessive amount of risk in their balance sheets. In other words, solvency ratios and Value at Risk (VaR) will buy stability up to a selected probability level of crisis occurrence, but they will not affect the probability of occurrence of the crisis itself. Regulation and supervision will not affect the distribution of asset returns. Even in those cases where regulation and supervision are entrusted with removing market imperfections, financial risk remains largely a fact of nature, and not a fruit of human action, providing a strong justification for self-regulation as a tool of effective supervision.

2.2 Endogenous Risk: A General Equilibrium Formulation

The alternative framework, supporting the macro regulatory approach, has been moving away from the finance perspective since the 1970s, when Cass and Stiglitz (1970) emphasized the restrictive nature of the functional assumptions on which finance separation theorems rested. But only in the 1990s did the imperfect information paradigm succeed in presenting financial risk as the endogenous outcome of a general equilibrium framework. Kiyotaki and Moore (1997) and Bernanke, Gertler, and Gilchrist (1999) helped establish the link between the dynamics of output and asset prices and the role played by real and financial assets as collateral in lending operations. Shin (2008), Brunnermeier and Sannikov (2010) and others have translated these concepts into asset pricing models applying general equilibrium models to the derivation of asset prices.

Common to previous models is the notion that systemic non-diversifiable risk may be generated by the behavior of economic agents and can therefore be endogenous.⁴ Feedback

⁴ Haldane (2010) reaches a similar conclusion: "Tail risk within some systems is determined by God, in economist-speak, it is exogenous ... Tail risk within financial systems is not determined by God but by man; it is not exogenous but endogenous."

mechanisms, built into existing regulations or balance sheet constraints, tend to magnify (accelerate) exogenous shocks that would otherwise have a more limited economic impact.

The distinguishing feature of the macro-prudential literature is the acknowledgment that financial systems may themselves affect the risk profile of the whole economy and that risks outbursts are not necessarily “acts of God” but also of “manmade actions.” In other terms, financial instability is not only the result of unfortunate realizations of occurrences located far away in the tail of the distribution but of the realization of different return (and risk) distributions over time and across countries. The resulting responsibility of financial supervisors in control of the financial intermediation activity is largely expanded.

The magnification of exogenous shocks may take two forms:

- Magnification of idiosyncratic shocks
- Magnification of systemic shocks

2.2.1 Endogenous Transmission of Idiosyncratic Shocks

The determinants of asset returns are the same of the previous approach but the covariance term is now more complex. Equation (3) translates in discrete time the return equation derived by Danielsson, Shin and Zigrand (2009) from a structural model of liquidity demand and supply.

$$(3) \quad r_{i,t} = \alpha + \beta x_t + \varepsilon_{i,t} \quad \text{where} \quad \begin{aligned} &\varepsilon_{i,t} N.I.D.(0, \sigma_\varepsilon^2) \\ &Cov(\varepsilon_i, \varepsilon_j) = \rho_{i,j} \sigma_\varepsilon^2 \\ &\text{and} \quad x_t N.I.D.(\bar{x}, \sigma_m^2) \end{aligned}$$

The co-movement of asset returns is now given by two additive components: an exogenous component (σ_m), as in equation (2), and an additional term that reflects the endogenous transmission of idiosyncratic shocks across assets and is characterized by a non zero correlation coefficient ($\rho_{i,j}$).

$$(4) \quad Cov(r_i, r_j) = \beta^2 \sigma_m^2 + \rho_{i,j} \sigma_\varepsilon^2; \quad \sigma^2(r_i) = \beta^2 \sigma_m^2 + \sigma_\varepsilon^2; \quad \rho(r_i, r_j) = \frac{\beta^2 \sigma_m^2 + \rho_{i,j} \sigma_\varepsilon^2}{\beta^2 \sigma_m^2 + \sigma_\varepsilon^2}$$

In the structural model the correlation coefficient is shown to be function of budget or liquidity constraints. For example, the additional cross-correlation term reflects the price effect of “fire sales” triggered by sudden capital alignment with required VaR levels (Danielsson, Shin and Zigrand, 2009) or by margin calls (Adrian and Shin, 2009). Residuals in the pricing

equations violate the traditional i.i.d. assumption because idiosyncratic shocks are no longer uncorrelated across assets.

The description of asset returns of equation (3) reflects the price dynamics described by the Brady Commission on the 1987 stock market crash, where a myriad of parallel hedging transactions enacted by institutional investors in a seemingly uncoordinated fashion were in fact coordinated by similar trading strategies.

Policy implications of the new formulation are relevant. Financial regulators' responsibilities have now greater latitude. In addition to controlling risk exposure—as in the micro-partial equilibrium case—they now have to offset endogenously created volatility.

2.2.2 Endogenous Transmission of Exogenous Shocks

Borio (2003) and Brunnermeier and Sannikov (2010) observe that systemic shocks as well as idiosyncratic ones are magnified by the existence of feedback rules. For example, a positive productivity shock will negatively affect the returns of existing capital assets, inducing losses for those financial intermediaries that have invested in the now obsolete assets. Portfolio “fire sales” by intermediaries that have fallen below their solvency ratios will generate additional negative pressure on prices and returns that further reinforce the negative price spiral. The return equation becomes in this case:

$$(5) \quad r_{i,t} = \alpha + \beta(x_t + \lambda x_t) + \varepsilon_{i,t} \quad \text{where} \quad \varepsilon_{i,t} \sim N.I.D.(0, \sigma_\varepsilon^2) \\ \text{and} \quad x_t \sim N.I.D.(\bar{x}, \sigma_m^2) \\ \text{Cov}(\varepsilon_i, \varepsilon_j) = \rho_{i,j} \sigma_\varepsilon^2$$

The systemic volatility of asset returns is now magnified by the presence of the coefficient (λ), which is a function of parameters such as leverage, solvency, and liquidity that represent a binding constraint on banks' behavior and that magnify systemic shocks.

$$(6) \quad \text{Cov}(r_i, r_j) = \beta^2(1 + \lambda)^2 \sigma_m^2 + \rho_{i,j} \sigma_\varepsilon^2; \quad \sigma^2(r_i) = \beta^2(1 + \lambda)^2 \sigma_m^2 + \sigma_\varepsilon^2; \\ \rho(r_i, r_j) = \frac{\beta^2(1 + \lambda)^2 \sigma_m^2 + \rho_{i,j} \sigma_\varepsilon^2}{\beta^2(1 + \lambda)^2 \sigma_m^2 + \sigma_\varepsilon^2}$$

The covariance of asset returns now reflects two feedback mechanisms. The first, associated with non-zero λ values, is induced by system-wide constraints such as predefined loan-to-value ratios (Fisher, 1933) or loan-to-net worth ratios (Bernanke, Gertler and Gilchrist,

1999). The second, associated with non-zero ρ_{ij} values, reflects common responses to uncorrelated shocks and transforms idiosyncratic into systemic shocks.

3. Measurement and Policy Implications

In the absence of feedback effects (i.e., for $\lambda=\rho_{ij}=0$), equations (5) and (6) revert to the specification of equations (1) and (2). In other words, the general equilibrium specification reverts to the partial equilibrium, showing that—as expected—the partial equilibrium representation of asset returns and its volatility are a special case of the general equilibrium specification.

The measurement implication of this consideration is that observed market volatility can be divided into two components: “exogenous” (i.e., nature driven) volatility and “endogenous” (i.e., manmade) volatility.

$$(7) \quad \text{Observed volatility} = \text{Exogenous volatility} + \text{Endogenous volatility}$$

The fact that exogenous and endogenous volatility are additive components of total observed volatility of any asset portfolio provides a conceptual distinction that may guide the specification of empirical measurement efforts (as in this paper) as well as the division of responsibilities and tasks between micro and macro prudential policies. In other words, if there are no overlapping areas between the two sources of risks—at least in principle—it should also be possible to identify non-overlapping areas for policies aimed at controlling them such as micro and macro-prudential policies.

Equation (7) also suggests that if we can model and measure exogenous risk, endogenous risk can be evaluated residually as the difference between the observed volatility of an asset portfolio and its exogenous component. In fact, traditional asset pricing may offer, as previously discussed, the reference model for the empirical estimation of exogenous risk allowing for a quantification of the endogenous volatility based on the amount of unexplained or residual volatility.

In this paper the strategy adopted to identify the two sources of risks moves from similar considerations. In particular, we have selected a number of factors of domestic or international origin that affect financial asset returns and that can safely be considered as sources of exogenous risk. We then explore the residual explanatory power of additional risk factors of

financial nature. If such residual explanatory power is also found to be related to banks' balance sheets variables, as predicted by models of endogenous risk, we take this as prima facie evidence of an empirically relevant presence of endogenous risk.

If the null hypothesis of no endogenous risk is accepted, the policy implication is that traditional micro prudential policies are sufficient to insure financial stability. If instead the null hypothesis is rejected, then some form of macro prudential policy needs be envisioned.

4. Financial Frictions, Spillovers and the Cost of Capital

4.1 Introduction

In this section we present an empirical analysis to determine whether financial frictions and endogenous risks have significant spillover effects and affect non-financial firms' cost of capital. We chose to work with corporate spreads in order to examine the effect of financial frictions on the rest of the economy rather than on the banking system itself. In particular, we investigate the determinants of corporate spreads which can be grouped into: a) firm-level fundamentals, b) global financial variables, c) domestic macroeconomic fundamentals and d) domestic financial variables.

We find, as have previous researchers, that domestic financial variables such as country risk (the EMBI credit spread) and global financial variables such as the VIX and the US interest rate are highly significant in explaining individual corporate spreads, over and above the other determinants. The fact that EMBI spreads are significant in explaining corporate spreads (on top of firm fundamentals and macroeconomic fundamentals) may be considered prima facie evidence that domestic financial frictions play an important role. However, sovereign default would be expected to affect corporate default probabilities through many channels. While we include macroeconomic factors that would help to explain the likelihood of sovereign default, there is always the possibility that some other determinants are missing and that the EMBI spread summarizes the market's overall perception of the likelihood of sovereign default and its consequences for bondholders. To put this another way, if we could confidently say we included all fundamental variables that would predict sovereign default, then finding the EMBI significant would indeed suggest that other domestic financial factors were at play, but it is of course difficult to make this claim.

We therefore go beyond this initial evidence and consider what happens when there is a dislocation in financial markets, i.e., during financial crises. The hypothesis is that during financial crises there is an amplification effect of financial frictions and hence, even if we control for firm level, macroeconomic and global characteristics and the country risk at the time of the crisis, there will be a further impact on corporate spreads. Further, we investigate whether the magnitude of that amplification effect on corporate spreads depends on characteristics of the relevant financial system. The hypothesis here is that the larger and the weaker the financial system, the greater would be the amplification effect during the crisis.

4.2 The Data

We obtained data on the yield spread of 139 corporate issues from 65 corporations listed in 10 emerging countries, drawing on the dataset employed in Cavallo and Valenzuela (2009). The data were taken from Bloomberg where for each of the selected companies a spread is available for selected maturities, computed as the difference between a zero coupon yield curve for the firm and for the relevant government bond. Our dependent variable is then an indicator of firm-level credit risk.

Our explanatory variables may be grouped as follows: a) firm-level fundamentals, b) macroeconomic fundamentals, c) country financial variables and d) global financial factors. In the first group of explanatory variables we use firm balance sheet ratios including i) Debt to Assets, ii) Equity to Capital, iii) EBIT to Assets, iv) Return volatility and v) assets as a measure of size. In the second set we use country growth and per capita GDP. In previous papers these variables have been found to be significant in explaining country risk. We include the country bond spread (EMBI) in the third category of variables and in the final set (global financial conditions) we employ the US 10-year T-Bond yield, the yield of US non-investment grade corporates and the VIX (the CBOE Volatility Index).

To this data set we add the Reinhart and Rogoff (2009) database for crisis dummies.⁵ This is divided into four types of crises: i) banking system crises, ii) foreign exchange crises, iii) sovereign debt crises and, finally iv) stock-market crises. We also add to this database a set of variables related to domestic financial systems. They include information on the size of the financial system (namely credit to GDP from the IMF's International Financial Statistics) and a

⁵ See Reinhart and Rogoff (2009). Data available at www.reinhartandrogoff.com/data.

set of regulatory variables obtained from the IMF's Global Financial Stability Report. The regulatory ratios we employ are non-performing as a percentage of total loans, provisions as a percentage of non-performing loans and regulatory capital as a percentage of assets-at-risk (calculated using the Basel 1 methodology with fixed risk weights for different types of assets). The data are quarterly and cover the recent past before the start of the global financial crisis, namely the period 1999-2006.

Given the discussion above, our hypothesis is that corporate spreads variability will be determined by firm characteristics, country characteristics and international financial characteristics (as in Cavallo and Valenzuela, 2009), but that in addition corporate spreads will also rise at times of crisis due to endogenous risk or amplification effects. Moreover, we would expect that this amplification effect would be greater if the financial system is larger (higher credit to GDP) or the financial system is weaker (higher non-performing loans or lower provisions or regulatory capital). In our first set of analyses, we therefore introduce a dummy variable for any type of crisis, and we test for a set of interaction effects between the dummy variable and the various regulatory ratios as mentioned. All the regressions also include firm fixed effects and hence we are focusing here on time variations rather than any cross-section variations to drive the results.

An initial set of results is presented in Table 1. As can be seen from column 1, firm-specific characteristics, domestic economy variables and international financial variables are all highly significant. We do not dwell here on the discussion of these variables, as these results are common with the previous literature; suffice it to say that the model fits extremely well. However, it can also be noted in column 1 that the All crises dummy is significant and with a positive sign. This is our first evidence that there is an amplification effect due to endogenous risk. This indicates that even controlling for firm-specific characteristics, domestic macroeconomic variables including the country risk spread (EMBI) and international financial factors, the occurrence of a crisis induces corporate spreads to rise further than justified by all the other explanatory variables. We also observe in column 2 that replacing the international financial variables with a time dummy helps take into account some additional volatility not fully reflected in our three selected variables. We have, therefore, adopted this latter specification as our base estimation specification.

Our second result, however, is somewhat negative. In fact, as shown in Table 2, if in our preferred specification (column 1) we interact the crisis variable with variables representative of the quality of the financial safety net, such as the NPL, LLP and TIER 1 capital ratios, the interaction effects in this table (columns 2 to 5) appear not to be significant. The exception to this negative result is that of lagged credit to GDP. In other words, the larger the financial system, possibly as a result of rapid credit growth before the crisis, the greater the amplification effect of the crisis on the cost of capital in the economy irrespective of the type of crisis.

We now proceed to separate out the different types of crises. In particular, we separate banking crises from other types of crises. Table 3 accordingly introduces two crisis dummies (Banking and Other) and two sets of interaction effects with those crisis dummies. Column 1 shows that it is really banking crises that drive the results. Non-financial corporate spreads rise very significantly indeed above and beyond the level explained by the other explanatory variables when there is a banking crisis. They also rise when there is another type of crisis, but in this latter case results are not statistically significant. Endogenous risk and amplification effects are then related to the special role of the banking system; if there is no banking crisis there may be an effect, but it is not significant. Considering columns 2-5, all of the interaction effects with the banking crisis dummy are significant and with the expected sign. If the financial system has higher non-performing loans, lower provisions or lower regulatory capital, then the amplification effect is greater. In some cases the original dummy remains significant and in others it does not.

We view this as something of a horse-race between a one-zero dummy and a modulated dummy—whose magnitude varies, for example, with the level of non-performing loans—as the best explanatory variable. It turns out that the latter provides a better fit to the data. But in the case of provisions and regulatory capital, both the original dummy and the interaction effect are significant. Note also that in the case of credit to GDP, the interaction effect with banking crises is also positive and significant, higher credit growth before a banking crisis leads to a larger amplification effect and corporate spreads increase further. The effect of the size of the financial system is positive but is not significant in the case of other crises, but we will come back to that result.

Given that we have two sets of dummies and two sets of interaction effects, some may be concerned about collinearity between these various dummies. Hence in Table 4, we eliminate the Other Crisis dummies and those interaction effects. The results still hold with the interaction

effects remaining as significant for non performing loans, provisions and for credit. The effect of regulatory capital continues to have the correct sign, but it is not quite significant. We should remember, however, that all of these variables from the Global Financial Stability Report come with the health warning that they may not be strictly homogeneous in their definitions across countries and more importantly, particularly in regard to regulatory capital, there have been changes in the definitions over time.

The final table of results (Table 5) tests whether anything changes if we reduce the two dummies to just one All Crisis dummy but we separate out the interaction effects dependent on the two types of crises (Banking and Other Crises). There is only one interesting change, which is that now credit is significant for all types of crises, going back to the result in column 5 of Table 1. Indeed, the pre-crisis size of the credit market appears as significant throughout our results. By itself, this shows an amplification effect depending on the size of the market in all types of crises.

The empirical results therefore show an amplification of shocks during crisis times (for all crisis types) depending on the size of the credit market before the crisis (Table 1, column 5 and Table 4), increasing the cost of credit for firms during crisis times over and above the cost of credit explained by firm characteristics, macroeconomic characteristics and international financial factors. Moreover, particularly for banking crises, the weakness of the banking system amplifies shocks by increasing the cost of capital for non-financial firms, particularly during banking crises. We therefore consider these results therefore proof of the existence and importance of endogenous risk.

5. Conclusions

This paper contributes to the ongoing discussion on the scope and definition of macro-prudential risks and policy responses. The previous Basel Accords have largely focused on protecting banks from the economy, i.e., exogenous risks. The recent crisis has highlighted that it is also necessary to protect the economy from banking risks, which we see as endogenous risks. The micro and macro-prudential approaches—or a micro-macro approach—should in our view represent complementary policies to achieve both of these aims.

In particular, we think of endogenous risk as the amplification of exogenous risks due to financial frictions. This means that a weak financial sector may amplify exogenous shocks and,

by causing greater harm to the financial sector, it may feed back to the economy, generally exacerbating exogenous shocks.

In this paper we have developed a simple accounting framework that helps to describe and delineate these effects. Moreover, we have illustrated that these effects are significant in affecting the cost of credit in emerging economies. Specifically, the size of banking systems appears to increase non-financial corporate spreads at times of crisis over and above what would be expected relative to a very successful empirical model with firm-specific, domestic economic and international financial factors. In addition, weaker financial systems tend to increase corporate spreads when there is a banking crisis over and above the level that would be expected given a more standard empirical model.

We therefore consider that policies should be enacted to dampen these amplification effects. Increasing bank capital and liquidity in tranquil times and making bank capital and liquidity vary across the cycle, particularly to dampen the effect of credit booms, and hence have more reserves available at times of bust, would appear to be relevant policy interventions in this regard. Further work is required to attempt to calibrate and refine such proposals.

References

- Adrian, T., and H. Shin. 2009. "Liquidity and Leverage." Federal Reserve Bank of New York, Staff Report 328. New York, United States: Federal Reserve Bank of New York.
- Banca d'Italia. 2009. "Financial Sector Pro-Cyclicality: Lessons from the Crisis." *Questioni di Economia e Finanza* 44. Rome, Italy: Banca d'Italia.
- Bank of England. 2009. "The Role of Macroprudential Policy: A Discussion Paper." London, United Kingdom: Bank of England.
- Bernanke, B., M. Gertler and S. Gilchrist. 1999. "The Financial Accelerator in a Quantitative Business Cycle Framework." In: John B. Taylor and Michael Woodford, editors. *Handbook of Macroeconomics*. Volume 1C. Amsterdam, The Netherlands: North Holland.
- Borio, C. 2003. "Towards a Macroprudential Framework for Financial Supervision and Regulation?" BIS Working Paper 128. Basel, Switzerland: Bank for International Settlements.
- Brunnermeier, M., and Y. Sannikov. 2010. "A Macroeconomic Model with a Financial Sector." Princeton, United States: Princeton University. Mimeographed document.
- Brunnermeier, M. et al. 2009. *The Fundamental Principles of Financial Regulation*. Geneva Reports on the World Economy. London, United Kingdom: Centre for Economic Policy Research.
- Caballero, R. 2010. "Sudden Financial Arrest." *IMF Economic Review* 58(1): 6-36.
- Campbell, J., and J. Cochrane. 1995. "By Force of Habit: A Consumption Based Explanation of Aggregate Stock Market Behavior." NBER Working Paper 4995. Cambridge, United States: National Bureau of Economic Research.
- Cass, D., and J. Stiglitz. 1970. "The Structure of Investor Preferences and Asset Returns, and Separability in Portfolio Allocation." *Journal of Economic Theory* 2: 122-160.
- Cavallo, E., and P. Valenzuela. 2009. "The Determinants of Corporate Risk in Emerging Markets: An Option-Adjusted Spread Analysis." Research Department Working Paper 602. Washington, DC, United States: Inter-American Development Bank.
- Crockett, A. 2000. "Marrying the Micro- and Macroprudential Dimensions of Financial Stability." BIS Speeches, 21 September. Basel, Switzerland: Bank for International Settlements.

- Danielsson, J., and H. Shin. 2003. "Endogenous Risk." In: *Modern Risk Management: A History*. London, United Kingdom: Risk Books.
- Danielsson, J., H. Shin, and J-P. Zigrand. 2009. "Risk Appetite and Endogenous Risk." London, United Kingdom: London School of Economics.
- De la Torre, A., and A. Ize. 2009. "Regulatory Reform: Integrating Paradigms." Policy Research Working Paper 4842. Washington, DC, United States: World Bank.
- Diamond, D., and P. Dybvig. 1983. "Bank Runs, Deposit Insurance, and Liquidity." *Journal of Political Economy* 91(3): 401-419
- European Central Bank, 2010, Financial Stability Review, June 2010.
- Fisher, I. 1933. "The Debt-Deflation Theory of Great Depressions." *Econometrica* 1(4): 337-357.
- Greenwald, B. and J. Stiglitz. 1986. "Externalities in Economies with Imperfect Information and Incomplete Markets." *Quarterly Journal of Economics* 101(2): 229-264
- Grossman, S. and J. Stiglitz. 1980. "On the Impossibility of Informationally Efficient Markets." *American Economic Review* 70(3): 393-408
- Haldane, A. 2010. "The \$100 Billion Question." Comments by Mr. Andrew G Haldane, Executive Director, Financial Stability, Bank of England, at the Institute of Regulation and Risk, Hong Kong, March 30, 2010.
- Kiyotaki, N., and J. Moore. 1997. "Credit Cycles." *Journal of Political Economy* 105(2): 211-248.
- Longin, F., and B. Solnik. 2001. "Extreme Correlation of International Equity Markets." *Journal of Finance* 56(2): 649-676.
- Majnoni, G. 2010. "The Comovement of Asset Returns and the Micro-Macro Focus of Prudential Oversight." Policy Research Working Paper 5456. Washington, DC, United States: World Bank.
- Reinhart, C., and K. Rogoff. 2009. *This Time Is Different: Eight Centuries of Financial Folly*. Princeton, United States: Princeton University Press.
- Rochet, J-C. 2005. "A Framework for a Macroprudential Banking Regulation." Toulouse, France: Toulouse School of Economics (TSE), Institut d'Économie Industrielle (IDEI). Mimeographed document.

Shiller, R. 1981. "Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends?" *American Economic Review* 71: 421-436.

Shin, H. 2008. "Risk and Liquidity in a System Context." Princeton, United States: Princeton University. Mimeographed document.

Table 1. Corporate Spreads: All-Crisis Dummies

Dependent variable: log of the Option adjusted spread (OAS)

	1	2
All Crisis Dummy	0,189 [0.0539]***	0,221 [0.0381]***
Log of EMBI	0,314 [0.108]***	0,212 [0.0852]**
Log of EMBI x Log of Time to Maturity	-0,0882 [0.0226]***	-0,0799 [0.0202]***
EBIT to Assets ratio	-0,0433 [0.0119]***	-0,0487 [0.0113]***
Equity to Capital ratio	-0,0099 [0.00310]***	-0,0106 [0.00306]***
Debt to Assets ratio	0,0131 [0.00428]***	0,0116 [0.00428]***
Log of Assets	-0,18 [0.0229]***	-0,167 [0.0233]***
Equity Volatility	0,0152 [0.00181]***	0,0164 [0.00202]***
Log of Time to Maturity	0,483 [0.0583]***	0,492 [0.0592]***
Debt to Assets x Log of Time to Maturity	-0,00565 [0.00139]***	-0,00593 [0.00141]***
GDP growth (t-1)	-0,0215 [0.00590]***	-0,0184 [0.00553]***
Log of GDP per Capita (t-1)	0,713 [0.0441]***	0,595 [0.499]
High Yield	0,363 [0.0763]***	
Treasury 10 years	-0,511 [0.102]***	
VIX	0,00655 [0.00336]*	
Constant	-4,803 [4.002]	-3,886 [4.511]
Observations	1503	1503
R-squared	0,753	0,773
Root MSE	0,335	0,333
Time fixed effects	no	yes

Standard errors in brackets

* p<0.10, ** p<0.05, *** p<0.01

Table 2. Corporate Spreads: All-Crisis Dummies and Interactions

Dependent variable: log of the Option adjusted spread (OAS)

	(1,01)	(1,02)	(1,03)	(1,04)	(1,05)
All Crisis Dummy	0,221 [0.0381]***	0,057 [0.117]	0,328 [0.0744]***	0,348 [0.223]	0,145 [0.0649]**
Non Performing (t-1) x All Crises		1,097 [0.743]			
Provisions (t-1) x All Crises			-0,142 [0.125]		
Regulatory Capital (t-1) x All Crises				-1,016 [1.525]	
Credit to GDP (t-1) x All Crises					0,0784 [0.0447]*
Log of EMBI	0,212 [0.0852]**	0,178 [0.0834]**	0,189 [0.0872]**	0,289 [0.0696]***	0,218 [0.0854]**
Log of EMBI x Log of Time to Maturity	-0,0799 [0.0202]***	-0,059 [0.0186]***	-0,0588 [0.0186]***	-0,0772 [0.0201]***	-0,0809 [0.0203]***
EBIT to Assets ratio	-0,0487 [0.0113]***	-0,0455 [0.0119]***	-0,0451 [0.0119]***	-0,0449 [0.0129]***	-0,0496 [0.0115]***
Equity to Capital ratio	-0,0106 [0.00306]***	-0,0112 [0.00307]***	-0,0112 [0.00309]***	-0,00989 [0.00315]***	-0,0107 [0.00305]***
Debt to Assets ratio	0,0116 [0.00428]***	0,0117 [0.00424]***	0,0117 [0.00429]***	0,0139 [0.00456]***	0,0117 [0.00431]***
Log of Assets	-0,167 [0.0233]***	-0,171 [0.0241]***	-0,171 [0.0251]***	-0,19 [0.0246]***	-0,171 [0.0240]***
Equity Volatility	0,0164 [0.00202]***	0,018 [0.00237]***	0,0185 [0.00243]***	0,0187 [0.00249]***	0,016 [0.00206]***
Log of Time to Maturity	0,492 [0.0592]***	0,503 [0.0605]***	0,504 [0.0618]***	0,501 [0.0669]***	0,497 [0.0600]***
Debt to Assets x Log of Time to Maturity	-0,00593 [0.00141]***	-0,00628 [0.00146]***	-0,00629 [0.00149]***	-0,00612 [0.00162]***	-0,00605 [0.00143]***
GDP growth (t-1)	-0,0184 [0.00553]***	-0,018 [0.00615]***	-0,0252 [0.00726]***	-0,0227 [0.00677]***	-0,0176 [0.00580]***
Log of GDP per Capita (t-1)	0,595 [0.499]	0,624 [0.471]	0,351 [0.521]	0,838 [0.509]	0,599 [0.496]
Constant	-3,886 [4.511]	-4,086 [4.276]	-1,713 [4.740]	-6,163 [4.556]	-3,827 [4.498]
N	1503	1453	1447	1416	1503
r2	0,773	0,778	0,779	0,783	0,773
rmse	0,333	0,333	0,333	0,331	0,333

Standard errors in brackets

* p<0.10, ** p<0.05, *** p<0.01

Table 3. Corporate Spreads: Separating the Crises

Dependent variable: log of the Option adjusted spread (OAS)

	(2,01)	(2,02)	(2,03)	(2,04)	(2,05)
Banking Crisis Dummy	0,171 [0.0438]***	-0,156 [0.185]	0,585 [0.105]***	0,616 [0.262]**	-0,0205 [0.0817]
Other Crisis Dummy	0,0853 [0.0790]	0,159 [0.173]	0,105 [0.137]	0,119 [0.311]	0,0794 [0.117]
Non Performing (t-1) x Banking Crises		2,266 [1.258]*			
Non Performing (t-1) x Other Crises		-0,368 [1.185]			
Provisions (t-1) x Banking Crises			-0,722 [0.178]***		
Provisions (t-1) x Other Crises			0,173 [0.185]		
Regulatory Capital (t-1) x Banking Crises				-3,259 [1.867]*	
Regulatory Capital (t-1) x Other Crises				0,0734 [1.820]	
Credit to GDP (t-1) x Banking Crises					0,158 [0.0529]***
Credit to GDP (t-1) x Other Crises					0,331 [0.296]
Log of EMBI	0,212 [0.0852]**	0,184 [0.0831]**	0,193 [0.0856]**	0,299 [0.0713]***	0,221 [0.0866]**
Log of EMBI x Log of Time to Maturity	-0,0771 [0.0201]***	-0,0585 [0.0185]***	-0,0629 [0.0188]***	-0,0751 [0.0202]***	-0,0796 [0.0203]***
Equity to Assets ratio	-0,0474 [0.0114]***	-0,0459 [0.0119]***	-0,0471 [0.0118]***	-0,0448 [0.0130]***	-0,0501 [0.0115]***
EBIT to Assets ratio	-0,0105 [0.00308]***	-0,0112 [0.00309]***	-0,011 [0.00310]***	-0,0099 [0.00316]***	-0,0106 [0.00306]***
Debt to Assets ratio	0,0116 [0.00430]***	0,0116 [0.00425]***	0,0119 [0.00429]***	0,0139 [0.00459]***	0,0117 [0.00431]***
Log of Assets	-0,168 [0.0240]***	-0,168 [0.0244]***	-0,17 [0.0248]***	-0,19 [0.0251]***	-0,172 [0.0240]***
Equity Volatility	0,0166 [0.00206]***	0,0182 [0.00238]***	0,0185 [0.00242]***	0,0187 [0.00252]***	0,016 [0.00206]***
Log of Time to Maturity	0,487 [0.0596]***	0,5 [0.0607]***	0,509 [0.0619]***	0,499 [0.0674]***	0,496 [0.0602]***
Debt to Assets x Log of Time to Maturity	-0,00582 [0.00142]***	-0,00622 [0.00146]***	-0,00642 [0.00149]***	-0,00607 [0.00163]***	-0,00605 [0.00143]***
GDP growth (t-1)	-0,0157 [0.00540]***	-0,0161 [0.00625]**	-0,0271 [0.00824]***	-0,0208 [0.00736]***	-0,0141 [0.00615]**
Log of GDP per Capita (t-1)	0,352 [0.498]	0,487 [0.487]	0,556 [0.532]	0,681 [0.518]	0,454 [0.507]
Constant	-1,656 [4.522]	-2,898 [4.426]	-3,598 [4.826]	-4,759 [4.663]	-2,52 [4.602]
Observations	1503	1453	1447	1416	1503
R-squared	0,772	0,778	0,78	0,783	0,773
Root MSE	0,334	0,333	0,333	0,331	0,333

Standard errors in brackets

* p<0.10, ** p<0.05, *** p<0.01

Table 4. Corporate Spreads: Banking Crises and Interactions

Dependent variable: log of the Option adjusted spread (OAS)

	(4,01)	(4,03)	(4,04)	(4,05)	(4,06)
Banking Crisis Dummy	0,192 [0.0387]***	-0,0409 [0.119]	0,409 [0.0794]***	0,471 [0.227]**	0,0803 [0.0647]
Non Performing (t-1) x Banking Crises		1,643 [0.823]**			
Provisions (t-1) x Banking Crises			-0,335 [0.121]***		
Regulatory Capital (t-1) x Banking Crises				-2,013 [1.563]	
Credit to GDP (t-1) x Banking Crises					0,105 [0.0431]**
Log of EMBI	0,214 [0.0847]**	0,184 [0.0831]**	0,192 [0.0849]**	0,291 [0.0721]***	0,22 [0.0854]**
Log of EMBI x Log of Time to Maturity	-0,0774 [0.0202]***	-0,058 [0.0187]***	-0,0591 [0.0189]***	-0,0741 [0.0203]***	-0,0796 [0.0204]***
EBIT to Assets ratio	-0,0474 [0.0115]***	-0,0454 [0.0121]***	-0,0452 [0.0122]***	-0,0444 [0.0132]***	-0,0491 [0.0117]***
Equity to Capital ratio	-0,0105 [0.00308]***	-0,0112 [0.00309]***	-0,0111 [0.00311]***	-0,00986 [0.00317]***	-0,0106 [0.00307]***
Debt to Assets ratio	0,0117 [0.00430]***	0,0117 [0.00425]***	0,0119 [0.00431]***	0,0141 [0.00457]***	0,0119 [0.00432]***
Log of Assets	-0,17 [0.0235]***	-0,171 [0.0243]***	-0,174 [0.0249]***	-0,194 [0.0245]***	-0,174 [0.0238]***
Equity Volatility	0,0164 [0.00203]***	0,0181 [0.00237]***	0,0183 [0.00240]***	0,0185 [0.00251]***	0,0159 [0.00206]***
Log of Time to Maturity	0,49 [0.0594]***	0,502 [0.0606]***	0,506 [0.0618]***	0,502 [0.0671]***	0,496 [0.0601]***
Debt to Assets x Log of Time to Maturity	-0,00587 [0.00141]***	-0,00626 [0.00146]***	-0,00634 [0.00149]***	-0,00613 [0.00162]***	-0,00602 [0.00143]***
GDP growth (t-1)	-0,0153 [0.00539]***	-0,0155 [0.00594]***	-0,0216 [0.00694]***	-0,0202 [0.00604]***	-0,015 [0.00576]***
Log of GDP per Capita (t-1)	0,317 [0.492]	0,406 [0.479]	0,257 [0.490]	0,669 [0.463]	0,444 [0.482]
Constant	-1,267 [4.451]	-2,077 [4.339]	-0,758 [4.442]	-4,552 [4.173]	-2,345 [4.359]
N	1503	1453	1447	1416	1503
r2	0,771	0,778	0,778	0,782	0,772
rmse	0,334	0,333	0,334	0,331	0,334

Standard errors in brackets

* p<0.10, ** p<0.05, *** p<0.01

Table 5. Corporate Spreads: Credit Booms

Dependent variable: log of the Option adjusted spread (OAS)		
	(4,01)	(4,02)
All Crisis Dummy	0,221 [0.0381]***	0,0909 [0.0731]
Credit to GDP (t-1) x Banking Crises		0,0986 [0.0477]**
Credit to GDP (t-1) x Other Crises		0,322 [0.192]*
Log of EMBI	0,212 [0.0852]**	0,219 [0.0857]**
Log of EMBI x Log of Time to Maturity	-0,0799 [0.0202]***	-0,0796 [0.0201]***
EBIT to Assets ratio	-0,0487 [0.0113]***	-0,0496 [0.0115]***
Equity to Capital ratio	-0,0106 [0.00306]***	-0,0107 [0.00305]***
Debt to Assets ratio	0,0116 [0.00428]***	0,0117 [0.00430]***
Log of Assets	-0,167 [0.0233]***	-0,171 [0.0239]***
Equity Volatility	0,0164 [0.00202]***	0,0161 [0.00206]***
Log of Time to Maturity	0,492 [0.0592]***	0,497 [0.0599]***
Debt to Assets x Log of Time to Maturity	-0,00593 [0.00141]***	-0,00605 [0.00143]***
GDP growth (t-1)	-0,0184 [0.00553]***	-0,0157 [0.00581]***
Log of GDP per Capita (t-1)	0,595 [0.499]	0,482 [0.501]
Constant	-3,886 [4.511]	-2,779 [4.540]
Observations	1503	1503
R-squared	0,773	0,773
Root MSE	0,333	0,333

Standard errors in brackets

* p<0.10, ** p<0.05, *** p<0.01