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Financial Stability in Brazil[*]

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Abstract

This paper proposes a working definition for "financial stability" related to systemic risk. Systemic risk is then measured as the probability of disruption of financial services taking into account its time and cross-sectional dimensions and several risk factors. The paper discusses the implications of this definition for Brazil in the aftermath of the recent global financial crisis. A comparison with the United States and the Euro zone is provided. In addition, systemic risk in the Brazilian credit market is investigated given its crucial role as main financial stability driver. Finally, synthetic indicators of systemic risk are used to monitor financial stability. The link between systemic risk and synthetic indicators and/or well-correlated proxies (e.g., a credit-to-GDP gap) allows the calculation of the probability of disruption of the financial system across its time dimension. Therefore, if a Financial Stability Committee and/or the prudential regulator define its tolerance level for "financial stability" as a threshold measured by this probability of disruption, it might have the capability of determining the precise moment when it should strengthen its set of adequate macroprudential responses and policies.

JEL Classification: C15, E44, E58, G01, G18, G20, G28
Keywords: Systemic Risk, Financial Stability, Risk Factor

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Introduction

The global financial crisis identified, among many, at least four specific issues for supervisors and regulators of financial systems worldwide. First, microprudential tools[1] are insufficient to ensure financial stability. Before the crisis, the common view was that the existing financial regulation and supervision could maintain the stability of all individual institutions. The crisis showed that ensuring compliance at the individual institution level does not guarantee that the financial system as a whole is stable. Therefore and second, an overarching policy framework was absent before the crisis, which would be responsible for systemic financial stability; this systemic approach is now labeled macroprudential policy. But then, the third issue is what exactly do we mean by "financial stability"? In most cases, what implicitly comes to one's mind are features of financial "instability" such as bubbles in asset prices, excessive leverage by banks, etc. This lack of precision calls for a clear definition of financial stability in order to define an objective for macroprudential policy. The last and fourth issue is whether macroprudential policy needs to complement other policies (for example monetary policy) to ensure financial (and simultaneously) price stability.

Indeed, regarding financial stability, there is so far no agreed upon definition despite numerous instruments to conduct direct intervention in markets and many indicators of financial instability. Instruments range from liquidity or credit control measures, up to requirements for margin and capital adjustments, among many others. Moreover, the transmission mechanisms of such instruments are not well understood[2] and the Financial Stability Reports (FSR) exhibit worldwide different views regarding areas of financial system fragility and the likelihood of crises in specific markets[3].

In Brazil, the global financial crisis has spurred renewed efforts in the task of monitoring financial stability. In order to address the issue, the Central Bank of Brazil (BCB) established in 2011 a Financial Stability Committee[4] to coordinate and strengthen the supervision of the financial industry and reduce systemic risk. In addition, BCB has been publishing a semiannual FSR that describes the dynamics of the National Financial System (SFN) and, analyzes its resilience to eventual shocks, as well as its projected evolution.

In this paper we provide our specific definition of financial stability (Section 1), using existing definitions, including the associated notion of systemic risk, in the current literature and reports. Then we proceed in Section 2, to define the time and cross-section dimensions of systemic risk. In Section 3, the areas of vulnerabilities and of financial (in)stability are discussed. In Section 4 a comparison of systemic risk indicators is provided for Brazil, the US and the Euro Area offering a perspective of vulnerabilities and systemic risks based on selected credit market

[1] We define hereby microprudential instruments as any regulatory provision that sets binding constraints to the balance sheet of individual financial institutions and affects its behavior (e.g., minimum regulatory capital, maximum leverage ratio, maximum loan-to-value ratio, debt-to-income of potential borrowers, etc.)

[2] See Agénor P.R. and L. Pereira da Silva (2011).

[3] See Goodhart (2011) for a detailed discussion.

[4] The duties of the new committee are to guide the central bank's committee on regulation and supervision of financial markets, capital, insurance, private pension plans and other similar national and international forums, maintain financial stability by defining strategies and guidelines for the conduct of the central bank, allocate responsibilities between the internal units involved, to ensure integrated and coordinated action, and to order ongoing studies, research and work on financial stability and preventing systemic risk. See http://www.bcb.gov.br/?FINANCSTAB for further details.

indicators. In Section 5, we examine financial conditions in Brazil in light of the current macroeconomic setup, we detail a frequent indicator of financial (in)stability, focusing on the credit market. In Section 6, a broad synthetic indicator of financial stability is constructed in relation to systemic risk with an estimated probability of disruption of financial services. That probability, in turn, could be used to define policy guidelines and objectives.

1. A "Working" Definition for "Financial Stability"

"Financial stability" has become, especially in the light of the global financial crisis, an explicit objective of central banks and other public authorities (see Allen and Wood (2005)). For instance, the Bank of England used the term in 1994, to denote those of its objectives which were distinct from price stability or from the efficient functioning of the financial system. Many central banks and/or regulatory agencies have within their mandate the obligation to ensure "financial stability".

Mishkin (1991), *apud* Allen and Wood (2005), defines financial stability as "*the prevalence of a financial system, which is able to ensure in a lasting way, and without major disruptions, an efficient allocation of savings to investment opportunities*." More recently, Houben *et al*. (2012) argue that financial stability refers to the ability of the financial system to help the economic system allocate resources, manage risks and absorb shocks. But now almost twenty years after these proposed definitions, there is still no widely-accepted definition of "financial stability" and therefore, equally, no consensus across central banks and regulatory agencies on what policies should be pursued in the interest of financial stability.

Indeed, according to the Bank for International Settlements (BIS) – Committee on the Global Financial System (CGFS) (2010), there is no commonly shared definition of financial stability, towards which macroprudential policies would be geared. Alternative definitions would include robustness of the financial system to external shocks or to shocks originating within the financial system, and the vulnerability to financial distress in response to normal-sized shocks (or even larger ones). [5] We therefore propose the following definition.

Definition 1 of Financial Stability[6]: a financial system is "stable" when it continues performing its functions – e.g., maturity transformation, allocation of savings, etc. – across a time dimension (e.g., growing in a sustainable way across the financial cycle) without building-up systemic risk measured across its cross-section dimension. "Stability" requires also that when the system is submitted to a normal-sized shock (or even larger shocks up to a certain defined threshold) it would be resilient and return – within some timeframe – to its previous functioning pattern.

[5] Alternative definitions for financial stability could also be proposed within an analytical equilibrium setup including, for example, welfare and social costs issues, externality mechanisms and related policy instruments, efficiency issues (e.g., financial deepening and/or more complete markets increasing welfare), among many others relevant and related topics [see Borio and Drehmann (2009) for further details].

[6] In physics and in asynchronous distributed decision-making (ADDM) systems, a complex system is defined as a stable system if it returns to a steady state in finite time, following a shock or perturbation, provided that it is initiated in a steady state. Equilibrium or steady state have to be defined by measurement as well as "perturbation".

This definition requires, in turn, specifying "what is systemic risk"? One definition from the post-crisis work by the International Monetary Fund (IMF), the Financial Stability Board (FSB) and the BIS for the G20 defines it as "*a risk of disruption to financial services*[7] *that is caused by an impairment of all or parts of the financial system and has the potential to have serious negative consequences for the real economy*". Indeed, the notion of financial stability is often discussed in terms of the concept of systemic risk and its sources, for which again there is no consensus definition. The above-mentioned definition of systemic risk translates into the mapping of vulnerabilities by component (the "parts") of the financial sector that can cause potentially the "impairment" of the system mentioned above. We therefore propose our own definition of "systemic risk".

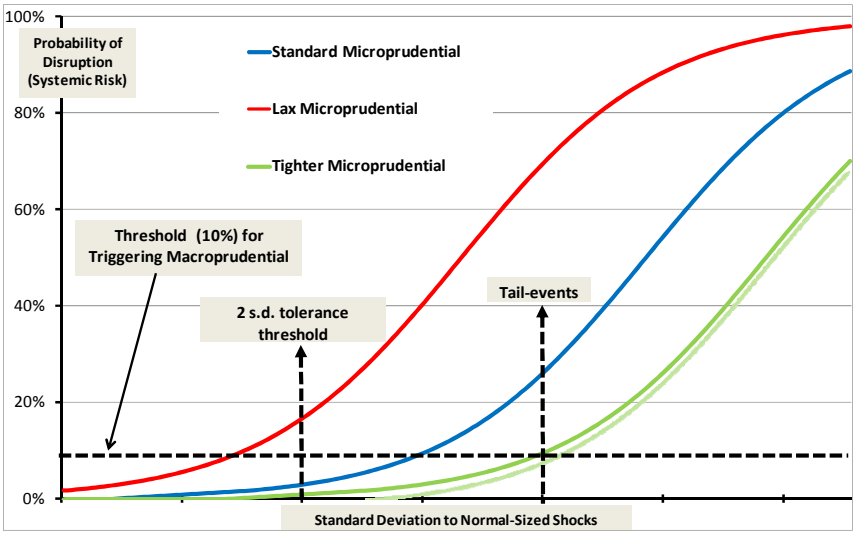
Definition 2 of Systemic Risk: systemic risk is measured by the probability of disruption of financial services, when the system is submitted to shocks, related to vulnerabilities such as inadequate leverage and levels of liquidity, and highly correlated co-movements of asset quality in the balance sheet of financial institutions, exacerbated by their interconnectedness and occurring despite the set of microprudential regulatory constraints that individual institutions have to comply with.

Therefore, systemic risk should be captured by a "probability of disruption" given a set of risk dimensions (e.g., time and cross-sectional), measured within an institutional and regulatory microprudential setup[8] and estimated according to the magnitude of shocks. Suppose, as an example, that we define a tolerance level of 2 standard deviation (s.d.) from normal-sized shocks (observing the past history of a financial system) as a reference to test a system's stability. Suppose also that we have – through stress-test – a mapping of the probability of disruption of the system and we define a tolerance threshold of say 10%. In a normal financial cycle, a financial system by itself and under its own set of standard microprudential regulations, should have its level of endogenously generated systemic risk below the agreed upon threshold. This corresponds, respectively in the figures 1 and 2 (diagram) below to the blue line and Situations of Type I. There could be, however, Situations of Type II portrayed by the red line. The probability of disruption might exceed a reasonable threshold (say within the 2 s.d. normal-sized shocks boundary). That may arise either because the system is not resilient or because potential for the built-up of vulnerabilities exists under the applicable set of microprudential regulation. This could occur for the following reasons: (1) the coverage of vulnerabilities is not complete: there are one or more dimensions of vulnerability that has been missed by microprudential regulators; (2) the coverage of vulnerabilities is adequate but the level or tightness of the overall microprudential regulation framework is not appropriate; and (3) both problems apply.

[7] See BIS-CGFS (2010), for these purposes, "financial services" include credit intermediation, risk management and payment services.

[8] Stress tests, for example, in some sense are supposed to capture this probability (depending on how they are conducted).

Figure 1: Stylized Probability of Disruption in a Financial System due to Systemic Risk



Definition 3 of Macroprudential Regulation: we define macroprudential regulation or approach as the set of policies and instruments that calibrate existing microprudential rules and/or extend them to cover exhaustively all dimensions of vulnerabilities in a financial system in order to put systemic risk below an agreed upon threshold.

For example, in our Figure 1 above, a tightening of regulations, i.e. the utilization of a macroprudential approach is portrayed by the green line. It should reduce the probability of disruption significantly, perhaps even in areas beyond the occurrence of "tail events". Therefore, there is a relationship between financial stability and systemic risk in the sense that we recognize that any financial system builds inherently some degree of systemic risk across the cycle but there is a level of systemic risk beyond which the probability of "disruption" becomes too high. For policy-makers defining the threshold beyond which this probability is indeed too high and the specific vulnerabilities associated with it is paramount in order to trigger macroprudential policy action.

Figure 2: Diagram of Macroprudential Regulations

		Normal Financial Cycle	Normal-sized Shock < 2 s.d.	Larger Shock > 2 s.d. & < 4 s.d.	Tail Event > 4 s.d.
Situation of Type I	Microprudential regulation	System Stable, Probability of disruption small	System Stable, Probability of disruption higher	System Stable (?), Probability of disruption (?)	System Unstable, Probability of disruption > threshold
	Macroprudential regulation	No need	No need	Some need	Imperative Requirement
Situation of Type II	Microprudential regulation	System Stable (?), Probability of disruption (?)	System Stable (?), Probability of disruption (?)	System Unstable, Probability of disruption > threshold	System Unstable, Probability of disruption > threshold
	Macroprudential regulation	Some need	Some need	Imperative Requirement	Imperative Requirement

Regardless of the definition adopted,[9] financial stability is difficult to measure, and is clearly affected by other policy areas such as monetary policy and fiscal policy. As a result, macroprudential policy can contribute to financial stability, but it cannot guarantee the delivery of this objective on its own. The focus of macroprudential policy is on systemic risks, which is investigated in the following section along distinct dimensions.

2. Time and Cross-Section Dimensions of Systemic Risk

Systemic risk is usually divided for analytical purposes into a time dimension and a cross-section dimension.

According to Houben *et al*. (2012) the time dimension deals with the evolution of aggregate risk in the financial system over time. Looking at diagram above (Figure 2), it means understanding the dynamics of the "blue curve" (representing systemic risk under standard microprudential regulations): would the curve shift towards the "red line" over the financial cycle, i.e. building more vulnerabilities endogenously? This property refers to "pro-cyclicality", a tendency of financial agents to assume excessive risk in the upswing and then to become overly risk averse in the downswing. Accordingly, this characteristic is illustrated by the cyclical patterns in the leverage and maturity mismatch positions in the financial system – a credit and liquidity cycle. The cross-section dimension, on the other hand, is related to the distribution of risk across the financial system at a given point in time, and has to be understood looking at the interconnectedness and resilience of the market structure.

Smets (2011) in turn argues that although the time dimension of systemic risk consists in investigating the build-up of financial imbalances in booms and its unraveling features in busts, while the cross-section dimension analyzes contagion in interconnected financial systems, the real challenge is how to properly link these two perspectives.

Borio (2011) brings to the discussion the so-called "paradox of financial instability": the system appears robust precisely when it is in fact the most vulnerable. According to the author, credit growth and asset prices are unusually strong, leverage measured at market prices artificially low, and risk premia and volatilities unusually low precisely when risk is at its highest. What looks like a low level of systemic risk is, in fact, a sign of aggressive risk-taking by agents. The experience of the recent global financial crisis provides a good example. This perspective is somehow discouraging because it means that assessing the probability of disruption using existing market price signals would be misleading.

In this context, the best leading indicators of financial distress in its time dimension try to turn the Borio paradox to the policy-makers' advantage. Borio (2011) stresses that indicators such as credit-to-GDP gaps and asset prices calculated using as benchmarks their historical norms provide reasonably reliable signals of systemic financial distress over horizons that vary between two-to-four years. Unfortunately, using similar approaches, macro-stress tests have so far failed to effectively identify these risks, probably due to their inability to capture the highly non-linear behavior of prices and quantities during crises owing to the shortcomings of existing macro models.

[9] See Allen and Wood (2005) for a detailed discussion on desirable features of a definition of financial stability.

Nonetheless, while the "paradox of financial instability" advises us to not use raw market prices in the time dimension, it does not prevent policy-makers using them to assess the cross-sectional dimension of systemic risk. In fact, there is a vast empirical literature suggesting that market prices have the ability to measure relative risk, which can be a powerful tool for policy makers to help calibrating prudential tools with respect to the systemic significance of individual financial institutions (see Borio, 2011). In practice, several cross-section measures of systemic risk (such as correlations or other measures of interdependence) are indeed based on market prices, and are usually complemented with inputs from supervisors, such as probabilities of default.

3. Areas of vulnerabilities and of Financial (In) Stability

Houben *et al*. (2012) state that making macroprudential policy operational is a major policy challenge. It means *inter alia* specifying – according to our definition of financial stability and systemic risk – what are the policy-makers' acceptable thresholds for the probability of disruption of its financial system (e.g., 10%? 20%? etc.) associated with an acceptable level of stress (e.g., 2 s.d., 3 s.d. for shocks) and under the existing set of microprudential regulations. Our definition 3 states that a macroprudential approach simply tightens the existing microprudential rules and/or extends their reach to cover all the areas of vulnerabilities in a given financial system.

One of the steps involved is to specify a policy strategy, which links the objectives of macroprudential policy to intermediate objectives and presumptive indicators for risk identification and instrument selection. Operational macroprudential policy requires concrete intermediate objectives, effective and efficient policy instruments for achieving these indicators, that prompt policy implementation and accountability mechanisms. Those, in turn, validate the much needed operational independence of regulators and central banks.

According to the authors, in essence, there are three groups of intermediate policy objectives, the first comprising leverage and credit, the second liquidity and funding and the third the resilience of the market structure. The third can be further divided into common exposures, "too big to fail" bail-out expectations and interconnectedness through the financial infrastructure.

In this regard, the CGFS segregates the vulnerabilities of financial stability into three main categories: leverage, liquidity (or market risk) and interconnectedness. Addressing the mentioned time series and cross-sectional dimensions of systemic risk requires different types of instruments. Ideally, a relatively small set of indicators would provide reliable early warning signals of financial fragilities. In practice, however, given the elevated uncertainty regarding the build-up of risk according to several indicators, enhancing the toolkit available to policy-makers might be a good approach.

According to BIS-CGFS (2010), a key element of developing macroprudential instruments is to adapt existing microprudential tools, such as strong prudential standards and limits on activities that increase systemic vulnerabilities and risks. These standards and limits might be occasionally altered, or adjusted in a countercyclical manner, especially with a view to "leaning against the financial cycle". When that is the objective, the instruments would be properly adjusted (dynamically) in response to changing assessments of financial risks. Adjustments

would need to occur both on the upswing, when vulnerabilities are growing, and on the downswing, when risks of a destabilizing credit contraction or crunch are rising.

The referred BIS-CGFS document also argues that existing microprudential instruments could be used for promoting financial system resilience. They can be recalibrated to limit the financial system's exposure to shocks. In this category, instruments include capital and liquidity requirements, leverage limits, constraints on currency mismatches, and measures that strengthen financial infrastructure. Table 1 presents some examples of macroprudential instruments, classified by the main risk factors they influence (or constrain) and by the financial system component they apply to.

Table 1: Macroprudential instruments by vulnerability and financial system component

		Financial system component				
		Individual Bank or deposit-taker		Non-bank investor	Securities market	Financial infrastructure
		Balance sheet*	Lending contract			
Vulnerability	Leverage	capital ratio	Loan-to-Value (LTV) cap			
		risk weights	debt service / income cap			
		provisioning	maturity cap			
		profit distribution restrictions	margin/haircut limit			
		credit growth cap				
	Liquidity or market risk	liquidity / reserve requirements	valuation rules (eg. MMMFs)	local currency or FX reserve requirements	central bank balance sheet operations	exchange trading
		FX lending restriction				
		currency mismatch limit				
		open FX position limit				
	Interconnectedness	concentration limits				central counterparties (CCP)
		systemic capital surcharge				
		subsidiarisation				

Source: BIS-CGFS (2010). *Capital and other balance sheet requirements also apply to insurers and pension funds, but we restrict our attention here to the types of institutions most relevant for credit intermediation.

In order to guide the adequate utilization of macroprudential instruments, systemic risk indicators are necessary to properly map the potential areas (or sectors) of increasing risk across the financial system. The key question is whether (in practice) the available indicators are sufficiently reliable. Both Goodhart (2011) and Borio (2011), *apud* Houben *et al*. (2012), point out to readily available data related to leverage, credit growth, housing and property prices, and perhaps also funding and liquidity. Indeed, these data are regularly used in Financial Stability Reports (FSRs) to indicate emerging risks. However, these available indicators might not be adequate to deal with extreme (tail) events, in which the relationship between macroeconomic and financial variables might change dramatically. In this case, tail risk measures would be indicated.[10] Apart from the difficulty of adequately identifying when a risk becomes excessive (and how much policy intervention is needed), empirical research is necessary in order to deepen our understanding of leading indicators and transmission channels.

[10] There is a fast growing literature on systemic risk, especially on tail risk related indicators. Just to mention some recent papers: Schechtman and Gaglianone (2012) shift the focus of financial stability monitoring from the usual conditional mean of a specific credit indicator to the conditional tail of this indicator based on quantile regressions. Adrian and Brunnermeier (2011) propose a measure for systemic risk so-called CoVaR, which is the value-at- risk (VaR) of the financial system conditional on institutions being under distress. More recently, Lopez-Espinosa et al. (2012) extended the CoVaR measure to capture the asymmetric response of the banking system to positive and negative shocks, capturing non-linear tail co-movement between system-wide and individual bank returns.

4. Comparison between financial systemic vulnerabilities in Brazil and the US and the Euro zone

In this section, we present a selected set of systemic risk indicators according to BIS-CGFS (2010) for Brazil, United States and Euro zone.[11] We use as proxy for leverage the credit-to-GDP gap, and for liquidity the loan-to-deposit (LTD) ratio. Interconnectedness is also analyzed based on individual network data from interbank transfers. A broad view of asset prices (stocks and property prices) along the three considered regions is also provided with the objective of investigating a possible temporal (lagged) relation between credit-to-GDP gap and asset prices, as often suggested in the literature (e.g., Borio, 2011). Finally, non-performing loan (NPL) series together with selected indicators (e.g., capital adequacy) are presented for comparison purposes.

4.1 Leverage

Financial development is commonly measured by the credit-to-GDP ratio. A useful leverage indicator extracted from this series is the credit-to-GDP gap[12], which is defined by the difference between the observable credit-to-GDP ratio and its estimated trend. According to Smets (2011), the credit-to-GDP gap can also be used as an early warning indicator and be helpful to calibrate macro-prudential policy responses (e.g., countercyclical capital buffers).

Several methods can be used to obtain the credit-to-GDP trend, such as linear trend techniques, quadratic or cubic trends, cubic splines and time series filters (e.g., Hodrick-Prescott (HP) and band-pass filters). In this paper, we adopt the HP filter for practical purposes despite its well known drawbacks (e.g., end-point unreliable estimation). [13] In addition, this is the trend extraction method often used in the MVTF's Consultative Documents.[14]

Based on annual data from the World Bank, a broad picture of the credit-to-GDP ratio of the three considered regions is shown in Figure 3. We can note the relatively low level of Brazilian credit in comparison to that of the US and the Euro area. Indeed, the domestic credit to the private sector (in % of GDP) in Brazil was reported by the World Bank as much lower than figures reported for the US (e.g. at 201% in 2010) and the Euro area (e.g. at 134% in 2010). Domestic credit to the private sector refers to all financial resources provided to the private

[11] The Euro zone (Euro area) refers to a monetary union among the European Union member states that have adopted the euro as their sole official currency. It currently consists of 17 countries: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain.

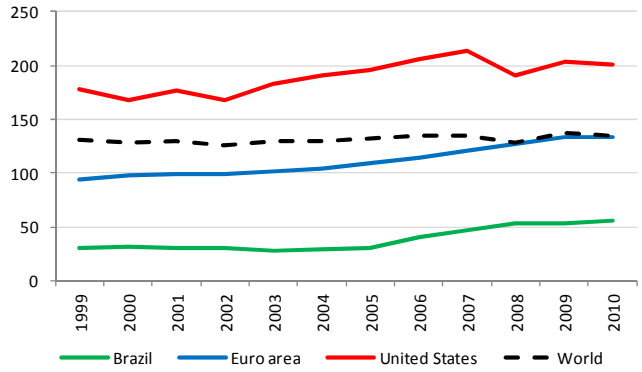
[12] For instance, there is an advantage of using a measure of excessive credit growth as a proxy for leverage if the main concern is about the resilience of the financial system to withstand a productivity (income) shock. Nonetheless, a drawback of this indicator is that credit-to-GDP gap possible accounts for risk-taking on both the asset and liability sides of the financial institutions' balance sheet. In addition, financial stability (for example) can also be impaired by dysfunctional money markets triggered by excessive risk taking by banks/other financial institutions (shadow banks). In this case, a measure of the heightened reliance of leverage by financial institutions (rather than by the nonbank private sector) should also be considered.

[13] A deeper empirical investigation should consider, for instance: (i) a robustness analysis of the credit gap estimation based on competing trend extraction techniques; (ii) recalibration of the adopted filters according to relevant credit cycle frequencies (which are often different from the business cycle ones); (iii) a forecast device to deal with the end-point issue by using (for example) an out-of-sample projection instead of the (in-sample) last HP-filtered trend point.

[14] Basel Committee's Macro Variables Task Force (MVTF).

sector, through loans, purchases of nonequity securities, and trade credits and other accounts receivable that establish a claim for repayment.

Figure 3: Domestic credit to private sector (% of GDP)



Source: World Bank (annual data). Domestic credit to private sector refers to financial resources provided to the private sector, such as through loans, purchases of non equity securities, and trade credits and other accounts receivable, that establish a claim for repayment.

Credit-to-GDP increased in Brazil, US and Euro area in comparison to its 2000 levels, but the underlying picture is very different across these regions. Lending conditions tightened noticeably in the Euro area recently, and credit growth slumped in late 2011. Developments were more positive in the United States. In Brazil, it exhibited a significant increase in past years but still remains in a sustainable path.

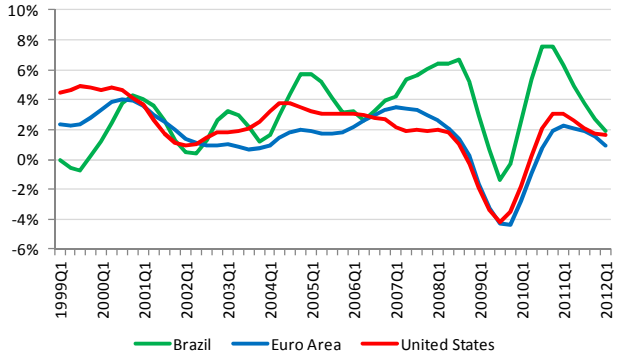
These developments are better understood when real GDP growth rates are analyzed. According to the IMF-WEO (2012), European GDP real growth has slowed sharply, and many economies in the region are now in or close to recession. The United States has seen a spate of encouraging economic news, with GDP growth increasing and unemployment falling. Latin America (and Brazil in particular) has shown resilience to the swings in risk aversion following the developments of the European crisis over recent months.

Table 2: Real GDP growth rate (*annual percent change*)

									IMF Projections		
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2017**
Brazil	5.7	3.2	4.0	6.1	5.2	–0.3	7.5	2.7	3.0	4.1	4.1
Euro Area	2.2	1.7	3.3	3.0	0.4	–4.3	1.9	1.4	–0.3	0.9	1.7
Unite States	3.5	3.1	2.7	1.9	–0.3	–3.5	3.0	1.7	2.1	2.4	3.3

Source: IMF – World Economic Outlook (WEO) – April 2012: Growth Resuming, Dangers Remain.

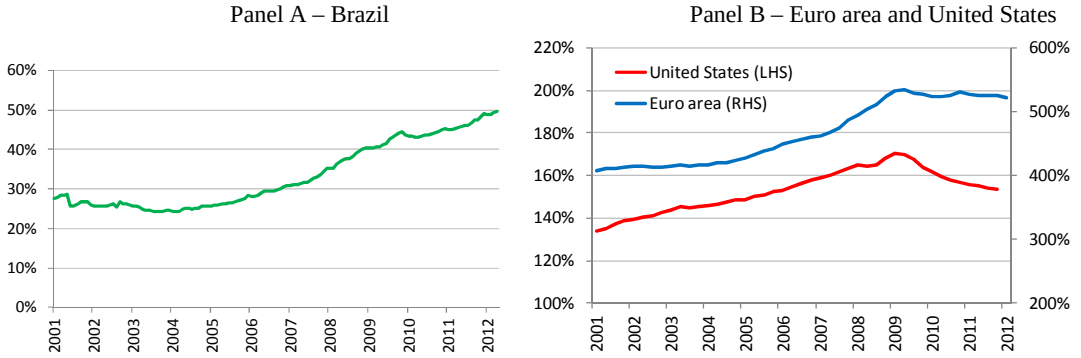
Figure 4: Real GDP growth rates (*annual percent change*)



Sources: Quarterly data from IBGE (Brazil), European Central Bank (ECB – Euro Area) and Bureau of Economic Analysis (BEA – United States).

In order to construct credit-to-GDP gap measures, we use quarterly frequency series. The credit-to-GDP ratio for Brazil is calculated by using financial system credit operations (% of GDP). For the US, we followed Edge and Meisenzahl (2011), in which the credit-to-GDP ratio is based on nominal credit (in the numerator) as the volume of credit market debt outstanding of the non-financial corporate business sector and household and nonprofit organization sector.[15] For the Euro area, we adopt the definition of Smets (2011) based on total Loans to the Euro area residents over nominal GDP.[16] Although these series might not be perfectly comparable, in the sense of using not exactly the same definitions for "credit", and distinct databases, we believe they are able to generate proper gap dynamics, provided that our objective here is to identify periods in which the observed credit-to-GDP series deviated from the estimated trends.

Figure 5: Credit (% of GDP)

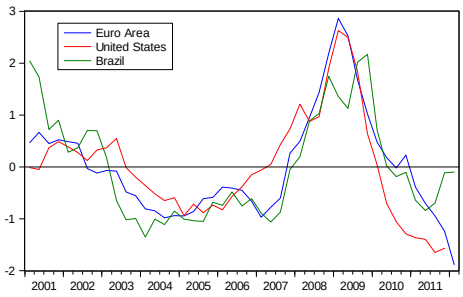


Source: Brazil: Central Bank of Brazil – Financial system credit operations (% of GDP). Earmarked and non-earmarked resources are included. Euro area: MFI Consolidated Balance Sheets (ECB Monetary Statistics) and Quarterly National Accounts (Eurostat). Data refer to the changing composition of the Euro area. USA: Nominal credit (in the numerator) from Federal Reserve Board (FRB) in the Flow of Funds Accounts (FOFAs) and nominal GDP (in the denominator) from the Bureau of Economic Analysis (BEA) in the National Income and Product Accounts (NIPAs).

[15] Nonetheless, the authors argue that *ex-post* revisions to the US credit-to-GDP ratio gap are sizable and as large as the gap itself, and that the main source of these revisions stems from the unreliability of end-of-sample estimates of the series' trend rather than from revised estimates of the underlying data. In this sense, the authors point out for potential costs of gap mismeasurement.

[16] The discrepancy of credit-to-GDP figures of the Euro area between Figures 3 and 5 is due to distinct databases and different concepts for "credit".

Figure 6: Credit-to-GDP gaps (*normalized*)



Source: Authors' calculations. Credit-to-GDP gaps are based on the previously presented quarterly credit-to-GDP series and HP-filter to extract the trends. Gap series are normalized (zero mean and unit variance) for comparison purposes.

Table 3: Correlations between Credit-to-GDP gaps

	Brazil	Euro area	USA
Brazil	1.00	-	-
Euro area	0.83	1.00	-
USA	0.64	0.84	1.00

Source: Authors' calculations. Sample period 2001Q1-2011Q4.

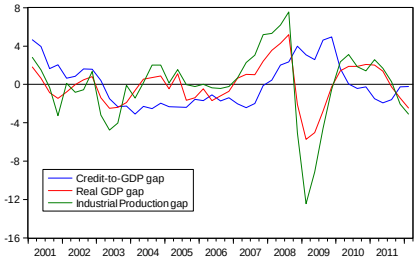
Some interesting features arise from the normalized credit-to-GDP gap comparison. First, one should note the high correlation of Euro area and US gaps, suggesting synchronic credit cycles between the two regions. Moreover, both gap series exhibit end-points with significant negative values, suggesting that their credit-to-GDP ratios could be below their respective trends.[17] The Brazilian credit cycle seems to be more connected to that of the Euro area. Its credit-to-GDP gap appears to be close zero, indicating that Brazil's recent credit growth path might be close to its potential.

According to Borio (2011), the financial cycle can be longer than the business cycle and empirical evidence could shed some light on how different monetary and financial regimes affect the relationship between financial and business cycles. This comparison between financial and business cycles can also be a guide to the more theoretical analysis. In this sense, we provide in Figure 7 and Table 4 a short, simple and naive comparison involving credit-to-GDP, output and industrial production gaps for Brazil, US and Euro zone, using only HP filters (with all the caveats involved) to measure all gaps.

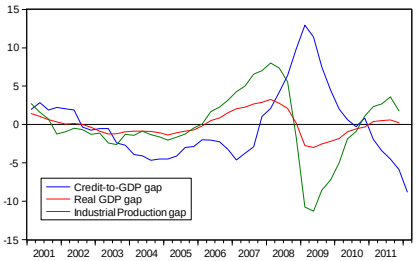
[17] According to IMF-WEO (2012), bank deleveraging is affecting primarily Europe. While such deleveraging does not necessarily imply lower credit to the private sector, the evidence suggests that it is contributing to a tighter credit supply. IMF estimates are that it may subtract another 1 percentage point from Euro area growth this year.

Figure 7: Gap comparison: Credit, GDP and industrial production

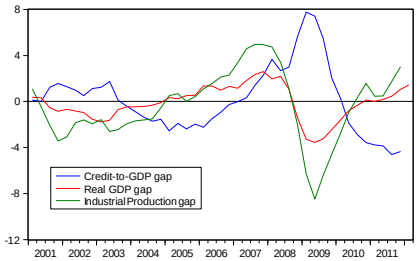
Brazil



Euro Area



United States



Source: Authors' calculations. The HP filter is used to generate all gaps in previous graphs. Credit-to-GDP gap for Euro area is divided by two for comparison purposes. For Brazil it is multiplied by two.

Table 4: Correlations between "gap" measures

	Brazil	Euro area	USA
Credit-to-GDP gap and Output gap	-0.06	-0.20	-0.44
Credit-to-GDP gap and Industrial production gap	-0.20	-0.44	-0.46
Output gap and Industrial production gap	0.94	0.95	0.95

Source: Authors' calculations. Sample period 2001Q1-2011Q4.

The negative signs obtained from correlations between the credit-to-GDP gaps and output (or industrial production) gaps indicate that financial and business cycles are indeed not synchronized. One possible explanation would be the (possible) longer duration of financial cycles. In addition, note that the 2008/2009 crisis imposed, firstly, a negative shock in the business cycles, whereas the credit gaps continued to increase in the same period. Secondly, a few quarters later, only when the business cycles reached its (local) lowest levels, then, the credit gaps suffered the negative crisis impact, leading the credit-to-GDP trajectory towards its historical trend.

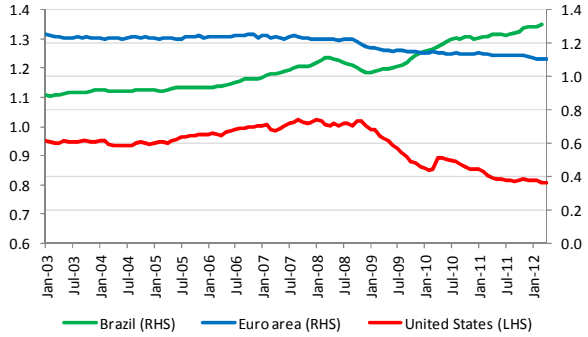
On the other hand, it is worth mentioning that the referred negative signs are higher (in absolute terms) when considering correlation between credit gaps and industrial production gaps than the respective correlations between credit gaps and output gaps. One possible explanation is that output gap includes other sectors besides industrial production (e.g. services) with distinct interactions in respect to credit market dynamics. Finally, it is also worth highlighting that correlations for Brazil are closer to zero, in comparison the US and Euro zone, which is probably due to its relatively lower level of credit-to-GDP and the relevant differences in financial depth across these regions.

4.2 Liquidity

We adopt the Loan-to-deposit (LTD) ratio as our indicator for liquidity risk. Aggeler and Feldman (1998) argue that the liquidity of a bank is usually evaluated by using a host of tools and techniques, but the traditional loan-to-deposit (LTD) ratio is a measure that often receives the most attention by analysts and regulators. According to the authors, it captures the bank's ability to repay depositors and other creditors without incurring excessive costs[18] and while continuing to fund its expansion. An increase in the LTD ratio may indicate that a bank exhibits less of the needed cushion to fund its business growth and to protect itself against a sudden recall of its funding, especially a financial institution that relies on deposits to fund growth.[19]

Although we present LTD series based on different definitions[20] we believe their growth rates can depict reasonably well the broad liquidity characteristics of the financial sectors in the three regions.

Figure 8: Loan-to-deposit ratio (LTD)



Sources: ECB Monetary Statistics (MFI Consolidated Balance Sheets): Total Loans (and Deposits) to (from) Euro area residents. Board of Governors of the Federal Reserve System (Assets and Liabilities of Commercial Banks in the United States – H.8): All commercial banks' LTD is defined as the ratio between loans (and leases) in bank credit and deposits. Central Bank of Brazil: LTD is defined as the ratio between loans and deposits of the financial system.

Table 5: Loan-to-deposit ratio (*annual percent change*)

	2004	2005	2006	2007	2008	2009	2010	2011
Brazil	1.6%	1.2%	3.7%	7.8%	4.0%	-0.9%	12.6%	4.5%
Euro Area	-0.4%	-0.1%	0.8%	-0.6%	-1.6%	-4.9%	-1.4%	-0.8%
United States	-0.7%	1.9%	2.8%	2.1%	0.5%	-8.1%	-6.3%	-5.3%

It should be remembered that European banks historically present high loan-to-deposit ratios. Indeed, the significant decrease in the US LTD series since 2009 is noticeable, confirming the fact that most US banks are currently highly liquid. One element to highlight is the sharp increase of LTD in Brazil in the past few years, mainly due to the source of bank financing. The main issue with Brazil's credit growth over recent years has been the nature of bank financing,

[18] Based on a survey of US banks and regression analysis the authors found that the LTD ratio was highly statistically significant and robust in explaining the likelihood that a bank would refuse a loan: the higher the LTD the more likely a bank would refuse a loan (probably due to liquidity constraints).

[19] It is worth mentioning that LTD ratio might be an adequate measure of liquidity for traditional retail banks that generate most of their operational income from the loan book. However, it is less relevant for banks that hold large trading books under the universal banking model (e.g. French banks) or for banks which are particularly active in mortgage lending financed by covered bonds (e.g. Spanish banks). For these banks, a measure of short-term wholesale funding would be more pertinent to capture liquidity risk.

[20] Given the scarcity of database covering the three regions altogether.

with loans backed more by debt issuance than deposits. This has led to a rapid increase in commercial banks' loan-to-deposit ratio and has created a system where many lenders (particularly smaller-sized banks) to a great extent are reliant on government-backed loans. Therefore, despite the current high Brazilian and European LTD figures (i.e., LTD ratio>1) it is worth mentioning some important differences between these ratios in respect to the nature of funding. First, Brazilian data regarding net inflows of bank deposits and mutual funds reveals a negative sample correlation, suggesting that resources often remain inside the financial conglomerates, thus, contributing to financial stability.[21] Second, the financial funds in the Euro area have drastically diminished since the 2008/2009 global financial crisis, leading (in some countries) to a fierce banking competition for deposits and the respective ECB reaction afterwards.

The most recent IMF´s Global Financial Stability Report (IMF-GFSR, 2012) states that advanced economy banks have been under pressure to reduce leverage since the outbreak of the subprime crisis, as many institutions had entered the crisis with thin capital cushions and a heavy reliance on wholesale funding. According to the Report, progress has varied in this adjustment process. While institutions in the United States have reduced their leverage and reliance on wholesale funding, Euro area banks still rely more on wholesale funding and, though leverage has been reduced, levels remain elevated. This has left the European banking system more exposed to structural and cyclical deleveraging pressures.

4.3 Interconnectedness

Banking lending networks are one of the most important aspects of financial systems and are one of the main channels of transmission of systemic risk. In fact, small shocks limited only to a few banks can spread by contagion and affect the entire system (Allen and Gale (2000) *apud* Tabak et al. (2011)). In this sense, Georg (2010) argues that one of the lessons from the recent crisis is that the network structure of the banking system has to be taken into account to assess systemic risk.

The fast growing literature on financial networks (see De Nicolò *et al*. (2012)) suggests that high interconnectedness mitigates the impact of small shocks by spreading them but, on the other hand, amplifies large shocks since they can reach more counterparties. According to the referred authors, banks operate in an interconnected system and, consequently, distress or failure of a single bank can affect other institutions. In this sense, spillovers effects arise because of asset price movements, bilateral interbank market exposures or feedback from the real economy.[22]

[21] Monthly data from March 1996 to December 2011 (Source: Central Bank of Brazil). In fact, during recent financial stress periods (e.g., November 1997, June 2002, September 2008) the financial resources from mutual funds massively moved towards banks deposits, returning back to mutual funds after a while, when market conditions normalized. This way, the banking system net outflow was relatively low in stress periods, indicating that Brazilian conglomerates had not faced severe funding issues during these periods. However, the drawback of the conglomerate setup for financial stability is relatively low competition in Brazilian banking sector, in comparison to international standards, high levels of taxation and financial costs, and concentrated controls of credit distribution channels. Therefore, there is a tradeoff between concentration and efficiency in respect to financial stability in Brazil which deserves to be further explored.

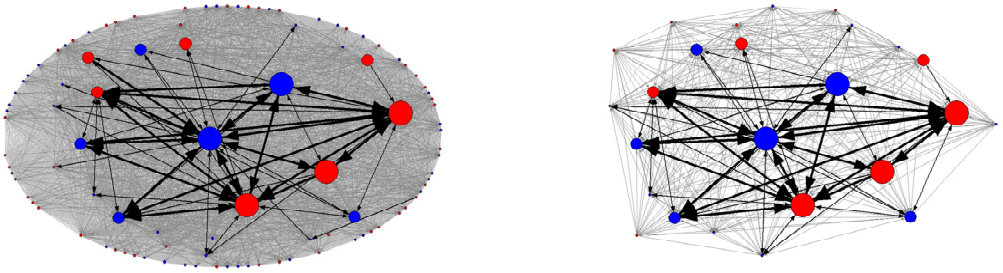
[22] Moreover, externalities provoked by interconnectedness are particularly significant for systemically important financial institutions, since they are often "backbones" of the whole financial infrastructure. It is worth mentioning that, although "systemic importance" has been generally associated with the size of

The interconnectedness of a financial institution inside a network can be measured by the number of other institutions with which it is connected (see Georg (2010, p.6) for a technical discussion).[23] In this section, we present the interconnectedness of the Brazilian, US and Euro area banking system to assess interbank overall exposure.

The Brazilian analysis is based on two interbank funds transfer systems (STR and Sitraf[24]) and considers interbank transfers of financial institutions and conglomerates (transfers between institutions of the same conglomerate are not included). We use data on daily transfers made between financial institutions within the Brazilian financial system for all financial institutions (and conglomerates) that have exposures in the interbank market.

Figure 9: Interconnectedness diagrams of the Brazilian banking system (data-base: 2011Q4)

100 institutions (BRL3.084 trillion) 25 institutions (BRL2.802 trillion)



Source: Central Bank of Brazil. Banking system (B1 and B2 segments) with individual exposure values above BRL1million. Blue (red) circle refers to positive (negative) net position in 2011Q4. Size of the circle indicates size of assets (big circle: above 5% of total assets, medium circle: between 0.5% and 5%, small circle: below 0.5%). Light-gray arrows refer to values up to quantile 50%, dark-gray arrows indicate values between quantiles 50% and 75% and black arrows refer to values above quantile 75%.

The 25 more connected institutions provided over 90% (in terms of value) of total transfers (and eight institutions were responsible for 76% of total transfers in 2011Q4). This evidence indicates a large heterogeneity[25] across banks and supports the hypothesis that Brazilian banking system interconnectedness has a fat tail distribution, in which there are few institutions that are highly connected and, thus, are key in the interbank exposure network.

The degree of interconnectedness of the whole system can be summarized by an index (α) which is proportional to the size of the left tail of the distribution of interconnectedness across financial institutions. In other words, as long as α increases there are more highly connected

financial institutions, recent events suggest a more complex picture: the interconnectedness would be also determined by its interbank market linkages, and its effects amplified by high leverage (see Drehmann and Tarashev, 2011). In addition, interconnectedness may also be present in nonbanking financial systems or institutions that support market infrastructure, such as central counterparty clearing houses.

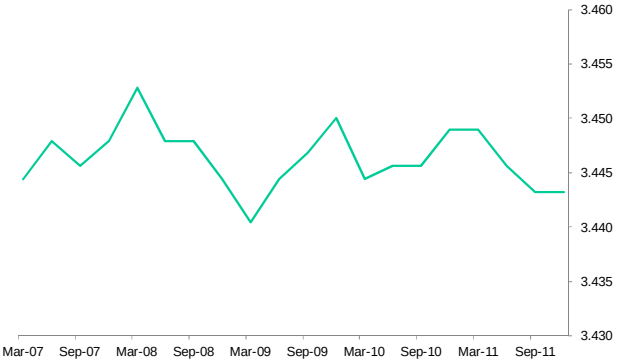
[23] Note that the definition of interconnectedness could be further refined to measure the potential of the interbank market to accelerate a shock's initial impact (e.g. from a defaulting institution) by propagating it through the system. For instance, Li and He (2011) show that tiered interbank market networks and random interbank market networks are more vulnerable against idiosyncratic shocks (e.g. a defaulting institution), while small-world interbank market networks and scale-free interbank market networks are generally more vulnerable against random shocks (e.g. systematic risk).

[24] Reserves Transfer System (Sistema de Transferência de Reservas – STR) and Funds Transfer System (Sistema de Transferência de Fundos – Sitraf). See http://www.bcb.gov.br/?INTERBANK for further information about the systems.

[25] Tabak *et al.* (2011) presents results which suggest that banks pursue different strategies within the interbank network, which may be due to diversity in obtaining funds domestically and internationally.

institutions, indicating that the net is more concentrated (and thus the systemic risk has increased, since an institution highly connected impacts several other institutions in the case of a default[26]). In Brazil, the highly connected institutions tend to be the same along time and the interconnectedness index (α) remained relatively stable in the past few years.

Figure 10: Interconnectedness index (α)



Source: Central Bank of Brazil.

Next we present some summary statistics of a broader Brazilian interbank network. The vertices (nodes) of the network are the commercial banks, and the edges are interbank loans between two banks. The value *in-degree* is a measure for the liabilities of a node while the value *out-degree* is a measure for its assets.

Table 6: Brazilian interbank network

Network statistics	2008Q4	2009Q4	2010Q4	2011Q4
Vertice	128	135	136	136
Edge	1,106	1,132	1,144	1,403
Max Out-degree	79	100	104	103
Max In-degree	48	43	48	64
Average Diameter	2.08	2.05	2.06	1.98
Exposure values (R$ billion)	114.4	95.2	115.4	137.9
Exposures/Fundings	5.7%	4.5%	4.2%	4.2%

Source: Central Bank of Brazil. Banking system (B1, B2 and B4 segments).

There is an increase in the number of edges (in comparison to the number of vertices) which might be a signal of financial deepening (and thus a signal of an augmented degree of complexity of the banking system as a whole). Nonetheless, the ratio between exposures and fundings has slightly decreased in the same period.

Tabak *et al*. (2011) provide more results on Brazilian interbank networks and investigate the concept of directed clustering coefficients as a measure of systemic risk in complex networks. The authors explore data from the Brazilian interbank network and show that the way through which banks make clusters of lending relationships has a different impact in terms of systemic risk, although systemic risk within this market seems to be very limited.

[26] Although the mentioned impact should be balanced by the capacity of the network to diffuse systematic shocks (see Allen and Gale, 2000).

Drehmann and Tarashev (2011) develop a measure[27] of systemic importance for international banking systems that accounts for the extent to which a bank propagates shocks across the system and is vulnerable to propagated shocks. An empirical exercise based on 20 large internationally active banks suggests that systemic importance greatly depends on the bank's role in the interbank network, both as a borrower and as a lender. On the other hand, regarding the international banking systems' deleveraging process observed in latest years, a recent paper by Singh (2012) argues that it would be grounded on a decline in the interconnectedness in the pledged collateral market as well as on the overall shrinking of balance sheets.[28]

Regarding the Euro area, the ECB´s 2012 Financial Stability Report (ECB-FSR, 2012) presents a financial network (static) analysis based on existing data for the Euro area, showing a banking structure which is well integrated across countries, with some banks playing an important role at the Euro area level while others have a more domestic focus. On the other hand, the Report also shows a dynamic network modeling approach, which can illustrate important aspects and fragilities of interbank activity[29] in a simulated network (in the absence of real micro data) used for stress testing purposes.[30] It is worth mentioning that this is a unique application of conceptual and analytical techniques that have only recently been introduced in financial analysis.

Table 7: Euro Area interbank network

Metrics at the network level	
Average number of links	69.640
Density	0.005
Average path length	2.510
Cluster coeffi cient	0.126
Weighed cluster coefficient	0.291
Assortativity	-0.410
Diameter	7.000

Source: ECB-FSR (2012, p.128). Refers to March 2012.

Overall, measures at the network[31] and node levels confirm that the security network has a centralized structure, with some important banks connected with many other peripheral ones.

[27] Based on Shapley values, this measure gauges the contribution of interconnected banks to systemic risk, in contrast to other measures proposed in the literature.

[28] Singh (2012) suggests a decomposition of deleveraging into two components: (i) the shrinking of balance sheets (due to increased haircuts/shedding of assets) and (ii) the reduction in the interconnectedness of the financial system, which has been contributing towards the higher credit cost to the real economy. In this sense, the author investigates the second aspect of deleveraging and shows that (post-Lehman) there has been a significant decline in the interconnectedness in the pledged collateral market between banks and nonbanks.

[29] The ECB´s 2011 Financial Stability Report (ECB-FSR, 2011) argues that evidence from the collateral held at the ECB supports the image of a highly interconnected banking system with respect to cross-holdings of bank securities. In this sense, one finds evidence of the key importance of a few core institutions for drawing funding from "satellite" banks across the Euro area, as only disproportionately few banks' bonds continue to be widely used as collateral. This reveals the significant potential impact that the default of one such core issuer would have on the system.

[30] The idea is to exploit information on the microstructure of banking activities to characterize the robustness of the banking sector to operating shocks.

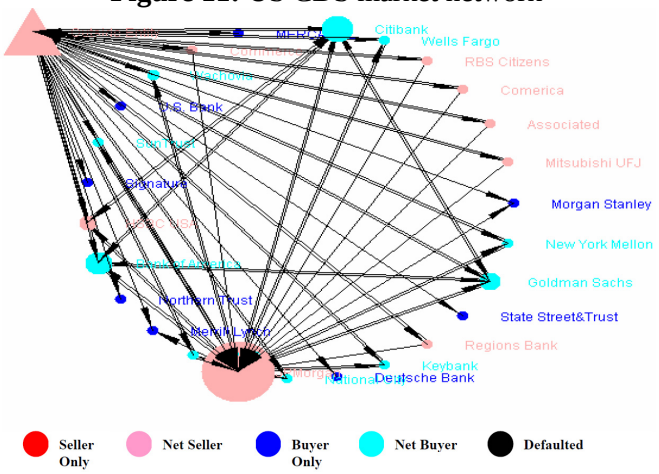
[31] The present analysis relies on observations which are available on a weekly basis starting in October 2008 (174 periods). The number of holding relationships (or links) of each bank with another bank is 17 on a simple average and 69 when using a value-weighted average (the value of securities representing the link). Thus, this network is characterized by a low density (very sparse network). Indeed the diameter (i.e., the greatest distance between any pair of nodes) comprises only seven nodes and the average path length is 2.51, indicating that typically banks are not "too distant" from each other in this type of

Moreover, the analysis of the securities network shows that the structure is well integrated across countries, with some banks playing an important role at the European level and others at the domestic level. Single measures alone may not be sufficient to analyze the securities network, as multiple levels of analysis are required to assess banks' network fragility in a complex banking system.

Regarding the United States (the only major industrialized country that does not publish a Financial Stability Report[32]), to our knowledge, there is no publicly available official report about the US interbank network following the approach previously presented for Brazil and the Euro area. Nonetheless, some few studies such as Markose et al. (2010) can help bridging this gap. The authors present an empirical exercise for the US-Credit Default Swap (CDS) market, based on 2008Q4 data and on 26 US banks.

Within this sample, the top 5 US banks account for 92% of the US bank activity in the USD34 trillion gross notional value of CDS for 2008Q4. Top 3 banks ranked in terms of their dominance in this market (JP Morgan, Citibank and Bank of America) account for 83% of the total CDS purchases. We present below a diagram of their modeled US network, in which the largest pink node represents JP Morgan as dominant net seller in the system.

Figure 11: US CDS market network



Source: Markose et al. (2010). The pure blue circles are banks that are sole buyers (these include Morgan Stanley, Merrill Lynch, Northern Trust, State Street and Trust, Deutsche Bank, US Bank and Signature), while the light blue nodes are net buyers and the larger of these represent Bank of America and Citigroup. An entity that is exclusively a CDS protection seller is marked in red (there are no such entities) while net sellers are marked in light pink. The pink triangular node represents the 'outside entity' constituted by (among others) non US banks involved in the CDS market and is a net seller as is required. On the buy side, the outside entity accounts for about USD3 trillion of CDS sold to it by the US banks and on the sell side it accounts for about USD3.2 trillion.

Table 8: Network statistics for degree distribution for US CDS Network

Initial Network Statistics	Mean	Standard deviation	Skewness	Kurtosis	Connectivity	Clustering coefficient
In Degrees CDS Buyers	3.04	4.44	3.13	9.12	0.12	0.92
Out Degrees CDS Sellers	3.04	5.34	3.60	14.12	0.12	0.92
Random Graph	3.48	1.50	0.70	0.04	0.12	0.09

Source: Markose et al. (2010)

relationship. This is a consequence of well-connected nodes being linked to less well-connected ones. While the concentration of banks in the network is also low (i.e., low clustering coefficient), the larger weighted coefficient implies strong relationships between the nodes.

[32] Although the Federal Reserve and other regulatory authorities have regular surveillance and monitoring programs.

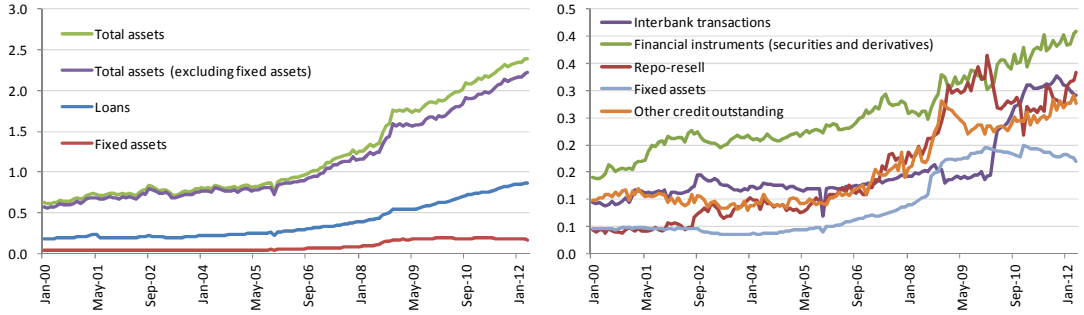
According to Markose et al. (2010), the results reflect the very high concentration of network connections[33] among the top 6 banks[34] in terms of bilateral interrelationships and triangular clustering, which is also underscored by the large cluster coefficient of 0.92.

4.4 Co-movement of Assets in Balance Sheets given Interconnectedness

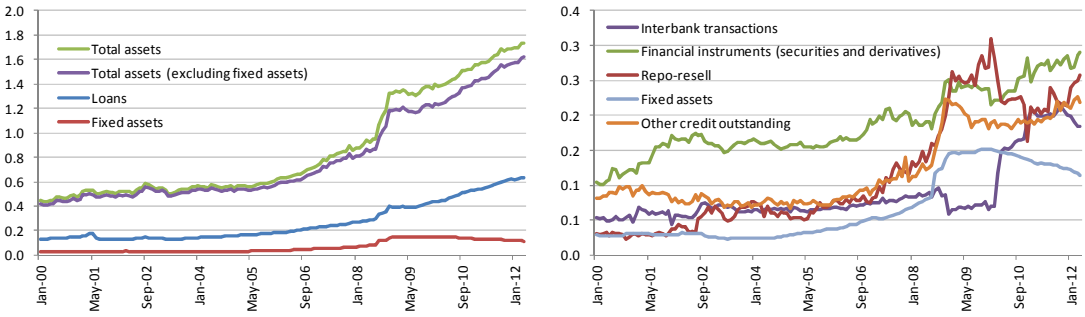
Previous section presented a comparison of banking system interconnectedness for Brazil, US and Euro zone. Now, we investigate the specific case of Brazilian banks by looking for distinct patterns of balance sheet assets' temporal dynamics within an interconnectedness setup. To do so, we consider two groups of banks: (i) the Brazilian banking system (covering a sample of 137 financial institutions) and (ii) the Top 8 most connected institutions (which represented, in 2011Q4, roughly 76% of total transfers –BRL2.3 trillion), and a sample period from January 2000 to April 2012. Figure 12 shows the total amount of balance sheet assets as well as its main components for both the banking system and the Top 8 most interconnected banks.[35]

Figure 12: Balance Sheet Assets (Brazil)

Banking System (BRL trillion, in constant prices of Jan2000)



Top 8 most interconnected Banks (BRL trillion, in constant prices of Jan2000)



Source: Central Bank of Brazil. Sample period: 2000m1-2012m4. Banking system covers 137 financial institutions. The IPCA inflation index (Jan2000 = 100) is used as a deflator to convert nominal series into real series.

[33] The highly asymmetric nature of the empirical CDS network is manifested in the large kurtosis or fat tails in degree distribution which is characterized by a few (two banks in this case) which have a relatively large number of in degrees (up to 14) while many have only a few. Note the asymmetries are greater in the out degree distribution in terms of bank activity as CDS protection sellers.

[34] According to Markose et al. (2010), the Top 6 ranking order in terms of dominance in the US CDS market is: JP Morgan, Citibank, Bank of America, Goldman Sachs, HSBC-USA and Wachovia. However, the authors recall that in terms of assets, Goldman Sachs is ranked in 11th place and Wells Fargo, which is the 4th largest in terms of assets (provided that Wachovia has been taken over), ranks only in 13th place in terms of CDS activity.

[35] Recall that balance sheet assets are influenced by asset price fluctuations. An alternative approach would be to construct an estimate of banks' assets market values by augmented their balance sheet assets by their equity market-to-book ratio.

Overall it is difficult to distinguish (at first sight) different behaviors between the Top 8 and the banking system asset series. First, total assets in both groups significantly increased along the investigated sample (as a consequence of decreasing interest rates and, more broadly, a more stable macroeconomic environment), which is perfectly in line with the (previously discussed) augment of credit-to-GDP ratio in Brazil. Second, all asset series have been significantly impacted by the 2008/2009 crisis (e.g. temporary reduction of interbank transactions by the end of 2008, partially offset by an increase of repo-resell operations and financial instruments).

Equality tests (mean and variance) of monthly real growth rates between the two bank groups suggest that although there is no statistical difference of average growth rates for all considered asset series, there are some differences in the volatility of assets series.

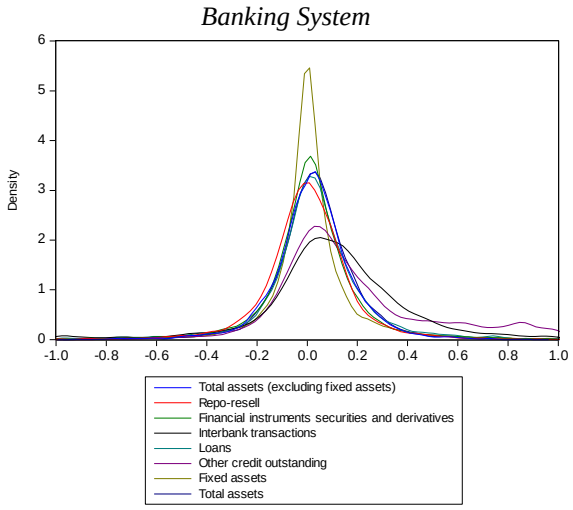
Table 9: Tests of equality between Top 8 and Banking System's real growth rates of selected assets (*p-values*)

	Mean	**Variance**
Total assets (excluding fixed assets)	0.973	0.132
Repo-resell	0.950	0.041 (*)
Financial instruments securities and derivatives	0.943	0.301
Interbank transactions	0.947	0.395
Loans	0.972	0.844
Other credit outstanding	0.968	0.024 (*)
Fixed assets	0.896	0.459
Total assets	0.964	0.118

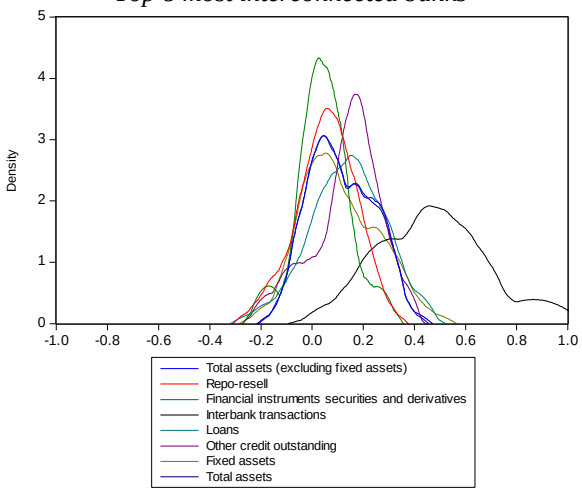
Source: Author´s calculations. Sample: 2000m1-2012m4. The mean equality test is a standard ANOVA F-test, whereas the variance equality test is an F-test. (*) indicates rejection of the null hypothesis at a 5% significance level.

A more detailed investigation of assets co-movement is provided by using disaggregated data. In other words, we take the real value and compute all bank individual assets' (pairwise) correlations of monthly real growth rates for the referred assets' time series across the banking system. For instance, the first group of banks is composed of 137 financial institutions, which results in a total amount of 9,316 pairwise sample correlations for each considered asset series. For the second group, the Top 8 institutions generate an amount of 28 pairwise correlations. The empirical distribution of those correlations is presented in next figures.

Figure 13: Co-movement of Assets: Empirical distributions of pairwise correlations



Top 8 most interconnected banks



Source: Author´s calculations. Probability density functions (PDF) estimated via Epanechnikov kernel. Sample period: 2000m1-2012m4. Banking system covers 137 financial institutions, resulting in a total amount of 9,316 distinct pairwise sample correlations, whereas the Top 8 banks group results in 28 pairwise correlations.

Table 10: Descriptive statistics of pairwise correlations (*balance sheet assets*)

	Banking System					***Top 8***				
	Mean	Median	Std. Dev.	Skewness	Kurtosis	Mean	Median	Std. Dev.	Skewness	Kurtosis
Total assets (excluding fixed assets)	0.02	0.03	0.17	-0.25	6.53	0.11	0.09	0.12	0.19	1.92
Repo-resell	0.00	0.00	0.18	-0.15	7.32	0.06	0.06	0.11	-0.32	2.84
Financial instruments securities and derivatives	0.02	0.01	0.19	-0.02	8.06	0.04	0.05	0.10	-0.01	3.54
Interbank transactions	0.10	0.10	0.28	-0.39	5.62	0.47	0.51	0.20	0.29	2.70
Loans	0.03	0.03	0.21	-0.22	7.46	0.14	0.13	0.14	-0.23	2.74
Other credit outstanding	0.17	0.10	0.30	0.85	3.75	0.13	0.16	0.13	-0.67	2.95
Fixed assets	0.01	0.01	0.18	0.33	10.35	0.11	0.07	0.14	0.42	2.44
Total assets	**0.03**	**0.03**	**0.17**	**0.05**	**6.94**	**0.11**	**0.09**	**0.12**	**0.23**	**2.02**

Source: Author´s calculations. Sample period: 2000m1-2012m4. Banking system covers 137 financial institutions, resulting in a total amount of 9,316 distinct pairwise sample correlations, whereas the Top 8 group results in 28 pairwise correlations.

The pairwise correlations analysis reveals clear differences of assets co-movements. First, note that mean correlation for total assets of the banking system is slightly below the respective figure for the Top 8 banks, indicating that more connected banks tend to alter their total assets in a more synchronized way than the entire banking system (in fact, this finding holds for all considered asset components, excepting other credit outstanding). Second (and most importantly) interbank transactions for the Top 8 banks exhibit an average correlation of 0.47, in sharp contrast to the 0.10 value for the whole banking system. Moreover, the distributions of correlations show a higher kurtosis (and an overall lower skewness) for the banking system, when compared to the Top 8 banks. These findings obtained from disaggregated data corroborate the hypothesis that interconnectedness indeed matters for understanding co-movement of assets. It also evidences that the more a system is concentrated and interconnected, the more it will be sensitive to changes in asset valuation, especially under tail event conditions.

4.5 Asset prices

The statistical observation of the previous section explains why intuitively stock market and property prices are often used as proxies for analyses of the behavior of asset prices and banks' balance sheet vulnerabilities. In this section, first we present selected stock indexes for Brazil, the US, Germany and France. Second, we also show some property price indexes for comparison purposes.

Figure 14: Stock indexes (Brazil, Germany, France and USA)

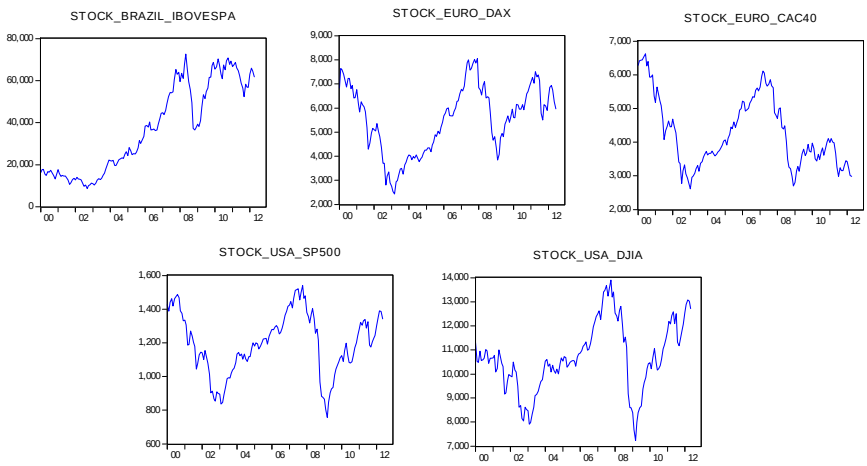
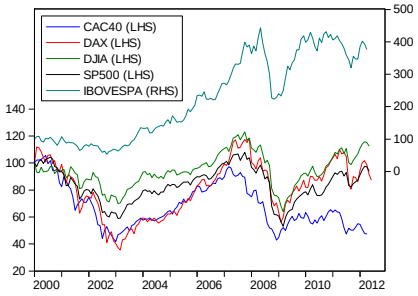


Figure 15: Stock indexes comparison (*Jan 2000 = 100*)



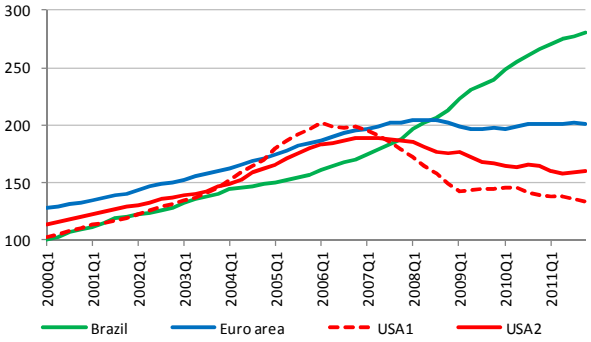
Source: Bloomberg.

Table 11: Stock indexes comparison (% *change of the annual average index*)

	2004	2005	2006	2007	2008	2009	2010	2011
Brazil-Ibovespa	52%	25%	38%	40%	2%	-4%	25%	-8%
France-CAC40	15%	19%	18%	7%	-30%	-12%	7%	-6%
Germany-DAX	24%	18%	27%	27%	-19%	-18%	23%	8%
USA-DJIA	15%	2%	8%	15%	-15%	-21%	20%	12%
USA-SP500	17%	7%	9%	13%	-17%	-22%	20%	11%

Source: Authors' calculations based on Bloomberg data.

Figure 16: Property price indexes



Source: BIS Property Price Statistics (Euro area and USA) and IBRE/FGV (Brazil). Euro area index (XM:0:1:0:0:0:0): all types of dwellings (new and existing houses and flats, index 2007=100). USA1 index (US:0:1:1:2:0:1): All types of existing dwellings, single-family homes (attached and detached) and condominiums and cooperatives (index Jan2000=100). USA2 index (US:0:2:1:3:0:0): Existing single-family houses (index 1980Q1=100). Brazilian real state IGMI-C index (capital return sub-index of commercial properties, index 2000Q1=100) provided by IBRE/FGV. USA2 index is divided by two (and Euro area index is multiplied by two) for graphical comparison purposes.

Table 12: Property prices (% *change of the annual average index*)

	2004	2005	2006	2007	2008	2009	2010	2011
Brazil	7%	5%	8%	9%	13%	13%	11%	7%
Euro Area	7%	7%	7%	4%	2%	-3%	1%	1%
USA1	15%	17%	6%	-6%	-14%	-11%	0%	-5%
USA2	9%	11%	7%	1%	-4%	-5%	-4%	-3%

Source: Authors' calculations based on data from BIS Property Price Statistics (Euro area and USA) and IBRE/FGV (Brazil).

As we know, the global correction in residential real estate markets has generated large declines in house prices and construction activity across a broad range of economies.[36] According to IMF-WEO (2012), there were about 2.4 million properties in foreclosure in the United States at the end of 2011, a nearly fivefold increase over the pre-crisis level. The "shadow inventory" of distressed mortgages suggests that this number could rise further. In Brazil, property prices have risen although it is fair to say that there is no comprehensive and reliable indicator for property prices. In some specific areas of large cities (e.g., São Paulo, Rio de Janeiro, etc.) the rise in real estate prices (i.e. in listed offered prices) might suggest some localized pressure in the domestic housing market, which can be directly linked to the credit expansion path of recent years but it is difficult to assess the situation in the absence of rigorous indices.

[36] In this sense, the IMF-WEO (2009) report argues that at a conceptual level, the impact of housing corrections on the real economy depend on the extent of house price misalignment; the impact of a given house price correction on macroeconomic variables – which could vary across economies due to differences in the characteristics of mortgage markets or because of differences in policy responses to housing shocks; and transmission and amplification mechanisms, such as the impact of defaults on bank balance sheets or the indirect effects on commercial real estate, which may not be fully captured in a standard macroeconomic model of the impacts of housing price shocks.

One important and extensive discussion in the literature has been the relationship between credit booms and bubbles. Therefore we turn now briefly to the discussion about using credit gaps as early warning indicators for asset booms.[37] We analyze here solely statistical relationships. Admittedly, in addition to existing literature (e.g., Borio and Lowe (2002), Alessi and Detken (2009)), there is a need for a better understanding of the transmission mechanisms between these variables.[38]

Table 13: Granger-causality between credit gaps and asset prices (*p-values*)

		Number of lags considered in Granger causality hypothesis test						
	Null hypothesis	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Brazil	STOCK_BRAZIL_IBOVESPA does not Granger Cause CREDIT_GAP_BRAZIL	0.412	0.729	0.036	0.080	0.096	0.035	0.076
	CREDIT_GAP_BRAZIL does not Granger Cause STOCK_BRAZIL_IBOVESPA	0.961	0.959	0.948	0.764	0.642	0.351	0.407
	PP_BRAZIL does not Granger Cause CREDIT_GAP_BRAZIL	0.265	0.070	0.063	0.028	0.003	0.000	0.001
	CREDIT_GAP_BRAZIL does not Granger Cause PP_BRAZIL	0.002	0.003	0.028	0.170	0.119	0.189	0.162
Euro Area	STOCK_EURO_CAC40 does not Granger Cause CREDIT_GAP_EURO	0.095	0.135	0.251	0.441	0.474	0.635	0.708
	CREDIT_GAP_EURO does not Granger Cause STOCK_EURO_CAC40	0.553	0.619	0.495	0.552	0.472	0.268	0.296
	STOCK_EURO_DAX does not Granger Cause CREDIT_GAP_EURO	0.022	0.089	0.246	0.205	0.313	0.217	0.321
	CREDIT_GAP_EURO does not Granger Cause STOCK_EURO_DAX	0.351	0.094	0.020	0.061	0.084	0.124	0.058
	PP_EURO does not Granger Cause CREDIT_GAP_EURO	0.611	0.735	0.649	0.870	0.872	0.566	0.680
	CREDIT_GAP_EURO does not Granger Cause PP_EURO	0.107	0.124	0.126	0.017	0.048	0.057	0.060
United States	STOCK_USA_DJIA does not Granger Cause CREDIT_GAP_USA	0.002	0.002	0.006	0.015	0.009	0.015	0.019
	CREDIT_GAP_USA does not Granger Cause STOCK_USA_DJIA	0.360	0.384	0.412	0.204	0.174	0.287	0.094
	STOCK_USA_SP500 does not Granger Cause CREDIT_GAP_USA	0.001	0.001	0.002	0.008	0.021	0.018	0.027
	CREDIT_GAP_USA does not Granger Cause STOCK_USA_SP500	0.345	0.380	0.396	0.407	0.518	0.605	0.546
	PP_USA1 does not Granger Cause CREDIT_GAP_USA	0.213	0.291	0.207	0.189	0.205	0.271	0.325
	CREDIT_GAP_USA does not Granger Cause PP_USA1	0.153	0.217	0.260	0.118	0.038	0.009	0.001
	PP_USA2 does not Granger Cause CREDIT_GAP_USA	0.828	0.622	0.555	0.835	0.851	0.753	0.717
	CREDIT_GAP_USA does not Granger Cause PP_USA2	0.232	0.361	0.244	0.132	0.314	0.267	0.273

Source: Authors' calculations. Sample: 2000Q1-2011Q4. Each cell indicates the p-value of the Granger causality test. Yellow cells indicate rejection of the null hypothesis at a 5% significance level (and blue cells at a 10% significance level).

Overall, in this simplified stylized overview, the results seem to suggest that stock price rises precede credit surges, and that credit booms anticipate property price increases, partially corroborating the hypothesis that credit-to-GDP gaps might be able to anticipate asset booms. For instance, the results for the US suggest that movements in both S&P500 and Dow Jones Industrial Average (DJIA) stock market indexes precede the credit gap dynamics, which, in turn, seems to anticipate property prices movements. However, it is worth mentioning that this empirical evidence is merely a statistical result (i.e., Granger causality) and does not necessarily implicates "causality" in the economic sense. The results for Brazil and the Euro area are less conclusive, although point out the same direction. Nonetheless, a deeper analysis on these results focused on the transmission mechanisms remains an important topic for future research.

4.6 Other indicators of systemic risk

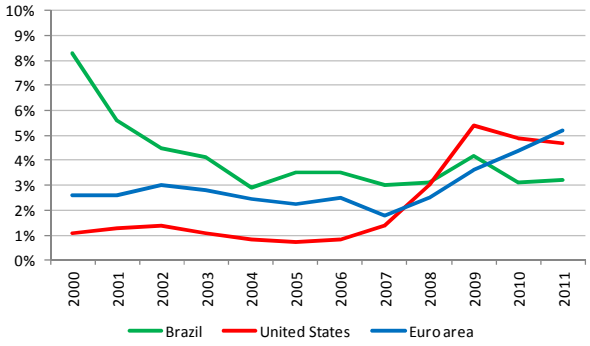
There are many additional financial indicators that are usually associated with systemic risk in the literature, such as balance sheet indicators or indicators based on credit quantities and asset markets (see BIS-CGFS (2010, p.18) for further details). Among them, and to continue our

[37] According to Alessi and Detken (2009), the global private credit gap and the global M1 gap seem to be the best early warning indicators for asset price boom/bust cycles. In this sense, global variables would be adequate indicators since asset price cycles are largely international phenomena.

[38] According to IMF-WEO (2009), since 1985, house price busts have been typically preceded by large deviations in credit relative to GDP, the current account balance, and investment. Output and inflation, on the other hand, would not display such large deviations. These conventional components of monetary policy rules have little ability to predict house price busts. For stock price busts, output and inflation perform slightly better as leading indicators, but credit, the current account balance, and residential investment have much more predictive ability, as they do for house price busts.

comparison of systemic risk indicators for Brazil, the US and the Euro Area, we show below the respective non-performing loans (NPL) ratios.

Figure 17: Bank non-performing loans to total gross loans (%)



Source: World Bank (annual data).

Non-performing loans (or loan loss provisions) are essentially backward-looking (or at most contemporaneous) indicators of financial distress (see Bongini et al (2002) *apud* BIS-CGFS (2010)). Nonetheless, they might provide an important picture about the overall credit quality in the banking system, and can signal for possible excessive credit growths and/or fragile lending standards.[39] The high NPL figures for the US and the Euro area observed in 2011 reflect the mentioned lower lending standards, as a direct consequence of the global economic and financial crisis. In Brazil, on the other hand, despite experiencing a temporarily hike in 2009, the NPL series decreased towards a moderate 3% level, suggesting that the (ongoing) global crisis did not impose a relevant change in domestic credit quality.[40] Finally, to conclude our comparisons, we show in Table 14 below some additional indicators of financial conditions selected from the IMF – Financial Soundness Indicators, which can be interpreted as indicators of financial distress based on balance sheet data.

Table 14: Other comparative indicators

Selected indicators	Period	Brazil	France	Germany	Italy	Portugal	Spain	USA
Regulatory Capital to Risk-Weighted Assets	2011 Q2	18%	13%	17%	13%	10%	12%	15%
Regulatory Tier 1 Capital to Risk-Weighted Assets	2011 Q2	14%	11%	13%	9%	8%	10%	13%
Non-performing Loans to Total Gross Loans	2011 Q2	3%	4%	-	11%	6%	5%	4%
Liquid Assets to Total Assets (Liquid Asset Ratio)	2011 Q2	32%	42%	43%	-	16%	-	13%
Liquid Assets to Short Term Liabilities	2011 Q2	108%	75%	138%	-	86%	-	61%
Household Debt to GDP	2010 Q4	16%	54%	60%	60%	104%	-	94%
Residential Real Estate Loans to Total Loans	2011 Q2	8%	-	17%	19%	33%	27%	36%

Source: IMF – Financial Soundness Indicators (FSI).

It can be noted that Brazilian regulatory capital level is quite high in comparison to that of other (advanced) economies, and the NPL ratio is the lowest among the selected countries. In this sense, Brazilian banks have strong capital cushions and capital adequacy is well above the minimum required, enabling Brazilian banks to absorb large loan losses. Liquidity indicators for Brazil are slightly better than the average figures presented by the US and some European countries, whereas household debt, despite substantially increasing over the last few years, still

[39] Although NPL might behave as a lagged indicator of excessive risk taking. An alternative systemic risk indicator is the Marginal Expected Shortfall or the CoVaR measure (Adrian and Brunnermeier, 2011).
[40] The country's banking sector has strong capital buffers and should easily withstand the upswing in bad loans typically associated with fast credit growth.

accounts for less than 20% of GDP, in sharp contrast to the US (94% of GDP) and the Euro area (around 60% of GDP for France, Germany and Italy). Residential loans in Brazil are also quite low in comparison to other countries.

Box: Financial Stability Assessment Program – 2012

The 2012 report of the Financial Sector Assessment Program (FSAP) regarding the Brazilian Financial System (see IMF-FSSA (2012) for further details) is based on the work of a joint IMF-World Bank mission to Brazil during March 6-21, 2012. The report presents an independent evaluation of the National Financial System, in respect to its vulnerabilities and robustness, and its main conclusions are quite positive: the Brazilian Financial System is solid, stable and shows low levels of risk, which corroborates the analysis of the Financial Stability Reports and the continuing efforts of the Central Bank of Brazil (BCB) to improve its supervision process. The mentioned report considered Brazil as equipped with a strong supervision and regulation, with excellent adherence to Basel Principles and compliance with international standards. In this sense, the report's evaluation emphasizes the following issues:

- The National Financial System (SFN) is strong and resilient to a wide range of shocks;
- Risk from the rapid credit growth of recent years is mitigated by a number of factors;
- The exposure of SFN to external risks is limited and the risk of contagion closely monitored;
- The exposure of SFN to risks from the corporate sector and the derivatives market is much lower in comparison to the peak of the global financial crisis (e.g., Lehman episode in 2008);
- The supervision of the SFN (in particular, banking supervision) is strong, well-developed and effective due to its comprehensive instruments of prevention and intervention;
- The financial safety net provided by the Credit Guarantee Fund (FGC) revealed to be effective during the last crisis;
- The Brazilian authorities' response to spillovers from the global financial crisis was swift, flexible, and effective; [1/]
- The improvement of the regulatory framework through the planned early implementation of Basel III will provide the BCB with additional tools to boost the resilience of the system and consolidate the financial stability; and
- The Brazilian system of payments and settlements exhibits high compliance with international standards.

Nonetheless, the report also points out several challenges, currently being addressed by Brazilian authorities:

(1) Challenges regarding financial development, capital market deepening and long-term investment finance; [2/]
(2) The need for monitoring potential overheating in household credit market; [3/]
(3) The small and medium-size banks, which rely more on wholesale funding and are relatively more vulnerable to liquidity risk, require closer monitoring and proactive measures to contain emerging vulnerabilities; [4/]
(4) The institutional architecture should be improved to enhance coordination among Brazilian authorities; [5/]
(5) Strengthening further the banking resolution regime by removing certain impediments, clarifying the legal provisions for purchase and assumption and bridge banks, and strengthening legal protection.

2012 FSAP Key Recommendations to the Central Bank of Brazil (BCB)

1. Issue regulation on credit bureaus to ensure broad availability of reliable positive information on borrowers (*under evaluation*);
2. Ensure compilation and publishing of a housing price index that is based on purchases, with broad geographic coverage (*under discussion with specialized bureaus*);
3. Strengthen the procedures and systems of the BCB to deliver ELA (Emergency Liquidity Assistance); [6/]
4. Reinforce legal protection to BCB-appointed directors, intervenors, or liquidators of financial institutions. The BCB has improved the procedures to obtain legal representation for directors and employees in respect to acts related to job duties (*Voto BCB nº 88/2012*).

Compliance with the Basel Core Principles: Cross-country comparison (cont'd)

Basel Core Principles	Brazil	South Africa	Germany	China	Spain	USA	Netherlands	Mexico	United Kingdom	Russia*	Sweden
	Jul-12	Dec-10	Sep-11	Apr-12	Jun-12	May-10	Jul-11	Mar-12	Jul-11	Nov-11	Sep-11
1 – Objectives, independence, powers, transparency and cooperation.											
1.1 Responsibilities and objectives	C	C	C	C	LC	C	C	LC	MNC	-	LC
1.2 Independence, accountability and transparency	LC	C	LC	MNC	LC	C	LC	NC	LC	-	MNC
1.3 Legal framework	C	LC	C	C	MNC	C	C	C	C	-	C
1.4 Legal powers	C	LC	C	C	MNC	C	C	C	C	-	LC
1.5 Legal protection for supervisors	C	C	LC	C	C	C	C	NC	C	-	LC
1.6 Cooperation among supervisors	C	C	C	C	C	C	C	C	C	-	C
2 – Permissible activities	C	C	C	C	C	C	C	C	C	-	LC
3 – Licensing criteria	C	C	C	C	LC	C	C	C	C	-	LC
4 – Transfer of significant ownership	C	C	C	LC	LC	C	C	C	C	-	C
5 –Major acquisitions	LC	LC	MNC	C	C	C	C	C	C	MNC	MNC
6 – Capital adequacy	C	LC	MNC	C	C	LC	C	C	LC	LC	C
7 – Risk management process	C	C	LC	MNC	LC	MNC	C	LC	LC	LC	LC
8 – Credit Risk	C	C	C	LC	C	LC	C	C	MNC	LC	C
9 – Problem assets, provisions and reserves	C	LC	LC	C	LC	C	C	C	C	LC	LC
10 –Large exposure limits	C	C	C	LC	LC	C	C	LC	C	-	C
11 – Exposures to related parties	C	MNC	LC	LC	LC	C	LC	LC	LC	MNC	LC
12 – Country and transfer risks	C	MNC	C	LC	C	C	C	LC	C	MNC	C
13 – Market Risk	C	C	C	C	C	LC	C	C	LC	-	LC
14 –Liquidity Risk	C	C	LC	C	C	LC	C	LC	LC	-	LC
15 – Operational Risk	C	LC	LC	LC	C	C	C	MNC	C	-	LC
16 – Interest rate risk in the banking book	C	C	C	LC	C	C	C	LC	C	-	C
17 – Internal control and audit	C	C	C	C	C	C	C	C	C	-	LC
18 – Integrity of the banking sector	C	C	LC	LC	C	C	C	LC	C	LC	LC
19 – Supervisory approach	C	C	C	C	C	LC	C	LC	MNC	-	LC
20 – Supervisory techniques	C	C	C	C	C	C	C	C	LC	-	MNC
21 –Supervisory reporting	C	LC	LC	C	C	C	LC	C	LC	-	LC
22 – Accountability and disclosure	C	C	C	LC	C	C	C	C	C	-	LC
23 – Corrective and remedial powers of supervisors	C	MNC	LC	C	LC	C	LC	LC	C	LC	LC
24 – Consolidated supervision	C	C	C	LC	C	LC	LC	LC	LC	MNC	C
25 –Home-host relationships	C	C	LC	C	C	C	C	C	LC	-	C
Summary											
Compliant - C	28	20	17	18	19	23	25	16	17	0	10
Largely Compliant - LC	2	7	11	10	9	6	5	11	10	6	17
Materially noncompliant - MNC	0	3	2	2	2	1	0	1	3	4	3
Noncompliant NC	0	0	0	0	0	0	0	2	0	0	0

Note: Months reflect dates when Detailed Assessment were published.
* Russia has only one Targeted Assessment.

More details about Basel Core Principles can be found at http://www.bis.org/publ/bcbs213.pdf

1/ In particular, the macroprudential measures used in 2010-2011 by the Central Bank of Brazil proved to be appropriate, and the active countercyclical role of state-owned banks during the global financial crisis was quite positive and helped containing the crisis impact.

2/ Although the same report also highlights that interest rates have declined and banking spreads have diminished with improved efficiency (lower administrative costs) and declines in regulatory costs and the net interest margin.

3/ Even though the credit-to-GDP ratio remains relatively low in respect to international standards and a great portion of the credit expansion is due to financial inclusion and the effects of macroeconomic stabilization. In addition, household debt and nonperforming loans have been diminishing since 2009.

4/ In this regard, several isolated cases have been solved without further stress to the system. This banking segment is properly capitalized, constitutes an important sector to the SFN (contributing to improve financial intermediation) and it is constantly monitored and supervised by BCB.

5/ For instance, according to the report, the Brazilian authorities should consider establishing a multipartite financial stability committee.

6/ For instance, improve the FGC's support in case of resolution (e.g., the 2012's resolution n. 4087 revised the composition of the board of the FGC). Moreover, since the FGC is a private institution, its role is clearer (due to new regulation) in respect to its contribution for help maintaining financial stability. In addition, the FGC is adequately capitalized and has alternative funding resources (e.g., anticipated contributions from associates) which have been successfully used in 2008.

5. A Frequent Indicator of Financial (In)stability: Credit

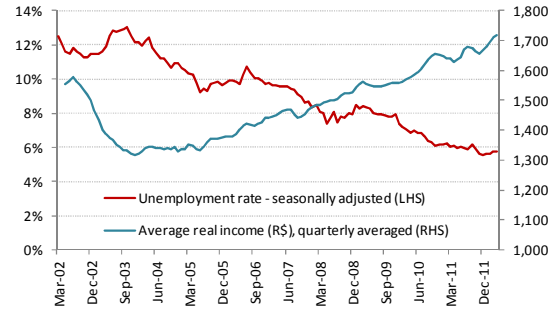
In this section, we analyze the patterns of the Brazilian credit market based on disaggregated credit growth gaps, in order to better understand the dynamics of the Brazilian credit market.

We present first a (short) macroeconomic overview of the Brazilian economy, which is important to argue that credit growth observed in past recent years is sustainable given its structural components and additional cyclical factors.

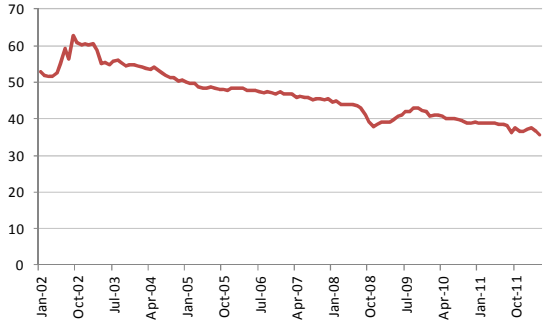
5.1 Macroeconomic fundamentals

Figure 18: Selected Brazilian macro variables

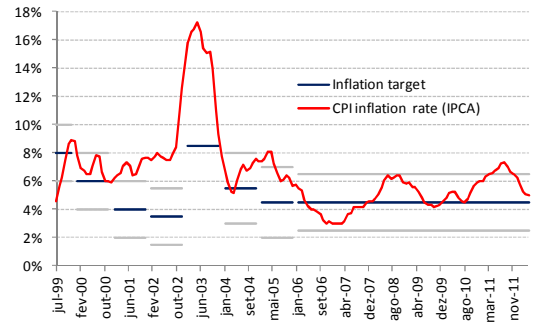
Unemployment rate (%) and real income sector



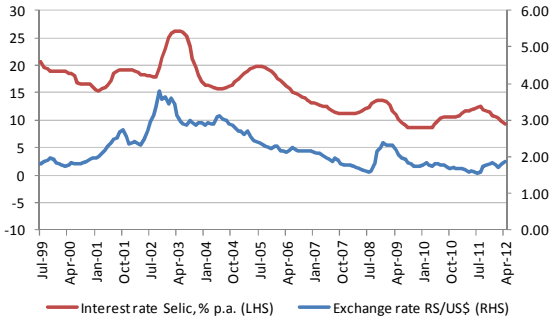
Net public debt (% GDP) – Consolidated public



Inflation rate and inflation target (% p.a.)

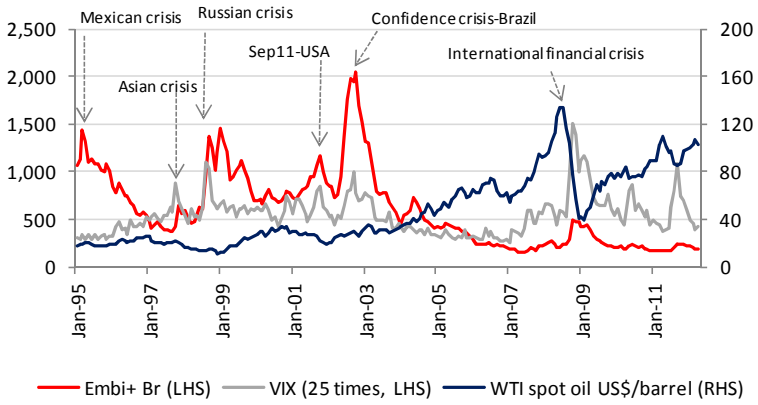


Interest rate and exchange rate



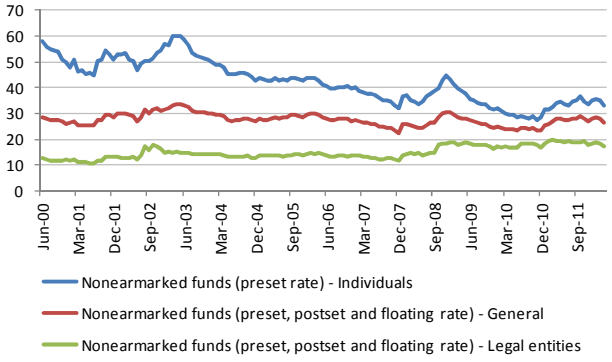
Source: Central Bank of Brazil.

Figure 19: Emergent Markets Bonds Index (Brazil), VIX and Oil price.



Source: Bloomberg. VIX refers to Chicago Board Options Exchange Market Volatility Index.

Figure 20: Brazil: Credit operations average spread (p.p.)



Source: Central Bank of Brazil.

Long before the crisis – since the mid-1990s – Brazil adopted standard macroeconomic policies to control inflation and anchor expectations, including an inflation targeting framework. Fiscal policies were strengthened to ensure that markets perceived debt dynamics as sustainable. Together with many (though not all) emerging markets, Brazil opted for a flexible exchange rate regime as a first buffer against capital market mood swings and volatility. Last but not least, Brazil did not embark on the fashionable financial deregulation movement of the 1990s, keeping a conservative prudential regulatory framework for its financial sectors, which remained tightly supervised and well-capitalized.

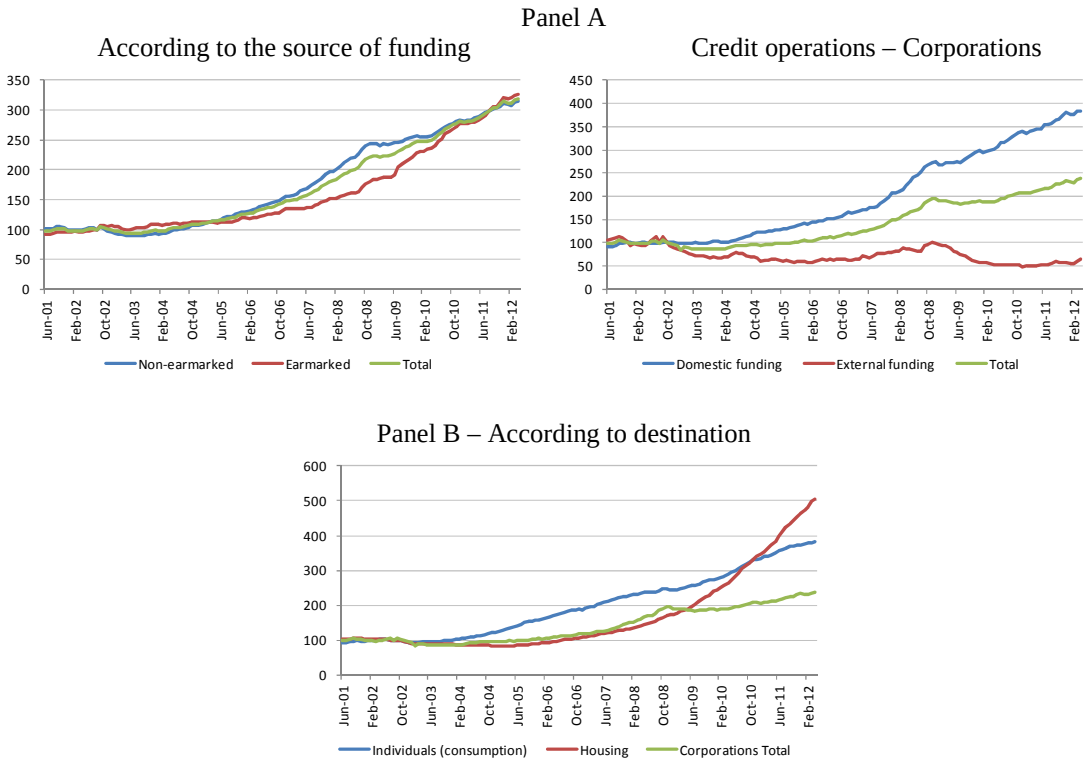
Therefore, several factors contributed to a sustainable credit expansion in the last ten years: the above mentioned macroeconomic stability led to an increase in formal employment and real income. Together with institutional reforms, social and financial inclusion policies, among other factors, led to a steady decline of the average domestic credit spread (and of the sovereign debt risk premium, measured by the Embi+Br index). The absence of significant external shocks in the 2003-2007 period must also be taken into account to understand the growth of credit in recent years.

With respect to financial deepening, according to IMF-GFSR (2012, Table 3.4) Brazil contributed in 2009 with only 1.63% to global financial depth[41] (and emerging markets as a whole with 17.97%), in sharp contrast to USA: 29.28%, UK: 7.73%, China: 7.13%, Germany: 6.04% and France: 5.40%; suggesting that Brazilian financial system is yet quite distant from financially-deep countries. These figures reveal the inability of emerging countries to contribute to the global supply of safe assets. According to the referred IMF Report, many emerging markets are still in the process of developing well-functioning financial systems, which are characterized by sound legal institutions and adequate property rights. Such limitations restrain the assets supply in local capital markets and limit the development of liquid financial markets.

Accordingly, although shrinking in recent years, the disparity in the degree of financial depth between emerging markets and advanced economies is still considerable (again, at the end of 2009, emerging markets accounted for roughly 40% of global GDP, although their contribution to financial depth was less than 20% that of advanced economies).

[41] Summing all assets and liabilities (held against residents and nonresidents) as a share of GDP gives a measure of the weight of total financial claims and counterclaims of an economy – both at home and abroad. Financial depth as a share of global depth is given by each country's contribution weighted by its GDP.

Figure 21: Brazil: Financial system credit operations (real indexes)



Source: Central Bank of Brazil and authors´calculations.

Table 15: Real growth of credit operations (*annual percent*)

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Financial system credit operations	-2%	-5%	8%	13%	16%	19%	25%	15%	13%	12%
Earmarked	-5%	3%	6%	3%	10%	12%	18%	23%	25%	17%
Non-earmarked	0%	-9%	10%	19%	20%	23%	28%	12%	8%	10%
Corporations - Total	2%	-13%	6%	7%	11%	17%	32%	9%	5%	11%
Corporations - Domestic Funding	6%	-1%	11%	19%	15%	19%	35%	15%	13%	12%
Corporations - External Funding	-2%	-26%	-4%	-14%	2%	14%	24%	-13%	-31%	2%
Individuals - Consumption	10%	-4%	16%	28%	24%	18%	14%	8%	18%	17%
Housing	-39%	-11%	-4%	1%	16%	20%	25%	35%	43%	39%

Source: Central Bank of Brazil and authors´calculations. Growth rates are based on annual averaged indexes.

The 2008/2009 crisis significantly affected credit market in Brazil. As an immediate consequence, supply conditions were severely compromised, due to adverse external financial conditions, low levels of liquidity in domestic interbank market and higher risk aversion hampering the concession of new loans. At the same time, credit demand was naturally dampened by unfavorable evolution of the expectations of unemployment, income and production, with direct effects on consumption and investment.[42]

The Brazilian authorities took immediate action in face of the shock.[43] First, they addressed liquidity problems both in domestic and foreign currencies: bank reserve requirements were

[42] The effects of the crisis were indeed severe. After the Lehman Brothers episode, in the last quarter of 2008, trade flows contracted 6.9% Year-Over-Year (YOY); industrial production fell by 27.0% Quarter-Over-Quarter (QOQ); capital outflows rose by 36.0% QOQ causing an exchange rate depreciation spike of 32% YOY; and credit growth fell by 35% YOY. In one month (October 2008), trade financing fell by 30% and the debt rollover ratio went down from 167% to 22%. From July to October, liquidity ratios in Brazilian banks also fell from 1.73 to 1.43.

[43] See M. Mesquita and M. Torós (2010) for a very comprehensive description of that period.

lowered, injecting about BRL116 billion worth of liquidity (or 4% of GDP) into the economy; lines of credit in foreign exchange were provided to the private sector; the Central Bank of Brazil offered USD14.5 billion (7% of total international reserves at the end of 2008) in spot market auctions. Foreign exchange swap contracts to the tune of USD33 billion were also offered by the Central Bank, helping an orderly wind down of large foreign exchange derivatives exposures by domestic corporations (amounting to an estimated USD37 billion at the end of September 2008).

The second line of action was to calibrate policy instruments to provide stimulus to economic activity: the monetary policy base rate was lowered by a total of 500 basis point (bps), from 13.75% p.a. to 8.75% p.a.; a number of tax breaks were put in place and the fiscal surplus target was reduced from 3.8% in 2008 to 2.5% of GDP in 2009; credit extension by public financial institutions rose by BRL105 billion (3.3% of GDP).

The response of the Brazilian economy was swift, and produced the expected V-shaped recovery pattern. In the credit market, the Central Bank of Brazil implemented several measures in order to reestablish credit market liquidity, especially for small and medium-size banks.[44] Moreover, state-owned banks played an important role as anti-cyclic agents by providing extra supply of resources in domestic credit market. These actions combined with fiscal stimulus contributed to boost sales of higher aggregate value and, therefore, domestic consumption. But despite the strong policy-driven rebound throughout 2009, GDP growth was still zero for that calendar year, but in 2010 GDP grew 7.5% YOY, domestic demand by 10.3%, with private consumption expanding 7.2% YOY and investment by 11.1% YOY.

But in any event, credit for individuals and firms exhibited different dynamic pattern. In particular, firms´ external funding sharply decreased after 2008, whereas consumption loans maintained a steady growth (mainly driven by fiscal stimulus, increasing real income and low unemployment) and housing credit faced a significant augment,[45] mainly due to lower interest rates and additional credit for this segment provided by state-owned banks.

5.2 Real growth Credit Gaps

In order to illustrate the recent evolution of Brazilian credit market, we construct real growth credit gap series, with the main objective of investigating potential imbalances between demand and supply in credit market. Differently from credit-to-GDP gaps, which are used as comparative indicators for leverage in Section 4, real growth credit gaps are used to investigate the Brazilian credit market in a more precise way, without including possible output gap effects (and related GDP data uncertainty in latest available observations) into the credit gap measure. Eight real growth credit indexes (monthly data, seasonally adjusted) are constructed[46] to capture

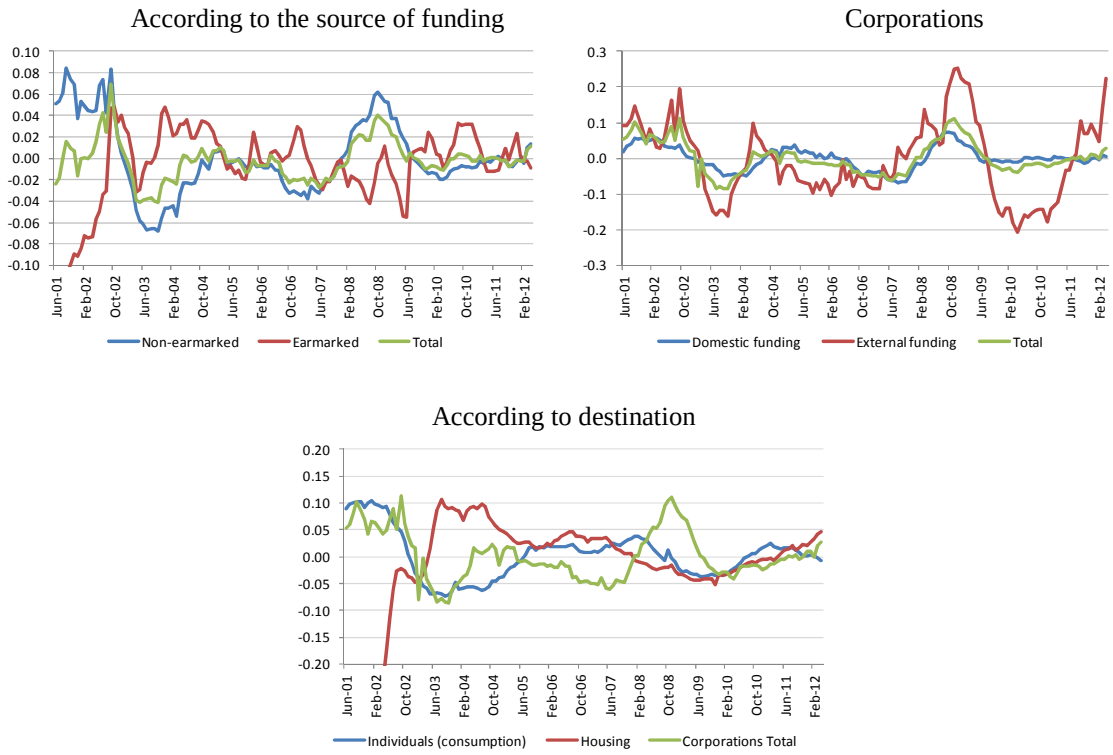
[44] Overall, throughout the global financial crisis, the Central Bank of Brazil has actively used a mix of monetary policy and macroprudential measures, for an account see L.A. Pereira da Silva and R. Harris (2012).

[45] Real estate credit market has been the most dynamic sector of Brazilian credit market in recent years. Although exhibiting a fast growing path it still represents a small amount of total credit in financial system.

[46] Firstly, each monthly nominal credit series (in BRL currency) is converted into real series (at constant prices of July 2002). Then, a real credit index is constructed such that the average 2002 index = 100 (as a common base-value for all eight considered real credit indexes). Subsequently, each index is seasonally adjusted (Census X12) and then HP filtered to generate both the trend and the gap series.

the Brazilian credit market across its various components. An excess demand for credit is represented by a positive gap, indicating that observed credit growth is above its potential growth (analogous to the definition of output gap). The results are displayed in Figure 22 below.

Figure 22: Financial system credit gaps



Source: Central Bank of Brazil and authors´calculations. All gaps in previous graphs are HP-filtered. Recall the discussion in Section 4.1 about trend extraction techniques and, in particular, the end-point issue related to the HP filter, which recommends cautious when interpreting the close-to-zero gaps by the end of the sample period.

In the credit gap series by source of funding, it is worth noting that non-earmarked and total financial system credit gaps exhibit similar patterns along the investigated sample period, whereas the earmarked credit gap presents a more volatile dynamic. Nonetheless, it is worth mentioning that all three gap series end up close to the zero gap line. In the credit gap series for corporations, the total and for domestic sources of funding, the gaps are very close to each other. However, for external sources of funding the gap presents quite dramatic changes since 2008. Finally, in the credit gap series by end-users, the credit gaps are close to zero at their end-point, which might be a signal of a credit market working close to its long-run trend.

Nonetheless, it seems that the major risk to financial stability in Brazil, from the credit market perspective, still comes from exogenous foreign shocks rather than excessively rapid domestic credit growth. We examine this risk below.

5.3 Credit-to-GDP and Credit Growth Gaps based on GE Models

Ideally, the credit gap should be measured in terms of growth rates of loans from its steady-state values within a General Equilibrium (GE) model, based on fundamental and structural relationships.[47] Smets (2011) points out that credit gaps need a connection with the theoretical literature on the sources of systemic risk. However, the development of such a model properly connecting the real economy (e.g. interaction between the macroeconomic environment and the monetary policy) to the financial sector (including the effects of macroprudential tools) is a work-in-progress in the literature.[48] In this sense, Borio (2011) asks in which direction current Dynamic Stochastic General Equilibrium (DSGE) models should be modified? According to the author, the key would be to allow scope for the cross-sectional and inter-temporal coordination failures that lie at the heart of business fluctuations and financial instability. A possible route is given by Woodford (2010), *apud* Borio (2011), which discuss a DSGE model with credit that makes the transition probability to a bad state (e.g. crisis) a function of the amount of leverage in the system. It is a good example of how to modify current DSGE models with financial frictions so as to formalize the desirability of a monetary policy that leans against the build-up of financial imbalances. Finally, another possible modeling strategy is taken by Agénor *at al*. (2011a, 2012a) using a DSGE with imperfect credit markets and an explicitly modeled Basel III-type countercyclical capital regulatory rule in its financial sector. Macroeconomic stability is defined in terms of a weighted average of inflation and output gap volatility, whereas financial stability is defined in terms of three alternative indicators (real house prices, the credit-to-GDP ratio, and the loan spread), both individually and in combination. Steady state credit growth rates can be defined under any set of macroeconomic and macroprudential financial conditions.

With respect to Brazil, De Castro *et al*. (2011) develop a DSGE model for the Brazilian economy (so-called *SAMBA – Stochastic Analytical Model with a Bayesian Approach*) to be used as part of the macroeconomic modeling setup of the BCB, providing support for policy analysis and forecasting. This model combines the main building blocks of standard DSGE models with specific features describing the Brazilian economy, including external finance for imports and financially constrained households. However, the banking sector is not explicitly modeled and there is no credit gap variable, since SAMBA was not originally designed to address financial stability issues. Nonetheless, the development of a DSGE model properly considering the financial system is an ongoing project of the BCB, which might generate structurally-oriented credit growth gaps in the near future, as potential candidates for financial stability proxies. In the mean time, in this paper (see below in 6.3), we conduct an analysis using HP-filtered credit gaps to investigate empirical evidences of credit growth at equilibrium based on historical statistical relationships.

[47] For instance, by considering that financial cycles can have a much longer duration than business cycles.
[48] A good review is given by BIS-CGFS (2010, p.21), which identifies four strands in the literature focused on how macroprudential tools interact with monetary policy: (i) monetary policy in DSGE models augmented with financial intermediaries; (ii) dynamic equilibrium models in which the financial sector does not internalize all the costs associated with excessive risk taking; (iii) models considering the role of bank capital in the monetary transmission mechanism (e.g. risk-taking channel); (iv) a very recent theoretical research that specifically examines the interaction between monetary policy and macroprudential policy (e.g. interaction between optimal monetary policy and endogenous bank risk).

5.4 Credit Market External Vulnerabilities[49]

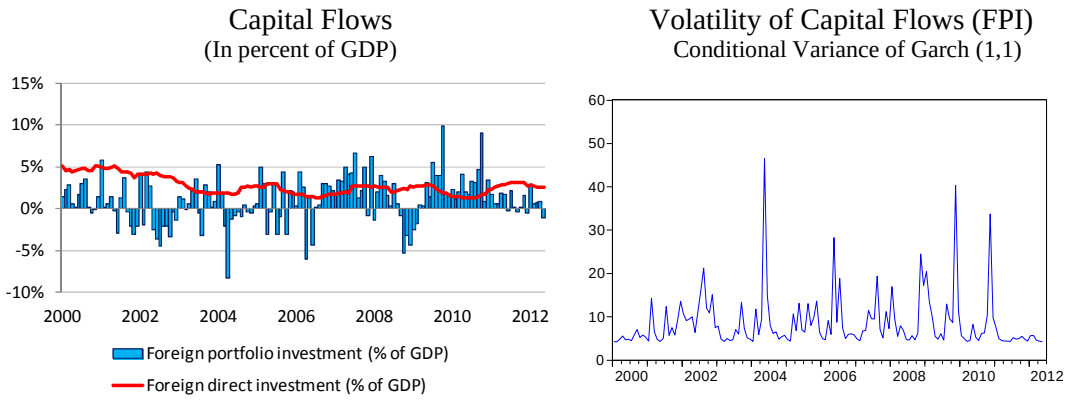
Brazilian economy is open and plays a sizeable role in global capital and commodity markets. As such, it remains vulnerable to sudden floods and sudden stops of capital flows, especially under the current conditions of volatility abroad. Due to its strong fundamentals, Brazil has been attracting large volumes of capital inflows, reflecting both economic factors at home (deep capital markets, large interest rate differential between Brazil and advanced economies, and strong economic performance) and global trends (spillovers from advanced economies). Therefore, managing the effects of large capital flows has been one of the main policy challenges for Brazil since the global crisis. Brazil managed those massive inflows primarily in standard textbook fashion, with aggregate demand contraction through fiscal and monetary policies, and significant currency appreciation while smoothing movements through sterilized reserve accumulation – which reduced the volatility of the exchange rate, without, however, aiming at distorting its structural trend. But Brazil's credit market was affected by capital inflows and a set of macroprudential measures was consequently adopted to smooth the financial cycle. There was evidence that, there were multiple sources of foreign funding that transmitted into credit markets, in addition to the confidence factors that are associated with periods of abundant liquidity. External funding at low cost, despite tight domestic prudential rules, creates incentives to increase risk taking and usually ends by distorting asset prices, including the exchange rate. In Brazil, excessive capital inflows contributed to the brisk pace of domestic credit growth, which fueled inflationary pressures associated with domestic demand-supply mismatches and created fertile ground for the domestic transmission of pressures stemming from global commodity prices.

Capital inflows into Brazil intensified in particular after the beginning of the financial crisis around mid-2007, and portfolio flows hovered around 10 percent of GDP at the end of 2009 (Figure 23). As it is extensively reported in the literature, these short-term flows are volatile and can behave with episodes of surges and reversals (sudden-floods and sudden stops). That, in turn affects the funding of banks and produce exchange rate volatility. Similarly, the equity and derivatives markets are also vulnerable to market sentiment, especially if foreign investors are responsible for large shares of trading (see Figure 24).

These issues were addressed with pragmatism, since it was painfully aware of the destabilizing effects of excessive levels of global liquidity, in particular when it transmits to domestic credit growth. Excessive capital inflows present several risks to recipient countries. They are potentially disruptive for emerging markets' price and financial stability. In the absence of any policy response, the economy may lose competitiveness and experience unsustainable trade account deficits. There is also a risk of financial instability. Banks tend to increase their foreign currency exposure and become more lenient in their credit standards when faced with higher foreign liquidity. Surges in capital inflows can lead to higher inflation and to credit and asset price bubbles.

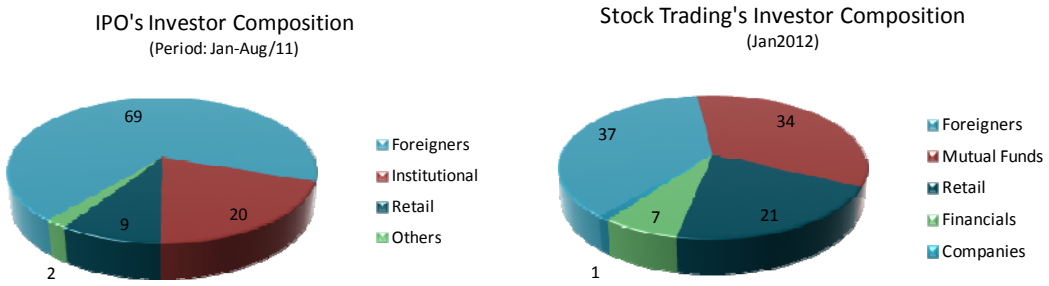
[49] This section uses information contained in the Financial System Stability Assessment (FSSA) for Brazil (see IMF – FSSA (2012)).

Figure 23: Brazil: Capital Flows and Volatility



Source: Central Bank of Brazil and authors' calculations.

Figure 24: Investor Composition in IPO and Stock Trading

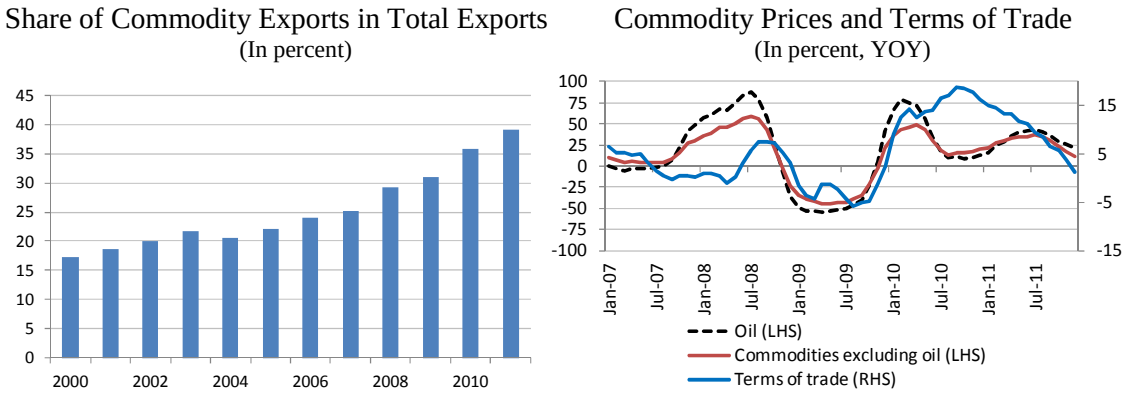


Source: BM&F Bovespa.

Given the importance of commodities in Brazil's trade, fluctuations in commodity prices[50] can bring an additional source of vulnerability that affect both equity and credit markets. The share of commodity exports in exports has been growing in the 2000s and it is important. The terms of trade and GDP growth in Brazil during the 2000s have been related to commodity prices, including oil (Figure 25). Under the current scenario of a prolonged period of low global growth, due to the Euro zone crisis and its fallout in other major economies (e.g., the US and China), it is possible that commodity prices will experience a stabilization and/or downturn. That could have a sizeable impact on Brazilian exporters and affect its financial sector.

[50] Commodity exports accounted for about 39-40% in Brazil's total exports in 2011.

Figure 25: Commodity Exports and Terms of Trade

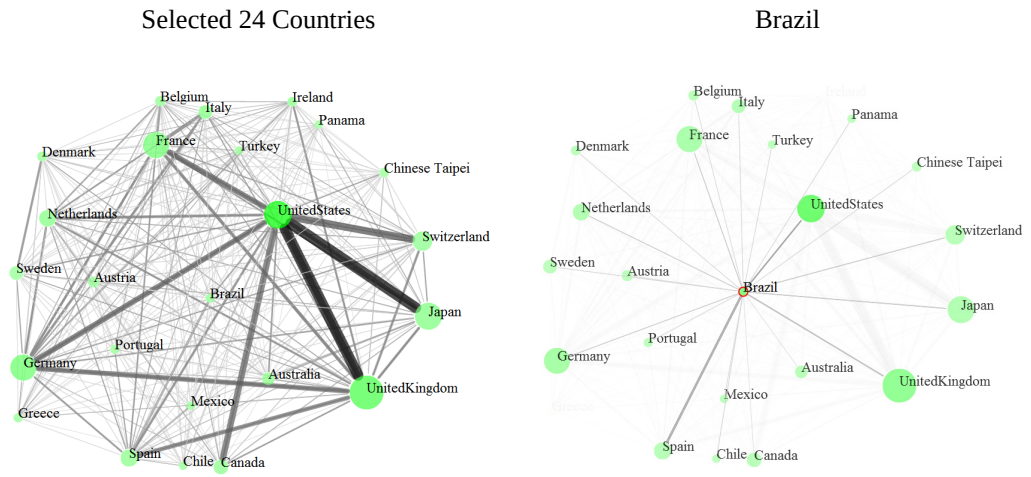


Source: CEIC database and authors' calculations.

Another traditional source of financial instability has been cross-border financial interconnectedness. That aspect has attracted considerable attention in the wake of the Euro zone debt crisis. In the case of Brazil, this risk is limited (Figure 26). The Brazilian financial system is characterized by a relatively small share of foreign banks presence (see Annex 1), small reliance of external sources of funding and limited foreign exposures. The financial system is rather geared toward the domestic market and its process of internationalization is recent and affects only a very small number of large conglomerates.

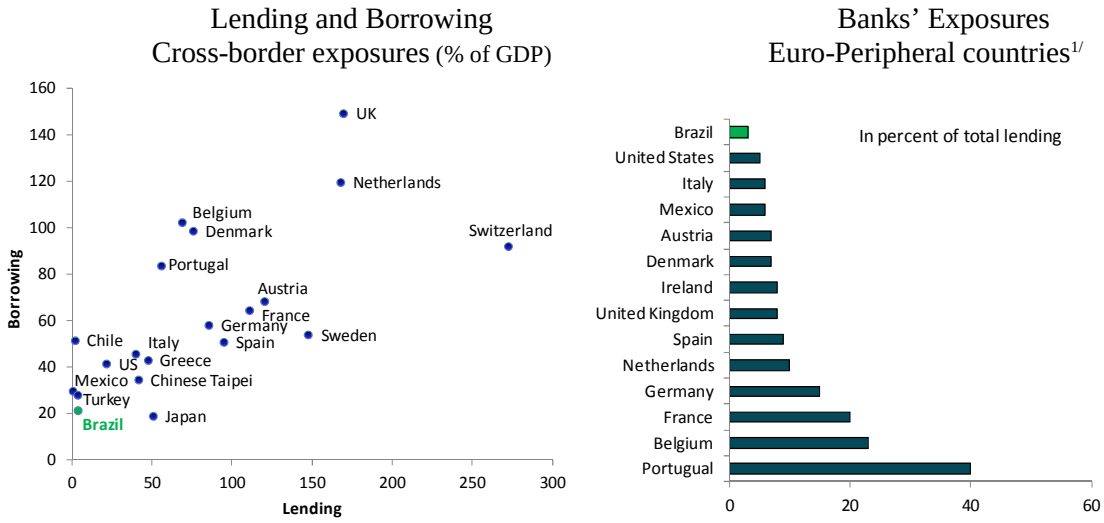
Therefore, foreign lending and borrowing exposures hovered around 5 and 20 percent of GDP respectively, and Brazilian banks' exposure to Euro zone crisis-affected countries is about 4% of its total loans by September 2011 (Figure 27). Brazilian banks' funding is mostly domestic through deposits and repos, and Brazilian conglomerates dispose of a large and diversified domestic funding base. The exposure to foreign currency liabilities is small (9%). The major exposure to international markets comes from the large public sector banks that are backed by the government. Currency mismatches in balance sheets are limited by regulation and constantly monitored by the BCB. The banks' net open position in foreign exchange have been monitored and subject to further regulatory tightening in 2010-2012, averaging only about 7 percent of banks' capital by end-June 2011.

Figure 26: Cross-border Interconnectedness[1/,2/]



Source: BIS Consolidated Banking Sector Statistics (as of December 2011). 1/ The size of a circle shows the amount of foreign bank's lending to each country and its color gets greener as the amount of inflows to the country gets larger. Two-way flows, an outflow and inflow from country A to B, overlap each other with two different gray colors. 2/ We would like to acknowledge *Financial Network Analytics* for its web-based program of network analysis.

Figure 27: Cross-border Banking Exposures



Source: BIS and authors' calculations (as of September 2011).
1/ Includes Greece, Ireland, Portugal, Italy and Spain. Right graph shows banks' exposure to Euro zone crisis-affected countries.

6. Broad Indicators of Financial (In) Stability

6.1 Financial Stability Map

In Brazil, systemic risk has declined since the peak of the global financial crisis (2008/2009). There are many ways to capture an overall perception of systemic risk and one route is that of mapping factors related to systemic risk into a single chart. For illustrative purpose, we construct a financial stability map based on the following six systemic factors: leverage, liquidity, interconnectedness, external vulnerability, bank soundness and economic conjecture. Table 16 shows the proxies used for each dimension of the map as well as the respective figures by the end of past years. The signs presented in the second column of Table 16 refer to the

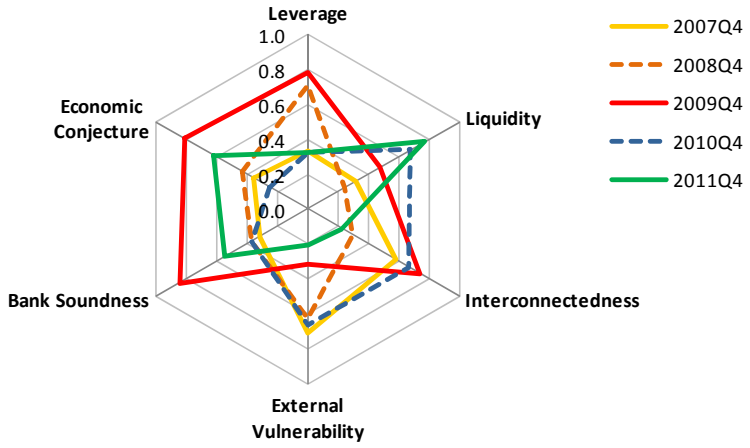
positive (or negative) correlation of the selected proxies in respect to the increase of risk (i.e., towards financial instability).[51]

Table 16: Dataset for Financial Stability Map

Dimension	Proxy	2007Q4	2008Q4	2009Q4	2010Q4	2011Q4
Leverage	(+) Credit-to-GDP gap *(normalized)*	-0.06	2.00	2.48	-0.12	-0.13
Liquidity	(+) Loan-to-Deposit ratio	1.07	1.03	1.14	1.23	1.28
Interconnectedness	(+) α index	3.448	3.444	3.450	3.449	3.443
External Vulnerability	(-) International reserves to short-term external debt ratio	4.6	5.3	7.7	5.0	8.8
Bank Soundness	(+) Non-performing loans to total gross loans	3.0%	3.1%	4.2%	3.1%	3.5%
Economic Conjecture	(-) Real GDP growth rate (YOY)	6.1%	5.2%	-0.3%	7.6%	2.7%

Source: Author's calculations based on data from Central Bank of Brazil, World Bank-Quarterly External Debt Statistics (QEDS/SDDS), IMF-Financial Soundness Indicators (FSI) and IBGE-SIDRA.

Figure 28: Financial Stability Map



Source: Author's calculations based on data from Central Bank of Brazil, World Bank-Quarterly External Debt Statistics (QEDS/SDDS), IMF-Financial Soundness Indicators (FSI) and IBGE-SIDRA. Away from center signifies higher risks.

A preliminary evaluation of Brazilian systemic risk factors in the figure 28 shows that the relative importance of individual risks has changed in the recent years. For instance, the leverage risk factor had been relatively high in comparison to other factors along the 2008/2009 period. However, as the global financial crisis and its spillover effects impacted the Brazilian financial system, the liquidity risk factor gained importance, replacing the leverage risk factor during the 2010/2011 period, whereas the interconnectedness risk factor, which significantly rose by the end of 2009, returned to relatively low levels by the last quarter of 2011.

Looking at the external vulnerability dimension[52], the indicator suggests a lower risk by the end of 2011, basically reflecting the sharp increase of international reserves during the last years,

[51] In order to adequately compare the systemic risk factors within a single picture, they are first transformed to a common scale (i.e. demeaned and re-scaled to unit variance, excepting the loan-to-deposit ratio which is demeaned around the unit value, that represents a balanced amount between loans and deposits) and, then, logit-transformed to map the individual risks from the real line into the [0;1] interval. The logit function is given by yt = 1/(1+exp(-xt)). Finally, the sign for each factor presented in Table 16 is considered in order to build the map dimensions according to the proper direction (i.e., away from center signifies higher risks).

[52] Other alternative proxies for the external vulnerability are: (i) the Credit Default Swap (CDS) representing sovereign risk; (ii) the ratio of total external debt-to exports (goods and services); (iii) the

which more than compensate the rise in short-term obligations. The bank soundness[53] proxy (non-performing loans to total gross loans) exhibits a hike in the last quarter of 2009 and relatively lower figures in other quarters, whereas the economic conjecture[54] depicts the domestic economic slowdown in recent years partially due to the impact of the global crisis in the Brazilian economy.

This framework can be used as a summary for assessing current systemic risk, and the preliminary impression conveyed by figure 28 is corroborated by a more in-depth analysis of selected risk factors.

6.2 Synthetic Indicators of Financial (In) Stability

Financial stability is measured by different components of the financial system. Indexes of overall financial conditions are often constructed as weighted (or simple) averages of a number of individual indicators, each representing one distinct aspect of systemic risk. Aggregate indexes of this sort have the advantage of capturing both the time series and cross-section dimensions of systemic risk mentioned throughout this paper. The main idea is to summarize in a single index the overall conditions of the financial system in order to help policy makers to monitor systemic risk, anticipate booms/crunches and develop adequate policy strategies.

Although there is no consensus in the literature (e.g., Borio and Lowe (2002), BIS-CGFS (2010) and De Nicolò et al. (2012))[55] about a unique indicator of financial stability, several of them can be constructed. Therefore, we generate three broad financial stability (synthetic) indicators, with the objective of summarizing the systemic risk aspects of Brazilian financial system. First, in order to deal with comparable components of the broad indicator, we transform the individual indicators (credit-to-GDP gap, loan-to-deposit ratio and interconnectedness α index, which are our proxies for leverage, liquidity and interconnectedness, respectively) to zero mean and unit variance series (excepting the loan-to-deposit ratio, which is demeaned around the unit value, which represents a balanced amount between loans and deposits). A growing positive value for the transformed indicator indicates an increase in financial instability. Second, we must decide how to aggregate these individual indicators into a single one.

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ratio of Brazilian banks' investment in foreign sovereign debt securities to total assets; (iv) the ratio of external funding (loans, bonds and securities issued abroad) to total assets of the Brazilian banking sector.

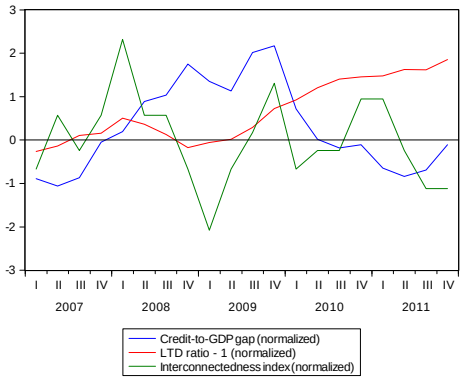
[53] Other possible proxies for bank soundness are: regulatory capital to risk-weighted assets, liquid assets to total assets (liquid asset ratio), return on assets, and FX net open position to capital.

[54] Regarding economic conjecture, we assume for simplicity that an increase in overall economic conjecture (i.e., higher real GDP growth rate) improves contemporaneous financial stability, although there might be exceptions to this positive relationship (e.g., an overheated economy might be associated with price bubbles and, thus, could lead to a deterioration of financial stability). Other possible proxies for this dimension are: growth rate of industrial production, private consumption growth rate, average real income growth rate, unemployment rate, consumer price inflation and current account to GDP ratio.

[55] According to De Nicolò et al. (2012), systemic risk is a multi-faceted phenomenon and there are a variety of metrics that help either signal the gradual buildup of imbalances or flag the concentration of risk within the system. In respect to prudential frameworks, Borio and Lowe (2002) argue that: "*Despite very encouraging steps in recent years, we are still a long way from achieving a greater consensus on the nature of the problem and hence on the possible solutions.*" In the same line, the BIS-CGFS (2010) report states that: "*In contrast to the monetary policy literature, research on macroprudential policy is still in its infancy and appears far from being able to provide a sound analytical underpinning for policy frameworks. This may be due to two main reasons. First, the macroprudential approach has come to play a visible role in policy discussions only very recently. Second, it reflects the lack of established models of the interaction between the financial system and the macroeconomy.*"

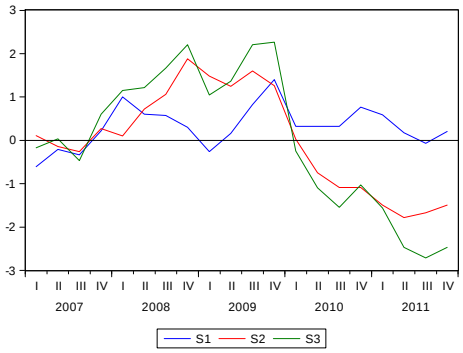
The first synthetic indicator is a simple average of our normalized proxies for leverage, liquidity and interconnectedness, which are assumed to represent both time series and cross-sectional dimensions.[56] The second proposed synthetic indicator aims to capture common risk factors among the individual systemic risk indicators. The main idea is to use the Principal Component Analysis (PCA), in which an orthogonal transformation of the set of individual indicators is employed to generate the so-called principal components.[57] A third synthetic indicator, based on a weighted average of the first and second principal components is also suggested as an alternative indicator to summarize the common patterns from the investigated financial stability individual indicators.[58]

Figure 29: Individual components of a Brazilian synthetic indicator



Source: Authors´calculations.

Figure 30: Synthetic indicators



Source: Authors´ calculations. S1 is a simple average of the three individual components, S2 is the first principal component (accounts for 44% of total variation) and S3 is a weighted average (based on eigenvalues) of the first and second principal components (cumulative account for 78% of total variation).

We first note that the simple average indicator seems to differ significantly from the two others: one explanation is that two of its components (e.g., credit-to-GDP and LTV) appear to offset each other in the averaging process. Second, both the two PC-based indicators (S2 and S3) indicate – quite right – a significant increase in financial instability in the run-up of the 2009 global financial crisis until the Lehman Brothers event (fourth quarter of 2009). After the

[56] Only the proxies for leverage, liquidity and interconnectedness are considered in our synthetic indicators for simplification purposes. Alternative synthetic indicators could further include (for instance) the proxies for external vulnerability, bank soundness and economic conjecture (i.e., the other dimensions of the financial stability map presented in Section 6.1).
[57] The first principal component accounts for most of the variation observed in the data and represents common patterns (e.g., co-movements) of the set of systemic risk indicators.
[58] To other indicators, see A. Sales, W. Areosa and M. Areosa (2012).

intensification of the 2008/2009 subprime-financial crises triggered by the collapse of Lehman Brothers, the S2 and S3 synthetic indicators seem to suggest that financial instability in Brazil has decreased or that financial stability has improved. That seems to be related to the decline in the credit-to-GDP gap component, despite the worsening of global economic growth and international financial conditions (mainly in the US and in the Euro zone). These features seemed to have induced a slowdown of domestic credit growth (e.g., via negative shocks in output), resulting in an overall balanced credit market, pictured here by a credit gap that falls into negative territory at the end of 2010-early 2011 and then rebounds to be close to zero by the end of 2011.

It is also noteworthy that by the end of 2011 the simple two S2-S3 principal component-based indicators are on the negative side, suggesting that financial stability is stronger despite a tightening of credit-to-GDP gap. In addition, the two S2-S3 indicators show a very similar dynamics since the last quarter of 2009, and they consistently change direction from 2011Q3 to 2011Q4 (as occurred in 2010Q4) which is in line with recent bout of risk aversion in 2012Q2 and the tightening of credit conditions observed in the global economy.

How would the synthetic indicators relate to other business and financial cycle variables?[59] In Table 17 we present the sample correlations of the synthetic indicators S2 and S3 with our proxies for business and credit cycles.[60] First, note that output and industrial production gaps are negatively correlated with our synthetic indicators, which is an expected result given that credit and business cycles have not been synchronized in recent years (as discussed in Section 4) and that our synthetic indicators (to a great extent) follow a credit gap dynamics. Second, it is noteworthy to see that the correlation for credit-to-GDP gap and for credit growth gaps (based on the whole financial system), is significant and positive in both cases. In fact, **the correlation of both S2 and S3 with the credit-to-GDP gap is high (around 0.8) which suggests that for Brazil the credit-to-GDP gap by itself appears to be a good proxy of "financial (in)stability"**.

Table 17: Correlations for synthetic indicators

	S2	S3
Output gap	-0.36	-0.17
Industrial production gap	-0.39	-0.21
Credit-to-GDP gap	0.82	0.79
Credit growth gap (financial system)	0.45	0.39
Credit growth gap (earmarked)	-0.37	-0.34
Credit growth gap (non-earmarked)	0.54	0.49
Credit growth gap (housing)	-0.60	-0.59
Credit growth gap (individuals-consumption)	-0.48	-0.36
Credit growth gap (corporations-total)	0.51	0.43
Credit growth gap (corporations-external funding)	0.51	0.41
Credit growth gap (corporations-domestic funding)	0.38	0.32

Source: Authors´ calculations. Sample: 2007Q1-2011Q4.

It is also worth noting that the correlation is negative for credit gaps regarding earmarked, individuals (consumption) and housing loans, which suggest that rapid growth of these credit

[59] For instance, if the objective of the policy maker is to dampen excessive fluctuations in the business cycle generated (partly) by the varying provision of financial services, a measure of the degree of procyclicality of the financial system is warranted.

[60] The results are very similar for S2 and S3 as expected, since sample correlation between these two series is equal to 0.96.

segments is not contemporaneous in respect to financial stability risks.[61] On the other hand, credit gaps for non-earmarked and corporations loans are positively correlated to S2 and S3, indicating that an increase of these credit lines above their potential growth might directly lead to a riskier environment and financial instability. Finally, excessive credit growth for corporations with external funding seems to be more damaging to financial stability in comparison to domestic funding. One reason would be that larger firms are more likely to access external funding, which in case of default impact the financial system in a riskier way than smaller/medium firms whose funding is based on domestic sources.

These empirical evidences should be properly viewed within the lens of theoretical models designed to understand the respective transmission channels and related threats to financial stability. As discussed in Section 5.3, credit gaps measured in terms of deviations of the growth rate of loans from its steady-state value (i.e. structurally-based) generated from General Equilibrium (GE) models, instead of statistical HP-filtered credit gaps, are likely better proxies for financial stability. Nonetheless, this topic remains an open route for future research.

Finally, it should be stressed that these results are merely illustrative and do not represent (or summarize) the overall financial conditions of the Brazilian financial system. They should therefore be interpreted with caution.[62, 63]

6.3 Measure of "Equilibrium" Rate for the Credit Growth

In the absence of deriving credit gaps from a GE model, we propose in this section a simple measure for the equilibrium rate of the Brazilian credit growth. In Table 18, we calculate the "potential" growth of the Brazilian financial system´s total credit (based on the HP-filtered observed real growth): it indicates an 11.6% (annual) growth by the end of 2011, after reaching 20.6% before the 2008/2009 crisis.

[61] A possible explanation would be an indirect (lagged) channel for individuals impacting financial stability. For instance, an excess of credit for individuals (combined with lower lending standards) might lead a lagged increase of non-performing loans, affecting both firms and financial institutions some periods later and, thus, financial stability as a whole in a non-synchronous way.

[62] For instance, financial stability could (in theory) weaken without a correspondent increase in the factors that drive S2 (e.g., if the quality of supervision declines). This missing link is somehow related to the capacity of the financial sector to withstand shocks. One possible suggestion to address this issue would be to construct a quantitative measure of financial disruption (e.g., a sudden contraction of credit, suboptimal risk transfer, inefficient price discovery, or liquidity freeze) and assess the marginal contribution of S2 to this metric through a probit/logit or panel model specification. Another possible way to test resilience is through an impulse response function under a structural vector autoregressive specification that would assess the dynamic reaction of the financial system to a particular shock within a pre-specified forecast horizon.

[63] The remainder of the paper grounds the analysis solely on the S2 synthetic indicator because it seems to better capture the dynamics of recent financial distress in comparison to S1 and S3. In addition, contrary to S1, which puts (*ad hoc*) equal weight to each risk component, the S2 indicator uses estimated PCA weights and is based only on the first principal component (instead of the first two principal components as the S3, in light of the reduced number of observations and the amount of only three risk variables to generate the synthetic indicators).

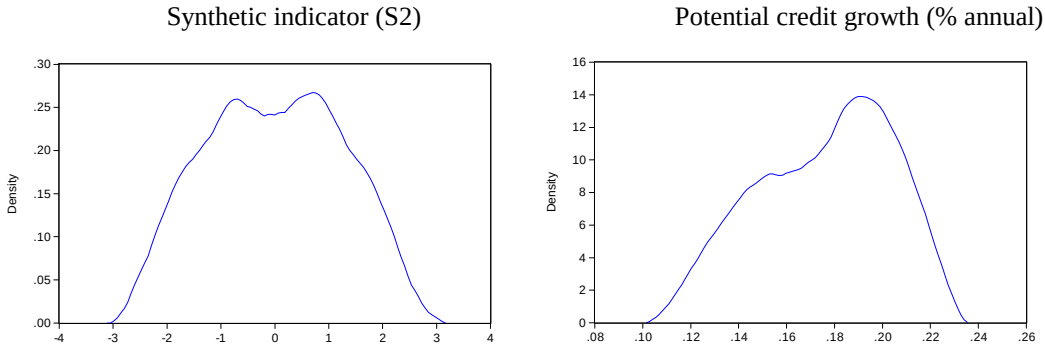
Table 18: Total financial system credit´s growth rate (*annual percent change*)

	Real growth rate (% p.a.)	HP-filtered trend´s growth rate (% p.a.)
2005	12.7%	14.8%
2006	16.3%	19.0%
2007	19.2%	20.6%
2008	24.7%	18.7%
2009	14.8%	15.3%
2010	13.1%	13.1%
2011	12.3%	11.6%

Source: Author´s calculations. Growth rates are based on annual averaged indexes.

When this potential credit growth rate is compared to the synthetic indicator S2, a positive sample correlation of 0.54 is obtained. A more in-deep analysis of the equilibrium rate is given by Figure 31, which shows the estimated unconditional distributions for the synthetic indicator S2 and the above mentioned potential credit growth. Note that the distribution of S2 is centered on zero (by construction) whereas the potential credit growth fluctuates around the 10-23% (annual growth rate) interval.

Figure 31: Probability Density Functions



Source: Author´s calculations. Densities estimated via Epanechnikov kernel. Sample 2007Q1-2011Q4.

Now, we define our equilibrium measure of credit growth as the potential credit growth which is compatible with a null synthetic indicator.[64] To do so, we employ a simple conditional model in order to estimate (via OLS – Ordinary Least Square) the respective equilibrium rate. The idea is to investigate the statistical relationship between the synthetic indicator S2 and the potential credit growth.[65] **According to this simple definition, the estimated equilibrium rate for credit (real) growth is equal to a 16% annual growth rate.** Note that this rate is below the observed real growth rates for the pre-crisis period (see Table 18); revealing a temporary higher credit growth trajectory until the aftermath of the global financial crisis of 2008/2009.

[64] In other words, the "equilibrium" is here defined as the credit growth rate which is compatible with a zero credit-to-GDP gap, a loan-to-deposit ratio equal to one, and an interconnectedness α index equal to its unconditional mean.

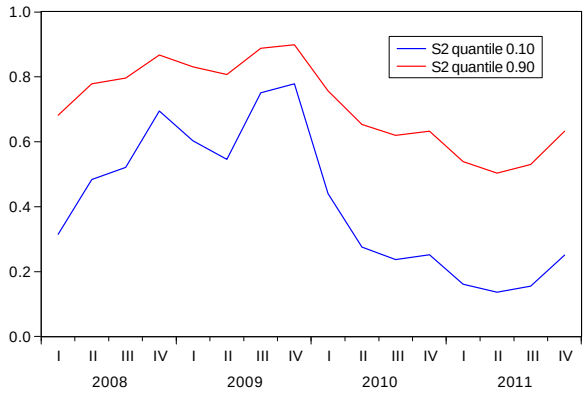
[65] The estimated equation (sample: 2007Q1-2011Q4) is the following: *potential_credit_growth = 0.160029 + 0.015953*S2*.

6.4 Probability of a Financial Stability Disruption

The synthetic indicators previously discussed can provide an important piece of information for a policy-maker that is the probability of a financial stability disruption at a given time period.[66] Based on the synthetic indicator S2, we construct a conditional model using the individual risk factors (leverage, liquidity and interconnectedness) as covariates, and estimate it by using the quantile regression (QR) technique[67], which enables us to generate conditional density functions and, therefore, calculate the probability of a disruption.[68] In addition, the following control variables (x_t) are considered in the model: real GDP growth rate, non-performing loans to total gross loans, and international reserves to short-term external debt ratio.[69]

In this sense, the first step is to estimate the following QR model: $S2_t = \alpha_0(\tau) + \alpha_1(\tau)*leverage_t + \alpha_2(\tau)*liquidity_t + \alpha_3(\tau)*interconnectedness_t + \beta(\tau)*x_t$ for a grid of selected quantiles $\tau \in [0;1]$.[70] Then, the estimated conditional quantiles are mapped into the zero-one interval (i.e., logit-transformed) and the respective probability density functions (PDF) are estimated for selected quarters via Epanechnikov kernel (see Figures 32 and 33).

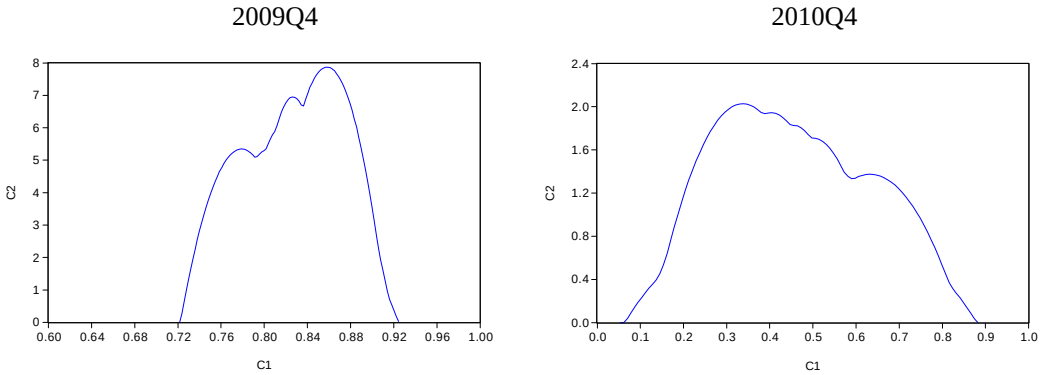
Figure 32: Estimated conditional quantiles for the (logit-transformed) Synthetic Indicator S2



Source: Author´s calculations.

[66] Borio and Lowe (2002) argue that sustained rapid credit growth combined with large increases in asset prices appears to increase the probability of an episode of financial instability.
[67] We follow the density estimation scheme of Schechtman and Gaglianone (2012), which use quantile regression to compute tail risks for Brazilian household non-performing loans.
[68] Recall that S2 is (by construction) a weighted average of the risk indicators: leverage, liquidity and interconnectedness. Since S2 is "quantile regressed" into these risk indicators, the estimated median quantile of S2 embodies, as expected, "coefficients" close to the referred PCA weights. Nonetheless, these "coefficients" are allowed to vary across distinct quantile-levels as long as one moves away from the central tendency. In other words, the relative importance of the risk factors can change according to the analyzed part of the estimated density of S2. Such approach does not lead to endogeneity since there is no loop of causality between the independent (risk factors) and the dependent (S2) variables.
[69] These series stand for the following financial stability dimensions discussed in Section 6 (respectively): economic conjecture, bank soundness and external vulnerability.
[70] Due to the model limited degrees-of-freedom (i.e., quarterly series) and taking into account only significant coefficients, the following covariates are used in the final specification: leverage and first principal component of the set of control variables x_t.

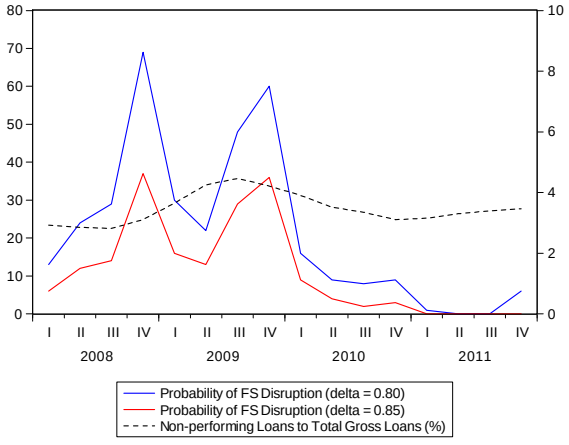
Figure 33: Probability Density Functions (PDF) of S2 at selected quarters



Source: Author´s calculations. Densities estimated via Epanechnikov kernel.

Finally, the probability of disruption is computed (for each period) by identifying the respective quantile which corresponds to a selected threshold value. In this paper, for illustrative purpose, we define the probability of a financial stability "disruption" as the probability of the (logit-transformed) synthetic indicator S2 surpassing (in each period) the threshold level δ=0.80 (or, alternatively, δ=0.85, provided that S2∈[0;1]).[71] The results are shown in Figure 34. Note that some financial stress periods are revealed during the 2008/2009 global financial crisis period, indicating that **the probability of a financial stability disruption (considering δ=0.80) reached 69% in 2008Q4; 60% in 2009Q4 and 9% in 2010Q4.** Considering a higher threshold δ=0.85, these **probabilities are 37%, 36% and 3%, respectively**. It is worth noting that despite the recent rebound of some risk factors by the end of 2011, the synthetic indicator (and the respective probability of disruption) remained in quite low levels in recent quarters.

Figure 34: Probability of Disruption (%)



Source: Author´s calculations. Probabilities on left-hand scale and NPL ratio on right-hand scale.

[71] In other words, the probability of disruption (p) at period t is given by $p=Prob(S2_t \geq \delta | F_t)$, which is equivalent to $Q_{\tau=p}(S2_t|F_t)=\delta$, in which F_t represents the set of model covariates and $Q_{\tau=p}$ (.) is the estimated conditional quantile of S2 at period t and quantile level $\tau=p$.

As discussed in Section 1, there is yet no consensus in the literature regarding the definition of financial stability (BIS-CGFS, 2010) and (much less) about how to compute the probability of "financial stability disruption".[72] In this sense, we propose a simple statistical definition for "disruption" which is not structurally derived within a general equilibrium model, but generated from selected risk factor variables. In other words, we compute the (*ex-post* and in-sample) probability of disruption based on an econometric (density) model, conditional on related risk factors and observable (control) variables.

Nonetheless, despite not being an observable variable, the computed probability of disruption can be compared to observed variables in order to reveal past periods of increased risk that might not be fully materialized in observed data. For instance, note on Figure 34 that the lower NPL levels observed until the third quarter of 2008 are not entirely accompanied by lower financial stability disruption probabilities. In fact, the probability has significantly risen along 2008, due to the impacts of the global crisis in the Brazilian economy (expressed here through our synthetic indicator S2 dynamics), whereas the observed NPL series reacted only a few quarters later, due to possible lagged transmission mechanisms of real shocks to financial risk indicators.

This type of exercise might be useful as a monitoring tool for central banks or regulatory agencies, and possible extensions include: (i) to condition the model on macroeconomic policy variables, such as monetary policy interest rates or macroprudential variables. These proxies could be further included into the x_t vector in order to analyze such policies in light of the probability of disruption, as discussed in Section 1; and (ii) to adapt the estimated model to investigate stress scenarios by conditioning the model on distressed variables.

6.5 Financial (In) Stability and Monetary Policy

The previous section assumes that we succeed identifying a "good" indicator for financial stability and systemic risk: either the synthetic indicator S2 (or, for example, the credit-to-GDP gap). We can therefore monitor the (logit-transformed) synthetic indicator and we can determine continuously when it surpasses an agreed upon threshold which would then correspond to a probability of disruption of the financial system above the policy-maker's tolerance level.

The early identification of that specific point in time would be an indication (among others) for the Financial Stability Committee of a potential threat to financial stability above the policy maker's tolerance level, thus suggesting the need for policy action including through the mobilization of macroprudential (new) rules and the strengthening of regulations. Therefore, the proposed methodology contributes to identify quantitatively – in addition to other warning signals and the policy-maker's own perception – the precise moment where special attention to financial stability is necessary.

The final and (still unresolved) issue that we mentioned earlier is whether monetary policy itself needs to be expressly concerned with financial stability objectives. And then, if the answer is affirmative, (a) whether it should also begin acting in the specific moment identified above[73];

[72] See Borio and Drehmann (2009) for a good discussion on financial instability measurement. See also N'Diaye (2009), which argues that binding countercyclical prudential regulations (e.g., capital adequacy rules) can help reduce output fluctuations and diminish the risk of financial instability.

[73] Or even earlier provided that the probability of disruption can be projected using the same methodology and given the time lags for monetary policy transmission.

(b) what financial indicators – say the S2 or the credit-to-GDP gap – monetary policy should respond to, and (c) what would be the new set of instruments to be used as an additional component of the policy framework aimed at preventing financial crises. In short, to what extent should regulatory rules and monetary policy be combined to ensure both macroeconomic and financial stability?

That discussion is evolving alongside the emergence of analytical research, testing and studying how these policies interact.[74] This new analysis explores the roles of macroprudential regulation and monetary policy in mitigating pro-cyclicality and promoting macroeconomic and financial stability. One avenue is to bring the qualitative insights into typical dynamic stochastic general equilibrium framework with explicitly modeled credit markets featuring some counter-cyclical (Basel-type) rules. There are some promising results suggesting that when both macroeconomic stability and financial stability are properly defined by quantitative benchmarks (e.g., the volatility of stock or housing prices for the latter) monetary policy could go beyond its conventional mandate under inflation targeting frameworks and address the time-dimension of systemic risk – if only during a transitory period, while more is learnt about the implementation and performance of the new macroprudential rules that are currently being discussed. Hence, there are promising arguments in favor of monetary policy reacting in a state-contingent manner to a credit growth gap measure, because of financial stability considerations. Nevertheless, monetary policy is not a replacement for macroprudential regulation either – because monetary policy cannot, in any event, address the cross-section dimension of systemic risk.

The broad direction of the new strand of literature that emerged after the crisis can be summarized in the following way: "leaning against the financial cycle", (i.e. excessively rapid growth in credit) can be done through a combination of monetary and macroprudential policies to avoid financial fragility and some prevention is not only recommended but achievable in an effective way. A combination of policies is effective involving monetary and macroprudential policies to act in a complementary fashion to ensure both macroeconomic and financial stability.

[74] For a summary of the literature see Agénor and Pereira da Silva (2012). For an analytical solution see Agénor, Alper and Pereira da Silva (2011, 2012). The stabilizing effect of a central bank reaction function with a credit rule is stronger than that of alternative rules following a classical Taylor-rule specification even when augmented by a set of macro-prudential regulations. These results hold for an open-economy with a flexible exchange rate, incorporating the interaction between capital inflows (sudden floods), credit creation and the macroeconomy.

Conclusion

According to Borio (2011), better policy calls for better analytics. The crisis has not just challenged policy-makers, but has also been a major wake-up call for the economic profession in general. This paper presents quantitative indicators of financial stability in Brazil in comparison to the US and Euro zone. These indicators help measuring systemic risk and explain the dynamics of financial distress.

We have proposed a working definition for "financial stability" together with that of systemic risk as "the probability of disruption of financial services, measured against an agreed upon threshold of shocks", exploring the respective time and cross-sectional dimensions of systemic risk and highlighting key areas of financial (in)stability (e.g., liquidity, interconnectedness and leverage). This definition allowed us to link systemic risk with synthetic indicators (e.g., S2 and/or a credit-to-GDP gap) of financial conditions and to calculate the probability of disruption of the financial system across its time dimension. At any point in time, we are therefore able to relate the cross-sectional dimension with the time dimension of systemic risk.

Therefore, this approach can link the probability of disruption with a tolerance level for "financial stability" set by the prudential regulator and thus enhances its capability of determining the precise moment when it should strengthen its set of analytical tools and calibrate operational instruments, such as countercyclical capital buffers, time-varying leverage ratios, changes in sectoral risk weights, limits to loan-to-value and loan-to-income ratios, capital surcharge, among many others (see Houben et al., 2012). The paper also discusses whether this should be done in complement with monetary policy action.

Taking individually each dimension of financial vulnerability for Brazil, several factors guarantee the robustness and solidity of the Brazilian financial system: capital adequacy buffers above international standards, rigorous rules for credit provisioning, elevated liquidity levels (e.g., net assets/short-term liabilities), credit expansion with decreasing interest rates and bank spreads. Moreover, domestic non-performing loans (NPL) are expected to diminish in the upcoming quarters.[75]

To sum it up, Brazil is facing the new round of global financial crisis in a proper and adequate way. Resilience of the Brazilian economy comes from its macroeconomic and financial solid fundaments, and from an autonomous and prompt economic policy. The results clearly contrast to the ones observed in past decades, when external shocks of much less intensity used to produce harmer effects in our economy.

[75] Mainly due to the following reasons: (i) new loans since 2011Q3 exhibit lower NPL levels (e.g., for automobile acquisitions); (ii) the current state of monetary (easing) cycle; (iii) lowering trajectories for interest rates and banking spreads; (iv) the perspective of a higher real GDP growth in the second semester of 2012; (v) the significant creation of new jobs; (vi) historically lower unemployment rates and rising real average income; (vii) declining inflation rate towards the target, preserving real wages; (viii) the relatively short-term maturities of domestic loans; among others.

Annex 1: Main Characteristics of the Brazilian Financial Sector and of its Supervision Framework

Table A1: Financial system data

Type	2007	2008	2009	2010	2011	2012*
Multiple bank	135	140	139	137	139	139
Commercial bank	20	18	18	19	20	21
Development bank	4	4	4	4	4	4
Savings bank	1	1	1	1	1	1
Investment bank	17	17	16	15	14	14
Exchange bank				2	2	2
Consumer finance company	52	55	59	61	59	58
Securities brokerage company	107	107	105	103	99	99
Exchange brokerage company	46	45	45	44	47	50
Securities distribution company	135	135	125	125	126	123
Leasing company	38	36	33	32	31	30
Real estate credit company and savings and loan association	18	16	16	14	14	14
Mortgage company	6	6	6	7	8	7
Development agency	12	12	14	15	16	16
	591	**592**	**581**	**579**	**580**	**578**
Credit cooperative	1,465	1,453	1,405	1,370	1,312	1,299
Micro-entrepreneur credit company	52	47	45	45	42	42
	2,108	**2,092**	**2,031**	**1,994**	**1,934**	**1,919**
Consorcio company	329	317	308	300	284	274
Total	**2,437**	**2,409**	**2,339**	**2,294**	**2,218**	**2,193**

Source: Central Bank of Brazil and authors´ calculations.

Table A2: Banking system ranking by total assets

Name	Ownership	Total assets (BRL billion)	Credit and leasing operations (BRL billion)	Total deposits (BRL billion)	Net worth (BRL billion)	Employees (Thousand)	Branches (#)	Basel capital ratio (%)
Banco do Brasil	Federal government owned	935	398	443	59	131	5,201	14.5
Itaú	Domestic private	815	289	253	73	122	3,849	16.0
Bradesco	Domestic private	666	237	218	56	99	4,643	15.0
BNDES	Federal government owned	604	213	21	61	3	1	21.5
Caixa	Federal government owned	511	250	260	20	110	2,300	13.3
Santander	Foreign controlled private	432	173	122	66	54	2,512	24.8
HSBC	Foreign controlled private	147	48	74	9	30	868	13.5
Votorantim	Domestic private	115	55	26	8	2	34	14.1
Safra	Domestic private	88	41	17	6	6	103	12.9
BTG Pactual	Foreign participation private	58	5	16	6	1	7	18.6
Others		642	270	210	85	75	1,787	
Banking segment total		**5,013**	**1,977**	**1,658**	**448**	**632**	**21,305**	

Source: Central Bank of Brazil and authors´ calculations.

Institutional Organization

The Brazilian Financial System is constituted manly of universal banks, which provide a wide range of banking services. Other institutions operate with a certain degree of specialization, as showed in the following examples: (i) commercial banks collect demand and savings deposits, and are traditional credit providers to firms (specially working capital) and households; (ii) investment banks collect time deposits and specialize in medium and long term financial operations; (iii) savings banks collect demand and savings deposits and operate strongly in housing finance; (iv) cooperative banks and credit unions provide credit and banking services to their members, which are rural producers in their majority; (v) savings and loan associations also collect savings deposits and provide housing finance; (vi) consumer finance companies provide consumer credit; (vii) brokers and dealers of foreign exchange, government securities, corporate bonds, stocks, and commodities and futures contracts; and (viii) consortium managers for self-acquisition of durable consumer goods and services.[76]

On the other hand, the regulating entities of the Brazilian financial system are the National Monetary Council (CMN), the National Council for Private Insurance (CNSP) and the National Council for Complementary Pension (CNPC). The supervision entities are the Central Bank of Brazil (BCB), the Securities and Exchange Commission (CVM), the Private Insurance Superintendence (SUSEP), and the National Complementary Pension Superintendency (PREVIC).

It is worth mentioning that all Financial Institutions (FIs) are both regulated and supervised, based on a financial regulation (mostly infra-legal, and generally conservative) which aims the convergence to international standards (IFRS, Basel II, IOSCO), through a constant participation of regulating and supervision entities in international forums (e.g., BCBS, G20, FSB).

The Brazilian financial system has a dense web of inter-linkages, characterized by a high degree of conglomeration, concentration, public sector presence, and low reliance on foreign funding. It is organized around a few financial conglomerates that control over 75 percent of the system's assets. Total (gross) assets in the system are equivalent to about 180 percent of GDP, 40 percent of which are held by commercial and multiple banks, 26 percent by mutual funds, 10 percent by pension funds, and 6 percent by insurance companies. Equity market capitalization is around 55 percent of GDP, close to the size of bank deposits. Foreign banks own about 20 percent of banking assets. Public sector presence in the financial sector is significant: government-owned banks account for over 40 percent of total (gross) banking assets, and directed (subsidized) credit for low-income housing, agriculture, and infrastructure represents around 35 percent of total credit. Insurance companies and pension funds, who cannot invest abroad, mainly held claims on other financial institutions, particularly mutual funds which, in turn, held a large share of their claims on the government and banks.

[76] Among these institutions, those of relevance in the Brazilian payment system are commercial banks, universal banks with commercial bank activities, savings banks and, to a lesser extent, credit unions. See the website http://www.bcb.gov.br/?COMPOSITION for further details.

Financial System Monitoring and Supervision

The supervision is grounded on a "risk-based approach", which includes constant analysis of financial and economic indicators, frequent on-site supervision and qualitative assessment of risk management and control (e.g. rating of supervised institutions). The monitoring system[77] directs on-site supervision towards the riskier areas, with specific monitoring of market and liquidity risks. As a consequence, the proper identification of areas to be monitored helps building the contingency planning and assessment of organizational structures dedicated to risks.

On the other hand, the supervision tasks also include the constant monitoring and evaluation of the credit, market and operational risks; whereas the FIs' risk management is grounded on board accountability, with mandatory internal controls (including a mandatory organizational structure for management of each risk factor). Mandatory registration of OTC derivatives and limits on large exposures and foreign currency exposures are some examples of regulatory tools used to help the supervision entities achieving its goals.

Regarding the capital adequacy, the minimum capital ratio is set at 11% of Risk-Weighted Assets (RWA), which is quite above the Basel minimum level of 8%. The capital requirement for credit risk is based on trading book exposures (except stocks), with forward-looking provisioning rules. Moreover, there are higher multipliers for standardized market risk requirement, and lower risk weights for residential property exposures conditioned to loan-to-value (LTV), in the following way:

LTV < 50%	->	35% risk weight
50% < LTV < 80%	->	50% risk weight
80% < LTV < 100%	->	75% (retail) or 100% (otherwise)

At the BCB, considerable manpower and resources are invested in macro-financial surveillance and the Financial Stability Committee (COMEF), has been created to have a coordinating role in detecting and monitoring systemic risk. In particular the Departamento de Monitoramento do Sistema Financeiro (DESIG)[1/] has been the leading instrument to help the COMEF fulfilling this task. The department monitors sources of financial instability at the individual bank micro-level, divided by types of institutions (banking and non-banking), of risks (credit, liquidity, and market risk), or of markets (security and FX). It is also responsible for systemic risk monitoring, stress tests, early warnings, and Financial Stability Reports. The DESIG collects data from many different sources,[2/] uses various tools to efficiently maintain databases, and runs a monitoring intranet to facilitate information sharing among divisions and with other parts of the BCB.

[77] The monitoring framework also includes: (i) the use of information on assets and derivatives registered in clearing houses; (ii) conciliation with FIs' accounting information; (iii) periodic application of stress tests to FIs' statements; and (iv) monitoring of aggregate evolution of systemic risk over time; among many others.

Overview of Financial System Monitoring Process[78]

Divisions in the DESIG

Divisions	Number of Staffs
Banking Sector Monitoring	19
Non-Banking Sector Monitoring	40
Credit Monitoring	30
Liquidity and Market Monitoring	14
Securities' Market Monitoring	21
Foreign Currency Monitoring	13
Systemic Risk Monitoring	6
Financial Stability Monitoring	9
Information Collection Compliance	33
Information Management	4
Regulatory Studies	4
IT support	3
Planning and Control	4
Managers and Administrative Support	23
Total	226

Data Collection

	Financial Institutions
Daily	-Bank Reserve Deposits -Foreign exchange transactions -Statement of capital requirements
Monthly	-Statement of Financial Risk Management: (assets / liabilities and off balance sheet) -Balance Sheets -Statement of Liquidity Risk -Statement of operational limits -Credit portfolio
Quarterly	-Relevant investments
When it changes	-Ownership structure
	Clearings and Depository trust Companies
Daily	-Interbank Deposits -Derivatives -Securities

1/ DESIG: Departamento de Monitoramento do Sistema Financeiro (Financial System Monitoring Department)
2/ Financial institutions, other regulators (CVM, SUSEP, and PREVIC), register centers, private databases like SERASA, etc.

The systemic risk monitoring in the DESIG can be broadly grouped along the following types of analysis:

Aggregate indicators of systemic imbalances: The BCB monitors aggregate indicators like leverage, credit growth, NPLs, and provisions, based on data from banks and non-banks. It also assesses asset prices and other macroeconomic variables to detect the build-up of systemic risks in the financial system and the economy at large. To facilitate timely monitoring processes, staffs uses various tools and databases such as SISMEF (Economic and Financial Monitoring System), SCR (Credit Information System), MRC (Credit Risk Monitor), SMM (Market Monitoring System), etc.

Macroeconomic Stress Testing: The BCB has developed VAR and dynamic panel models, which relate banks' NPLs and credit portfolios with stressed relevant macroeconomic variables to assess credit portfolio quality of banks under tail-risk scenarios.

Contagion Risk and Network Analysis: The BCB has identified and been monitoring interconnectedness across domestic financial conglomerates using a network analysis. The network is not limited to interbank deposits, but covers interbank deposits, term deposits, derivates (swaps, foreign exchange operations, forwards, boxes, and flexible options), repos with own securities, 'Letras Financeiras' bonds, etc. The analysis tests how serious domino effects a failure of a bank (or a set of banks) creates in the financial system.

Probability of Default: The model is adapted from Merton (1974). The BCB uses the moving average of 36 months for the parameters of return volatility of the asset and the cost of liability.

[78] This section draws from information assembled by the Financial Stability Assessment (FSAP) team.

CAMEL model: Various financial soundness indicators are used to set each bank's score.

Systemic Resilience: The resilience of the banking sector is assessed through a model that uses balance sheet and economic indicators to predict the probability of a financial crisis.

Quantitative Evaluation Model of SIFIs: SIFIs with high 'SIFI score' have been identified and monitored more closely than other. The SIFI score of each bank is calculated according to its size (total assets), interconnectivity (number of connections, amount of lending and borrowing, etc.), complexity (derivative and FX exposures), and substitutability (share on payment system, geographic coverage in Brazil).

Financial Stability Reports (FSRs): The BCB publishes semi-annual reports, describing recent national financial system dynamics and presenting stress-test results. [3/]

Financial Stability Committee (FSC): the BCB recently created its FSC which meets every other month and examines all issues related to financial stability. The decision-making group in the FSC is the same as in the Monetary Policy Committee (MPC), i.e. the Governor and deputy-governors.

3/ The 2009 and 2011 FSRs are only available in Portuguese at the BCB's website.

Annex 2: Recent Developments in the Brazilian Economy

Table A1: Macroeconomic Data

	Unit	2009				2010				2011			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Activity													
GDP	% YOY	2.9	0.7	-1.4	-0.3	2.5	5.4	7.6	7.5	6.3	4.9	3.7	2.7
Domestic demand	% YOY	-0.5	-0.2	1.0	7.6	10.8	9.8	8.4	7.1	5.7	5.3	2.3	2.0
Ind. Production	% YOY	-14.6	-12.3	-8.2	5.9	18.2	14.3	8.0	3.3	2.8	0.6	0.0	-2.1
Unemployment	%	8.6	8.6	7.9	7.2	7.4	7.2	6.6	5.7	6.3	6.3	6.0	5.2
Capital Flows (Gross)													
Reserves	USD b	190.4	201.5	221.6	238.5	243.8	253.1	275.2	288.6	317.1	335.8	349.7	352.0
Reserves	% YOY	-2.5	0.3	7.3	23.1	28.0	25.6	24.2	21.0	30.1	32.7	27.1	22.0
Portfolio	USD b	25.1	46.4	55.0	46.9	29.7	30.1	38.7	35.1	24.5	28.6	22.7	25.2
Portfolio % of GDP	%	8.6	13.4	11.9	8.9	5.8	5.6	7.1	6.4	4.1	4.6	3.6	4.0
Bank credit	USD b	2.3	5.2	4.0	8.1	10.3	7.6	12.3	13.2	25.7	15.3	14.4	4.8
Bank credit % of GDP	%	0.8	1.5	0.9	1.5	2.0	1.4	2.2	2.4	4.3	2.5	2.3	0.8
FDI	USD b	6.6	5.0	7.6	11.2	6.7	12.1	11.9	24.7	15.6	16.8	19.1	17.3
FDI % of GDP	%	2.3	1.4	1.6	2.1	1.3	2.3	2.2	4.5	2.6	2.7	3.0	2.7
Total	USD b	72.5	101.2	106.6	127.2	94.8	104.9	119.1	146.4	134.9	139.0	146.8	127.4
Total Percent of GDP	%	24.9	29.3	23.0	24.2	18.5	19.5	21.8	26.7	22.5	22.3	23.4	20.2
Credit (Oustanding)													
Consumer	% YOY	18.5	17.0	15.7	17.7	18.4	16.3	17.1	19.1	17.9	18.2	16.9	13.9
Payroll-guaranteed	% YOY	22.6	30.3	33.9	36.1	37.2	29.7	27.8	28.4	21.8	19.5	17.8	12.5
Housing	% YOY	40.3	41.8	43.0	40.8	48.1	50.1	50.7	55.5	49.9	49.4	47.1	44.1
Ear-marked	% YOY	27.2	24.3	32.0	28.9	30.7	34.9	28.6	27.1	25.8	23.8	26.4	26.6
Non-earmaked	% YOY	23.6	17.0	10.4	9.1	10.9	13.2	15.7	17.7	18.0	17.8	15.7	14.7
Total	% YOY	24.7	19.1	16.6	15.0	16.9	19.8	19.9	20.9	20.6	19.9	19.4	18.8
Total Percent of GDP	%	40.7	41.5	43.6	43.7	43.1	43.6	44.3	45.2	45.2	46.0	47.4	49.0
Prices / Asset Prices													
CRB Metals (USD)	% YOY	-48.1	-39.5	-10.3	48.6	85.2	43.5	17.6	27.8	30.0	35.1	25.9	-6.6
CRB Food (USD)	% YOY	-21.9	-23.0	-25.4	7.6	20.2	14.0	27.4	26.8	38.2	40.4	27.8	6.9
CRB Total (USD)	% YOY	-28.0	-24.7	-16.0	18.9	34.6	23.2	19.8	24.0	30.0	30.8	20.7	-0.4
CPI (IPCA)	% YOY	5.6	4.8	4.3	4.3	5.2	4.8	4.7	5.9	6.3	6.7	7.3	6.5
CPI-food	% YOY	9.3	5.0	4.1	3.2	5.6	5.1	5.4	10.4	8.8	8.9	9.9	7.2
CPI-services	% YOY	6.8	7.2	6.9	6.4	6.9	6.8	6.9	7.6	8.5	8.8	9.0	9.0
WPI (IGP-M)	% YOY	5.6	-0.6	-3.0	-4.4	0.5	5.0	9.3	13.9	13.5	9.7	7.6	4.3
ER nominal	% YOY	30.4	19.0	1.1	-31.3	-25.9	-8.0	-5.7	-3.3	-7.4	-13.0	1.8	8.1
REER	% YOY	13.2	6.5	-6.2	-26.0	-20.0	-13.3	-9.0	-7.9	-6.3	-6.7	0.8	5.2
Real estate (SP)	% YOY	22.8	23.5	23.9	24.2	24.5	25.1	26.2	27.4	24.5	27.4	28.8	27.8
Real estate (RJ)	% YOY	13.9	15.0	17.6	20.6	23.5	29.0	34.7	38.6	41.7	44.0	42.3	37.3
BOVESPA	% YOY	-39.9	-23.4	21.7	60.2	54.2	16.9	12.1	1.0	-2.6	2.4	-28.3	-20.0

Source: Central Bank of Brazil and Pereira da Silva and Harris (2012).

Table A2: Credit market

	Unit	2009				2010				2011			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Firms													
Total (growth rate)	% YOY	28.5	19.7	16.0	12.6	14.5	20.4	19.9	19.6	20.1	18.2	17.8	18.4
Average interest rate	%	30.2	28.2	26.4	26.0	26.2	26.8	28.8	28.4	30.4	31.0	30.8	29.3
Spread	p.p.	18.6	18.4	17.8	17.1	17.1	16.8	18.3	17.7	19.0	19.2	19.1	18.7
NPL (90 days overdue)	%	1.94	2.55	2.75	2.43	2.20	1.97	1.80	1.68	1.73	1.84	1.90	1.91
Households - Total Credit													
Total (growth rate)	% YOY	20.1	18.4	17.3	18.3	20.0	19.0	19.9	22.5	21.2	22.0	21.5	19.3
Total Percent of GDP	%	17.7	18.5	19.3	19.3	19.3	19.3	19.6	20.2	20.3	20.7	21.4	22.0
Average rate	%	52.6	47.2	44.2	43.3	42.0	41.0	39.9	40.0	44.2	46.6	45.9	45.2
Spread over deposit	p.p.	41.6	37.3	34.3	32.5	30.9	29.2	28.5	28.3	31.7	34.1	34.2	35.0
Total Debt to Income	%	32.5	33.3	34.2	35.2	36.1	37.2	38.2	39.0	39.8	40.7	41.8	42.5
Total Debt Service to income	%	18.8	19.5	19.3	19.5	19.2	19.4	19.1	19.3	19.8	20.3	21.9	22.2
NPL (90 days overdue)	%	7.1	7.0	7.1	6.5	6.1	5.7	5.4	5.0	4.9	5.2	5.3	5.5
Worst risk category/Total	%	9.4	9.2	9.1	8.8	8.3	7.9	7.6	7.1	6.9	7.2	7.4	7.6
Households - Consumer Credit													
Total (growth rate)	% YOY	18.5	17.0	15.7	17.7	18.4	16.3	17.1	19.1	17.9	18.2	16.9	13.9
Total Percent of GDP	%	13.0	13.7	14.2	14.2	14.0	14.0	14.1	14.5	14.4	14.5	14.8	15.0
Average rate	%	53.9	47.0	44.6	44.6	43.8	42.6	41.9	43.2	47.9	49.5	49.3	49.7
Spread over deposit	p.p.	43.0	37.0	34.6	33.5	32.4	30.6	30.3	31.3	35.2	36.9	37.6	39.5
Average Maturity	months	13.0	14.8	15.1	15.2	15.5	15.7	16.1	16.2	16.2	16.3	16.5	17.6
NPL (90 days overdue)	%	8.5	8.5	8.3	7.9	7.3	6.9	6.5	6.2	6.2	6.6	7.0	7.3
Worst risk category/Total	%	9.9	9.7	9.7	9.4	8.8	8.4	8.0	7.5	7.4	7.8	8.2	8.5
Households - Car Loans													
Total (growth rate)	% YOY	-3.3	0.6	4.5	17.8	26.5	33.8	43.3	50.7	48.0	45.3	35.7	27.8
Total Percent of GDP	%	2.5	2.5	2.7	2.7	2.8	3.0	3.3	3.5	3.6	3.8	4.0	4.1
Average rate	%	32.0	28.6	26.0	25.4	24.3	24.0	23.6	23.8	28.1	30.4	29.1	27.3
Spread over deposit	p.p.	21.0	18.5	15.9	14.2	12.8	12.0	12.0	11.9	15.4	17.8	17.4	17.1
Average Maturity	months	N/A	16	17	17	18	19	19	20	20	19	19	19
NPL (90 days overdue)	%	6.4	6.9	6.1	5.5	5.0	4.4	3.8	3.2	3.7	4.5	5.2	5.9
Loan-to-Value (average)	%	71.2	72.0	74.7	74.9	77.4	77.9	78.6	77.8	70.6	74.9	73.6	71.9
Worst risk category/Total	%	6.3	6.6	6.0	5.5	4.8	4.2	3.6	2.8	3.1	3.6	4.2	4.8

Source: Central Bank of Brazil and Pereira da Silva and Harris (2012).

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