



# BRAZIL

## SELECTED ISSUES

May 2015

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# BRAZIL

## SELECTED ISSUES

March 4, 2015

Approved By  
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## CONTENTS

<b>FILLING THE GAP: INFRASTRUCTURE INVESTMENT IN BRAZIL</b>	<b>5</b>
A. Overview	5
B. How Integrated is Brazil?	6
C. The State of Infrastructure	8
D. Infrastructure Investment Trends	17
E. The Role of the Concession Program	19
F. Filling the Gap	20
<b>BOXES</b>	
1. The Choice of Infrastructure Comparator	9
2. Infrastructure Adequacy Indicator	13
3. Electricity Sector Woes	16
<b>FIGURES</b>	
1. Infrastructure Quality Indicators	10
2. Transportation. Infrastructure Quality Indicators	11
3. Infrastructure Quality and Income	15
<b>APPENDICES</b>	
I. Infrastructure Indictors	21
II. Panel Unit Root Methodological Note	22
<b>REFERENCES</b>	<b>23</b>
<b>MACROECONOMIC IMPLICATIONS OF MINIMUM WAGE INCREASES IN BRAZIL</b>	<b>24</b>
A. Introduction	24

B. The Minimum Wage and Inequality in Brazil	25
C. Is Brazil's Minimum Wage too High?	26
D. Potential Macroeconomic Implications of the Current Minimum Wage Rule	29
E. Policy Implications	31

**APPENDIX**

Regressions and General Equilibrium Model	32
---	----

<b>REFERENCES</b>	<b>38</b>
-------------------	-----------

**FISCAL MULTIPLIERS FOR BRAZIL** 39

A. Fiscal Policy and Growth in Brazil since the Global Financial Crisis	39
B. Fiscal Multipliers in Brazil: What do we know?	40
C. Methodology	41
D. Estimated Fiscal Multipliers	43
E. Have the Multipliers Changed?	45
F. Robustness	48
G. Policy Implications	49

**FIGURES**

1. Fiscal Stimulus and Economic Growth	39
2. Basic Multipliers	44
3. Multipliers, Basic Shocks	46
4. Multipliers, Credit Shocks	47
5. Basic Multipliers	48

**APPENDIX**

Data	50
------	----

<b>REFERENCES</b>	<b>51</b>
-------------------	-----------

**NORMALIZATION OF GLOBAL MONETARY CONDITIONS: THE IMPLICATIONS FOR BRAZIL** 52

A. The Taper Episode and Beyond	52
B. Why did Long-Rates Rise in the U.S.?	53
C. What was the Impact on Brazil?	54
D. Why are Brazilian Interest Rates so Responsive to U.S. Developments?	57
E. Policy Implications	57

**FIGURES**

1. Brazil and U.S. Sovereign Bond Yields	52
2. Cumulated Change in U.S. 10Y Bond Yield	53
3. Impact of Money and News Shocks	59
4. Explanatory Power of Different Shocks at Different Horizons	60
5. Cumulated Changes Since Taper Episode and Contributions	61

**APPENDIX**

Data	62
------	----

**REFERENCES** 63**ASSESSMENT OF FOREIGN EXCHANGE INTERVENTION** 64

A. Background	64
B. Intervention Tool Kit	66
C. Intervention Program Following the ‘Tapering Talk’	69
D. Distribution Channels to Spot and Derivative Markets	72
E. Effectiveness	74
F. Limits to Intervention	80
G. Discussion	82

**FIGURES**

1. Foreign Currency Intervention	66
2. USD Linked Debt and Foreign	66
3. Cupom cambial, FX Rate, and FX	66
4. Convertibility Risk	66
5. Ratio of Daily Turnover in Derivatives Markets to Spot Market	67
6. Outstand Balance of FX Swap and FX	70
7. FX Swap Exposure by Counterparties	70
8. FX Swaps at Maturity	71
9. Net Increase of FX Swap	71
10. Rollover Rate of FX Swap	71
11. Capital Flows	72
12. FX Flows Financed by FX Repo and Commercial Banks’ Short FX Position	73
13. End Users of FX Swaps	73
14. FX Implied Volatility Relative to Peers	77
15. Foreign Exchange Rate	78
16. International Reserve Adequacy	81
17. Size of FX Swap to Measures of External Debt	83

**TABLES**

1. Explaining Volatility	76
2. Impacts of Important Announcements of FX Swap Auctions	79
3 Public Sector Net Creditor Position	81

<b>REFERENCES</b>	<b>84</b>
-------------------	-----------

**NON-FINANCIAL CORPORATE SECTOR VULNERABILITIES** 85

A. Global Environment	85
B. Balance Sheet Developments	87
C. Corporate Defaults	95
D. Sensitivity Analysis	99
E. Discussion	101

**BOX**

Data Sources	87
--------------	----

**FIGURES**

1. Selected Countries: Debt-to-Equity Ratio and Change in NFC Debt	86
2. Issuance of Bond and Equity	88
3. Brazil and Selected Countries: Corporate Debt	89
4. Brazil and Regional Peers: Corporate Leverage	90
5. Brazil and Regional Peers: Interest Servicing Capacity	91
6. Brazil and Selected Countries: Capital Expenditure and Profitability	92
7. Brazil and Selected Countries: Corporate External Debt	95
8. Share of FX Debt by Borrowers with or without Hedging Mechanisms	95
9. Corporate NPL Ratio	96
10. Corporate NPL Rate of Selected Non-earmarked Loans	97
11. Corporate NPL Rate by Size of Companies and Sectors	97
12. Delinquency Index by Serasa Experian and Corporate NPL Rate	98
13. Expected Default Probability	99

**TABLES**

1. Explaining Capital Expenditure	93
2. Stress Test Results	100

# FILLING THE GAP: INFRASTRUCTURE INVESTMENT IN BRAZIL<sup>1</sup>

*This chapter assesses Brazil's infrastructure. Brazil's infrastructure endowment ranks low by international standards, and its low quality affects productivity, market efficiency, and competitiveness. Boosting infrastructure investment is key to unleashing economic growth going forward.*

## A. Overview

**1. Developing an economic strategy to scale up infrastructure investment requires establishing the link between infrastructure provisions and growth, determining the infrastructure gap, and identifying financing and optimal provisioning.** Areas where Brazil's competitiveness has lagged include, but are not limited to, education, innovation, governance and justice. Yet, inadequate infrastructure is increasingly identified as the key bottleneck behind low productivity, stagnating export performance, insufficient domestic market integration, and weak growth potential. Market segmentation caused by divergence in relative prices can have potentially severe social and macroeconomic implications. Income inequality may also increase with market segmentation, as low income producers in rural areas are adversely impacted by difficulties accessing large consumer markets. Several years of underinvestment in infrastructure have contributed to reducing potential growth. It has been estimated that inefficiencies due to inadequate infrastructure subtract 10–15 percent from the country's GDP (Credit Suisse, 2013).<sup>2</sup>

**2. To underscore Brazil's need for greater investment in infrastructure, we attempt to throw some light on Brazil's infrastructure gaps.** Infrastructure investment is often seen as a strategy to promote internal integration and export competitiveness. Following this logic, we first look at how infrastructure affects domestic integration by analyzing price convergence across major cities. Second, using quantity and quality indicators, we look closely at infrastructure gaps across sectors against Brazil's current income levels and against infrastructure levels and quality of Brazil's competitors in its export markets. We then document historical infrastructure investment trends in Brazil, and describe the authorities' concessions program in light of the most pressing infrastructure needs. Finally, we discuss policies that could help close the infrastructure gap.

<sup>1</sup> Prepared by M. Garcia-Escribano, C. Goes, and I. Karpowicz.

<sup>2</sup> According to Credit Suisse (2013), most of the R\$1 trillion investment gap is infrastructure related. Underinvestment is especially notable in greenfield projects as brownfield projects were granted to the private sector through concessions. Airports, ports, and rail are the most constrained sectors.

## B. How Integrated is Brazil?

**3. We assess market segmentation in Brazil by analyzing convergence of prices across major metropolitan areas.** We construct price indices for 51 products across 12 metro areas over the past 14 years, from extended monthly CPI micro data, and test for panel unit root using the methodology developed by Im, Pesaran, and Shin (2003).<sup>3</sup> Intuitively, we are testing for the law of one price (LOOP): if goods markets are well integrated, the difference between the log of price levels ( $p_{it}$ ) for tradable products in different  $i$  cities should be stationary, that is, mean reverting, with relatively fast reversion to the mean after some shock causes a divergence to appear.

**4. Empirical results suggest that most tradables prices converge to the mean, but slowly.** We reject the null of unit root for about 2/3 of the tradable products, for which the LOOP holds. These are most notably food and fuels. However, we note that, following a shock to the relative price of a tradable good, prices converge to the long-run national trend only very slowly. The average time it takes for half of the initial price discrepancy to disappear (the so-called 'half-life') is 14 months, with the speed of convergence varying across cities significantly. In Curitiba, for example, the half-life of tradables price convergence is 11 months, while in Belo Horizonte it is 17 months. Around 90 percent of price convergence occurs over 3 years.

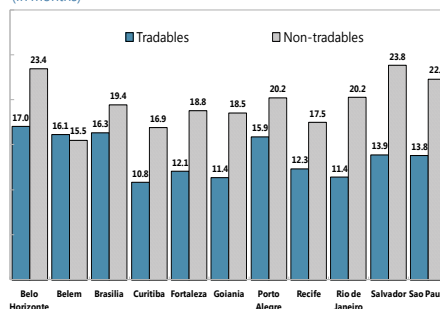
**5. The majority of non-tradable products fail to satisfy the LOOP.** As expected, we fail to reject the null hypothesis of panel unit root for most non-tradables prices. Additionally, individual Augmented Dickey-Fuller equations show that, while only 5 percent of tradable product prices have explosive processes, about 16 percent of non-tradable prices do. Moreover, for all products that satisfy the LOOP, convergence is considerably slower for prices of non-tradable products. The average half-life of non-tradable price convergence is 20 months, whereas the half life of tradable price convergence is 14 months.

**Market Integration: Convergence of Tradable Prices**

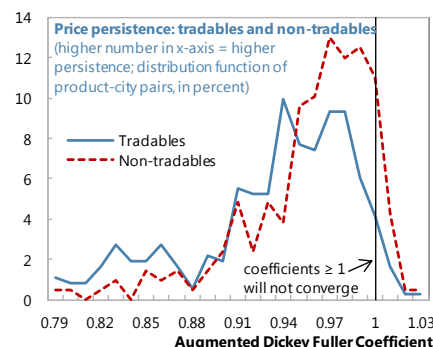
**Null Hypothesis: Unit Root**

Reject	Not Reject
Cereals, seeds and oilseeds	Canned and preserved foods
Flours and pasta	Salt and spices
Tubers, roots and legumes	Cleaning chemicals
Sugars and derivatives	Furniture
Vegetables	Utensils and ornaments
Fruits	TV, stereos and computers
Meats	Women's clothes
Fishes	Shoes and accessories
Processed meat and fish	Jewelry
Poultry and eggs	Fabrics and haberdashery
Milk and dairy products	
Bakery products	
Oils and fats	
Beverages and infusions	
Pre-cooked meals	
Fuels (domestic)	
Residential electricity	
Bed, bath and table	
Domestic appliances	
Menswear	
Children clothes	
Fuels (vehicles)	
Tobacco	

**Brazil: Metro-Area CPI Divergence Half-Lives**  
(in months)

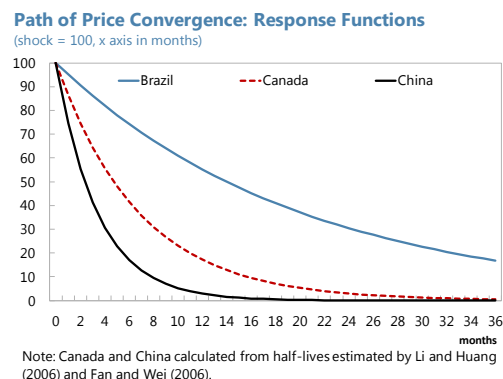


Source: Staff estimates

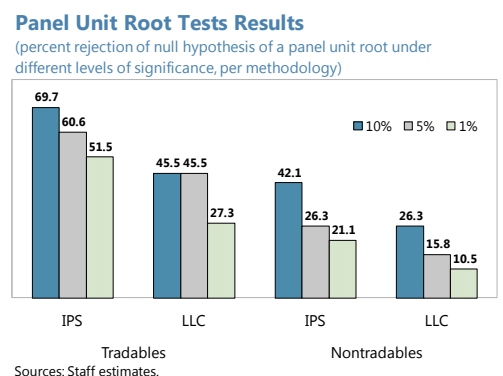


<sup>3</sup>See Appendix II for more detail on the estimation procedure. Half-life ( $h$ ) is defined as:  $h = \ln(0.5)/\ln(|\rho|)$ .

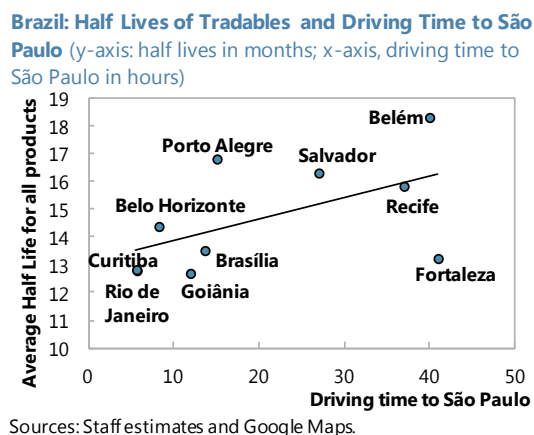
**6. Price convergence in Brazil is slower than in comparator countries.** International evidence using similar empirical approaches, also applied to monthly CPI data, points to significantly lower half-lives of price convergence in other countries. The average half-life of convergence for China between 1993 and 2003 (Li and Huang, 2006) was 2.4 months, and the half-life for Canada between 1978 and 1994 was 5 months (Fan and Wei, 2006). The results for both countries suggest that more than 90 percent of relative price shocks disappear within 18 months, much faster than in the case of Brazil.<sup>4</sup>



**7. Robustness checks confirm slow price convergence and evidence of market segmentation in Brazil.** Using an alternative methodology proposed by Levin, Lin and Chu’s (2002), the estimated average half-life of tradable products price convergence is slightly higher (16 months), with a smaller percentage of tradable products satisfying the LOOP. Estimates of convergence of prices using São Paulo as a reference<sup>5</sup> instead of the national mean yield broadly similar results with 61 percent tradable product satisfying the LOOP at slightly higher average half-life of 15 months.



**8. Poor infrastructure contributes to market segmentation.** Using the São Paulo version of our model, we find a correlation between slower domestic price convergence and longer commuting times between cities. Half-lives of tradables price convergence are found to increase with the travel time between cities. Market integration could therefore benefit from an overall improvement in transport infrastructure, namely roads, that could bring considerably down travel times effectively lessening the shipping times between cities. Still, it is worth noting that even controlling for physical distance, convergence occurs too slowly in Brazil (see the vertical intercept of the chart above). This suggests that other barriers to inter-state trade are also



<sup>4</sup> Using the aforementioned half-lives ( $h$ ), we derive the autoregressive term as  $|\rho| = \exp(\ln(0.5)/h)$  and plot their respective response functions.

<sup>5</sup> We estimate co-integration for every product between the price level in each city and the price level in São Paulo. See Appendix II for details.



important—among them, the system of state-level indirect tax, the ICMS, is likely a significant factor. But the analysis of the ICMS is beyond the scope of this chapter.

### C. The State of Infrastructure

**9. Brazil scores low on a large variety of qualitative indicators of infrastructure adequacy.**

Based on overall infrastructure quality, Brazil ranked 120 out of 144 countries surveyed by the World Economic Forum in 2014, with particularly poor results for roads and air transport quality. In other areas, Brazil ranked in the bottom third of countries surveyed. Brazil's rankings have been low over the past decade, and have generally worsened over the past 5 years (see Figure in Appendix I).<sup>6</sup> But for a more meaningful set of comparisons, we have chosen to benchmark Brazil's infrastructure against that of its main competitors in its own export markets (Box 1 explains our approach to selecting Brazil's group of export rivals).

**10. Brazil has inferior overall infrastructure quality relative to almost all its export competitors.**

Brazil's scores for adequacy of physical capital across all areas of transport infrastructure—roads, ports, railroads and air transport infrastructure—are substantially lower than those of its main export competitors. Only in the area of electricity and telecommunication does Brazil have a better ranking than some competitors, areas in which it has invested comparably more in recent years and more efficiently—through greater participation of the private sector. Still, according to the 2010 World Bank Enterprise Survey, 46 percent of firms in Brazil indicated that electricity was a major constraint to activity (against 38 percent in LAC) while 28 percent of firms considered transportation to be a major constraint (against 23 percent in LAC).

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<sup>6</sup> The WEF Survey captures the opinions of 14,000 business leaders around the World on a broad range of topics, including the quality of infrastructure. As such, qualitative infrastructure indicators are based on the aggregation of subjective perceptions. (For the methodology see : [World Economic Forum - Methodology](#))

**Box 1. The Choice of Infrastructure Comparators**

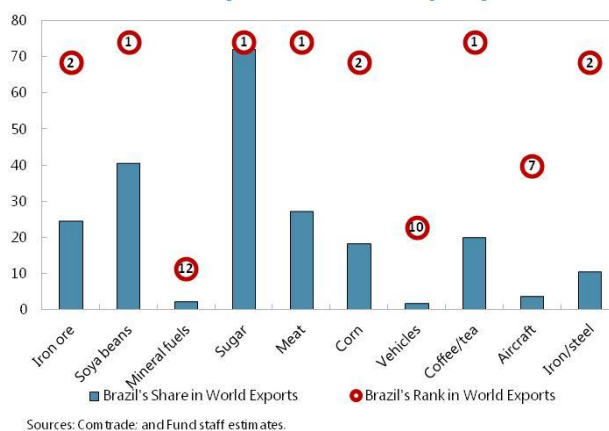
**One way of looking at infrastructure gaps is to assess the adequacy of Brazil’s physical capital against that of its exports competitors.** Infrastructure gaps are often measured in terms of distance from a benchmark defined by a country’s level of development, or the level of infrastructure necessary to reach the next development stage. But a gap can also be considered to exist when infrastructure quality (and quantity) falls below that of trading competitors. When gaps exist, countries should be able to extract more rents from exports, and possibly gain market share by decreasing business costs from inadequate infrastructure.

**The optimal infrastructure mix will also depend on the type of products exported.**

Brazil is a diversified economy and a closed one, where exports of goods represent only around 11 percent of GDP. However, Brazil is a leading exporter of some commodities, and the number-one exporter of soybeans, cane sugar, meats and coffee/tea. Over two thirds of the world’s cane sugar is produced in Brazil. Yet, other commodity exports, such as iron ore, of which Brazil is the second largest exporter, generate higher revenues from exports.

**Who are Brazil’s main competitors?** Brazil’s 10 largest commodity exports by value are used to determine its competitors. Brazil’s prospective competitors in each of these products are the 10–15 countries with the largest shares of world exports; Brazil’s main competitors are those countries that compete in at least 3 of these products. According to this scale, Brazil’s closest competitor is the U.S., competing in 6 of Brazil’s export categories, closely followed by Canada and India, competing in 5 export categories. Other competitors include Argentina, Australia, China, Kazakhstan, Mexico, Russia and South Africa.

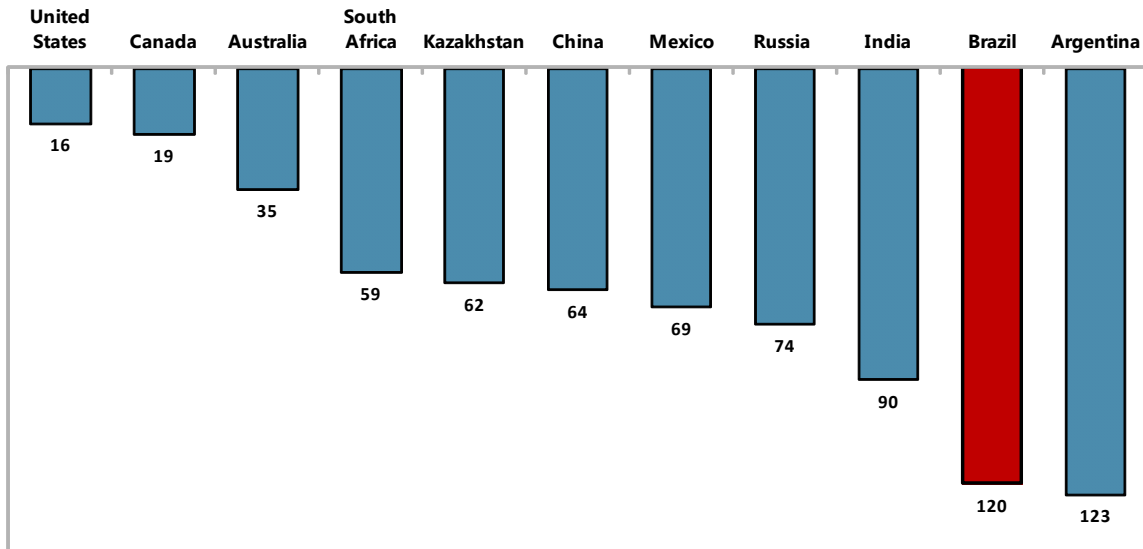
**Brazil’s “Top 10” Commodity Exports**



**Figure 1. Infrastructure Quality Indicators**

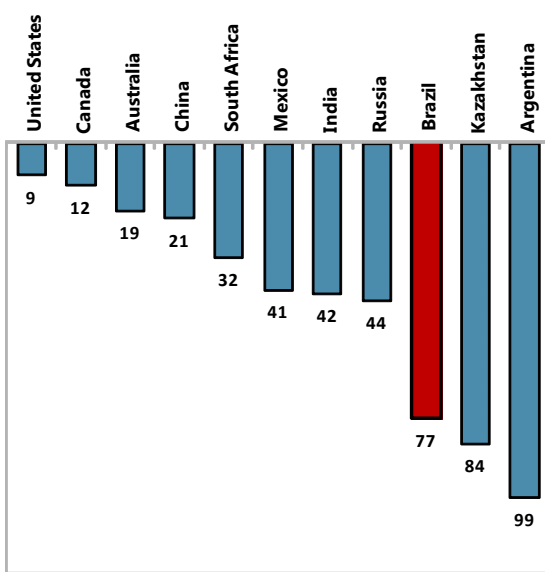
**Quality of Overall Infrastructure**

(1 = best; 144 = worst)



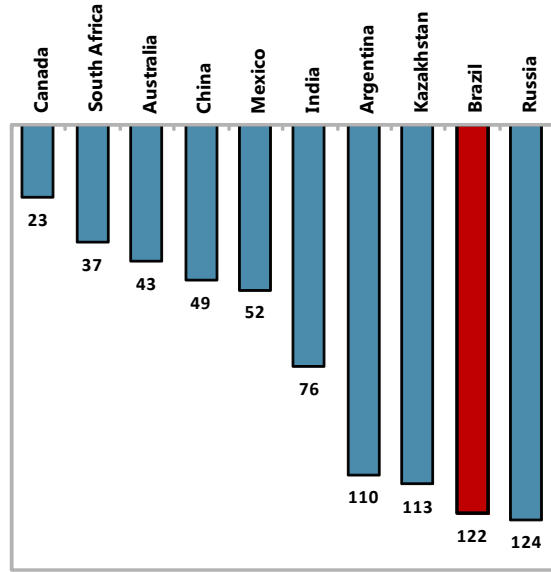
**Quality of Transport Infrastructure**

(1 = best; 144 = worst)



**Quality of Electricity Infrastructure**

(1 = best; 144 = worst)

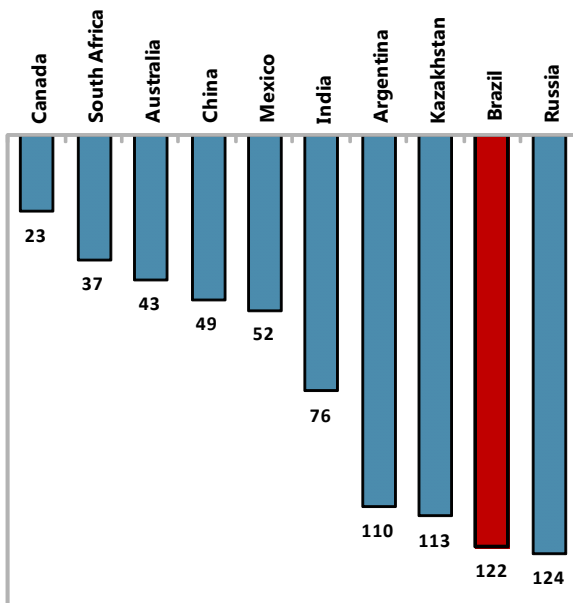


Source: World Economic Forum

Figure 2. Transport Infrastructure Quality Indicators

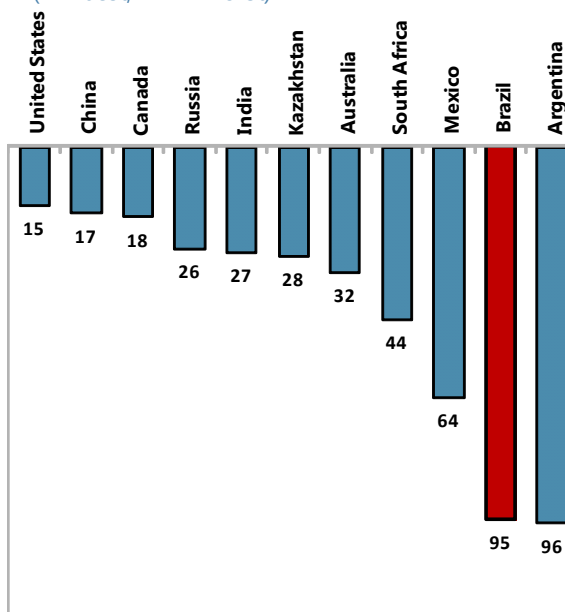
Quality of Roads Infrastructure

(1 = best; 144 = worst)



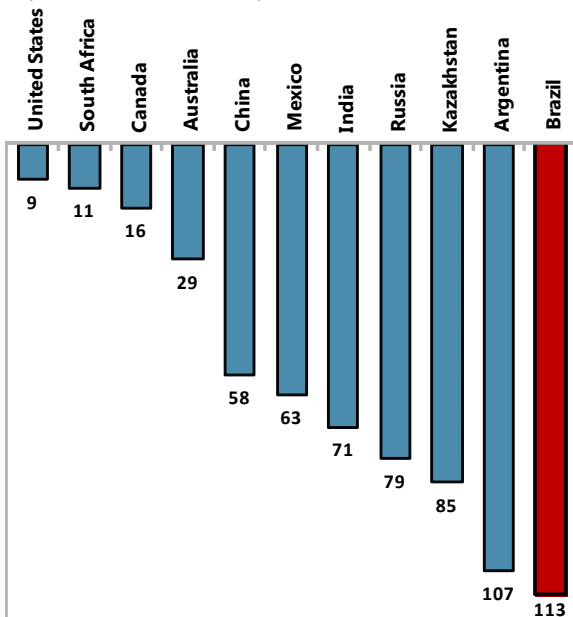
Quality of Railroad Infrastructure

(1 = best; 144 = worst)



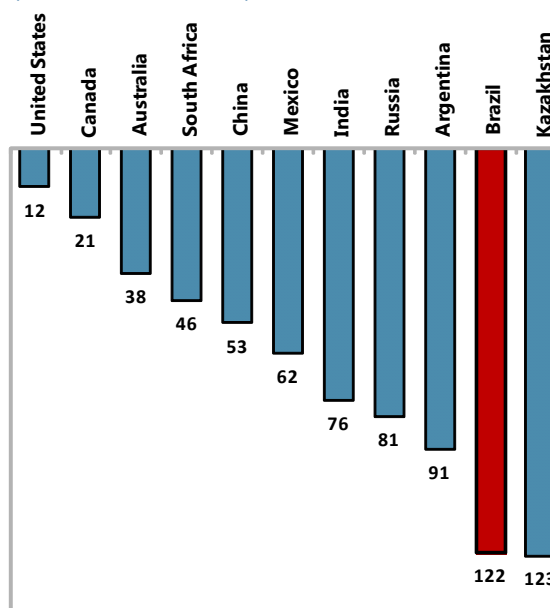
Quality of Air Transport Infrastructure

(1 = best; 144 = worst)



Quality of Port Infrastructure

(1 = best; 144 = worst)

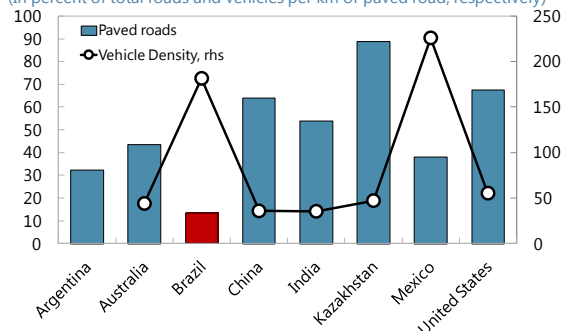


Source: World Economic Forum

**11. Quantitative indicators of infrastructure also paint a grim picture (Box 2).** Less than 15 percent of Brazil’s roads are paved and congestion is a concern; the estimated number of vehicles per km of road was 25 in 2008 and this number has likely increased in the wake of the recent boom in auto loans as vehicle sales have more than doubled over the past ten years.<sup>7</sup> As a share of paved roads, congestion levels are among the highest against comparators. Moreover, multi-lane roads are still relatively rare in Brazil, although they have doubled over the past half decade.

**Paved roads and Vehicle Density**

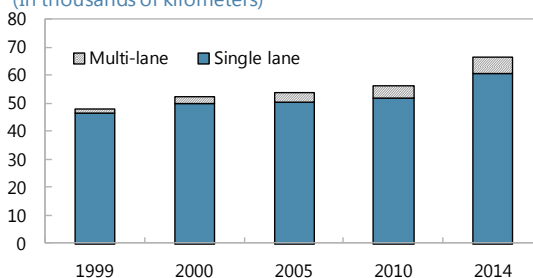
(In percent of total roads and vehicles per km of paved road, respectively)



Source: World Development Indicators, The World Bank.

**Federal paved roads**

(In thousands of kilometers)

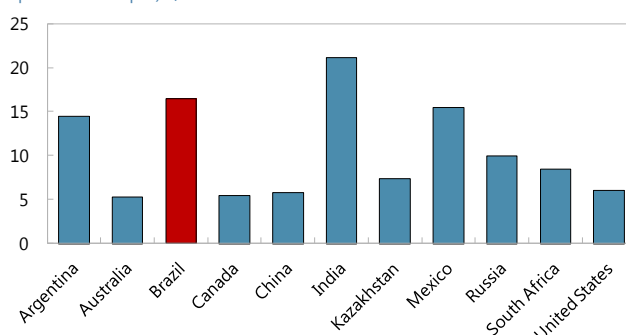


Source: Departamento Nacional de Infraestrutura de Transportes (DNIT) and Fund staff calculations.

**12. Energy indicators are less unfavorable.**<sup>8</sup> Per capita electricity generation and consumption have more than doubled since the 1980s and coverage is near universal. However, electric power transmission and distribution losses have increased and now exceed 15 percent of electricity output. Moreover, the recent draught has underscored vulnerabilities from the high dependence on hydropower for electricity generation (Box 3).

**Electric power transmission and distribution losses**

(In percent of output) 1/



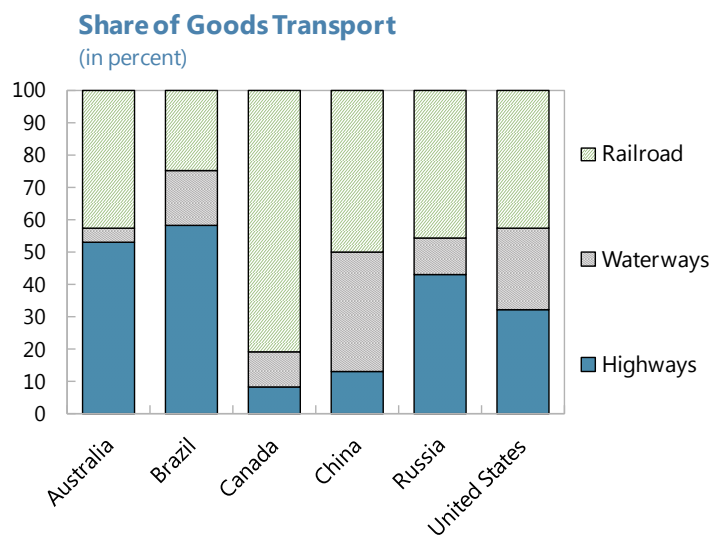
1/ Electric power transmission and distribution losses include losses in transmission between sources of supply and points of distribution and in the distribution to consumers, including pilferage.

Source: World Development Indicators, The World Bank.

<sup>7</sup> It is estimated that some 20 million of new vehicles were sold in Brazil since 2008.

<sup>8</sup> Doing Business ranks Brazil in the top 20 based on affordability and the number of procedures and days it takes to obtain electricity.

**13. Infrastructure gaps in transport appear more dramatic when quality and quantity indicators are coupled with Brazil's transportation mix.** Brazil's competitors rely more on rail for moving goods, which is better suited to high-volume, low-value-added commodities. In Brazil, 60 percent of agricultural commodities are transported by highways, while most of the iron ore exported travels by rail (Credit Suisse, 2013). Coupled with the poor state of roads, this transportation mix appears to be a constraint on exports and competitiveness.



Source: Credit Suisse based on World Bank data, 2013

### Box 2. Infrastructure Adequacy Indicators

Infrastructure gaps are usually quantified by estimating the existing capital stock and comparing it to a benchmark, typically based on the country's development level. This method can take into account evolving infrastructure needs along different stages of development and can provide an estimate of underinvestment in a sector. Other quantitative indicators generally measure outputs, such as electricity generation, available km of roads, railroads, or waterways, or airline passenger traffic. These indicators are valuable but they may be difficult to compare across countries.

In practice, the information content of quantitative indicators is partial for a variety of reasons. For instance, the indicator "share of paved roads in total roads" fails to take account of the state of road support services (gas stations, emergency equipment), how well roads connect main business centers, and how many lanes each road has. Maintenance is also an important unknown. Because obsolete infrastructure cannot adequately support production, qualitative indicators should be used to complement the analysis, ideally along with more detailed, sector-specific surveys. Such an approach may shed light on infrastructure quality and its suitability to meet the evolving needs of its users.

**14. Ports and airports are also constrained.** Only one of Brazil's ports—the port of Santos (Sao Paulo) —was in the top 100 list of best ports in the world in 2013, occupying the 41st position, thanks to a 6.2 percent rise in throughput in 2012 (Containerisation International). Anecdotal evidence of bottlenecks in Brazilian ports is easy to find; for example, Credit Suisse (2013) notes “10-mile line of trucks waiting at gates to unload the crop and 200 ships waiting to load the cargo”. While part of the growing infrastructure gap may be due to inadequate maintenance and intensification of use, the largest share of the gap is most likely due to a prolonged period of underinvestment in relative to other countries.<sup>9</sup>

**15. Brazil's infrastructure quality is also below the average in countries with similar income levels.** Over 2005–10, the overall infrastructure quality score for Brazil was lower than an average constructed using the distribution of GDP per capita across countries (PPP, constant 2005 international \$). Among Brazil's export competitors, the distance from the average was larger only for Argentina. However, the overall result masks differences across sectors. Brazil's electricity supply and telecommunication infrastructure score relatively high. In contrast, the quality of roads, railroads, ports and airports was significantly below average with the largest gaps in road and port infrastructure.

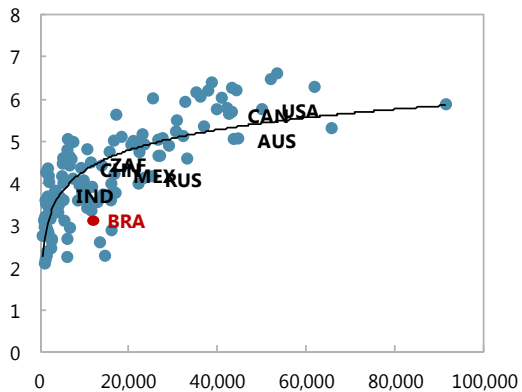
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<sup>9</sup> Sector-specific gaps can accrue also as a result of changing production patterns, technological change, energy costs, and changes in income distribution, among other factors.

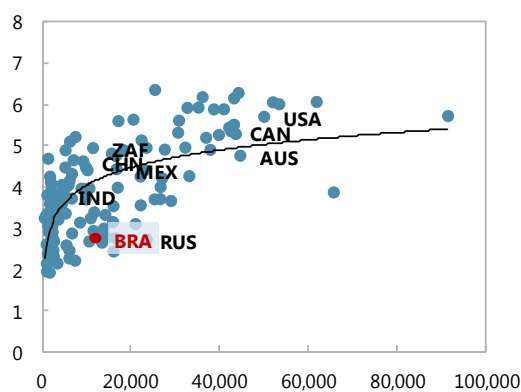
**Figure 3. Infrastructure Quality and Income**

(y-axis: quality of infrastructure, 2014, 10 = best; x-axis: GDP per capita, PPP dollars, 2012)

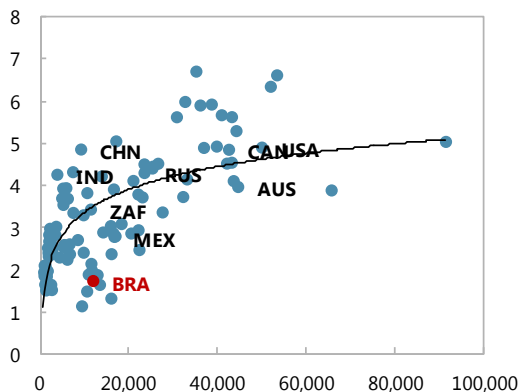
**Quality of Infrastructure**



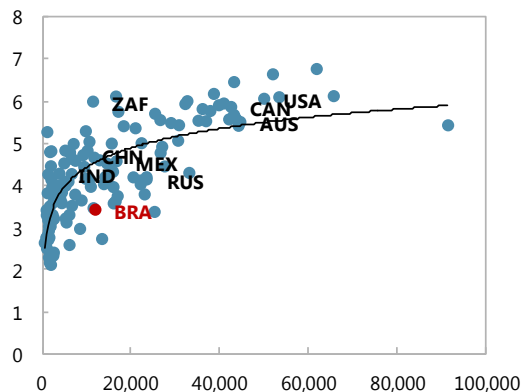
**Quality of Roads**



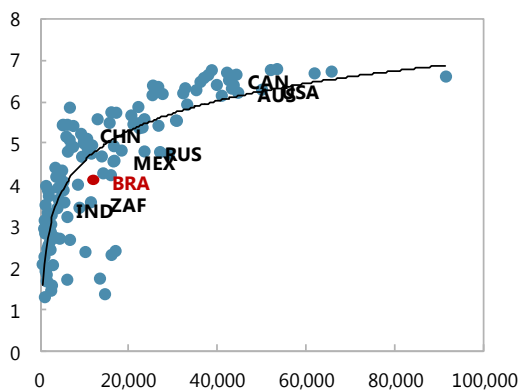
**Quality of Railroads**



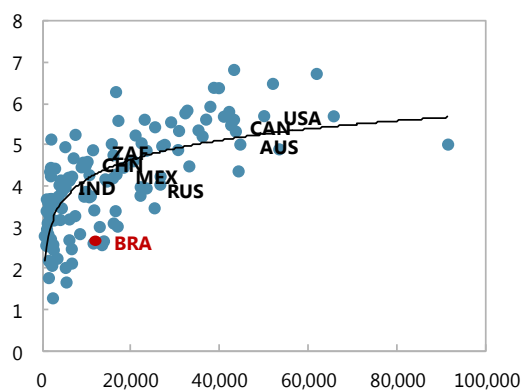
**Quality of Air Transport**



**Quality of Electricity Supply**



**Quality of Ports**



Sources: World Bank WDI; and WEF; and Fund staff estimates.

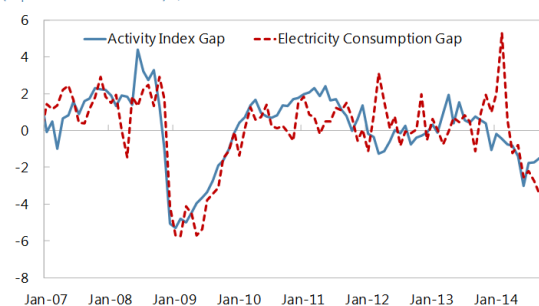


### Box 3. Electricity Sector Woes

**Several years of low rainfall and increasing demand have strained water reservoir levels that are approaching historical minimums.** With still vivid memories of the 2001 nationwide mandatory rationing episode<sup>1</sup>, the Southeast region, constituting almost  $\frac{2}{3}$  of total generation and consumption of electricity, has entered the rainy season with exceptionally low reservoir levels. While rainfall and natural hydropower—the capacity to transform rainfall into power—have been at or slightly above the 10-year median level and the level recorded in 2001 in the North and South, these regions account for only 12 percent of national capacity.

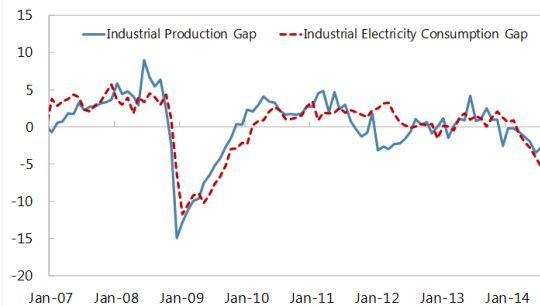
**Demand for electricity was boosted by improved credit availability over recent years and raising incomes.** Increasing electricity demand since 2009, mostly in residential consumption, was driven by the boom in the acquisition of household appliances. Moreover, increasing average temperature levels, in particular during the recent drought period, also called for more elevated electricity consumption on air conditioning, putting further pressure on energy supply. Nevertheless, some relief may be coming from the demand side in the period ahead with the recent widening of the industrial production gap and the general slowdown in activity in 2014 that are strongly correlated with electricity consumption. Lower cost of running thermal power due to lower international fuel prices may also provide a needed temporary cushion.

**Brazil: Economic Activity and Electricity Consumption Gaps**  
(in percent of trend level) 1/



Source: Staff estimates with BCB and EPE data.  
1/ Trend is the non-cyclical component of a HP filter calculated with monthly seasonally adjusted data with a smoothing factor set to 129,650.

**Brazil: Industrial Production and Electricity Consumption Gaps**  
(in percent of trend level) 1/



Source: Staff estimates with IBGE and EPE data.  
1/ Trend is the non-cyclical component of a HP filter calculated with monthly seasonally adjusted data with a smoothing factor set to 129,650.

**In the face of demand pressures, hydropower supply is constrained by storage capacity and challenges related to transmission costs.** Down from 80 percent in 2001, hydropower still constitutes a very large share of total generation, despite some scaling up of investment in thermal and wind energy in recent years. However, while total electricity generation nearly doubled over this period, the last investment in hydropower storage capacity took place in the distant 1990. Moreover, because many of Brazil's hydropower generating facilities are located far away from the main demand centers, transmission and distribution losses are high and accounted for 16 percent of power output loss in 2011. Investments directed towards the electricity sector in the government's concession program focus mainly on upgrading distribution capacity and logistics, with no regard to the need for greater storage space, highlighting the trade-off dictated by limited availability of projects.

**In the face of the continuing drought, these factors increase the likelihood of electricity rationing in the near future.** In the Southeast, the natural hydropower was about 40 percent below the long-term average and 20 percent below the 2001 level in November this year. With reservoirs at lowest levels, the prospect of energy rationing in 2015 may already be affecting investment decisions and will depend

<sup>1</sup> In response to the 2001 energy crises, the government introduced consumption quotas based on historical and target consumption levels. Bonuses were offered for consumption below the prescribed level and penalties applied for over-consumption. Consumption levels were reduced by 20 percent over eight months. Generators and distributors, however, experienced losses that were eventually covered by increases of tariffs.

### Box 3. Electricity Sector Woes (Concluded)

heavily on the amount of rainfall in the first quarter of next year.<sup>2</sup> The direct effect of a 10 percent energy rationing throughout 2015 is estimated to subtract over 1 percentage point from the annual GDP growth, mainly through a contraction in manufacturing industry and commerce, while the effect on inflation from tariff increases and food prices was estimated at 0.7 percentage points. (“Brazilian Utilities”, Credit Suisse Research; November 2014).

#### **Greater investment in the energy sector calls for further liberalizing the regulatory framework.**

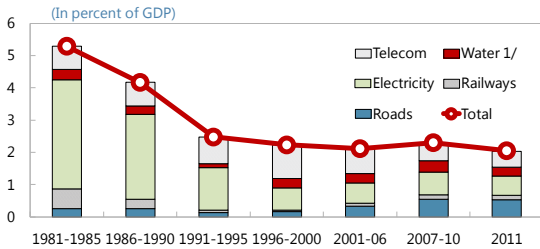
The 2004 reforms increased competition by establishing energy auctions as the main procurement mechanism for distribution companies to acquire energy. The 2012 reform aimed in turn at lowering some taxes affecting the electricity sector companies, decreasing tariffs of regulated consumers by 20 percent, and renewing concessions that were due to expire in 2015 and 2017. The power sector is expected to receive US\$73.8 billion of new investment over the next 5 years (R\$18 billion in renewable, R13 billion in transmission lines and R\$35.8 billion in thermo and hydropower). But to increase private participation in energy investments it will be necessary to promote long-term finance, improve the environmental licensing process, and allow some adjustment in tariffs over time to increase profitability and attractiveness of concessions in the energy sector.

<sup>2</sup> The probability of rationing is very difficult to assess because historical volatility in rainfall is very high—while the median rainfall between 1931 and 2013 was 210 GW, the standard deviation was 49 GW.

## D. Infrastructure Investment Trends

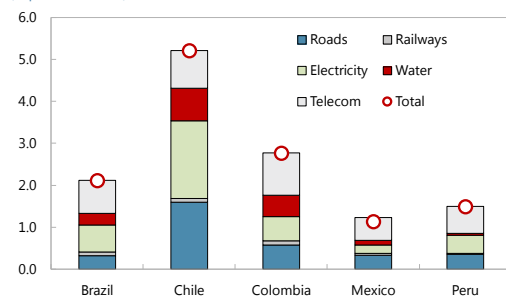
**16. The infrastructure bottlenecks described above reflect a prolonged period of low infrastructure investment.** Infrastructure investment in Brazil has dropped significantly from an average of 5.2 percent of GDP in the early 1980s to an average of 2¼ percent of GDP over the last two decades, and slightly increased to around 2½ percent of GDP in 2013. While good and standardized infrastructure investment data, in particular for cross-country comparison, is not available, different data sources confirm that for a couple of decades Brazil’s infrastructure investment has fallen short of the levels observed in other Latin America and emerging market countries, such as Chile, China and India (Calderón and Servén, 2010; Frischtak, 2013). There are also important differences in the investment levels by sector. In particular, the electricity and telecommunications sectors continue to represent the bulk of infrastructure investment in Brazil, reflecting the participation of the private sector under the concessions scheme. In contrast, Chile has invested more in roads and distribution/supply of water and sanitation.

**Brazil: Infrastructure Investment**



Sources: The chart shows data till 2006 from Calderón and Servén, 2010; and for the period 2007-2011 from Frischtak, 2013. Differences across data bases are minor: for example, total infrastructure for the period 2001-06 averaged 2.11 percent of GDP in Servén and Calderón's dataset, while it averaged 2.08 percent of GDP in Frischtak's dataset over the same period.  
1/ Includes also infrastructure investment in ports and airports.

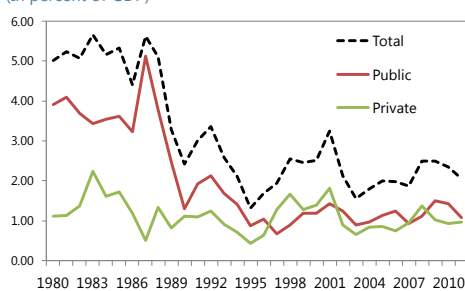
**Latin America: Infrastructure Investment, average 2001-06**



Sources: Calderón and Servén, 2010.

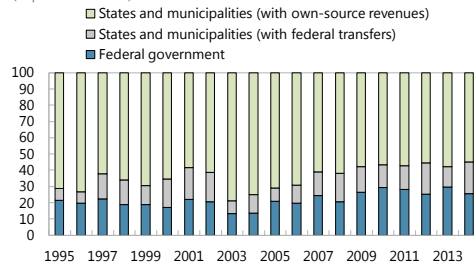
**17. The decline in infrastructure investment in Brazil is mostly explained by a reduction in public infrastructure investment.** The 1988 Constitution reduced the pool of federal funds available for capital expenditures as it replaced sector-specific federal taxes earmarked to energy, transport, and telecommunications with non-specific state-level ones; raised transfers to sub-national governments; and earmarked revenues to certain current public expenditures. The fiscal adjustment effort carried out from 1999 limited the available fiscal space for public investment, due to the budgetary rigidities and mandatory current primary spending. Consequently, public expenditures allocated for infrastructure investment have remained subdued since then, despite initiatives aimed at prioritizing infrastructure investment such as the *Programa de Aceleração do Crescimento* (PAC), which was launched in 2007 by the Federal government with the goal of accelerating economic growth.<sup>10</sup> At present, about 75 percent of total investment for the general government is being executed at the subnational level.

**Brazil: Public and Private Sector Infrastructure Investment**



Source: The chart shows data till 2006 from Calderón and Servén, 2010; and for the period 2007-2011 from Frischtak, 2013.

**Brazil: Public Investment by Level of Government 1/ 2/**



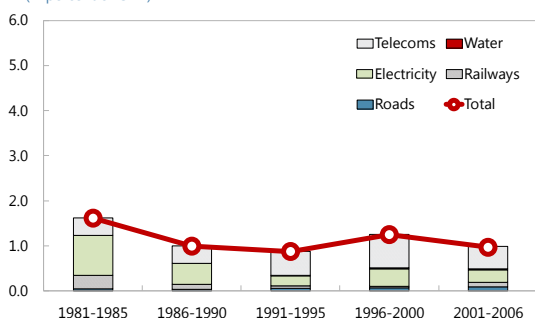
Source: Ministry of Finance.  
1/ Excludes public enterprises.  
2/ Investment refers to gross capital formation, and therefore, covers not only infrastructure investment.

**18. Meanwhile, private sector investment has not filled the space vacated by the public sector.** During the 1990s, privatization and concessions opened up key infrastructure sectors such as

<sup>10</sup> The PAC—excluding allocations to defense, education and the Minha Casa Minha Vida programs—amounted 0.5 percent of GDP in 2013, up from 0.3 percent of GDP in 2007.

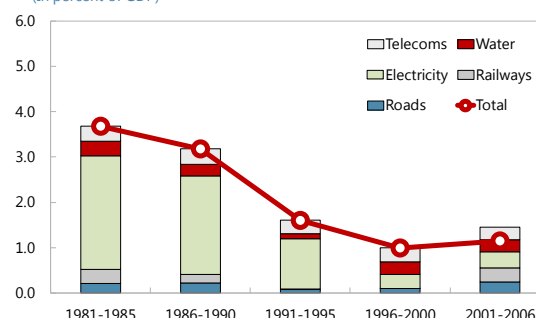
telecommunications, energy, and transport to private investment, but private investments have not been sufficient to compensate for the decline in public investment.<sup>11</sup> Private participation in infrastructure in Brazil has been low in comparison with other Latin America countries, in particular, Chile, corroborating that the investment environment, including investment opportunities, and regulatory and institutional frameworks play a major role in determining overall infrastructure investment levels and therefore tackling the infrastructure gaps.

**Brazil: Infrastructure Investment by Private Sector**  
(In percent of GDP)



Source: Calderón and Servén, 2010.

**Brazil: Infrastructure Investment by Public Sector**  
(In percent of GDP)



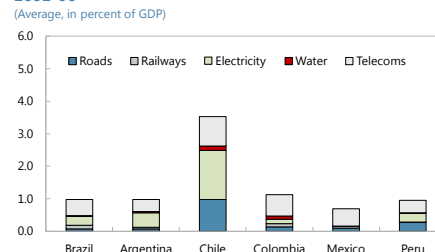
Source: Calderón and Servén, 2010.

## E. The Role of the Concession Program

### 19. Brazil has been pursuing opportunities for concessions with the aim of filling infrastructure gaps.

The concessions can bring in private sector expertise and efficiency and also help bypass some of the challenges faced by public investment—such as contracting obstacles—and therefore speed-up the process of investment. A first phase of concessions in Brazil took place during the late 1990s. Through privatization, the private sector became the main operator in telecommunications, electricity and railways. Concessions were also granted for about 5,000 km of federal roads. It is worth noting that private sector investment through concessions in the telecommunications and electricity sectors helped eliminate the infrastructure gaps and improved Brazil's ranking in these areas, as mentioned earlier in the text.

**Latin America: Infrastructure Investment by Private Sector, 2001-06**  
(Average, in percent of GDP)



Source: Calderón and Servén, 2010.

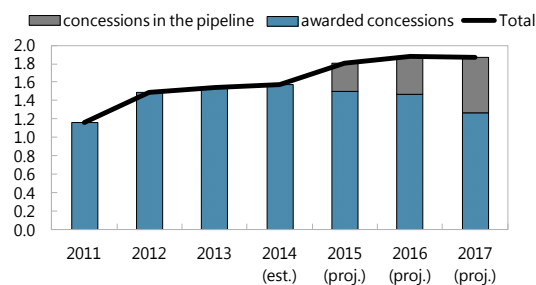
<sup>11</sup> In contrast, in Chile, the private sector more than compensated for the fall in public expenditures since 1989, with a net positive impact on total investments (World Bank, 2007).

**20. The current phase of concessions was launched a few years ago and focuses on projects in critical infrastructure sectors such as roads, ports and airports.**

During the period 2011–14, concession projects were auctioned in the areas of transport, energy, with an associated total investment estimated at R\$183.4 billion, split between airports (R\$35.8 billion), ports (R\$8.4 billion), roads (R\$29.2 billion), urban transportation (R\$6.9 billion), power generation and transmission (R\$96.7 billion) and telecommunications (R\$6.4 billion). The federal government plans include the awarding of projects in the areas of transportation (roads, railways, and ports), power generation and transmission, telecommunications and urban transportation, with estimated total investment of R\$109 billion (Secretaria de Acompanhamento Econômico, 2015). The concession period usually ranges from 20 to 35 years, with most of the infrastructure investments taking place during the first five years. Concessions awarded in the past and the ones in the pipeline are expected to add about  $\frac{3}{4}$  percentage points of GDP in infrastructure investment per year over the period 2011–17. Delays in the biddings and changes to the contracts could dilute investments over time. The infrastructure concession program could also be hampered by the probe into corruption concerning Petrobras, as several of the largest construction companies are involved in the investigation and these could see their access to funding diminished.

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**Brazil: Annual investments through concessions 1/ 2/**  
(In percent of GDP)



Source: Secretaria de Acompanhamento Econômico do Ministério da Fazenda.

1/ Awarded concessions and concessions in the pipeline as of end-2014.  
2/ Excludes investments in new railways, oil, gas and urban transportation.

## F. Filling the Gap

**21. Brazil's infrastructure gap has become a major obstacle to growth.** Brazil's business climate and competitiveness have been suffering in recent years from obstacles related to the complex tax system, administrative hurdles, judicial inefficiencies, red tape, inadequate regulatory framework, that have come to be known under the name "*custo Brasil*". While infrastructure bottlenecks are not considered part of this "soft" burden on business attractiveness, they are believed to be among the main constraints to raising potential growth. Infrastructure is not adequate to support current income levels, foster regional integration, and put Brazil on a more competitive footing against rivals in main export products which include some of the advanced economies.

**22. Filling the gap will entail increasing investment, but also stepping up other reforms.** The infrastructure gap has grown over time due to low public and stagnating private investment across all sectors over the past decade. The government's concession program has the potential to step up and speed up infrastructure investment; but by itself, it may not be enough to boost potential growth significantly. Other reforms to eliminate "soft" bottlenecks, including reforms to enhance governance standards, will have to accompany efforts to fill the infrastructure gap to make the business environment more attractive to foreign and domestic investments in an environment where regional competition to attract investments is set to intensify.

## Appendix I. Infrastructure Indicators

**Figure 1. Brazil: Infrastructure Quality, 2006-15**  
(rank out of 144)



Source: The World Competitiveness Report, World Economic Forum.

## Appendix II. Panel Unit Root Methodological Note

We first run individual ADF regressions of the time-effect treated price level ( $p_{i,t}^* \equiv p_{i,t} - \bar{p}_t$ ) for every city  $i$ . Lag-lengths  $K_i$  are selected using the Akaike Information Criterion and are allowed to be heterogeneous amongst individuals. For those processes which are not explosive, we calculate the half-life ( $h_i$ ) of the autoregressive parameter from the individual ADF regressions.

$$(1) \quad \Delta p_{i,t}^* = \tilde{c}_i + \sum_{k=1}^{K_i} \phi_{i,k} \Delta p_{i,t-k}^* + (\rho_i - 1)p_{i,t-1}^* + \eta_{i,t}, \quad i = [1, 2, \dots, 11]'$$

$$(2) \quad h_i = \frac{\ln(0.5)}{\ln(|\rho_i|)}, \quad |\rho_i| < 1 \forall i$$

Afterwards, we collect individual t-statistics for  $i$  cross sections ( $t_{iT}$ ) and from their average calculate a panel  $Z_{t-bar}$  statistic, which should also be asymptotically normally distributed.  $E[t_{iT} | \rho_i = 1]$  and  $Var[t_{iT} | \rho_i = 1]$  are obtained by interpolating the values from Im, Pesaran, and Shin (2003) tables.

$$(3) \quad Z_{t-bar} = \frac{\sqrt{N}(N^{-1} \sum_{i=1}^N t_{iT} - N^{-1} \sum_{i=1}^N E[t_{iT} | \rho_i = 1])}{\sqrt{N^{-1} \sum_{i=1}^N Var[t_{iT} | \rho_i = 1]}}, \quad \rho_i(\bar{\rho}, \sigma_{\rho_i}^2).$$

In repeating the exercise using São Paulo rather than national prices, we simply re-set  $p_{i,t}^*$  as  $p_{i,t}^* \equiv p_{i,t} - p_{jt}$ , where  $p_{jt}$  stands for prices in São Paulo. This estimates co-integration between each city price levels with São Paulo price levels rather than the national trend. This was necessary to have a travel benchmark between the cities. The baseline model is more informative insofar as it tests for co-integration among all cities. But the alternative model is necessary to assess the association between average half-lives and shipping times.

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# MACROECONOMIC IMPLICATIONS OF MINIMUM WAGE INCREASES IN BRAZIL<sup>1</sup>

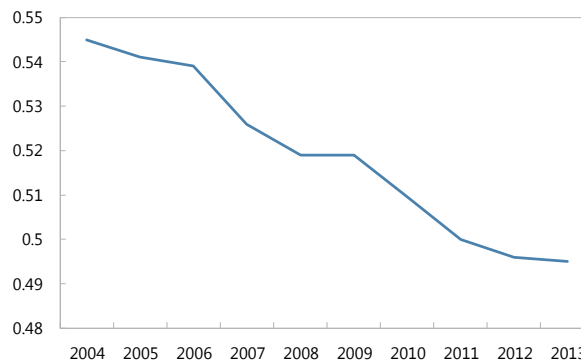
*Over the past decade or so, real increases in the minimum wage have contributed to declining poverty and inequality in Brazil. This paper highlights the potential trade-off between economic performance and the reduction in inequality. While Brazil's current minimum wage rule is contributing to a reduction in inequality, the empirical and theoretical results show that well-designed alternative minimum wage rules can help to improve competitiveness, job creation, and inflation outcomes. In this context, the current minimum wage rule should be re-evaluated against alternative rules and policy objectives. In addition to re-examining the current minimum wage rule, other policies could be considered to better target inequality, such as well-designed social policies and tax reform.*

## A. Introduction

**1. Minimum wage increases have contributed to a decline in inequality in Brazil over the past decade or so.** This paper discusses the macroeconomic implications of the Brazilian minimum wage rule, looking at effects on output, investment, employment, wages, prices, and inequality. The impact of minimum wage increases on macroeconomic aggregates, such as employment for example, is a controversial issue. The largest body of literature exists in the U.S. Two famous debates are Card and Krueger (1994 and 1998) and Neumark and Wascher (1997), and Dube et al. (2010), Allegretto et al. (2011) and Neumark and Wascher (2013). The authors argue for and against a negative employment effect of minimum wage increases arising from a well identified episode of wage increases in a specific region of the U.S., bringing to bear different approaches and different sources of microeconomic data, leading each time to new patterns being revealed in this economic relationship. In this light, while this paper goes a long way in applying and developing a coherent econometric and theoretical framework, it presents a first set of results, which should be tested with different econometric and theoretical models in the future.<sup>2</sup>

**Brazil: Gini Index, 2004-2013**

(0 = minimum inequality; 1 = maximum inequality)



Source: IBGE.

<sup>1</sup> Prepared by Fabian Lipinsky and Carlos Goes.

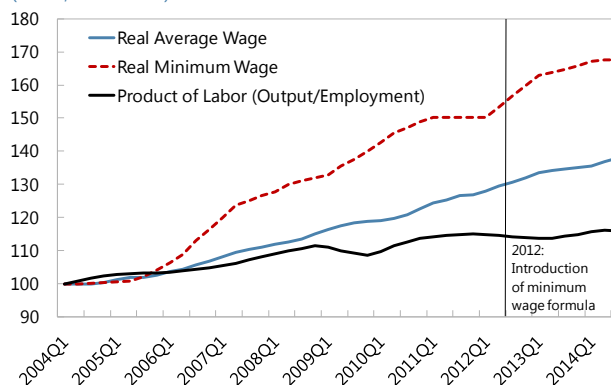
<sup>2</sup> For example, similar to Dolton and Bondibene (2012), further control variables could be included. Another robustness check would be to test for level effects.

**2. Whether the minimum wage is too low or too high matters for employment.** If the minimum wage is low, then employers may abuse their bargaining strength in wage negotiations with low-skilled workers and pay less than the marginal product of labor. Employers will be willing to hire more easily at those rates, but the rents they receive tend to increase inequality—which could also rise if part of the rents are distributed to higher skilled workers. On the other hand, if minimum wages are very high, employment growth will be curtailed, other things constant. However, unskilled workers will make a better living, and in sectors with rents these can end up shared with poorer workers, which would reduce inequality. A minimum wage policy should strike a balance between providing appropriate remuneration and encouraging employment.

## B. The Minimum Wage and Inequality in Brazil

**3. The minimum wage in Brazil currently increases according to a pre-determined formula.** Law 12.382 came in force on February 25, 2011, determining the annual minimum wage increase during the period 2012–15 to be equal to inflation over the previous year plus annual real GDP growth from two years before the current year. For example, the minimum wage for 2012 was set at annual inflation during 2011 plus annual real GDP growth during 2010. During 2015 a new bill will be sent to the National Congress, providing for the minimum wage policy for the period 2016–19.

**Brazil: Wage and Labor Productivity Growth**  
(Index; 2004=100)

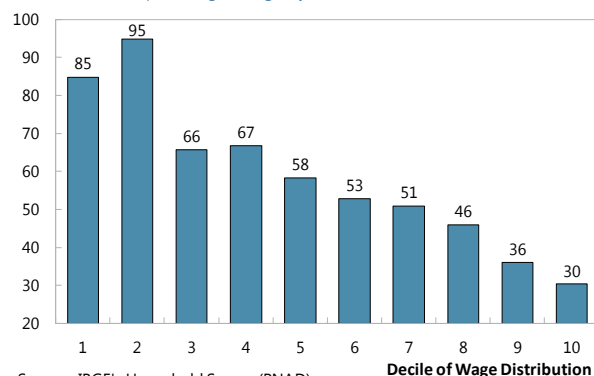


Sources: IBGE and IMF staff calculations.

**4. During the past decade, wages and the minimum wage have increased above the rate of labor productivity while inequality, as measured by the Gini index, has declined.**

According to Maurizio (2014), increases in the minimum wage led to wage compression, which helped to reduce inequality. While she focuses exclusively on the effect of minimum wage increases, other factors such as economic growth, increasing terms of trade, and social policies, including *Bolsa Família*, were arguably equally important for the reduction in inequality.

**Brazil: Real Change in Wages, 2004-2013**  
(In cumulative real percentage change, by decile)



Source: IBGE's Household Survey (PNAD).

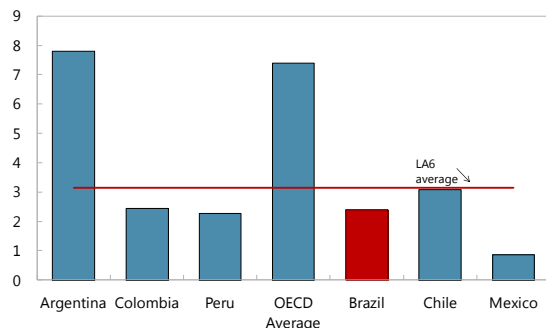
**5. In line with evidence from other countries, wage levels at the lower end of the wage distribution (closest to the minimum wage) have responded most strongly to increases in the minimum wage.** The progress of Brazil in reducing inequality is encouraging; the reduction in inequality has been continuous and long-lasting. A comparison of inequality in Brazil with other countries shows that inequality is still an issue, and further improvement is needed (see Arnold and

Jalles, 2014). Given that the minimum wage has already increased substantially, the question arises whether further increases in the minimum wage are the right tool to reduce inequality going forward, especially in an environment of low economy growth

**6. The minimum wage in Brazil is below the average of major Latin American countries (LA6), and significantly below the OECD average.** However, the minimum wage relative to per capita GDP is very close to the OECD average.<sup>3</sup>

Selected Countries: Hourly Minimum Wage, 2014

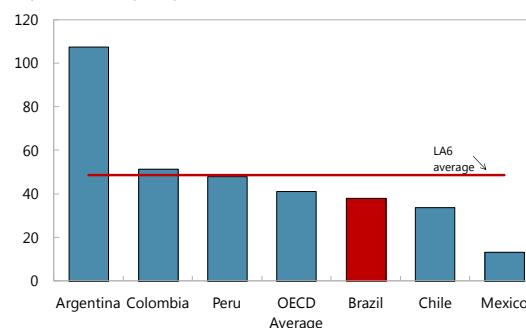
(In PPP dollars)



Sources: OECD; Haver Analytics; and IMF staff estimates.

Selected Countries: Minimum Wage, 2014

(In percent of GDP per capita)



Sources: OECD; Haver Analytics; and IMF staff estimates.

## C. Is Brazil's Minimum Wage too High?

*To assess whether the minimum wage is relatively high or low in Brazil, two approaches are followed. First, Brazil's minimum wage is benchmarked against other countries.*

*Second, panel regressions are used to determine whether the increase in minimum wages affects employment.*

**7. Probably the most common concept used to determine whether the minimum wage is high or low is the "Kaitz index", the ratio of the minimum wage relative to the average or the median wage.** In general, because the median wage tends to be below the average wage, the ratio between minimum wage and median wage should be the preferred measure, because it measures to which extent the minimum wage puts pressure from below on the wage distribution. The closer the minimum wage is to the median wage, the bigger will be the knock-on effects of increases in the minimum wage (e.g. if lower skilled workers benefit from wage increases, higher skilled workers will also demand wage increases to maintain a wage differential between differently skilled labor).

<sup>3</sup> In fact, the LAC6 average is above the OECD average, owing to high Minimum Wage-GDP ratios for Argentina, Colombia and Peru.

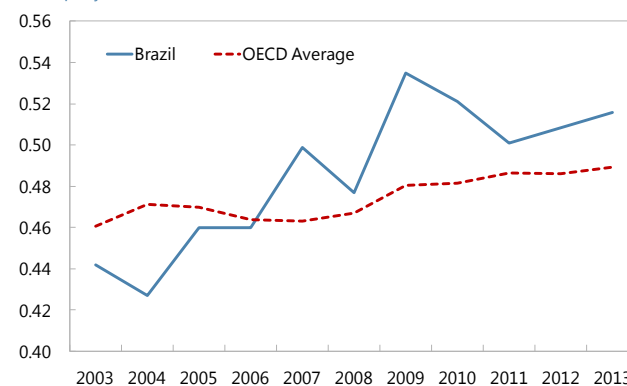
## Benchmarking

### 8. The trajectory of the Kaitz index for Brazil is rising over time.

This is consistent with the policies in place, which ensure that over time the minimum wage increases faster than average labor productivity in the economy. While this rule does not ensure by itself a rising Kaitz ratio, it makes that very likely. As a starting point for benchmarking, it is reasonable to assume that every country in the world with an active minimum wage policy tries to strike a balance between the pros and cons of minimum wage increases. Given that a large

sample of countries exists, countries, on average, should follow a minimum wage policy that finds a good balance between pros and cons. A comparison of Brazil's Kaitz index with the average of a large set of countries shows that increases in the minimum wage led from a regime of low minimum wages to high minimum wages, relative to the average of other countries.

**Selected Countries: Minimum Wage to Average Wage Ratio**  
(Ratios, per year)



Source: For Brazil, Maurizo (2014) and staff calculations; for all other countries, OECD.

## Panel Regressions

**9. The impact of increases of the minimum wage on employment has been debated for decades.**<sup>4</sup> However, more recently, a consensus seems to be emerging, which follows the intuitive explanation provided above: Whether minimum wage increases have a negative employment effect depends on whether the minimum is binding, other things constant. The more the minimum wage is binding—measured for example by an increase in the Kaitz index—the more likely is a negative employment effect. The negative employment effect is more pronounced for the least-skilled group of workers—workers, who earn one or a fixed multiple of the minimum wage. To identify this effect, it is important to control for economic growth, which is a determinant of employment growth for any given level of wages. The most convincing cross-country evidence is based on a sample of 33 OECD countries for the period 1971–2009.<sup>5</sup> Since this sample includes largely Non-Latin American countries, we run panel regressions with fixed effects on a panel of Latin American countries, including Brazil, Chile, Colombia, Mexico and Peru, for the period 2000–14. The econometric model takes the following form:

$$E_{i,t} = \alpha + \beta Y_{i,t} + \gamma Kaitz_{i,t} + J_i + u_{i,t}$$

<sup>4</sup> For a literature review of the impact of changes in the minimum wage on employment, including in Brazil, see Neumark and Wascher (2007).

<sup>5</sup> Dolten and Bondibene 2012.

where  $E_{i,t}$ ,  $Y_{i,t}$  and  $Kaitz_{i,t}$  denote the yearly percentage change in quarterly employment, real output and the Kaitz index. The Kaitz index is computed as the ratio of the real minimum wage to the real average wage, as time series for median wages of certain Latin American countries were not readily available.  $J_i$  controls for country fixed effects.<sup>6</sup>

**10. The empirical findings suggest that increases in the minimum wage in excess of the average wage increases tend to reduce employment.** Specifically, a ten percent year-on-year increase in minimum wages above average wage increases lead to an employment decline of about 0.6–0.85 percent, depending on whether fixed effects are included. The result is robust to different specifications. It also holds for Brazil in isolation, with the coefficient for the Kaitz index being in the same order of magnitude between -0.07 to -0.12 (Appendix A). This suggests that the decline in the unemployment rate observed in Brazil for the last decade has occurred despite the high minimum wage rate growth, and thanks to the country’s record of output growth during the sample period, which has been relatively high by historical standards. This is an important result: high GDP growth can help to offset the drag on employment growth from a rise in the Kaitz index. But the question this result poses is whether, in a lower GDP growth scenario, such as the one faced by Brazil now, employment growth may be strongly affected by the continuation of a policy that tends to increase the Kaitz index (by raising real minimum wages faster than average labor productivity).

Table. Panel Data Regressions		
	Dependent Variable: Year-on-Year Percentage Change in Employment	
	(1)	(2)
Year-on-Year Percentage Change in GDP	0.188*** (0.059)	0.164*** (0.056)
<b>Year-on-Year Percentage Change in the Kaitz Index</b>	<b>-0.084*** (0.027)</b>	<b>-0.062*** (0.024)</b>
Constant	2.243*** (0.318)	2.235*** (0.312)
Country Fixed Effects	Yes	No
Obs	224	224
Periods (average)	55	55
Cross-sections	5	5
r2	0.081	0.108

Note: Robust standard errors in parentheses.  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**11. Low-skilled workers tend to be more affected by minimum wage increases than higher skilled workers.** The model is estimated at the monthly frequency where GDP changes are replaced with changes in industrial production for Brazil (Appendix B). The results suggest that employment of younger workers is more affected by minimum wage increases than employment of older workers, with an elasticity of -0.3. This result reflects that wages of young workers are more likely to be in the lower half of the wage distribution and closer to the minimum wage and is broadly in line with the literature.<sup>7</sup>

<sup>6</sup> This specification includes a version of the panel in which the variables would be measured in deviations from the steady state, denoted by a star:  $E_{i,t} - E_i^* = \alpha + \beta(Y_{i,t} - Y_i^*) + \gamma(Kaitz_{i,t} - Kaitz_i^*) + u_{i,t}$ .

<sup>7</sup> Dolten and Bondibene (2012) reports elasticities of about -0.05 for adult and -0.2 for youth employment.

## D. Potential Macroeconomic Implications of the Current Minimum Wage Rule

**12. Many empirical results suffer from a partial equilibrium critique in the sense that interactions with omitted variables are not captured.** Research contributions on the impact of minimum wage increases often focus on one dimension, like the impact of minimum wages on the wage distribution or the impact of minimum wages on employment. Other dimensions like the impact on aggregate demand and consumption are often neglected. According to Maurizio (2014):

*"The exercises that arise are of partial equilibrium nature and could be thought of as short-term. [...] For example, it is not considered how changes in the minimum wage affect consumption (and, in turn, aggregate demand and employment), especially in those cases where the population directly affected by minimum wage has a high propensity to consume."*

**13. To address such criticism, we construct a novel general equilibrium model.** A natural starting point is a New-Keynesian General Equilibrium Model, which is the most widely used theoretical model in central banks around the world. The model choice is further motivated and supported by our empirical findings—the negative employment effect of changes in the Kaitz index, is consistent with New-Keynesian Models with an explicit trade-off between higher wages and less employment, other things constant. In the standard model there is only one type of consumer, accordingly we make a minimalistic change to the model and include a second type of consumer with lower productivity and higher propensity to consume, to differentiate between low skilled and high skilled workers. The final model ingredient is the Brazilian minimum wage rule. Low skilled workers earn the minimum wage, which changes in accordance with the minimum wage rule. The model is described in greater detail in the appendix.

**14. The current minimum wage rule is assessed by comparing the impulse response functions following demand and supply shocks under two different scenarios:**

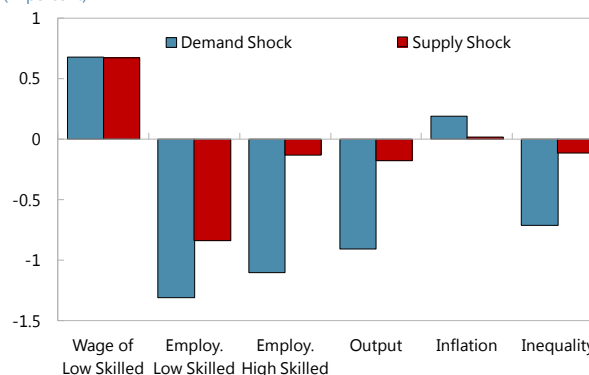
- *Scenario 1 – Minimum Wage Rule:* The wage of low skilled workers is determined by the current minimum wage formula:

$$\Delta MW_t\% = \Delta Inf_{t-1}\% + \Delta GDP_{t-2}\%$$

- *Scenario 2 – Standard Wage Rule:* The wage of low skilled workers is determined by labor market tightness, e.g. wages compensate workers for the opportunity cost of not producing the home-produced good.

**15. The results suggest that the minimum wage rule leads to higher wages and reduces inequality, but it reduces employment and output, and raises inflation relative to the standard wage rule.** The results comparing impulse responses following a demand shock and a supply shock are displayed below. The bars in the figure reflect percentage gains from the minimum wage rule relative to the standard wage rule following a demand shock and a supply shock.<sup>8</sup>Negative

**Model Results: Difference of Minimum Wage Rule vs. Standard Rule**  
(In percent)



Source: IMF staff calculations.

numbers reflect losses relative to the standard wage rule. The theoretical model confirms the econometric results—employment of low skilled and high skilled workers is lower under the current minimum wage rule. Specifically, the results show that:

- Following a positive demand shock (higher demand, the blue bars), employment of low skilled workers is 1.3 percent lower under the current minimum wage rule in comparison to the standard rule.
- Following a positive supply shock—with similar differential impact on low skilled wages—(higher TFP, the red bars) employment of low skilled workers is 0.8 percent lower under the current minimum wage rule.

**16. A deeper analysis of the model shows that there are two channels at work that affect inflation, a cost channel and a demand channel.** Higher wages increase the marginal cost of firms, but also raise incomes of low-skilled workers that benefit from wage increases, and therefore their demand for goods. Both channels support inflationary pressures, higher interest rates, and lower investment. This suggests that if minimum wages increase with a premium above inflation equal to real GDP growth, then employment, output and investment tend to be lower and inflation tends to be higher. On the other hand, strong minimum wage increases tend to reduce inequality more, posing a potential trade-off between macroeconomic performance and inequality.<sup>9</sup>

<sup>8</sup> Specifically, the figure displays the percentage difference in cumulative change of each variable over 10 quarters following each shock.

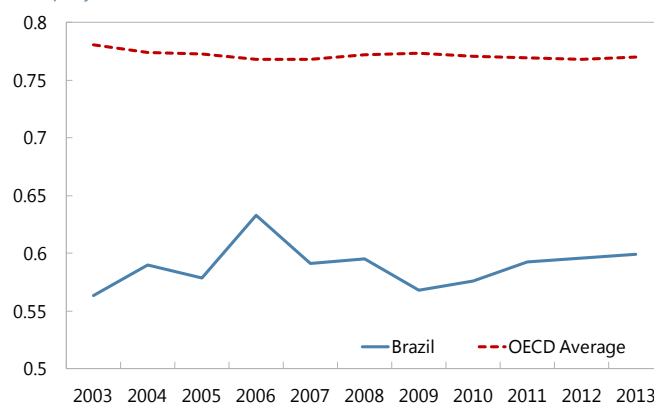
<sup>9</sup> While the magnitude of the elasticities depends on the calibration of the general equilibrium model, the qualitative direction of the results is very robust and insensitive to changes in the calibration.

## E. Policy Implications

**17. The results highlight the potential trade-off between economic performance and the reduction in inequality.** While Brazil's current minimum wage rule is contributing to a reduction in inequality, empirical and theoretical results show that well-designed alternative minimum wage rules can improve competitiveness, job creation, and inflation outcomes. In this context, the current minimum wage rule should be re-evaluated against alternative rules and policy objectives.

**18. In addition to re-examining the current minimum wage rule, other policies could also be considered to better target inequality.** Neumark et al. (2006) found that in environment of low growth and declining terms of trade, minimum wage increases do not have the intended positive distributional effects, pointing towards the tension of higher wages for some and less employment for others. If inequality is a concern, other social policies could be used to more efficiently boost incomes at the lower end of the wage distribution. Moreover, inequality in Brazil also reflects a large disparity in earnings in the upper half of the distribution, evidenced by the large gap between the average and the median wage, suggesting that tax policy could also play a greater role in reducing inequality in the future.

**Selected Countries: Median Wage to Average Wage Ratios**  
(Ratio, per year)



Source: For Brazil, Maurizo (2014) and IMF staff calculations; for all other countries OECD.



## Appendix—Regressions and General Equilibrium Model

### A. Quarterly Time Series Regressions

<b>Table. Brazil: Quarterly Time Series Regressions</b>				
<b>Dependent Variable:</b>	Year-on-Year Percentage Change in Total Employment (1)	Year-on-Year Percentage Change in Total Employment (2)	Year-on-Year Percentage Change in Total Employment (3)	Year-on-Year Percentage Change in Total Employment (4)
Dependent variable (t-1)			0.698*** (0.078)	0.689*** (0.079)
Year-on-Year Percentage Change in GDP	0.167 (0.167)	0.058 (0.171)	0.160* (0.084)	0.138 (0.091)
Dummy for 2014 Months		-3.620*** (1.887)		-0.707 (1.017)
<b>Year-on-Year Percentage Change in the Kaitz Index</b>	<b>-0.096** (0.046)</b>	<b>-0.115** (0.046)</b>	<b>-0.071** (0.035)</b>	<b>-0.076** (0.036)</b>
Constant	3.037*** (0.853)	3.779*** (0.914)	0.653 (0.497)	0.846 (0.571)
Frequency	Quarterly	Quarterly	Quarterly	Quarterly
Periods	55	55	54	54
r <sup>2</sup>	0.128	0.195	0.673	0.677
Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1				

The figure shows various single country regressions for Brazil. The fit of the regression improves and the Kaitz index coefficient (in absolute terms) becomes larger, if a dummy accounting for the break in participation rates in 2014 is included. The Kaitz index-employment elasticities are in the range of -0.07 to -0.12.

## B. Monthly Time Series Regressions

<b>Table. Brazil: Monthly Time Series Regressions</b>				
<b>Dependent Variable:</b>	Year-on-Year Percentage Change in Adult Employment	Year-on-Year Percentage Change in Adult Employment	Year-on-Year Percentage Change in Youth Employment	Year-on-Year Percentage Change in Youth Employment
	(1)	(2)	(3)	(4)
Dependent variable (t-1)		0.770*** (0.058)		0.621*** (0.056)
Dependent variable (t-12)		-0.127* (0.697)		-0.290*** (0.063)
Year-on-Year Percentage Change in ICB-Br	0.393*** (0.007)	0.121* (0.0537)	0.451* (0.260)	0.031 (0.164)
Dummy for 2014 Months	-3.127*** (0.604)	-0.604 (0.647)	-16.990*** (2.565)	-7.957*** (2.502)
<b>Year-on-Year Percentage Change in the Kaitz Index</b>	<b>-0.0839* (0.042)</b>	<b>-0.0562* (0.033)</b>	<b>-0.607*** (0.220)</b>	<b>-0.296*** (0.112)</b>
Constant	-1.922 (1.370)	-0.402 (0.902)	-1.922 (1.370)	-0.402 (0.902)
Frequency	Monthly	Monthly	Monthly	Monthly
Periods	128	116	128	116
r <sup>2</sup>	0.246	0.678	0.276	0.749
Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1				

The figure shows various single country regressions for Brazil. The robustness of the results is improved by increasing the number of data points, using monthly data. The lag order of the dependent variable is select to assure stationarity and absence of serial correlation in residuals. The resulting Kaitz index-employment elasticities are -0.06 for adults and -0.3 for youth employment.

## C. General Equilibrium Model

### Households

There are two representative households, representing high skilled and low skilled workers. High skilled and low skilled workers maximize expected lifetime utility, deriving utility from consumption and home goods. The objective functions of high and low skilled workers are:

$$E_0 \sum_{t=0}^{\infty} \beta^t [u(c_t) + u(c_t^H)] \text{ and } E_0 \sum_{s=0}^{\infty} \beta^s [u(c_t^{MW}) + u(c_t^{H,MW})]$$

where  $\beta < 1$  denotes the subjective discount factor,  $c_t$  the consumption good, and  $c_t^H$  the home good. The superscript "MW" (like the minimum wage) denotes quantities and prices specific to low skilled workers.

The home good is produced by members of the households that are not participating ( $np_t$ ) or unemployed ( $u_t$ ), and spend time at home. Controlling for population growth, assuming a constant household size ( $s = np_t + u_t + e_t$ ), it becomes clear that consumption of the home good depends on employment:

$$c_t^H = np_t + u_t = s - e_t \text{ and } c_t^{H,MW} = np_t^{MW} + u_t^{MW} = s^{MW} - e_t^{MW}$$

High skilled and low skilled households differ in the budget constraint. With respect to expenses, high skilled households consume ( $c_t$ ), and decide how much to invest in bonds ( $d_t$ ) and capital ( $k'_t$ ). They also pay lump sum taxes ( $T_t$ ). Next period, they receive interest ( $R_t = 1 + i_t$ ) on bonds, and the rental rate  $r_{k,t}$  on capital and sell the un-depreciated part of the capital stock at its market price  $Q_t$ . For each employed worker, the household receives a wage  $W_t$ , and it receives the profits of firms.  $P_t$  denotes the overall price level in the economy. The budget constraint of high skilled households is:

$$P_t c_t + d_t + Q_t k'_t + T_t = (r_{k,t} + (1 - \delta)Q_t)k'_{t-1} + R_{t-1}d_{t-1} + W_t e_t + Prof_t$$

The low skilled households are hand-to-mouth consumers, and consequently have a higher propensity to consume. Each employed member consumes what she/he earns  $c'_t = W_t^{MW}$ .

Aggregating over all employed low skilled household members, it follows that  $c'_t = \frac{P_t c_t^{MW}}{e_t^{MW}}$ , and the budget constraint of low skilled households is:

$$P_t c_t^{MW} = W_t^{MW} e_t^{MW}$$

- Scenario 1 – Minimum Wage Rule: In the first scenario, the wage of low skilled workers follows the current minimum wage rule in Brazil, in which  $\pi_t = \frac{P_t}{P_{t-1}}$  denotes inflation.

$$\frac{W_t^{MW}}{W_{t-1}^{MW}} = g_t^{MW} = \frac{\pi_{t-1} Y_{t-2}^d}{Y_{t-3}^d}$$

- Scenario 2 – Standard Wage Rule: In the second scenario, the wage of low skilled workers increases with market tightness, and compensates low skilled workers for the opportunity cost of not producing the home good. It is equal to the first order condition of low skilled households, with respect to the supplied number of household members, who are seeking employment.

$$\frac{W_t^{MW}}{P_t} = \frac{u'(c_t^{H,MW})}{u'(c_t^{MW})}$$

### Firms and Labor Unions

There is a final good producer, a continuum of intermediate goods producers (with index  $i$ ), an entrepreneur and a capital good producer. The final good producer maximizes the following objective:

$$P_t Y_t^d - \int P_{i,t} Y_{i,t} di$$

subject to the following production function, where  $\varepsilon$  is the elasticity of substitution between different intermediate goods:

$$Y_t^d = \left( \int Y_{i,t}^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}}$$

Intermediate goods producers are subject to Calvo pricing. In each period, only a fraction of  $1 - \theta$  producers can change their prices, while all other producers can only index their prices to past inflation. Indexation is controlled by a parameter  $\tau \in [0,1]$ , where  $\tau = 0$  implies no indexation and  $\tau = 1$  implies total indexation. The maximization problem of producer  $i$ , who chooses its price  $P_t^*$  is:

$$E_t \sum_{s=0}^{\infty} (\beta\theta)^s (\lambda_{t+s}/\lambda_t) P_{t+s} \left[ \frac{P_t^* a_{t+s}}{P_{t+s}} - \frac{P_{M,t+s}}{P_{t+s}} \right] Y_{i,t+s}$$

subject to the demand function for its product, which results from the optimization problem of the final good producer:

$$Y_{i,t+s} = \left( \frac{P_t^* a_{t+s}}{P_{t+s}} \right)^{-\varepsilon} Y_{t+s}^d$$

where the factor  $a_{t+s}(\tau)$  results from indexation, and  $\lambda_t$  is the shadow value of an additional unit of income. The resulting first order condition is often referred to as the New-Keynesian Phillips Curve and determines prices as a mark-up over marginal costs.

Entrepreneurs hire workers and rent capital, and supply the produced output to intermediate goods producers. The objective function of the entrepreneur is:

$$P_{M,t} Y_t^S - (W_t e_t + W_t^{MW} e_t^{MW} + r_{k,t} k_t)$$

The production function is of the standard Cobb Douglas form, with constant returns to scale ( $\alpha + \beta_p + \gamma = 1$ ):

$$Y_t^S = z_t k_t^\alpha e_t^{\beta_p} (e_t^{MW})^\gamma$$

Lower skilled workers have lower productivity ( $\gamma = 0.1 < \beta_p = 0.68$ ).

Capital goods producers supply capital to high skilled households, maximizing the following objective:

$$Q_t i_t - \left( 1 - S \left( \frac{i_t}{i_{t-1}} \right) \right) i_t$$

The inclusion of capital adjustment costs represented by the function  $S \left( \frac{i_t}{i_{t-1}} \right)$  makes impulse responses of investment more persistent.

There are labor unions, which negotiate wages on behalf of high skilled workers, charging the entrepreneurs a markup over marginal costs. Since minimum wage increases support wage negotiations of labor unions, the mark-up is affected by the minimum wage growth rate:

$$W_t = (1 - s) \frac{u'(c_t^H)}{u'(c_t)} P_t + s g_t^{MW} W_{t-1}$$

In the first scenario  $s = 0$ ; in the second scenario  $s = 0.5$ . It turns out that magnitude of  $s$  only affects the magnitude of elasticities, but not the qualitative conclusions. All qualitative results still hold if  $s = 0$  in both scenarios.<sup>1</sup>

<sup>1</sup> The other parameters are close to standard values in the DSGE literature.

## Government and Monetary Authority

The government issues bonds and finances government purchases  $g_t$  with lump sum taxes.<sup>2</sup>

$$g_t + R_{t-1}d_{t-1} = d_t + T_t$$

The monetary authority sets interest rates according to a Taylor rule:

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\gamma_R} \left(\left(\frac{\pi_t}{\pi}\right)^{\gamma_\pi} \left(\frac{Y_t^d}{Y^d}\right)^{\gamma_Y}\right)^{1-\gamma_R} \epsilon_{M,t}$$

## Market Clearing, Inequality and Exogenous Processes

The market clearing condition demonstrates how minimum wage increases affect aggregate demand through consumption:

$$\begin{aligned} c_t + c_t^{MW} + g_t + i_t &= Y_t^d \\ k_t &= k'_{t-1} \\ k'_t &= (1 - \delta)k'_{t-1} + \left(1 - S\left(\frac{i_t}{i_{t-1}}\right)\right)i_t \end{aligned}$$

Inequality is measured by the difference in consumption:

$$inequality_t = c_t - c_t^{MW}$$

Demand and supply shocks result from the processes of government expenditure  $g_t$  and TFP  $z_t$ :

$$\ln(g_t) = (1 - \rho_g)\ln(g) + \rho_g \ln(g_{t-1}) + \epsilon_{g,t} \text{ and } \ln(z_t) = \rho_z \ln(z_{t-1}) + \epsilon_{z,t}$$

<sup>2</sup> An interesting extension could be to replace lump-sum taxes with taxes on labor (that are progressive with earnings) capital and consumption.

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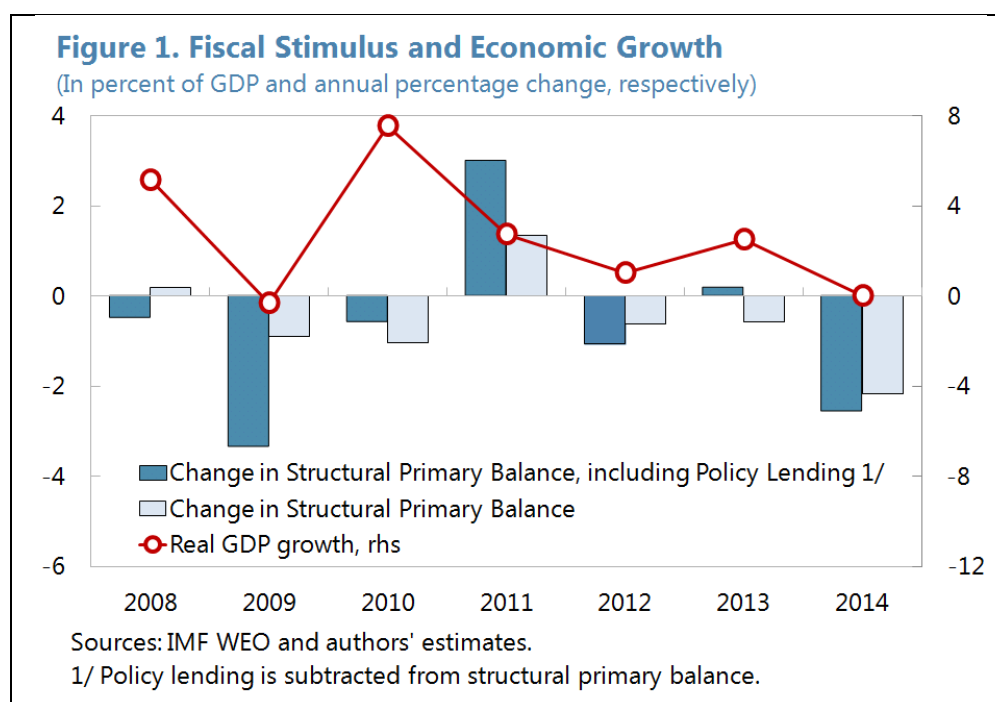
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## FISCAL MULTIPLIERS FOR BRAZIL<sup>1</sup>

We find historical fiscal multipliers for Brazil around 0.5, larger than what existing literature typically identifies for the average emerging market. However, spending and public credit multipliers seem to have dropped to near zero since the global financial crisis, as the estimate for the whole sample period (1999–2014) is about  $\frac{1}{2}$  of that for pre-crisis years. By contrast, revenue multipliers have remained broadly stable. We conclude that fiscal consolidations based on expenditure and public credit retrenchment are likely to entail a modest drag on growth in the near term.

### A. Fiscal Policy and Growth in Brazil since the Global Financial Crisis

**1. Fiscal policy in Brazil has been broadly expansionary over the past six years.** The structural primary balance declined from near  $3\frac{1}{2}$  percent in 2008 to -0.6 in 2014, dropping consecutively through the period with the single exception of 2011 (Figure 1). This deterioration exceeded the impact of automatic stabilizers, totaling a negative  $\frac{3}{4}$  percent of GDP, and has been dominated by an expansion in public spending considerably above GDP. Tax stimulus measures have however played a larger role since mid 2012.



<sup>1</sup> Prepared by Joana Pereira (FAD) and Troy Matheson (WHD).



**2. Beyond the supportive budgetary position, the government has also implemented substantial quasi fiscal stimulus.** Credit extended by public banks grew substantially from 2008 onwards, particularly by BNDES and Caixa Econômica Federal (Caixa), as private credit supply retrenched in the aftermath of Lehman's bankruptcy. The expansion was supported by transfers from the Treasury, which in net terms add up to 8 percent of 2014 GDP since 2008. More recently, policies geared at keeping energy and fuel prices artificially low further supported consumers and corporations, with a cost that is only partially absorbed in the budget. Despite this large fiscal and quasifiscal support, however, economic activity has remained subdued.

**3. Going forward, consolidation measures will be needed to rebuild fiscal buffers.** A scenario where the fiscal stance remains broadly neutral over the coming years would entail a substantial rise of the public debt ratio, with increased pressure on interest rates. Thus, despite the current downturn, fiscal consolidation is urgent to rebuild buffers and put debt on a firm declining path, thereby reducing yields and opening fiscal space for future productive spending. Consolidation needs relative to 2014 are large, in the order of 2.5 percent of GDP to stabilize debt and at least 3 to reduce it with high likelihood (see Pereira (2013)).

**4. How much could the necessary consolidation hurt growth in the short to medium term, and what does this imply for the design of fiscal consolidation?** This paper contributes to this discussion by estimating the size of fiscal multipliers—the effect of a 1 percent change in the structural fiscal balance on GDP—for spending and tax policy, as well for public credit. It will also assess how much multipliers have changed since the global crisis. To the best of our knowledge, no other paper has previously attempted to quantify the short-term impact of extending public bank lending in Brazil. Furthermore, existing studies on Brazil's fiscal multipliers use data up to 2011 only, therefore missing the period of low growth discussed above. The next Section summarizes related literature, and the methodology is described in Section C. Section D presents results for the full sample, while in Section E we comment on changes relative to the pre-crisis period. The robustness of baseline estimates to different model specifications are discussed in Section F. We conclude with remarks on the policy implications of our results in Section G.

## B. Fiscal Multipliers in Brazil: What do we know?

**5. A growing literature highlights that fiscal multipliers in emerging markets (EMEs) tend to be lower than in advanced economies.** Multipliers are notoriously difficult to measure. A vast literature has pointed to a wide range of estimates, depending on the country and time sample, as well as econometric (typically SVARs) or modeling (typically DSGEs) specification.<sup>2</sup> Nevertheless, on average, spending and revenue first-year multipliers (in normal times) have been calculated at about 0.75 and 0.25, respectively, for advanced economies (AEs). In its turn, the scarce empirical literature focusing on EMEs suggests lower multipliers, with minor differences between spending and revenue

<sup>2</sup> For an overview of the literature measuring fiscal multipliers, see Batini et al. (2014).

measures. Using a panel of EMEs, Ilzetzki (2011) finds short term spending and revenue multipliers lie in the 0.1–0.3 and 0.2–0.4 range, respectively. Pre-crisis studies highlighted potential *non-keynesian* effects, concluding that fiscal multipliers can be even negative, particularly in the long run and when debt is high (IMF (2008)). The level of development has also been found to influence the persistence of multipliers; Ilzetzki and others (2013) estimate not only lower but also considerably less persistent output responses to increases in EMEs, relative to AEs.<sup>3</sup>

**6. There are few Brazil specific studies, particularly covering the post crisis period.** Using an SVAR approach, Peres (2006) finds small but significant positive fiscal multipliers in 1995–2004. In contrast, Mendonça and others (2009) and Cavalcanti and Silva (2009) provide evidence of *non-keynesian* effects of fiscal policy in Brazil during 1995–2008. Their findings could be influenced by the debt distress episodes in the late nineties, and/or expectations that fiscal expansions will eventually be compensated by offsetting consolidation measures (a sort of Ricardian equivalence). Controlling for the effect of monetary policy shocks and external economic conditions, Orenge (2012) concludes that fiscal multipliers were positive and larger than previously estimated (close to AEs levels) in 2004–11, a period of stronger macroeconomic stability and relatively contained fiscal sustainability concerns.

**7. Fiscal multipliers depend on specific economic conditions, some of which vary in the short term.** Batini et al. (2014) surveys the literature on the various factors by which fiscal multipliers can change across countries and time. Countries with (i) high import propensity, (ii) high propensity to save, (iii) limited liquidity constraints, (iv) flexible wage setting, (v) floating exchange rate regimes, (vi) large automatic stabilizers, and/or (vii) high debt levels tend to have smaller multipliers. Although Brazil scores low in (i)–(iv), which suggests large multipliers, by all other accounts, multipliers should be on the low end. It is also difficult to judge how the various aspects balanced out over time. The macro stabilization achieved in the early 2000s and subsequent reduction in public debt arguably contributed to an increase in multipliers. On the other hand, financial deepening and flexibilization of the exchange rate would have had the opposite effect. More recently, as public finances deteriorated and the need for adjustment became clearer, Ricardian effects arguably lowered the multiplier. Conjunctural factors also matter, however. Fiscal multipliers tend to be higher during downturns or when monetary policy remains accommodative.

## C. Methodology

**8. A structural vector-autoregressive model (SVAR) is used to estimate fiscal multipliers for government spending, government revenue (tax), and public credit.** The basic VAR specification is:

$$Y_t = AY_{t-1} + U_t$$

<sup>3</sup> In the context of SVAR estimates, the result is driven also by persistence in fiscal policy execution; with shocks being shorter lived in EMEs.

where  $Y_t = [W_t, S_t, C_t^*, X_t, C_t, P_t, T_t, R_t]'$  is an eight-dimensional vector of endogenous variables and  $U_t$  is the corresponding vector of reduced-form shocks.<sup>4</sup> The endogenous variables set includes the real minimum wage ( $W_t$ ), real primary government spending ( $S_t$ ), real public credit to the private sector ( $C_t^*$ ), real GDP ( $X_t$ ), real private credit to the private sector ( $C_t$ ), the consumer price index ( $P_t$ ), real primary government revenue ( $T_t$ ), and the short-term interest rate (SELIC) ( $R_t$ ). The data are measured at the quarterly frequency and the sample period is 1999Q1 to 2014Q1.<sup>5</sup>

**9. How are the fiscal shocks identified?** All variables can influence each other with some lags. In order to identify the structural shocks, we employ a Cholesky decomposition. The decomposition imposes a recursive causal structure that restricts the contemporaneous impact of each variable on the other variables. The causal ordering assumed in the baseline specification is:

$$W_t \rightarrow S_t \rightarrow C_t^* \rightarrow X_t \rightarrow C_t \rightarrow P_t \rightarrow T_t \rightarrow R_t$$

### Spending

An unexpected movement in government spending is assumed to have an immediate (within the same quarter) impact on output, while an unexpected movement in output only influences government spending with a lag. Effectively, it is assumed that policymakers take longer than one quarter to adjust spending in response to output surprises due to legislative lags. At the same time, because a significant share of spending is tied to the minimum wage, government spending is impacted immediately by movements in the minimum wage.<sup>6</sup>

### Revenue

Unexpected changes in government revenue are assumed to impact the interest rate in the same quarter (since monetary policy can react quickly), and the remaining variables with a lag. Thus, the central bank is assumed to respond to unexpected changes in tax policy by changing its policy rate within the same quarter, while tax revenue in any given quarter is impacted by unexpected movements in wages, spending, credit, output, and prices.

<sup>4</sup> The model includes one lag of all variables, as suggested by the Schwarz-Bayesian criterion.

<sup>5</sup> The natural logarithm is taken of each variable prior to estimation, except the interest rate, which is left in levels (see the appendix for a more detailed description of the data). The VAR is estimated in levels and is stationary; it has a well-defined vector-moving-average representation and the impulse response functions are not explosive.

<sup>6</sup> The minimum wage directly influences with social welfare spending, given that the minimum benefit is, by a constitutional requirement, linked to the minimum wage. Higher benefits are indirectly linked to the minimum wage, through its impact on average wages.

## Public credit

An unexpected movement in public credit is assumed to immediately impact output, private credit, prices, government revenue, and the interest rate, with unexpected movements in these variables only impacting public credit with a lag. Similar to the assumptions related to government spending, policymakers are assumed to take more than one quarter to respond to output, private credit, prices, government revenue, and interest rate surprises. Public credit can be immediately impacted by wages and government spending, considering that unexpected movements in government spending lead to an adjustment in the policy mix between on-budget spending and the amount of credit public banks extend. Private credit is assumed to be more endogenous than public credit and is immediately impacted by unexpected movements in output.

**10. The fiscal multiplier measures the output effect in reais of a one real increase in discretionary spending or revenue.** Specifically, the multiplier at horizon  $t$  is:

$$\text{Multiplier} = \frac{\Delta X_t}{\Delta Z_0} / S_z$$

where  $\Delta X_t$  is the change in output in period  $t$ ,  $\Delta Z_0$  is the initial change in the fiscal variable (i.e.  $Z = S, T, \text{ or } C^*$ ), and, to convert these changes into reais,  $S_z$  is the average share of the fiscal variable in output over the sample. The impact multiplier is measured at  $t=0$ .

## D. Estimated Fiscal Multipliers

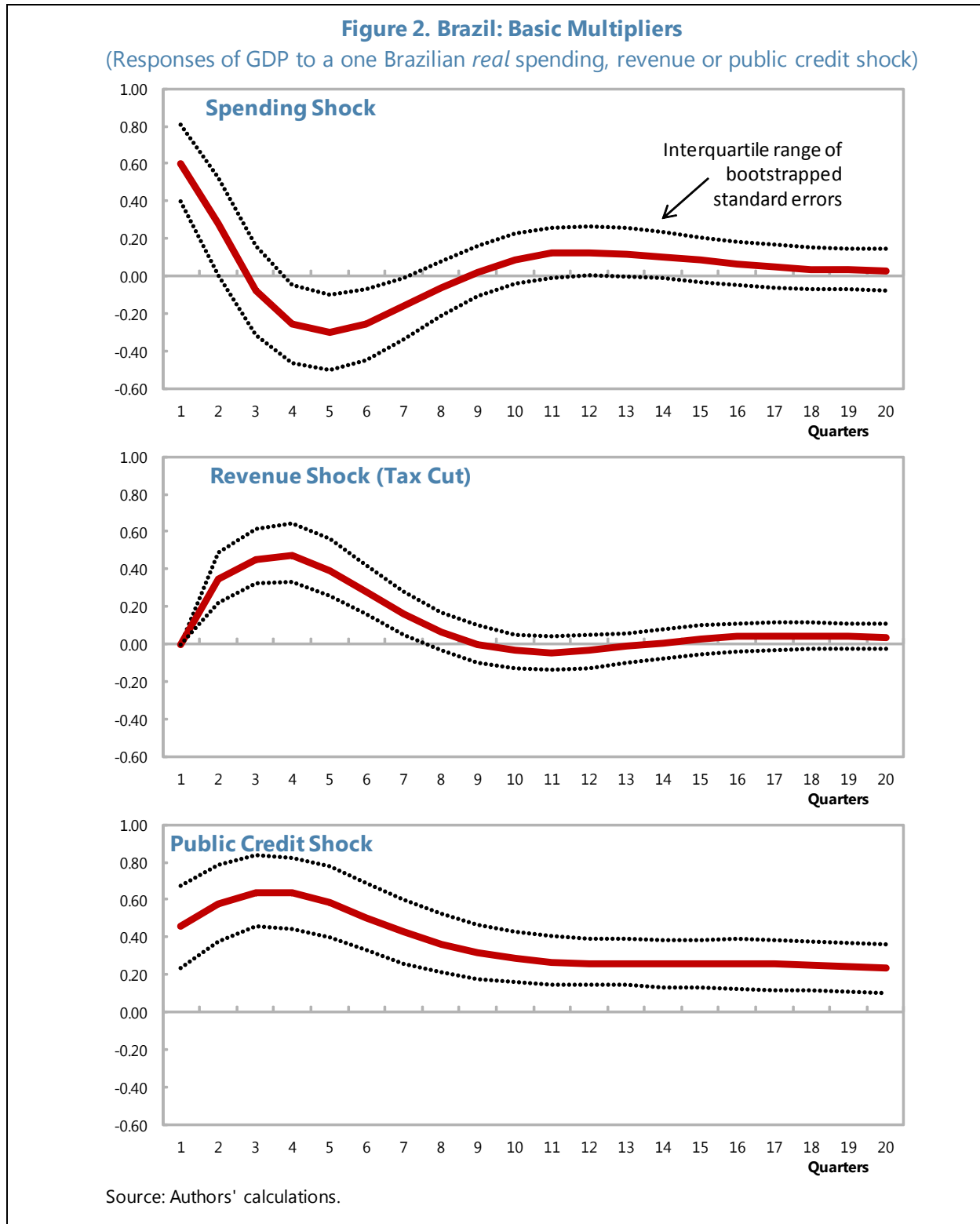
The estimated multipliers are displayed in Figure 2. The model is estimated 1000 times using bootstrapped data.<sup>7</sup> Figure 2 displays the median multipliers for each variable along with the 25<sup>th</sup> and 75<sup>th</sup> percentiles.

**11. The government spending multiplier peaks at around 0.5 in the same quarter as the spending increase.** The impact multiplier is high for an EME, but still below AEs levels.<sup>8</sup> The output effect is nevertheless short lived, consistent with previous findings for EMEs and Brazil. By the end of the second year after the shock, the accumulated multiplier is virtually zero. Two factors may contribute to this finding. First, in the context of a binding primary surplus target, surprise increases in government spending in a given quarter will likely generate consolidation measures later on. Second, the nature of spending increases matter. Public investment, which typically entails larger and more persistent multipliers, is exceptionally low in Brazil; thus shocks to  $S_t$  may be dominated by

<sup>7</sup> Bootstrapping involves the following steps: 1) estimate the model parameters and obtain the residuals; 2) resample (with replacement) from the estimated residuals and simulate the model using the parameters from 1; 3) re-estimate the model, saving the parameters; 4) repeat steps 2 and 3 a large number of times.

<sup>8</sup> The lower spending multipliers in EMEs has been often attributed to relative expenditure inefficiencies and the difficulty of unwinding expenditure growth, both of which of potential relevance in Brazil.

current spending, particularly transfers which have a short lived impact (working as a demand boost which fuels inflation and expectations of future monetary tightening).



**12. Likewise, the revenue multiplier peaks at around 0.5 one year after a tax cut.**

Traditionally, the literature relying on SVAR estimates has identified lower revenue than spending multipliers. However, some recent papers (e.g. Mertens and Ravn (2012)) dispute that conclusion, using a ‘narrative approach’ to the identification of shocks. The marginal effect on output in Brazil seems to also come down to zero after two years, but the medium-run (accumulated) multiplier of tax cuts is positive, at about 2.

**13. Finally, the public credit multiplier peaks at around 0.5 one year after the credit**

**increase and is notoriously persistent.** After 2 years, the accumulated multiplier of public credit reaches 3.8 and the policy continues to prop up GDP through the end of the forecast horizon. Public credit has been mostly extended by BNDES to support investment, and public banks played an important countercyclical role at the beginning of the crisis, when private credit supply dried out. Thus, a large and persistent effect seems reasonable. As discussed next, however, public credit has become less effective in boosting GDP in more recent years.

## E. Have the Multipliers Changed?

**14. Government spending and public credit multipliers have fallen since the global**

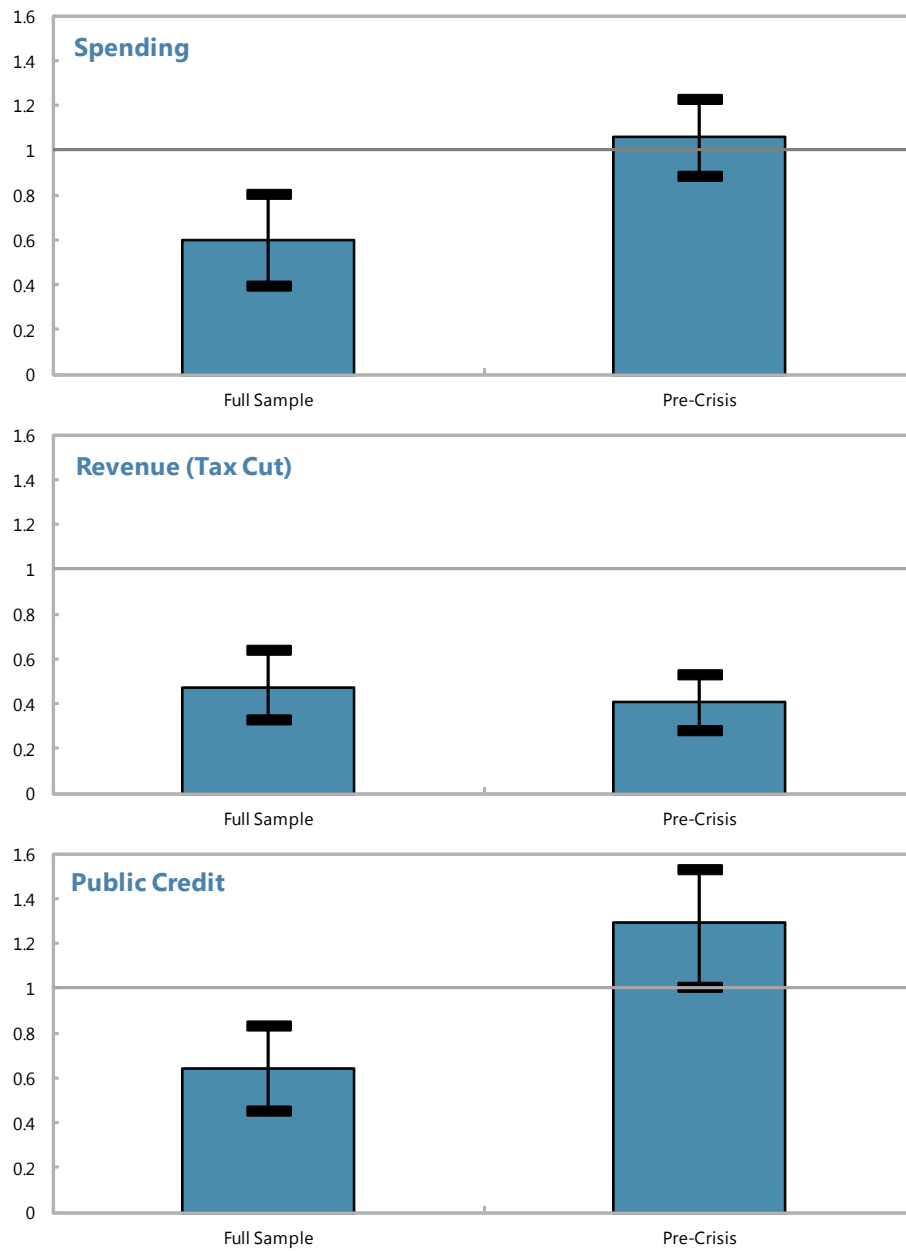
**financial crisis, while the revenue multiplier has remained broadly stable** (Figure 3). The former practically halved from pre-crisis levels<sup>9</sup>, indicating that the effectiveness of government spending and expansion of credit by public banks was close to zero in the recent past. Given subdued growth performance—generally associated with larger multipliers<sup>10</sup>—this may be a consequence of inefficiencies in public spending increases (mostly pensions), impact on debt levels (traditional crowding out effect and expectation of a sharp adjustment need in the future), and possibly the crowding out of private bank activity (which market share declined continuously since 2011). The lower estimated multiplier for public bank lending could also reflect easier access to private funding (including external) by many Brazilian corporates over time, particularly the larger ones, rendering public bank support less critical for these firms. Interestingly, we obtain very similar estimates in the pre-crisis period to those obtained by Oreng (2012) for 2004–11.

<sup>9</sup> The pre-crisis subsample ends in 2007Q4.

<sup>10</sup> The size of the output gap is not included in the framework; thus Figure 3 plots average multipliers over the cycle. Supply constraints in the post crisis period can, however, have contributed to lower multipliers. We do not expect such impact be significant, though, as revenue multipliers would also be lower, which does not seem to be the case.

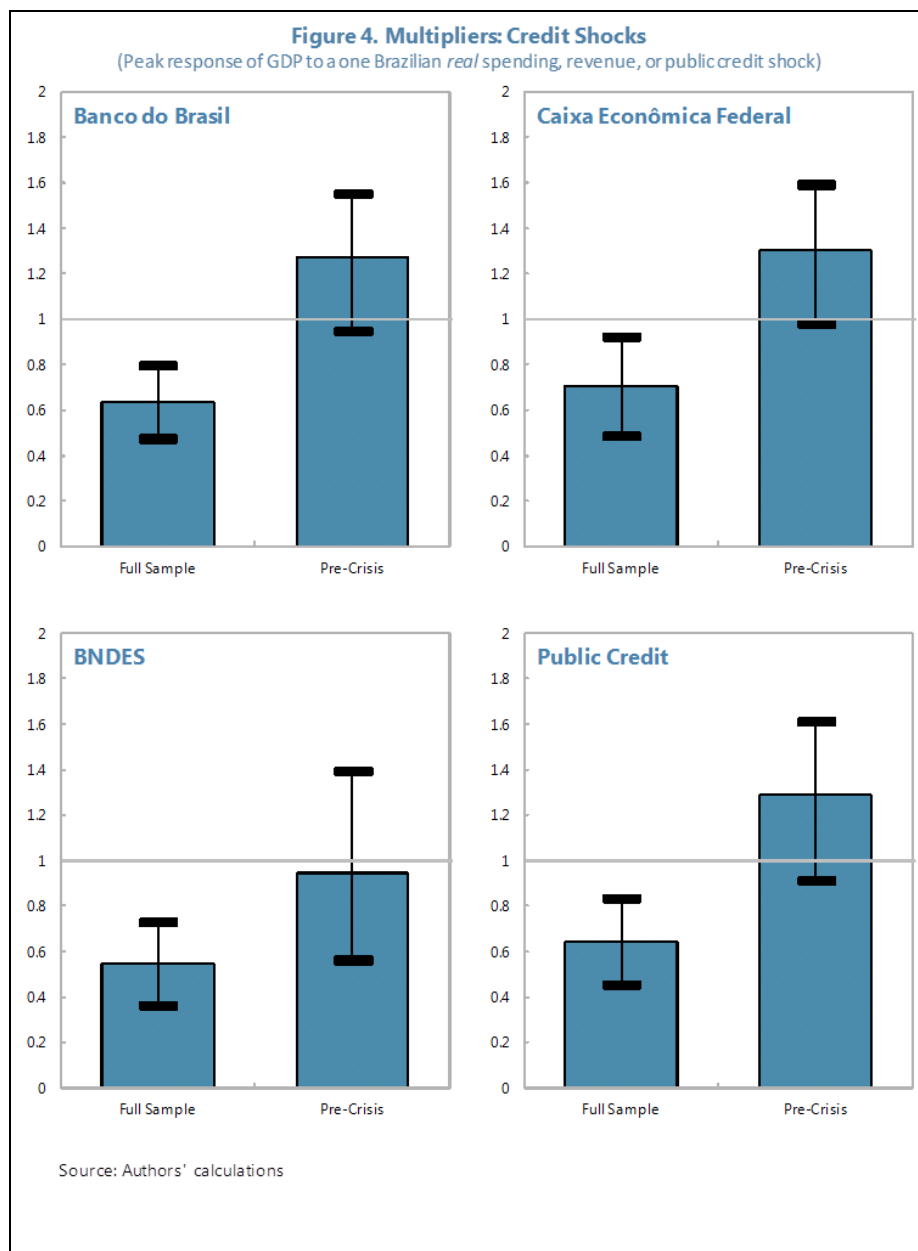
**Figure 3. Multipliers, Basic Shocks**

(Peak response of GDP to a one Brazilian *real* spending, revenue, or public credit shock)



Source: Authors' calculations.

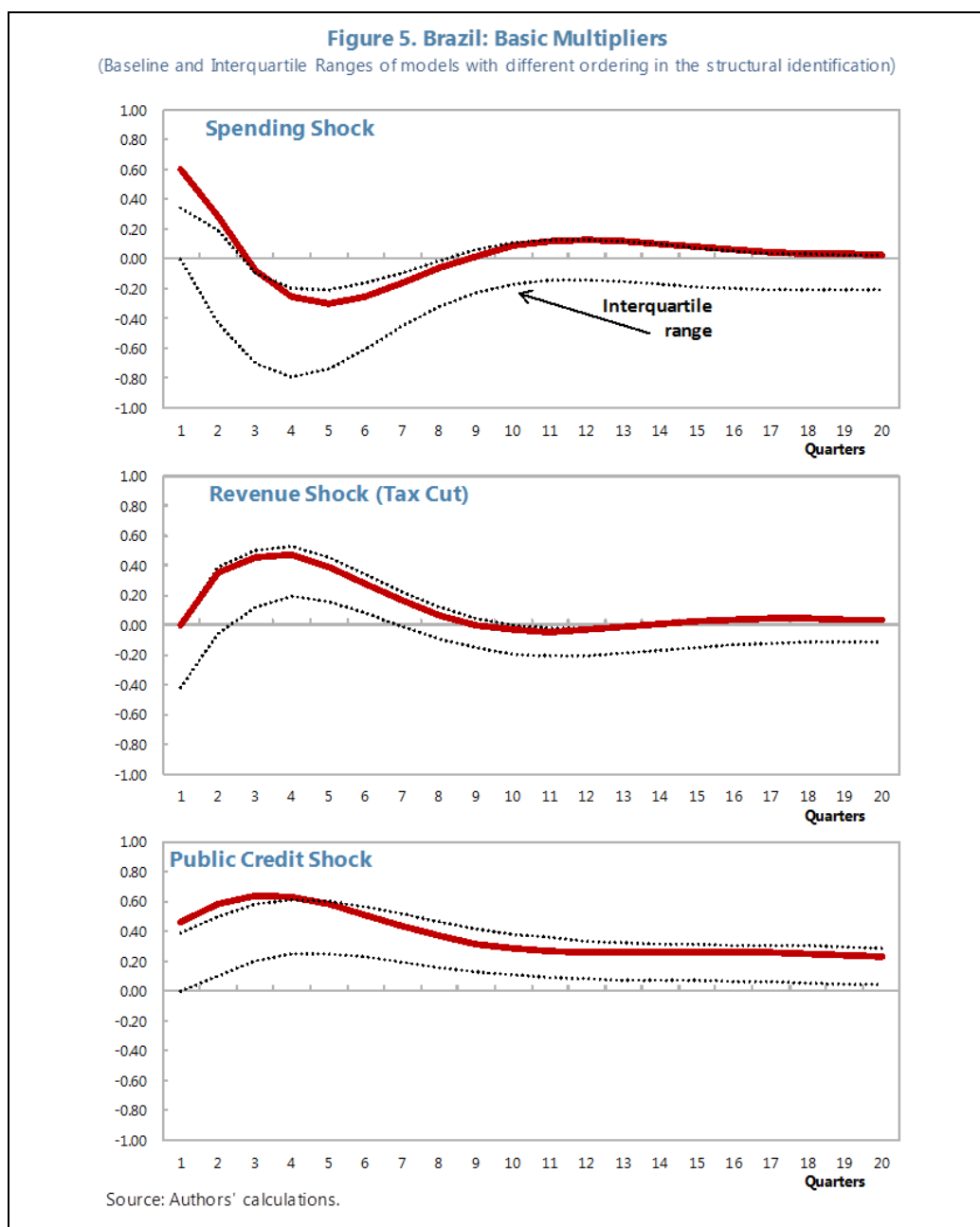
**15. Does the public credit multiplier differ across public banks?** To shed further light on the nature of the public credit multiplier, we also investigate potential differences across the three main federal banks, which pursue very different business segments (Figure 4). BNDES finances exports, working capital for large firms, and long-term infrastructure projects. Caixa traditionally provides housing loans, although in recent years it branched into other types of credit, such as non-payroll personal loans, credit card, and SME loans. Banco do Brasil supplies rural credits, but has also recently increased its share of housing loans. We however obtain similar estimated multipliers for all three banks, despite their different business models.





## F. Robustness

**16. Our main results are robust to alternative specifications.** Taking an agnostic view, as a robustness check, each fiscal variable was ordered from first to last in the identification scheme, and 1000 multipliers are computed for each of the 8 identification schemes. The results are in Figure 5. Multiplier estimates are broadly similar across specifications, although the baseline specification tends to produce impact multipliers that are on the high side. The results are also robust to the inclusion of US growth (as a proxy for global economic conditions) in the model, as well as to different cut-off dates for the pre/post-crisis sample split (2008Q4 and 2009Q4).



## G. Policy Implications

### 17. The exercise in this paper sheds light onto three important features of fiscal multipliers in Brazil:

- (1) The impact of fiscal policy on economic activity should be measured not only by the strict budgetary impulse but also by the effect of public bank lending. Public lending multipliers in the 1999–2014 period are similar to those of budgetary expenditures.
- (2) Fiscal multipliers in Brazil are comparable to those of AEs, but have substantially declined since the global financial crisis. At the current juncture, fiscal stimulus, particularly in the form of larger current spending or extended public credit, is expected to be ineffective, and *non-keynesian* effects are more likely to prevail should fiscal consolidation be biased towards expenditure rationalization and phasing out of on-lending through public banks.
- (3) Revenue based consolidations will likely entail a larger fiscal drag. On the one hand, Figure 2 shows that although the maximum impact on growth is similar (for the whole sample period), the accumulated effect after two years is larger. Additionally, the revenue multiplier has not declined in the recent past.

## Appendix. Data

All data are seasonally adjusted, with the exception of the short-term interest rate.

- Real minimum wage ( $W_t$ ), deflated with GDP the deflator (Instituto Brasileiro de Geografia e Estatística).
- Real primary government spending ( $S_t$ ) and revenue ( $T_t$ ), deflated with the GDP deflator (Secretaria do Tesouro Nacional). Note: The revenue and expenditure series are netted out for the impact of (i) the 2010 operations with Petrobras (oil concession and capitalization), and (ii) transfers to and withdrawals from the Sovereign Wealth Fund (in 2008, 2012).
- Real GDP ( $X_t$ ) (Instituto Brasileiro de Geografia e Estatística)
- Real private credit to the private sector ( $C_t$ ), deflated with the GDP deflator (Banco Central do Brasil).
- The consumer price index ( $P_t$ ) (Instituto Brasileiro de Geografia e Estatística).
- Short-term interest rate (SELIC) ( $R_t$ ) (Banco Central do Brasil).

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# NORMALIZATION OF GLOBAL MONETARY CONDITIONS: THE IMPLICATIONS FOR BRAZIL<sup>1</sup>

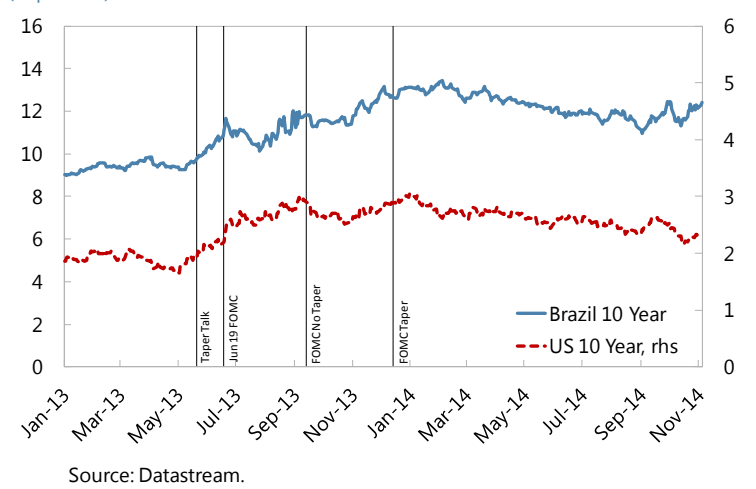
*Global financial conditions are poised to tighten further as the global recovery proceeds. While monetary policy normalization should be a healthy global development as growth continues to recover in advanced economies, financial spillovers seen during the taper episode—which started with the announcement in May 2013 of possible tapering of U.S. asset purchases—hint at potential challenges for Brazil. The Fed’s communications related to normalization have improved significantly since the taper episode and, at present, a rise in Fed Funds rate in 2015 is widely anticipated by markets—arguably the most widely anticipated tightening of monetary policy in history. While Brazil could benefit from tighter global financial conditions associated with improved global prospects, bouts of heightened uncertainty about the future course of monetary policy cannot be ruled out. Thus, the correct diagnosis of the underlying reasons behind tighter global financial conditions remains crucially important for Brazil. Adverse spillovers can be mitigated by strengthening policy frameworks and fundamentals.*

## A. The Taper Episode and Beyond

**1. The May 2013 announcement of possible tapering of U.S. Federal Reserve asset purchases revealed potential challenges going forward.** In response to a question during his testimony to Congress on May 22, 2013, Ben Bernanke said that whenever stimulus efforts began to taper off, it would not happen in an “automatic, mechanistic program” and that “any change would depend on the incoming data.” After the details of the Federal Open Market Committee meeting on April 30 and May 1, 2013 were released later that day, many market participants were surprised by the number of voices inside the Fed calling for a slowdown in the stimulus effort in the near future. The announcement triggered significant volatility amid a repricing of risk and capital flow reversals in some emerging markets, including Brazil. In the U.S., 10-year Treasury bond yields

**Figure 1. Brazil and U.S. Sovereign Bond Yields**

(In percent)



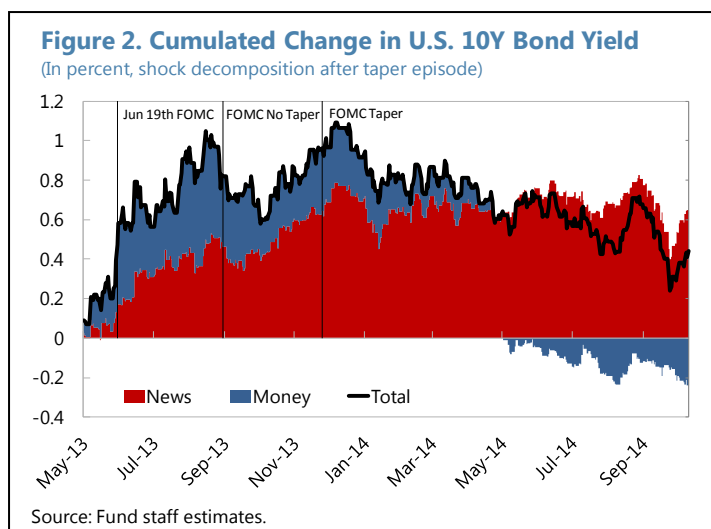
<sup>1</sup> Prepared by Troy Matheson (WHD).

rose by about 100 basis points during the summer. By the end of August, Brazilian 10-year Government bond yields had risen by more than 200 basis points and the real had depreciated by around 15 percent against the U.S. dollar. (The central bank had started a monetary tightening cycle in April to curtail inflation concerns; as part of this cycle, the central bank raised its benchmark interest rate by 150 basis points between the taper speech and end-August.)

**2. A key lesson from the taper episode is that the source of tightening of financial conditions is critical to understanding transmission channels and spillovers.** Monetary policy normalization due to better economic prospects in advanced economies should be a healthy global development. However, the adjustment in global financial conditions triggered by the tapering announcement was followed by unusual volatility in financial markets. As noted in IMF (2014), tightening monetary conditions due to better economic prospects has not historically been coupled with such uncertainty and re-pricing of risk. This highlights the importance of differentiating between shocks to financial conditions from economic developments—growth or risk appetite—and shocks from monetary developments.

## B. Why did Long-Rates Rise in the U.S.?

**3. The rise in the long-term Treasury yield can be attributed to monetary shocks (related to uncertainty about the future course of monetary policy) and shocks related to better economic prospects.** As discussed in IMF (2014) and Matheson and Stavrev (2014), the approach used to distinguish between these two shocks relies on a sign-restricted VAR estimated at the daily frequency. The intuition is simple: positive (tightening) money shocks push up yields and depress stock prices; positive economic news shocks increase both yields and stock prices.



**4. Monetary policy shocks drove up long-term bond yields in the U.S. immediately after the tapering announcement, but shocks related to better economic prospects have since become increasingly important (Figure 2).** Uncertainty about the future course of monetary policy, “monetary shocks”, dominated in the immediate aftermath of the tapering announcement, adding about 20 bps to the U.S. 10-year bond yield in May 2013 and another 30 basis points following the FOMC meeting in June 2013, where the Federal Reserve confirmed that tapering could begin by the end of 2013. The FOMC meeting in September revealed that tapering would not begin before the end of 2013, with the press release noting that the Committee saw the improvement in economic activity and labor market conditions since it began its asset purchase program as

consistent with the growing underlying strength in the broader economy. Nevertheless, just prior to that announcement, monetary shocks had already accounted for the majority of the 100 basis points rise in 10-year yields since May 2013. The subsequent announcement in December (in which tapering was confirmed to begin in 2014) had little impact on yields, and was perceived by markets as confirmation of the Fed's desire to taper due to an improving economic outlook.

**5. Federal Reserve communications have improved since the taper episode, reducing the impact of monetary shocks on long rates.** Janet Yellen was confirmed as the new Chairperson of the Federal Reserve Bank Board in early 2014, and the Fed has gradually improved its communications related to monetary policy normalization. In particular, the end of asset purchases in October 2014 was widely anticipated by markets due to the successful Fed communications throughout the year. The eventual rise in the Fed Funds rate from the zero lower bound has also been well communicated to markets, with expectations that the rise will occur in earnest during 2015. At the same time, the Fed's communications under Janet Yellen have increasingly been perceived as being more 'dovish' than under Ben Bernanke, putting downward pressure on long rates since the middle of 2014.

### C. What was the Impact on Brazil?

**6. As global economic prospects improve, financial conditions will continue to normalize and tighten going forward.** However, as the tapering episode in 2013 showed, the communication and interpretation of monetary policy intentions in the U.S. could also pose policy challenges for Brazil. To better understand how global developments impact the Brazilian economy, we employ an empirical approach that utilizes the U.S. monetary and economic news shocks described above.

#### Methodology

**7. This exercise treats developments in the U.S. as being exogenous to developments in Brazil.** By estimating the historical shock contributions to 10-year bond yields for the U.S. from monetary and economic news shocks and treating them as exogenous to developments in Brazil, we can disentangle the differentiated effects of these two shocks on the Brazilian economy using a simple vector-autoregressive (VAR) model. The VAR is estimated using monthly data from late 2006 and includes the following domestic variables: the central bank's real economic activity index, the policy interest rate, the 10-year government bond yield, the CPI, the nominal exchange rate versus the U.S. dollar, and business confidence.<sup>2</sup> It is assumed that U.S. developments can affect Brazilian variables contemporaneously (within a month) and through lags, but Brazilian variables cannot affect the U.S. variables. Note that the sample period is limited because Brazil only began issuing 10-year government bonds in late 2006.

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<sup>2</sup> The natural logarithm is taken of each variable prior to estimation, except interest rates, which are left as levels (see the appendix for a more detailed description of the data). The model includes one lag of all variables, as suggested by the Schwarz-Bayesian criterion.

## Results

**8. What are the implications of a 100 basis point increase in 10-year bond yields in the U.S. for Brazil?** The results when the 10-year bond yield increases by 100 basis points due to *either* a monetary shock *or* a news shock in the U.S. are displayed in figure 3. The bars reflect average responses of the domestic variables over a 6 month period when the model is simulated 1000 times; the lines reflect the standard deviation of the average responses. Note that the size of each shock is relatively large when put in context—that is, a shock that raises the 10-year bond yield in the U.S. by 100 basis points would typically imply a significantly larger increase in the Fed funds rate. Note also that, given the small sample size, the confidence bands around the estimates are relatively wide.<sup>3</sup>

**9. While higher interest rates in the U.S. increase interest rates in Brazil, the impact on the rest of the Brazilian economy depends on the nature of the shock.** Regardless of the nature of the shock in the U.S., the policy rate and the long rate (10-year bond yield) rise by a quantitatively significant amount. Monetary shocks increase the policy rate by around 80 basis points and the long-rate by around 200 basis points, effectively steepening the yield curve. In contrast, positive economic news prompts an increase in the policy rate and the long rate of around 100 basis points, leaving the slope of the yield curve broadly unchanged. The relatively large impacts on the policy rate and the long rate suggest the central bank has responded to foreign developments relatively strongly since 2006.

**10. The impact on Brazilian long-rates is broadly in line with other studies.** As discussed above, this work aims to examine how the effects of a change in the U.S. 10-year bond yield resulting from better economic news differs from a change resulting from monetary shocks. In contrast, most other studies focus on the impact of changes in U.S. yields, without determining why the changes occur. This makes the results difficult to compare. Nevertheless, averaging the impacts of economic news and monetary policy shocks give us a rough basis for comparison. The results show that a 100bps rise in the U.S. 10-year bond yield that is equally driven by economic news and monetary shocks leads to a rise in Brazil's 10-year bond yield by around 150bps. This impact is broadly similar to results found using different estimation methodologies, sample periods, and data frequencies (see, for example, Kamil and others, 2014, and IMF, 2013).

**11. The implications for the domestic variables differ depending on the nature of the shock. In particular, the results suggest:**

- **A monetary shock depreciates the exchange rate, and reduces economic activity and business confidence.** A monetary shock in the U.S. leads to a depreciation of the Brazilian real's nominal exchange rate against the U.S. dollar as U.S. assets become more attractive to investors. At the same time, worsening prospects for the U.S.

<sup>3</sup> Overall, the impacts on the Brazilian variables are qualitatively very similar to those found in IMF (2014) for emerging economies more generally.



economy and higher domestic interest rates reduce business confidence and economic activity.

- **A positive economic news shock appreciates the exchange rate, increases activity and business confidence, and puts upward pressure on prices.** Better economic prospects in the U.S. improve the outlook for global demand and Brazil's nominal exchange rate appreciates against the U.S. dollar. Economic activity and business confidence improve in Brazil, increasing the price level.

**12. Developments in the U.S. have a significant impact on interest rates in Brazil, particularly at longer horizons (Figure 4, top 2 panels).** The results show that a significant proportion of the forecast error variance of the Brazilian policy rate is driven by domestic developments at short horizons.<sup>4</sup> However, developments in the U.S., particularly shocks related to economic news, account for more than  $\frac{3}{4}$  of the variance of the policy rate after one year. In contrast, the forecast error variance of the long rate is impacted almost immediately by monetary shocks in the U.S., with positive economic news becoming increasingly important over time.

**13. Domestic developments are more important drivers of the exchange rate, output, the price level, and business confidence (Figure 4, bottom 4 panels).** Unlike interest rates, domestic shocks are more important drivers of the forecast error variance for the other Brazilian variables. This suggests that financial linkages between the U.S. and Brazil are much tighter than linkages through economic activity and trade. Interestingly, the nominal exchange rate against the U.S. dollar is also more driven by domestic factors than by developments in the U.S. This likely reflects links between domestic fundamentals and a risk premium associated with investing in Brazil. This result, however, should be treated with an element of caution, because here we assume that structural shocks to the exchange rate are domestically sourced, while in practice they will capture *all* developments not explained by the other variable in the model (some of which may be foreign).

**14. What happened after the taper episode in May 2013?** Figure 5 shows contributions to the cumulated changes in the domestic variables since April 2013. The results suggest:

- **Positive economic developments in the U.S. appear to have significantly contributed to the rise in interest rates.** Monetary shocks had an important positive impact on long-term yields immediately following the taper episode, but this effect began to unwind by the end of summer 2013. Positive economic news in the U.S. then became the most important driver of the long-term rate, with domestic developments

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<sup>4</sup> The decomposition shows the amount of information each shock contributes to explaining each variable in the VAR by determining how much of the forecast error variance of each of the variables can be explained by each of the exogenous shocks. Forecasts for each variable in the model at each point in time are uncertain due to developments in the (structural) shocks. Given the estimated parameters of the model, including the estimated shock variances, the forecast error variance for each variable can be computed at each horizon, allowing each forecast error variance to be attributed among the different structural shocks.

(possibly associated with perceptions about country risk) also becoming more important over late 2013 and early 2014.

- **The exchange rate depreciated because the impact of positive U.S. economic news was outweighed by U.S. monetary shocks and negative domestic developments.** The exchange rate initially depreciated sharply following the taper episode, but it recovered some ground following the central bank's announcement of the FX intervention program in August.
- **Activity, prices, and confidence benefited from better U.S. economic news, but this was largely offset by the impact of deteriorating domestic conditions.** The deterioration in domestic conditions was quite dramatic. From mid-2013 to mid-2014, consensus growth forecasts for 2014 fell by around 1.5 percent to just over 1 percent and inflation expectations rose by around 0.5 percent, close to the ceiling of the tolerance region around the target.

#### D. Why are Brazilian Interest Rates so Responsive to U.S. Developments?

**15. Fundamentals matter.** IMF (2014) suggests that key fundamentals can dampen the response to money shocks. In particular, emerging economies with relatively strong fundamentals experienced lesser reactions to rising long-term yields in the U.S. Higher reserves, lower inflation, a higher current account balance, deeper financial markets, and stronger underlying growth all help mitigate adverse spillovers from tighter global financial conditions. Thus, the evidence suggests that deteriorating domestic fundamentals have contributed to the heightened responsiveness of Brazilian yields relative to other emerging economies.

#### E. Policy Implications

**16. As economic prospects in the U.S. continue to improve, financial conditions are expected to normalize in a smooth fashion.** Overall, recovery in the U.S. is beneficial to the global economy and Brazil. However, the tapering episode highlighted that potential challenges may arise going forward.

**17. Central banks' objectives have become more complex, giving rise to communication challenges, and the potential for further bouts of market volatility.** Following the global financial crisis, central banks have become more mindful of the tradeoff between financial stability and price stability. This potential conflict in objectives is amplified by the need to manage the multiple instruments (policy rates and balance sheets), adding to the complexity of policy communication going forward, and raising the specter of further bouts of uncertainty and market volatility.

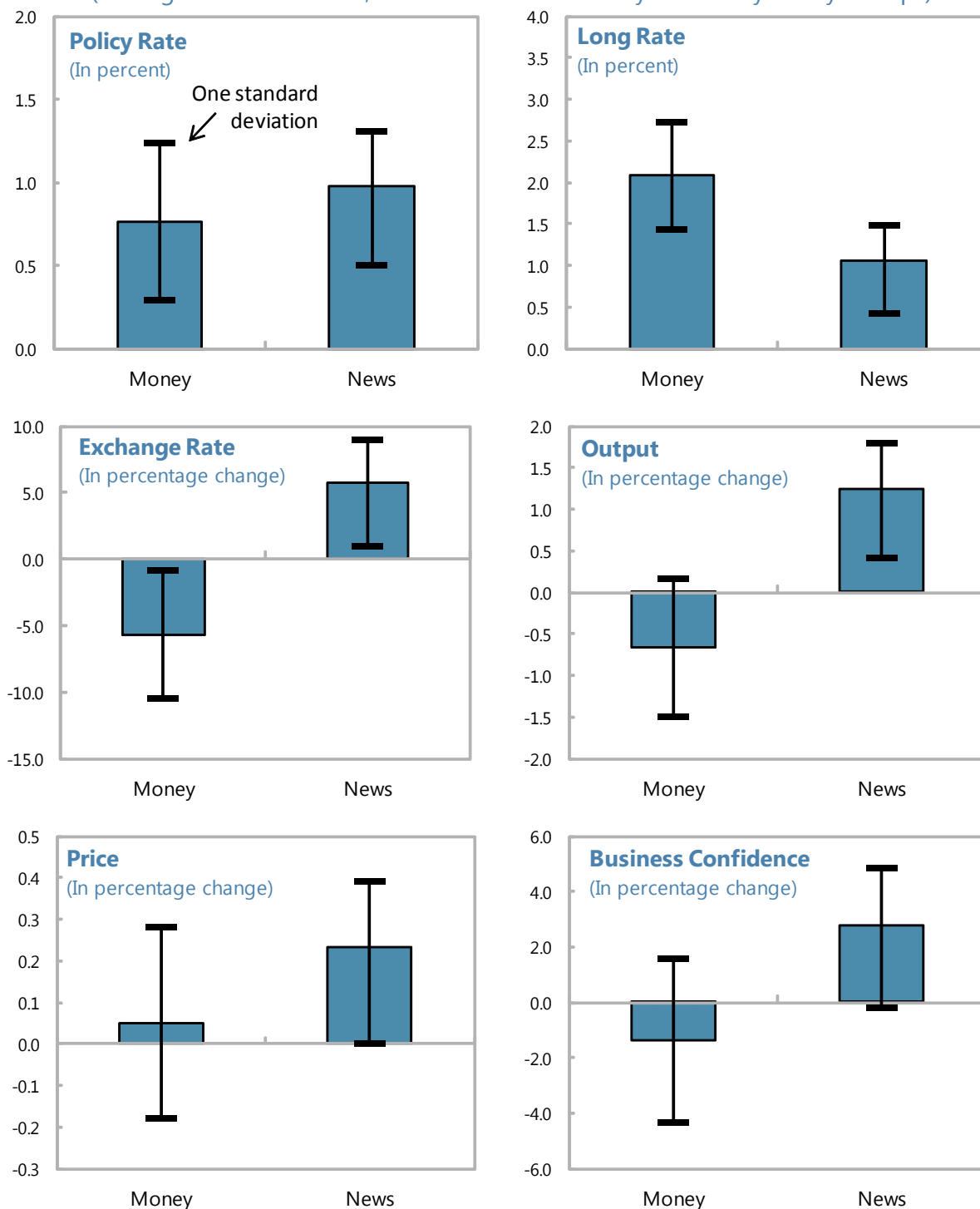
**18. The appropriate policy responses will depend on the underlying drivers of tighter financial conditions.** The results suggest that positive global economic developments will put upward pressure on interest rates, and cause nominal exchange rate appreciation and output gains,

while money shocks will trigger nominal exchange rate depreciation and output losses. Getting the correct diagnosis of tighter global financial conditions is thus critical to choosing the best policy course.

**19. Sound policy frameworks and fundamentals can mitigate spillovers.** Better understanding the role of policy credibility and sound fundamentals in the transmission of global shocks will improve economic policy, especially monetary policy. Spillovers from money shocks have typically been milder in countries with sound policy frameworks and fundamentals. Spillovers could also be amplified if a lack of credibility hinders the ability to respond to global shocks.

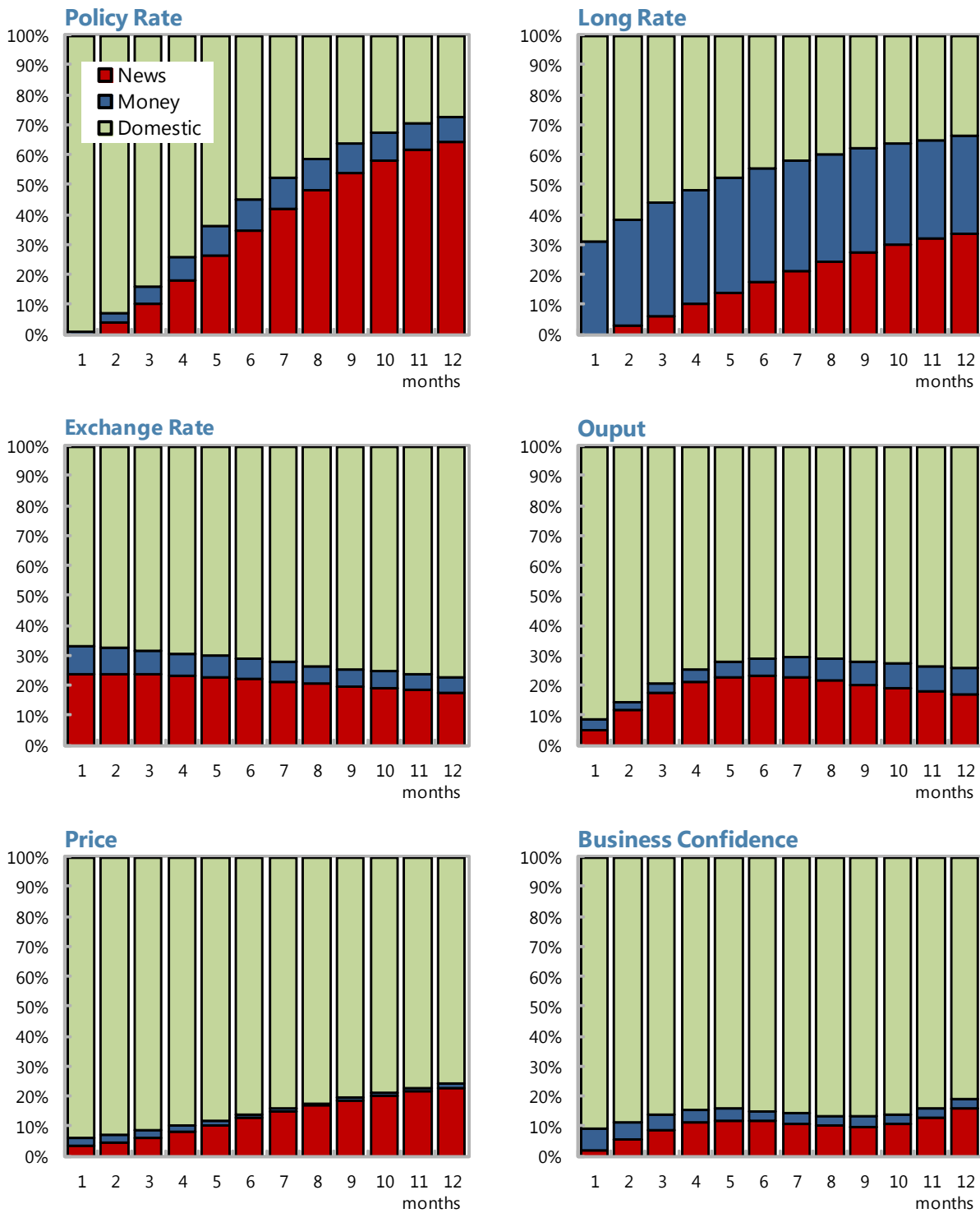
**Figure 3. Impact of Money and News Shocks**

(Average over six months, shocks increase U.S. 10 year bond yield by 100bps)



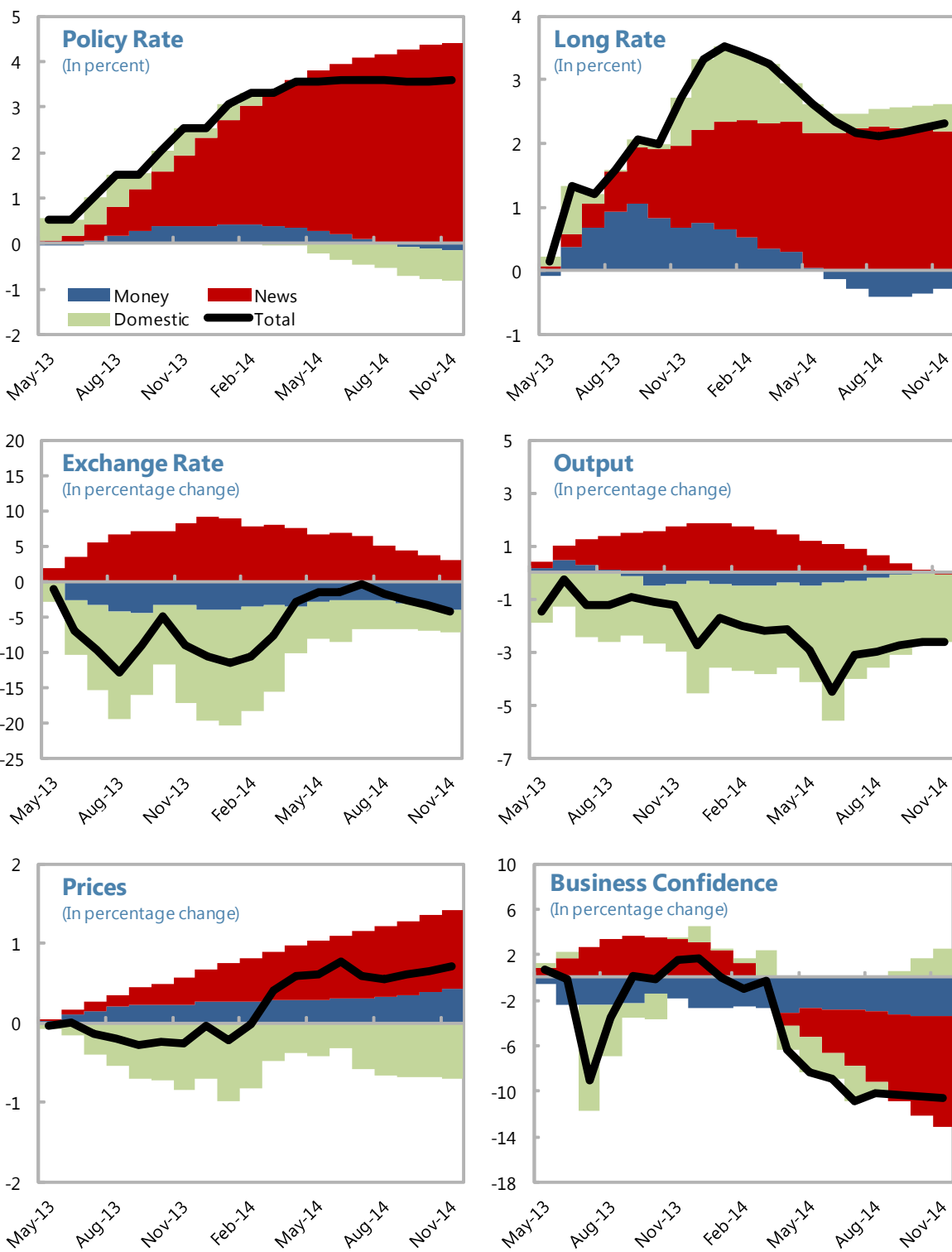
Source: Fund staff estimates.

**Figure 4. Explanatory Power of Different Shocks at Different Horizons**



Source: Fund staff estimates.

**Figure 5. Brazil: Cumulated Changes since Taper Episode and Contributions**



Source: Fund staff estimates.

## Appendix. Data

The data used in the empirical work are described below.

### **United States (Daily Data)**

10-year Treasury Yield at Constant Maturity (Board of Governors of the Federal Reserve System)

S&P 500 Index (The New York Times)

### **Brazil (Monthly Data)**

SELIC Target Interest Rate (Banco Central do Brasil)

10-year Government Bond Yield (Haver)

Nominal Exchange Rate, reais/dollar (Banco Central do Brasil)

Economic Activity Indicator, seasonally adjusted (Banco Central do Brasil)

Extended National CPI, seasonally adjusted (Instituto Brasileiro de Geografia e Estatística)

Business Confidence Index, seasonally adjusted (Confederação Nacional da Indústria)

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# ASSESSMENT OF FOREIGN EXCHANGE INTERVENTION<sup>1</sup>

*This chapter assesses the Central Bank of Brazil's (BCB) foreign exchange intervention since June 2013, with a particular focus on the program of pre-announced interventions launched in August 2013 and in effect through end-March 2015. We find that the BCB used adequate tools to contain excessive exchange rate volatility following the Bernanke tapering speech; preannouncing the program succeeded in lowering volatility by reassuring investors with open FX positions; the size of the program and the maturity of its instruments likely filled a market gap beyond increasing the supply of hedge at the margin. However, the program may have slowed exchange rate convergence to more competitive levels. Its continued renewal—including during periods of low global volatility—raised questions about the BCB's objectives and prevented the real's depreciation to its equilibrium level. Our recommendation is not to continue the program beyond March. Further intervention would be limited to episodes of excessive volatility.*

## A. Background

**1. Intervention in foreign exchange markets is a well established policy tool in many countries.** Central banks in a large number of countries have intervened in foreign exchange markets since June 2013, mostly through purchases or sales of foreign currencies in spot markets (e.g. China, Malaysia, Russia, Singapore, Thailand and Turkey). Such transactions are typically sterilized through the issuance/sale or purchase of domestic debt securities. Sterilized intervention can be successful at influencing exchange rate movements to the extent that private market participants do not fully take advantage of the resulting arbitrage opportunities. Reasons why this may not happen are imperfect capital mobility as well as portfolio rebalancing or signaling effects.<sup>2</sup>

**2. The BCB has intervened frequently in foreign exchange markets since the adoption of the floating exchange rate regime in January 1999.**

- In 2001–2002, pressures on the Brazilian *real* intensified amid three major shocks—spillovers from the Argentine debt crisis, the '9.11' market jitters in the U.S., and public debt solvency concerns following the presidential election. The *real* depreciated by up to 44 and 71 percent in 2001 and 2002, respectively, as international reserves fell below US\$40 billion. The BCB responded by using U.S. dollar linked debt instruments (Treasury securities (NTN-D) and BCB notes (NBC-E)) in support of the currency, at a high costs to public accounts. The more U.S.

<sup>1</sup> Prepared by Heedon Kang and Christian Saborowski.

<sup>2</sup> See Sarno and Taylor (2001) and Bayoumi, Gagnon and Saborowski (2014).

dollar linked debt instruments were used, the less they were seen as good substitutes for actual foreign currency by the public. The increased perception of credit risk carried by these instruments caused their rollover rates to drop.

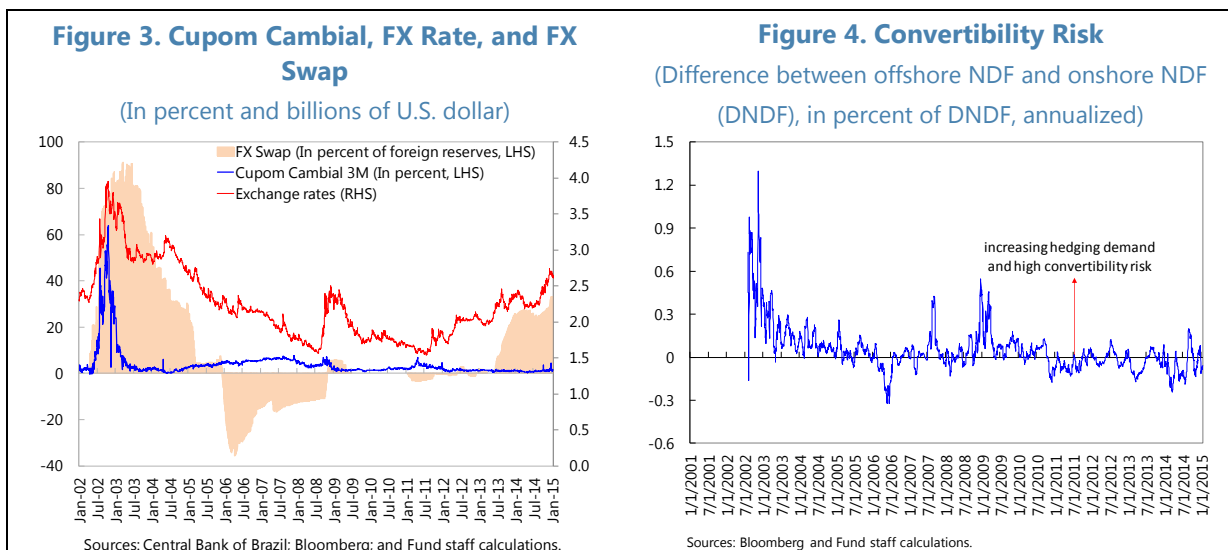
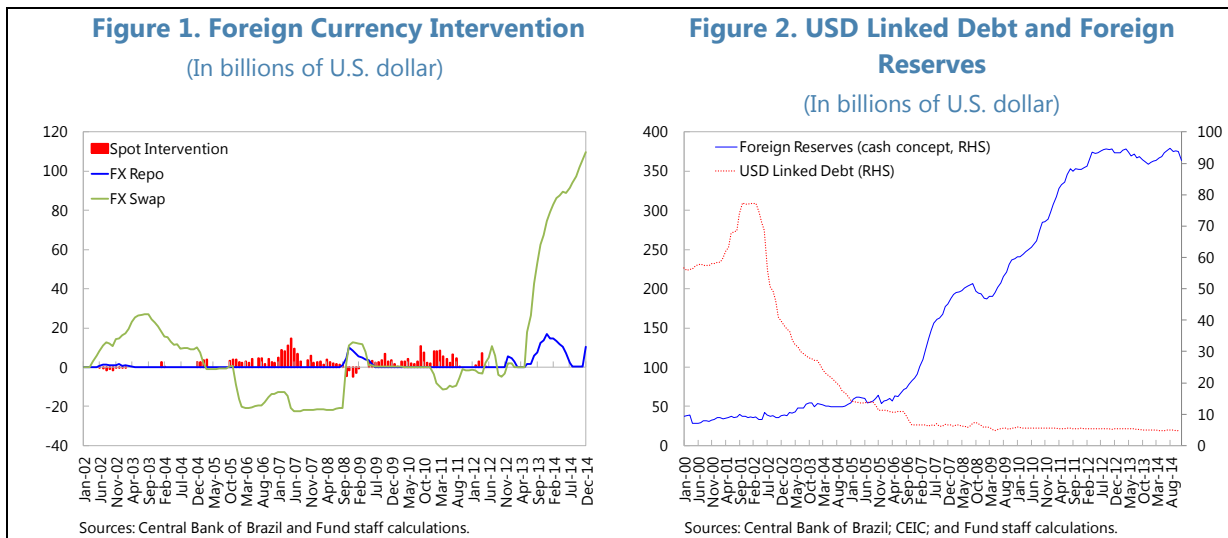
- From April 2002, the BCB replaced U.S. dollar linked instruments with Brazilian FX swaps, which were perceived as carrying a lower credit risk because they were traded and settled at the BM&F (the mercantile exchange) and offered daily margin adjustments (Figures 1 and 2);<sup>3</sup> However, market participants continued to fear sovereign defaults which could endanger the payments of U.S. dollar linked debts and the convertibility of outstanding FX swaps. As onshore futures prices dropped below spot rates and offshore forwards, perceived convertibility risk pushed up the *cupom cambial* which reached a peak at end-2002 (Figures 3 and 4).<sup>4,5</sup>
- Since 2003, as the newly elected government strengthened the macroeconomic framework and resilience to external shocks, the BCB gradually unwound the stock of FX swaps; the outstanding amount of U.S. dollar linked debt instruments also decreased substantially by end-2005, reducing the sensitivity of public debt to currency movements;
- Between 2006 and 2012, besides a short period following the Lehman Brother's bankruptcy, the Brazilian *real* came under appreciation pressure amid buoyant capital inflows. The BCB began to engage in *reverse* FX swaps and spot dollar purchases, building international reserves to about 17 percent of GDP. During September 2008–May 2009, the BCB intervened via a range of tools simultaneously, including spot dollar sales, auctions of FX swaps and FX repos, and even indirect dollar loans to Brazilian firms through the banking system (Stone and others, 2009).

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<sup>3</sup> Not all FX swap contracts were adjusted daily in 2002.

<sup>4</sup> Convertibility risk is defined in this paper as the percentage difference between the offshore non-deliverable forward rate (NDF) and the onshore non-deliverable forward rate (DNDF) in percent of DNDF.

<sup>5</sup> The *cupom cambial* reflects the onshore dollar interest rate implied by the domestic local currency interest rate, the spot exchange rate, and currency futures prices traded in BM&F BOVESPA. As an example, a one-year local currency interest rate of 12 percent, a spot rate of 2.5 *reais* per dollar, and a one-year forward exchange rate of 2.75 *reais* per dollar, would imply an onshore dollar interest rate of 2 percent. Assuming that onshore and offshore dollar instruments are close substitutes, the *cupom cambial* would be equal to the prevailing one-year domestic interest rate in the U.S. (Stone and others, 2009). In practice, however, instances of perceived convertibility risk have in the past driven a significant wedge between the two.

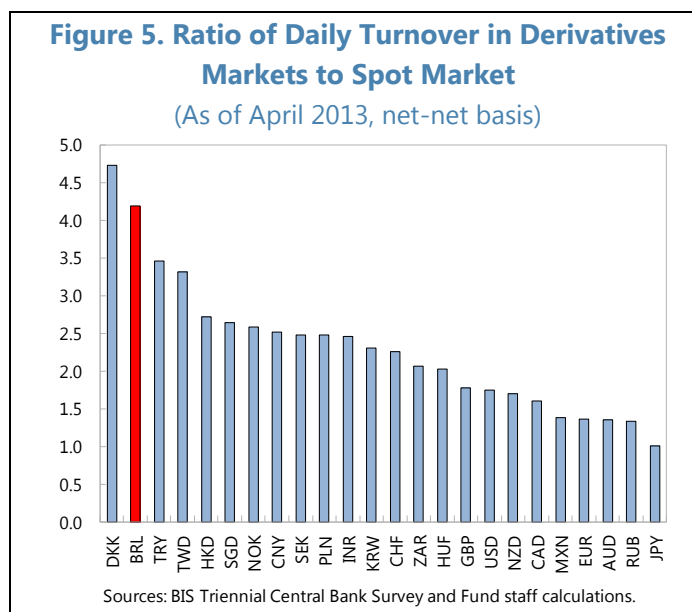


## B. Intervention Tool Kit

**3. Sterilized intervention in spot markets is one instrument at the disposal of the BCB but by no means the only one.** The BCB uses a variety of instruments to intervene in foreign exchange markets, including outright USD sales, FX repos and FX swaps. However, it has not intervened in spot markets since May 2012, in part due to the spot market’s limited size and access. While access to domestic spot markets is restricted to chartered banks, laws preclude trading or delivering the *real* offshore, and domestic bank accounts denominated in foreign currency are forbidden by law.

**4. Intervention in Brazil’s large and vibrant derivatives markets has become more frequent than spot intervention in recent years.** Brazil’s large derivatives markets developed amid investor interest in trading interest and exchange rate risk onshore (including due to Brazil’s history of high inflation, high nominal interest rates and devaluations). Foreign investors, in particular, have used derivatives to hedge exposures, including from carry trades. Today, Brazil’s derivatives markets

are among the largest in the world.<sup>6</sup> In particular, Brazil has active FX futures markets (BM&F BOVESPA) and dollar forward OTC markets (CETIP) whose trading volumes are four times larger than those in domestic spot markets (Figure 5). Importantly, the Brazilian exchange regime prohibits financial instruments traded in Brazilian markets from settling in foreign currency with a few exceptions.<sup>7</sup> As a result, policymakers can make use of a highly liquid market for FX derivatives that settle in local currency.



## 5. Two important instruments in the BCB's toolkit are the so-called Brazilian FX repos and Brazilian FX swaps:

- The most frequently used instrument is the Brazilian FX swap, a non-deliverable future settled in local currency (unlike conventional cross-currency swaps). While other countries (e.g. Colombia, Korea, South Africa, and Mexico) have intervened in foreign exchange markets via derivative products, the FX swap is unique in that it settles in local currency. Formally, the BCB announces details on each FX swap auction one business day in advance of receiving market participants' bids through the SELIC system ("Special System for Settlement and Custody").<sup>8</sup> As contracts

<sup>6</sup> See Dodd and Griffith-Jones (2007) and Garcia and Volpon (2014).

<sup>7</sup> Brazilian law (Decree-Law No. 857) states that every contract, security, document or obligation, in order to be fulfilled in Brazil, can't stipulate payment in gold or foreign currency, or, in any form, restrict or refuse fulfillment in the Brazilian currency. The exceptions to that law are: currency exchange operations, import/export contracts, export financing (when a Brazilian bank buys, paying in *reais*, in advance, the amount of foreign currency to be received by an exporter in an export operation) or loans or any obligations in which the creditor or debtor is domiciled outside Brazil.

<sup>8</sup> The BCB announces detailed information prior to each auction, such as the exact time of the auction, the maximum quantity of contracts that the BCB offers, and the maturity. Bidders are allowed to place up to five bids, specifying the quantity and price quotation for the bids. But, every bid-winner pays the same SELIC rate and receives the same

(continued)

mature, it pays its counterparts the observed exchange rate variation plus the pre-set *cupom cambial* and receives the ex ante SELIC rate in return.<sup>9</sup> At the auction, participants bid the *cupom cambial*, since SELIC is known. While the FX swap has no direct impact on international reserves, the central bank implicitly takes a short dollar position as part of the transaction.

- The Brazilian FX repo is akin to a conventional FX swap, resembling a dollar credit line. It has traditionally been used to provide FX liquidity to the market during periods of seasonal shortages. Formally, the BCB conducts an auction to sell spot dollars to its counterparts and receives Brazilian *reais* as collateral with an agreement to repurchase these dollars at maturity according to the auctioned forward rate.<sup>10</sup> In other words, the BCB pays the SELIC rate and receives the *cupom cambial*. While FX repos temporarily reduce international reserves, these recover fully upon maturity of the FX repo; both spot and forward rates are set at the time of the auction.<sup>11</sup>

**6. The FX swap can be used as a substitute to spot market intervention to the extent that convertibility risk is negligible.** FX swaps provide hedge to investors with open *real* positions, thus directly bidding down the forward exchange rate. The crucial difference to non-deliverable forward contracts (NDF) is that the Brazilian FX swap settles in local currency without an exchange of notional principal. In other words, at time of settlement, the BCB pays its counterparty the additional amount of *reais* necessary to keep the dollar value of her initial (notional) *real* position unchanged (that is, the excess depreciation of the real relative to the forward rate implicit in the auction parameters). From the investor's perspective, the FX swap is thus a good substitute for spot dollars (or an NDF) to the extent that the *real* will be fully convertible to dollars at the date of settlement. This rests on the expectation that the BCB will provide spot dollars at maturity if necessary and that convertibility will otherwise not be restricted (e.g. by capital outflow controls, a decision to alter the FX regime or rapid depreciations around the settlement date).<sup>12</sup>

**7. FX swaps are well suited to meet demand for hedge while spot dollar supply may increase depending on market participants' willingness to "transform" the instrument.** Given that FX swap contracts are settled in *real* and do not involve the exchange of principal, any given

cupom cambial and exchange rate variation. The BCB has its discretion to accept any volume of contracts up to the maximum that is on offer. The cut-off procedure is decided based on market analysis, such as auction consensus and the cupom cambial curve. The FX swap contracts are registered at the BM&F BOVESPA.

<sup>9</sup> In the past, the instrument was defined such that BCB received the CDI rate rather than the SELIC rate.

<sup>10</sup> The counterpart includes the dealer banks that are authorized by the BCB.

<sup>11</sup> For accounting purposes, the forward points (forward rate–spot rate) are accrued daily by the maturity date (the maturity varies from 30 to 365 days).

<sup>12</sup> Note that, by law, the Brazilian *real* can only be bought and sold in Brazil. Hence, a dollar shortage in Brazil represents a convertibility risk.

swap contract can be settled without recourse to foreign exchange reserves.<sup>13</sup> The instrument is thus well suited to meet demand for hedge or speculative FX exposure amid excessive volatility in foreign exchange markets. However, a different situation arises if there is a need to service either current obligations or capital outflows. In this case, the BCB can only substitute spot intervention with FX swap intervention to the extent that market participants are willing to bring dollar liquidity onshore as a counterpart to their long dollar derivative position. In normal times, commercial banks can fill this role (Garcia and Volpon, 2014).

**8. Intervention through FX swaps directly targets the market where price discovery takes place.** Garcia et al (2014) show that the Brazilian FX futures market dominates the spot market in terms of price discovery; it adjusts more quickly to the arrival of new information and is faster to recover to equilibrium in case of a shock to fundamentals. FX swap auctions take advantage of the powerful distribution channel to spot and derivatives markets. Institutions that purchase FX swaps, such as financial institutions and institutional investors, can take offsetting exposures in the CETIP OTC market or BM&FBOVESPA exchange and thereby provide FX cover to other market participants such as corporates with open FX positions.

**9. FX swaps may fill a market gap for hedging instruments with long maturities when extended in large volumes. Intervention based on FX swaps may fill a market gap for long-maturity hedging contracts.** Private party FX futures contracts traded on BM&F BOVESPA tend to have shorter maturities, and OTC market derivative products with longer maturities are not sufficiently liquid to meet steep increases in demand.<sup>14</sup> In particular, the net long dollar derivative position of corporates and households alone increased seven-fold from US\$7 billion at end-May 2013 to 48 billion by end-October 2014, while non-residents shifted their US\$6 billion short position into a US\$36 billion long position over the same period.

### C. Intervention Program Following the ‘Tapering Talk’

**10. Volatility in FX markets following the Fed’s tapering talk led the BCB to intervene actively since June 2013.** The Brazilian currency was hit hard following Governor Bernanke’s “tapering” speech on May 22, 2013. Following a period of discretionary intervention between June and August 2013, the BCB announced a program of pre-announced interventions on August 22. The instruments of choice have been Brazilian FX swaps and, to a much lesser degree, FX repos (Figure 6).

- The pre-announced intervention program initially consisted of daily auctions of foreign exchange swaps and repos equivalent to US\$3 billion a week—US\$500 million in FX swaps from Monday to Thursday and US\$1 billion in repos on Friday—through end-2013;

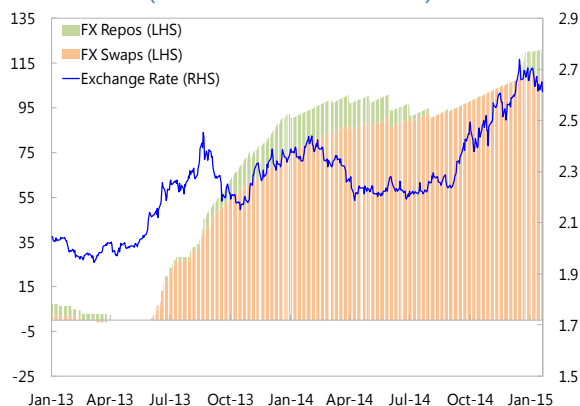
<sup>13</sup> However, if the BCB accumulates a large short position, it can incur significant losses if the *real* depreciates.

<sup>14</sup> About 90 percent of private party U.S. dollar futures trades are concentrated in maturities of less than 30 days, while the maturity of about 90 percent of the BCB’s FX swaps has been over 200 days.

- In December, the program was extended on a smaller scale—US\$200 million in swaps from Monday to Friday and FX repos only “on demand”—until end-June 2014. In late June, the program was extended on unchanged terms until end-2014;
- By the end of 2014, the notional balance of outstanding FX swaps amounted to US\$110 billion, which were primarily bought by commercial banks (52 percent) and domestic institutional investors (45 percent), with foreign investors directly holding only a small portion (Figure 7).
- The FX repos with commercial banks amounted to US\$17 billion by end-2013, but were unwound by end-August 2014. To provide FX liquidity to the market during a period that is generally market by capital outflows every year, the BCB carried out auctions for US\$10.3 billion in FX repos in December 2014; and
- At the end of December 2014, the BCB announced a further extension of its FX swap program, but with a reduced scale and period. It decided to offer US\$100 million per day until March 2015, while previous extensions lasted for six months with twofold volume.

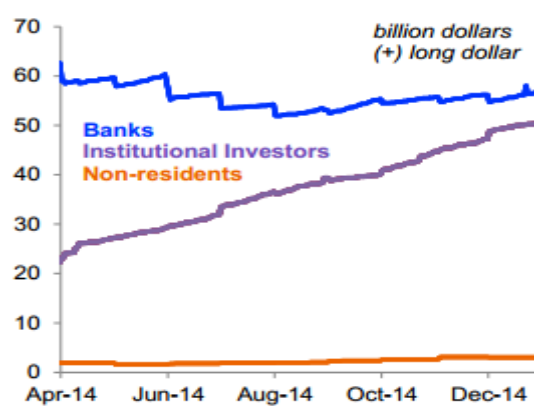
**Figure 6. Outstand Balance of FX Swap and FX Repo since 2013**

(In billions of U.S. dollar)



**Figure 7. FX Swap Exposure by Counterparties**

(In billions of U.S. dollar)

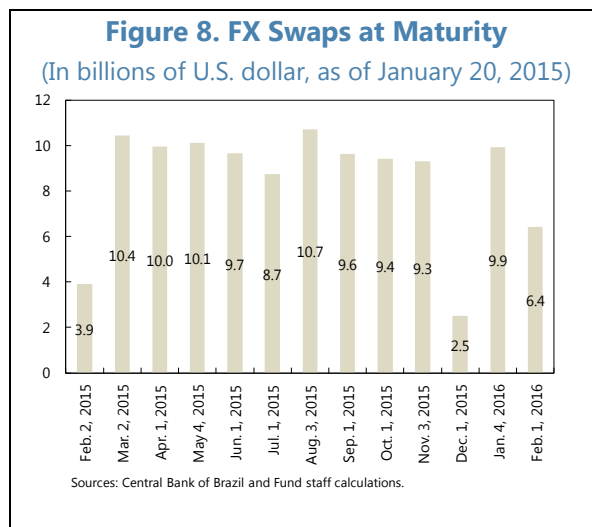


**11. Recourse to FX repos and FX swaps paired with the policy preannouncement was adequate as demand for hedge dominated.** Convertibility risk remained negligible throughout the current intervention episode as shown in Figure 4. Exchange rate pressures did not appear to be driven by outflow pressures as FDI and portfolio inflows remained stable amid the BCB’s monetary policy tightening cycle and measures to ease the IOF tax (Figure 11). While FX repos addressed temporary liquidity needs, FX swaps bid down the price of hedge for open FX positions and may have filled a market gap as discussed above.

**12. The large outstanding stock of FX swaps runs the risk of losses on FX swaps.** Given the depreciation pressure in the FX market, the BCB could make considerable realized losses from the ongoing intervention program. The loss would, however, be more than offset by unrealized valuation gains on international reserves.

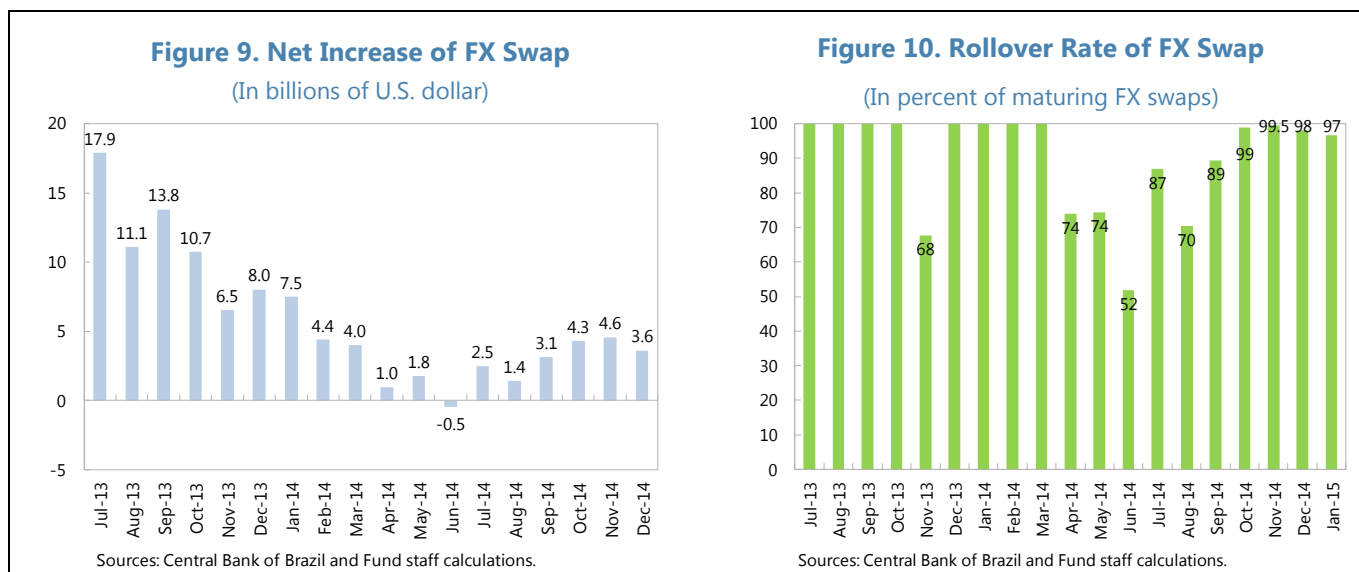
**13. The maturity structure of the outstanding stock of FX swaps is distributed relatively evenly going forward (Figure 8).**

About US\$10 billion in outstanding FX swaps is set to mature during the first business day of each month until November 2015. The FX swaps sold in January 2015 will mature in September and December 2015. In addition, the central bank has continued to roll over contracts worth US\$10.4 billion maturing in February 2015 at a pace of 10,000 contracts per day.

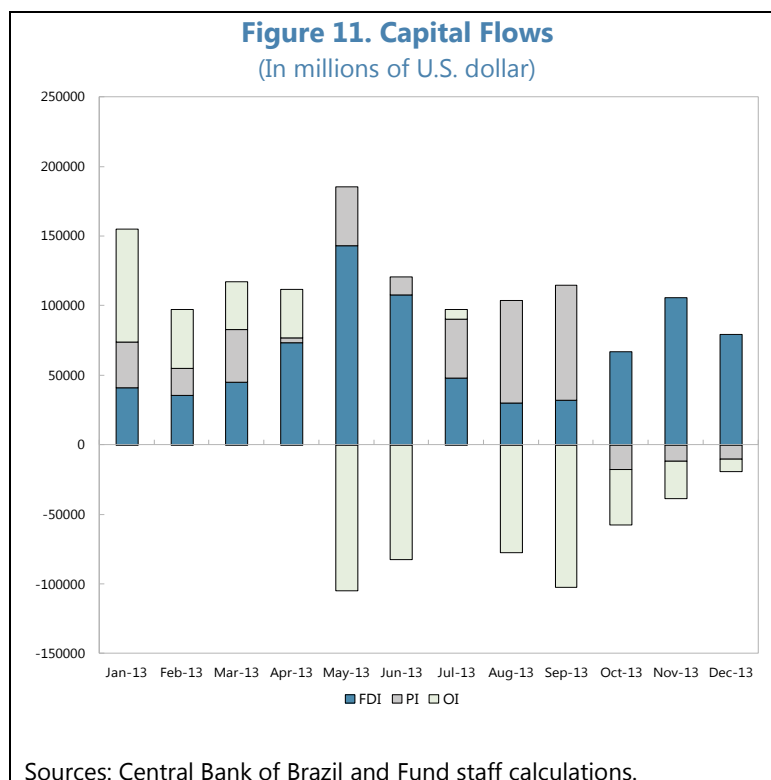


**14. Although auctions of new swaps follow preannounced schedules and amounts under the program, the BCB has the discretion to determine the rollover rate of maturing swaps.**

Initially, maturing swaps were fully rolled over, except those due on November 1, 2013; but once exchange rate volatility started to abate around April 2014, the rollover rate was reduced to the point that the outstanding notional value of FX swaps decreased on a net basis in June 2014 (Figure 9). As the Brazilian *real* came under renewed pressure in the run-up to the first-round presidential elections in October 2014, the BCB increased rollover rates back to almost 100 percent (Figure 10).



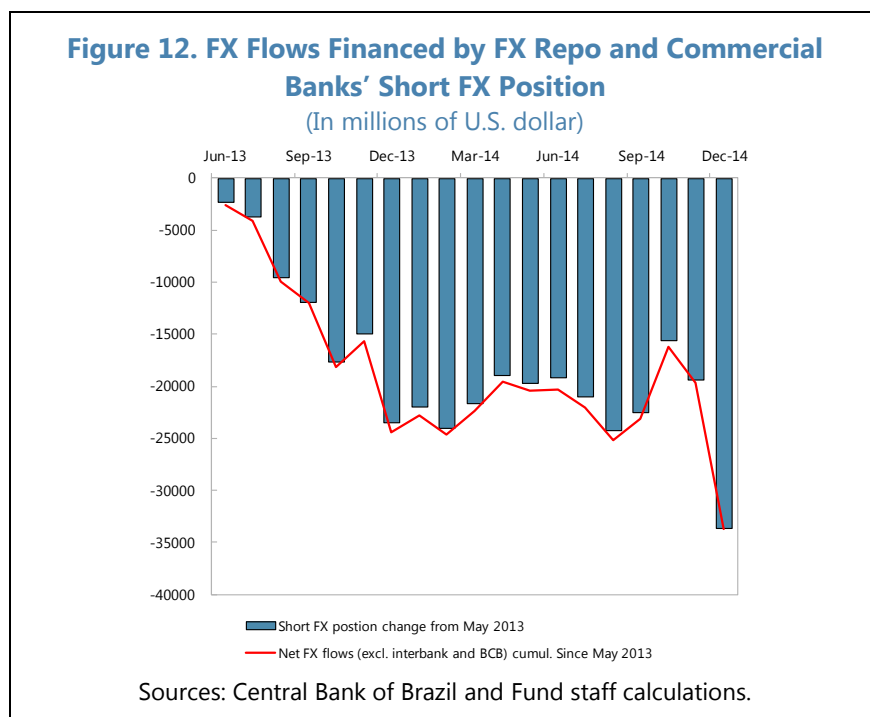




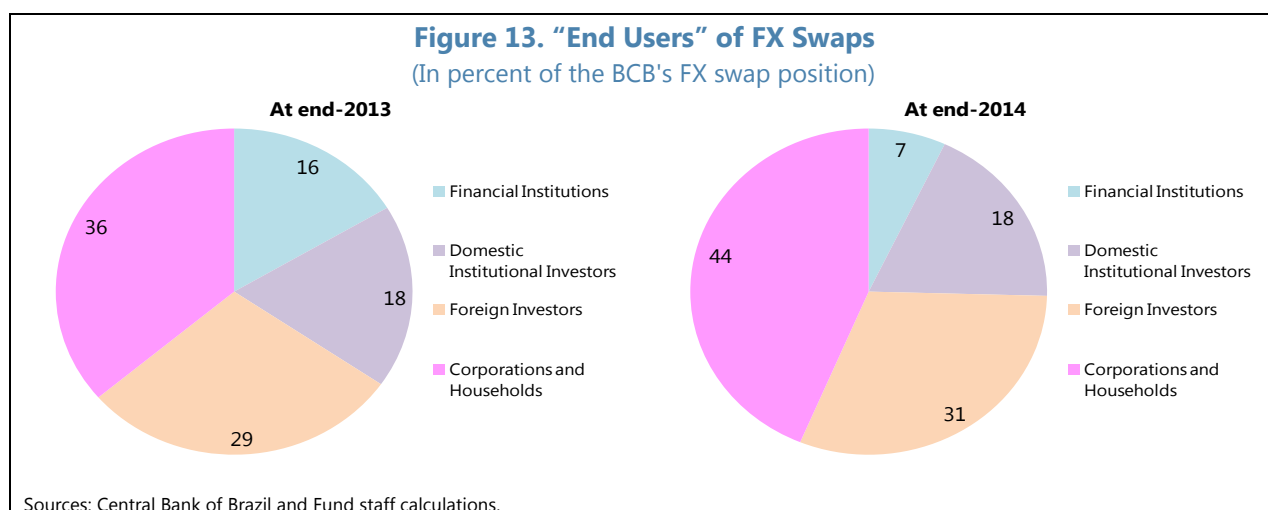
## D. Distribution Channels to Spot and Derivative Markets

### 15. Commercial banks have been key players in channeling FX hedge to market participants due to their exclusive ability to trade in both FX spot and derivatives markets:

- Commercial banks have sold DDI&USD futures in the BM&F BOVESPA and U.S. dollar forwards in the OTC market (registered at the CETIP exchange) against their long swap positions to market participants (mainly corporates and foreign investors), allowing them to hedge their BRL exposures. At end-2014, banks' short positions in the two FX derivative products totaled about US\$20 billion and US\$30 billion, respectively. Summing these positions up against their FX swap position, commercial banks' net long position in FX derivatives amounts to US\$8 billion;
- In the spot market, commercial banks have sold dollars, either obtained through FX repos from the BCB or borrowed from abroad at Libor plus a spread (Figure 12). At end-2014, commercial banks held short spot positions of US\$28 billion, compared with their long spot positions of US\$5 billion in May 2013.
- Overall, commercial banks' net open position currently reaches US\$20 billion, or 0.7 percent of banking system assets.



**16. Corporates, foreign investors, and domestic institutional investors are the main “end-users” of the BCB’s swap program** (Figure 13). As the main beneficiary of a lower cost of hedge, corporates’ long position in FX derivatives totals US\$48 billion, or 44 percent of the stock of outstanding FX swaps. Foreign investors, in turn, hold long positions in FX derivatives of about US\$34 billion; this amounts to about 19 percent of foreign holdings of domestic debt securities. Domestic institutional investors purchase a large share of FX swaps from the BCB but also sell futures and forwards to corporates and foreign investors such as commercial banks, partially dollarizing their portfolios but keeping long positions relatively small at US\$20 billion.



## E. Effectiveness

**17. The intervention program aims at taming volatility in the foreign exchange market.** A key factor in the design of the policy has been the policy's pre-announcement. Both foreigners' and private domestic market participants' demand for hedge increased following Bernanke's tapering speech amid mismatches between local currency assets and foreign currency liabilities on corporate balance sheets (see SIP on corporates). Preannouncing the program aimed at lowering excess volatility by reassuring investors with open FX positions; in addition, the size of the program and the maturity of its instruments likely filled a market gap beyond increasing the supply of hedge at the margin. Figure 14 illustrates that the volatility in the Brazilian real indeed dropped substantially on impact of the program announcement while later program announcements had less discernible effect. In order to substantiate this finding, we move to a simple regression approach.

**18. A simple regression approach is taken to assess whether the BCB achieved its policy objective** (Table 1). We define the dependent variable as the implied volatility in the Brazilian real relative to the implied volatility in the currencies of a number of peers.<sup>15</sup> The data is daily, ranging from January 2010 to March 2014 in the baseline sample and to June 2014 in a robustness check.<sup>16</sup> The main variables of interest are dummies that indicate the time of announcement of the initial program as well as of its extensions. The dummies take the value one starting on the day following the relevant announcement and the value zero before that. The estimated coefficients can thus be interpreted in a cumulative fashion and indicate the contribution of each announcement to the volatility in the Brazilian real relative to peer currencies throughout the remainder of the sample period.<sup>17</sup> Control variables include the Bernanke "tapering" announcement on May 22, 2013, the Federal Reserve's "delay taper" announcement on September 18, 2013, announcements to scale back the IOF tax as well as macro (policy) controls. The latter include the SELIC rate (to proxy for monetary policy) and a consumer confidence indicator (to proxy for volatility resulting from domestic confidence).<sup>18</sup> Finally, alternative regressions 2 and 3 additionally include roll-over announcements by the central bank as controls, and regression 3 extends the sample period to June 2014.

**19. Our findings suggest that the intervention program successfully tamed volatility in foreign exchange markets in the aftermath of Bernanke's tapering speech.** The Bernanke speech on May 22, 2013 increased volatility by between 6 and 9 percent relative to Brazil's peers. In other words, the announcement to taper the Fed's asset purchases had a relatively stronger impact

<sup>15</sup> In principle, this should allow us to rule out global factors that affect all EMs more or less equally as driving the results.

<sup>16</sup> Following June, the volatility in the real reached record levels as domestic factors including the election dominated the picture.

<sup>17</sup> This definition appears appropriate since the outstanding stock of swaps should be what matters for volatility. The reason is that its magnitude determine the share of open FX positions that can be hedged.

<sup>18</sup> Monthly data is transformed to daily data by assuming it to be constant within each given month.

on the *real* than on the currencies of Brazil's peers. Interestingly, even the Fed "delay taper" announcement increased the real's relative volatility by between 8 and 12 percent.<sup>19</sup> At the same time, the regressions suggest that the initial announcement of the intervention program reduced volatility by 13 to 15 percent relative to peers; combined with a further reduction through the December 18 announcement, the program managed to almost entirely offset the excess-volatility effects of the Fed announcements. Interestingly, the announcement of IOF tax reduction on derivatives transactions reduced volatility as well; as did tighter monetary policy, while worsening consumer confidence tended to increase volatility relative to peers. In other words, the effectiveness of intervention can, to a degree, be linked to the presence of other reinforcing policies.

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<sup>19</sup> Since the announcement likely reduced volatility in EM currencies, the coefficient can be interpreted as having reduced volatility in the real by less than for peer currencies.

**Table 1. Explaining Volatility**

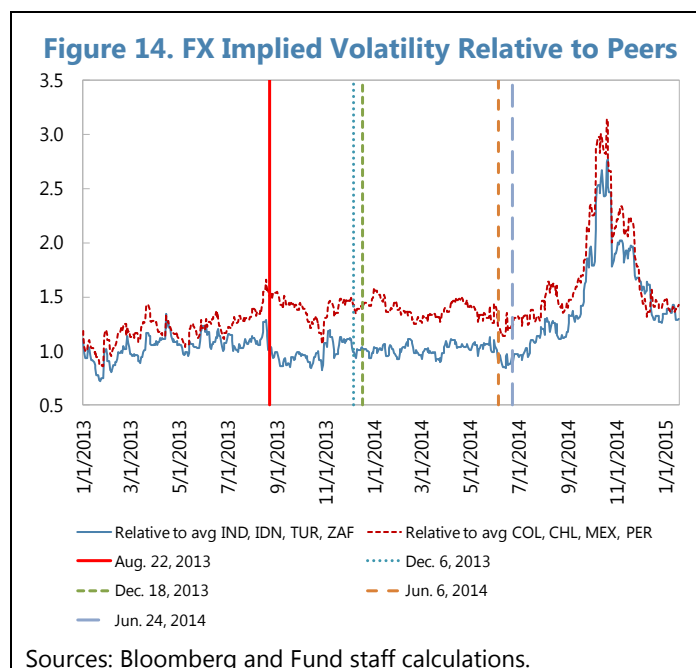
Dependent variable: Implied volatility of Brazilian real as a share of implied volatility in peer currencies

Sample	Jan '13 -Mar '14	#REF!	Jan '13 - Jun '14
Bernanke "tapering" speech 5/22/2013	0.09***	0.07***	0.06***
	0.02	0.02	0.02
Fed "delay taper" policy announcement 09/18/2013	0.12***	0.08**	0.08**
	0.02	0.04	0.04
Program announcement 8/22/2013	-0.13***	-0.14***	-0.15***
	0.02	0.02	0.02
Program extension announcement 12/6/2013	0.03	-0.02	-0.03
	0.03	0.03	0.03
Program extension amount 12/18/2013	-0.06**	-0.02	-0.02
	0.02	0.02	0.02
Program extension announcement 6/6/2014			-0.09**
			0.04
Program extension amount 6/24/2014			0.07**
			0.03
IOF fixed income removal June 3, 2013	0.01	0.01	0
	0.03	0.03	0.03
IOF derivatives removed June 12, 2013	-0.06**	-0.07***	-0.07***
	0.03	0.03	0.03
IOF external removed June 3, 2014			-0.06
			0.08
Selic rate	-0.06***	-0.04**	-0.02
	0.02	0.02	0.02
Consumer confidence indicator	-0.03***	-0.03***	-0.03***
	0.00	0.00	0.00
Rollover announcement 9/13/2013		-0.02	-0.03
		0.04	0.04
Rollover announcement 10/21/2013		0.08***	0.07***
		0.02	0.02
Rollover announcement 11/11/2013		0.02	0.01
		0.02	0.02
Rollover announcement 1/15/2014		-0.04*	-0.05**
		0.02	0.02
Rollover announcement 2/15/2014		-0.02	-0.02
		0.02	0.02
Rollover announcement 3/7/2014		-0.09***	-0.04**
		0.02	0.02
Rollover announcement 4/3/2014			0.02
			0.07
Rollover announcement 5/2/2014			0.01
			0.02
Rollover announcement 5/13/2014			-0.13***
			0.04
Rollover announcement 6/2/2014			0.02
			0.08
Constant	4.54***	4.99***	4.70***
	0.39	0.37	0.36
R-squared			
Observations	0.394	0.487	0.487
Robust standard errors in parentheses	455	455	546

\* p&lt;0.1, \*\* p&lt;0.05, \*\*\* p&lt;0.01

\*\* Peers are defined as Chile, Colombia, India, Indonesia, Mexico, Peru, South Africa and Turkey.

Source: IMF.



**20. However, as volatility subsided in international markets, the extension of the intervention program in June 2014 sent conflicting signals about the program’s objectives.**

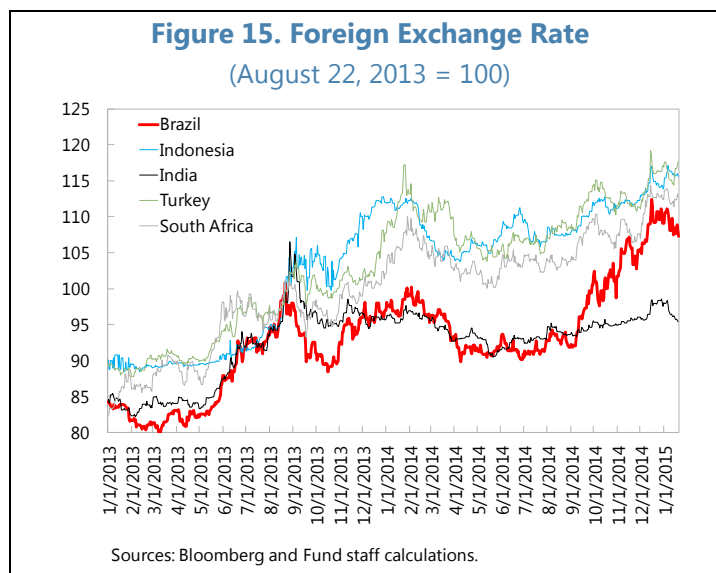
Volatility in global financial markets dropped to lows by mid-2014.<sup>20</sup> Indeed, the regression results in Table 1 suggest that the two announcements regarding the program’s extension in June 2014 reduced volatility only at the margin.<sup>21</sup> One reason may have been the fact that the outstanding stock of FX swaps already accounted for some 80 percent of short term external debt as of end-June 2014. The decision to extend the program therefore raised questions among market participants as to the BCB’s policy objectives and the program’s nature as an extraordinary and temporary measure.

**21. While not an explicit objective of the central bank, the intervention program likely supported the *real* in a very similar way as sterilized spot intervention would have done.** As discussed previously, sterilized spot intervention is effective to the extent that private market participants do not offset the arbitrage opportunity resulting from increasing deviations from UIP following the intervention. If indeed successful, the change in the spot rate feeds through to the forward rate. Assuming that the intervention through NDFs is effective, it would operate as follows: the NDF would directly bid down the forward exchange rate. This provides an arbitrage opportunity as the *cupom cambial* increases, inducing market participants to bring dollar liquidity onshore, thus supporting the spot exchange rate. Ex ante, there is no reason to believe that NDFs would be less

<sup>20</sup> Volatility increased markedly in the second half of 2014, largely as a result of domestic factors including the election.

<sup>21</sup> It is important to highlight that the effect of the various program announcements is cumulative in the present model. In other words, any effect of the June 2014 would have come on top of the effect of the existing announcements.

effective in moving the exchange rate level, especially when derivatives markets are significantly more liquid than spot markets. The FX swap, in turn, is no different from the NDF aside from it being settled in domestic currency. In other words, it is unlikely to affect the exchange rate in a different way as long as convertibility concerns are negligible. Indeed, Kohlscheen and C. Andrade (2013) find that discretionary intervention using FX swaps during 2012 had sizable effects on the exchange rate. A glance at the *real's* evolution relative to peer currencies suggests that the current pre-announced intervention program also strengthened the *real*: it appreciated significantly relative to its peer currencies in the immediate aftermath of the program announcement (Figure 15).



**22. Given that the intervention program was largely pre-announced, however, assessing its impact on exchange rate levels is difficult.** Starting on August 22, market participants would have priced in any pre-announced action by the central bank in advance of it being taken. Even before August 22, market participants may have at least expected a continuation of the discretionary interventions before the pre-announced intervention program was announced. The only elements of discretion for policymakers were the extension announcements in December 2013 and June 2014, as well as the monthly roll-over rates for maturing swaps.

**23. Some elements of surprise are found in the initial program announcement, the announcements to extend the program and in some roll-over announcements.** We use intraday data to search for surprises both on the day of each announcement and on the day the auction was actually implemented (Table 2). These event studies confirm the regression results that the intervention announcements had a significant impact on volatility. The August 22 announcement reduced volatility by about 3 percent within 3 hours and more than 5 percent within 24 hours, and the *real* appreciated by 2–2.5 percent in both forward and spot FX markets within 3 hours and by around 3.5 percent within 24 hours after the announcement. It appreciated a further 1.4 percent once the program was announced to continue on December 6, 2013. The June 6th 2014 announcement to continue the program further appreciated the *real* by about 1 percent. In addition,

announcement effects were observed before and/or after other events, although these are mostly found to be small.

**Table 2. Impacts of Important Announcements of FX Swap Auctions 1/**  
(In percent, the appreciation of the *real* before and after the announcement)

**Announcement: Introduction and Extension of FX Intervention Program**

Announcement Date	Change in Spot Rates					Change in Forward Rates					Change in Volatility					Content of Announcement
	D-24H	D-1H	D+1H	D+3H	D+24H	D-24H	D-1H	D+1H	D+3H	D+24H	D-24H	D-1H	D+1H	D+3H	D+24H	
5-Jun-2013	-0.6	0.3	-0.1	-0.1	-0.3	-0.6	0.3	-0.1	-0.1	-0.4	4.3	0.1	-1.1	-1.6	-4.5	Discretionary FX swap intervention
22-Aug-13	-0.8	0.1	-1.6	-2.2	-3.6	-0.2	0.4	-1.9	-2.5	-3.4	-2.2	0.1	-3.4	-3.2	-5.4	Announcement of pre-announced intervention program
23-Aug-13	-3.5	-0.4	-0.3	-0.4	0.9	-3.5	-0.4	-0.3	-0.4	0.9	-3.2	-0.6	-1.4	-3.2	0.5	First auction under a pre-announced program
5-Dec-13	-0.8	-0.1	-0.1	0.0	-1.4	-0.8	-0.1	-0.1	0.0	-1.4	0.8	0.1	0.1	-1.6	-6.6	Speech by Governor Tombini on extension of the program
18-Dec-13	0.5	-0.5	0.7	1.2	1.1	0.9	-0.3	0.2	0.6	0.3	-3.9	-4.2	0.0	-0.1	0.5	Official announcement of the extension of the program until June 30, 2014
6-Jun-14	-0.7	-0.1	-0.4	-0.8	-0.8	-0.8	-0.1	-0.5	-0.8	-1.0	-12.2	0.0	-0.8	0.3	1.6	Announcement of the extension of the program until end-2014 without details
24-Jun-14	0.3	0.0	-1.0	-0.8	-0.8	0.3	-0.1	-1.0	-0.8	-0.8	2.2	-0.3	-0.1	0.9	-1.7	Official announcement of the extension of the program until the end of 2014

**Announcements: Start or Increase of Rollovers in Each Month**

Announcement Date	Change in Spot Rates					Change in Forward Rates					Change in Volatility					Content of Announcement
	D-24H	D-1H	D+1H	D+3H	D+24H	D-24H	D-1H	D+1H	D+3H	D+24H	D-24H	D-1H	D+1H	D+3H	D+24H	
24-Jun-13	-0.7	-0.1	-0.4	-0.3	-0.6	-0.8	0.0	-0.5	-0.4	-0.7	-2.3	0.2	-2.7	-2.7	-6.0	Rollover on Jul. 1, 2013
17-Jul-13	-1.2	0.0	0.6	0.1	0.1	-0.9	0.2	0.3	-0.3	-0.4	-1.3	-0.3	-0.3	-0.3	-0.7	Rollover on Aug. 1, 2013
16-Aug-13	0.3	0.0	0.1	0.9	1.8	0.3	0.0	0.2	0.9	1.7	0.0	0.1	-0.3	1.2	18.0	Rollover on Sep. 2, 2013
13-Sep-13	0.3	0.0	-1.1	-0.9	0.0	0.3	0.0	-1.1	-0.9	0.0	-5.1	0.4	-2.8	-2.5	-1.1	Rollover on Oct. 1, 2013
21-Oct-13	0.0	-0.3	0.4	-0.1	-0.1	-0.2	-0.4	0.5	-0.1	-0.1	5.8	0.2	2.8	-1.0	-3.8	Rollover on Nov. 1, 2013
11-Nov-13	0.8	0.1	0.3	0.4	0.0	0.8	0.2	0.2	0.3	-0.1	-5.8	0.1	2.6	1.0	-4.1	Rollover on Dec. 2, 2013
6-Dec-13	-1.0	0.1	-0.6	-0.3	-0.6	-1.3	0.1	-0.6	-0.3	-0.5	-6.1	0.0	-0.1	-1.5	-3.1	Rollover on Jan. 2, 2014
15-Jan-14	0.4	0.1	0.1	0.4	0.1	-0.3	-0.3	0.5	0.8	0.6	0.2	0.9	-0.1	0.6	0.2	Rollover on Feb. 3, 2014
5-Feb-14	-0.1	0.1	0.0	0.2	-0.9	-0.5	0.0	0.1	0.4	-0.6	-2.9	0.1	-0.7	-1.8	0.1	Rollover on Mar. 5, 2014
7-Mar-14	1.2	0.1	-0.7	-0.4	0.2	1.1	0.1	-0.7	-0.4	0.2	0.9	0.1	-3.9	-3.1	-2.5	Rollover on Apr. 1, 2014
3-Apr-14	0.5	-0.1	-1.8	-1.8	-1.7	0.5	0.0	-1.8	-1.8	-1.7	-1.6	-0.1	-3.7	-3.4	-3.0	Rollover on May 2, 2014
2-May-14	-0.5	0.1	0.1	0.4	1.0	0.2	0.1	0.0	0.3	0.9	-4.9	0.0	-2.9	-2.8	0.6	Rollover on Jun. 2, 2014
30-May-14	0.8	0.0	0.7	1.2	1.6	0.6	0.0	1.6	2.1	2.1	-2.6	0.2	7.2	18.1	15.4	Rollover on Jul. 1, 2014
2-Jun-14	1.6	0.1	-0.7	-0.5	0.2	2.1	-0.3	-0.4	-0.2	0.5	15.4	1.6	-1.9	-3.3	-1.0	Increase of the rollover amount
1-Jul-14	-0.6	-0.1	0.3	0.6	1.0	0.8	-0.1	0.3	0.6	0.9	-1.0	0.2	-1.3	0.1	0.5	Rollover on Aug. 1, 2014
1-Aug-14	-0.3	-0.1	-0.3	0.2	0.0	0.5	0.0	-0.4	0.1	-0.1	3.1	0.0	-8.3	-7.7	-7.4	Rollover on Sep. 1, 2014
8-Aug-14	-0.5	-0.1	-0.3	-0.2	-0.3	-0.5	-0.2	-0.3	-0.2	-0.3	0.6	0.0	-8.2	-7.6	-8.5	Increase of the rollover amount
5-Sep-14	0.0	0.1	0.3	0.3	1.0	0.1	0.2	0.1	0.2	0.9	-1.0	0.0	1.5	2.0	4.1	Rollover on Oct. 1, 2014
23-Sep-14	0.5	-0.1	-0.2	0.3	-1.0	0.5	-0.1	-0.2	0.2	-1.0	5.3	0.0	1.1	1.2	0.9	Increase of the rollover amount
30-Sep-14	-0.3	0.1	0.3	0.4	1.5	-0.2	0.0	1.0	1.0	2.2	9.8	-0.8	0.1	0.2	0.4	Rollover on Nov. 3, 2014

Sources: Bloomberg and Fund staff calculation.

1/ Yellow, pink, and green color show the appreciation of more than 0, 1, and 3 percent, respectively.



## F. Limits to Intervention

**24. An interesting question is where the limit of the intervention program lies.** The notional value of the outstanding stock of FX swaps stood at some US\$110 billion at end-2014. This is equal to about 29 percent of international reserves. However, because FX swaps are settled in local currency, the stock of reserves is unaffected by FX swap based intervention.

**25. The stock of reserves can be seen as a natural limit for the intervention program.** While FX swaps allow the central bank to intervene in the market without committing foreign reserves, these implicitly serve as collateral for the transaction.<sup>22</sup> Any potential buyer would presumably purchase FX swaps under the premise that both principal and proceeds can be converted into dollars at the time of maturity. If the notional outstanding stock of FX swaps becomes larger than available reserves, the central bank can no longer guarantee that dollar liquidity will be available once the contract matures. Moreover, FX swaps may become unattractive instruments before the notional stock outstanding actually reaches 100 percent of reserves. Historical experience, nevertheless, shows that the central bank has approached this natural limit in the past. In 2003, the ratio of the FX swaps to international reserves reached a high of about 90 percent in March and April, leaving little room for the BCB to intervene further.

**26. Defending the public sector's net creditor position in foreign exchange would likely limit the program at an earlier stage.**<sup>23</sup> A net creditor status can work as an insurance against capital account crises that involve exchange rate depreciations. The higher the net creditor position, the stronger the fiscal position in a crisis scenario, everything else equal. In Brazil, the public sector has held a net creditor position in foreign exchange since 2007. Table 3 illustrates that its positive territory is still comfortable at a surplus of about US\$141.3 billion. Everything else equal, the net creditor position would thus be eroded if the notional value of the outstanding stock of FX swaps reaches around US\$250 billion.

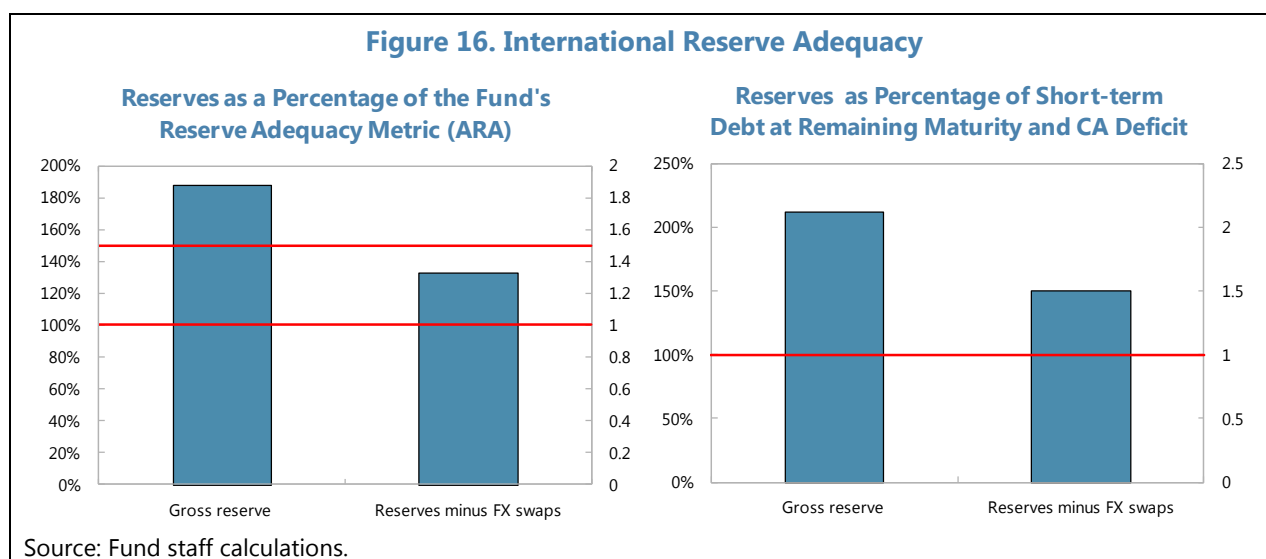
**27. Reserve adequacy would be an argument to limit the outstanding stock of swaps even before the net creditor position is compromised.** To the extent that market participants view reserves as collateral for FX swaps, one may want to examine reserve adequacy after subtracting FX swaps from the stock of reserves. Figure 16 illustrates that reserves are currently more than adequate from the perspective of the Fund's reserve adequacy metric. Even when subtracting the stock of FX swaps, reserves would be well within the adequacy range of 100–150 percent. However, reserves would fall below this range if the stock of FX swaps reaches about US\$180 billion.

<sup>22</sup> Depending on the ability and willingness to roll over hard currency liabilities by Brazilian corporations, and the desire of foreigners to hold on to BRL-denominated debt, further demand for spot dollars could arise as these two agents choose to "un-hedge" their position. Thus we would treat these positions as "contingent" demand of BCB hard currency reserves (Volpon and Lei, 2013 and 2014).

<sup>23</sup> See Bradesco (2014).

**28. Prudential limits on commercial bank balance sheets may constitute another limit to FX swaps based intervention.** As discussed previously, their growing long dollar FX swap position against the BCB has allowed commercial banks to increase their short spot dollar positions to service onshore dollar liquidity needs (Figure 14). While the short spot position is covered by the long derivative position, commercial banks likely face self-imposed prudential limits as to the size of the short spot position they are able to take (Volpon and Lei, 2013 and 2014). If such a limit were to be reached at some point in the future, FX swaps would no longer be an instrument suited to alleviate actual dollar liquidity needs in the market.<sup>24</sup>

**29. The stock of reserves forms an upper limit for the outstanding stock of FX swaps.**



**Table 3. Public Sector Net Creditor Position**  
(In billions of U.S. dollar)

	2010	2011	2012	2013	2014			
					March	June	September	October
International reserves (cash concept) (A)	288.6	352.0	373.1	358.8	363.9	373.5	375.5	375.8
Public sector external debt (B)	103.9	102.4	113.6	118.7	121.4	126.6	129.0	132.5
FX swap (C)	0.0	-1.6	2.1	75.1	87.4	89.9	97.5	102.0
Net creditor position (A-B-C)	184.7	251.2	257.4	165	155.1	157	149	141.3

Source: Authorities' Data.

<sup>24</sup> There are no specific statutory limits to open short USD positions a commercial bank may carry on June 25, 2013 the BCB revoked regulation that stipulated mandatory reserves be collected against short USD spot positions.

## G. Discussion

**30. The intervention program was well calibrated and achieved its objectives.** The BCB used adequate tools to contain excessive exchange rate volatility following the Bernanke tapering speech; preannouncing the program succeeded in lowering volatility by reassuring investors with open FX positions. What is more, the size of the program and the maturity of its instruments likely filled a market gap beyond increasing the supply of hedge at the margin.

**31. However, the program's continued extension raised questions about the BCB's objectives.** The June 2014 announcement to extend the program came in an environment of low volatility and does not appear to have contributed to lowering volatility further. At the same time, the notional value of the outstanding stock of bonds already covered more than 80 percent of short-term debt at remaining maturity. While volatility increased subsequently in an environment of uncertainty in the run-up to the elections, observers increasingly questioned the objectives behind the program extension. Similarly, at the time of the most recent extension at end-2014, the program amounted to US\$110 billion and thus more than 100 percent of short-term debt at remaining maturity, some 60 percent of foreign holdings of domestic debt, 35 percent of non-financial corporate external debt, and about 20 percent of total external debt. The coverage of all four measures of external debt is now higher than during previous FX swap programs (Figure 17).<sup>25</sup>

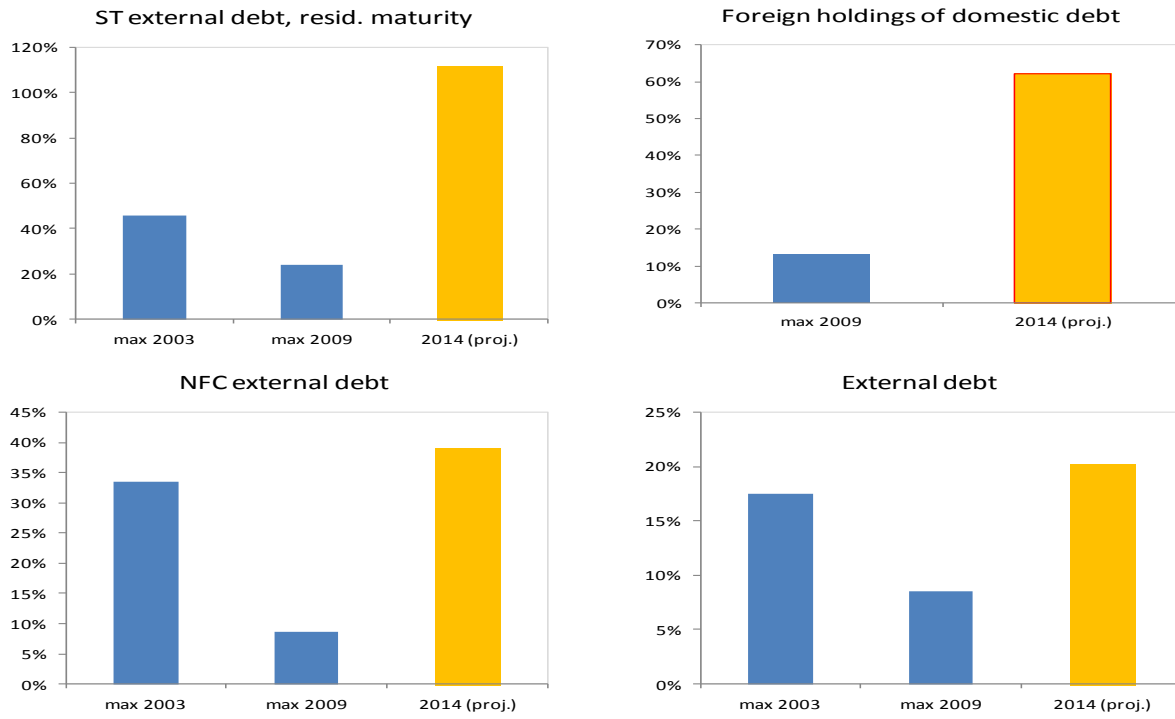
**32. The program may have slowed exchange rate convergence.** According to staff's assessment, the real continues to be moderately over-valued (see external sector assessment). The BCB's intervention program likely contributed to preventing its depreciation to a level in line with fundamentals.

**33. The exchange rate should remain the main external shock absorber, with intervention limited to episodes of excessive volatility.** Volatility in global markets has fallen since the tapering speech in May 2013. Our recommendation is not to continue the program beyond March. Further intervention should be limited to episodes of excessive volatility.

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<sup>25</sup> The stock of FX swaps in 2003 and 2009 is defined as the maximum stock of outstanding notional principal during that the respective year.

**Figure 17. Size of FX Swap to Measures of External Debt**  
(In percent)



Source: Fund staff calculations.

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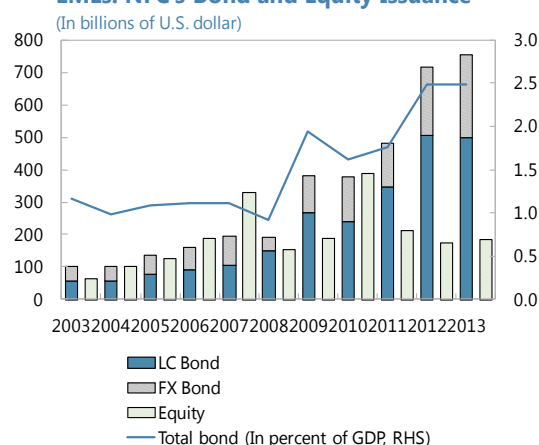
## NON-FINANCIAL CORPORATE SECTOR VULNERABILITIES<sup>1</sup>

*Non-financial corporate (NFC) firms in Brazil have taken advantage of the favorable global financial environment since 2009 by issuing debt at low cost and long maturities. Leverage—already high by international standards—has edged up without translating into higher capital outlays as Brazilian firms built cash cushions instead of augmenting their capital stock. Costly liquidity holdings have contributed to depressing profitability and weakened interest service capacity. The share of external debt has increased, although it remains below the levels attained in the early 2000s and is largely hedged. While corporate non-performing loans (NPLs) remain low at about 2 percent, weak economic activity has already led to an uptick in overdue loans as well as higher expected default probabilities. Furthermore, the recent Petrobras scandal has left related large construction companies vulnerable which can result in adverse spillovers. Sensitivity analysis suggests that Brazilian corporates are particularly vulnerable to a worsening growth outlook, especially when paired with tighter financial conditions. Vulnerabilities are mitigated by strong financial supervision and a well capitalized banking system.*

### A. Global Environment

**1. The search for yield in global financial markets boosted emerging market debt issuance.** The global financial environment of unconventional monetary policies in advanced economies (AMEs) has given NFCs in emerging market economies (EMEs) access to bond finance at unprecedented magnitudes and low rates. Bond issuance has tripled in GDP terms since 2008 amid ample liquidity in financial markets. At the same time, equity issuance remained broadly flat in nominal terms.

**EMEs: NFC's Bond and Equity Issuance**



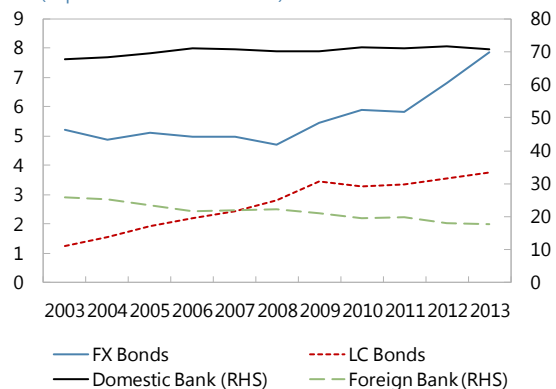
Sources: Dealogic and Fund staff calculations.

<sup>1</sup> Prepared by Heedon Kang and Christian Saborowski.

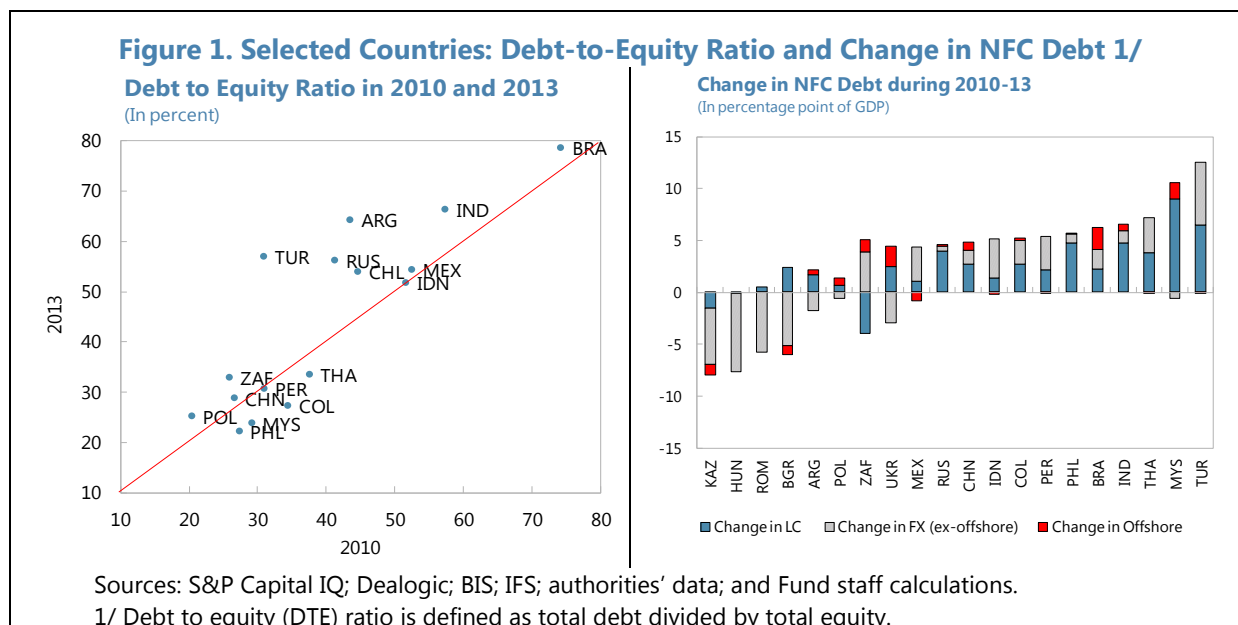
**2. The share of bond finance in total** outstanding **debt increased notably**. The share of bond finance in total NFC debt stocks increased from about 7 percent in 2007 to 11 percent in 2013 as cross-border bank loans dropped following the retrenchment of bank flows from European countries since the global financial crisis. In fact, the marked rise in NFC bond issuance has more than offset the retrenchment in foreign bank financing.

**3. As a result, corporate debt as a share of GDP increased in most emerging market economies (EMEs) since 2007, and by 5 percent or more in about half of the larger EMEs since 2010 alone.** A significant share of this increase is explained by foreign exchange denominated debt, often contracted through offshore issuance of foreign incorporated subsidiaries. Since equity issuance did not keep pace, leverage increased substantially in a number of larger EMEs despite strong valuations (Figure 1).

**EMEs: Average NFC Debt Composition**  
(In percent of total NFC debt)



Sources: Dealogic; BIS; IFS; authorities' data; and Fund staff calculations.



### Box. Data Sources

The paper uses several data sources to take advantage of complementarities. These include Dealogic Analytics, S&P Capital IQ, Worldscope, Economática, Moody's KMV Credit Edge, and data from the Brazilian authorities:

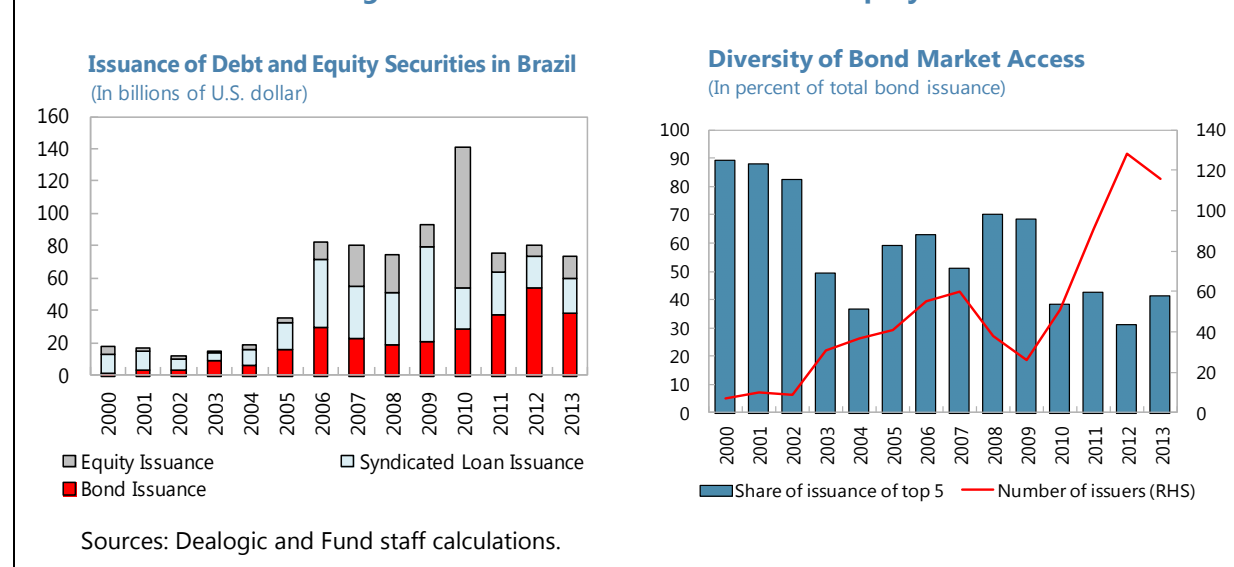
- Dealogic Analytics: the database covers transaction level bond, syndicated loan and equity issuance, including information on maturity dates, currency of issuance and issuer nationality. Information is aggregated at country and sectoral level in the IMF's Vulnerability Exercise Securities Database (VESD).
- S&P Capital IQ: The database contains firm-level balance sheet and income statement information for 693 Brazilian listed companies. It does not include information on foreign currency debt;
- Worldscope: The IMF's Corporate Vulnerability Utility (CVU) provides a template to analyze financial conditions of publicly traded firms listed in Worldscope. The number of Brazilian firms reflected in the data is significantly smaller than those in S&P Capital IQ (225 versus 693 as of 2013). Worldscope data is therefore used only to compare to and complement S&P Capital IQ data;
- Economática and authorities' data: Complementing S&P Capital IQ, data from Economática and country authorities are used to assess Brazilian firms' exposure to foreign exchange risk.
- Moody's KMV Credit Edge: Moody's KMV comprises expected default frequencies (EDFs) for publicly listed companies, where EDF measures the probability that a company will default within a given period;
- In Section 1, to allow for a cross-country comparison, total corporate debt is defined as the sum of outstanding bonds (Dealogic), domestic bank loans (IFS and country authorities), and foreign bank loans (BIS— foreign bank loans to domestic non-banks). In Section 2, the paper uses data on Brazil's corporate debt stock provided by the country authorities

## B. Balance Sheet Developments

**4. NFC bond issuance has boomed in Brazil amid easy global financial conditions, mirroring developments seen in other EMEs** (Figure 2). Total bond issuance more than doubled since 2008 as equity and syndicated loan issuance declined in nominal terms.<sup>2</sup> The bond market boom also increased access to a more diversified variety of borrowers.

<sup>2</sup> Equity issuance spiked in 2010 due to the Petrobras IPO. In September 2010, Petrobras raised about US\$70 billion from a public IPO, selling 2.4 billion common shares for 29.65 *reais* and 1.87 billion preferred shares at 26.30 *reais* per share.

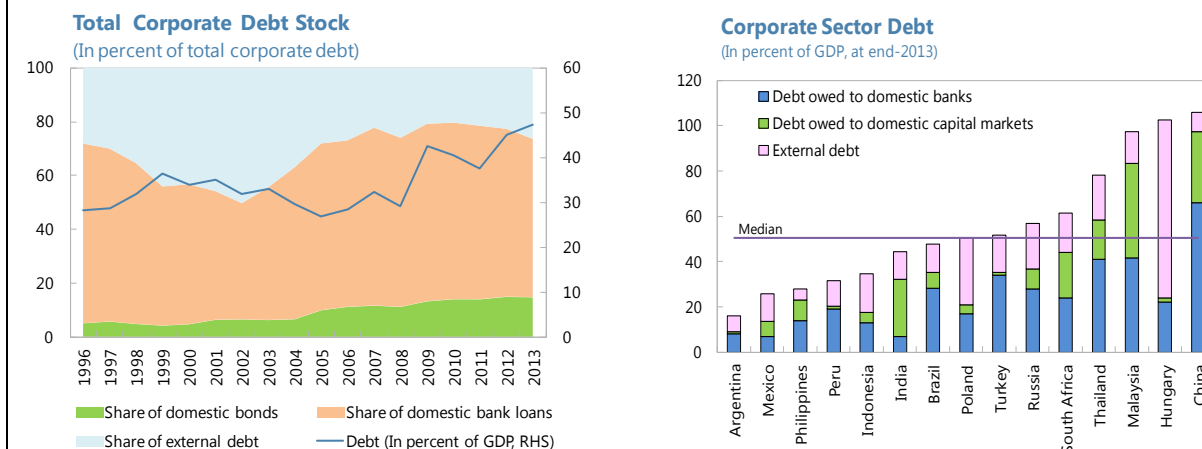


**Figure 2. Brazil: Issuance of Bond and Equity**

**5. Bond issuance contributed to a substantial rise in the stock of NFC debt.** Corporate debt has grown by some 15 percentage points of GDP since 2007 and 7 percentage points since 2010. As of end-2013 and June 2014, it stands at a historical high of 47 and 49.2 percent of GDP respectively. This leaves the debt stock, close to the median among selected EME peers (Figure 3). Domestic bank loans remain the most important component of corporate debt, accounting for about 60 percent. However, the composition of debt has increasingly shifted towards domestic bond markets in recent years. External debt declined as a share of total corporate debt since the early 2000s, but has increased since 2010 alongside other EMEs, in part due to offshore issuance by foreign incorporated subsidiaries (see External Sector Assessment) and depreciation of the *real*.<sup>3</sup> In recent years, the composition of bank loans to NFCs has shifted, with earmarked loans from public banks, in particular BNDES, accounting for a higher share of the total, which tends to be associated with lower rates and longer maturities.

<sup>3</sup> External debt is also subject to relatively low and largely fixed interest rates.

**Figure 3. Brazil and Selected Countries: Corporate Debt**

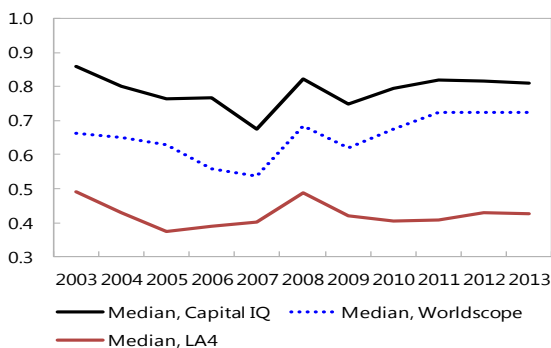


**6. Rising debt, paired with stagnant equity issuance, has led to increasing leverage despite strong valuations (Figure 4).** Brazil's debt to equity (DTE) ratio has increased to about 0.8 according to firm-level data from S&P Capital IQ. While leverage has increased, it is not high when compared to the early 2000s. When compared to EME peers, leverage is—and has historically been – high, not only at the median but also at both the lower and the upper quartile of the distribution. Worldscope, an alternative database for firm-level balance sheet information, similarly documents a considerable increase in the DTE ratio, although 2013 levels here are closer to 0.7.<sup>4</sup> Breaking the sample of companies down into different industries, we find that leverage is particularly high, and has increased most, among firms that belong to “industrials” (e.g. transportation, infrastructure business, and heavy equipment productions) and produce consumer staples. When focusing only on the largest companies, leverage is about as high as for the sample as a whole, although recent dynamics differ somewhat.

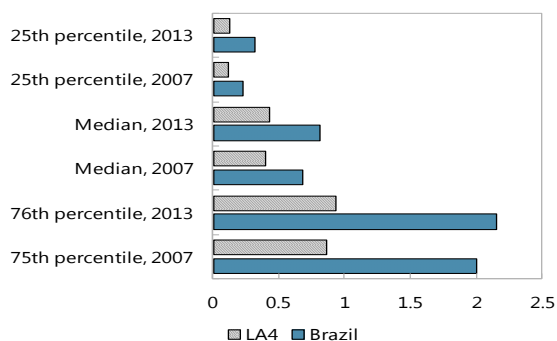
<sup>4</sup> S&P's Capita IQ comprises about 693 Brazilian companies compared to 225 in Worldscope.

**Figure 4. Brazil and Regional Peers: Corporate Leverage <sup>1/, 2/</sup>**

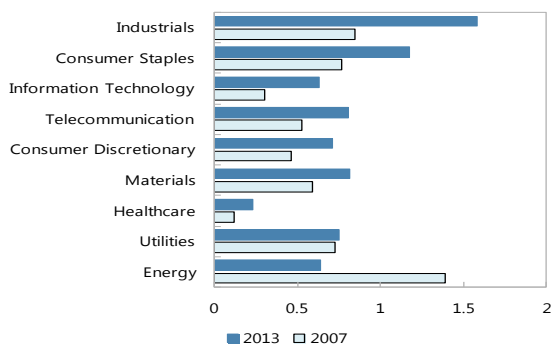
**Debt to Equity Ratio**



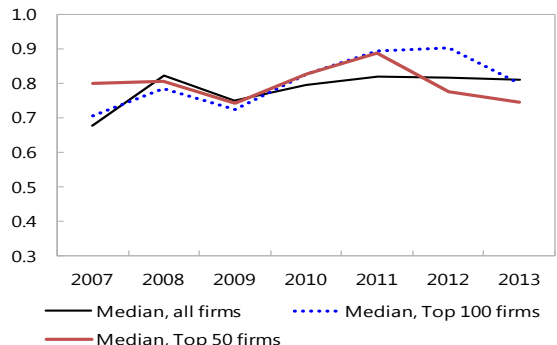
**Debt to Equity Ratio**



**Debt-to-Equity by Industry**



**Debt to Equity Ratio by Samples**



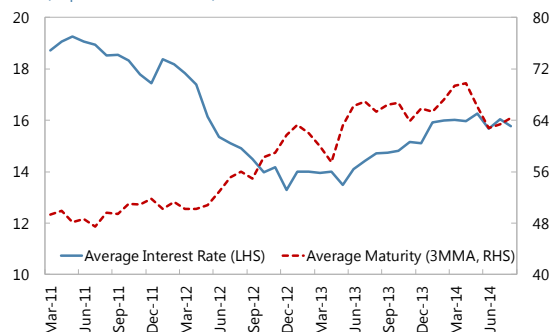
Sources: S&P Capital IQ; Worldscope; and Fund staff calculations.

1/ Debt to equity (DTE) ratios are defined as total debt divided by total equity.

2/ LA4 includes Chile, Colombia, Mexico, and Peru.

**7. Higher leverage has weakened interest servicing capacity since 2010 although it looks much improved compared to earlier years (Figure 5).** The IMF's global financial stability report (GFSR) suggests that corporates are at solvency risk if they operate with an interest coverage ratio (ICR) smaller than 1, and corporates that operate with the ICR smaller than 2 are seen as potentially subject to liquidity risk, given currency global financial conditions. Brazilian firms on average operate with ICRs comfortably above both

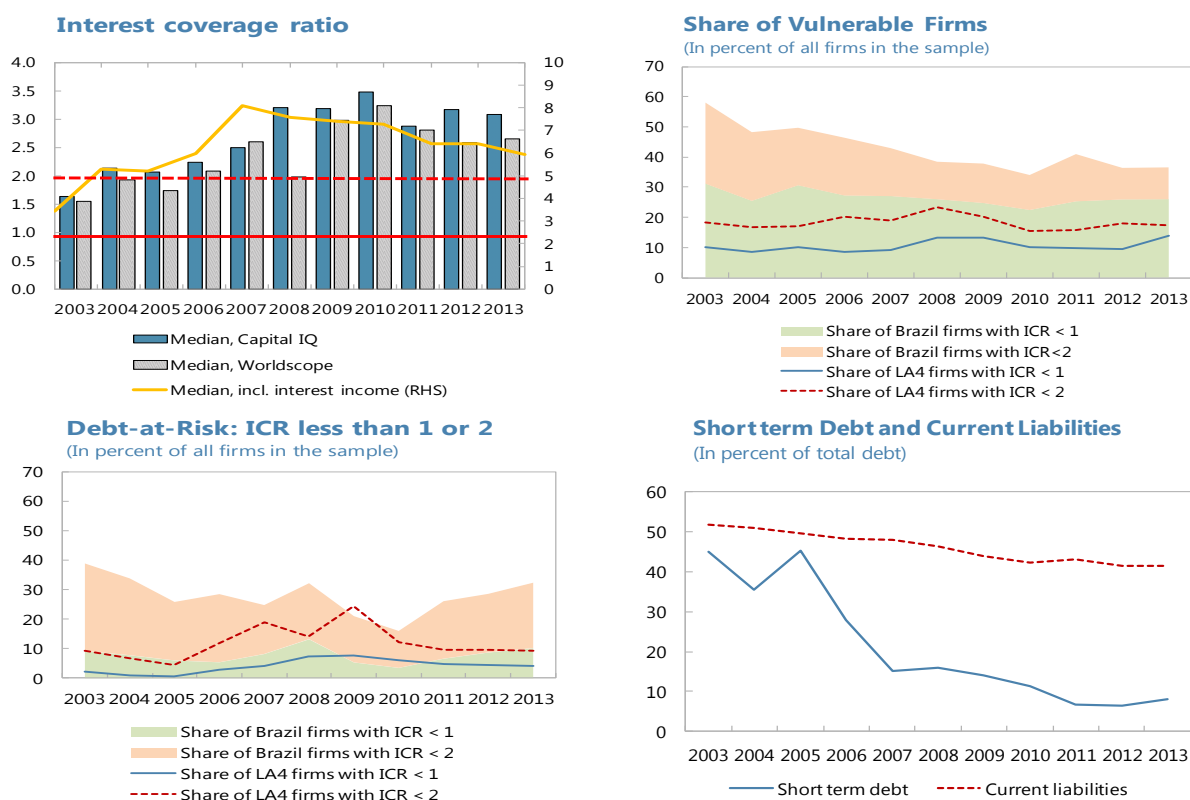
**Interest Rates and Maturity of Bank Loans**  
(In percent and month)



Sources: Central Bank of Brazil and Fund staff calculations.

thresholds, although average ICRs have fallen and remain low compared to peers.<sup>5</sup> The share of firms with interest coverage below 1 was about a quarter in 2013, while the share below the threshold of 2 amounted to about 37 percent. When measured by the share of total debt held by firms below the respective threshold, the picture looks improved, yet still unfavorable compared to regional peers: 10 percent of total NFC debt is held by corporates with ICR below 1, and 22 percent is held by corporates with ICR below 2. At the same time, debt servicing capacity has benefited from an improving maturity structure including due to a favorable shift in firms' liabilities away from short-term debt.

**Figure 5. Brazil and Regional Peers: Interest Servicing Capacity 1/**



Sources: S&P Capital IQ; Worldscope; and Fund staff calculations.

1/ The interest coverage ratio (ICR) is defined as EBITDA divided by interest expenditure.

**8. An interesting finding in the macroeconomic data is that investment failed to recover despite the boom in debt issuance (Figure 6).** Using micro data, this finding is confirmed. The data show that Brazilian firms boosted debt issuance but did not increase capital outlays at the same

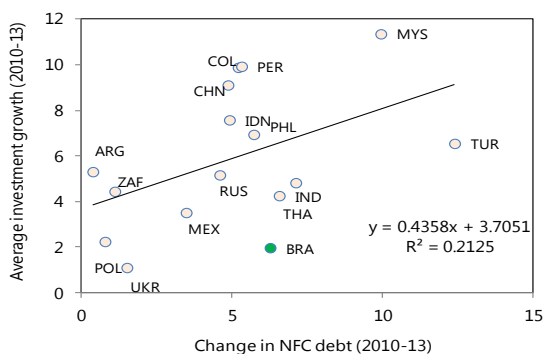
<sup>5</sup> The yellow line in the first chart in Figure 5 illustrates that ICRs are substantially higher in Brazil—closer to 6—when defining the ICR as EBITDA over net interest expenditure. The reason is high liquidity holdings on Brazilian corporates' balance sheets.

pace.<sup>6</sup> Since 2007, the ratio of capital expenditure to total debt has fallen from 26 percent to 10 percent. While a similar development was visible in other countries in the region up until 2009, the bond market boom has boosted investment in these economies since then. Interestingly, capital expenditure to total debt is lowest in industries that are among those in which leverage has increased most, namely industrials and those involved in the production of consumer goods.

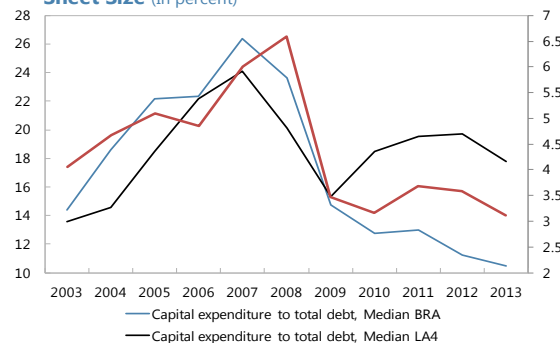
**9. Rather than investing, firms have used proceeds from debt issuance to build up cash cushions.** This behavior is reflected in a markedly higher ratio of cash holdings to gross interest expenditures. Strengthened liquidity positions have enhanced companies' resilience to financial shocks and can be rationalized as an opportunistic build-up in cash positions as pre-financing for expected future (capital) outlays at a time when funding is unusually cheap. However, the higher liquidity also reduces profitability as can be seen by the marked fall in the median return on equity since 2009. Nevertheless, profitability remains strong with a return on equity of about 8 percent and in line with firms in Brazil's peer countries.

**Figure 6. Brazil and Selected Countries: Capital Expenditure and Profitability**

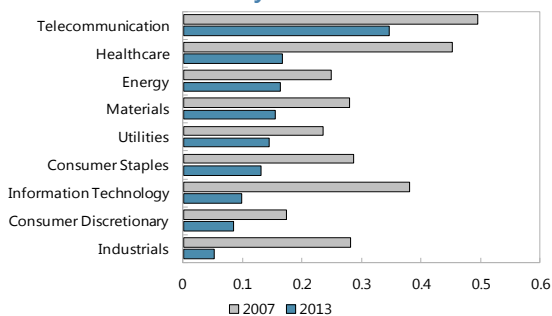
**Investment Growth and Change in Corporate Debt**  
(In percent points and percent)



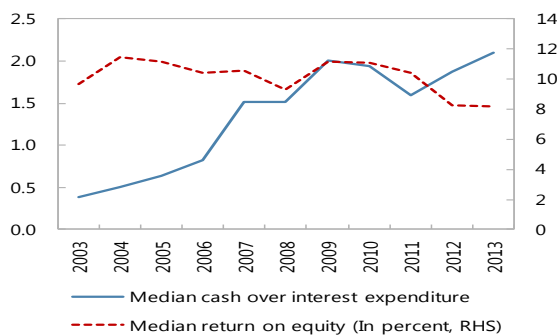
**Capital Expenditure relative to Balance Sheet Size** (In percent)



**Capital expenditure to total debt by industry**



**Liquidity and Profitability**



Sources: S&P Capital IQ; WEO; Dealogic; BIS; IFS; authorities' data; and Fund staff calculations.

<sup>6</sup> A similar picture arises when plotting capital expenditure relative to total assets and the size of a company's balance sheet.

**10. While liquidity holdings may reflect pre-financing of future capital outlays, higher leverage and higher numbers of vulnerable firms could further dampen investment.** Table 1 presents findings from firm-level regressions of the ratio of capital expenditure to total debt. While liquidity holdings tend to be associated with future investment, higher leverage and higher numbers of vulnerable firms would depress capital outlays. Interest servicing capacity appears to matter in a non-linear fashion as a drop below the vulnerability thresholds of 1 and 2 has a more significant bearing on investment than a marginal decrease in interest coverage above these thresholds.

	Reg 1	Reg 2	Reg 3	Reg 4	Reg 5	Reg 6
Lagged total debt over total assets	-1.28***	-1.29***	-1.21***	-1.21***	-1.29***	-1.21***
	0.26	0.27	0.27	0.27	0.28	0.27
Lagged cash over total debt	0.03**	0.03**	0.03**	0.03**	0.03**	0.03**
	0.01	0.01	0.01	0.01	0.01	0.01
Lagged ICR		0	0	0	0	0
		0	0	0	0	0
Lagged dummy for ICR<1			-0.20**	-0.20**	-0.20**	-0.20*
			0.1	0.1	0.1	0.1
Lagged dummy for ICR<2			-0.06	-0.06	-0.06	-0.06
			0.08	0.08	0.08	0.08
Lagged total debt over total equity					0.01	
					0.01	
Lagged ROE						0
						0.06
Constant	0.78***	0.78***	0.80***	0.80***	0.82***	0.80***
	0.09	0.09	0.09	0.09	0.09	0.09
Observations	2761	2761	2761	2761	2761	2761
Robust standard errors in parentheses						
* p<0.1, ** p<0.05, *** p<0.01						

**11. A further implication of the recent bond market boom is the increase in NFC external debt.** The share of external debt in total NFC debt has increased from 20 percent in 2010 to 26 percent in 2013, but remains relatively low compared with that in other EMEs (Figure 7).<sup>7</sup> An important question is the extent to which the growing offshore issuance of foreign incorporated subsidiaries of Brazilian parent companies is reflected in these statistics. In the case of NFCs, offshore issuance is included in aggregate residency based external debt statistics as long as the proceeds return to Brazil as intercompany loans through the balance of payments. As illustrated in the External Sector Assessment, this indeed appears to be the case for the vast majority of such

<sup>7</sup> Less than 1 percent of companies have foreign currency debt, and they account for more than 60 percent of total debt.

issuance.<sup>8</sup> Using micro level data from Economática for listed firms only, the share of foreign exchange denominated debt (FX debt) amounts to about 31 percent, including FX debt raised locally.

**12. FX exposure is largely covered through both natural and financial hedges in Brazil's large foreign exchange derivatives market.** Looking at both listed and unlisted firms with foreign exchange exposure individually (Figure 8),

- Petrobras accounts for some 13.5 percent of total NFC FX debt. It hedged 70 percent of its FX exposure through both domestic and global derivative markets despite ample FX income.<sup>9</sup>
- Other exporting companies account for 36 percent of FX debt.
- Non-exporting companies with at least 80 percent of their FX debt hedged in domestic derivatives markets account for 17 percent of FX debt.
- Non-exporting companies (both foreign-owned and domestic firms) with hedge for less than 80 percent of their exposures account for 33.5 percent of NFC FX debt,<sup>10</sup> or about 10 percent of total debt (Financial Stability Report, September 2014).<sup>11</sup>

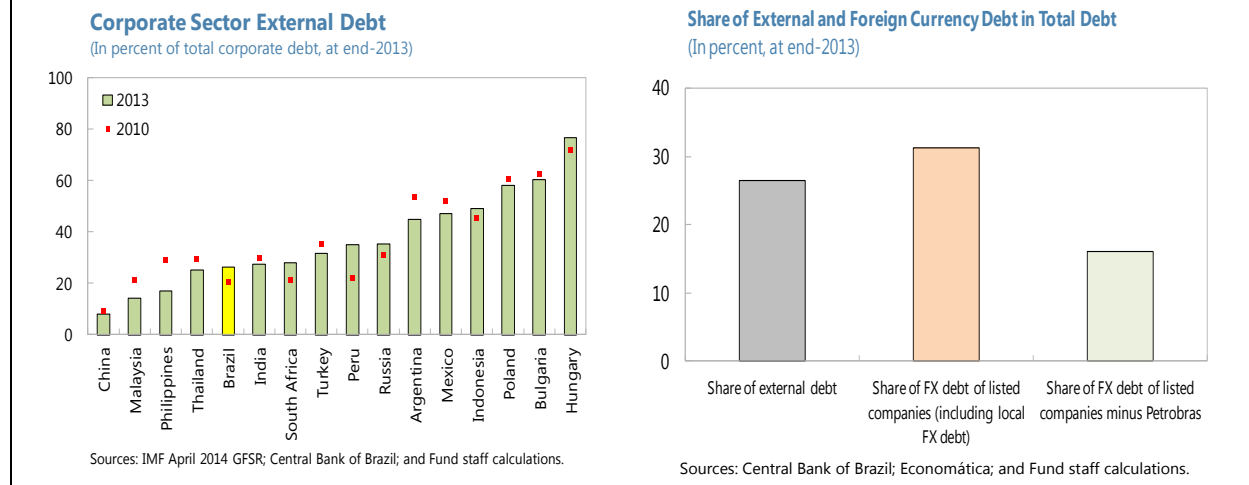
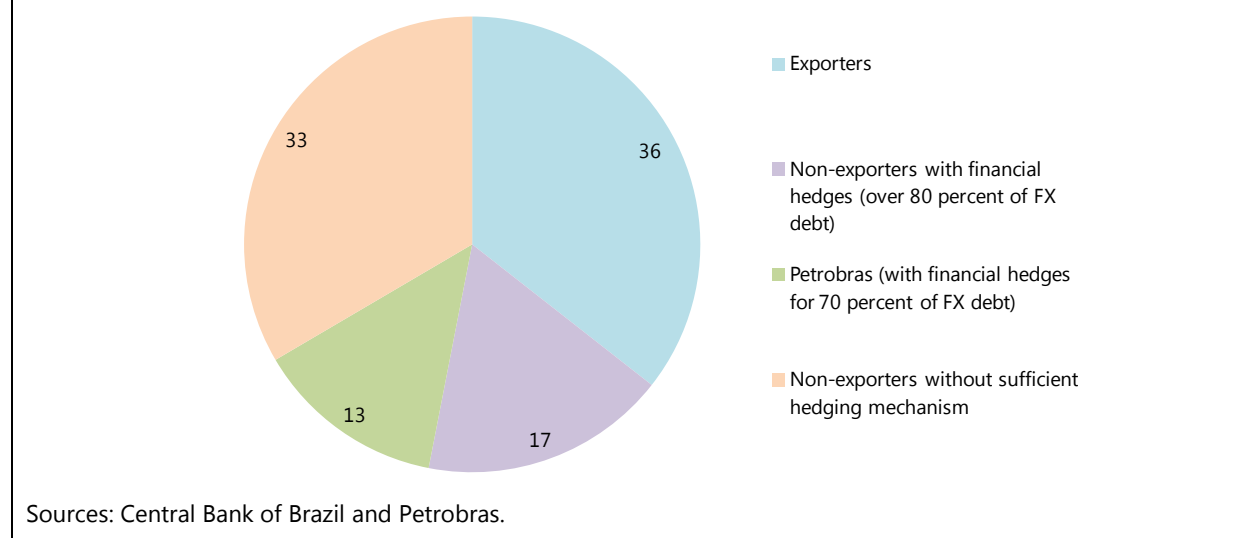
**13. Importantly, the Central Bank of Brazil (BCB) has taken the role of key counterpart to long dollar positions in the domestic FX derivatives market.** As shown in the SIP on the foreign exchange intervention program, the BCB alone has provided hedge for exposures to the tune of US\$ 110 billion as of December 2014. Either directly or indirectly, the BCB is thus the main counterpart of corporate FX hedge in domestic financial markets.

<sup>8</sup> A so far unpublished analysis by the Central Bank of Brazil suggests that about 90 percent of the proceeds of offshore issuance by foreign incorporated subsidiaries of Brazilian firms returns to Brazil.

<sup>9</sup> Note that this analysis takes into account financial hedges in foreign markets only in the case of Petrobras.

<sup>10</sup> In aggregate level, they hedge only about 10 percent of their FX debt.

<sup>11</sup> When excluding foreign-owned companies that may receive intra-group financial support, the share of non-exporting companies without hedge declines to 16.8 percent of total FX debt and 5.8 percent of total NFC debt.

**Figure 7. Brazil and Selected Countries: Corporate External Debt****Figure 8. Brazil: Share of FX Debt by Borrowers with or without Hedging Mechanisms**  
(In percent of total FX debt)

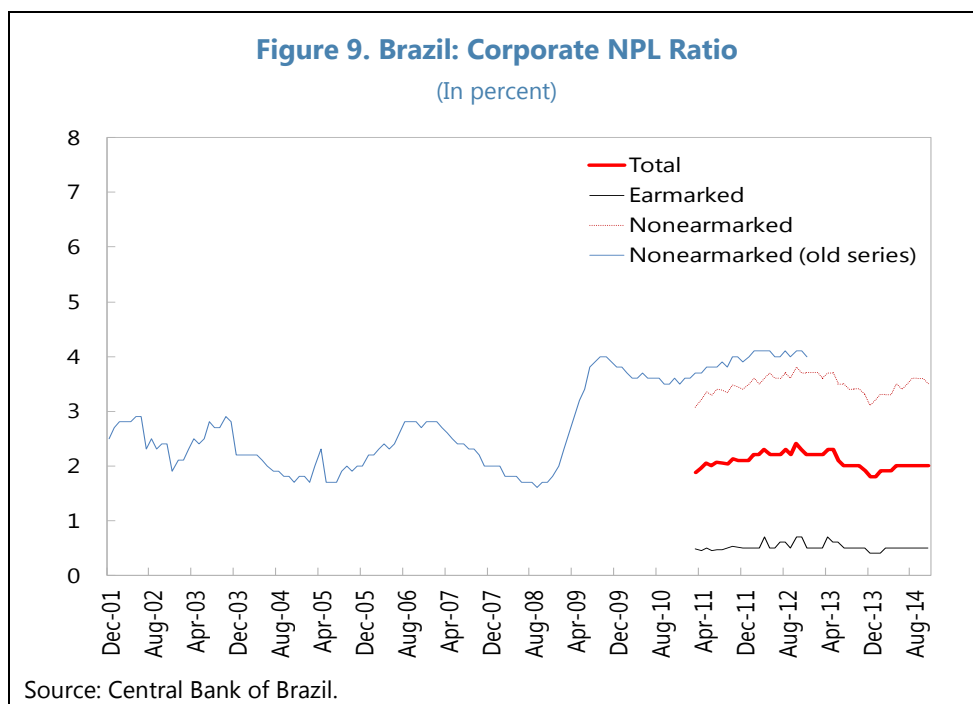
## C. Corporate Defaults

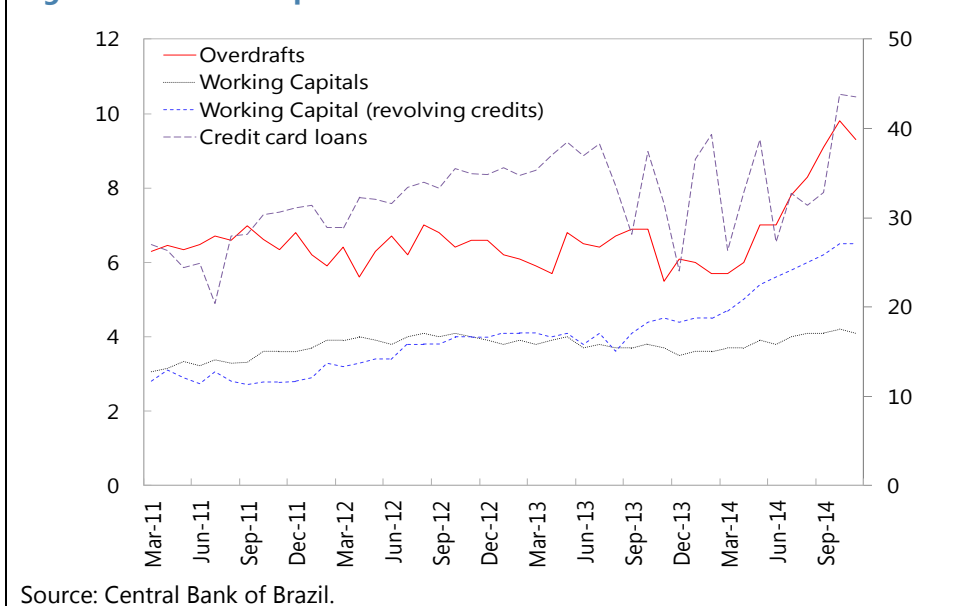
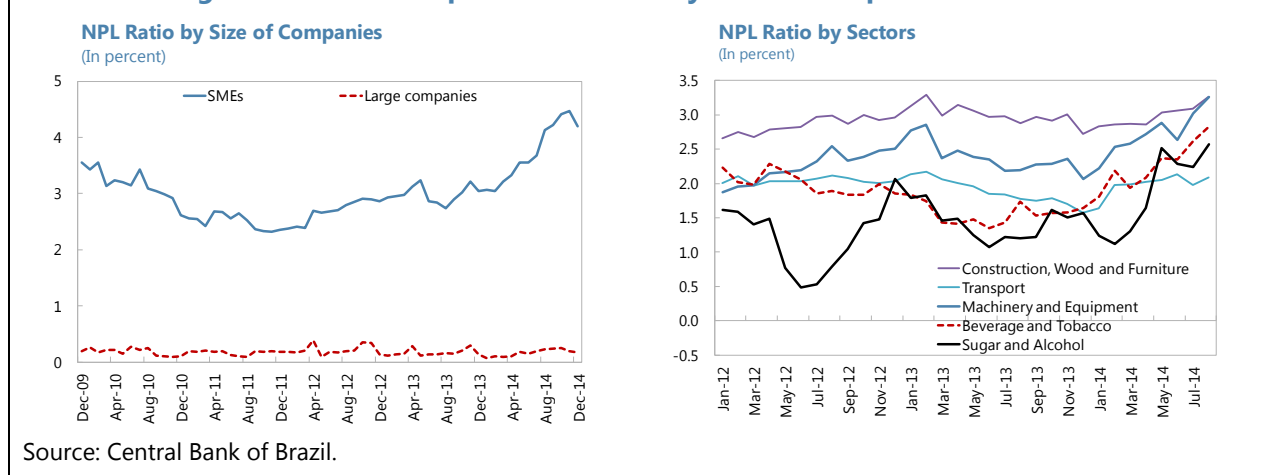
**14. The worsening economic environment has so far only had a limited bearing on corporate defaults.** The overall corporate NPL ratio has remained at a low level of around 2 percent, over the past four years. After peaking at 2.4 percent in mid-2012, the default cycle moved downward (Figure 9). The NPL ratio for earmarked corporate loans—such as rural credits, real estate loans, and BNDES funded loans—has been stable at around 0.5 percent over the same period, irrespective of the economic cycle.



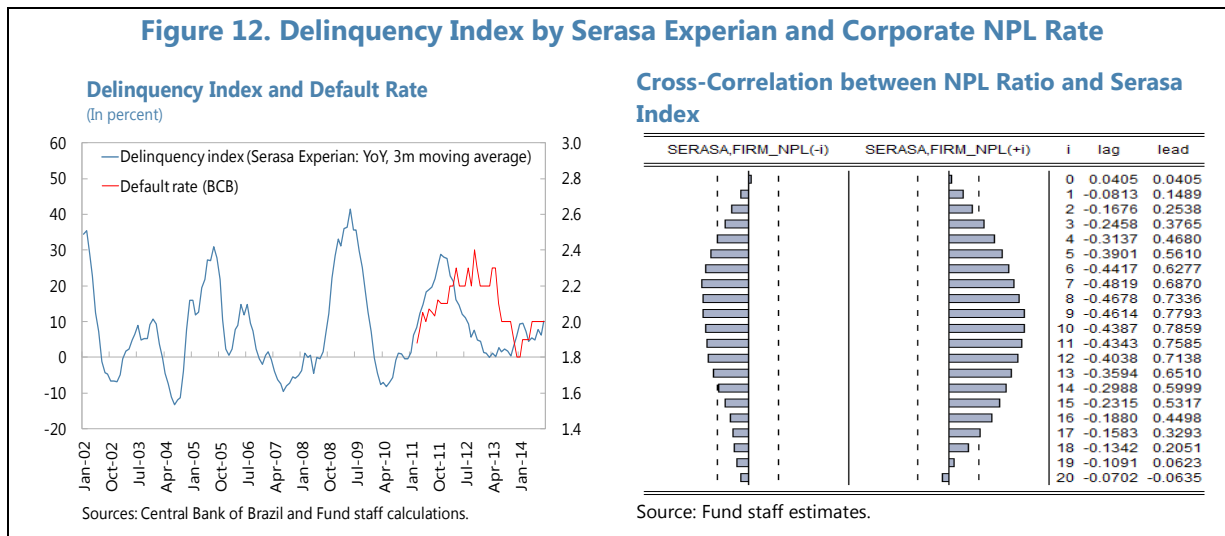
**15. Weak economic activity and tighter financing conditions have, however, led to an uptick in defaults for SME loans and other corporate loan classes.** The prolonged economic slowdown limits corporate profits and increases financial constraints. In response to inflationary pressures, the policy rate was hiked by 375 bps to 11 percent between April 2013 and April 2014 which resumed with a further increase of 125 bps since October 2014, and an interest rate on long-term subsidized loans (known as “TJLP”) was raised by 50 bps in December 2014, increasing refinancing costs for corporate borrowing from banks. NPLs for non-earmarked NFC loans rose from 3.1 to 3.6 percent over the past several months in 2014. The increase in certain loan classes, such as overdraft, credit card loans, and revolving credits, already amounts to 2–20 percentage points (Figure 10). Default rates of SME loans rapidly increased from 2.7 to 4.2 percent since August 2013. NPL ratios increased most among firms that produce industrial goods (machinery and equipments) and consumer staples—sectors that are highly leveraged (Figure 11).

**16. At the same time, companies affected by the Petrobras corruption probe warrant close monitoring.** Prospects of a sustained period of lower oil prices and the ongoing corruption investigation are casting a shadow over Petrobras (see Box 3 in the staff report). Investment plans may need to be revisited, and access to low cost financing represents an important risk. Furthermore, adverse spillovers from the probe to other firms could be significant. Implied default risks among firms in the construction and infrastructure business have already started to increase, in part because the probe could hinder their participation in the infrastructure concessions program. At present, 23 companies have been banned from new contracts with Petrobras. The default of OAS S.A., a major construction firm, highlights the risk that the probe could reduce access to finance both for companies directly involved in the scandal and their suppliers, creditors, and possibly the financial system as a whole (although risks to the banking system appear moderate at this point).



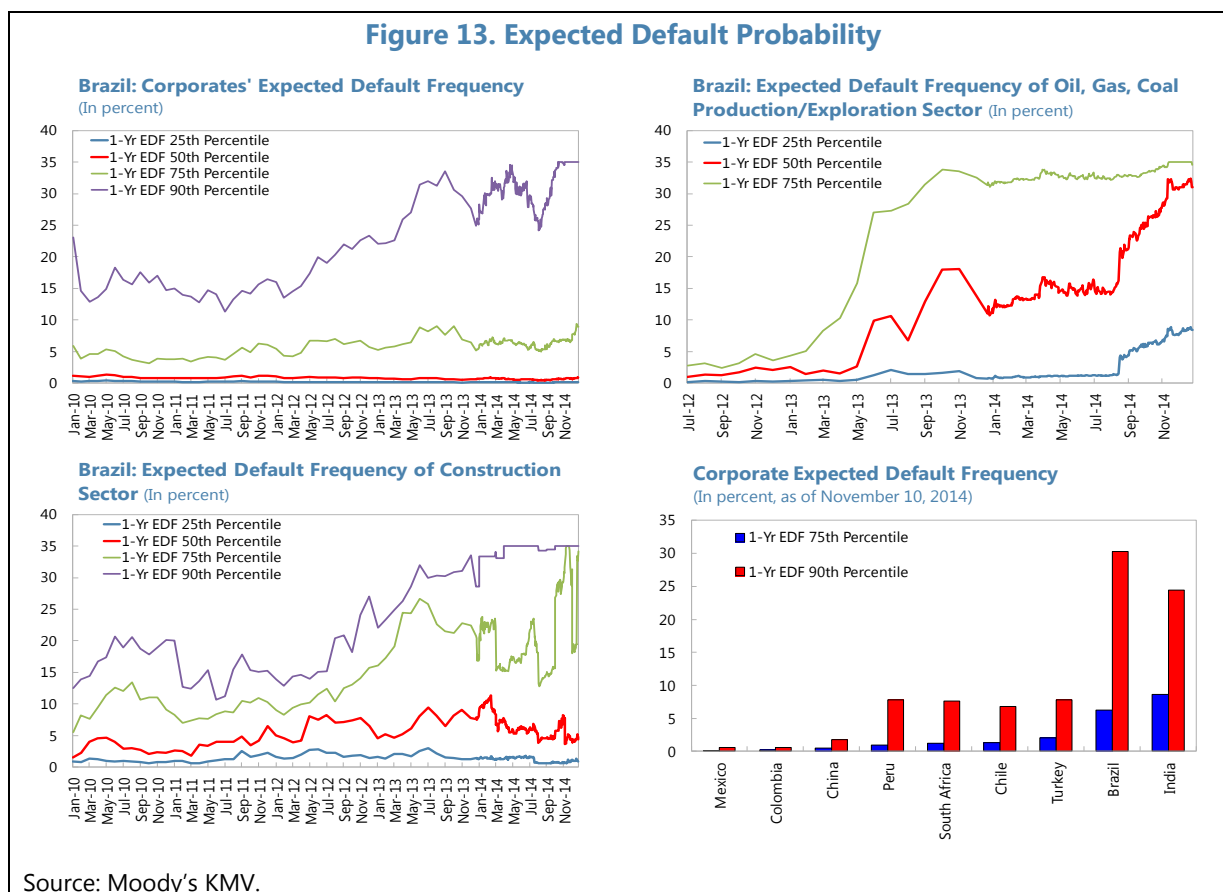
**Figure 10. Brazil: Corporate NPL Rate of Selected Non-Earmarked Loans****Figure 11. Brazil: Corporate NPL Rate by Size of Companies and Sectors**

**17. The monthly delinquency index compiled by Serasa bottomed out in November 2013, suggesting that some pickup in corporate defaults is expected in 2015 (Figure 12).** The delinquency index appears to lead the corporate NPL ratio by about a year. In other words, a new corporate default cycle might be expected from late 2014. The current uptick in the Serasa index seems to be less steep than was the case in previous occasions, reflecting the fact that the share of low risk earmarked loans and long-term loans increased in recent years. Ample corporate liquidity may help mitigate the impacts of slow economic growth and tight financing conditions for some time. The rise of corporate defaults may thus be expected to take place gradually but last for a longer period of time, *ceteris paribus*. However, if the Petrobras event exacerbates, the pickup of corporate defaults can be more rapid than what is expected otherwise.



**18. High-frequency data also confirm that default risk is increasing.** Moody's KMV computes the one-year-ahead probability of default at the firm level. The 25<sup>th</sup> and 50<sup>th</sup> percentile of expected default probability of Brazilian firms in the dataset remain low at less than 1 percent, but the probability for 50<sup>th</sup>, 75<sup>th</sup> and 90<sup>th</sup> percentiles started to rise from September 2014, led by sectors related to the Petrobras probe (Figure 13) (e.g. oil, gas, coal production/exploration sector and construction sector). Moreover, the probability for the 75<sup>th</sup> and 90<sup>th</sup> percentiles exceeds the level in peer countries, pointing to significant stress at the tail of the corporate default distribution.

Figure 13. Expected Default Probability



## D. Sensitivity Analysis

**19. We explore the sensitivity of interest servicing capacity to a set of macroeconomic shocks.** We model three shocks, namely a profit shock, an interest rate shock and an exchange rate depreciation shock. We define all three shocks on the basis of balance sheet information from Capital IQ at end-2013.

**20. The baseline interest coverage ratio is defined as EBITDA divided by interest expenditure.** Depending on the nature of the shock, we calculate its effect on both EBITDA and interest expenditure separately before recalculating the 'shocked' ratio. The profit shock is defined as a percentage shock to EBITDA; the interest rate shock is defined as the impact on short-term (one year) refinancing costs, and is calculated as the percentage point change in interest rates multiplied by the stock of short-term (less than one year) debt outstanding at the end of the previous year.<sup>12</sup> In addition, rising interest rates are assumed to boost the return on financial assets by the same

<sup>12</sup> An important caveat of the analysis is the fact that not all corporate debt is linked to market interest rate developments. Refinancing costs for the share of debt linked to the TJLP would not necessarily change with market interest rates.

increase in percentage points. Finally, the exchange rate shock is defined as an increase in interest expenditure on the share of firms' assets denominated in foreign currency.<sup>13</sup> To account for hedging, we assume earnings to increase by the change in interest expenditure multiplied by the share of foreign currency debt that is hedged.<sup>14</sup>

**21. The sensitivity analysis suggests that Brazilian corporates are particularly vulnerable to a worsening growth outlook.** A 10 percent shock to profits would lower the median ICR to 2.8 while a 50 percent shock would push it below the liquidity risk threshold defined in the GFSR (Table 2). A plausible interest rate shock would have a somewhat less critical impact. The reason is that the share of short-term debt in total debt is relatively small, and the impact is further mitigated by sizable holdings of financial assets on firms' balance sheets. A 30 percent depreciation of the real, in turn, would see the median ICR drop to about 2.4. Finally, a combined shock of significantly tighter financial conditions and lower profits could have a sizable impact on firms' balance sheets. For example, the combination of a 50 percent shock to profits and a 500 bps increase in interest rates would see the median ICR drop to a critical level of 1.3. These would be clearly severe conditions.

**Table 2. Stress Test Results**

		ICR	Share of firms		Share of debt	
			ICR<1	ICR<2	ICR<1	ICR<2
Baseline		3.1	26%	37%	10%	22%
Profit shock	10%	2.8	27%	38%	11%	24%
	50%	1.5	36%	58%	22%	44%
Interest rate shock	500 bp	2.9	26%	38%	10%	19%
Combined shock	25%/500bp	2.3	28%	46%	11%	30%
	50%/500bp	1.3	40%	60%	23%	47%
FX shock	30%	2.4	27%	42%	11%	29%

Sources: S&P Capital IQ and Fund staff estimates.

<sup>13</sup> Note that this shock definition does not encapsulate the impact of exchange rate movements on the amortization of debt principal. Considering debt amortization would require defining the ICR based on EBIT rather than EBITDA. We decided to stick to EBITDA in order to stay with the definition used in the Global Financial Stability Report.

<sup>14</sup> In the absence of firm-level data on currency composition and hedging contracts, we assume that the share of foreign currency debt is equal to the average of around 30 percent, where 70 percent of the foreign currency debt is hedged (see analysis in previous sections).

## E. Discussion

**22. Rising corporate leverage, including through overseas borrowing, should be carefully monitored.** Non-financial corporate (NFC) firms have taken advantage of the favorable global financial environment since 2009 by issuing debt at low cost and long maturities, mirroring developments seen in other EMEs. Leverage—already high by international standards—has edged up without translating into higher investments as firms built liquidity buffers instead of augmenting their capital stock. Costly liquidity holdings have contributed to depressing profitability and weakened interest service capacity. The share of external debt has increased, although it remains below the levels attained in the early 2000s. While the sector appears to be largely hedged, FX exposures should be monitored carefully, in particular if the BCB should decide to reduce its supply of FX swaps going forward.

**23. Brazil's well capitalized banking system and strong financial supervision will help mitigate risks in a context characterized by a weak growth outlook and concerns related to repercussions from the Petrobras probe.** While corporate NPL ratios remain low, weak economic activity has already led to an uptick in overdue loans, especially SME loans, as well as higher expected default probabilities. Sensitivity analysis suggests that Brazilian corporates are particularly vulnerable to a worsening growth outlook, especially when paired with tighter financial conditions. Furthermore, the recent Petrobras scandal has put pressure on the balance sheets of some large construction companies involved in the scandal. Adverse spillovers would impact both suppliers and creditors. Vulnerabilities would be mitigated by strong financial supervision and a well capitalized and provisioned banking system, but careful scrutiny should be in place to assess the economic and financial fallout from the scandal.