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Commodity Price Shocks and Financial Sector Fragility

by Tidiane Kinda, Montfort Mlachila,
and Rasmané Ouedraogo

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IMF Working Paper

African Department

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Prepared by Tidiane Kinda, Montfort Mlachila, and Rasmané Ouedraogo[1]

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Abstract

This paper investigates the impact of commodity price shocks on financial sector fragility. Using a large sample of 71 commodity exporters among emerging and developing economies, it shows that negative shocks to commodity prices tend to weaken the financial sector, with larger shocks having more pronounced impacts. More specifically, negative commodity price shocks are associated with higher non-performing loans, bank costs and banking crises, while they reduce bank profits, liquidity, and provisions to non-performing loans. These adverse effects tend to occur in countries with poor quality of governance, weak fiscal space, as well as those that do not have a sovereign wealth fund, do not implement macro-prudential policies and do not have a diversified export base. These findings are robust to a battery of robustness checks.

JEL Classification Numbers: E30, E44, G38.

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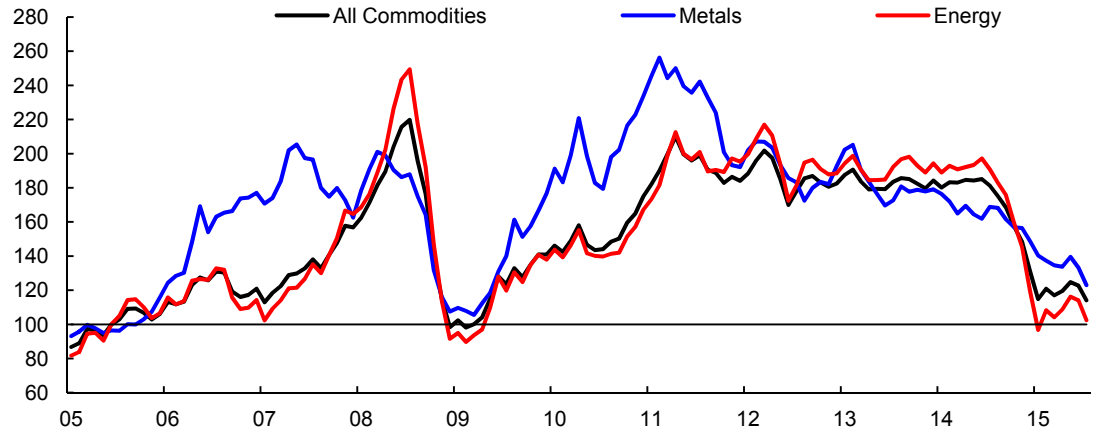
I. INTRODUCTION

The recent decline in commodity prices, especially for oil, has revived once again interest in their economic impact**.** Most commodities prices have declined by about 50 percent between mid-2014 and mid-2015, leading to significant losses in export earnings for commodity exporters (Figure 1). While commodity markets may be undergoing a transition to an era of low prices, such a sharp decline is not unprecedented. The large occurrence of commodity price shocks has led to a large number of studies analyzing the impact of lower commodity prices on various variables such as economic growth (Deaton and Miller 1995, Dehn 2000), debt (Arezki and Brückner 2000, Arezki and Ismail 2013), conflict (Brückner and Ciccone 2009), etc.

Adverse commodity price shocks can also contribute to financial fragility through various channels. First, a decline in commodity prices in commodity-dependent countries results in reduced export income, which could adversely impact economic activity and agents' (including governments) ability to meet their debt obligations, thereby potentially weakening banks' balance sheets. Second, a surge in bank withdrawals following a drop in commodity prices may significantly reduce banks' liquidity and potentially lead to a liquidity mismatch. . If large enough, commodity price shocks can also adversely affect bank balance sheets by weighing on international reserves and increasing the risk of currency mismatches. Third, a decline in commodity prices can reduce commodity exporters' fiscal performance (by lowering revenue), which in turn may push government to adjust their budgets to accommodate revenue shortfalls. Often this can happen in a disorderly manner through the accumulation of payment arrears to suppliers and contractors, who in turn are unable to adequately service their bank loans.

Figure 1. Commodity Price Indices
(2005=100)



Source: IMF, Primary Commodity Price System.

However, the literature lacks a systematic empirical analysis of the impact of negative commodity price shocks on the financial sector**.** The lack of evidence could be due to the lack of data on developing countries (Navajas and Thegeya, 2013) and the imprecise definition of the financial fragility, which is difficult to quantify (Francis, 2003). Financial fragility can be defined as the increased likelihood of a systemic failure in the financial system, for which the most obvious indicator would be a systemic banking crisis. A less dramatic definition of financial fragility could capture the sensitivity of the financial system to relatively small shocks. That said, the corresponding indicator(s) would be relatively more complex and not obvious to construct. The closest existing empirical analysis in the literature examines the impact of terms of trade shocks on the occurrence of banking crises (Demirgüç-Kunt and Detragiache, 2000). The lack of empirical evidence is rather surprising given the growing awareness of financial stability issues in many countries, and the close link between commodity markets and the financial sector.

Using a large sample of commodity exporters among developing economies, this paper highlights that negative commodity price shocks tend to weaken the financial sector and can lead to banking crises**.** The paper attempts to fill a gap in the empirical literature by analyzing the impact of adverse commodity price shocks on the fragility of the financial sector and has three main findings. First, negative shocks to commodity prices tend to weaken the financial sector and increase the probability of banking crises, with larger shocks having more pronounced impact. More specifically, negative commodity price shocks increase non-performing loans and bank costs, reduce the provisions to non-performing loans and bank profits (return on assets and return on equity). Second, these detrimental effects are more common in countries with poor quality of governance, high public debt, and low financial development but are less common in countries under IMF-supported programs, holding sovereign wealth funds (SWF), implementing macro-prudential policies, and with a diversified export base. Third, GDP growth, fiscal performance (fiscal deficit and government revenue), savings, and debt in foreign currency are the main transmission channels of commodity price shocks to the financial sector.

The rest of the paper is organized as follows. Section 2 presents the literature review. Section 3 focuses on measurement issues of commodity price shocks and describes some stylized facts. Section 4 discusses the econometric model while Section 5 presents the empirical analysis and the results. Section 6 provides concluding remarks, pointing out key policy implications of the findings.

II. FROM COMMODITY PRICE SHOCKS TO FINANCIAL FRAGILITY

A. A Brief Review of Related Literature

The literature analyzing the impact of commodity price shocks on financial fragility is rather limited. This section therefore focuses on studies related to the two main components of our

empirical question, namely (i) the effects of commodity price shocks; and (ii) the determinants of financial fragility and banking crises.

Commodity price slumps tend to undermine economic performance. From their seminal papers, Deaton and Miller (1995), and Deaton (1999) show that downturns in international commodity prices led to lower economic growth in 35 Sub-Saharan African commodity exporters. In the same vein, Dehn (2000) found that per capita growth rates were significantly reduced by large negative commodity price shocks in 113 developing countries over the period 1957-1997. The author also highlighted that ex-ante price uncertainty does not affect growth. What matters for growth is the actual realization of negative shocks, not the prospect of volatile world prices. Bruckner and Ciccone (2010) found that not only were commodity price shocks negatively associated with GDP growth, but they also increased the probability of civil war outbreak in 39 Sub-Saharan African countries during the period 1980-2006. Villafuerte and Lopez-Murphy (2010) show that countries' responses to the 2009 decline in commodity prices illustrated pro-cyclical fiscal policies, with most of the fiscal adjustment coming from reduction in current expenditures.

Macroeconomic factors matter for financial fragility. Somewhat closer to our empirical questions, Babihuga (2007) highlighted that macroeconomic factors and banking supervision and regulation matter for financial stability. Using a sample of 96 countries over the period 1998-2005, the author showed that economic growth is negatively correlated with capital adequacy and non-performing loans (NPLs), while higher inflation, unemployment, and real interest rates as well as real exchange rate appreciation reduce bank profits and worsen asset quality. Financial development and better quality of regulatory frameworks and supervision tend to dampen these adverse effects. De Bock and Demyanets (2012) also analyzed the determinants of non-performing loans in 25 emerging countries during 1996-2010. The authors found that GDP growth rates, exchange rates, portfolio and bank flows, and changes in terms of trade are the main determinants of non-performing loans. In 2014, Hà, Triep and Diep studied the macro-determinants of non-performing loans and stress testing of 8 Vietnamese commercial banks' credit risk using a value-at-risk (VaR) approach. They found that GDP growth rate is negatively related to nonperforming loans while lending rate is positively related to them. In contrast, inflation and exchange rate were not found to have a statistically significant impact on nonperforming loans.

Earlier studies focused on the role of macroeconomic factors in the occurrence of banking crises. On a sample of 105 developing countries over 1975-1992, Eichengreen and Rose (1998) found that banking crises in emerging markets are strongly associated with adverse external conditions. Demirgüç-Kunt and Detragiache (2000) showed that banking crisis are negatively associated with GDP growth and real GDP per capita, while real interest rate, inflation, M2/reserves, and credit growth positively affect the occurrence of banking crises. The authors did not distinguish positive and negative shocks and found that terms of trade shocks were not a significant determinant of banking crises. In a follow-up study, Demirgüç-Kunt and Detragiache (2005) confirmed their previous results. Kaminsky and Reinhart

(1999) used a signal approach on a sample of 20 industrial and emerging countries during the period 1970-95 to show that monetary growth, interest rates (both lending and deposit rates), export downturn and the real exchange rate appreciation are leading signals of a banking crisis. Using a sample of 100 countries over the period 1994-2004, Čihák and Schaeck (2007) highlighted that high capital to risk-weighted assets and return on equity as well as higher GDP per capita reduce the probability of occurrence of systemic banking crisis. In contrast, an increase in non-performing loans to total loans and the ratio of M2/reserve is conductive to banking turmoil.

All the aforementioned studies do not focus on resource rich-countries. Moreover, they do not explicitly link commodity price downturns to financial sector fragility. A number of these studies only focus on the macroeconomics determinants of banking fragility, including the terms of trade shocks. Such studies do not really capture commodity exports price shocks since a terms of trade index takes into account both import and export prices. Furthermore, the terms of trade index includes both manufacturing and commodity goods. While some of papers above explore the consequences of commodity price shocks, they do not focus on the financial sector. This paper fills this gap by focusing on the effects of commodity price downturns on financial sector fragility. The impact of commodity price shocks on the financial sector could be either directly or through a number of transmission channels. The next section reviews several of these transmission channels.

B. Transmission Channels

Economic growth and unemployment. Economic growth and unemployment tend to transmit commodity price shocks. A number of papers have found that there is a negative relationship between commodity price shocks and GDP growth (Deaton and Miller 1995, Deaton 1999, Brückner and Antonio Ciccone 2010, Dehn 2000). This is particularly the case for negative price shocks. Dehn (2000) shows that growth rates are significantly reduced by large negative commodity price shocks. For instance, economic activity dropped by 6 percent in Venezuela during the 1998 oil price decline.[2] Demirguc-Kunt and Detragiache (2000), Kaminsky and Reinhart (1999) also showed that higher GDP growth is negatively correlated with the occurrence of banking crises. Blanchard and Gali (2010) found that negative commodity price shocks result in a large rise of the unemployment rate. Makri, Tsagkanos and Bellas, (2014) found that a higher unemployment rate could increase non-performing loans, thereby jeopardizing the health of the banking sector. For instance, unemployment rate increased from 27.7 to 29.3 percent in Algeria during the 1998 oil price decline.

Savings and deposits withdrawals. A fall in export revenues following a price decline may lead to a significant withdrawal of deposits from domestic banks, jeopardizing financial

[2] Source: WEO data.

stability. Cherif and Hasanov (2012) show that if productivity of the tradable sector is low, oil producers would optimally accumulate high levels of savings and invest relatively little in order to protect against excessive revenue volatility. Bems and Carvalho (2011) add that the main explanation is that commodity exporters consider price increases as temporary, and should then build up precautionary savings to address this future uncertainty. If the windfalls are saved in domestic banks, this could threaten the financial sector in case of negative shocks that could lead to sizeable withdrawals. For instance, savings were down from 42.6 to 27 percent of GDP between 1997 and 1998 in Kuwait due to the 1998 price bust, and from 56.6 to 51.9 percent of GDP between 2013 and 2014 because of the recent price decline.

Fiscal performance. It is well-known that changes in commodity prices translate into shifts in fiscal performance (Alesina and others 2008). In other words, fiscal performance in commodity exporting countries depends significantly on commodity prices. A decline in international commodity prices reduces tax revenue and worsens the terms of trade. A negative price shock translates directly into lower revenues, and if there is no fiscal adjustment (e.g., through cutting of non-essential expenditures), it increases fiscal deficits. However, a fiscal adjustment forced by a commodity bust can reduce the incomes of companies that depend on government contracts, and their ability to service their loans, and thereby weakening banks' balance sheets. Governments with weak fiscal space often implement disorderly fiscal adjustments through the accumulation of payment arrears to suppliers and contractors. The combination of loss of tax revenues and competiveness as well as fiscal deficits poses a threat to the financial sector. For instance, government revenue dropped from 40.4 to 34.2 percent of GDP in Angola between 2013. As a consequence, the overall fiscal balance worsened from a surplus of 0.3 percent of GDP in 2013 to a deficit of 4.8 percent of GDP in 2014.[3]

Exchange rate and foreign currency debt. As outlined above, a significant decline in commodity price could result in increasing fiscal deficits and a decline of international reserves. In such a vulnerable fiscal position the government as well as domestic banks may be tempted to borrow in international markets, increasing foreign currency-denominated debt. Vulnerabilities also increase when domestic agents have high levels of foreign currency exposures, e.g., in the form of debt. If domestic banks have large amounts of unhedged foreign currency debt, a sudden depreciation due to a commodity price bust may cause a sharp fall in the net worth of banks, thereby increasing the vulnerability of the domestic banking sector. For instance, debt in foreign currency increased from 23.3 to 33.7 percent over GDP between 2013 and 2014 in Ghana during of the recent decline in oil prices.[4]

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[3] Source: WEO, IMF: https://www.imf.org/external/np/sec/pr/2014/pr14410.htm.

[4] Source: WEO, April 2015.

III. THE IDENTIFICATION STRATEGY

In order to estimate the effect of commodity price shocks on financial sector fragility, we specify two econometric models. This is largely because of the nature of our data which are binary variables for banking crisis data and continuous variables for financial soundness indicators. We use the panel fixed effects method to estimate the effect of commodity price busts on financial soundness indicators. More specifically, we estimate the following equation:

$$FSI_{i,t} = \alpha + \beta PriceShocks_{i,t} + \sum_{m=1}^{M} \gamma_m X_{mi,t-1} + \omega_{it} \quad (1)$$

Where $FSI_{i,t}$ is the financial soundness indicator and $PriceShocks_{i,t}$ represents commodity price shocks. $X_{mi,t-1}$ denotes control variables of interest at time, and ω_{it} stands for the error term including a country-specific fixed effect and an idiosyncratic term. Given that each country in the sample has its own economic, political, and institutional characteristics that are likely to be correlated with the explanatory variables, panel fixed-effects models are more appropriate to estimate the effects of commodity price shocks on financial soundness variables. These techniques allow us to control for the presence of country-specific effects and prevent biased estimates.[5]

Banking crisis analysis is based on a dependent variable that is a dummy taking the value of 1 if there is a banking crisis and 0 otherwise. The identification of the causal effect of commodity price shocks on banking crises is difficult. Confounding, measurement errors, selection bias, and random errors are the main issues. Probit and logit models are among the most widely used members of the family of generalized linear models in the case of binary dependent variables. We estimate the following equations:

$$Bcrisis_{i,t} = \beta PriceShocks_{i,t} + \sum_{m=1}^{M} \gamma_m X_{mit} + \omega_{it}, \quad (2)$$

Where $Bcrisis_{i,t}$ is the banking crisis dummy. As above, X_{mit} denotes the control variables, and ω_{it} the error term.

The conditional fixed effects logit model is more suitable for the banking crisis analysis. Because probit models do not allow controlling for fixed effects, which are important for our analysis as explained above, the paper will rely on logit model. Unconditional models use the least squares dummy variable estimator (as in a linear panel) to estimate equation (2). This could lead to inconsistent estimation of γ in the logit model since we have a dummy dependent variable. Such issue is known on the terms "incidental parameters problem". However, Andersen (1970) and Chamberlain (1980) offer an estimator of the structural

[5] Various autocorrelations tests indicate that there is no serial correlation, making the estimation of a dynamic model with GMM not essential.

parameters that is consistent even in the presence of incidental parameters. This estimator is obtained by conditioning the likelihood function on minimal sufficient statistics for the incidental parameters and then maximizing the conditional likelihood function. This is the conditional fixed effects estimator, which is used in this paper. The conditional fixed effects logit model focuses on the variation in the data observed within countries. To employ the conditional fixed effects logit model, two conditions should be met:

- The dependent variable must be measured on at least two occasions for each country.
- The independent variables must change across time for some substantial portion of the countries.

Both these two conditions are met in the present paper since our study period is 1997-2013 and our control variables are not constant over time. Fixed effects estimates use only within-individual differences, essentially discarding any information about differences between individuals.

A number of explanatory variables are included in equations (1) and (2). Following previous literature on the main determinants of banking crises, we consider the variables that proxy for monetary policy, fiscal policy, macroeconomic policy sustainability and stabilization concerns, and financial sector position. More specifically, we include a change in the exchange rate, real interest rate, inflation rate, M2 over international reserves, credit growth, real GDP per capita, and public debt. National currency overvaluation could lead to the vulnerability of the banking sector since a loss of competitiveness might lead to business failures, and subsequently a decline in the quality of loans. Rising interest rates reduce the value of bonds held by a bank, and force the bank to pay relatively more on its deposits than it receives on its assets, while high rates of credit expansion may finance an asset price bubble that may cause a crisis when it bursts.

Regarding M2/external reserves, the uncertainty about the economic and financial environment could trigger a significant capital outflows, and therefore jeopardize the financial sector. Finally, we include public debt and inflation to control for macroeconomic policy sustainability and stabilization concerns. High public debt signals tighter financial conditions and reduces fiscal space. Indebted countries could be shut out of international financial markets because of recent history of default or high debt, therefore no external credit is available to face problems affecting the banking sector. High inflation can affect a government's ability to adjust to the economic and financial cycle.

As for the identification strategy for the transmission channels, we adopt an approach of two independent steps. First, we estimate the effect of commodity price shocks on each transmission channel. This allows us to state whether the outlined channels hold. Second, we estimate the effects of each transmission channel on the financial soundness indicators. Given that each transmission channel affects the financial sector differently, this second step

clarifies whether a given transmission variable matters for a given financial soundness indicator.

IV. Data, Measurement Issues and Stylized Facts

A. Data

We construct a comprehensive dataset of 71 countries covering the period 1997-2013. The database is compiled from various sources, including the IMF *International Financial Statistics* (IFS) for commodity price indices, and the *World Economic Outlook* (WEO) for various control variables. The United Nation's Comtrade dataset serves as a source for data on export and import by commodity and country during the base year (2005).[6] The World Bank's *World Development Indicators* database and various internal IMF datasets helped in providing additional control variables for our robustness checks. To be included in the sample, each country and commodity should meet the following conditions: (i) the country should be a net exporter of the given commodity during the base year (2005); and (ii) the commodity must represent at least 10 percent of the country's total exports during the base year. The aim of the latter threshold is to include a maximum of countries. Moreover, we focus on non-renewable resources including hydrocarbons (oil and gas), and mineral raw materials.[7] Apart from these criteria, only data availability restricted our sample (see Table A1 in the appendix for a list of countries and commodities).

The availability of financial soundness indicators only during the period from 1997 to 2013 constrains our estimation period. Data on financial sector fragility are from the financial soundness indicators of FinStat (IMF and Bankscope), and systemic banking crisis data are from Leaven and Valencia (2013). Laeven and Valencia (2013) define banking crisis by two types of events: (i) there are significant signs of financial distress in the banking system (as indicated by significant bank runs, losses in the banking system, and/or bank liquidations); and (ii) there are significant banking policy intervention measures in response to significant losses in the banking system.[8] They consider the first year that both criteria are met to be the year when the crisis became systemic.

Due to data limitations on some indicators, we use seven financial stability indicators: (i) bank non-performing loans (NPLs); (ii) provisions to NPLs: (iii) return on assets: (iv) return on equity: (v) cost to income ratio; (vi) liquid assets to deposits and short term funding; and

---

[6] We rely on SITC1 system to extract dollar values of exports and imports of the different commodities..

[7] The list of commodities includes aluminum, coal, copper, gas, gold, manganese, nickel, iron, petroleum, phosphate, silver, tin, and zinc.

[8] Policy interventions in the banking sector are considered as significant if at least three out of the following six measures have been used: (i) extensive liquidity support (5 percent of deposits and liabilities to nonresidents); (ii) bank restructuring gross costs (at least 3 percent of GDP); (iii) significant bank nationalizations; (iv) significant guarantees put in place; (v) significant asset purchases (at least 5 percent of GDP); and (vi) deposit freezes and/or bank holidays.

(vii) regulatory capital to risk-weighted assets.[9] IMF (2011) stressed that banks' non-performing loans to total loans and the ratio of liquid assets to short term liabilities are the most important indicators used by policy makers to monitor the stability of the financial sector. Since *ex ante* it is difficult to establish which indicators matter more for financial fragility, we also generate a composite index using the aforementioned indicators. To this end, we first normalize all these indicators between 0 and 1 so that high values correspond to a sound financial sector and then we compute the mean of these indicators. It is computed so that high values represent the aggregate index of the stability of the financial sector.

Data from additional sources were compiled for further our analysis**.** Transmission channels such as GDP growth, government revenue, overall balance, savings and debt in foreign currency are from the WEO database and unemployment rate is from International Labor Organization database. Governance indicators are from the World Bank's Worldwide Governance Indicators; the degree of democracy—Polity2—from Polity IV project (Marshall and Jaggers 2002) and the investment risk profile is from International Country Risk Guide (ICRG). [10] They are by far the most popular measures of countries' political governance thanks to their coverage and comprehensiveness. Variables capturing IMF programs and sovereign wealth fund (SWF) are dummy variables collected from IMF documents and various sources, respectively.[11] Public debt over GDP is from the database by Abbas and others (2010) while credit to the government and public enterprises is from FinStat (IFS). The classification of exchange rate regimes is from Ilzetzki, Reinhart and Rogoff (2008), and information on the use of macro-prudential instruments are from Cerutti, Claessens and Laeven (2015). We compute the first difference in order to focus on the adoption of new instruments. Information on the diversification of export base is from the IMF.[12] Appendix A3 summarizes the set of data source used in the analysis.

B. Price Shock Measures

The literature has quantified commodity price shocks through two approaches. The first approach uses the change in price as a metric for shocks (Arezki and Brückner 2010, Brückner and Ciccone 2010). This method computes a country specific index by using the following formula:

$$PriceShocks_{i,t} = \sum_{ceC} \theta_{i,c} \, \Delta \log\left(ComPrice_{c,t}\right) \qquad (3)$$

[9] See in appendix for the definitions of these indicators.

[10] These variables are: corruption, government effectiveness, and regulatory quality.

[11] Peterson Institute for International Economics and IMF survey.

[12] https://www.imf.org/external/np/res/dfidimf/diversification.htm.

Where $(ComPrice_{c,t})$ is the international price of commodity c in year t, and $\theta_{i,c}$ is the average (time-invariant) value of exports of commodity c in the GDP of country i.

A disadvantage of this measure is that it does not account for the potential trend related to price change. This method does not attempt to isolate the trend and therefore does not ensure that the price index is stationary.[13] Furthermore, policy makers and company owners could make some forecasts on commodity prices evolution and then act endogenously to the price shock. This means that if they anticipate that the commodity price will decrease, they may accordingly adjust their policies and therefore address the anticipated price bust. Such policies could thus increase the endogeneity of the commodity price shock indices.

The second approach uses a regression that explains the price index by its lags (up to three) and a time trend, and considers the residuals as the shock indicator. This method computes shocks following two steps. In the first stage, a geometrically-weighted price index is computed following Deaton and Miller (1995):

$$PI_{i,t} = \sum_{j=1}^{n} \prod P_{j,t}^{wi,j} \tag{4}$$

Where $PI_{i,t}$ is the commodity price index in country i for the year t; $P_{j,t}$ is the world price of item j at time t and $w_{i,j}$ is the country-specific weighting of the commodity at the base year (the share of commodity j in total exports). As is common in the literature (see Combes and others 2014, Musayev 2014), we take the mid-point of the sample period (2005) as base year. Then the individual 2005 export values for each commodity are divided by this total in order to compute 2005 country-commodity specific weights, $w_{i,j}$.

$$w_{i,j} = \frac{P_j * Q_{i,j}}{\sum_{j=1}^{n} P_j * Q_{i,j}} \tag{5}$$

Where $Q_{i,j}$ denotes the export volume of commodity j at the base year. These values are held fixed over time and applied to the world price indices of the same commodities ($P_{j,t}$) to form the country-specific geometrically-weighted index of commodity export prices ($PI_{i,t}$).[14]

The second step consists of computing the shock variables. More formally, shocks are measured as the estimated residuals of an econometric model of the logarithm of commodity price regressed on its lagged values (up to three) and quadratic time trend as follows: [15]

[13] This is important since price can be I(1) or I(2).

[14] Furthermore, the fact that the decline in a given commodity could be offset by the increase in another commodity is taken in the analysis.

$$lnPI_{i,t} = \alpha_{i,0} + \alpha_{i,1}t + \delta_{i,1}t^2 + \sum_p^3 \theta_{i,p} lnPI_{i,t-p} + \varepsilon_{i,t} \quad (6)$$

The residuals from the equations above are the shocks. By doing so, one *de facto* makes the price shock indices stationary and removes predictable elements from the stationary process.

We build on the second approach in the subsequent empirical analysis because it is more robust and attempts to isolate the trend. Since policy makers can make forecasts on commodity prices, removing the predictable elements up to three years ensures the unpredictability of price shocks.[16] Furthermore, because we focus on commodity price shocks, holding a constant base year deals with shocks from supply side.[17] Musayev (2014) stressed that since the index uses a constant base year, it does not cope well with shifts in the structure of trade. In particular, the index does not capture resource discoveries and other quantity shocks after the base year. Nor does it capture temporary volume shocks other than those which happen to occur in the base year itself. Figure 2 illustrates well how our estimated price shocks capture well observed price changes.[18]

---

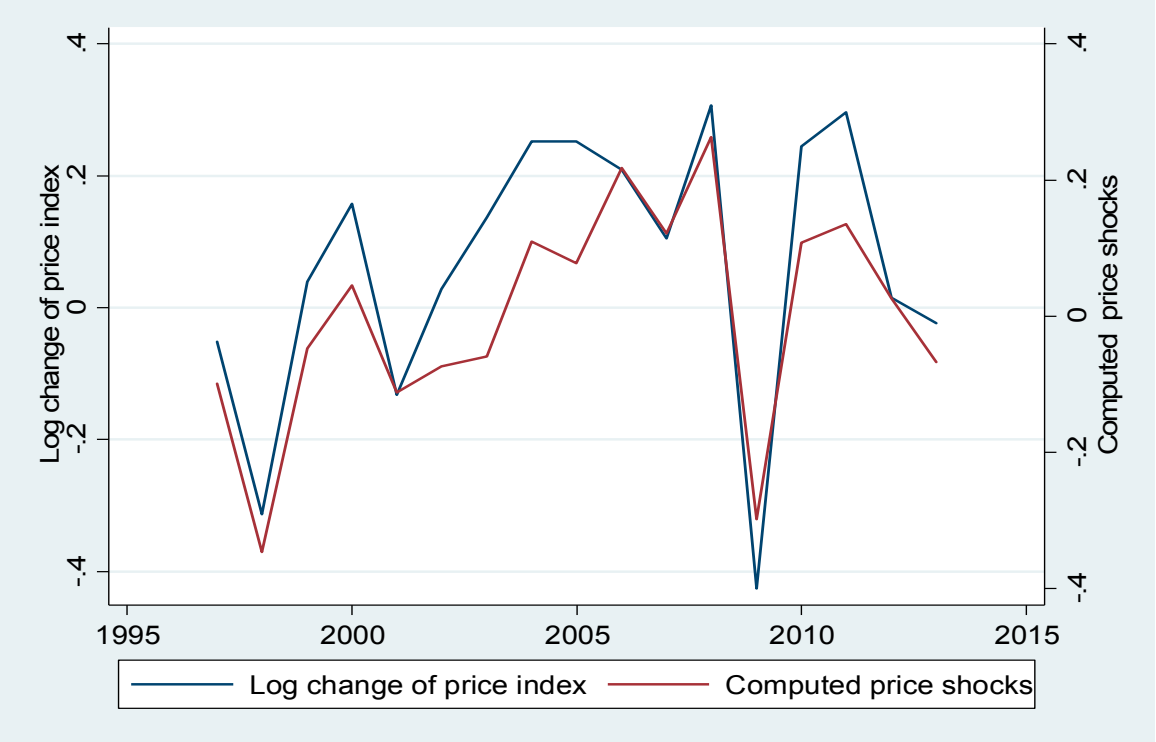
[15] We compared the linear time trend and the quadratic one, and we found that the quadratic time trend fit better the price indices. See in appendix some figures on selected countries.

[16] We will also use the first approach in robustness checks.

[17] Commodity producers could adjust production to price trends. For instance, they could reduce the production of commodities if there is negative price shock and vice versa.

[18] The coefficient of correlation between the logarithm change of commodity price index and the computed price shocks is equal to 0.92.

Figure 2. Evolution of Commodity Prices and the Computed Price Shocks



Sources: WEO, UNCTAD and authors' calculations.

We then normalize the estimated residuals to re-scale them between 0 and 1. Since price shocks are generated country by country, the normalization aims to bring all of them into proportion with one another (see Collier and Dehn, 2001). Furthermore, given the fact that we are mainly interested in commodity price busts, we set up positive shocks to zero and then we normalize negative price shocks so that the new variable increases with the importance of the shock. In section V, we do a robustness check by generating a dummy variable that takes the value of 1 if there is a negative shock and zero otherwise, following Combes and others (2014).

C. Stylized Facts

In this sub-section, we briefly describe some stylized facts on the relationship between commodity price shocks and the fragility of the financial sector.

Commodity price shocks are quite common in developing countries. From 1997 to 2013, there have been 562 country-year cases of positive shocks and 693 country-year cases of commodity price downturns. That said, negative price shocks occur more frequently than price upturns. Do financial soundness indicators react differently to positive versus negative price shocks?

Preliminary evidence indicates that negative shocks to commodity prices tend to worsen financial sector fragility. Figure 3 presents the average of selected financial soundness indicators during negative and positive shocks. It illustrates a more dramatic increase of non-performing loans and banking crises during adverse commodity price shocks, as opposed to positive price shocks. A similar difference can be observed for bank profitability where the decline in return on assets (ROA) and return on equity (ROE) is much larger during price declines.[19]

Adverse commodity price shocks impact the financial sector in all regions and income groups even if the impact varies across groups. Figure 3 shows, however, that the effects vary a great deal across regions, as well as across income groups. Sub-Saharan African countries experienced an increase in NPLs and banking crises, and a drop in ROE, while East Asia and Pacific countries experienced in addition a decline in return on assets. Latin America and Caribbean countries experienced only an increase in NPLs and banking crises. Middle Eastern and North African countries do better since they only suffer a small increase in NPLs. Most of countries of this region are the important oil producers and hold significant fiscal buffers, allowing them to smooth out commodity price declines. Regarding income groups, the effects seem to be the same both in developing and high income non-OECD countries, except for banking crises that seem to be more common in the developing world.

[19] The mean comparison test (t-test) show that the differences are statistically significant for NPLs, provisions to NPLs, return on equity, bank costs and banking crises.

Figure 3. Financial Fragility during Positive and Negative Shocks

Sources: IMF and authors' calculations.

Negative shocks to commodity prices are strongly correlated with financial fragility. Table 1 presents the correlations between adverse commodity price shocks and financial soundness indicators. Non-performing loans, bank costs and banking crises are strongly positively correlated with negative commodity price shocks, while provisions to non-performing loans are negatively correlated with commodity price busts. This is in line with Figure 2 where the three indicators seem to be more sensitive to adverse commodity price shocks. As expected, financial soundness indicators are strongly correlated with each other.

Table 1. Correlations Among Negative Commodity Price Shocks and Financial Soundness Indicators

	Price shocks	NPLs	Prov. to NPLs	ROA	ROE	Cost	Reg. capital	Liquidity	Index	Crisis
Negative shocks	1									
NPLs	0.1971***	1								
Prov. to NPLs	-0.1276***	-0.3493***	1							
ROA	-0.0471	-0.2686***	0.0914***	1						
ROE	-0.0533*	-0.3007***	0.0971***	0.8196***	1					
Cost	0.1114***	0.1816***	0,0054	-0.3883***	-0.3198***	1				
Reg. capital	-0.0176	-0.1151***	-0.0791**	0.3323***	0.2745***	-0.1279***	1			
Liquidity	-0,0162	0,0519	0.099***	0.0789***	0.0485**	-0.0639***	0.3059***	1		
Index	-0,0288	-0.4489***	0.5638***	0.2541***	0.2918***	0.2547***	0.4651***	0.5301***	1	
Crisis	0.1015***	0.2676***	-0,0502	-0.1943***	-0.2007***	0.1808***	-0.1625***	-0,0247	-0.0697***	1

The p-value is shown in parentheses. ***p<0.01, significant at 1%, **p<0.05, significant at 5%, *p<0.10, significant at 10%.
NPLs= Non-Performing Loans; ROA=Return on Assets; ROE=Return on Equity; Reg. capital=regulatory capital ; Index=composite index
Prov. to NPLs= Provisions to non-performing loans

Box 1 discusses the 1998 oil price decline, which led to various bank failures in many commodity-exporting countries. The fall in international oil prices by more than 30 percent between the end of 1997 and during 1998 constituted a serious threat to the viability of the financial sector in many oil-exporter countries.[20] Lower prices resulted in economic crises and high unemployment, forcing some banks to close and leading to governments' bailouts in many cases.

[20] See WEO, October 1998, Chapter 2. Available at https://www.imf.org/external/pubs/ft/weo/weo1098/pdf/1098ch2.pdf .

Box 1. The Oil Price Collapse of 1998 and Financial Sector Fragility

Ecuador
Seven financial institutions, accounting for 25–30 percent of commercial banking assets, were closed in 1998-99. In March 1999 bank deposits were frozen for 6 months. By January 2000, 16 financial institutions accounting for 65 percent of the assets had either been closed (12) or taken over (4) by the government. All deposits were unfrozen by March 2000. In 2001 the blanket guarantee was lifted.

Malaysia
The finance company sector was restructured, and the number of companies was reduced from 39 to 10 through mergers. Two finance companies were taken over by the central bank, including the largest independent finance company. Two banks deemed insolvent—accounting for 14 percent of financial system assets—were merged with other banks. Nonperforming loans peaked to 25-35 percent of banking system assets and fell to 10.8 percent by March 2002.

Nigeria
Twenty eight banks were closed and bank non-performing loans reached 43 percent. While the oil price shock was a catalyst to the closure of the banks, there were a number of existing major banking sector weaknesses such as poor governance, low capitalization, non-observance of prudential regulations, etc. At the same time these bank heavily relied public sector funds as well as foreign exchange trading.

Philippines
After January 1998 one commercial bank, 7 of 88 thrifts, and 40 of 750 rural banks were placed under receivership. The banking system nonperforming loans reached 12 percent by November 1998, and 14 percent in 1999.

Russia
Nearly 720 bank were deemed insolvent. These banks accounted for 4 percent of sector assets and 32 percent of retail deposits. According to the central bank, 18 banks holding 40 percent of sector assets and 41 percent of household deposits were in serious difficulties and required rescue by the state.

Vietnam
Two of four large state-owned commercial banks-accounting for 51 percent of banking system loans- were deemed insolvent; the other two experience significant solvency problems. Several joint stocks banks were in severe financial distress. The banking system nonperforming loans reached 18 percent in late 1998.

Source: Caprio and Klingebiel (1999), World Bank (2003), and Egbo (2012).

V. Empirical Results

A. Baseline Results

Overview

There is strong evidence that negative commodity price shocks weaken the financial sector (Table 2).[21] More specifically, provisions to non-performing loans, return on assets (ROA) and return on equity (ROE) are negatively associated with negative commodity price shocks,

[21] We report at the top of the table the results related to the effects of the current commodity price shocks and at the bottom those of the lagged values.

while non-performing loans are positively associated with adverse commodity price shocks. Furthermore, the composite index measuring the stability of the financial sector declines following negative commodity price shocks.

As a result of this fragility, negative shocks to commodity prices increase the probability of banking crises occurring. The coefficients associated to non-performing loans and provisions to non-performing loans significant at 1 percent level (Table 2, columns 1 and 2, respectively). More specifically, a fall of 3.6 standard deviations in commodity prices, which correspond to a fall of 50 percent in commodity prices similarly to the current prices decline, results in an increase of non-performing loans of 3.5 percentage points and a fall of provisions to NPLs by 41 percentage points.[22] A negative shock in commodity prices reduces economic activity and creates unemployment, which in turn deteriorate the ability of borrowers to service their debts, thereby increasing NPLs. Furthermore the drop in income following adverse commodity price shocks reduces the extent of provisions available to cover non-performing loans.

Regarding bank profitability, we find that ROA and ROE are negatively correlated with negative commodity price shocks ((Table 2, columns 3 and 4, respectively). The coefficients associated with the two variables are statistically significant at 1 percent level. A decline by 50 percent in commodity prices pushes ROA down by 0.4 percentage points and ROE down by 3.7 percentage points. This could be explained by the fact that the fall in economic activities following negative shocks to commodity prices reduces the net income of the banks. Also, the inability of some borrowers to pay back loans cuts banks' profits.

This combination of increasing NPLs, decreasing provisions to NPLs and declining profits raises the fragility of the financial sector and often leads to banking crises. Indeed, the coefficient associated with the composite index is negative and statistically significant at 5 percent level (see Table 2, column 8), while the one associated with banking crises is positive and significant at 5 percent level (see Table 2, column 9). In other words, a one standard deviation increase in commodity price reduces the aggregate index of the stability of the financial sector by 0.34 standard deviation and increases the probability of banking crises occurring by 0.8 standard deviation. However, negative commodity price shocks do not seem to affect bank costs, regulatory capital to risk-weighted assets, and liquid assets to deposits and short-term funding. The coefficients associated to these variables are statistically insignificant.

Negative commodity price shocks have a limited lasting impact on financial fragility. The coefficient associated with commodity price shocks in $t-1$ is only significant and negative

[22] These measures are obtained by multiplying the coefficient estimate by average standard deviation of negative price shocks and the mean of NPLs or provisions to NPLs, and then dividing by the standard deviation of NPLs or provisions to NPLs. This applies to the other figures of this section.

for provisions to NPLs (Table 2, column 2), while the $t-2$ one is significant and positive for NPLs and bank costs to income ratio (see Table 2, columns 1 and 5, respectively). This said, the lasting effects of adverse commodity price shocks are a decline of provisions to NPLs and an increase of NPLs and bank costs. These results are consistent with the current effects of negative commodity price shocks, except bank costs. A fall of 50 percent in commodity price at $t-2$ drives up bank costs by 11.7 percent points. This is largely due to the fact that the banks have to manage higher bad loans without necessarily recovering a lot of them.

Control variables

Other control variables are in line with our expectations. An appreciation of the exchange rate results in an increase of NPLs and a fall in provisions in provisions to NPLs (Table 2). The appreciation of the real exchange rate decreases the competiveness of the economy, causing a loss of income for producers of tradable goods including commodities, which in turn weaken their ability to service their debts. This is in line with previous literature (Klein 2013). The real interest rate appears as an important factor for the financial factor. Indeed, it is positively associated with NPLs, bank costs, and bank crises; and negatively correlated with provisions to NPLs and bank profits. This is consistent with Demirgüç-Kunt and Detragiache (2000). An increase in the real interest rate imposes a burden on debt services which is weighing heavily on the ability of banks' borrowers to service their debt. This also holds for inflation rate and the ratio of M2 to foreign exchange reserves. As expected, the richer the country, the lower the probability of occurrence of banking crises (Demirgüç-Kunt and Detragiache 2000). Furthermore, we found that public debt is positively associated with NPLs and bank costs and negatively correlated with bank crises, and high credit growth tends to reduce financial stability.

Income groups and regions

The effects of adverse commodity price shocks differ across regions and income groups. Table 3 reports results by region and Table 4 by income group.[23] The results are consistent with those presented in Table 2. Negative commodity price shocks affect NPLs (level or provisions to) in Europe and Central Asia, Middle East and North Africa; while they impact bank profits and capital in Asia and Pacific. In Latin America and the Caribbean, negative commodity price shocks affect financial sector health in general, and in particular NPLs (level and provisions to bad loans) and bank liquidity. Adverse commodity price shocks tend to cause banking crises in Sub-Saharan Africa and Latin America and Caribbean, two regions which depend strongly on commodity exports and revenues. Sub-Saharan African countries also suffer from bad loans (high NPLs and low provisions to) following unfavorable

[23] The limited number of observations for low income countries does not allow a separate estimation of this group.

commodity price evolution. Table 4 shows that adverse commodity price shocks increase NPLs and bank costs and push down provisions to NPLs and bank profits in both developing countries and high-income non-OECD countries. While negative commodity price shocks increase NPLs and reduce provisions to NPLs in upper middle- and lower middle-income developing countries, they increase bank costs only in upper middle income countries. Moreover, in emerging markets, negative shocks to commodity prices result in an increase of NPLs and a decline of ROA and provisions to NPLs.

B. Transmission Channels

This section explores the main channels through which adverse commodity price shocks affect the financial sector. As outlined above, we assess the channels of GDP growth, government revenue, fiscal deficits, savings, unemployment and debt in foreign currency. Since these transmission channels could be direct or indirect, we first estimate the effects of negative shocks to commodity prices on each variable and then we estimate the effects of each variable on the financial sector. Results are reported in Table 5 and Table 6.

Adverse commodity price shocks are conducive to financial sector fragility through the transmission channels aforementioned**.** Table 5 shows that negative shocks to commodity prices lower GDP growth, government revenues, and savings (columns 1, 2 and 6, respectively), while they increase debt in foreign currency and unemployment (columns 3 and 4).[24] As highlighted in Section 2, economic slowdown and unemployment, combined with savings withdrawal, and loss of revenue jeopardize the financial sector. Moreover, Table 6 illustrates that the above-mentioned variables affect the financial sector as expected and that the transmission channels vary depending on the financial sector indicator.

Indeed, GDP growth and savings seem to be the transmission channels for NPLs and banking crises occurring since the two variables are negatively and significantly associated with NPLs and banking crises (columns 1 and 9, respectively). In other words, a commodity price bust that reduces GDP growth and savings results in an increase of NPLs leading to a banking crisis. Beyond GDP growth and savings, unemployment, government revenues and debt in foreign currency are additional transmission channels for provisions to NPLs (Table 6, column 2). With respect to banks' profitability, we find that GDP growth is the main transmission channel (Table 6, column 3 and 4), while unemployment is the main one for bank costs (column 5). Government revenues and debt in foreign currency are the main transmission channels for liquid assets to deposits and short-term funding.

[24] Quantitatively, a drop by 50 percent in commodity price busts reduces GDP growth by 1.1 standard deviations, government revenue by 0.3 standard deviation, and savings by 1.6. It increases, debt in foreign currency by 1.6 standard deviations and unemployment by 0.17.

VI. Sensitivity Analysis and Robustness Checks

A. Sensitivity Analysis

Overall approach

Existing policy framework influence how countries absorb commodity price shocks. The recognition that commodity price shocks are an important source of financial fragility raises questions about the appropriate framework to ensure financial stability in face of these shocks. While there is not much that macroeconomic policy can do to prevent commodity price shocks, the impact of these shocks on the banking system will depend upon the economic, financial and political conditions in place when the shocks occur.

We follow previous literature by focusing on what matters for a couple of conditional factors and a given financial soundness indicator. For instance, there is a vast literature on the relationship between banking crises and exchange rate regimes, but not yet on the relationship between NPLs and exchange rate regime. Thus, we prefer estimating whether the effect of commodity price shocks on banking crises is different given the exchange rate regime, rather than estimating for NPLs. This rule holds for the other estimates of this section. This helps us to save space and be in line with previous literature. Then, macro-prudential policies and export diversification are tested for the financial soundness indicators, while all the other variables are estimated for banking crisis.

We first focus on the conditional factors for banking crises. More precisely, we estimate equation (2) for several groups of countries according to their economic policy and institutional setting, such as the presence of IMF programs, sovereign wealth fund, the quality of governance, the level of financial development and debt, and the exchange rate regime. For each variable we estimate equation (2) for countries with strong versus a weak score. First, we divide the initial sample into two subsamples in function of the median score: high-score countries, which have scores above the median and low-score countries, which have scores below the median. Second, we estimate the model in equation (2) for each of the resulting groups of countries, i.e., two subgroups for each variable considered.[25]

Presence of sovereign wealth funds and IMF-supported programs

The results highlight that countries under IMF-supported programs or holding a SWF (or a similar arrangement) are better able to cope with adverse commodity price shocks (Table 7, columns 1-4). IMF-supported programs are typically accompanied by macroeconomic

[25] It is worth noting that we could also estimate these conditional variables by including in equation (6) the interaction between commodity price shocks and each variable and the latter itself, as a control variable. However, the conditional panel fixed effects model requires variations in data which in turn could not be met with some variables as SWF, IMF programs and others. To deal with this issue, the split of the sample into two subsamples appears to be a good alternative.

reforms which are likely to improve the performance of public finances as well as the effectiveness of policies necessary to strengthen financial stability. These programs could also stabilize the banking sector through credit availability and the implementation of macroeconomic policies and reforms. To address commodity prices shocks, many resource-rich countries have set up fiscal institutions over the past decade in the forms of stabilization funds, which seem to help absorb shocks.

Quality of governance

A better the quality of governance helps contain the negative effects of commodity price shocks on banking crises (See bottom Table 7, columns 1-10). Adverse commodity price shocks tend to result in banking crises in countries with high levels of corruption, autocracy, low government effectiveness, low investment profile, and low regulatory quality. In these countries, rent-seeking behavior and the ineffectiveness of the government increases the probability of banking crises in the aftermath of negative shocks to commodity prices. In countries with weak governance, financial fraud and excessive risk-taking may prosper during good times and only become evident when adverse states of nature materialize. For instance, Francis (2003) stressed that good governance plays an important role in promoting financial stability as it affects the performance of the state in executing its core functions and through this, the performance of countries in meeting their main economic and financial goals.

Public debt and exchange rate regime

Negative shocks to commodity prices tend to lead to banking crises in countries with high public debt (Table 7, columns 9-10), while the level of financial development does not seem to matter. As outlined by Ayala and others (2015), financial development *per se* may not ensure financial stability because financial development may increase economic and financial volatility and the probability of a crisis, by promoting greater risk-taking and leverage. On the other hand, higher public debt reduces fiscal space and limits the ability of the government to intervene in the financial sector in order to avoid banking crises occurring in the aftermath of adverse commodity price shocks.

Banking crises are more common in countries with floating exchange rate regime (Table 7, columns 5-6). This is at variance with orthodox theory according to which flexible exchange rates typically have a stabilizing effect on the financial system since the exchange rate can absorb some of the real shocks to the economy (Mundell, 1961). However, as outlined by Demirgüç-Kunt and Detragiache (2005), commodity producers could suffer from more pronounced effects of exchange rate volatility due to their high liability dollarization. In contrast, the lack of an effective lender of last resort may discourage risk-taking by bankers, decreasing the probability of a banking crisis when the country is under a peg exchange rate regime (Eichengreen and Rose 1998).

Macro-prudential policies and exports diversification

Macro-prudential policies are gaining attention internationally as a useful tool to address system-wide risks in the financial sector.[26] Macro-prudential policies act as an important factor for the stability of the financial sector. Macro-prudential instruments cover policies related to borrowers, loans, banks' assets or liabilities, foreign currency credit, reserve requirements and policies that encourage counter-cyclical buffers (capital, dynamic provisioning and profits distribution restrictions).[27] They may act as a tool to monitor the financial sector, therefore reducing the risk-taking and allowing the government to intervene on time.

The results show that negative commodity price shocks increase NPLs and bank costs, and decrease bank profits only in countries without macro-prudential policies (Tables 8). In contrast, countries with macro-prudential instruments are better able to cope with the detrimental impacts of adverse commodity price shocks. The implementation of macro-prudential policy does not matter when it comes to provisions to NPLs as commodity price slumps lower provisions to NPLs in countries with or without macro-prudential policy.

Adverse commodity price shocks tend to lead to financial problems in non-diversified economies. The results also highlight (that the detrimental effects of commodity price shocks are more common in countries with a low diversification of their export base Table 9). A lack of diversification may increase exposure to adverse external shocks and vulnerability to macroeconomic instability (IMF, 2012). While a diversified export base may allow countries to better handle declines in commodity related revenues with alternative sources.[28]

B. Robustness Checks

Our main finding that financial sector fragility increases as a result of adverse commodity price shocks is robust to a battery of robustness checks. We primarily focus on the use of alternative measures of commodity price shocks, subcategories of commodities, and the occurrence, duration, intensity, and instability of commodity price shocks.

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[26] According to the IMF (2011), a large majority (88 percent) of countries uses macro-prudential policy as a formal mandate for financial stability.

[27] We use data from Cerutti, Claessens and Laeven (2015) which in turn is extracted from IMF (2011). The total number of indicators is 60. So they aggregate the different measures along two categories: those aimed at borrowers' leverage and financial positions; and those aimed at financial institutions' assets or liabilities. Instruments are each coded for the period they were actually in place, i.e., from the date that they were introduced until the day that they were discontinued. They then construct binary measures of whether or not the instruments were in place. Like Cerutti, Claessens and Laeven (2015), we do not attempt to capture the intensity of the measures and any changes in intensity over time.

[28] Liquid assets to deposits and short term funding fall in countries with diversified exports. This surprising result will require more investigation.

Alternative measure of commodity price shocks. We test whether our findings are robust to an alternative measure of commodity price shocks. We use the first approach outlined in Section 3. In this case, commodity price shocks are measured as the change in price weighted by the values of the commodities in the GDP of the given country. The results (Table 10) show that our findings are robust. Furthermore, the coefficients associated with commodity price shocks are higher than those of Table 2, except for provisions to NPLs and banking crises. This reflects that the simple measure of shock used tends to capture more variability in commodity prices. Table 10 also highlights that adverse commodity price shocks reduce regulatory capital to risk-weighted assets, and liquid assets to deposits and short-term funding.

Commodity subcategories. We test whether our conclusions depend on the type of the commodity. We choose the dichotomy hydrocarbons and other commodities. Indeed, unlike other commodities which are diverse and produced by many countries, hydrocarbons are produced by fewer countries and they typically play a bigger role in these economies, especially with regard to government revenues. Table 11 shows that our findings remains robust. Adverse commodity price shocks jeopardize the financial sector in both hydrocarbons and non-hydrocarbon producing countries. However, the coefficients seem to be higher in non-hydrocarbon producing countries. Beyond the adverse effects on NPLs and bank profits like in non-hydrocarbon producing countries, negative shocks to commodity prices reduce bank liquidity in hydrocarbons producing countries.

Occurrence of the shocks. We focus on the occurrence of adverse commodity price shocks by generating a dummy variable that takes the value of one if there is negative commodity price shock and zero otherwise. The results (Table 12) confirm that adverse commodity price shocks negatively affect the financial sector. Furthermore, the coefficients associated with commodity price shocks are smaller than when the magnitude of shocks is accounted for (Table 2).

Duration of shocks. So far, we measured the shock on an annual basis. Here, we focus on the long-lasting shocks, i.e., situations where adverse commodity price shocks last more than one year. We aim to isolate temporary shocks and focus on lasting ones which may create tighter economic and financial conditions for commodity exporters.[29] Table 13 shows that long-lasting adverse commodity price shocks also weaken the financial sector. The detrimental effects on banking crises and liquid assets are higher when price busts last at least two years.

Intensity of shocks. Until now, we have considered all adverse commodity price shocks. However, one can assume that their effects could differ depending on whether the shock is small or large. We define different subsamples of extreme observations which give the idea

[29] Because of the limited time span of our sample, long lasting shocks have a maximum duration of two years. Going beyond three years significantly reduces the number of observations, yielding non-significant results.

of extreme shocks. To this end, we compute deciles associated with the negative shocks. Then, for instance, the 50 percent most extreme shocks are those negative observations which exceed the median value of the negative tail. While the results (Table 14) confirm our previous findings, they also highlight that the bigger the shocks, the higher the adverse effects on the financial sector (except provisions to NPLs and bank liquidity).

Instability of commodity price shocks. Here, we assess the effect of price unpredictability on the financial sector. We then use the logarithm of the standard deviation of the residuals series obtained in equation (7) as a measure of price instability. The results (Table 15) confirm our previous findings (except bank costs and liquidity), but illustrate that the level of commodity price shocks matters than its unpredictability. This is consistent with Dehn (2000) who showed that what reduces growth is not the prospect of volatile world prices, but the actual realizations of negative shocks.

Positive commodity price shocks. So far, we have focused on negative commodity price shocks. Here we investigate the effects of positive commodity price shocks on the financial sector. To this end, we redefine commodity price shock indices by setting up negative shocks to zero and then normalizing positive shocks between 0 and 1 so that the new variable increases with the importance of the shock. We then estimate the equations (1) and (2) by using the panel fixed effects model and the conditional panel fixed effects, respectively.

Table 16 shows that positive commodity price shocks improve the performance of the financial sector. More precisely, price increases result in a decline of bank non-performing loans and the probability of banking crises occurring while they raise bank profitability (ROA and ROE) and provisions to bank non-performing loans. Quantitatively, an increase of 50 percent in commodity prices results in a decline of bank non-performing loans by 3 percentage points, and an increase of provisions to bank-performing loans by 18.3 percentage points, ROA by 0.3 percentage points and ROE by 2.4 percentage points. Through a comparison with the case of a fall of prices by 50 percent, we can conclude that negative commodity price shocks hurt more the financial sector than the positive ones improve.

VII. CONCLUSION

This paper has investigated the impact of commodity price shocks on financial sector fragility, an important issue given recent sharp declines in commodity price. The paper presents a more comprehensive analysis of the issue from multiple angles than done so far in the existing literature.

Using a sample of 71 commodity exporters among emerging and developing countries over the period 1997-2013, we show that negative shocks to commodity prices are associated with higher financial sector fragility, as measured by a wide range of indicators. This adverse effect is more evident in countries which are not under IMF programs, do not have sovereign

wealth funds (or similar arrangements), and have poor governance and high debt. At the same time, commodity price shocks increase the probability of systemic banking crises.

The paper also highlights the importance of macro-prudential policies. Indeed, we found that countries implementing macro-prudential policies are better able to cope with the detrimental effects of negative shocks to commodity prices**.** The paper also puts forward the benefits of economic diversification as it shows that the detrimental effects of adverse commodity price shocks occur in countries with low diversification of their export base. Finally, we found that negative price shocks affect the financial sector through lower economic activity (low growth rate and high unemployment), worse fiscal performance (low government revenue), saving withdrawals and increasing debt in foreign currency. Our findings are robust to alternative measures of commodity price shocks, commodity subcategories, and the occurrence of the shocks. They are also consistent for long-lasting shocks and extreme ones.

In terms of policy implications, the findings underscore the necessity of adopting policies to increase the resilience of resource rich-countries. First, developing countries should promote sound economic policies and good governance that will ensure the effective use of natural resource windfalls and build fiscal buffers, including through sovereign wealth funds or similar arrangement. The presence of a sovereign wealth fund can effectively mitigate the impact of commodity price shocks and stabilize the economy. More generally, sound fiscal policy, characterized by low debt levels is an important buffer against exogenous shocks. Second, countries should implement macro-prudential policies in order to limit or mitigate systemic risk. Finally, countries should diversify their production and exports base in order to have more alternative sources of revenues allowing them to deal with the volatility of commodity exports related revenues.

Table 2. Baseline Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	NPLs	Provisions to NPLs	ROA	ROE	Cost	Reg. Capital	Liq. Assets	Index	Crisis
Negative shocks	2.2840***	-16.0300***	-0.5810***	-6.5350***	1,5370	-0,3440	-1.9730	-0.0083**	1.8750**
	(0.65)	(3.82)	(0.18)	(2.52)	(1.05)	(0.41)	(1.21)	(0.00)	(0.78)
Exchange rate, t-1	4.7850**	-16.6900**	-1,1000	-22,0800	4,9110	-2,7760	-0.6880	-0.0133	-0.6720
	(2.03)	(7.39)	(0.69)	(14.47)	(6.07)	(2.11)	(2.18)	(0.01)	(1.12)
Real interest, t-1	0.1160***	-0.8220***	-0.0223**	-0.2310*	0.1380*	0,0009	-0.0502	-0.0005***	0.0977***
	(0.03)	(0.15)	(0.01)	(0.1310)	(0.07)	(0.02)	(0.05)	(0.00)	(0.03)
M2/reserve, t-1	0,0500	-0.7010*	0,0099	0,1010	0.0828	-0,0013	-0.0980**	0,0002	0.3730**
	(0.07)	(0.38)	(0.01)	(0.12)	(0.08)	(0.05)	(0.04)	(0.00)	(0.15)
Inflation, t-1	0,0001	0.0523	0,0051	0,1510	0,0058	0.0388**	0,0300	0,0001	0.0855**
	(0.03)	(0.05)	(0.00)	(0.12)	(0.05)	(0.02)	(0.02)	(0.00)	(0.04)
Credit growth, t-1	-5.0090***	1400	-0,2430	-5,8580	-0,3940	-5.3770***	-6.7660***	-0.0140**	0,0444
	(1.91)	(11.32)	(0.36)	(5.59)	(2.39)	(1.46)	(2.53)	(0.00)	(2.98)
Log(GDPPC), t-1	-1.5950*	-3,6980	-0,1660	0,0153	-2,0160	-0.1780	-6.4890***	-0.0132***	-3.4290**
	(0.84)	(4.03)	(0.21)	(2.93)	(1.43)	(0.48)	(1.19)	(0.00)	(1.54)
Debt, t-1	0.1070***	0.0298	-0,0053	0,0082	0.0696***	0.0218	0,0026	-0.00004	-0.0225*
	(0.03)	(0.11)	(0.00)	(0.08)	(0.02)	(0.02)	(0.02)	(0.00)	(0.01)
Constant	40.9800*	185.1000*	6,0470	15,6500	99.5600***	20.9800*	195.5000***	0.8470***	
	(21.34)	(100.50)	(5.29)	(72.78)	(35.43)	(12.50)	(29.08)	(0.10)	
Observations	457	426	691	691	693	454	697	697	191
Countries	45	45	58	58	58	45	58	58	15
R-squared	0,5800	0,6530	0,2870	0,1830	0,5500	0,5970	0,6480	0,5180	
One-year lagged price shocks									
	NPLs	Provisions to NPLs	ROA	ROE	Cost	Reg. Capital	Liq. Assets	Index	Crisis
Negative shocks, t-1	0,5650	-7.6340*	0,1050	-0.4440	0,5660	0,2470	-1.3720	-0,0017	0,4180
	(0.68)	(4.27)	(0.21)	(2.33)	(1.26)	(0.54)	(1.40)	(0.00)	(0.79)
Observations	469	438	704	704	706	466	710	710	198
Number of id	45	45	58	58	58	45	58	58	15
R-squared	0,5630	0,6400	0,2720	0,1760	0,5460	0,5830	0,6450	0,5110	
Two-years lagged price shocks									
	NPLs	Provisions to NPLs	ROA	ROE	Cost	Reg. Capital	Liq. Assets	Index	Crisis
Negative shocks, t-2	1.0300*	-1.3650	-0.2660	-3.3720	2.4430**	-0.2940	-0.2590	-0,0013	0,989
	(0.56)	(4.17)	(0.17)	(2.45)	(1.14)	(0.39)	(1.28)	(0.00)	(0.73)
Observations	481	450	717	717	719	478	723	723	205
Number of id	45	45	58	58	58	45	58	58	15
R-squared	0,5620	0,6360	0,2700	0,1770	0,5440	0,5700	0,6430	0,5080	
Three-years lagged price shocks									
	NPLs	Provisions to NPLs	ROA	ROE	Cost	Reg. Capital	Liq. Assets	Index	Crisis
Negative shocks, t-3	0,3300	3,5860	-0.0745	-0.6000	1,592	-0.1770	-0.7280	-0,0006	0,465
	(0.58)	(4.39)	(0.15)	(1.78)	(1.16)	(0.40)	(1.19)	(0.00)	(1.40)
Observations	469	441	684	684	686	467	689	689	142
Number of id	45	45	58	58	58	45	58	58	11
R-squared	0,5950	0,6490	0,3540	0,2280	0,5460	0,5740	0,6470	0,5620	

Note: All control variables and fixed effects are included. Robust standard errors in parentheses

***p<0.01, significant at 1%, **p<0.05, significant at 5%, *p<0.10, significant at 10%.

Table 3. Baseline Results, by Region

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	NPLs	Provisions to NPLs	ROA	ROE	Cost	Reg. Capital	Liq. Assets	Index	Crisis
Sub-Saharan Africa									
Negative shocks	2.8700**	-7.8850*	-0.2070	-3.9020	0,9470	-0.9380	0,6120	0,0021	2.7690**
	(1.18)	(4.44)	(0.24)	(4.80)	(1.64)	(0.78)	(2.09)	(0.00)	(1.36)
Constant	6.7140***	70.8100***	2.0630***	19.8000***	60.27***	16.2500***	42.1400***	0.5280***	
	(0.57)	(2.35)	(0.09)	(1.35)	(0.926)	(0.36)	(1.33)	(0.00)	
Observations	99	79	311	311	316	100	317	317	71
Countries	10	10	18	18	18	10	18	18	4
R-squared	0,4450	0,5150	0,1640	0,0340	0,4120	0,5210	0,5410	0,2960	
East Asia and Pacific									
Negative shocks	4,2600	-2.1350	-1.2970*	-25.1700*	3,351	-2.7190	1,2740	-0,0107	1,3680
	(3.46)	(8.12)	(0.66)	-14,24	(2.12)	(1.64)	(1.82)	(0.01)	(0.87)
Constant	8.4320***	55.3600***	1.2100***	13.3400***	53.8100***	16.5800***	30.5000***	0.4990***	
	(1.79)	(4.74)	(0.18)	(3.39)	(1.20)	(0.48)	(1.04)	(0.00)	
Observations	53	51	98	98	97	53	99	99	76
Countries	4	4	6	6	6	4	6	6	4
R-squared	0,1140	0,2420	0,0840	0,0930	0,6540	0,0870	0,4190	0,0700	
Europe and central asia									
Negative shocks	4.5940**	-5.7550	-0.5080	-9.0890	3,299	0,9700	3,1870	-0,0006	9,4730
	(1.80)	(6.66)	(0.88)	(8.75)	(2.27)	(1.3)	(2.58)	(0.01)	(7.91)
Constant	7.2810***	58.6300***	2.0120***	12.0800***	58.2100***	21.7***	44.4200***	0.5340***	
	(0.97)	(4.58)	(0.26)	(2.12)	(1.13)	(0.721)	(1.48)	(0.00)	
Observations	95	85	148	147	152	105	152	152	66
Countries	10	10	10	10	10	10	10	10	4
R-squared	0,4160	0,4810	0,1120	0,0860	0,1650	0,4320	0,3230	0,2520	
Latin America and Carribean									
Negative shocks	1.7670*	-34.9300***	-0.2820	-2.0360	3,5200	0.1230	-6.6630**	-0.0211***	1.0940*
	(0.98)	(8.96)	(0.29)	(2.85)	(2.55)	(0.54)	(3.12)	(0.00)	(0.59)
Constant	5.5260***	140.1000***	1.2670***	12.0400***	65.9200***	14.7700***	34.9400***	0.5360***	
	(0.64)	(5.44)	(0.19)	(1.88)	(1.31)	(0.27)	(1.90)	(0.00)	
Observations	124	124	175	175	176	118	176	176	127
Countries	10	10	11	11	11	10	11	11	8
R-squared	0,1560	0,3040	0,2970	0,2620	0,3030	0,3450	0,4770	0,4090	
Middle East and North Africa									
Negative shocks	4.1270**	-5.2780	-0.1520	-1.3530	4,226	-0.9940	-2.3220	0,0021	
	(1.63)	(4.03)	(0.11)	(2.57)	(3.78)	(0.86)	(3.63)	(0.01)	
Constant	11.7500***	68.7200***	0.8190***	8.6710***	47.2800***	16.7600***	52.2400***	0.5220***	
	(0.84)	(2.08)	(0.08)	(1.78)	(2.75)	(0.47)	(2.12)	(0.00)	
Observations	57	57	123	123	124	57	126	126	
Countries	5	5	7	7	7	5	7	7	
R-squared	0,3740	0,3110	0,3080	0,2790	0,0760	0,7580	0,6530	0,4830	

Robust standard errors in parentheses. Fixed effects are included

***p<0.01, significant at 1%, **p<0.05, significant at 5%, *p<0.10, significant at 10%.

Table 4. Baseline Results, by Income Group

				Developing countries					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	NPLs	Provisions to NPLs	ROA	ROE	Cost	Reg. Capital	Liq. Assets	Index	Crisis
Negative shocks	3.2330***	-15.2900***	-0.3850*	-6.3630**	2.5290**	-0.4110	-0.6810	-0,0051	1.5420***
	(0.73)	(3.67)	(0.19)	(2.82)	(1.06)	(0.45)	(1.22)	(0.00)	(0.42)
Constant	7.3740***	87.6900***	1.6000***	14.4900***	58.5600***	17.2500***	41.1900***	0.52700***	
	(0.40)	(2.22)	(0.07)	(0.88)	(0.64)	(0.23)	(0.75)	(0.00)	
Observations	431	399	872	871	883	436	888	888	359
Countries	40	40	53	53	53	40	53	53	21
R-squared	0,3690	0,6260	0,1650	0,0840	0,3790	0,5630	0,5690	0,3470	
				Emerging Markets					
VARIABLES	NPLs	Provisions to NPLs	ROA	ROE	Cost	Reg. Capital	Liq. Assets	Index	Crisis
Negative shocks	2.0130*	-16.6200***	-0.9850**	-7.4690	3.1690	0.7260	-0.4390	-0.0033	0.9520
	(1.17)	(5.88)	(0.47)	(6.30)	(2.33)	(0.44)	(2.82)	(0.00)	(0.92)
Constant	41.0900	308.3000**	2.0250	-232.1000	132.2000	-18.1200	3.2950	0.5560***	
	(33.26)	(140.30)	(18.57)	(294.10)	(85.19)	(16.58)	(59.80)	(0.21)	
Observations	191	185	194	194	192	189	194	194	113
Countries	15	15	15	15	15	15	15	15	9
R-squared	0.5500	0.7230	0.2780	0.3070	0.5110	0.4780	0.5650	0.5520	
				Upper middle income					
Negative shocks	2.7130***	-18.0800***	-0.3630	-4.3530	2.8520*	0,3400	-1.0310	-0,0049	1.2180**
	(0.76)	(4.59)	(0.35)	(3.59)	(1.67)	(0.52)	(2.07)	(0.00)	(0.55)
Constant	6.2210***	95.7100***	1.4110***	12.2900***	58.5200***	16.8600***	39.7700***	0.5270***	
	(0.43)	(2.81)	(0.13)	(1.19)	(0.94)	(0.28)	(1.21)	(0.00)	
Observations	236	226	366	366	370	240	370	370	160
Countries	20	20	23	23	23	20	23	23	10
R-squared	0,3820	0,7100	0,1340	0,1250	0,4460	0,5030	0,5250	0,3370	
				Lower middle income					
Negative shocks	2.9410*	-11.9700*	-0.2580	-5.8490	0,8870	-1.2570	-0.8320	-0.0080	1.5710**
	(1.62)	(6.95)	(0.24)	(4.26)	(1.54)	(0.89)	(1.69)	(0.00)	(0.71)
Constant	9.8960***	78.2000***	1.4890***	13.5000***	57.5100***	17.9300***	40.7200***	0.5210***	
	(0.92)	(4.21)	(0.09)	(1.40)	(1.05)	(0.44)	(1.11)	(0.00)	
Observations	155	146	349	348	353	156	358	358	166
Countries	16	16	21	21	21	16	21	21	9
R-squared	0,2970	0,4030	0,2570	0,1240	0,2520	0,6290	0,6510	0,3720	
				High income: non OECD					
Negative shocks	2.4110**	-12.7200**	-0.7490**	-5.9600*	4.3880**	0.9040*	3,112	-0,0032	
	(0.92)	(4.95)	(0.33)	(3.47)	(1.98)	(0.54)	(2.20)	(0.00)	
Constant	6.2050***	83.4700***	1.7200***	13.5900***	47.7200***	16.9300***	34.1100***	0.5110***	
	(0.51)	(3.02)	(0.11)	(1.56)	(0.97)	(0.26)	(1.19)	(0.00)	
Observations	134	127	205	205	206	133	206	206	
Countries	10	10	12	12	12	10	12	12	
R-squared	0,2340	0,5830	0,2040	0,1310	0,6430	0,4440	0,2200	0,2460	

Robust standard errors in parentheses. Fixed effects are included

***p<0.01, significant at 1%, **p<0.05, significant at 5%, *p<0.10, significant at 10%.

Table 5. Transmission Channels

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	GDP growth	Revenue	Debt in foreign cur.	Unemployment	Deficit	savings
Negative shocks	-2.8230***	-0.7180*	0.0402**	0.4150**	-0.7150	-3.8780***
	(0.45)	(0.43)	(0.02)	(0.20)	(0.66)	(0.79)
Exchange rate, t-1	-2.3570**	1.3710	0.0656	0.5480	1.2300	-0.7990
	(1.04)	(1.60)	(0.05)	(0.39)	(0.97)	(1.28)
Real interest, t-1	-0.0573*	-0.0660***	0.0035***	0.0151**	-0.0514*	-0.1490***
	(0.03)	(0.02)	(0.00)	(0.00)	(0.03)	(0.04)
M2/reserve, t-1	-0.0286	-0,0195	0.0026***	0.0127***	-0.0309	0,0423
	(0.02)	(0.02)	(0.00)	(0.00)	(0.03)	(0.02)
Inflation, t-1	0.0112	-0.0688*	-0.0038***	-0.0040	-0,0097	-0,0004
	(0.01)	(0.04)	(0.00)	(0.00)	(0.00)	(0.01)
Credit growth, t-1	1.2610	-2.8390**	-0,0042	-0.5610	-5.6330***	-6.3520***
	(1.03)	(1.11)	(0.02)	(0.43)	(1.57)	(1.67)
Log(GDPPC), t-1	-2.5310***	2.4120***	-0.0939***	-0.6560***	5.6110***	2.9340***
	(0.67)	(0.58)	(0.02)	(0.24)	(1.50)	(0.78)
Debt, t-1	-0.0179***	0.0148**	0.0025***	-2.41e-05	0.0245	-0,0015
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.01)
Constant	67.5200***	-28.1600**	2.3560***	25.6500***	-134.6000***	-44.2500**
	(16.20)	(14.32)	(0.48)	(5.81)	(36.75)	(19.20)
Observations	715	686	397	716	384	697
Countries	60	60	35	60	43	58
R-squared	0,4490	0,8700	0,8110	0,9100	0,4960	0,6530

Robust standard errors in parentheses. Fixed effects are included

***p<0.01, significant at 1%, **p<0.05, significant at 5%, *p<0.10, significant at 10%.

Table 6. Effects of Transmission Channel Variables on the Financial Sector

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	NPLs	Provisions to NPLs	ROA	ROE	Cost	Reg. Capital	Liq. Assets	Index	Criss
				GDP growth					
GDP growth	-0.5670***	2.0370***	0.1730***	2.1960**	-0,0952	0.0647	0.1910	0.0019***	-0.534***
	(0.09)	(0.35)	(0.04)	(0.92)	(0.15)	(0.08)	(0.13)	(0.00)	(0.14)
Observations	457	426	690	690	692	454	696	696	191
Countries	45	45	58	58	58	45	58	58	15
R-squared	0,6550	0,6640	0,3800	0,2510	0,5500	0,5990	0,6470	0,5370	
				Unemployment					
Unemployment	0.2000	-2.8780***	-0.0411	-0.0844	0.6760***	0.1950	0.3490	-0,0001	-0.0923
	(0.14)	(0.66)	(0.04)	(0.69)	(0.19)	(0.13)	(0.23)	(0.00)	(0.16)
Observations	457	426	691	691	693	454	697	697	191
Countries	45	45	58	58	58	45	58	58	15
R-squared	0,5690	0,6500	0,2780	0,1770	0,5560	0,6020	0,6480	0,5140	
				Government revenue					
Revenue	-0,0016	2.6650***	-0.0103	-0.0167	-0.0223	0,0092	0.3250***	0.0010***	-0.2710
	(0.08)	(0.68)	(0.02)	(0.18)	(0.11)	(0.06)	(0.10)	(0.00)	(0.22)
Observations	446	414	666	666	668	442	672	672	148
Countries	45	45	58	58	58	45	58	58	12
R-squared	0,5700	0,6640	0,2770	0,1830	0,5500	0,5920	0,6460	0,5170	
				Debt in foreign currency					
Debt in foreign cur.	5.1320	-47.6100*	-0.9070	-4.7500	5.3810	2.1210	-15.1400***	-0.0287***	22.3300
	(4.09)	(25.23)	(0.80)	(10.04)	(4.88)	(2.73)	(3.51)	(0.01)	(18.82)
Observations	230	214	388	388	390	229	390	390	87
Countries	26	26	34	34	34	26	34	34	7
R-squared	0,5770	0,6710	0,3780	0,2100	0,6100	0,7030	0,6550	0,5870	
				Deficit					
Deficit	-0.2020	0.9420	0.0237	0.1200	-0.4140	-0.1590**	-0.3220*	-0,0012	-0.2460
	(0.15)	(0.96)	(0.03)	(0.43)	(0.33)	(0.07)	(0.17)	(0.00)	(0.24)
Observations	235	222	379	379	381	232	383	383	97
Countries	29	29	43	43	43	29	43	43	11
R-squared	0,6770	0,7120	0,4220	0,2690	0,5370	0,6970	0,7690	0,6830	
				Savings					
Savings	-0.0787**	0.8280**	0,0089	0.1590	-0.0153	0.0203	0.0173	0.0001	-0.5400***
	(0.03)	(0.32)	(0.01)	(0.16)	(0.05)	(0.05)	(0.05)	(0.00)	(0.15)
Observations	457	426	681	681	683	454	687	687	191
Countries	45	45	57	57	57	45	57	57	15
R-squared	0,5700	0,6440	0,2770	0,1780	0,5450	0,5970	0,6410	0,5120	

Robust standard errors in parentheses. Note that control variables and fixed effects are included

***p<0.01, significant at 1%, **p<0.05, significant at 5%, *p<0.10, significant at 10%.

Table 7. Effect on Banking Crisis: Sensitivity Analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	IMF program		**SWF**		**Exchange regime**		**Financial development**		**Debt**	
	Yes	No	Yes	No	Flotting	Peg	Low	High	Low	High
Negative shocks	0.8330*	2.7950***	24.0000	1.2320***	1.3900***	0.5260	0.9930*	1.0900*	0.4940	2.0310***
	(0.49)	(0.81)	(32.31)	(0.39)	(0.45)	(0.83)	(0.52)	(0.63)	(0.62)	(0.62)
Observations	175	92	12	399	281	78	195	109	138	146
Countries	19	9	1	24	20	7	18	10	10	16
	Polity2		**Investment profile**		**Corruption**		**Gov. effectivness**		**Reg. quality**	
	Autocracy	Democracy	Low	High	Low	High	Low	High	Low	High
Negative shocks	2.1740***	1.3610**	1.4970***	1.4080	0.6430	1.7070***	1.9120***	1.1340*	2.5220***	1.2840**
	(0.78)	(0.56)	(0.51)	(1.49)	(0.57)	(0.60)	(0.73)	(0.65)	(0.92)	(0.62)
Observations	112	136	159	40	153	174	162	143	118	141
Countries	10	10	18	4	18	16	13	11	11	14

Robust standard errors in parentheses

***p<0.01, significant at 1%, **p<0.05, significant at 5%, *p<0.10, significant at 10%. We tested the Chow test but it does not work.

We lost observations since the conditional panel fixed effects logit model is a with-in estimator

Table 8. Sensitivity Analysis: Macro-Prudential Policies

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	NPLs		**Provisions to NPLs**		**ROA**		**ROE**	
	No	Yes	No	Yes	No	Yes	No	Yes
Negative shocks	2.8440***	0.4000	-14.2400***	-18.6400***	-0.5450***	-0.5540	-5.1970***	-6.9800
	(0.71)	(0.92)	(4.21)	(7.09)	(0.16)	(0.36)	(1.58)	(5.43)
Observations	270	187	252	174	371	320	371	320
Countries	33	41	33	38	41	58	41	58
R-squared	0,5350	0,7520	0,7800	0,6530	0,5000	0,4120	0,4750	0,3730

	Cost		**Reg. capital**		**Liq. Assets**		**Index**	
	No	Yes	No	Yes	No	Yes	No	Yes
Negative shocks	1.8860*	0.5590	0.2060	-0.6350	-1.5850	-1.8700	-0.0069**	-0,0034
	(1.06)	(1.91)	(0.43)	(0.83)	(1.58)	(1.59)	(0.00)	(0.00)
Observations	371	322	268	186	371	326	371	326
Countries	41	58	33	41	41	58	41	58
R-squared	0,7250	0,5950	0,7180	0,6570	0,6650	0,7880	0,6910	0,5800

Robust standard errors in parentheses. Fixed effects and control variables are included

***p<0.01, significant at 1%, **p<0.05, significant at 5%, *p<0.10, significant at 10%.

Table 9: Sensitivity Analysis: Extensive Diversification

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	NPLs		**Provisions to NPLs**		**ROA**		**ROE**	
	Low	High	Low	High	Low	High	Low	High
Negative shocks	2.5040***	1.9910	-20.3400***	1.8960	-0.8490***	-0.1830	-8.8920**	-3.0760
	(0.82)	(1.94)	(4.31)	(11.77)	(0.26)	(0.24)	(3.56)	(3.42)
Observations	321	77	308	65	431	191	431	191
Countries	43	18	42	18	51	34	51	34
R-squared	0,6030	0.643	0.684	0.691	0,2980	0,3950	0,2370	0,2350

	Cost		**Reg. capital**		**Liq. Assets**		**Index**	
	Low	High	Low	High	Low	High	Low	High
Negative shocks	2.5270*	1.8650	-0.3360	0.9710	-0.9630	-4.2640*	-0,0052	-0,0094
	(1.31)	(2.22)	(0.48)	(1.44)	(1.59)	(2.36)	(0.00)	(0.00)
Observations	430	194	317	78	434	194	434	194
Countries	51	34	43	18	51	34	51	34
R-squared	0,59	0,608	0,591	0,751	0,675	0,727	0,58	0,577

Robust standard errors in parentheses. Fixed effects and control variables are included
***p<0.01, significant at 1%, **p<0.05, significant at 5%, *p<0.10, significant at 10%.

Table 10: Robustness: Using Alternative Price Shocks Measure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	NPLs	Provisions to NPLs	ROA	ROE	Cost	Reg. Capital	Liq. Assets	Index	Crisis
Negative shocks	2.9290***	-11.9900***	-0.7370***	-8.7350**	1.2010	-0.8750**	-1.8960*	-0.0123***	1.4150***
	(0.59)	(3.30)	(0.22)	(3.72)	(0.93)	(0.39)	(1.05)	(0.00)	(0.53)
Exchange rate, t-1	4.8060**	-16.9700**	-1.1070	-22.1500	4.9980	-2.7370	-0.7160	-0.0135	-0.5420
	(1.88)	(7.56)	(0.68)	(14.24)	(6.42)	(2.03)	(2.26)	(0.01)	(1.18)
Real interest, t-1	0.1120***	-0.8110***	-0.0221**	-0.2290*	0.1370*	0,0027	-0.0493	-0.0005***	0.0933**
	(0.03)	(0.15)	(0.01)	(0.13)	(0.08)	(0.02)	(0.05)	(0.00)	(0.03)
M2/reserve, t-1	0.0627	-0.8040**	0,0096	0.0967	0.0840	-0.0037	-0.1010**	0,0002	0.3450**
	(0.06)	(0.36)	(0.01)	(0.13)	(0.08)	(0.05)	(0.04)	(0.00)	(0.16)
Inflation, t-1	-0.0070	0,0647	0,0058	0.1580	0.0040	0.0395**	0.0317*	0,0001	0.0761**
	(0.03)	(0.06)	(0.00)	(0.12)	(0.05)	(0.02)	(0.02)	(0.00)	(0.04)
Credit growth, t-1	-4.7710**	13.1900	-0.2050	-5.4600	-0.5600	-5.2780***	-6.6530***	-0.0132**	1.1240
	(1.87)	(11.41)	(0.37)	(5.74)	(2.42)	(1.46)	(2.51)	(0.00)	(2.77)
Log(GDPPC), t-1	-1.9100**	-1.4720	-0.0884	0.8440	-2.3080	-0.1570	-6.1810***	-0.0122***	-3.4990**
	(0.81)	(4.00)	(0.21)	(2.96)	(1.40)	(0.48)	(1.19)	(0.00)	(1.51)
Debt, t-1	0.1090***	-0.0263	-0.0053	0.0105	0.0718***	0.0182	0,0022	-0.00003	-0.0243*
	(0.03)	(0.10)	(0.00)	(0.08)	(0.02)	(0.02)	(0.02)	(0.00)	(0.01)
Constant	48.7200**	130.6000	4.1470	-4.6440	106.8000***	20.7200*	187.9000***	0.8230***	
	(20.54)	(99.64)	(5.19)	(73.68)	(34.78)	(12.35)	(28.92)	(0.10)	
Observations	460	429	694	694	696	457	700	700	194
Countries	45	45	58	58	58	45	58	58	15
R-squared	0,5970	0,6480	0,2940	0,1890	0,5460	0,6010	0,6470	0,5260	

Robust standard errors in parentheses. Fixed effects are included
***p<0.01, significant at 1%, **p<0.05, significant at 5%, *p<0.10, significant at 10%.

Table 11. Robustness: Testing for Commodity Subcategories

Hydrocarbons only									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	NPLs	Provisions to NPLs	ROA	ROE	Cost	Reg. Capital	Liq. Assets	Index	Crisis
Negative shocks	3.0220***	-27.5600***	-1.2500**	-16.2900**	2.7760	-0.8220	-4.3670*	-0.0175***	4.8750**
	(1.16)	(7.43)	(0.52)	(6.91)	(2.34)	(0.76)	(2.52)	(0.00)	(2.14)
Exchange rate, t-1	5.2260**	-13.4200	-1.4700*	-26.9200*	5.0940	-3.2950	-2.4260	-0.0148	-1.2280
	(2.18)	(8.80)	(0.78)	(16.28)	(6.52)	(2.31)	(2.25)	(0.01)	(2.02)
Real interest, t-1	0.1030***	-0.9580***	-0.0361***	-0.3840**	0.2030**	-0.0091	-0.1340**	-0.0005***	0.0778*
	(0.04)	(0.18)	(0.01)	(0.16)	(0.10)	(0.02)	(0.05)	(0.00)	(0.04)
M2/reserve, t-1	0.0506	-0.6510**	0,0118	0.1090	0.0531	-0,0165	-0.1090**	0,0002	1.2940*
	(0.06)	(0.29)	(0.01)	(0.17)	(0.08)	(0.06)	(0.04)	(0.00)	(0.68)
Inflation, t-1	-0,0075	0,0418	0,0085	0.1940	0,0036	0.0435**	0.0422**	0.0001*	0.0664
	(0.03)	(0.06)	(0.00)	(0.14)	(0.05)	(0.02)	(0.02)	(0.00)	(0.05)
Credit growth, t-1	-5.4100**	32.1500**	0,0036	-3.3430	-1.0450	-6.4470***	-3.4470	-0,0058	3.5520
	(2.11)	(15.31)	(0.46)	(7.30)	(2.69)	(2.03)	(2.84)	(0.00)	(4.92)
Log(GDPPC), t-1	-1.2540	9,429	0.1160	4.3770	-1.1120	-0.1160	-3.6160**	-0,0032	-7.9940*
	(0.91)	(6.55)	(0.31)	(5.33)	(1.99)	(0.58)	(1.41)	(0.00)	(4.11)
Debt, t-1	0.1090***	0.0636	-0.0030	0.0999	0.1410*	0.0349	0.0882**	0,0002	-0.0526
	(0.03)	(0.16)	(0.01)	(0.24)	(0.07)	(0.02)	(0.04)	(0.00)	(0.05)
Constant	33,86	-141.5000	-1.1820	-97.5600	75.8600	18.5800	124.9000***	0.5960***	
	(23.33)	(166.70)	(7.97)	(139.40)	(51.61)	(14.96)	(35.18)	(0.11)	
Observations	292	276	407	407	406	286	410	410	126
Countries	26	26	33	33	33	26	33	33	9
R-squared	0.5030	0.6260	0.2480	0.1760	0.5430	0.4750	0.6010	0.5110	
Raw materials Only									
VARIABLES	NPLs	Provisions to NPLs	ROA	ROE	Cost	Reg. Capital	Liq. Assets	Index	Crisis
Negative shocks	7.5720***	-28.7900***	-1.9130*	-23.7900	-2.3990	-1.6330	0.4630	-0.0219*	8.2320***
	(2.36)	(10.02)	(1.05)	(20.85)	(2.81)	(1.66)	(2.33)	(0.01)	(2.40)
Exchange rate, t-1	5.5640**	-26.5400***	-2.8470*	-58.6600*	24.7700*	-4.5970*	-4.4850**	-0.0332	-0.5650
	(2.77)	(9.22)	(1.54)	(30.17)	(13.64)	(2.63)	(1.93)	(0.02)	(1.37)
Real interest, t-1	0.1260***	-1.3260***	-0.0128	0.0394	0.1020	0.0243	-0.0060	-0.0006**	0.1240***
	(0.05)	(0.29)	(0.02)	(0.24)	(0.07)	(0.04)	(0.06)	(0.00)	(0.04)
M2/reserve, t-1	-0.0603	-0.3870	0.0137*	0.1860	-0.0251	0,0052	-0.1530***	-0.0001	0.4460**
	(0.07)	(0.41)	(0.00)	(0.11)	(0.04)	(0.05)	(0.03)	(0.00)	(0.18)
Inflation, t-1	-0.0597	0.1020	0.0206	0.4670*	-0.1480	0.0541**	0.0638***	0,0003	0.1050**
	(0.08)	(0.07)	(0.01)	(0.25)	(0.11)	(0.02)	(0.01)	(0.00)	(0.05)
Credit growth, t-1	-2.5630	17.5900	-0.7660	-15.6100	3.0750	-5.4730***	-10.1500***	-0.0170	-1.0090
	(2.24)	(13.43)	(0.77)	(12.52)	(3.32)	(1.97)	(2.96)	(0.01)	(3.75)
Log(GDPPC), t-1	-3.3070**	0,0044	-0.4420	0.4190	1.6950	0.0675	-8.5970***	-0.0128	-3.4470*
	(1.33)	(6.69)	(0.35)	(5.67)	(2.19)	(0.99)	(1.46)	(0.00)	(1.77)
Debt, t-1	0.0786*	0.1910	-0,0041	0.0645	0.0773***	0.0326	-0.0298	-0.0001	-0.0204
	(0.04)	(0.16)	(0.00)	(0.11)	(0.02)	(0.03)	(0.02)	(0.00)	(0.01)
Constant	83.0200**	94.1200	12.7100	3.0990	14.2900	14.4800	243.3000***	0.8430***	
	(33.81)	(168.40)	(8.37)	(137.70)	(52.71)	(25.35)	(35.27)	(0.19)	
Observations	301	276	447	447	448	301	450	450	151
Countries	29	29	37	37	37	29	37	37	12
R-squared	0.5960	0.6020	0.2900	0.2230	0.5750	0.5880	0.7320	0.5090	

Robust standard errors in parentheses. Fixed effects are included

***p<0.01, significant at 1%, **p<0.05, significant at 5%, *p<0.10, significant at 10%.

Table 12. Robustness: Using Price Shocks Occurrence

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	NPLs	Provisions to NPLs	ROA	ROE	Cost	Reg. Capital	Liq. Assets	Index	Crisis
Negative shocks	1.7320***	-13.0600***	-0.4300***	-4.6790**	1.2720	-0.2270	-1.6490*	-0.0063**	1.2180**
	(0.53)	(3.20)	(0.14)	(1.82)	(0.85)	(0.34)	(0.98)	(0.00)	(0.62)
Exchange rate, t-1	4.7170**	-16.2800**	-1.0870	-21.9400	4.8760	-2.7710	-0.6460	-0.0131	-0.6990
	(2.02)	(7.39)	(0.69)	(14.50)	(6.06)	(2.11)	(2.17)	(0.01)	(1.14)
Real interest, t-1	0.1160***	-0.8190***	-0.0222**	-0.2310*	0.1370*	0,0009	-0.0498	-0.0005***	0.0928***
	(0.03)	(0.15)	(0.01)	(0.13)	(0.07)	(0.02)	(0.05)	(0.00)	(0.03)
M2/reserve, t-1	0,0527	-0.7150*	0,0097	0.0982	0.0830	-0.0018	-0.0981**	0,0003	0.3670**
	(0.07)	(0.37)	(0.00)	(0.12)	(0.08)	(0.05)	(0.04)	(0.00)	(0.15)
Inflation, t-1	0,0013	0.0478	0.0050	0.1490	0,0062	0.0387**	0.0296	0,0001	0.0814**
	(0.03)	(0.05)	(0.00)	(0.12)	(0.05)	(0.02)	(0.02)	(0.00)	(0.04)
Credit growth, t-1	-4.9220**	13.6000	-0.2640	-6.1190	-0.3600	-5.4020***	-6.8070***	-0.0143**	0.7170
	(1.91)	(11.40)	(0.36)	(5.63)	(2.38)	(1.46)	(2.53)	(0.00)	(2.92)
Log(GDPPC), t-1	-1.6260*	-3.7620	-0.1570	0.1550	-2.0110	-0.1640	-6.4980***	-0.0131***	-3.4700**
	(0.85)	(4.06)	(0.22)	(3.00)	(1.44)	(0.49)	(1.19)	(0.00)	(1.53)
Debt, t-1	0.1070***	0.0319	-0,0054	0,0079	0.0697***	0.0219	0,0025	-0.0000	-0.0232*
	(0.03)	(0.11)	(0.00)	(0.08)	(0.02)	(0.02)	(0.01)	(0.00)	(0.01)
Constant	41.8000*	186.6000*	5.8080	12.0400	99.4200***	20.6300	195.7000***	0.8450***	
	(21.56)	(101.40)	(5.38)	(74.85)	(35.66)	(12.68)	(29.13)	(0.10)	
Observations	457	426	691	691	693	454	697	697	191
Countries	45	45	58	58	58	45	58	58	15
R-squared	0.577	0.652	0.285	0.181	0.550	0.597	0.648	0.517	

Robust standard errors in parentheses. Fixed effects are included

***p<0.01, significant at 1%, **p<0.05, significant at 5%, *p<0.10, significant at 10%.

Table 13. Robustness: Testing for Long LastingShocks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	NPLs	Provisions to NPLs	ROA	ROE	Cost	Reg. Capital	Liq. Assets	Index	Crisis
Negative shocks	2.2190***	-17.1900***	-0.4530**	-5.3580*	1.7090	-0.2110	-2.7110**	-0.0081**	2.0610***
	(0.83)	(5.17)	(0.21)	(3.14)	(1.20)	(0.51)	(1.27)	(0.00)	(0.79)
Exchange rate, t-1	4.4530**	-15.5100**	-1.0700	-21.7400	4.8110	-2.7640	-0.5560	-0.0129	-0.7390
	(2.03)	(7.34)	(0.69)	(14.48)	(6.04)	(2.12)	(2.15)	(0.01)	(1.13)
Real interest, t-1	0.1100***	-0.7710***	-0.0206*	-0.2110	0.1310*	0,0015	-0.0392	-0.0005***	0.0972***
	(0.03)	(0.15)	(0.01)	(0.13)	(0.07)	(0.02)	(0.05)	(0.00)	(0.03)
M2/reserve, t-1	0.0421	-0.6310*	0,0095	0.0967	0.0830	-0,0009	-0.0971**	0,0002	0.3850**
	(0.07)	(0.37)	(0.00)	(0.12)	(0.08)	(0.05)	(0.04)	(0.00)	(0.15)
Inflation, t-1	0,0073	0.0465	0,0049	0.1490	0,0062	0.0387**	0.0297	0,0001	0.0910**
	(0.03)	(0.05)	(0.00)	(0.12)	(0.05)	(0.02)	(0.02)	(0.00)	(0.04)
Credit growth, t-1	-4.7130**	11.8600	-0.3050	-6.5320	-0.2610	-5.4470***	-6.9060***	-0.0148**	-0.0749
	(1.91)	(11.13)	(0.36)	(5.67)	(2.40)	(1.45)	(2.51)	(0.00)	(2.99)
Log(GDPPC), t-1	-1.1870	-7.1140	-0.2150	-0.6240	-1.7160	-0.1870	-7.0470***	-0.0144***	-3.2670**
	(0.88)	(4.60)	(0.21)	(2.79)	(1.47)	(0.49)	(1.20)	(0.00)	(1.60)
Debt, t-1	0.1080***	0,0269	-0,0055	0.0060	0.0703***	0.0219	0,0016	-0.0001	-0.0250*
	(0.03)	(0.10)	(0.00)	(0.08)	(0.02)	(0.02)	(0.02)	(0.00)	(0.01)
Constant	31.2000	267.6000**	7.1340	30.1000	92.4500**	21.1400*	208.8000***	0.8770***	
	(22.40)	(114.60)	(5.23)	(69.62)	(36.33)	(12.66)	(29.18)	(0.11)	
Observations	457	426	691	691	693	454	697	697	191
Countries	45	45	58	58	58	45	58	58	15
R-squared	0.575	0.649	0.281	0.180	0.550	0.597	0.649	0.517	

Robust standard errors in parentheses. Fixed effects are included

***p<0.01, significant at 1%, **p<0.05, significant at 5%, *p<0.10, significant at 10%.

Table 14. Robustness: Different Extreme Shocks Samples

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	NPLs	Provisions to NPLs	ROA	ROE	Cost	Reg. Capital	Liq. Assets	Index	Crisis
				All					
Negative shocks	2.2840***	-16.0300***	-0.5810***	-6.5350***	1.5370	-0.3440	-1.9730	-0.0083**	1.8750**
	(0.65)	(3.82)	(0.18)	(2.52)	(1.05)	(0.41)	(1.21)	(0.00)	(0.79)
Observations	457	426	691	691	693	454	697	697	191
Countries	45	45	58	58	58	45	58	58	15
R-squared	0.5800	0.6530	0.2870	0.1830	0.5500	0.5970	0.6480	0.5180	
				90% most extreme shocks					
Negative shocks	2.4380***	-16.0500***	-0.5180***	-5.8240*	1.6610	-0.3130	-2.0420*	-0.0082**	1.9880**
	(0.66)	(3.789)	(0.20)	(3.04)	(1.07)	(0.43)	(1.19)	(0.00)	(0.77)
Observations	457	426	691	691	693	454	697	697	191
Countries	45	45	58	58	58	45	58	58	15
R-squared	0.5820	0.6530	0.2850	0.1820	0.5510	0.5970	0.6480	0.5180	
				80% most extreme shocks					
Negative shocks	2.7950***	-14.9000***	-0.5960***	-6.6700**	1.9430*	-0.3660	-1.8120	-0.0075**	2.2620***
	(0.68)	(3.78)	(0.21)	(3.21)	(1.12)	(0.45)	(1.20)	(0.00)	(0.77)
Observations	457	426	691	691	693	454	697	697	191
Countries	45	45	58	58	58	45	58	58	15
0.5870	0.587	0.6500	0.2880	0.1830	0.5510	0.5970	0.6480	0.5170	
				70% most extreme shocks					
Negative shocks	2.9380***	-15.5300***	-0.6830***	-8.4970**	1.2410	-0.7940*	-1.7940	-0.0091**	2.2410***
	(0.69)	(3.86)	(0.24)	(3.88)	(1.09)	(0.45)	(1.23)	(0.00)	(0.71)
Observations	457	426	691	691	693	454	697	697	191
Countries	45	45	58	58	58	45	58	58	15
R-squared	0.5880	0.6510	0.2910	0.1870	0.5500	0.6000	0.6480	0.5190	
				60% most extreme shocks					
Negative shocks	3.17200***	-16.4700***	-0.7710***	-9.4360**	0.8990	-0.8040*	-1.7210	-0.0122***	2.0600***
	(0.69)	(3.76)	(0.24)	(3.98)	(1.11)	(0.45)	(1.22)	(0.00)	(0.65)
Observations	457	426	691	691	693	454	697	697	191
Countries	45	45	58	58	58	45	58	58	15
R-squared	0.5930	0.6530	0.2950	0.1890	0.5500	0.6000	0.6470	0.5230	
				50% most extreme shocks					
Negative shocks	3.1060***	-15.4700***	-0.8450***	-10.3900**	1.3190	-0.5570	-1.1280	-0.0088**	2.7630***
	(0.73)	(3.97)	(0.27)	(4.48)	(1.16)	(0.47)	(1.28)	(0.00)	(0.77)
Observations	457	426	691	691	693	454	697	697	191
Countries	45	45	58	58	58	45	58	58	15
R-squared	0.5900	0.6500	0.2970	0.1910	0.5500	0.5980	0.6470	0.5180	
				40% most extreme shocks					
Negative shocks	3.1290***	-15.2100***	-0.8960***	-11.2400**	0.2000	-0.6480	-0.6870	-0.0090**	3.5970***
	(0.79)	(4.34)	(0.31)	(5.15)	(1.22)	(0.52)	(1.35)	(0.00)	(0.93)
Observations	457	426	691	691	693	454	697	697	191
Countries	45	45	58	58	58	45	58	58	15
R-squared	0.5880	0.6480	0.2970	0.1910	0.5490	0.5980	0.6460	0.5180	
				30% most extreme shocks					
Negative shocks	2.7930***	-14.8000***	-0.9450**	-11.8300*	0.8370	-0.8460	-0.7470	-0.0112**	3.7410***
	(0.97)	(4.82)	(0.40)	(6.93)	(1.44)	(0.63)	(1.61)	(0.00)	(1.15)
Observations	457	426	691	691	693	454	697	697	191
Countries	45	45	58	58	58	45	58	58	15
R-squared	0.5790	0.6450	0.2940	0.1890	0.5490	0.5990	0.6460	0.5190	
				20% most extreme shocks					
Negative shocks	3.3080***	-13.2200***	-0.9310***	-11.4300**	0.3930	-0.8430	-0.4070	-0.0096**	3.4860***
	(0.83)	(4.51)	(0.33)	(5.62)	(1.29)	(0.54)	(1.43)	(0.00)	(0.99)
Observations	457	426	691	691	693	454	697	697	191
Countries	45	45	58	58	58	45	58	58	15
R-squared	0.5890	0.6440	0.2960	0.1900	0.5490	0.5990	0.6460	0.5180	
				10% most extreme shocks					
Negative shocks	3.3930***	-14.5300***	-1.1600**	-15.3600*	1.0060	-1.3330	-1.2300	-0.0148**	7.4050***
	(1.16)	(4.94)	(0.48)	(8.48)	(1.67)	(0.81)	(1.79)	(0.00)	(2.09)
Observations	457	426	691	691	693	454	697	697	191
Countries	45	45	58	58	58	45	58	58	15
R-squared	0.5820	0.6430	0.2990	0.1950	0.5490	0.6010	0.6470	0.5210	

Note that all control variables and fixed effects are included. Robust standard errors in parentheses
***p<0.01, significant at 1%, **p<0.05, significant at 5%, *p<0.10, significant at 10%.

Table 15. Robustness: Instability of Commodity Price Shocks

	(1)	(2)	(3)	(4)	(5)	(6)	(8)	(9)
VARIABLES	NPLs	Provisions to NPLs	ROA	ROE	Cost	Reg. Capital	Liq. Assets	Index
Price unpredictability	0.0623***	-0.3010*	-0.0195***	-0.1930*	-0.1780***	-0,0079	0.1000*	-0.0005***
	(0.01)	(0.17)	(0.00)	(0.09)	(0.04)	(0.01)	(0.05)	(0.00)
Exchange rate, t-1	3.9560*	-9.4330	-0.7800	-19.1600	3.3520	-1.7550	3.2490	-0,0013
	(2.17)	(9.28)	(0.81)	(16.94)	(7.57)	(2.36)	(3.88)	(0.01)
Real interest, t-1	0.0144	0.2920	-0.0063	-0,0681	0.1390*	0.0300	0.1050	0,0001
	(0.03)	(0.18)	(0.01)	(0.09)	(0.07)	(0.02)	(0.06)	(0.00)
M2/reserve, t-1	-0.1120*	-0.4970	0,0071	0.1450	-0.0788	-0.1900***	0.0648	0,0003
	(0.06)	(0.40)	(0.01)	(0.13)	(0.11)	(0.07)	(0.13)	(0.00)
Inflation, t-1	-0.0279	0.1270*	0,0052	0.1540	0.0305	0.0395**	0.0325	0,0001
	(0.03)	(0.07)	(0.01)	(0.14)	(0.06)	(0.02)	(0.03)	(0.00)
Credit growth, t-1	-3.4010*	6.6770	0.4090	0.3370	2.2090	-1.1780	0.1270	0,0083
	(1.96)	(12.20)	(0.37)	(5.28)	(2.67)	(1.66)	(2.72)	(0.00)
Log(GDPPC), t-1	-0.3140*	10.6000***	-0.2550***	-2.2040**	-0.0009	-0.9080***	0.9040	0.0010
	(0.18)	(1.49)	(0.05)	(0.86)	(0.40)	(0.15)	(0.56)	(0.00)
Debt, t-1	0.0701***	0.0657	-0.0045**	-0,0018	0.0664***	-0,0039	0.0861***	1,00E-04
	(0.02)	(0.08)	(0.00)	(0.02)	(0.02)	(0.01)	(0.02)	(0.00)
Constant	9.8220**	-163.6000***	8.8600***	75.9500***	63.7800***	40.0000***	3.9820	0.5190***
	(4.91)	(39.79)	(1.44)	(22.84)	(11.52)	(4.19)	(15.58)	(0.03)
Observations	493	462	729	729	731	490	735	735
Countries	15	15	15	15	15	15	15	15
R-squared	0.3210	0.1760	0.1010	0.0720	0.1290	0.1750	0.0850	0.0890

Robust standard errors in parentheses. Fixed effects are included
***p<0.01, significant at 1%, **p<0.05, significant at 5%, *p<0.10, significant at 10%.

Table 16. Effects of Positive Shocks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	NPLs	Provisions to NPLs	ROA	ROE	Cost	Reg. Capital	Liq. Assets	Index	Crisis
Positive shocks	-9.4360***	35.6300**	1.5580*	21.6600*	-7.8550	-0.9270	4.3700	0.0210	-25.3100*
	(2.68)	(17.99)	(0.83)	(12.58)	(5.00)	(1.46)	(5.96)	(0.01)	(13.99)
Exchange rate, t-1	4.8200**	-17.3800**	-1.0910	-22.0100	4.9340	-2.7800	-0.6610	-0.0132	-0.5780
	(1.94)	(7.24)	(0.70)	(14.54)	(6.09)	(2.12)	(2.22)	(0.01)	(1.17)
Real interest, t-1	0.1090***	-0.7990***	-0.0210*	-0.2130	0.1310*	-4.60e-05	-0.0472	-0.0005***	0.0864***
	(0.03)	(0.16)	(0.01)	(0.13)	(0.07)	(0.02)	(0.05)	(0.00)	(0.03)
M2/reserve, t-1	0.0441	-0.7140**	0,0093	0.0948	0.0828	-0.0037	-0.1010**	0,0002	0.3150**
	(0.06)	(0.36)	(0.01)	(0.12)	(0.08)	(0.05)	(0.04)	(0.00)	(0.15)
Inflation, t-1	-0.0014	0.0545	0,0051	0.1500	0,0053	0.0387**	0.0297	0,0001	0.0758**
	(0.03)	(0.05)	(0.01)	(0.12)	(0.05)	(0.02)	(0.02)	(0.00)	(0.04)
Credit growth, t-1	-4.4560**	9.6960	-0.3080	-6.5260	-0.2740	-5.4950***	-7.0020***	-0.0150**	0.5590
	(1.89)	(11.55)	(0.37)	(5.74)	(2.42)	(1.45)	(2.54)	(0.00)	(2.94)
Log(GDPPC), t-1	-1.8500**	-1.4740	-0.1010	0.6430	-2.0920	-0.0789	-6.2510***	-0.0122***	-3.0330**
	(0.83)	(4.05)	(0.22)	(2.99)	(1.42)	(0.48)	(1.21)	(0.00)	(1.50)
Debt, t-1	0.1000***	0.0788	-0.0049	0.0132	0.0680***	0.0215	0,0034	-3.57e-05	-0.0226*
	(0.03)	(0.10)	(0.00)	(0.08)	(0.02)	(0.02)	(0.02)	(0.00)	(0.01)
Constant	48.9500**	120.7000	4.1580	-3.4500	102.5000***	18.5300	188.7000***	0.8210***	
	(21.20)	(100.20)	(5.35)	(75.17)	(34.92)	(12.51)	(29.19)	(0.10)	
Observations	457	426	691	691	693	454	697	697	191
Countries	43	43	58	58	58	43	58	58	15
R-squared	0.5770	0.6400	0.2790	0.1800	0.5500	0.5970	0.6470	0.5150	

Robust standard errors in parentheses. Fixed effects are included
***p<0.01, significant at 1%, **p<0.05, significant at 5%, *p<0.10, significant at 10%.

APPENDICES

Table A1: Sample

Country	Commodities	Country	Commodities
Angola	Petroleum	Kyrgyz Republic	Gold
United Arab Emirates	Petroleum	Kuwait	Petroleum
Argentina	Gas, iron, petroleum	Libya	Petroleum
Armenia	Copper, iron	Sri Lanka	Copper
Azerbaijan	Petroleum	Morocco	Phosphate
Burundi	Gold	Mexico	Petroleum
Bulgaria	Copper, iron, Petroleum	Macedonia. FYR	Iron
Bahrain	Petroleum	Mali	Gold
Bosnia and Herzegovina	Aluminium	Mongolia	Coal, gold
Belarus	Petroleum	Mozambique	Aluminum, gas
Bolivia	Gas, gold, petroleum, silver, tin	Malaysia	Gas, petroleum
Botswana	Nickel	Namibia	Copper, zinc
Brazil	Aluminum, gold, iron	Niger	Gold
Chile	Copper	Nigeria	Petroleum
Cote d'Ivoire	Petroleum	Nicaragua	Gold
Cameroon	Aluminum, petroleum	Oman	Gas, petroleum
Congo Republic	Petroleum	Peru	Copper, gold, tin
Colombia	Gas, petroleum	Philippines	Copper
Dominican Republic	Gold, iron, petroleum	Qatar	Gas, petroleum
Algeria	Gas, petroleum	Russian Federation	Gas, petroleum
Ecuador	Petroleum	Saudi Arabia	Gas, petroleum
Egypt. Arab Rep.	Gas, petroleum	Sudan	Gold, petroleum
Ethiopia	Gold	Syrian Arab Republic	Petroleum
Fiji	Gold	Togo	Phosphate
Gabon	Manganese, petroleum	Trinidad and Tobago	Gas, petroleum
Georgia	Gold, iron	Tanzania	Gold, silver
Ghana	Gold	Uganda	Gold
Guinea	Gold	Ukraine	Iron
Equatorial Guinea	Petroleum	Venezuela. RB	Aluminum, iron, petroleum
Guyana	Gold	Vietnam	Petroleum
Indonesia	Coal, copper, gas	Yemen. Rep.	Petroleum
Iran. Islamic Rep.	Gas, petroleum	South Africa	Aluminum, coal, gold, iron
Iraq	Petroleum	Zambia	Copper
Jordan	Phosphate	Zimbabwe	Gold, iron, nickel
Kazakhstan	Coal, copper, gas, iron, petroleum		

DEFINITIONS OF EACH INDICATOR ARE AS FOLLOWS:

➔ Banks non-performing loans to gross loans: bank nonperforming loans to total gross loans are the value of nonperforming loans divided by the total value of the loan portfolio (including nonperforming loans before the deduction of specific loan-loss provisions).
➔ Provisions to non-performing loans: they show the extent to which non-performing loans are already covered by provisions. A non-performing loan is a loan that is in default or close to being in default.
➔Return on equity: Banks' after-tax net income to yearly averaged equity.
➔Return on asset: Banks' after-tax net income to yearly averaged assets.
➔ Regulatory capital/risk weighted assets: it is the capital adequacy of deposit takers. It is a ratio of total regulatory capital to its assets held, weighted according to risk of those assets.
➔Liquid assets/short-term funding: the ratio of the value of liquid assets (easily converted to cash) to short-term funding plus total deposits. Liquid assets include cash and due from banks, trading securities and at fair value through income, loans and advances to banks, reverse repos and cash collaterals. Deposits and short term funding includes total customer deposits (current, savings and term) and short term borrowing (money market instruments, CDs and other deposits).
➔Bank cost to income ratio: Operating expenses of a bank as a share of sum of net-interest revenue and other operating income.

-Leaven and Valencia (2013): They define banking crisis if two conditions are met:

(i) Significant signs of financial distress in the banking system (as indicated by significant bank runs, losses in the banking system, and/or bank liquidations)

(ii) Significant banking policy intervention measures in response to significant losses in the banking system.

They consider the first year that both criteria are met to be the year when the crisis became systemic. Policy interventions in the banking sector are considered as significant if at least three out of the following six measures have been used:

1) Extensive liquidity support (5 percent of deposits and liabilities to nonresidents)

2) Bank restructuring gross costs (at least 3 percent of GDP)

3) Significant bank nationalizations

4) Significant guarantees put in place

5) Significant asset purchases (at least 5 percent of GDP)

6) Deposit freezes and/or bank holidays.

Table A2: Descriptive statistics of the main variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Price shocks	1,255	0.45	0.41	0	1
NPLs	914	8.61	7.92	0,50	74,10
Provisions to NPLs	843	79.78	45.80	0,83	457,20
ROA	1,825	1.54	2.44	-51,31	20,81
ROE	1,822	12,90	33.52	-732,93	170,95
Cost	1,848	58.41	17.90	8,66	194,53
Reg. capital	918	16.84	5.41	-20,10	48,60
Liq. Assets	1,859	37.37	19.97	4,93	149,29
Index	1,870	0.517	0.06	0.08	0.85
Crisis	2,109	0.03	0.19	0	1

Table A3: Data Sources

Code	Variable	Data sources
NPLs	Non-performing loans	IMF FSI database
Provisions to NPLS	Provisions to non-performing loans	IMF FSI database
ROA	Return on assets	IMF FSI database
ROE	Return on equity	IMF FSI database
Cost	Cost-to-income ratio	IMF FSI database
Reg. capital	Regulatory capital to risk-weighted assets	IMF FSI database
Liq. assets	Liquid assets to deposits and short-term funding	IMF FSI database
Index	Composite index of the 7 above variables.	Authors' calculations
Crisis	Banking crisis. It is a dummy variable that takes the value of 1 if there is a banking crisis and 0 otherwise.	Laeven and Valencia (2013)
Price shocks	Dummy variable that takes the value of one if there is a negative price shock and 0 otherwise.	Authors' calculations
GDP growth	Rate of real GDP growth	World Economic Outlook (WEO), 2015
Debt	Public debt in percentage of GDP	Abbas, A.S., N. Belhocine, A. Elganainy and M. Horton (2010). A historical public debt database. IMF Working Paper, 10/245.
Exchange rate	Real exchange rate.	World Economic Outlook (WEO), 2015
Real interest rate	Real interest rate which is equal to nominal interest rate divided by GDP deflator	World Economic Outlook (WEO), 2015
M2/reserves	Broad money (M2) to international reserves ratio	World Economic Outlook (WEO), 2015
Inflation	Inflation rate	World Economic Outlook (WEO), 2015
Credit growth	Rate of domestic credit growth	World Economic Outlook (WEO), 2015
GDPPC	GDP per capita	World Economic Outlook (WEO), 2015
IMF	Dummy variable that takes a value of 1 if the country has an IMF program and 0 otherwise.	IMF datasets
Revenue	Government revenue in percentage of GDP	IMF database
Deficit	Budget balance in percentage of GDP	World Economic Outlook (WEO), 2015
Debt in foreign cur.	Debt in foreign currency over GDP	World Economic Outlook (WEO), 2015
Unemployment	Unemployment rate	International Labor Organization database, 2015
Savings	Domestic savings in percentage of GDP	World Economic Outlook (WEO), 2015
SWF	Sovereign wealth fund. Dummy variable that takes a value of 1 if the country has a SWF in the current year and 0 otherwise.	Peterson Institute for International Economics and IMF survey
Exchange regime	Exchange rate regime classification (coarse).	Ilzetzki, Reinhart and Rogoff (2008)
Private credit	Domestic credit to the private sector over GDP	World Economic Outlook (WEO), 2015
Polity 2	Degree of democracy. The polity 2 score ranges from -10 to +10, with higher value representing more democracy.	Polity IV project (Marshall and Jaggers 2002)
Investment profile	It evaluates the risk to investment. High score points equates to very low risk.	International Country Risk Guide (ICRG)
Corruption	It represents the extent to which public power is exercised for private gain, including petty and grand forms of corruption.	Worldwide Governance Indicators - World Bank
Gov. Effectiveness	It measures the quality of public services, the quality of the civil service and the degree of its independence from political pressures and the quality of policy formulation	Worldwide Governance Indicators - World Bank
Reg. Quality	It measures the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.	Worldwide Governance Indicators - World Bank
Macro-prudential policies	Year-to-year change in the number of macro-prudential instruments	Cerutti, Claessens and Laeven (2015)
Diversification	Extensive diversification of exports	IMF datasets

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