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Strategy, Policy, and Review Department

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Abstract

We study the role of the bank-lending channel in propagating fluctuations in commodity prices to credit aggregates and economic activity in developing countries. We use data on more than 1,600 banks from 78 developing countries to analyze the transmission of changes in international commodity prices to domestic bank lending. Identification relies on a bank-specific time-varying measure of bank sensitivity to changes in commodity prices, based on daily data on bank stock prices. We find that a fall in commodity prices reduces bank lending, although this effect is confined to low-income countries and driven by commodity price busts. Banks with relatively lower deposits and poor asset quality transmit commodity price changes to lending more aggressively, supporting the hypothesis that the overall credit response to commodity prices works also through the credit supply channel. Our results also show that there is no significant difference in the behavior of foreign and domestic banks in the transmission process, reflecting the regional footprint of foreign banks in developing countries.

JEL Classification Numbers: F30; F34; G21; Q02.

Keywords: Bank lending; Commodity prices; Macro-financial linkages; Developing countries.

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1 Introduction[1]

Developing countries have traditionally been extremely vulnerable to adverse external shocks, with severe impact on output growth and macroeconomic and political stability (Deaton, 1999; Loayza *et al.*, 2007; Raddatz, 2007; Brückner and Ciccone, 2010; Dabla-Norris and Bal Gunduz, 2014; Bazzi and Blattman, 2014). Among external shocks, commodity price shocks tend to be particularly important for developing countries, given their high reliance on commodity exports. While changes in commodity prices can be expected to directly affect earnings of firms and government revenues, and thereby economic activity, the role of the banking sector in propagating these shocks to the real economy is less clear. In this paper, we focus on uncovering this latter channel in the transmission of commodity price shocks to the real economy through bank lending. As the size of the financial sector increases with economic growth in developing countries, macro-financial linkages can play an increasingly important role in the transmission of shocks, both domestic and external, to the real economy. While there is no dearth of studies on the international transmission of shocks through the banking sector in the context of advanced and emerging market economies (Cetorelli and Goldberg, 2011; Schnabl, 2012; De Haas and Van Horen, 2013; Ivashina *et al.*, 2015; Ongena *et al.*, 2015; Morais *et al.*, 2017), there is little evidence on the transmission of global shocks to developing countries, possibly because banks are relatively less integrated in the global financial system. At the same time, banks still represent an important source of finance for domestic firms in an environment of limited financial depth. Thus, depending on its potency, the transmission of international shocks through bank lending could have important effects on the real economy in developing countries, where bank credit is a key driver of firm growth and entrepreneurship, and can have significant welfare implications through employment creation and poverty alleviation. (Burgess and Pande, 2005; Beck and Demirguc-Kunt, 2006; Karlan and Zinman, 2010; Banerjee and Duflo, 2014; Bruhn and Love, 2014).

In this paper, we try to fill this gap in the literature by assessing whether and to what extent banks in developing countries transmit changes in international commodity prices to the do-

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mestic economy through the bank-lending channel. We also investigate the mechanisms that drive the transmission process, to uncover differences in these channels compared to the experience of financially more advanced economies. Specifically, we examine whether the funding and capital structure of banks play a role, whether bank ownership (foreign vs domestic) matters, and whether there are asymmetries across episodes of commodity prices increases versus declines.

Examining the strength of spillovers from global shocks to developing countries through the lens of global commodity price changes is ideal for three main reasons. First, many developing countries are highly reliant on commodities and fluctuations in commodity prices are often a major source of economic volatility. Fernández *et al.* (2017), for instance, estimate that over a third of the variance of output, consumption, and investment in developing countries is accounted for by fluctuations in commodity prices and the world interest rate. Similarly, Raddatz (2007) shows that even if most of the variance in real per capita GDP in low-income countries is explained by domestic factors, the effect of external shocks is economically meaningful and, among external shocks, changes in commodity prices are the most important sources of output fluctuations. Second, the last 15 years have been characterized by ample swings in countries' idiosyncratic terms of trade, which provide enough variability in the data to look at the effect of international commodity price changes on bank lending. Finally, international commodity prices—and their changes—could be considered exogenous to bank lending behavior (see Bazzi and Blattman, 2014, for a comprehensive discussion of commodity price shocks in a developing country setting).[2]

International commodity price swings can impact real activity directly by affecting margins of exporters — a fall in commodity net export prices would have a negative impact on the profits of exporters, likely inducing a scale back in employment or postponement of investment. To the extent some of the economic activity was financed through borrowing, the shock will also result in a lower demand for credit. This is the *direct* effect of a fall in commodity prices. In addition, low commodity prices could also dampen credit through an additional channel vis-a-vis a liquidity shock or a deterioration of bank health. For instance, lower deposits due to slower economic activity could generate a liquidity shock to domestic banks. Insofar as banks cannot easily substitute deposit funding with wholesale funding (which is typically the

[2]A possible concern is that some countries are not 'price-takers': for those countries, if growth collapses for a different reason, the recession could affect both international prices and bank lending—via lower demand—generating a spurious correlation between the two variables. However, demand for credit should affect all bank equally in this case, while our identification relies on differential bank exposure to the commodity sector, and in particular, on the deterioration of bank credit quality. In addition, since our commodity net export price index considers exports and *imports* of a comprehensive basket of 45 commodities, we argue that the possible effect of one commodity would be partially washed out by other commodity prices for which the country is 'price-taker'. Finally, as a robustness check, we exclude countries that depend on a single commodity (see Section 4).

case in developing countries), they would respond by curtailing credit (Kashyap and Stein, 2000; Jayaratne and Morgan, 2000; Khwaja and Mian, 2008). Moreover, government arrears and weak revenue growth of commodity dependent firms may render them unable to service their loans, thereby worsening bank asset quality and eroding capital. The diminished ability of banks to raise market funding would impact the asset side and, as a result, bank lending to the economy can slow down further (Gambacorta and Shin, 2016). This is the *indirect* effect of a fall in commodity prices through the bank-lending channel.

Our analysis focuses on uncovering this *indirect* channel through which international commodity price changes can induce changes in domestic credit. We estimate the effect of international commodity prices on domestic bank lending over the period 2004-2015 using a large sample of over 1,600 banks in 78 developing countries. This period is characterized by large swings in commodity prices and our identification strategy hinges on differential exposure of individual banks to variations in country-specific commodity net export prices. In the spirit of Acharya and Steffen (2015) and Beck *et al.* (2017), we construct a time-varying, bank-specific measure of exposure or sensitivity for each listed bank in our sample using factor loadings from a regression of daily bank stock prices on the broad market index and commodity prices. In particular, we are interested in the heterogeneous response of banks to commodity net export prices, depending on their sensitivity to the commodity sector.

Our baseline results confirm that banks which are more exposed to the commodity sector (i.e. banks whose stock prices show a higher comovement with commodity prices) reduce lending more in response to a fall in international commodity prices, even after controlling for bank specific characteristics and macroeconomic factors. A one standard deviation decline in the commodity net export price index (which amounts to about 10 percent decline in the net commodity export price for a median economy) is associated with a 1.1 percentage points decline in lending by a bank weakly exposed to the commodity sector and with a 1.8 percentage points decline for a highly exposed bank.[3] We also find that this effect is driven by banks located in low-income countries, especially commodity exporters. For instance, a decline in net export prices similar to that experienced by Nigeria between 2009 and 2010 leads to a 4.9 percentage points contraction in lending by banks highly exposed to the commodity sector.

A key challenge is identifying whether the change in bank lending is the result of a shift in the demand or supply of credit. On the one hand, after a decline in commodity prices, banks which are more exposed to the commodity sector can see a larger contraction in lending rela-

[3] A one standard deviation decline in the commodity net export price index in our sample broadly corresponds to the average decline between 2010 and 2013. We define banks as weakly (highly) exposed to the commodity sector if they are at the 10^{th} (90^{th}) percentile of the sensitivity measure, as defined below, Section 2.

tive to weakly exposed banks if exporters postpone their investment and reduce their demand for credit. This is the *credit demand channel* of commodity prices. On the other hand, the *credit supply channel* would be at play if highly exposed banks experience a liquidity shock, and this would result in an additional reduction in bank lending. A sharp decline of commodity prices will likely slow down economic activity, possibly leading to a fall of bank deposits (see Figure 1). Given the high reliance of banks in developing countries on retail funding, the liquidity shock may end up affecting the credit supply of highly exposed banks. The credit supply channel can also operate through a deterioration in bank asset quality, as exporters find it unable to service their loan repayments, leading to an increase in non-performing loans of the highly exposed banks. While we can control for a set macroeconomic variables which could affect the demand for credit (mainly GDP growth and interest rates), and we saturate the model with bank, country, and time fixed effects[4], we cannot absorb bank-specific time-varying shifts in credit demand. Thus, our baseline analysis cannot establish if the response of credit to commodity prices is due to a credit supply or a credit demand channel. To try to disentangle between these two channels we exploit the heterogeneity in bank balance sheet characteristics. If the demand channel is explaining the positive correlation between commodity prices and bank lending seen in the baseline results, the transmission mechanism should not depend on funding and balance sheet strength of banks. However, if the transmission mechanism is working also through the credit supply channel, it should be stronger for banks with weak deposit-to-assets ratio and worse asset quality.

When looking at bank heterogeneity, our findings suggest that bank balance sheet changes (in liquidity and asset quality) induce an additional effect of international commodity price shocks on the supply of credit. We find that the deposits-to-assets ratio and asset quality (as measured by the ratio of NPLs to gross loans) are important factors driving how aggressively a bank responds to changes in commodity prices. Banks with low deposits-to-assets ratio and with high non-performing loans to gross loans reduce lending more in the event of a decline in commodity prices, consistent with the presence of a credit supply channel. In terms of economic magnitude, a bank at the 90th percentile of our sensitivity measure, and with low (high) deposits, contracts lending by 4.1 (1.6) percentage points in response to a one standard deviation decline in the commodity net export price index.

We provide further evidence that the credit response to changes in commodity prices is significantly affected by the credit supply channel by looking at the direct effect of commodity prices on a set of bank balance sheet characteristics. We find that, in response to a commodity

[4]While there is not enough variation in our data to include country $\times$ year fixed effects, we are able to add to the model country $\times$ bi-annual fixed effects to proxy for time-varying country-specific changes in demand.

price bust, bank deposits contract more in banks more sensitive to commodity prices, consistent with the hypothesis that the slowdown in loan growth is due to a liquidity shock (Kashyap and Stein, 2000). We also find that non-performing loans increase more for banks more sensitive to commodity prices, in line with the idea that banks reduce their credit supply because of worsening asset quality and subsequent problems in raising market funding.

Our analysis provides two other insights. First, we do not find any significant difference in the response of foreign banks and domestic banks to fluctuations in commodity prices. This finding can be explained by the prevalence of 'regional' foreign banks in low-income countries, or the fact that foreign banks are locally incorporated and reliant on retail funding, as compared to 'global' foreign banks in advanced economies. Hence, a foreign bank in Ghana from Nigeria may not be able to source funding from its home country as commodity price busts affect all commodity exporters (Nigeria and Ghana in this example) simultaneously. Second, our results reveal that the transmission of commodity price shocks to the banking sector is asymmetric. The positive relationship between commodity net export prices and loan growth observed in the overall sample is driven exclusively by period declining commodity prices.

Our results are robust to a number of additional exercises, which use alternative sensitivity measures and country-specific commodity price indexes, expand the set of macroeconomic variables to control for the credit demand channel, and use different model specifications.

Our paper speaks to the literature on the economic effects of commodity price changes in developing countries and makes a contribution on three fronts. First, we expand on the literature on the international transmission of macroeconomic shocks through the bank lending channel (Peek and Rosengren, 1997; Cetorelli and Goldberg, 2011; Schnabl, 2012; Ivashina *et al.*, 2015; Ongena *et al.*, 2015; Baskaya *et al.*, 2017; Morais *et al.*, 2017) by focusing on the role of commodity prices, which represent a key external shocks for many developing countries. In this respect, understanding the role of banks in the transmission of international commodity prices could provide novel insights, given that the banking sector in developing countries differs along a number of features compared to more advanced economies—bank size and efficiency, funding and capital structure, and foreign ownership (Beck *et al.*, 2010; Allen *et al.*, 2014; Claessens and Van Horen, 2014). Indeed, the lack of evidence of any specific role for foreign banks in amplifying or dampening the transmission of shocks is unique to the experience of low-income countries, and can be explained by the prevalence of regional banks, the strong reliance on retail funding also of foreign banks, and the ineffectiveness of internal capital market funding. Instead, a strong transmission for banks with low deposits indicates that banks' ability to tap other sources of funding is limited, consistent with a lower share of

wholesale funding in developing countries. While the analysis focuses on bank-specific effects, the aggregate country-specific effects would also clearly be higher for countries that are more dependent on commodity exports and thereby are host to banks that are more sensitive to commodity prices.

Second, we quantify the role of the financial intermediation channel in the transmission of commodity price shocks on real activity, which has been often overlooked by the development literature (Mendoza, 1997; Deaton, 1999; Bleaney and Greenaway, 2001; Raddatz, 2007). Our results suggest that fall in commodity prices could have a second-round effect on economic activity through a contraction in credit supply, and this effect could be economically significant, given the heavy reliance of several developing countries on the traditional banking sector.[5]

Third, we provide new evidence on the asymmetric effect of commodity prices and on the importance of bank balance sheet strength and macroeconomic fundamentals for the transmission of the shock to domestic credit, which can guide the current debate on macroprudential policies in developing countries.

The rest of the paper is organized as follows: Section 1 presents the data, Section 2 outlines the empirical strategy, Sections 3 and 4 discuss the results and a set of robustness checks, while Section 5 concludes.

2 Data and stylized facts

2.1 A country-specific commodity net export price index

In the spirit of Deaton and Miller (1995) and Bazzi and Blattman (2014), we consider a country-specific measure of commodity prices based on 45 commodities. More specifically, we use the commodity net export price ($CNEP$) index constructed by Gruss (2014), starting from monthly data, as follows:

$$CNEP_{i,t} = \sum_{j=1}^{J} P_{j,\tau}\omega_{i,j,t} \tag{1}$$

where, $P_{j,\tau}$ is the logarithm of the relative price of commodity j in period (month) τ within year t (in U.S. dollars and divided by the IMF's unit value index for manufactured exports),

[5]To the best of our knowledge only a few papers have investigated the effects of commodity prices on the financial sector in developing countries. Kinda *et al.* (2016) look at the effect of commodity prices on financial fragility in a sample of emerging and developing countries and show that negative commodity price shocks are associated with higher non-performing loans, lower profitability, and a higher likelihood of banking crises. Ftiti *et al.* (2016) look at the relationship between commodity prices and credit to the private sector in three African commodity exporters—Burkina Faso, Niger and Ivory Coast—and show a strong association between fluctuations in commodity prices and private credit. Moreover, in another recent contribution, Caggiano *et al.* (2014) focus exclusively on LICs to identify the drivers of banking crises, but they do not explicitly take into consideration the role of commodity prices.

and the weights are pre-determined and calculated as a three-year average:

$$\omega_{i,j,t} = \frac{1}{3}\sum_{s=1}^{3}\frac{x_{i,j,t-s} - m_{i,j,t-s}}{\sum_{j=1}^{J} x_{i,j,t-s} + \sum_{j=1}^{J} m_{i,j,t-s}} \tag{2}$$

where, $x_{i,j,t-s}$ is the export value (in USD) of commodity j from country i in year $t-s$, and $m_{i,j,t-s}$ is the import value (in USD) of commodity j by country i in year $t-s$. Hence, the weights reflect the net-export of each commodity as a share of total trade (sum of exports and imports of all commodities) in a given country.

The key advantage of such a measure, compared to a more standard commodity price index, is that being country-specific, it can take into account the fact that prices of different commodities have been moving quite differently in past years, so that not all countries have been equally hit by the slowdown in commodity prices.[6] Also, having predetermined weights, rather than fixed ones, it takes into consideration the rapid change in the composition of export products in several developing countries.

Data on macroeconomic variables—GDP, domestic interest rates, inflation, exchange rates, credit to the private sector—are from the IMF's World Economic Outlook and International Financial Statistics Database, and the World Bank's World Development Indicators, while the index of capital account openness is taken from Chinn and Ito (2006). See Table A2 for variable definitions and data sources.

2.2 Bank-level data

We use bank-level data from Bankscope, a global database of banks' financial statements which covers about 90 percent of the total assets of the banking system in each country. The sample is constrained by the availability of bank-level data in Bankscope. In particular, we limit our analysis to developing countries with data for at least 5 active banks in any year and we retain banks with at least one non-missing value for the key bank-level variables used in the baseline model.[7] As a result, our sample consists of 78 countries with 1,642 active banks for the time period 2004-2015.[8] We use the following bank-level variables from Bankscope: the growth rate of total loans (measured in nominal USD), the ratio of equity over assets, the ratio of deposits over assets, liquidity (defined as the ratio of liquid assets over deposit and short term funding), size (as the log of total assets), return on assets (ROA), and the ratio of non-performing loans

[6] This indicator also shows an improvement in the country-specific terms of trade for commodity-importing countries when commodity prices decline.

[7] We use the World Bank classification of low- and middle-income country groups, excluding G-20 countries, to define developing countries in our sample.

[8] Out of the 1,642 banks in the sample, 495 are headquartered in low-income countries and 249 banks are listed. See Appendix Table A1 for the list of countries and the number of banks (and listed banks) included in the sample.

to gross loans.[9] Daily data on stock prices for listed banks in our sample is from Datastream and Bloomberg and data on stock market index in each country is from Bloomberg.

Table 1 presents the summary statistics for loan growth and the key bank characteristics, isolating banks headquartered in low-income countries in the bottom panel. It is important to note that there is significant variation across banks in terms of balance sheet characteristics, a feature that we will exploit in our analysis of the transmission of commodity prices on lending across different banks. In particular, average (median) loan growth in the sample is 18.6 (12.6) percent, but it shows a large variation across banks. Loan growth is somewhat higher (about one percentage point) for domestic compared to foreign banks and for stronger capitalized banks. More interesting differences in loan growth emerge across other bank characteristics. Banks with low deposit funding and low NPL ratios shows much higher loan growth, on average, than banks with relatively higher deposits and NPL ratios, and this is true also with the sample of low-income countries. Loan growth tends to be sensitive to commodity prices, especially in countries with a high share of commodity exports to GDP. A simple plot of the data illustrates the positive correlation between loan growth and the commodity net export price index, particularly in low-income countries (Figure 2).

3 Empirics

3.1 Bank sensitivity to commodity prices

Our strategy to identify the effect of commodity prices on bank lending relies on the differential sensitivity of banks to variations in commodity prices. The ideal method to compute sensitivity of banks to commodity prices would be to directly observe the balance sheets of these banks and look for the share of loans to commodity exporters in total lending. However, we are restricted by our sample from doing so. Balance sheet data for banks in developing countries do not allow us to compute a precise measure of sensitivity using loans to commodity exporters. Instead, we use a novel methodology to construct our measure of bank-level sensitivity, motivated from the observation that stock prices of banks that are strongly exposed to the commodity sector tend to move together with commodity prices. Figure 3, for instance, shows a strong correlation between stock returns and the commodity price index between 2011 and 2017 for two large Nigerian banks—First Bank of Nigeria and Skye Bank—which are particularly exposed to the energy sector.[10] Following Acharya and Steffen (2015) and Beck *et al.*

[9] Total loans include credit extended to all sectors of the economy and we are not able to distinguish between private and public sector lending. The definition of each variable is in Table A2; all variables are winsorized at the 5^{th} and 95^{th} percentile to remove outliers.

[10] See a recent article on Vanguard (2015) for a recent overview of the effects of energy prices on the financial sector in Nigeria.

(2017), we compute a time-varying sensitivity measure for each listed bank in our sample by estimating the following regression on a one-year rolling window for each year and each listed bank:

$$\ln(P)_{bd} = \alpha + \beta \ln(COMMODITY\ PRICE)_d + \gamma \ln(MARKET\ INDEX)_d \quad (3)$$

where, $\ln(P)_{bd}$ is the log of daily stock price of bank b on day d, $\ln(COMMODITY\ PRICE)_d$ is the log of commodity price index on day d and $\ln(MARKET\ INDEX)_d$ is the log of stock market index of the country where the bank is located.[11] To get the sensitivity measure of a bank b to commodity prices for year t, we estimate equation (3) using daily data in the period $t-1$ to t and use the coefficient β as our sensitivity measure.[12] Figure 4 shows the distribution of our bank-level measure of sensitivity to commodity prices, calculated for the 249 listed banks in our sample, separating between the whole sample and those restricted to banks headquartered in low- and middle-income countries. The chart shows that the estimated β are normally distributed in all samples, even though the mean (and the median) is larger in LICs than in MICs (0.284 versus 0.025), suggesting a greater dependence of banks headquartered in low-income countries on the commodity sector.

Since about 15 percent of the banks in our sample are listed, if we retain only the listed banks in our sample we are not left with enough observations to run a cross-country analysis. Hence, to maintain enough degrees of freedom, we impute the sensitivity measure for the unlisted banks in two steps: first, for a given country-year pair, we impute the sensitivity measure for unlisted banks as the average bank-level sensitivity measure of listed banks in that country and for that year. For those countries in our sample without listed banks, we use the share of commodity exports in the country's GDP as our measure of sensitivity. This choice ensures that we do not exclude countries with underdeveloped financial markets from the analysis. In doing so, we assume that banks located in commodity-dependent countries are more affected by commodity price shocks than the ones located in countries with low dependence on commodity exports, and that all banks in the country are equally exposed to the commodity sector.[13] Figure 5 shows that there is a substantial variation in the share of commodity exports over GDP across banks. For the bank in the median country, the share of commodity exports to GDP is around 7 percent, but the share varies substantially across banks—the third quartile is above 15 percent and, on average, commodity exports account for

[11] Both indices are taken from Bloomberg. In particular, we use the BCOM Index for commodity prices.

[12] To the best of our knowledge, this is the first paper which computes sensitivity of banks to commodity prices using this methodology.

[13] Since these are indeed quite strong assumptions, in Section 4 we show that our results do not depend on this choice, as they are robust to the exclusion of the banks headquartered in countries without listed banks.

more than 20 percent of GDP in a number of countries in the sample (e.g., Bolivia, Congo, Mauritania, Mongolia, Nigeria, Tajikistan, Vietnam, Yemen and Zambia).

3.2 Loan growth and commodity prices

We look at the response of bank lending to changes in commodity prices by estimating the following model, based on the traditional specifications used to estimate the reaction of bank lending to monetary policy shocks (Kashyap and Stein, 1995; Gambacorta and Mistrulli, 2004; Gambacorta, 2005; Gambacorta and Marques-Ibanez, 2011; Aiyar *et al.*, 2016):

$$\begin{aligned} \Delta LOANS_{bct} &= \alpha_1 CNEP_{ct-1} \times SENS_{bct-1} + \alpha_2 CNEP_{ct-1} + \alpha_3 SENS_{bct-1} + \\ &+ \mathbf{COUNTRY}_{ct-1} + \mathbf{BANK}_{bct-1} + \delta_b + \tau_t + \epsilon_{bct} \end{aligned} \tag{4}$$

where $\Delta LOANS_{bct}$ is the growth rate of outstanding loans (in nominal USD) of bank b, located in country c, in year t; $CNEP_{ct-1}$ is the country-specific commodity price index presented in equation 1 for country c in the previous year $(t-1)$; $SENS_{bct-1}$ is the lagged sensitivity measure of bank b to commodity prices, as discussed above; $\mathbf{COUNTRY}_{ct-1}$ is a set of country-specific control variables including real GDP growth and the logarithm of domestic interest rates; $\mathbf{BANK}_{bct-1}$ is a set of time-varying bank-specific controls, lagged one period, including past loan growth, measures of liquidity, size, capitalization, and deposits to asset ratio; δ_b and τ_t are bank and year fixed effects; and ϵ_{bct} is the standard error term.[14] Since the sensitivity measure varies at the bank level, standard errors are also clustered at the bank level to allow for intra-bank autocorrelation of the residuals within banks. The coefficient of interest is α_1, which identifies the extent to which changes in commodity prices affect bank lending, exploiting the differential sensitivity of banks to the commodity sector.

A key challenge when estimating the effect of commodity prices on bank lending is disentangling the credit demand from the credit supply channels. The estimated coefficient on the commodity price index, in fact, could capture a change in the supply of bank lending, but also a shift in demand for credit. For instance, a sharp decline in the terms of trade would induce a slowdown of economic activity of exporters, which will demand less bank credit. However, it could also affect bank asset quality (e.g., through an increase in NPLs due to worse economic conditions), so that banks will contract their balance sheets—this would be the supply channel. While the baseline estimation is silent on which of these channels is driving the result, we will try to tackle this issue providing further evidence on the transmission mechanism in Section

[14] Compared to the traditional literature cited above, our data are at annual frequency, rather than quarterly, so that we simply take all the explanatory variables lagged one year, rather than including a more complex lag structure.

3.2.

Bank fixed effects control for the possibility that a systematic matching between banks and firms confounds the identification of the effect of commodity prices. For instance, there is a consistent literature showing that large banks often lend to large firms (Berger and Udell, 2002) and that the latter are more likely to be exporters (see, for instance, Rankin *et al.*, 2006, for evidence on Africa) and affected by commodity prices. In that case, the change in prices would affect the demand for credit, rather than the supply. Controlling for bank fixed effects enables us to get around this issue to some extent, however, it does not allow us to get clean estimates of the credit supply channel.

The inclusion of year fixed effects absorb global shocks that may change the demand for credit (i.e., the global financial crisis), while GDP growth and the level of interest rate absorb part of the country-specific demand for credit.[15] To control for country-specific unobserved heterogeneity in credit demand, we include country fixed effects and, as a robustness exercise, we also include time-varying country fixed effects to absorb differential shifts in credit demand over time and across countries (see Section 4). However, even though time-varying country fixed effects may be able to capture cross-country unobserved heterogeneity in credit demand, they do not allow us to capture bank-specific heterogeneity in credit demand, preventing a clean identification of the credit supply channel.

4 Results

4.1 Baseline results

Table 2 presents the results from our baseline model, estimated on a sample of 1,642 banks in 78 countries. We start by documenting the relationship between international commodity prices and bank lending. The first two columns include sequentially year, country and bank fixed effects, while column 3 adds bank-level controls, and column 4 further augments the model with country-level variables. Results indicate a positive, *unconditional*, association between commodity prices and bank lending in developing countries. The coefficient on commodity net export prices is positive and precisely estimated and, in the specifications with all controls and fixed effects, indicates that one standard deviation in the commodity net export prices index—which in our sample broadly corresponds to the average decline between 2010 and 2013—is associated with a contraction of 1.5 percentage points in bank lending one year ahead. The coefficients on control variables have the expected sign and are significant: loan growth is faster for more liquid, better capitalized and smaller banks, and for those with

[15] Results are robust to the inclusion of several other macroeconomic variables, see Section 4.

a higher deposits-to-assets ratio. The positive and significant coefficient on the lagged loan growth indicates some persistence in bank credit. Bank lending is also stronger in countries that grow faster (the effect decreases comparing contemporaneous and lagged growth), and it slows down in response to a (contemporaneous) increase in interest rates.

To identify the effect of international commodity prices on the domestic economy through the financial intermediation channel, in column 5 we exploit the cross sectional variation of bank sensitivity to the commodity sector. Once we introduce the interaction term between the lagged value of the commodity price index and the measure of sensitivity to fluctuations in commodity prices of the country in which the bank is located, we find that the effect of commodity prices on loan growth depends on the intensity of bank sensitivity to the commodity sector. The positive and significant coefficient on the interaction term $CNEP \times SENS$ implies that banks which are more sensitive to commodity price shocks curtail lending more in response to a fall in commodity prices. In terms of economic magnitude, one standard deviation decline of the commodity net export price index is associated with a contraction of loan growth of 1.8 percentage points for banks highly exposed to the commodity sector (i.e., those with $SENS$ at the 90^{th} percentile of the sample distribution), and with a 1.1 percentage points reduction for weakly exposed banks (those with $SENS$ at the 10^{th} percentile of the sample distribution.

To check whether the positive relationship between commodity prices and credit is a specific feature of low-income countries, we split the interaction term $CNEP \times SENS$ into two country groups—low-income and middle-income countries (column 6). We find that the interaction term is significant and positive only for LICs. In the last column we run the baseline model of column 5 only on the sample of banks headquartered in LICs and we find a coefficient on the interaction term very similar, albeit marginally higher, to that estimated on the whole sample. This result can be explained by different factors. A less developed and shallow banking system in low-income countries could be more vulnerable to fluctuations in commodity prices. Even if the banking system is resilient to shocks, a higher dependence of LICs on commodity exports, would imply a stronger transmission from prices to credit aggregates.

Thus, from now on we will base the analysis of the bank lending channel of commodity prices on the sub-sample of banks located in LICs, focusing on heterogeneous effects across bank and country characteristics.

4.2 Bank heterogeneity

Our baseline results suggest that in the event of a commodity price decline, banks with a high exposure to commodity prices reduce lending more relative to banks with low exposure. This result is agnostic of the distinction between credit supply and credit demand channel. Changes in commodity prices can, in fact, affect bank lending through the credit demand or the credit supply channel. As commodity prices fall, banks which are more exposed to commodities can see a larger decline in lending relative to weakly exposed banks if exporters postpone their investment and reduce their demand for credit. This is the credit demand channel of commodity prices. If, however, highly exposed banks experience a liquidity shock—as deposits fall due to a decline of commodity prices—they will be more likely to curtail lending, as retail deposits is typically the dominant source of funding for banks in developing countries. This is the credit supply channel of commodity prices. This channel can also operate through a deterioration in bank asset quality, as exporters find it unable to service their loan repayments, leading to an increase in non-performing loans of the highly exposed banks. If the demand channel is explaining the positive correlation between commodity prices and bank lending seen in the baseline results, the transmission mechanism should not depend on funding and balance sheet strength of banks. However, if the transmission mechanism is working through the credit supply channel, it should be stronger for banks with weak deposit-to-assets ratio and worse asset quality (measured by the ratio of non-performing loans to total loans).

To uncover the mechanisms behind the transmission of commodity prices to credit growth and provide evidence supporting the credit supply channel, we focus on three measures of bank balance sheet strength—bank capital, deposits and non-performing loans. When considering balance sheet characteristics, we divide the banks into *high* and *low* groups, where *low* refers to the banks in the lowest decile of the sample distribution of the bank-characteristic in question, while *high* refers to the remaining banks. We enrich the model in equation 4 by splitting the coefficient on the interaction term $CNEP \times SENS$ between the two groups of banks (low and high levels of capital, deposits and NPLs), as follows:

$$\begin{aligned} \Delta LOANS_{bct} \;=\; & \gamma_1 CNEP_{ct-1} + \gamma_2 SENS_{bct-1} \\ & + \gamma_h CNEP_{ct-1} \times SENS_{bct-1} \times BANK^{HIGH}_{bct-1} \\ & + \gamma_l CNEP_{ct-1} \times SENS_{bct-1} \times BANK^{LOW}_{bct-1} \\ & + \mathbf{COUNTRY}_{ct-1} + \mathbf{BANK}_{bct-1} + \delta_b + \tau_t + \epsilon_{bct} \end{aligned} \tag{5}$$

In this model, we are interested in the coefficients γ_h and γ_l, which quantify the differential effect of commodity prices on lending across bank characteristics. Then, we consider bank

ownership (foreign vs domestic) to test whether foreign banks could mitigate or amplify the effects of external shocks.[16] All specifications include the standard set of bank and country-level controls and bank, year, and country fixed effects.

Table 3 summarizes the results. In column 1, 2, and 3 we show the estimates for banks with low and high equity, deposits and NPLs, respectively. While bank capital does not seem to play any role, the results on bank deposits and asset quality unveil interesting heterogeneities in the transmission process. Banks with a low deposits-to-assets ratio (column 2) and high non-performing loans to gross loans (column 3) are those which exhibit a stronger transmission of commodity price shocks to loan growth. The p-values reported at the bottom of Table 3 show that the difference between high and low categories is statistically significant. These findings lend support to the transmission of the external shock to loan growth via the credit supply channel. The exposure to commodity prices affects only the supply of credit of banks whose deposit base dries up, leading to a contraction in their lending capacity. Similarly, when commodity net export prices go down, non-performing loans start to accumulate as exporters suffer losses and government arrears grow. This negative effect on bank asset quality will impair bank ability to raise market funding and force them to reduce lending.

Overall, our results suggest that the bank-lending channel increases the vulnerability of the domestic economy to international shocks and provides another indirect mechanism that could magnify the transmission of commodity price changes to firms and to the real economy in LICs. The results are also economically relevant: in response to a one standard deviation decline of the commodity net export price index, a bank with high exposure (at the 90^{th} percentile of the sample distribution) and low-deposit contracts lending by 4.1 percentage points. This effect is not trivial, given that the median loan growth for banks with low deposits to asset ratio is 19.8 percent. By contrast, the credit contraction for a bank with high deposits is only 1.1 percentage points. The effect for banks with relatively higher NPLs is smaller, as a one standard deviation decline in $CNEP$ leads to a 1.7 percentage points lower credit growth (for those banks the median growth is 15.6 percent).

In column 4 we test for a differential effect across domestic and foreign banks. Contrary to the existing evidence pointing to foreign banks as a channel of transmission of financial shocks across borders (Cetorelli and Goldberg, 2012; Cull and Martinez Peria, 2010; De Haas and Van Lelyveld, 2014; Ongena *et al.*, 2015), we do not find any significant difference in the transmission behavior of foreign and domestic banks and the point estimates are extremely close. One possible reason behind the common effect across bank ownership is the similarity

[16] We classify a bank as a foreign bank if the country code of the global ultimate owner of the bank is different from the country code where the bank operates.

of business models between domestic and foreign banks that operate in low-income countries. Many banks in low-income countries are regional banks (e.g., 'Pan-African' banks, see International Monetary Fund, 2015) that are locally incorporated and share a similar business model to many domestic banks and differ from large international banks (Claessens and Van Horen, 2014). For instance, in our sample the foreign banks headquartered in LICs rely on retail funding as much as domestic banks, and their access to wholesale funding is much smaller than that of foreign banks headquartered in emerging economies.[17] Hence, if the home country of the foreign bank is simultaneously hit by a similar commodity price shock, the parent bank is unable to provide a protective liquidity buffer to its subsidiary in the host country.

Even though we do not find evidence that bank ownership matters for the transmission, we further rule out the possibility that our results are driven by the presence of foreign banks, some of which may have access to alternative sources of funding via internal capital markets, by replicating our analysis in the sub-sample of domestic banks. The results, presented in columns 5 and 6, indicate that the deposits-to-assets ratio and non-performing loans are the key channels for the transmission of commodity prices to bank lending.[18]

4.3 Commodity prices and bank balance sheet strength

The results discussed in the previous section suggest that changes in commodity prices could affect the supply of credit in developing countries through a bank funding shock and worsening of asset quality. In this section we conduct a direct test to validate the mechanisms behind the transmission of the international commodity price shock to domestic lending. To formally assess the impact of commodity prices on the health of the banking system, we estimate a set of simple panel regressions in which a set of bank health indicators—equity over assets, the return on assets, non-performing loans to gross loans, and deposits over assets—are function of the lagged price changes ($CNEP$) and its interaction with the measure of bank sensitivity to commodity price changes ($SENS$). As in the loan growth equation, we include country, bank and year fixed effects to absorb bank-specific and country-specific unobserved heterogeneity and the effect of global shocks on bank performance.

Our results, based on the sample of banks headquartered in LICs, show that commodity net export prices indeed affect bank deposits and NPLs. Banks that are more sensitive to

[17] For banks located in LICs, retail funding is equal to 85 percent of total funding for the average foreign bank and 83 percent for the average domestic bank. By contrast, in emerging markets the average share of retail funding for foreign banks is 61 percent.

[18] One may still wonder if our results are picking up something else. In particular the one related to a funding shock could be related to bank size, as smaller (independent) banks tend to rely more on retail deposits, while larger banks have an easier access to other liabilities (Kashyap and Stein, 2000; Campello, 2002). However, when we divide banks between small and large we do find that the effect of commodity prices on lending is similar across the two groups (results available upon request).

fluctuations in commodity prices experience a reduction of deposit funding and an increase in NPLs in response to a fall in commodity net export prices (Table 4, columns 1 and 2). This evidence is in line with that found for the lending equation and provides further support to the credit supply channel, according to which banks more exposed to the commodity sector are more likely to experience a liquidity shock and a deterioration of asset quality, leading to a slowdown in the supply of credit. By contrast, there is no significant correlation with bank profitability, even though the coefficients have the expected signs (column 3). Finally, when looking at the total equity-to-assets ratio, results indicate that when commodity net export prices increase, the ratio decreases with the exposure of banks to the commodity sector. While counter-intuitive, this result could be explained by an expansion in bank assets following a positive change in commodity prices (column 4).

4.4 Country heterogeneity and asymmetry

The effect of commodity prices on bank lending could also depend on the characteristics of the countries where banks are located. In particular, the dependence on commodity prices could explain why the transmission of commodity prices to lending is limited to LICs. We look at the transmission of commodity prices to bank lending in countries with high and low dependence on commodity exports, by splitting the sample at a level of commodity exports equal to 15 percent of GDP, which approximately corresponds to the third quartile of the sample distribution of exports to GDP ratio. We find that only lending by banks in countries with high dependence on commodity exports is significantly affected by fluctuations in commodity prices, and the effect is stronger than in the overall sample: for a highly-exposed bank, one standard deviation decline in $CNEP$ (amounting to about 10 percent decline) leads to a 4 percentage points fall in lending. By contrast, the coefficient on the interaction term for banks in more diversified exporters is smaller and not statistically significant (Table 5, columns 1 and 2).

Since the macroeconomic effects of commodity prices can be non-linear (see, for instance, Hamilton, 2003, on oil shocks), we investigate the presence of an asymmetric effect of commodity price changes. While it is intuitive to see that a fall in commodity prices would affect bank health negatively and hamper credit growth, it is not obvious how an increase in commodity prices will immediately lead to an improvement in bank health. With declining commodity prices, exporting firms suffer losses and are unable to service loan repayments. This trend would manifest itself as a liquidity shock and a deterioration of bank credit quality, which can potentially lead to a fall in lending as banks' balance sheets worsen. A commodity boom, however, may not affect bank lending as greater profits of commodity exporters and govern-

ment may end up being spent on more consumption rather than increasing the deposit base of the banking system via more savings. To the extent the commodity sector is financed by foreign direct investment instead of domestic borrowing, one can also expect banks to not see an increase in lending during commodity price increases.

To understand the transmission mechanism more clearly, in Table 5 we look separately at the effect of positive and negative commodity price changes on bank lending. We find that the positive correlation between commodity prices and loan growth is driven by negative price changes and in this case the coefficient is more than twice as large as in the baseline (column 4), while there is no response of loan growth to a positive change in commodity prices (column 3). This result is in line with the evidence provided by Beck and Poelhekke (2017), who show that natural resource windfalls are not intermediated by the banking system, but are rather channeled to the economy through higher government consumption.[19]

5 Robustness exercises

In this section, we test the robustness of our key results to alternative measures of sensitivity, sub-samples, additional variables, and model specifications.

5.1 Alternate measure of sensitivity

To make sure our results are not driven by the way we define our sensitivity measure, we construct an alternative measure of sensitivity to commodity prices— an index of specialization in the commodities sector, based on Beck *et al.* (2017). The intuition is as follows: if a bank is well-diversified, its stock price should highly co-move with the broad stock market index, which moves in response to macroeconomic or system-wide news. Hence, for a well-diversified bank, a regression of daily bank stock prices on the broad market index should be able to explain most of the variation in its stock price. However, if a bank is more exposed to certain sectors, like commodities, its stock price should respond more to news specific to the commodities sector, after controlling for the macroeconomic impact that this sector-specific news may have. In this case, a model that regresses the bank's stock price on the broad stock market index alone may not be able to capture large part of the variation in the bank's stock price. Adding the commodity price index to the model should increase its explanatory power.

To compute the measure of specialization in commodities for each listed bank, we first estimate a model with the bank's daily stock price as the dependent variable and the broad

[19] In the same spirit, Mlachila and Ouedraogo (2017) document a financial development resource curse in commodity exporters, according to which bank deposits and credit to the private sector fall not only in downturns, but also during commodity booms, when the commodity sector catalyze existing resources.

market index as the independent variable:

$$\ln(P)_{bd} = \alpha + \beta \ln(MARKET\ INDEX)_d \tag{6}$$

Next, we include the daily commodity price index as an additional regressor:

$$\ln(P)_{bd} = \alpha + \beta \ln(COMMODITY\ PRICE)_d + \gamma \ln(MARKET\ INDEX)_d \tag{7}$$

Similar to equation 3, the above two equations are estimated in a one-year rolling window for each year. Our measure of specialization ($SPEC$) is given by the difference in R-squared from the two regressions: $R^2[7] - R^2[6]$. This measure varies between 0 and 1 and it is close to zero for banks whose portfolios are not concentrated in commodities. Figure 6 shows the distribution of our specialization measure, which has a mean value of 0.16 and a standard deviation of 0.19.

Our main results, re-estimated using the specialization measure, are presented in Table 5. The first column shows that the coefficient on the interaction term $CNEP \times SPEC$ is still significant and positive, confirming our baseline result of the presence of a bank lending channel for the transmission of international commodity prices to domestic credit. Columns 2 and 3 show the results for the sample split between positive and negative price changes and confirm that the overall positive correlation between commodity price and loan growth is driven by negative price changes. Finally, columns 4 and 5 replicate the key results for bank-level heterogeneity. We still find that banks with lower deposits-to-assets ratio show a stronger transmission from international commodity prices to loan growth. Banks with high levels of non-performing loans are also more vulnerable to fluctuations in commodity prices than those with low NPLs, even if the coefficients are less precisely estimated and therefore not statistically different.

5.2 Additional macroeconomic variables and controlling for credit demand

Next, we test whether our results are robust to controlling for other macroeconomic factors which could potentially explain the positive relationship between loan growth and commodity prices (Table 7). For instance, one concern is that countries which see a fall in commodity prices are also likely to experience volatility in their exchange rate, which could have an impact on the credit supply. Since our identification strategy exploits variation in exposure to commodity prices at the bank-level, changes in exchange rates would confound our identification strategy only if the banks which are more exposed to commodity prices are also the ones which are more exposed to exchange rates, which is not necessarily the case. Nevertheless, in

column 1 we control for exchange rates at the country-level and find that our key result is robust: the coefficient on the interaction term between commodity prices and sensitivity remains positive and significant and with a magnitude very close to that of the baseline (Table 2, column 7). Another concern could be that countries with open capital account could see capital outflows during periods of commodity busts and capital inflows during periods of commodity booms, which could explain the positive relationship between lending and commodity prices. To address this concern, we include an index of *de jure* capital account openness (Chinn and Ito, 2006) and we find that our baseline results remain robust, while financial openness does not contribute to explain the variation in loan growth (column 2).

To better control for credit demand, we run additional tests. We start by augmenting the baseline model with: 1) the one-period ahead GDP growth forecast, to capture changes in demand for bank credit due to expectations and changes in investment (column 3), and 2) the ratio of credit to the private sector over GDP, as more financially developed countries could have a higher demand for loans (column 4). In both cases the coefficient on the interaction term $CNEP \times SENS$ remains precisely estimated. Interestingly, we find that the coefficient on the one-period ahead GDP growth forecast is positive and significant, suggesting that it may help to capture part of credit demand (the R^2 in fact increases to 0.49).

Then, to further allay concerns that our results are driven by credit demand rather than credit supply, we include country $\times$ bi-annual fixed effects, which should be a reasonably good proxy for changes in demand at the country-level. We do not include country $\times$ year fixed effects since in our data there is not enough variation, given that the main variable of interest, $CNEP$, varies at the country-year level. We believe that the next best alternative is to use bi-annual fixed effects. Results, reported in column 5, show that the interaction terms remain significant at 1 percent and very similar in magnitude to that of the baseline, strengthening our hypothesis of the presence of a credit supply channel.

5.3 Other robustness checks

Finally, we conduct a few other tests to ensure that our results are robust to changes in model specification, sample, and variable definitions (Table 8). We begin by conducting robustness test on alternative specifications of our baseline regression (see equation 4). Given that the presence of a lagged regressor could bias the fixed effects coefficients, we estimate a static model and find that the coefficient on the interaction term remain almost unchanged and precisely estimated even if we exclude the lagged dependent variable (column 1). We also estimate the model by excluding bank fixed effects since the differential exposure of banks to commod-

ity prices could be a function of the bank-specific business model. Including bank fixed effects would absorb significant variation in differential exposure to commodities and could weaken our results. We find that our results do not change if we exclude bank fixed effects (column 2).

In column 3, we make sure that the significance of our findings is not driven by the choice of clustering the standard errors at the bank level. Since we use also the share of commodity exports over GDP to construct the measure of sensitivity (i.e., for banks headquartered in countries without listed banks), we replicate the baseline regression by clustering the standard errors at the country level. Even though the standard errors are around 10-25 percent larger than in the baseline, the key estimated coefficients remain significant at least at the 5 percent level.

To be able to run our model on a sufficiently large sample of banks, we have constructed the sensitivity measure by merging bank- as well as country-level exposure to the commodity sector (Section 2.1). In order to address the concern that the country-level measure of exposure could be less precise and introduce measurement error in the $SENS$ variable, we restrict our sample to countries which have at least one listed bank. In doing so, we exclude all banks for which we were earlier using the sovereign measure of sensitivity—the share of commodity exports over GDP. In this sub-sample the measure of sensitivity varies only at the bank-level. Column 4 shows that, notwithstanding the significant drop in sample size (from over 495 to 239 banks), the coefficient on the interaction term retains its statistical significance.

An additional exercise deals with the possibility that large events in some countries can affect global commodity prices even if these countries are not “price makers" for those commodities (for example, large supply shock that shuts down all coal or copper mines in one country could temporarily affect world commodity prices for coal or copper). In that case, fluctuation in international commodity prices could be endogenous to local economic conditions. This possibility should not weaken our identification, since a negative shocks that affect the economy and international prices would have the same effect across all domestic banks, while our identification hinges on different bank exposure to the commodity sector. However, to fully address any remaining concern, we exclude from the sample banks headquartered in countries where a single commodity has a significant weight in the basket of exports. Formally, we calculate the average weight ($\omega_{i,j}$ in equation 1) for each country-commodity pair over the sample period and, for each country, we select the highest weight. Then, we exclude all countries with the highest weight greater than 5 percent, assuming that those countries will be able to influence international prices for that commodity.[20] Our results are robust to this exercise

[20]These countries are Cote d’Ivoire, The Gambia, Mauritania, Niger, Tajikistan and Zambia.

(column 5).

In the last three columns we introduce alternative measures for our key variables. In column 6 we replace our measure of sensitivity with one obtained estimating the beta coefficients running a set of bank-level regressions (see equation 3) on daily stock prices on a two-year rolling window. Then, in column 7 we calculate loan growth in real USD, rather than in nominal terms. In both cases results are unaffected by these choices. Finally, as an alternative measure to the country-specific commodity price index used so far, we introduce a measure of commodity export prices (CEP), which is defined as follows:

$$CEP_{i,t}^{alt} = \sum_{j=1}^{J} P_{j,\tau} \hat{\omega}_{i,j,t} \tag{8}$$

where, $P_{j,\tau}$ is the logarithm of the relative price of commodity j in period t within year t (in U.S. dollars and divided by the IMF's unit value index for manufactured exports); the weights are pre-determined and calculated as a three-year average:

$$\hat{\omega}_{i,j,t} = \frac{1}{3} \sum_{s=1}^{3} \frac{x_{i,j,t-s}}{\sum_{j=1}^{J} x_{i,j,t-s}} \tag{9}$$

where, $x_{i,j,t-s}$ is the export of commodity j from country i in year $t-s$. Hence, the weights reflect the share of each commodity in total commodity exports of country i. This measure takes into account only the exports side and, hence, it could better capture the possibility that in some countries, what really matters for the transmission of the shock to banking sector health is a decline in export revenues. We estimate the baseline model using this measure and find that the positive relationship between commodity prices and loan growth is again significant (column 8).

6 Conclusions

This paper explores the role of bank lending channel in the transmission of international commodity prices to the domestic economy. We show that bank credit reacts to fluctuations in commodity prices and we document that the vulnerability to the bank lending channel is limited to low-income countries and stronger for countries with more dependence on commodity exports.

Our identification strategy exploits variation in exposure to commodity prices at the bank-level and tries to absorb the credit demand channel through a number of macroeconomic controls and fixed effects. Baseline results show that lending by banks that are more exposed to the commodity sector reacts more to changes in commodity prices. This result could be

driven either by supply or demand forces. We attempt to tease out the credit supply channel by exploiting the heterogeneity in bank balance sheet characteristics, especially by focusing on liquidity and bank asset quality indicators. We observe that commodity price shocks have a negative effect on deposit funding and asset quality, which is associated with a contraction of the supply of credit. Consistent with these results, we find that banks with low deposits-to-assets ratios and with high non-performing loans are those that reduce loan growth relatively more in response to a fall in commodity prices.

Overall, our results indicate that the bank lending channel could reinforce the direct effect of negative commodity price shocks on economic activity, which operates through a decline in export earnings, firm profitability, and government revenue, further constraining firm growth and investment. Moreover, the potency of bank lending channel of commodity prices is larger for banks which have lower deposits-to-assets ratios and higher non-performing loans. These findings underscore the importance to put in place strong financial regulation and macroprudential polices in developing countries, to strengthen the resilience of banking systems to commodity price shocks.

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Figures

Figure 1: Commodity prices and bank lending: transmission channels

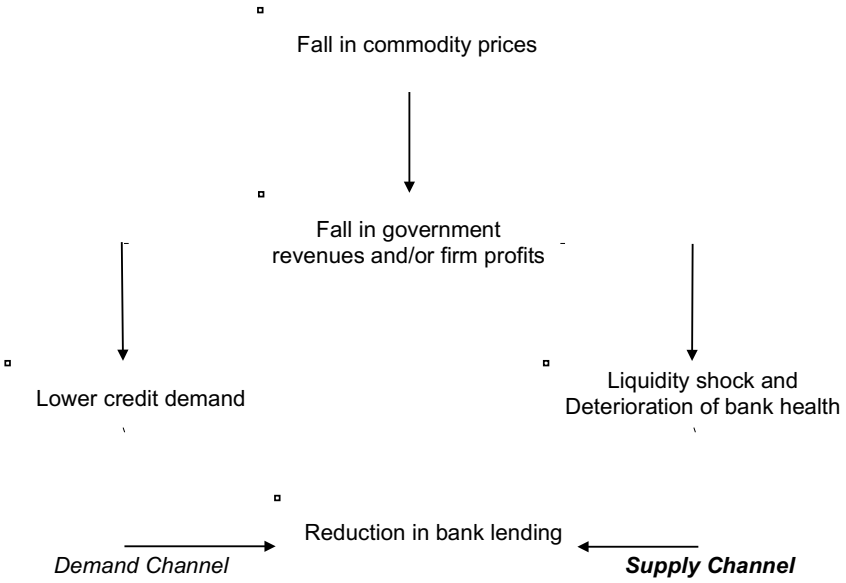
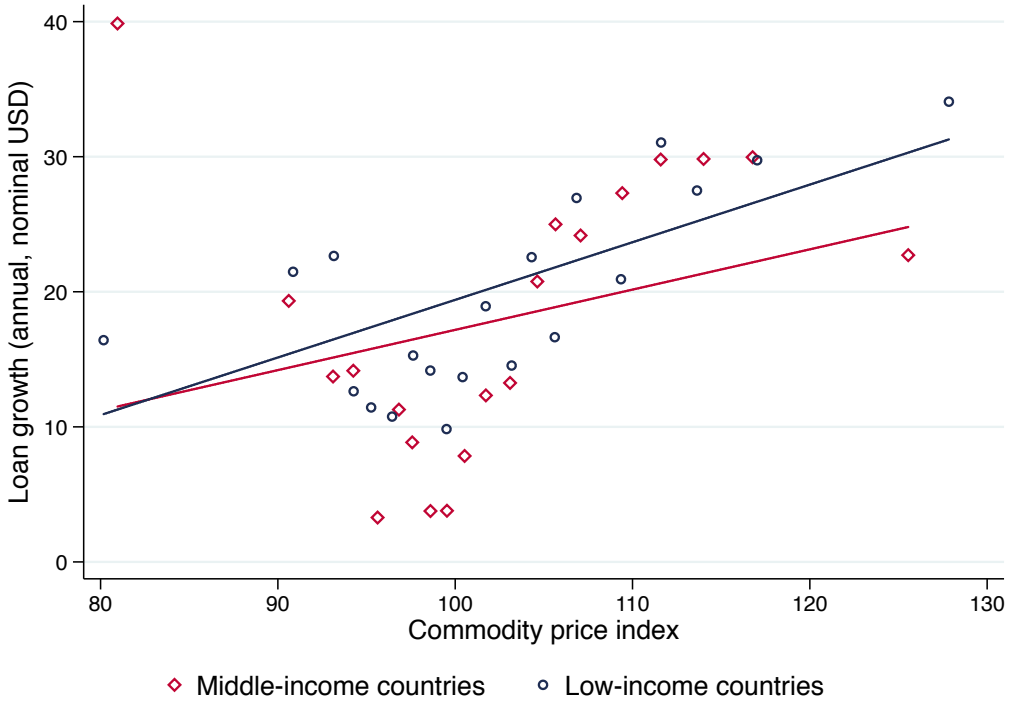
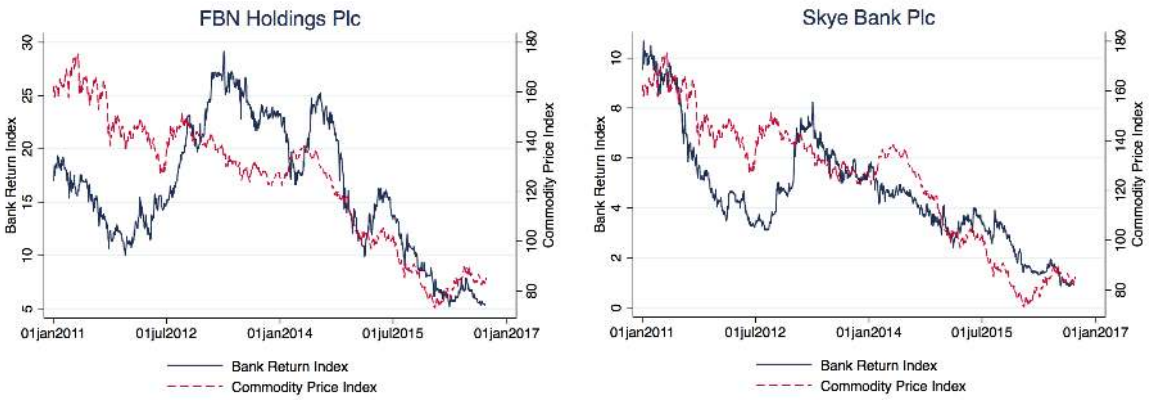


Figure 2: Commodity prices and loan growth



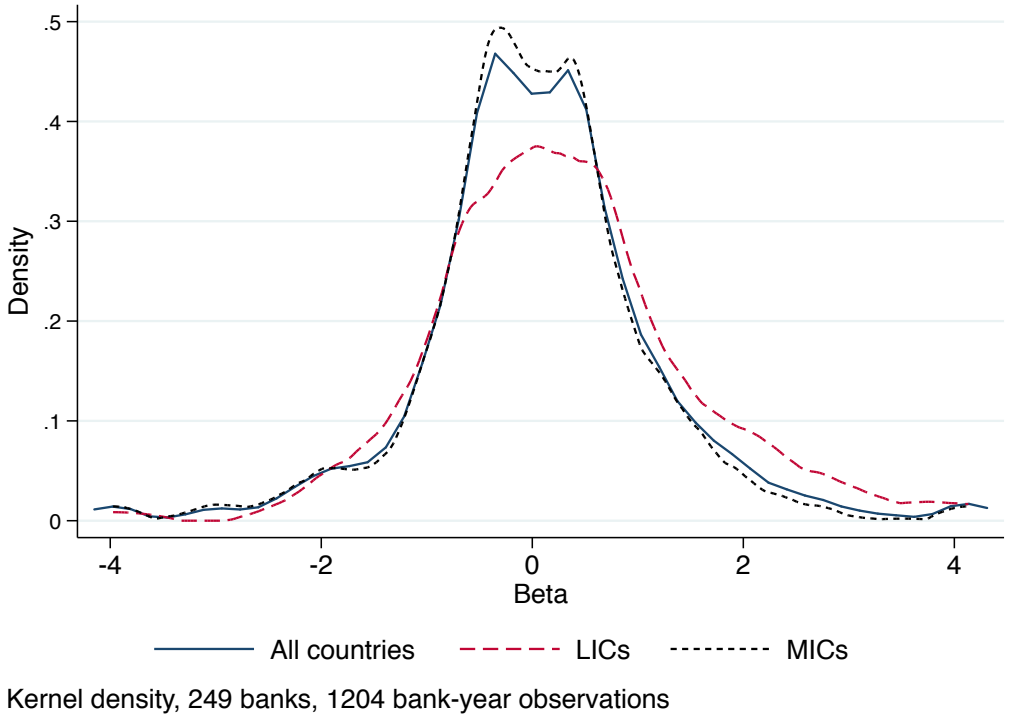
Notes: The figure shows a binned scatterplot of loan growth (defined as yearly percentage change in outstanding loans, in nominal USD) and the commodity net export price index ($CNEP$, as defined in equation 1), separately for low-income and middle-income countries. To generate the binned scatterplot, starting from the regression sample (see Table 2, column 1), $CNEP$ is grouped into 20 equal-sized bins, then the chart plots, for each bin, the mean of $CNEP$ and loan growth within each bin. Data on loan growth are from Bankscope.

Figure 3: Commodity prices and bank returns



Notes: The commodity price index in the figure is the BCOM Index from Bloomberg. Data on stock retruns for FBN Holdings and Skye Bank are from Datastream.

Figure 4: Distribution of the bank-specific sensitivity measure to commodity prices



Notes: The bank-specific sensitivity to commodity prices for each listed bank is measured as the factor loadings from a regression of daily bank stock prices on the commodity price index, over a one-year rolling window, after controlling for the overall stock market index (equation 3).

Figure 5: Share of commodity exports over GDP, sample distribution

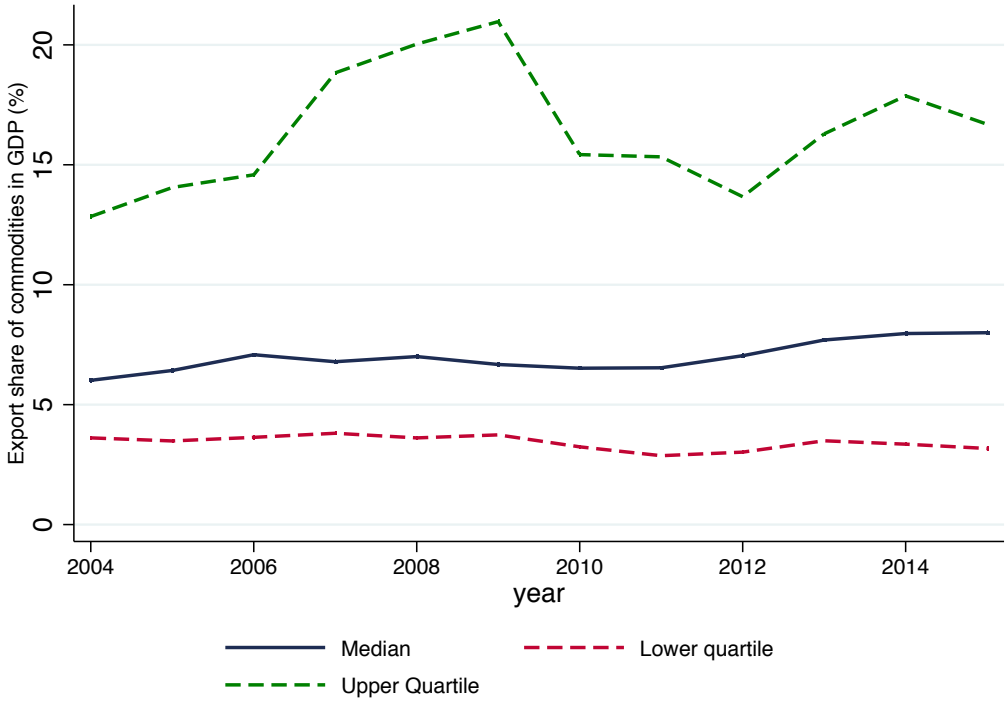
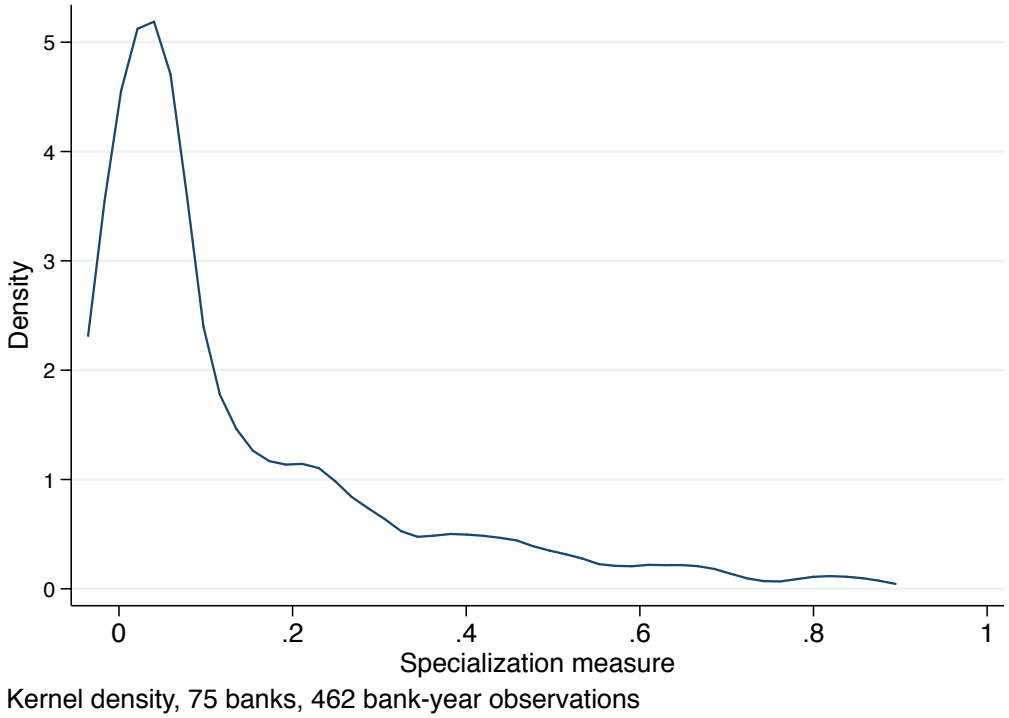


Figure 6: Distribution of the bank-specific specialization in commodities



Notes: The bank-specific specialization measure for each listed bank is computed as the difference in R-squared of the regression of daily bank stock prices on commodity price index, with and without the broad stock market index (equation 6 and equation 7).

Tables

Table 1: Summary Statistics: Loan growth by bank characteristics

This table shows the summary statistics for the bank-characteristics; statistics for loan growth ($\Delta LOAN$) are shown also for the sub-sample of banks used in the bank heterogeneity regressions (see 3). The top panel shows the summary statistics for the full sample while the bottom panel is for the sample of low-income countries. Dummies for low bank characteristics are constructed considering the banks in the bottom decile of the sample distribution. All other banks are grouped in the high characteristic dummy.

Loan growth	Obs	Mean	S.D.	25^{th}	Median	75^{th}
	Full sample					
$\Delta LOAN$:						
All banks	9,540	18.68	33.04	-0.34	12.57	29.04
Domestic banks	6,409	19.06	32.78	0.90	13.16	29.08
Foreign banks	3,131	17.90	33.55	-2.66	10.94	28.91
Weakly capitalized banks (lowest decile)	954	17.99	31.26	-1.13	11.66	29.89
Other banks	8,586	18.75	33.23	-0.22	12.64	28.85
Low deposit banks (lowest decile)	954	22.20	40.07	-2.33	12.38	35.44
Other banks	8,586	18.29	32.14	-0.12	12.60	28.53
Low NPLs banks (lowest decile)	668	28.21	33.12	7.76	20.15	43.59
Other banks	8,872	17.96	32.92	-0.84	11.93	27.97
LIQUIDITY	9,540	33.34	24.41	16.5	26.01	42.47
SIZE	9,540	13.21	1.78	11.93	13.20	14.54
EQUITY	9,540	15.26	10.35	8.76	11.99	17.46
DEPOSITS/ASSETS	9,540	71.11	18.10	64.26	77.06	84.06
NPLs	6,728	7.52	8.79	1.75	4.00	9.72
	Low-income countries					
$\Delta LOAN$:						
All banks	2,848	20.89	29.73	3.22	15.85	32.61
Domestic banks	1,755	21.06	29.67	3.76	15.98	32.22
Foreign banks	1,093	20.62	29.85	1.54	15.65	33.33
Weakly capitalized banks (lowest decile)	337	20.90	28.69	3.50	15.96	34.34
Other banks	2,511	20.89	29.87	3.14	15.84	32.27
Low deposit banks (lowest decile)	278	30.29	40.05	4.41	19.75	48.35
Other banks	2,570	19.88	28.21	3.07	15.67	31.03
Low NPLs banks (lowest decile)	194	26.19	26.92	10.1	21.23	38.96
Other banks	2,654	20.51	29.89	2.71	15.61	31.96
LIQUIDITY	2,848	35.95	22.68	19.31	29.75	46.75
SIZE	2,848	12.79	1.49	11.72	12.74	13.78
EQUITY	2,848	13.85	8.48	8.45	11.60	16.27
DEPOSITS/ASSETS	2,848	67.95	16.25	60.87	71.75	79.77
NPLs	2,059	6.82	7.53	1.88	4.14	8.74

Table 2: Baseline results

This table reports the estimates from the baseline regression, estimated over the period 2004 - 2015 using annual data. The dependent variable is loan growth, defined as yearly change in nominal USD outstanding loans. The main independent variable are the commodity net export price index ($CNEP$, lagged one period) and its interaction with a measure of bank specific sensitivity to the commodity sector ($SENS$). Columns (1) and (2) include only the commodity net export price index and a different set of fixed effects; columns (3) and (4) add bank-level and country-level control variables, respectively. Column (5) includes our main variable of interest–the interaction of commodity price index with the sensitivity measure. Column (6) splits the interaction term into two country groups–LICs and MICs. Column (7) reports the results for the sub-sample of LICs. All bank-level variables are lagged by one year. The set of fixed effects included in each columns is reported at the bottom. All regressions are estimated over the period 2004-2015. Standard errors, clustered at the bank level, are in parentheses.. *** p<0.01, ** p<0.05, * p<0.1.

Dep. Var.: $\Delta LOAN_t$	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$CNEP_{t-1}$	0.1246***	0.1162**	0.1447***	0.1481***	0.1025**	0.1199***	0.0561
	(0.047)	(0.047)	(0.043)	(0.044)	(0.045)	(0.045)	(0.060)
$CNEP_{t-1} \times SENS_{t-1}$					0.2637*		0.2974***
					(0.136)		(0.102)
$CNEP_{t-1} \times SENS_{t-1}$, MIC						0.0822	
						(0.264)	
$CNEP_{t-1} \times SENS_{t-1}$, LIC						0.2938**	
						(0.126)	
$SENS_{t-1}$					-26.917**	-29.801**	-30.32***
					(13.602)	(12.688)	(10.098)
$\Delta LOAN_{t-1}$			0.0515***	0.0403**	0.0406**	0.0402**	-0.0089
			(0.018)	(0.017)	(0.017)	(0.017)	(0.027)
$LIQUIDITY_{t-1}$			0.3294***	0.3142***	0.3151***	0.3152***	0.3120***
			(0.041)	(0.041)	(0.041)	(0.041)	(0.060)
$SIZE_{t-1}$			-22.05***	-21.06***	-21.08***	-21.06***	-25.83***
			(1.757)	(1.726)	(1.728)	(1.726)	(2.927)
$EQUITY_{t-1}$			0.3359**	0.3222**	0.3229**	0.3216**	0.2259
			(0.143)	(0.143)	(0.143)	(0.143)	(0.266)
$DEPOSITS/ASSETS_{t-1}$			0.2418***	0.2240***	0.2242***	0.2240***	0.0890
			(0.061)	(0.061)	(0.061)	(0.061)	(0.099)
$GROWTH_t$				0.5421***	0.5397***	0.5327***	1.2641***
				(0.099)	(0.099)	(0.097)	(0.196)
$GROWTH_{t-1}$				0.4218***	0.4249***	0.4165***	0.2373
				(0.075)	(0.075)	(0.073)	(0.214)
IR_t				-7.475***	-7.565***	-7.617***	-6.627**
				(1.927)	(1.925)	(1.921)	(3.341)
IR_{t-1}				4.1508**	4.2462**	4.2241**	2.4427
				(1.813)	(1.816)	(1.816)	(2.876)
Observations	9,540	9,540	9,540	9,540	9,540	9,540	2,848
Number of banks	1642	1642	1642	1642	1642	1642	495
R^2	0.198	0.411	0.466	0.474	0.474	0.474	0.488
Bank fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample	All	All	All	All	All	All	LICs

Table 3: Heterogeneous effects across bank characteristics

This table reports the estimates for the regression of loan growth on bank-level characteristics. In column (1), the interaction term between the commodity net export price index ($CNEP$) and the sensitivity measure ($SENS$) is split into banks with high and low equity. Column (2) splits the interaction term between banks with high and low ratios of deposits to assets. Column (3) splits the interaction term between banks with high and low NPL ratios. Dummies for low bank characteristics (equity, deposits, and NPLs) are constructed considering the banks in the bottom 10% of the sample distribution. All other banks are grouped in the high characteristic dummy. Column (4) splits the interaction term between banks domestic and foreign banks. A bank is defined as a foreign bank if the country code of global ultimate owner of the bank is different from the country code of the bank. The p-value for the test in the difference of coefficients of high and low bank characteristics is also reported in the table. Column (1), (2), (3) and (4) report the results for the sample of low-income countries. Column (5) and (6) estimate the results for deposits and NPLs for the sub-sample of only domestic banks in low-income countries. All columns include bank- and country-level controls and bank, country, and time fixed effects. All regressions are estimated on banks headquartered in low-income countries over the period 2004-2015. Standard errors, clustered at the bank level, are in parentheses.. *** p<0.01, ** p<0.05, * p<0.1.

Dep. Var.: $\Delta LOAN_t$	(1)	(2)	(3)	(4)	(5)	(6)
$CNEP_{t-1}$	0.0549	0.0479	0.0589	0.0563	0.0374	0.0444
	(0.060)	(0.059)	(0.060)	(0.060)	(0.078)	(0.079)
$CNEP_{t-1} \times SENS_{t-1}$, high equity	0.2935***					
	(0.102)					
$CNEP_{t-1} \times SENS_{t-1}$, low equity	0.2945***					
	-0.104					
$CNEP_{t-1} \times SENS_{t-1}$, high deposits		0.2917***			0.2597**	
		(0.102)			(0.126)	
$CNEP_{t-1} \times SENS_{t-1}$, low deposits		1.0158***			0.9461***	
		(0.303)			(0.350)	
$CNEP_{t-1} \times SENS_{t-1}$, high NPLs			0.2850***			0.2631**
			(0.103)			(0.131)
$CNEP_{t-1} \times SENS_{t-1}$, low NPLs			0.1459			0.1247
			(0.103)			(0.128)
$CNEP_{t-1} \times SENS_{t-1}$, domestic banks				0.2952***		
				(0.107)		
$CNEP_{t-1} \times SENS_{t-1}$, foreign banks				0.2974***		
				(0.101)		
Observations	2848	2848	2848	2848	1755	1755
Number of banks	495	495	495	495	320	320
R^2	0.488	0.491	0.49	0.488	0.517	0.516
T-test (p-value)	0.972	0.012	0.000	0.901	0.041	0.000
Bank controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Sample	All banks				Domestic Banks	

Table 4: Commodity prices and bank health

This table shows the results for the transmission channels at the bank-level. The dependent variables are deposits/assets (column 1), the ratio of non-performing loans to gross loans (column 2), the return on assets (column 3), and the total equity-to-assets ratio (column 4). In all columns, the main independent variable is the interaction term between the commodity net export price index ($CNEP$) and the sensitivity measure ($SENS$). All columns include bank, country, and year fixed effects. All regressions are estimated on banks headquartered in low-income countries over the period 2004-2015. Standard errors, clustered at the bank level, are in parentheses.. *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)	(4)
Dep. Var.:	Deposits/Assets	NPLs	ROA	Equity/Assets
$CNEP_{t-1}$	-0.0001	0.0014	0.0017	-0.0006
	(0.000)	(0.015)	(0.004)	(0.012)
$SENS_{t-1}$	-0.0598	7.9000***	-0.4439	3.9417**
	(0.037)	(1.769)	(0.546)	(1.963)
$CNEP_{t-1} \times SENS_{t-1}$	0.0006*	-0.0787***	0.0045	-0.0390**
	(0.000)	(0.018)	(0.006)	(0.020)
Observations	2,842	2,111	2,838	2,848
Number of banks	494	395	495	495
R^2	0.809	0.684	0.640	0.851
Bank fixed effects	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes

Table 5: Asymmetric effects and cross-country heterogeneity

This table reports the estimates for the country heterogeneity and asymmtery regression from section 3.4. The dependent variable is loan growth, defined as yearly change in nominal USD outstanding loans. Column (1) and (2) show the results for sub-samples of countries with high and low levels of country exports to GDP ratio. A country is grouped into high category if the ratio of exports to GDP exceeds 15 percent (about the third quartile of the sample distribution). Column (3) and (4) report the results for sub-samples of positive and negative changes in the commodity price index. All columns include bank- and country-level control variables as in the baseline regressions, in addition to bank, country and year fixed effects. All regressions are estimated on banks headquartered in low-income countries over the period 2004-2015. Standard errors, clustered at the bank level, are in parentheses.. *** p<0.01, ** p<0.05, * p<0.1.

	Country Exports/GDP		**Asymmetry**($\Delta CNEP_{t-1}$)	
	High	Low	Positive	Negative
$CNEP_{t-1}$	0.2505	-0.0999	0.0456	-0.0909
	(0.181)	(0.098)	(0.129)	(0.111)
$SENS_{t-1}$	-38.3470**	-19.0514	-17.0016	-76.297***
	(14.811)	(12.094)	(17.325)	(14.190)
$CNEP_{t-1} \times SENS_{t-1}$	0.3556**	0.1971	0.1699	0.7501***
	(0.142)	(0.126)	(0.173)	(0.142)
$\Delta LOAN_{t-1}$	-0.0891*	0.0318	-0.0847	0.0362
	(0.046)	(0.034)	(0.063)	(0.035)
$LIQUIDITY_{t-1}$	0.3669***	0.2901***	0.3314***	0.2798***
	(0.106)	(0.073)	(0.098)	(0.083)
$SIZE_{t-1}$	-26.49***	-25.42***	-24.59***	-23.46***
	(4.628)	(3.582)	(5.898)	(3.649)
$EQUITY_{t-1}$	0.1508	0.4255	-0.2044	0.4473
	(0.398)	(0.35)	(0.524)	(0.344)
$DEPOSITS/ASSETS_{t-1}$	-0.1649	0.1446	-0.0052	0.1710
	(0.154)	(0.131)	(0.143)	(0.145)
$GROWTH_t$	1.4760***	1.2085***	1.0343***	1.5273***
	(0.375)	(0.255)	(0.387)	(0.287)
$GROWTH_{t-1}$	0.1162	0.1893	-0.2053	0.4976
	(0.281)	(0.288)	(0.388)	(0.307)
IR_t	-15.475***	-3.2343	-7.4748	-3.3311
	(4.713)	(4.247)	(6.09)	(4.357)
IR_{t-1}	-1.5036	2.0093	-3.1824	2.1059
	(4.984)	(3.592)	(5.898)	(3.699)
Observations	841	1985	992	1,660
Number of banks	170	354	317	394
R^2	0.540	0.501	0.605	0.519
Bank fixed effects	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes

Table 6: Robustness: Specialization measure

This table reports the estimates from a robustness exercise which uses an alternative measure of bank specific sensitivity to commodity prices. The dependent variable is loan growth, defined as yearly change in nominal USD outstanding loans. In column (1), the main independent variable is the interaction between the commodity price index and the alternative measure of specialization in commodities, $SPEC$. Column (2) and (3) replicate the asymmetry results for positive and negative commodity price changes, using the alternative measure of specialization. Column (4) and (5) replicate the bank heterogeniety results for deposits and NPLs using the alternative measure of specialization. All columns include bank- and country-level control variables as in the baseline specification, in addition to bank, country, and year fixed effects. All regressions are estimated on banks headquartered in low-income countries over the period 2004-2015. Standard errors, clustered at the bank level, are in parentheses.. *** p<0.01, ** p<0.05, * p<0.1.

Dep. Var.: $\Delta LOAN_t$	Baseline	Asymmetry ($\Delta CNEP_{t-1}$)		Bank heterogeneity	
		Positive	Negative		
	(1)	(2)	(3)	(4)	(5)
$CNEP_{t-1}$	-0.0274	0.2563	-0.1900	-0.0308	-0.0248
	(0.089)	(0.181)	(0.137)	(0.089)	(0.089)
$SPEC_{t-1}$	-85.1373*	94.6304	-178.0137***	-81.8859*	-84.2666*
	(48.580)	(64.146)	(65.412)	(48.662)	(48.448)
$CNEP_{t-1} \times SPEC_{t-1}$	0.8967*	-0.8875	1.6421**		
	(0.476)	(0.633)	(0.644)		
$CNEP_{t-1} \times SPEC_{t-1}$, high deposits				0.8457*	
				(0.477)	
$CNEP_{t-1} \times SPEC_{t-1}$, low deposits				1.6685***	
				(0.581)	
$CNEP_{t-1} \times SPEC_{t-1}$, high NPLs					0.9016*
					(0.474)
$CNEP_{t-1} \times SPEC_{t-1}$, low NPLs					0.4895
					(0.553)
Observations	2,848	992	1,660	2,848	2,848
Number of banks	495	317	394	495	495
R^2	0.488	0.606	0.518	0.491	0.489
T-test (p-value)				0.0201	0.1477
Bank controls	Yes	Yes	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes

Table 7: Robustness: Macroeconomic variables and controlling for credit demand

This table reports the results for robustness exercises which include expanding the set of country specific macro variables and controlling for demand for credit. The dependent variable is loan growth, defined as yearly change in nominal USD outstanding loans. The main independent variable in all columns is the interaction between commodity prices and the sensitivity measure. Column (1) estimates the baseline regression with the addition of exchange rates; column (2) adds capital account openness; column (3) adds the one period ahead GDP forecast; column (4) adds the ratio of credit to GDP. Column (5) adds country × bi-annual fixed effects to the baseline model. Columns (1) - (4) include bank, country, and year fixed effects. All regressions are estimated on banks headquartered in low-income countries over the period 2004-2015. Standard errors, clustered at the bank level, are in parentheses.. *** p<0.01, ** p<0.05, * p<0.1.

Dep. Var.: $\Delta LOAN_t$	(1)	(2)	(3)	(4)	(5)
$CNEP_{t-1}$	0.0535	0.0902	0.0400	-0.0290	0.2512**
	(0.061)	(0.066)	(0.060)	(0.065)	(0.115)
$SENS_{t-1}$	-31.5434***	-28.3232***	-30.0209***	-47.5995***	-26.9596***
	(10.073)	(9.283)	(9.959)	(14.585)	(9.521)
$CNEP_{t-1} \times SENS_{t-1}$	0.3112***	0.2840***	0.2943***	0.4700***	0.2600***
	(0.102)	(0.095)	(0.100)	(0.142)	(0.095)
$\Delta LOAN_{t-1}$	-0.0112	-0.0022	-0.0110	-0.0473	-0.0454
	(0.028)	(0.034)	(0.028)	(0.032)	(0.029)
$LIQUIDITY_{t-1}$	0.3011***	0.2614***	0.3081***	0.3287***	0.3067***
	(0.060)	(0.065)	(0.060)	(0.070)	(0.063)
$SIZE_{t-1}$	-25.3242***	-25.5010***	-25.6794***	-30.6465***	-27.1477***
	(2.947)	(3.313)	(2.876)	(4.056)	(3.334)
$EQUITY_{t-1}$	0.2157	0.2503	0.2397	0.2560	0.2011
	(0.270)	(0.292)	(0.263)	(0.317)	(0.267)
$DEPOSITS/ASSETS_{t-1}$	0.0921	0.0549	0.0898	0.1124	0.0321
	(0.099)	(0.122)	(0.098)	(0.132)	(0.112)
$GROWTH_t$	1.2961***	1.3795***	1.0554***	1.2414***	1.1938***
	(0.199)	(0.207)	(0.213)	(0.236)	(0.286)
$GROWTH_{t-1}$	0.3156	0.3461	0.1598	0.5957**	0.4659
	(0.217)	(0.236)	(0.219)	(0.252)	(0.293)
IR_t	-6.0903*	-9.8793***	-7.2159**	-11.2777***	-6.5836
	(3.483)	(3.729)	(3.339)	(3.894)	(5.317)
IR_{t-1}	2.6673	5.5795*	1.8813	3.7704	-0.0968
	(2.875)	(3.352)	(2.853)	(3.541)	(3.770)
$EXCHANGE\ RATE_{t-1}$	-0.1058				
	(0.132)				
$KA\ OPENNESS_t$		-0.0487			
		(0.114)			
$GROWTH_{t+1}$			1.0866***		
			(0.407)		
$CREDIT/GDP_{t-1}$				-0.2024	
				(12.242)	
Observations	2,790	2,452	2,848	2,166	2,838
Number of banks	486	424	495	423	493
R^2	0.492	0.487	0.491	0.482	0.558
Bank fixed effects	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	-
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Country × bi-annual fixed effects	No	No	No	No	Yes

Table 8: Robustness: Model specification, sample, and variable definition

This table reports the results from additional robustness exercises, including different model specifications, samples, and alternative variable definitions. The dependent variable is loan growth, defined as yearly change in nominal USD outstanding loans (except that in column 6). The baseline model is estimated excluding the lagged value of loan growth (column 1), excluding bank fixed effects (column 2), and clustering the standard errors at the country level (column 3). In column 4 the sample is restricted to countries with at least one listed bank, hence excluding all the countries for which the measure of sensitivity was at the country level; while column 5 excludes countries for which the average share of commodity exports over GDP (calculated over the sample period) exceeds 5 percent (those countries are Cote d'Ivoire, The Gambia, Mauritania, Niger, Tajikistan and Zambia). In column 6, the sensitivity measure ($SENS$) is calculated by estimating the β coefficients in equation 3 on a two-year rolling window. In column 7 loan growth is defined in real USD. In column 8 $CNEP$ is replaced with the commodity export price index (CEP, as defined in equation 8). All regressions are estimated on banks headquartered in low-income countries over the period 2004-2015. Standard errors, clustered at the bank level (except that in column (3), where they are cluster at the country level), are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Dep. Var.: $\Delta LOAN_t$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$CTOT_{t-1}$	0.0561	0.0730	0.0561	0.0752	0.0400	0.0558	0.0603	
	(0.060)	(0.063)	(0.096)	(0.151)	(0.072)	(0.061)	(0.060)	
$SENS_{t-1}$	-30.2055***	-25.0880***	-30.3175**	-19.4297*	-31.8443***	-28.8974***	-34.5438***	-21.4285***
	(10.063)	(9.103)	(12.767)	(10.858)	(9.383)	(9.282)	(9.987)	(6.409)
$CTOT_{t-1} \times SENS_{t-1}$	0.2962***	0.2433***	0.2974**	0.2006*	0.3106***	0.2814***	0.3354***	
	(0.101)	(0.091)	(0.123)	(0.110)	(0.095)	(0.094)	(0.101)	
$\Delta LOAN_{t-1}$		0.1575***	-0.0089	-0.0365	0.0147	-0.0114	0.0006	-0.0084
		(0.030)	(0.027)	(0.035)	(0.028)	(0.028)	(0.025)	(0.028)
$LIQUIDITY_{t-1}$	0.3144***	0.1488***	0.3120***	0.4349***	0.3210***	0.2975***	0.3192***	0.3138***
	(0.058)	(0.043)	(0.063)	(0.088)	(0.063)	(0.060)	(0.054)	(0.060)
$SIZE_{t-1}$	-25.8541***	-4.6762***	-25.8313***	-27.2357***	-25.7867***	-25.4263***	-21.3804***	-25.9448***
	(2.896)	(0.734)	(3.230)	(4.624)	(3.047)	(2.888)	(2.691)	(2.933)
$EQUITY_{t-1}$	0.2283	-0.0797	0.2259	-0.0255	0.1077	0.2704	0.2234	0.2249
	(0.267)	(0.126)	(0.301)	(0.338)	(0.281)	(0.272)	(0.239)	(0.266)
$DEPOSITS/ASSETS_{t-1}$	0.0916	0.0341	0.0890	0.0500	0.0582	0.0927	0.1633*	0.0905
	(0.098)	(0.057)	(0.117)	(0.138)	(0.098)	(0.099)	(0.092)	(0.099)
$GROWTH_t$	1.2572***	1.1793***	1.2641***	2.2092***	1.4890***	1.2729***	1.2210***	1.2716***
	(0.196)	(0.205)	(0.230)	(0.677)	(0.226)	(0.194)	(0.187)	(0.197)
$GROWTH_{t-1}$	0.2286	-0.1114	0.2373	0.8501	0.1765	0.2283	0.1416	0.2027
	(0.210)	(0.213)	(0.196)	(0.612)	(0.253)	(0.215)	(0.209)	(0.210)
IR_t	-6.6852**	-8.3901**	-6.6268	-3.7530	-6.6218*	-6.1123*	-13.4855***	-6.8813**
	(3.341)	(3.282)	(6.766)	(4.954)	(3.396)	(3.342)	(3.455)	(3.317)
IR_{t-1}	2.5581	5.6496*	2.4427	2.4493	2.5712	2.3416	5.3977*	2.2905
	(2.834)	(3.011)	(3.929)	(4.531)	(2.940)	(2.853)	(2.829)	(2.883)
CEP_{t-1}								0.1893***
								(0.057)
$CEP_{t-1} \times SENS_{t-1}$								0.0005
								(0.052)
Observations	2,848	2,848	2,848	1,069	2,557	2,853	2,850	2,848
Number of banks	495	40	495	239	446	497	496	495
R^2	0.488	0.233	0.488	0.544	0.483	0.487	0.475	0.488
Bank fixed effects	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Bank	Bank	Country	Bank	Bank	Bank	Bank	Bank
Sample	All	All	All	Restricted	Restricted	All	All	All

Online Appendix

A-I Additional Tables

Table A1: Countries and number of banks in the sample

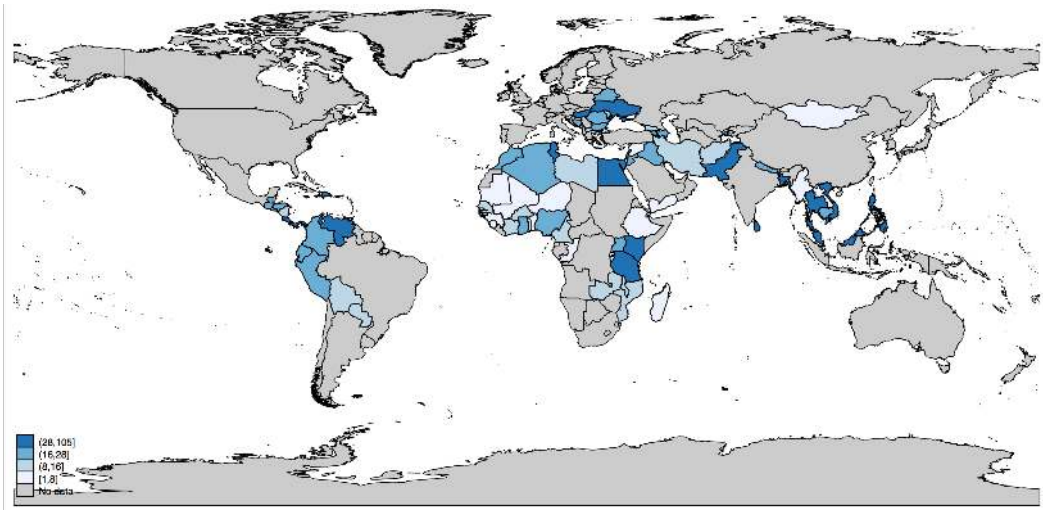
This table lists the total number of banks and that of listed banks in each country in the sample. LIC: low-income countries, MIC: middle-income countries, according to the Word Bank classification. G-20 countries are excluded from the sample. There are 1,642 banks in 78 countries (495 in LICs), out of which 249 banks are listed.

Country	LIC	Banks	Listed banks	Country	LIC	Banks	Listed banks
AFGHANISTAN	1	9	0	LEBANON	0	36	6
ALBANIA	0	15	0	LIBYA	0	11	0
ALGERIA	0	19	0	MACEDONIA	0	15	6
ARMENIA	0	19	0	MADAGASCAR	1	4	0
AZERBAIJAN	0	26	0	MALAWI	1	12	3
BANGLADESH	1	38	26	MALAYSIA	0	83	9
BELARUS	0	24	0	MALI	1	8	0
BENIN	1	7	0	MAURITANIA	1	7	0
BOLIVIA	1	12	0	MONGOLIA	1	7	0
BOSNIA	0	27	4	MOROCCO	0	22	6
BULGARIA	0	25	3	MOZAMBIQUE	1	14	0
BURKINA FASO	1	9	1	MYANMAR	1	4	0
BURUNDI	1	4	0	NEPAL	1	18	0
CAMBODIA	1	24	0	NICARAGUA	0	12	0
CAMEROON	1	10	0	NIGER	1	5	0
COLOMBIA	0	21	1	NIGERIA	1	23	13
CONGO	1	3	0	PAKISTAN	0	45	16
COSTA RICA	0	58	0	PANAMA	0	58	0
COTE D'IVOIRE	1	11	0	PARAGUAY	0	9	0
DJIBOUTI	1	4	0	PERU	0	24	5
DOMINICAN REP.	0	63	0	PHILIPPINES	0	51	14
ECUADOR	0	20	4	REP. MOLDOVA	1	12	0
EGYPT	0	33	12	ROMANIA	0	28	3
EL SALVADOR	0	11	0	RWANDA	1	8	0
ETHIOPIA	1	7	0	SENEGAL	1	10	0
GAMBIA	1	2	0	SIERRA LEONE	1	7	0
GEORGIA	0	16	1	SRI LANKA	0	42	14
GHANA	1	25	6	SYRIAN ARAB REP	0	5	0
GUATEMALA	0	28	0	TAJIKISTAN	1	8	0
GUINEA	1	3	0	THAILAND	0	40	18
HAITI	1	4	0	TOGO	1	8	0
HONDURAS	1	19	0	TUNISIA	0	30	17
HUNGARY	0	35	1	UGANDA	1	21	3
IRAQ	0	17	7	UKRAINE	0	105	6
ISLAMIC REP. IRAN	0	13	0	TANZANIA	1	29	3
JAMAICA	0	10	1	VENEZUELA	0	33	6
JORDAN	0	18	15	VIETNAM	1	42	8
KENYA	1	36	9	YEMEN	1	4	0
LAO PDR	1	1	0	ZAMBIA	1	16	2

Table A2: Variable definitions and data sources

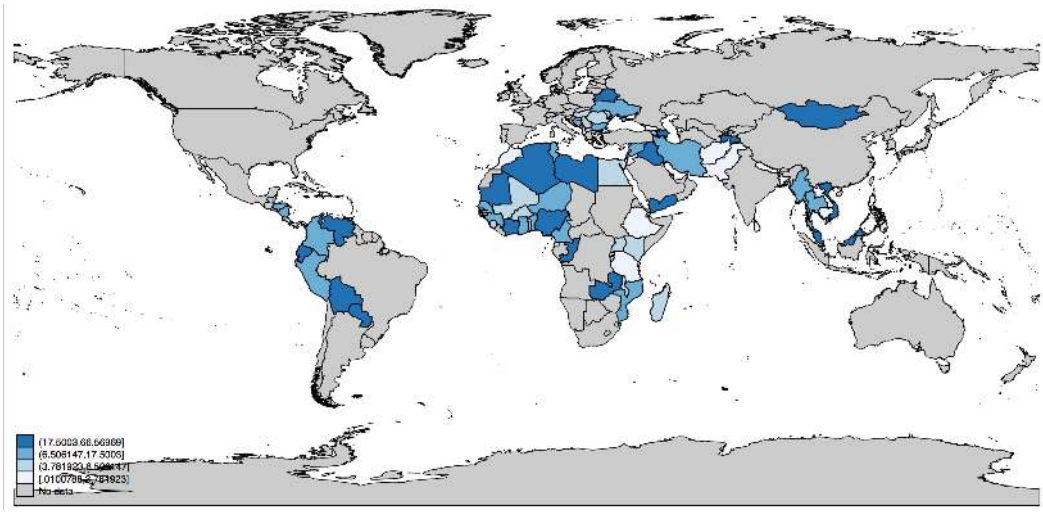
Variable	Definition	Source
Loan Growth	Growth of gross loans in nominal USD (%)	Bankscope
Size	Logarithm of total assets	Bankscope
NPL	Ratio of non-performing loans to gross loans	Bankscope
Deposits/Assets	Ratio of customer deposits to total assets	Bankscope
Equity	Total equity to assets ratio	Bankscope
Liquidity	Liquid assets to deposits and short-term funding	Bankscope
ROA	Return on assets	Bankscope
Price index	Country-specific commodity price index	Gruss (2014)
Exposure	Ratio of commodity exports to GDP (three-year moving average)	Gruss (2014) and authors' calculations
Growth	Growth rate of real GDP	World Economic Outlook (IMF)
IR	log of domestic interest rates	International Financial Statistics (IMF) and World Development Indicators (World Bank)
Private Credit/GDP	Credit to the private sector over GDP	International Financial Statistics (IMF) and World Development Indicators (World Bank)
ER	Exchange Rate	International Financial Statistics (IMF)
Growth Forecast	One period ahead forecast of GDP growth	World Economic Outlook (IMF), different vintages
KA Open	Dummy for capital account openness	Chinn and Ito (2006), updated

Figure A1: Number of banks in the sample



Note: The map shows the quantile distribution of number of banks in the sample.

Figure A2: Commodity exposure of countries in the sample



Note: The map shows the quantile distribution of exposure of each country to commodity exports. Commodity exposure is defined as the share of commodity exports to GDP. The darkest shaded countries are the ones which are most exposed to commodity exports.