# Commodity Price Shocks and Non-Performing Assets in the Indian Banking Sector*

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**Abstract**

Non-performing assets in the Indian banking sector increased significantly in the 2010s, accompanied by a slowdown in credit and GDP growth rates. In this paper, we show that non-performing assets in the banking sector and profit ratios in commodity-sensitive non-financial sectors are highly correlated with global commodity prices. To estimate the effect of movement in commodity price on non-performing assets, we create nominal price and inflation exposure indices for banks using novel data on banks' sectoral exposure and commodity prices. These measures capture banks' exposure to commodity prices through their borrowers' profitability and cash flow and act as income shocks for banks. Results from a range of models suggest that a 1% decline in nominal exposure increases non-performing assets by 0.20-1.35% and these models explain 30% of the increase in non-performing assets. Since public sector banks in general had higher exposure to

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commodity-sensitive sectors, they experienced a relatively higher decline in nominal exposure and a more significant rise in non-performing assets after the price crash of the 2010s. The increase in non-performing assets is followed by a decrease in credit growth. These results help us in understanding the origins of India's twin balance sheet crises of the 2010s.

Keywords: Non-performing Assets; Commodity Prices; Instrumental Variable; Sectoral Exposure; Sectoral Prices

JEL Classification: E31; G21; F31

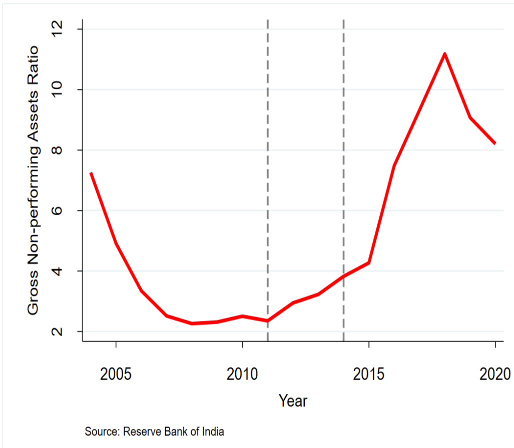
# 1 Introduction

Scheduled commercial banks in the Indian banking system had an alarmingly high proportion of non-performing assets (NPAs; approximately 16% of gross advances) in the mid-1990s. After a series of reforms in the 1990s, at the start of the 2000s India witnessed a surge in its trend GDP growth rate, along with a significant improvement in the health of its banking system. Overall, gross non-performing assets (as a per cent of gross advances) fell quickly to less than 3.5% by 2005-06 and further declined and remained at a little over 2% for the next few years.[1] Although GDP growth fell in 2008-09 in response to the North Atlantic Financial Crisis (NAFC), the Indian economy rebounded sharply based on its strong fundamentals, large amounts of fiscal and monetary stimulus, and regulatory support such as forbearance measures. However, the trend of falling NPAs reversed, with gross NPAs rising from 2011 on and reaching a peak of 11.18% by the financial year ending in 2018 (Figure 1a).

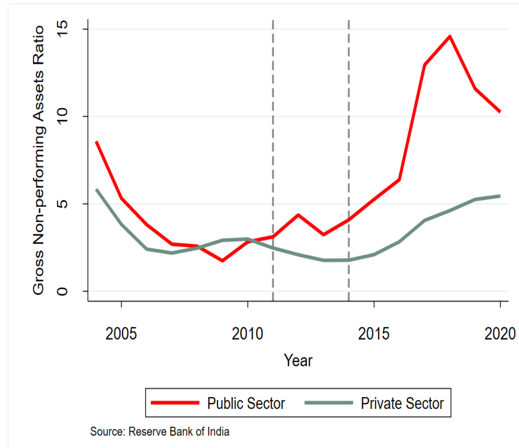
NPAs are neither homogeneous across banks, nor are they homogeneous across banking groups. In the early 2000s, when they were declining overall, NPAs were slightly higher for public sector banks than for private sector banks. However, NPAs for public sector

[1]See Mohan and Ray (2017, 2019) for a detailed study on the evolution of the Indian financial system. Mohan and Ray (2022) also suggests three distinct phases of non-performing assets from early 2000 onwards.

banks fell marginally below NPAs for private sector banks around 2008 and remained so till 2011 when they diverged (Figure 1b). After the asset quality review (AQR) in 2015-16, NPAs for both public and private sector banks increased, but the increase was far greater for public sector banks.




(a) All Scheduled Commercial Banks




(b) Public and Private Banks

Figure 1: Annual Gross Non-Performing Assets Ratios
Notes: Figure 1(a) gives the gross NPAs for all scheduled commercial banks. It is obtained by dividing total gross NPAs with total gross advances for all scheduled commercial banks. Figure1(b) gives the bank group-wise NPA ratio. For private sector banks this is obtained by dividing total gross NPAs with total gross advances of private sector banks. Till 2017, the Reserve Bank of India used to report public sector banks in two categories - nationalised banks and the State Bank of India and its associates. Since 2018, it has reported them together as public sector banks. We take the sum of the gross advances and gross NPAs for these two groups before 2017 to obtain the NPAs of public sector banks till 2017. Source: Reserve Bank of India.

NPAs are the stock of defaulted loans, and their evolution depends significantly on the availability of bank capital. Two banks facing the same value of loan defaults may have different NPAs because they can write off different amounts due to differences in their capital availability. Thus, in this paper, we measure the flow of NPAs using two additional variables: 'slippage', and 'slippage+restructured', which refer to the flow of NPAs and the sum of the flow of NPAs and the stock of restructured assets, as we cannot obtain the flow of restructured assets.[2]

[2]Slippage refers to the fresh addition to NPAs during a given financial year. Restructured loans are

There are several potential reasons for the rise in gross NPAs during 2010-18. Mohan and Ray (2022) suggests four: (i) regulatory forbearance; (ii) the surge in infrastructure projects and their unviability with the growth slowdown; (iii) governance issues in public sector banks; and (iv) the decline in commodity prices post 2011. The Reserve Bank of India introduced a series of regulatory forbearance measures during the financial crisis, which remained in effect for an extended period.[3] Chari et al. (2020) suggest that stressed banks increased their lending significantly to bad firms during the period of the regulatory forbearance. Further, in industries with a high proportion of 'zombie' firms,[4] credit was reallocated to these firms and away from solvent ones. But regulatory forbearance cannot be the cause of the origin of NPAs, although it is likely to have exacerbated the problem. In normal times, capital-constrained banks may evergreen illiquid borrowers to avoid having to make fresh provisions. But with regulatory forbearance, this is not required as there is no provision for restructuring illiquid loans.

those for which borrowers in financial trouble revise the terms of the loan with banks to avoid a default.

[3]During the financial crisis in 2008-09, the Reserve Bank of India had introduced a policy of regulatory forbearance which allowed banks to reclassify their assets. Earlier, only industrial non-SME accounts could avail of the benefits of restructuring, but during the period of forbearance this was extended to include real estate and micro-finance institutions as well. The measure was extended as, during a crisis, it is difficult to distinguish between illiquidity and insolvency. In normal times, banks deal with illiquidity by restructuring assets and making provisions for them. But regulatory forbearance allows banks to deal with illiquidity problems without any fresh provisioning, as the restructuring does not require any provision. This reclassification allowed banks to avoid higher provisioning which would have resulted in a reduction in credit flow and eventually led to a fall in economic growth rates. In 2010, as an incentive to hasten the implementation of the restructuring package, the promoters' sacrifice (an erosion in the fair value of the advance) and additional funds required to be brought in by promoters upfront was reduced by half (with the remaining 50% to be paid within a year). Bank loan growth rebounded rapidly to 21.5% in FY2011 after dropping to 16.9% in FY2008. In May 2011, the RBI introduced a provisioning of 2% for standard restructured assets in the first two years from the date of restructuring. But since it is difficult to distinguish between illiquidity and insolvency, banks restructured insolvent projects as well to some extent. Further, banks with lower capital and low profits had the incentive to classify insolvent projects as illiquid and restructure them, as this would not adversely affect their capital situation. The Economic Survey 2020-21 argues that the continuation of regulatory forbearance measures for longer than required had adverse consequences for the health of India's banking system. Further, these forbearance measures promoted zombie lending, as many of the insolvent borrowers' assets were not classified as NPAs. The Reserve Bank of India withdrew asset reclassification, with a few exemptions, in April 2015, and completely in 2018.

[4]Zombie firms are firms that are not in a position to cover debt servicing costs from current profits over an extended period.

Therefore, it is not obvious that regulatory forbearance increased the evergreening of loans. Thus, the behaviour of banks did not change with regulatory forbearance, as their provisioning requirements for insolvent borrowers remained unchanged during this period.

But regulatory forbearance can lead to a deliberate classification of insolvent loans as illiquid to avoid provisioning by capital-constrained banks. Choudhary and Jain (2021), using data from Pakistan, provide evidence that classifying a loan as non-performing is more expensive for banks with less capital, so restructuring the loan may be a better option for them. As such, it can lead to loans being extended to insolvent borrowers, as they may not be declared insolvent, which would divert scarce capital away from healthy and productive borrowers. At the same time, there is some merit in regulatory forbearance as suggested by the existing literature. Ahamed and Mallick (2017a) suggest that higher levels of restructured assets significantly reduce risk-taking by banks; they also find (2017b) that regulatory forbearance measures could significantly increase the stability of the banking sector. The important point is that even if we believe that regulatory forbearance measures caused zombie lending, this does not imply that zombie lending was the only source of NPAs. By definition, zombie lending refers to loans given to insolvent firms, but it does not say anything about what led to insolvency in the first place. The late 2000s and early 2010s also experienced a surge in infrastructure projects especially in PPP (public-private partnership) mode and banks had significant exposure in these projects. Many of these projects may have turned unviable once the trend growth decreased in the early 2010s and are likely to have contributed to the NPAs in the banking sector. Due to a paucity of data, we do not pursue this line of research in this paper.

Since the rise in NPAs has been significantly higher among public sector banks vis-a-vis private sector banks, the governance and management of public sector banks have often been mentioned as reasons for the increase in their NPAs. Acharya et al. (2019) argue that in the aftermath of the financial crisis private sector banks experienced deposit flight, a significant amount of which was later lent by public sector banks which eventually underperformed. Banks lend primarily from their deposited funds; hence a deposit flight would result in lower credit from private banks and higher from public sector banks which is not surprising. Effectively Acharya et al. (2019) argue that public sector banks made bad lending decisions which led to the generation of NPAs.

As mentioned earlier, public sector banks improved their performance significantly from the mid-1990s, which by 2007-08 was at par with or even better than that of private sector banks. It is hard to believe that the governance and management of these banks could have deteriorated so rapidly as to give rise to a large amount of NPAs. Further, regulatory forbearance was implemented uniformly across all scheduled commercial banks and therefore regulatory forbearance is not sufficient to explain the heterogeneity in NPAs across public and private sector banks. It is almost impossible to disentangle bad practices from genuine assistance provided by banks to their large borrowers who were facing difficulties in repaying their loans because of unforeseen conditions. One can better understand this from an old quote from Keynes (1945): "If you owe your bank a hundred pounds, you have a problem. But if you owe your bank a million pounds, it has." Faria-e-Castro et al. (2021) using a model based on relationship banking suggests that lenders have an incentive to evergreen loans by offering better terms to less productive, more-indebted firms, so as to improve their chances of being paid back.

As it happens, the increase in NPAs coincides with the decline in global commodity prices after 2011 (Figure 2). In fact, earlier episodes of a rise or fall in gross NPAs have been attributed by banks to changes in commodity prices; the two variables have a significant reduced-form correlation but this has been ignored in the literature. In the late-1990s when NPAs in the Indian banking sector had increased sharply, ICICI Bank in its SEC filings stated that the decline in commodity prices was one of the key reasons for the increase in their impaired loans: "The growth in impaired loans can be attributed to several factors, including increased competition arising from economic liberalization in India, a slowdown in industrial growth, a sharp decline in commodity prices, which reduced profitability for certain of our borrowers, and the restructuring of certain Indian companies in sectors such as iron and steel, man-made fibers and textiles."[5]

[5] Form 20-F, SEC Filings, for the fiscal year ending March 2001 (available at https://www.sec.gov/Archives/edgar/data/0001103838/000095010301501392/bank20f-final.pdf).

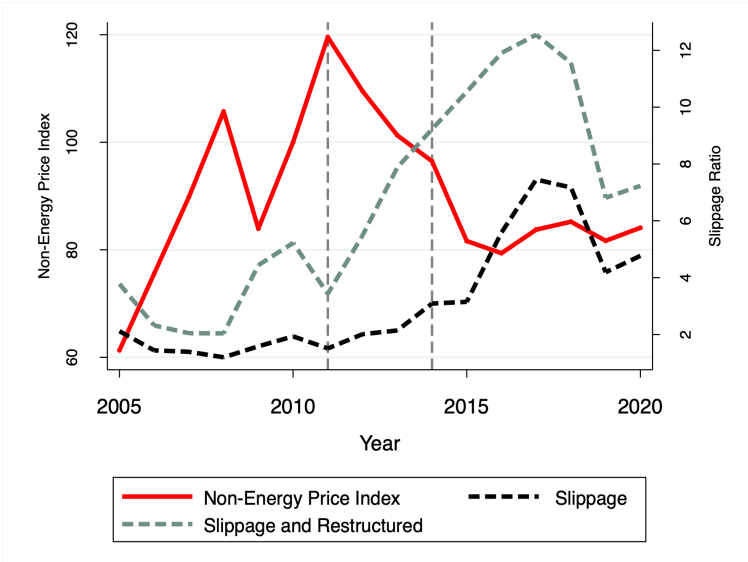



Figure 2: Non-Performing Assets and the Non-Energy Price Index
Notes: The slippage ratio is defined as new additions to NPAs divided by standard advances. Standard advances is the difference between gross advances and gross NPAs. Slippage and Restructured is defined as the sum of new additions to NPAs and restructured assets divided by standard advances, based on the annual average of individual ratios across banks. Source: World Bank and Reserve Bank of India.

In 2008, SEC filings by the same bank attributed the sharp decrease in their non-performing assets to the increase in commodity prices. Thus, the increase in commodity prices after 2003 had a favourable impact on the operations of corporations in several sectors, leading to lower defaults and improvements in banks' balance sheets. [6] Further, ICICI Banks' SEC filings in 2020 state that the recent increase in their NPAs was largely due to the commodity price crash post-2011.[7] Data suggest that ICICI Bank has not been as heavily exposed to commodities as many other banks, thus the effect on the

[6]See the SEC filings for the financial year ending in 2008 by ICICI Bank, one of the major private sector banks in India (available at `https://www.sec.gov/Archives/edgar/data/1103838/000095010308002444/dp11348_20f.htm#loanportfolio`). It also mentions that in the past, ICICI Bank had experienced a high level of default and restructuring in its project finance loan portfolio as a result of the downturn in some global commodity markets, because the commodity price decline had caused stress in the operating performance of Indian companies.

[7]https://www.icicibank.com/managed-assets/docs/investor/annual-reports/2020/Form-20-F-FY2020.pdf

other banks would be far more severe. There is a void in the research that explores the link between global commodities prices and NPAs in the Indian banking sector: our study aims to fill this gap.

As mentioned earlier, we use slippage and slippage+restructured as measures of NPAs. Since we regress bank-level variables in this paper, we use the average of bank-level values over the years in Figure 2 for comparison. The correlation between measures of NPA and commodity prices is negative and statistically significant. Although the decline in commodity prices during 2008-09 led to an increase in NPAs, the increase was not very large, possibly for the following reasons. First, the decline in commodity prices reversed quickly. Second, the Indian government and Reserve Bank of India implemented large-scale fiscal and monetary stimulus measures to handle the crisis, so the growth rate rebounded rapidly. Third, the Reserve Bank of India announced the introduction of regulatory forbearance measures which gave banks little or no provisioning for restructured assets.

As we can see from Figure 2 during 2008-09, the slippage+restructured assets ratio (the addition to NPAs+restructured assets as a per cent of standard advances) increased much more sharply than the slippage (the addition to NPAs as a per cent of standard advances). As commodity prices started decreasing again in 2011, both measures of NPAs used in this paper - the slippage and the slippage+restructured ratios - started increasing, but slippage increased far more sharply after 2015. This could be for two reasons. First, domestic commodity prices started declining only after 2014 as we show in the next section. Second, regulatory forbearance measures were removed, and the asset quality review was implemented in 2015-16, therefore restructured assets were identified as non-performing.[8] We visit this issue in detail later in the paper. Also, as we can see from Figure 2, once commodity prices started increasing from 2017 onwards, both the slippage and slippage+restructured ratios declined.

[8]The introduction of new bankruptcy procedures in 2016 may also have given banks an incentive to declare a higher level of NPAs than they would have done otherwise, and to move to bankruptcy courts for a quick recovery (https://www.ibbi.gov.in/)

It can be argued that with regulatory forbearance, the slippage ratio is not exogenous, as banks may have used these measures to restructure assets which should otherwise have been declared as NPAs (slippages) since restructuring requires little or no provisioning. The slippage+restructured ratio is less likely to suffer from this issue. Further, banks would be inclined to restructure assets rather than declare them as non-performing, if they did not have an adequate capital buffer. Therefore, conditional on profits, the deliberate restructuring of NPAs would be less severe, and hence we control for bank-level profits in our analysis.

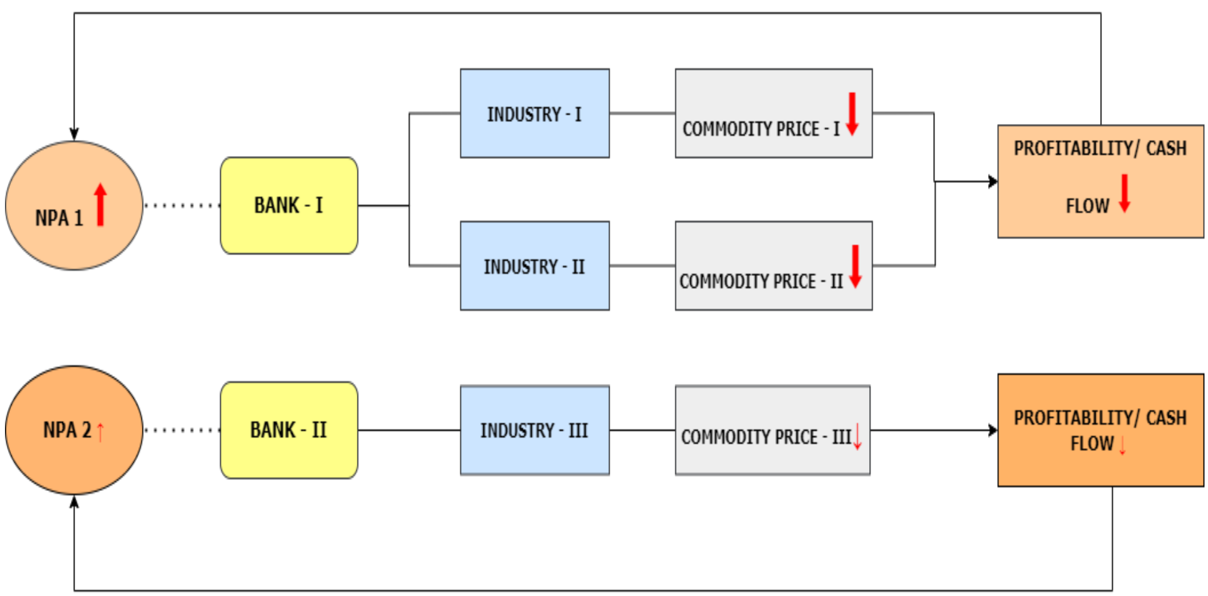



Figure 3: Research Design
Notes: A decline in commodity prices decreases the cash flow and profitability of non-financial firms, causing an increase in their defaults. This increases the impaired loans for banks exposed to commodity-sensitive sectors.

Thus, in this paper, we explore the emergence of NPAs using the heterogeneity in banks' NPAs and banks' exposure to commodity-sensitive sectors. The channel of operation is through the effect of a fall in commodity prices on cash flows and the profitability of bank borrowers, i.e., non-financial firms (see Figure 3). A fall in commodity/sectoral prices decreases the cash flow and profitability of non-financial firms and depresses the price of their assets. We show using firm-level data that sales, prices, and average profits in commodity-sensitive sectors are very closely related to international and local commodity prices. They also increase non-financial firms' real debt and lead to defaults, thus impairing the balance sheets of associated financial firms.[9] It is important to highlight that the sharp decline in commodity prices can lead to a fall in overall prices (deflation), which is different from a slowdown in inflation (disinflation). Rajan and Ramcharan (2015) give evidence of this channel from US data. They show that a fall in agricultural commodity prices in 1920 reduced land prices significantly in US counties, which led to defaults by borrowers who had borrowed to buy these tracts of land. These defaults had a long-term effect on the availability of credit.

A change in commodity prices has been treated as an income shock in a large section of the literature on commodity prices. One of the main contributions of this paper is to map these income shocks to respective banks based on their differential exposure to commodity sectors. Gurkaynak et al. (2019) using US data, explore the effect of cash-flow exposure through non-financial firms' holding of floating debt. They show that firms with a higher share of floating rate debt experience a much sharper response in their stock prices from a surprise monetary policy shock. The empirical strategy adopted in this paper is very similar to this literature.

As mentioned above, we estimate a statistically significant correlation between average slippage and global commodity prices. Although this correlation indicates a possibility of commodity prices causing NPAs, it is difficult to make this argument for a number of reasons. First, our sample size is small, so there is a greater likelihood of obtaining a spurious correlation. The second problem is that this correlation tells nothing about the differences in NPAs across banks. Given the intense debate on the differences in NPAs across public and private banks, the correlation is not helpful. Third, if we resolve the 'small sample size' issue by doing a bank-level regression, there is still no variable that

[9] See Fisher(1933) for a detailed analysis on debt deflation.

can account for differences in NPAs across banks. All aggregate macroeconomic variables - national and international - remain the same for these banks and hence cannot explain the bank-wise heterogeneity in NPAs.

To address these issues, we create a price exposure index that varies across banks each year and therefore can help us to explain differences in NPAs across banks. The index is created by adding across all sectors the product of sectoral exposure (as a per cent of total advances) of a particular bank in a specific sector and prevailing prices in that sector. Banks' sectoral exposure comes from banks' annual Pillar 3 fillings - a requirement under the Basel framework under which banks have to publicly disclose information about their sectoral lending. Commodity prices are obtained from the respective commodity wholesale price indices published by the Ministry of Statistics and Programme Implementation (MoSPI) of India. To the best of our knowledge, these data have not been used previously to understand the origin of NPAs. Although this index helps in explaining bank-wise heterogeneity in NPAs, one can argue that NPAs can cause a change in exposure. To resolve this, we create two additional variations of our index, one of which has constant weights, so it resolves the issue of endogeneity in weights (see Bazzi and Blattman, 2014; Ciccone, 2018; Eberhardt and Presbitero, 2021).

Banks are important for financial intermediation and help in transferring funds from savings-surplus units to saving-deficit units. Bank credit is important for entrepreneurship, capital accumulation, growth, and poverty reduction (Banerjee and Duflo, 2014; Beck and Demirguc-Kunt, 2006; Bruhn and Love, 2014; Burgess and Pande, 2005; Karlan and Zinman, 2010). An increase in NPAs makes banks capital-constrained and reduces their credit growth. We estimate additional models with growth in advances as the dependent variable to substantiate our main result. Our regression results substantiate this: exposed banks when faced with a decline in the value of their exposure have significantly lower credit growth than non-exposed banks, after the commodity price crash.

The rest of the paper is structured as follows. Section 2 lists related literature in which movements in commodity prices have been treated as an income shock. Section 3 explains the data and provides evidence that sharp movements in commodity prices affect the profitability of non-financial firms. Section 4 explains the difficulties in estimating the effect of commodity prices on NPAs and argues that the exposure indices constructed in this paper help us obtain a causal estimate for this. Section 5 presents and discusses the main results and this is followed by concluding remarks and policy implications. The appendix at the end provides results from several robustness exercises carried out in this paper and a separate online appendix contains further econometric evidence to substantiate the main result of this paper.

# 2 Related Literature

This paper relates to four main strands of literature. The first relates to exposure to commodity prices and their impact on banking crises in low-and middle-income countries. Eberhardt and Presbitero (2021) show that commodity price volatility can lead to a banking crisis as price movements can impact the real economy through their effect on bank balance sheets. For their analysis, they create commodity exposure weights for each country $i$ and commodity $j$ in their sample as $w_{ij} = \frac{\text{net export share}_{ij}}{\text{GDP}_i}$ and multiply these with time varying respective commodity prices to obtain an exposure index for each country $i$ at time $t$. They prefer to use constant commodity exposure weights to diminish the endogeneity bias. We also construct an exposure index for banks based on constant weights and sectoral commodity prices. Eberhardt and Presbitero (2021) show that for every one standard deviation increase in country-specific aggregate commodity exposure index volatility, the probability of a banking crisis increases by 2.5 percentage points. They further show that private credit growth is not a reliable predictor of banking crises in low- and middle-income countries.

Agarwal et al. (2020a) explore the effect of commodity prices on lending using exposure based on exports. The weight for country $i$ and commodity $j$ is a three-year average of net exports as a share of total trade for commodity $j$, and is the same for each bank in that country. This is multiplied by the respective commodity price to obtain the export exposure index for each country. Further, they measure banks' sensitivity to commodity prices using stock price data. The returns due to commodity prices is referred to as sensitivity to commodity prices. According to them, a decrease in commodity prices leads to the deferral of investments by firms and a fall in their demand for credit. Banks face a financing shock as a result of reduced commodity-related deposits, which further reduces their credit supply. Agarwal et al. (2020b), using a difference-in-differences framework, provide evidence from Mexico after the decline of energy prices in 2014. Banks with greater exposure to the energy sector extended their exposure to these borrowers with lower lending margins in order to assist their businesses. Hence, all the increase in lending to exposed sectors cannot be termed 'zombie lending', as it may have arisen from business necessity as well.

The second strand in the literature is the use of commodity prices to understand growth in low- and middle-income countries and resource-rich countries. De V et al. (2015) suggest that high volatility in commodity terms of trade has a detrimental effect on economic growth, mainly because it reduces the accumulation of physical and human capital. Deaton and Miller (1995) use commodity prices as instruments for economic growth in Sub-Saharan African countries to understand the relationship between growth and political exits. Ferraro and Peretto (2017) build an endogenous growth model for commodity-rich countries and suggest that commodity prices affect short-run growth through transitional dynamics, although they have no long-run effects on growth.

The third strand in the literature comprises studies exploring the link between commodity prices and conflict. This is another set of literature using commodity price as an income shock similar to the empirical strategy in this paper. Positive income shocks increase the size of state capture, 'prize', and could increase conflict. At the same time, large income shocks increase the opportunity cost of a revolt. Bazzi and Blattman (2014) use an exogenous country-specific measure of annual commodity export price shocks and rule out the state prize[10] and opportunity cost theories. They find a reduction in conflict from favourable income shocks, but this is largely due to higher revenue for the state. Dube and Vargas (2013) also test the relationship between opportunity cost and the prize

[10] According to the state prize theory, higher revenues boost incentives to seize the state.

(rapacity) effect.[11] Their results suggest that commodity prices affect conflict but the dominance of these effects depends upon the type of commodity. Blair et. al. (2021), using a meta-analysis of 46 natural experiments based on the difference-in-difference method, find that commodity prices significantly affect conflict. Further, income shocks in labour-intensive sectors such as agricultural commodities reduce conflict, whereas increases in the price of oil, a capital-intensive commodity, provoke conflict, which is similar to the findings in Dube and Vargas (2013).

The literature on the subject has recently expanded to include banks' susceptibility, not just to commodity prices, but also to exposure to the housing market. This is the fourth strand of literature with which our work is associated. Kara and Vojtech (2017) create a county-wise exposure index for banks using data for 2005 and 2006, where the weights are a proportion of the mortgage originating in county C out of the total mortgage, which is multiplied by the median price-to-household income ratio in that county. They find that banks with greater exposure to the housing market had higher mortgage delinquency and NPAs, and significantly higher probabilities of failure during the crisis. This is because banks with higher exposure in 2005 and 2006 faced a significantly larger decline in the value of their exposure as a result of higher housing-price corrections.

Our methodology is very similar to the one applied here, as we use novel data on banks' sectoral exposure and commodity prices to create exposure indices for banks. Banks with a higher exposure to commodity-sensitive sectors experienced a larger decline in their exposure when the commodity price crash finally passed through to the Indian economy and ended up with higher NPAs.

[11] Income shocks affect armed conflict. Higher wages may reduce conflict by limiting the amount of labour available for violent resource appropriation. On the other hand, if the benefits from appropriation are increased, violence may rise in tandem with a rise in contestable revenue. This is called the rapacity effect.

# 3 Data

Our research and analysis rely on a wide range of data: on commodity prices, the sectoral exposure of banks, sectoral/commodity prices, bank balance sheets, balance sheets of non-financial firms, and aggregate macroeconomic variables. The World Bank commodity price data (the Pink Sheet) gives us annual and monthly prices (in US dollars) of several commodities. The non-energy commodity price index comprises agriculture (including food and beverages, raw materials such as timber, cotton, rubber, etc., fertilisers, and metals and minerals excluding precious metals). The annual rupee-US dollar exchange rate is also obtained from the World Bank. Local commodity prices in India are obtained by multiplying US dollar commodity prices with the bilateral exchange rate. The World Bank database also provides us with India's annual GDP growth rate and GDP deflator, and the GDP growth rate for low- and middle-income countries. We use aggregate commodity prices from the Federal Reserve Bank of Saint Louis.

Table 1: Correlation between Commodity Prices

| | All Commodities | Non-Energy | Food | Metals |
|---|---|---|---|---|
| All Commodities | 1 | | | |
| Non-Energy | 0.9363* | 1 | | |
| Food | 0.8796* | 0.9404* | 1 | |
| Metals | 0.7690* | 0.7886* | 0.5527* | 1 |

Notes: * denotes significance at 5%.
Sources: All Commodities (representing the global price index for all commodities) is from the Federal Reserve Bank of Saint Louis; The Non-Energy, Food and Metals price indices are from the World Bank Pink Sheet.

We use the Reserve Bank of India database on the Indian economy for bank-level data. It covers all the scheduled commercial banks, and lists variables that are critical for assessing the financial condition of banks' assets and liabilities. It gives various classifications of banks' impaired assets such as their gross NPAs, additions to NPAs, restructured assets, and so on. From the entire bank database, we exclude small finance banks, banks with total assets lower than Rs 10,000 crore, and those whose credit-deposit ratio is over 100 in most years. The banks remaining in our dataset account for over 90% of the total gross advances by all banks. We calculate the standard advance by subtracting gross NPAs from the gross advance.

The slippage ratio, slippage+restructured ratio, and growth of advances are the three main dependent variables used in this paper. We term the additions to NPAs divided by standard advances as the 'slippage ratio': this is the same as the percentage of loan default faced by a given bank in a given year. We term the additions to NPAs+restructured assets divided by standard advances as the 'slippage+restructured ratio'. The growth in total advances can be gleaned from the balance sheet data. We also obtain other bank-level information, such as the profit ratio and cost of funding, from the same database. This database is also the source of aggregate variables such as industry-wise deployment of bank credit, real and nominal effective exchange rates, and interest rates.

Table 2: Correlation between Non-Performing Assets and Commodity Prices

| | All Commodity | Metals | Slippage | Slippage+Restructure |
|---|---|---|---|---|
| All Commodity | 1 | | | |
| Slippage | -0.4341* | -0.4563* | 1 | |
| Slippage+Restructured | -0.2896* | -0.5368* | 0.8610* | 1 |

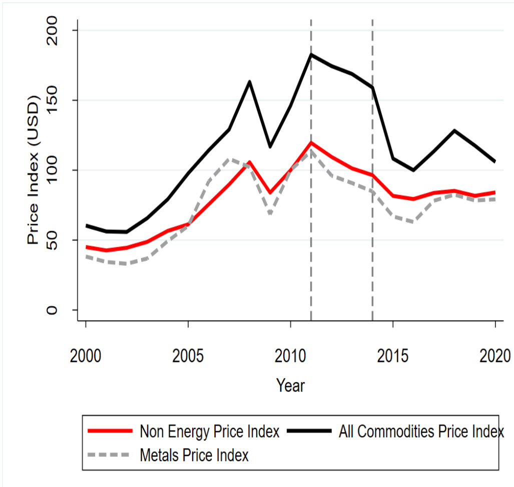
Notes: * denotes significance at 5%. The slippage ratio is defined as new additions to NPAs divided by standard advances. Slippage+Restructured Assets is the sum of fresh additions to NPAs and restructured assets as a share of standard advances. Standard advances is the difference between gross advances and gross NPAs. We take the annual average of individual slippage ratios across banks.

Table 2 gives the correlation between commodity prices and the two measures of NPAs being used in this paper. As we can see, the correlations between commodity prices and both measures are negative and significant. Sectoral and aggregate commodity price data are taken from the wholesale price index published by the Office of the Economic Advisor at the Ministry of Commerce and Industry. We concord wholesale prices indices for two base years (2004-05 and 2011-12) to obtain a continuous series of sectoral prices. Bank-wise sectoral credit data are obtained from the CMIE Prowess database. Banks are required to make public this information under the new Basel accord, which sets out requirements for banks disclosures on their risks, and capital and risk management, so as to strengthen market discipline.[12] As these data are available from 2008 to 2020, our regression analysis covers this time period. CMIE Prowess lists sectoral credit for 83 industry categories, whereas the number of industries reported by banks varies across years. We map these 83 categories with uniform sectoral prices. Thereafter, we create a nominal price exposure index and nominal inflation exposure indices, which are the product of sector weight and sectoral prices or inflation.

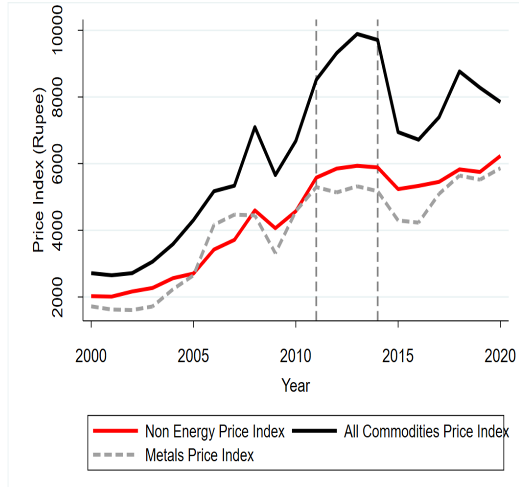
We extract bank-level stock price data and firm-level data for non-financial firms from the CMIE Prowess database and the BSE Sensex index data (from Yahoo finance). We categorise firms by the industrial classification (NIC-2008, from Prowess), e.g., metals, food and beverages, gems and jewellery, etc. We use data on net profits, operating profits and sales for non-financial firms. We also collate bank information from annual reports, supplements to annual reports, and the Insolvency and Bankruptcy Board of India (IBBI).

NPAs and loans in the banking sector arise from prevailing macroeconomic conditions, internal as well as external. We now provide a brief overview of the macroeconomic data that suggests delayed pass-through of decline in commodity prices into domestic markets. Using firm-level data we show that the decline in commodity prices indeed led to decline in profitability, that is the channel through which commodity prices cause NPAs. The decline in global commodity prices after 2011 was not immediately passed on to the Indian economy, unlike the decline in commodity prices in 2008-09 (Figures 4a and 4b). But profits started to decline from 2011 on.

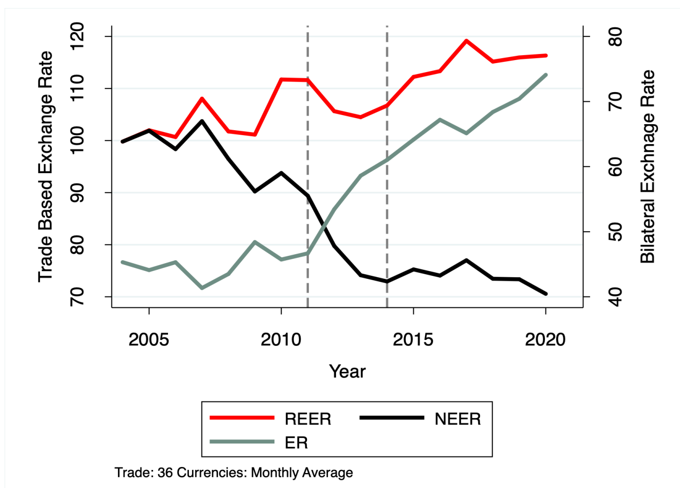
[12]Banks lend public deposits and borrowed funds to a variety of borrowers, with varying levels of risk. This exposes them to a range of default risks, which in extreme circumstances could result in their failure. The Basel Committee on Banking Supervision (BCBS), the primary global standard-setting agency for the prudential regulation of banks, provides a forum for regular cooperation on banking supervisory matters for the central banks of different countries. Three pillars (1, 2, 3) make up the Basel III capital adequacy framework: the Pillar 3 document requires banks to provide a range of disclosures, the most important of which are related to risk, capital, leverage, and liquidity. The Reserve Bank of India stipulates that all banks must publish all the terms and conditions of all instruments included in regulatory capital on their websites. This also applies to banks' sectoral fund-based and non-fund-based lending, and their NPAs in a given time period. We use sectoral fund-based lending as a measure of sectoral exposure.




(a) Commodity Price Indices in US Dollars




(b) Commodity Price Indices in Indian Rupees




(c) Trade-Based and Bilateral Rupee-US Dollar Exchange Rates

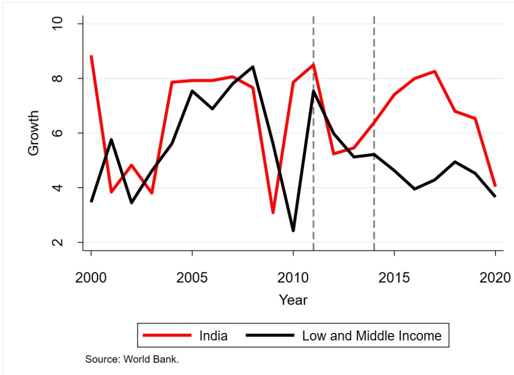
Figure 4: Transmission of International Commodity Prices into Domestic Market
Notes: The original commodity price indices in US dollars are multiplied by the bilateral rupee-dollar exchange rate to obtain commodity price indices in Indian rupees. Source: World Bank and Reserve Bank of India.

This could be for several reasons. First, the decline in prices world-wide made Indian firms less competitive viz-a-viz low-cost producers such as China. Second, prices fell because of a global decline in the demand for commodities, which can be expected to affect profits adversely. Third, although domestic prices did not decrease immediately, domestic firms exporting these commodities would have experienced a decline in their margins due to the fall in global prices. International commodity prices affect revenue from exports and hence profitability. The pass-through of global commodity prices to domestic prices depends upon the nominal exchange rate. Although the nominal Rs/USD exchange rate experienced a secular depreciation during 2011-14, the depreciation in the nominal exchange rate was more than commensurate, which meant that rupee commodity prices kept rising (Figure 4c).

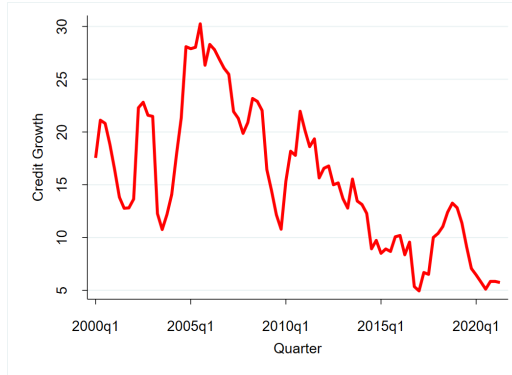
But from 2014 on, the nominal depreciation (of bilateral Rupee/USD exchange rate) was not sufficient and global commodity price decreases were accompanied by declines in domestic commodity prices. Hence, claiming that the asset quality review (AQR) was solely responsible for the increase in NPAs would be overstating the case: the macroeconomic scenario presented above suggests that this was a time when domestic prices declined significantly, which may have also contributed to the development of NPAs.

The delayed pass-through of global commodity prices to local commodity prices could have had a lagged effect on the creation of NPAs, which we try to capture through regressions in the local projection framework. Bank credit growth in India reached a peak of 30% around 2005, but has seen a secular decline since then (Figure 5b). Credit growth recovered quickly from a sharp decline during the financial crisis, but it resumed its downward trend after 2011; it did have a surge after the AQR in 2015-16, but this was short lived.

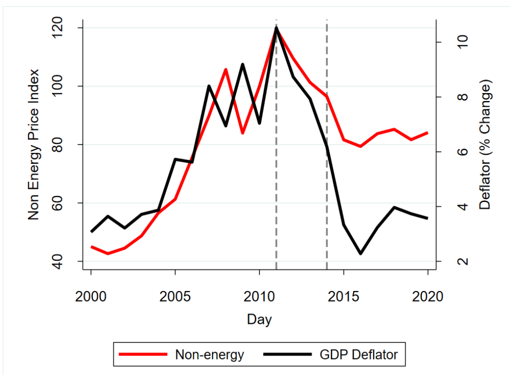
GDP growth increased sharply around 2003, and remained high till the 2008 financial crisis when it declined; although it recovered sharply after, it declined again in 2011 and recovered, but has been declining since 2015-16 when NPAs in the economy reached their peak after the AQR. Chopra et al. (2021) argue that the AQR was carried out without ensuring a capital backstop, and that under-capitalisation led to under-investment and risk-shifting through zombie lending.



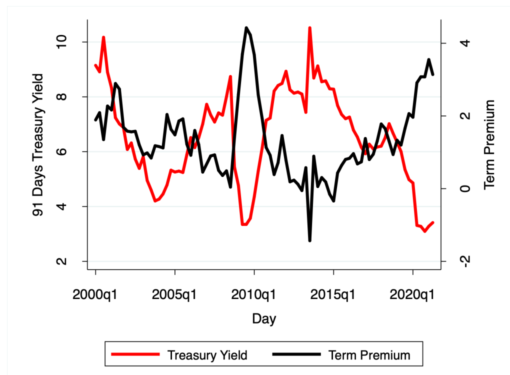

(a) Annual GDP Growth: India and Low-and Middle-Income Countries




(b) Industrial Credit Growth




(c) Non-Energy Commodity Prices and GDP Deflator



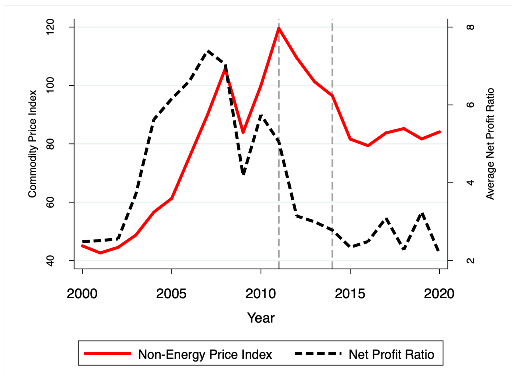

(d) Short-Term Rate and the Term Premium (10 Year Rate - 91 Days T-Bill)

Figure 5: Macroeconomic Scenario in India
Source: World Bank and Reserve Bank of India.

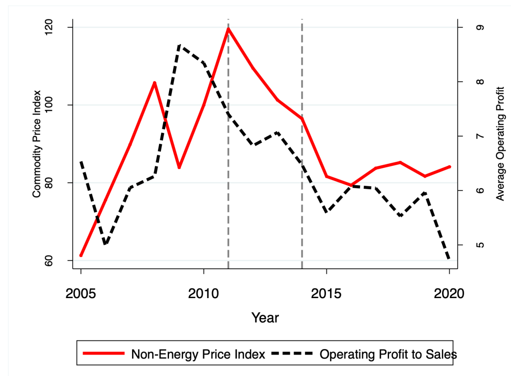
These can have significant real effects, and they impacted growth adversely. The increase in NPAs also coincided with a secular decline in the average growth rate of low- and middle-income countries (Figure 5a).[13] The decline in global commodity prices after 2011 coincided with a decreasing year-on-year change in India's GDP deflator (Figure 5c). The interest rate became highly accommodative during the financial crisis but increased

[13]Fernandez et al. (2017) suggest that in the post-2000 period, commodity price shocks explain more than 50% of the forecast error variance of the growth rates of individual economies.

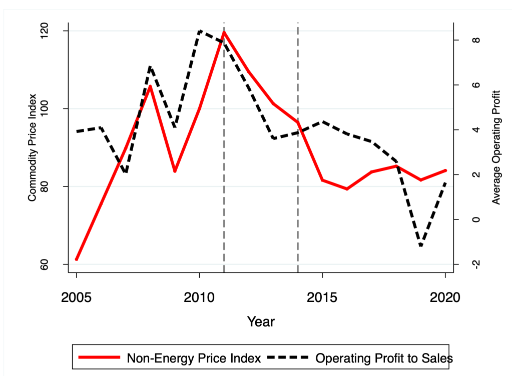
sharply after, and remained high for some time (Figure 5d). The term premium (the difference between the ten-year government bond yield and the 91-day treasury bill yield) was negative during 2013-16 (Figure 5d).



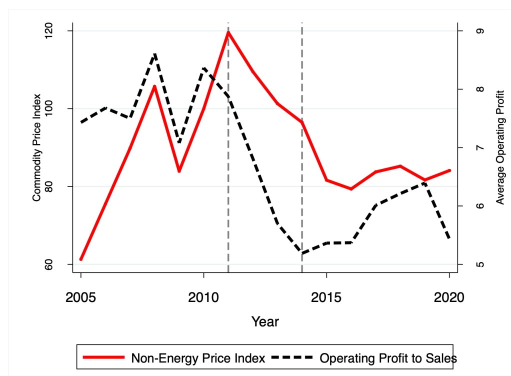

(a) Net Profit Ratio: All Non-Financial Firms in CMIE Prowess




(b) Operating Profit Ratio: Food and Beverages




(c) Operating Profit Ratio: Gems and Jewellery




(d) Operating Profit Ratio: Metal and Metal Products

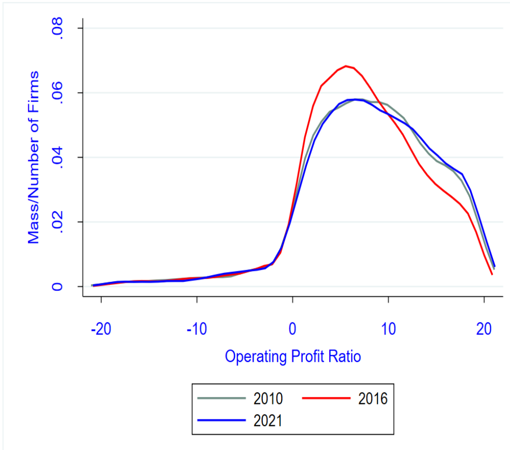
Figure 6: Commodity Prices and Profitability of Non-financial Firms

Notes: The original commodity (non-energy) price index is in US dollars. (a) The data includes all firms in the Prowess dataset, except for those with negative sales. (b), (c) and (d) relate to firms from the respective industries. We exclude firms with negative sales and fixed assets, or firms with operating profits and net profits over 100% and less than -100%. We calculate the mean of operating profits for all firms in the relevant sector yearly. Sources: CMIE Prowess and World Bank

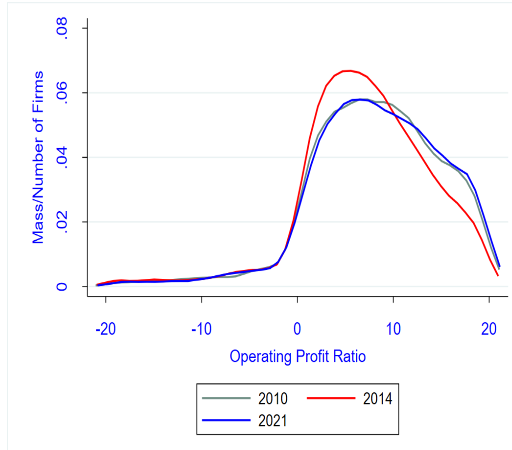
We include these relevant macro variables in our regression. Although, it is difficult to argue a causal effect of any of them in our regression framework, we use them as time-varying controls because our treatment variables - the nominal price exposure index and nominal inflation exposure indices - are time-varying. International commodity prices can affect the profitability of firms, as we demonstrate in Figure 6. Figure 6 (a) shows that the average net profit ratio for non-financial firms is strongly correlated with commodity prices.

It is no surprise that the profitability of non-financial firms has increased significantly during the COVID period despite adversely affecting the real growth rate. This is because commodity prices have increased significantly during the last two years (between 2020 and 2021). The increase in profits has been followed by a strong performance by stock market which provided an almost 100% return between March 2020 to March 2022. Figures 6(b), 6(c) and 6(d) suggest that the operating profit ratios in commodity-sensitive sectors are correlated with global commodity prices and declined significantly post-2011, after the crash in global commodity prices.

The impact of commodity prices on profits and cash flow is not straightforward. It can be argued that a decrease in commodity prices ought to lead to a decrease in input costs, which should not have a large effect on profitability. But there was a significant decline in firms' operating profit ratios, which suggests that the fall in sales revenue is much sharper than the decline in the cost of goods sold. Also, an increase in commodity prices implies higher growth and strong demand in the economy, so firms are able to pass on the increase in the costs of inputs, such as raw materials, to buyers. The other main component of operating cost is wages, which take time to adjust due to wage contracts, so the increase or decrease in product prices are not immediately passed on to wages. Firms also have a significant level of fixed costs. The increase in their top line due to an increase in prices is not associated with a concomitant increase in fixed costs, so profitability increases. A decline in their top line would mean that profitability decreases as fixed costs remain the same.




(a) Smooth Distribution of Profit (I)




(b) Smooth Distribution of Profit (II)

Figure 7: Profit Distribution of Non-financial Firms and Movements in Commodity Prices
Notes: (a) and (b) includes all firms in the Prowess dataset, except for firms with negative sales and profits and with wage growth of more than 100% or less than -100%. We also exclude firms with operating profits over 100% and less than -100%. Source: CMIE Prowess

Figure 7 depicts this transition. Commodity prices do not affect the profitability of firms with very high or low profits. But a decline in commodity prices negatively impacts the operating profits of firms in the middle of the profit distribution, moving a large number of those with high operating profits to a low operating profit range. The increase in commodity prices does the opposite. This is the channel through which movements in commodity prices affect average profitability, and can lead to defaults by firms which experience a significant decline in their operating profit ratios.

# 4 The Empirical Framework

## 4.1 Empirical Issues

We started by looking at correlations between commodity prices and the slippage and the slippage+restructured ratios (Table 2). Despite the statistical significance of the correlations between these variables, it is difficult to infer causation from them for three reasons. First, we have a very small sample of annual data on average slippage ratios and commodity prices. Second, different banks are impacted differently by changes in commodity prices depending on their exposure to commodity-sensitive sectors. Third, there are various types of commodity prices and it is difficult to choose among them, although they are highly correlated as shown in Table 1.

Table 3: Baseline Regression with Commodity Price

| | All Banks | Non-Exposed Banks | Exposed Banks |
|---|---|---|---|
| D.LMetals | -0.0314*** | -0.0153 | -0.0531*** |
| | (0.007) | (0.270) | (0.008) |
| Indian Growth Rate | 0.472*** | 0.329** | 0.618** |
| | (0.001) | (0.037) | (0.016) |
| Interest Rate | -1.443*** | -1.395*** | -1.435** |
| | (0.000) | (0.002) | (0.025) |
| Profit Ratio | 2.149*** | 1.887*** | 3.095** |
| | (0.000) | (0.009) | (0.012) |
| Cost of Funds | -1.824*** | -1.320** | -3.100*** |
| | (0.000) | (0.018) | (0.003) |
| Low Income Growth Rate | -0.371*** | -0.237** | -0.587*** |
| | (0.000) | (0.048) | (0.000) |
| Constant | 6.557** | 4.644 | 7.979 |
| | (0.036) | (0.248) | (0.171) |
| Bank Fixed Effects[14] | Yes | Yes | Yes |
| Observations | 398 | 237 | 161 |
| R Square | 0.327 | 0.404 | 0.313 |

Notes: *, **, and *** denotes significance at 10, 5, and 1% levels, respectively. The dependent variable is the slippage ratio, defined as new additions to NPAs divided by standard advances. Standard advances is the difference between gross advances and gross NPAs. D.L Metals is the log difference of the metal price index from the World Bank Pink Sheet.
- Model A is for all banks in our sample.
- Model B is for banks not exposed (less than mean exposure) to the iron and steel sector in 2011.
- Model C is for banks exposed (greater than mean exposure) to the iron and steel sector in 2011.

[14]The complete table for bank fixed effects is available in the online appendix.

We address the small sample size issue by using bank-level data to estimate the regression presented in Table 3. The difference between Tables 2 and 3 is that Table 3 controls for bank fixed effects and includes other bank-level and macro variables. Bank fixed effects, by definition, control for time-invariant, bank-specific characteristics that can influence NPAs. *The important point is that the coefficient for the metal price index is negative and significant for the overall sample. We also estimate the regression for exposed and non-exposed banks separately. We calculate the average exposure of banks in the iron and steel sector in 2011; banks with an above-mean exposure are labelled 'exposed' banks, while the rest are treated as non-exposed*.

We can see that the effect of prices on NPAs is higher (more than 1.5 times more negative) for banks which were exposed to the metals sector in 2011, relative to the impact on all banks.[15] This brings us to our main point - that even bank-level analysis with aggregate prices will make little sense, as it will not control for heterogeneity in exposure (Table 3). We would like to emphasise that the bank fixed effects only control for time-invariant bank-level characteristics, and that bank-level exposure is not necessarily a time-invariant characteristic. Moreover, even in the exposed group, as all banks do not have the same exposure it could be argued that the estimates would still be biased for that group, as they are in our overall estimates. Therefore, while including bank-level data helps resolve the small-sample issue, it does very little or nothing to address concerns related to differential exposure.

The other variables in the table are used as controls and it is difficult to claim any causal interpretation because of simultaneity. These are effectively correlations between

[15]We also use global commodity prices as instruments for exposure indices; these results are available in the online appendix. The results in the Table 3 shows that global commodity prices are likely to satisfy the exclusion restriction. One of the tests for the validity of the instrument is zero first stage, based on identifying a sub-sample which is not treated; so the instrument is unlikely to cause any effect, and hence the regression of the outcome on the instrument should produce an insignificant coefficient. Our non-exposed group is such a sub-sample, and hence the insignificant coefficient on the commodity prices suggests that it is a potential instrument. We would also like to clarify that the instrument will not produce a zero coefficient for the treated group because it is correlated with the treatment variable, i.e., exposure. In the online appendix, we perform a more comprehensive test for the validity of our instrument.

bank-level averages and macro variables, as macro variables are the same for all the banks and cannot address significant bank-wise heterogeneity in their NPAs. Further, slippage can cause many of these variables and hence these are likely to be endogeneous, making their coefficients biased. We find a positive and significant relationship between the profit ratio of banks and the slippage ratio. This is because banks with a higher profit have fewer concerns about the depletion of their capital base, so they declare a higher slippage conditional on unobserved true NPAs; this is in comparison with banks with a lower or negative profit. We find a positive relationship between growth and slippage because a large share of the increase in slippage took place during a period of increasing real growth and a declining GDP deflator (Figure 5c). A lower value of the deflator implies higher real growth for a given nominal rate of growth: thus, if commodity prices decline, the deflator decreases and we have higher real growth with little nominal growth[16], which gives rise to a positive relationship between real growth and slippage.

The cost of funds allows us to control for differences in the business patterns of the two types of banks in our sample, private and public sector banks. For domestic interest rates, higher slippage may be followed by the central bank lowering rates to stimulate growth and help other banks. 'Low-Income Growth Rate' is the growth rate of low- and middle-income countries, and this controls for external demand. We find a negative relationship here, because the increase in slippage has been accompanied by a secular decline in the growth rate of low- and middle-income countries (Figure 5a).

## 4.2 Commodity Price Exposure Indices for Banks

It is clear from the above discussion that there is heterogeneity in the exposure/loans of banks to different sectors, which has implications for NPAs if the representative price[17]

[16]See Subramanian (2019) for a detailed discussion on this. His argument is based on oil prices and he points out the concerns especially for the manufacturing sector. We find a very close relationship between non-energy commodity prices and the deflator for aggregate GDP. Also, there has been a complete disconnect between international oil prices and domestic oil prices in recent times (Figure B.1 in the appendix).

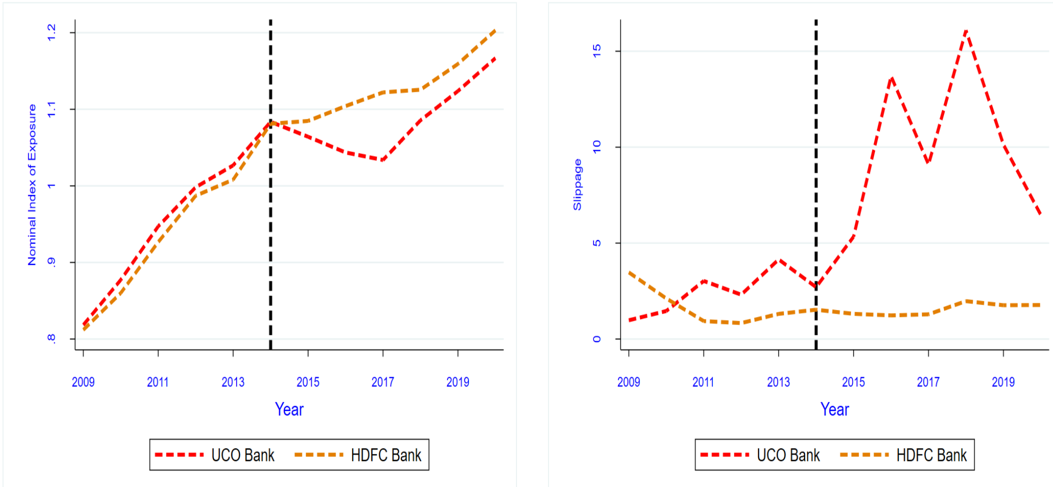
[17]We use industrial classification based on NIC-2008 and map these industries/sectors to a representative price from the WPI (available at base years 2004-05 and 2011-12). As mentioned before, the WPI

of the respective sector changes significantly. This is important as, given that all the exposed banks do not have the same exposure to different sectors, estimating the effect of commodity prices on NPAs using prices alone would be biased, as shown above. Hence, we need to create a weighted index where effective price changes in a sector are greater for banks with higher exposure in that sector. Another reason for creating exposure indices is that we have many commodity prices and the regression with a particular aggregate price would be problematic because of the choice of aggregate price; it is not clear ex-ante how to explain these, as we find opposite signs when we use two of them (metal and food prices) together, possibly due to a high correlation between them (see Table D.1 in the online appendix). High collinearity between explanatory variables usually leads to coefficients with opposite signs. We have sectoral exposure for banks from the Pillar 3 declaration. We map the sectoral exposure to wholesale price indices to obtain the price indices for bank exposure to different sectors. Using sectoral loans and respective commodity prices, we create exposure indices for banks, which reduces the multidimensional variables to one dimension. Movements in these exposure indices act as income shocks and we estimate their effects on NPAs. We create three exposure indices which are explained below. The first (Index-I) is the nominal price exposure index which is obtained using sectoral exposure and prices. The nominal price exposure index ($EXP_{it}$) is given by:

$$EXP_{it} = \sum_{j=1}^{m} p_{jt} w_{ijt} \quad \text{for sector } j = 1, 2, .., m \tag{1}$$

where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from wholesale price indices and mapped to a bank's sectoral exposure; $w_{ijt}$ is the exposure (proportion of the loans in sector $j$) of bank $i$ in sector $j$ at time $t$. The important point to note is that banks will face different aggregate prices due to varying exposure, although all banks face the same sectoral prices. We expect that a large decline in prices will affect the profitability of borrowers and result in NPAs in banks.

dataset contains prices for more than 600 categories, and these categories are very similar to industries in the NIC classification.




(a) Nominal Price Exposure Indices

(b) Slippage Ratio

Figure 8: Nominal Price Exposure and Slippage Ratios
Notes: $EXP_{it} = \sum_{j=1}^{m} p_{jt} w_{ijt}$ for sector $j = 1, 2, .., m$ where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. The slippage ratio is defined as new additions to NPAs divided by standard advances. Standard advances is the difference between gross advances and gross NPAs.

Figure 8 presents a visual representation of our empirical design. We plot the nominal exposure index and slippage for two banks: HDFC Bank and UCO Bank. HDFC Bank, one of India's largest private sector banks, is known for having a lower NPAs ratio relative to its peers. A substantial portion of its loan portfolio consists of consumer and housing loans, limiting its exposure to commodity-sensitive industries. UCO Bank is a large public sector bank, which between 2014-18 was one of the poorest performers in terms of NPAs. Its lending portfolio has a very high exposure to commodity-sensitive sectors. As we can see from Figure 8, banks which saw a higher decline in the value of their nominal price exposure index experienced greater slippage. This gives us confidence in our empirical strategy.

Changes in the nominal price exposure index mostly took place in 2014 and not in 2011, because of the pass-through of international commodity prices into local wholesale price indices being used to construct the nominal price exposure index. Also, the benefit of our empirical strategy is clear from Figure 8. Thus, banks which experience sharper declines in their exposure values are likely to face more defaults because of a larger decline in their borrowers' profitability and cash flow.

Thereafter, we obtain the log change in the nominal price exposure index, $\Delta EXP_{it}$, and regress $NPA_{it}$ (NPAs of bank $i$ at time $t$) using (2):

$$\Delta EXP_{it} = \sum_{j=1}^{m} log \left( \frac{p_{jt} w_{ijt}}{p_{jt-1} w_{ijt-1}} \right)$$

$$NPA_{it} = \beta_0 + \beta_1 \Delta EXP_{it} + \theta' z_{it} + \gamma' x_t + \phi_i + \epsilon_{it} \tag{2}$$

where $z_{it}$ are other bank-level controls and $x_t$ includes aggregate macro variables; $\phi_i$ are the bank fixed effect. We expect $\beta_1$ to be negative, i.e. an increase in prices leads to lower NPAs (and a decrease in price leads to higher NPAs). We use slippage and slippage+restructured as measures of NPAs. As bank-level controls, we use the profit ratio and cost of funding. We use India's GDP growth and interest rates as controls for the domestic macroeconomic scenario. The profit ratio controls for bank-level heterogeneity in declaring NPAs, as banks with low profits may be less inclined to declare these. The interest rate controls for a common cost of borrowed funding for banks, whereas the cost of funding controls for differences in costs of funding due to differences in business models. Historically, public sector banks have largely relied on deposits as a source of funding, so their non-deposit borrowed funding is minimal, unlike private sector banks. We cannot control for a public or private dummy with our fixed effect regression as this is time-invariant, but the cost of funding allows us to capture the difference between these two groups of banks to a large extent (see Figure A.2 in the appendix). GDP growth controls domestic demand in the economy; we also use the GDP growth rates of low- and middle-income countries as these exhibits a similar pattern to commodity prices and control for external demand faced by Indian firms. .

We would like to mention that we want to examine the change in exposure which can be attributed to a change in prices alone. This is because we are interested in exploring the effect of price changes on NPAs. $\Delta EXP_{it}$ may change due to changes in either prices or exposure/ weights. Hence, we create a second index (Index-II) using inflation, which is termed the nominal inflation exposure index ($EX\Delta Pit$) and is given by:

$$EX\Delta P_{it} = \sum_{j=1}^{m} log\left(\frac{p_{jt}}{p_{jt-1}}\right) \times w_{ijt} \tag{3}$$

Nominal inflation exposure takes the log prices (change in prices in the current period over the previous period) and sectoral lending weights for a bank in the current period. This index is statistically better than the $\Delta EXP_{it}$ (which includes the difference in prices and weights), as the weights are likely to be endogenous, because banks may change their lending due to the presence of NPAs, and we want to look at the change in the index driven only by a change in prices. As we can see, $EX\Delta P_{it}$ takes changes in prices, although the weights are still time-varying and endogeneity concerns are not fully addressed.

We thus create a third index (Index-III) of exposure which is given by:

$$EX\Delta P_{it}1 = \sum_{j=1}^{m} log\left(\frac{p_{jt}}{p_{jt-1}}\right) \times w_{ij} \tag{4}$$

where $w_{ij}$ is the average exposure of bank $i$ in sector $j$. The nominal inflation exposure index $EX\Delta P_{it}1$ is statistically better than $EX\Delta P_{it}$ because it keeps weights constant (at 2011 levels) and has a minimal bias due to the endogeneity of sectoral exposure. With $EX\Delta P_{it}1$, the change in the index is purely driven by a change in prices (which is our objective) and hence is superior to the previous two indices. We also estimate (2) using $EX\Delta P_{it}$ and $EX\Delta P_{it}1$ instead of $\Delta EXP_{it}$. We estimate similar regressions for growth in advances, as well as models for slippage and slippage+restructured with lagged $\Delta EXP_{it}$, $EX\Delta P_{it}$, and $EX\Delta P_{it}1$, as these models can be helpful in reducing the endogeneity bias. The results from these are given in the appendix.

It is clear from the earlier discussions that the pass-through of global commodity prices to local prices takes place with a time lag, and that banks may be not directly declaring assets as slippage. It is likely that banks will restructure assets in the beginning and avoid higher provisions as bank capital is costly. We expect that the effect of commodity price shocks on NPAs will persist for some time as it will impact firms in the affected sector after a time lag. Hence, we estimate the local projection regression using:

$$NPA_{it+j} = \beta_0^j + \beta_1^j \Delta EXP_{it} + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j \quad \text{for } j = 0, 1, 2, 3. \tag{5}$$

$$NPA_{it+j} = \beta_0^j + \beta_1^j EX\Delta P_{it} + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j \quad \text{for } j = 0, 1, 2, 3. \tag{6}$$

$$NPA_{it+j} = \beta_0^j + \beta_1^j EX\Delta P_{it}1 + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j \quad \text{for } j = 0, 1, 2, 3. \tag{7}$$

This allows us to understand the evolution of slippage and slippage+restructured after the commodity price shock. We use slippage and slippage+restructured as measures of NPAs in the above regression. We also estimate a similar local projection regression for the growth of advances.

### 4.2.1 Endogenous Exposure and Potential Bias across Exposure Indices

The bias arising from the endogeneity of the independent variable of interest is one of the main concerns in drawing inferences from a regression. As mentioned earlier, both simultaneity and omitted variables can cause endogeneity and make the coefficients biased. Simultaneity arises if the dependent variable influences the independent variable, thus implying that the independent variable is not exogenous. In regression model (2), an increase in NPAs may lead to banks changing their exposure ($w_{jt}$) resulting in simultaneity. For example, if a bank is facing increasing defaults from firms in the iron and steel industry which raises its NPAs, the bank may decrease the share of its loans to the iron and steel industry. Omitted variable bias arises if we do not include variables which are correlated with the independent variable of interest and which also influence the dependent variable. In the regression models above, potential omitted variables would be those correlated with the exposure index (price and weight) which also influence NPAs. As a result, we include variables such as the GDP growth rate, interest rate and bank-level controls such as the profit ratio, size and bank fixed effects. Since it is hard to rule out the presence of omitted variables even after controlling for relevant variables, we also perform alternative estimations (as discussed later in this section) to minimise these concerns.

If, for simplicity, we only consider the independent variable of interest ($\Delta EXP_{it}$) we can present equation (2) as:

$$NPA_{it} = \beta_0 + \beta_1 \Delta EXP_{it} + \epsilon_{it}$$

The estimator of $\beta_1$ is $\hat{\beta}_1$ and is given by

$$\hat{\beta}_1 = \frac{Cov\left(\Delta EXP_{it}, NPA_{it}\right)}{Var\left(\Delta EXP_{it}\right)} = \frac{Cov\left(\sum_{j=1}^{m} log\left(\frac{p_{jt}w_{ijt}}{p_{jt-1}w_{ijt-1}}\right), NPA_{it}\right)}{Var\left(\sum_{j=1}^{m} log\left(\frac{p_{jt}w_{ijt}}{p_{jt-1}w_{ijt-1}}\right)\right)}$$

Using $NPA_{it} = \beta_0 + \beta_1 \Delta EXP_{it} + \epsilon_{it}$

$$\hat{\beta}_1 = \frac{Cov\left(\sum_{j=1}^{m} log\left(\frac{p_{jt}w_{ijt}}{p_{jt-1}w_{ijt-1}}\right), \left(\beta_0 + \beta_1 \Delta EXP_{it} + \epsilon_{it}\right)\right)}{Var\left(\sum_{j=1}^{m} log\left(\frac{p_{jt}w_{ijt}}{p_{jt-1}w_{ijt-1}}\right)\right)}$$

$$\hat{\beta}_1 = \beta_1 + \frac{Cov\left(\sum_{j=1}^{m} log\left(\frac{p_{jt}w_{ijt}}{p_{jt-1}w_{ijt-1}}\right), \epsilon_{it}\right)}{Var\left(\sum_{j=1}^{m} log\left(\frac{p_{jt}w_{ijt}}{p_{jt-1}w_{ijt-1}}\right)\right)}$$

As we can see from the above equation, $\hat{\beta}_1 = \beta_1$ if the covariance term is not zero and the estimator $\hat{\beta}_1$ would be biased. There are two potential reasons for bias -simultaneity and omitted variable bias. Simultaneity or reverse causality arises if there is a possibility that an independent variable is caused by the dependent variable. Omitted variable bias arises if we do not include variables which are correlated with the independent variable of interest. Both these biases arise due to non-zero covariance in the above equation. It is not hard to argue that commodity prices are exogenous and hence not correlated with the error term. With free trade, firms in these sectors have very little pricing power.[18]

[18]In a forthcoming paper, we show that even the government intervention of additional duties in the metal sector could not stop the pass through of lower global prices into domestic economy.

But even if we assume that commodity prices are exogenous, it is hard to rule out the significant correlation between $\epsilon_{it}$ and $w_{ijt}$. This is because if banks experience an increase in NPAs in some sectors, they may reduce their exposure in that sector.

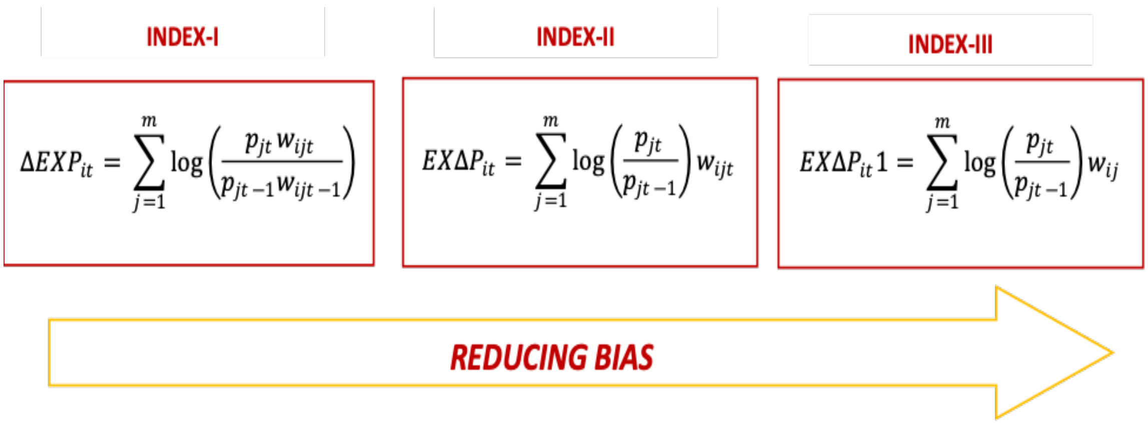



Figure 9: Bias and Exposure Indices

This is a simultaneity bias and is given by $\frac{Cov\left(\sum_{j=1}^{m} log\left(\frac{p_{jt} w_{ijt}}{p_{jt-1} w_{ijt-1}}\right), \epsilon_{it}\right)}{Var\left(\sum_{j=1}^{m} log\left(\frac{p_{jt} w_{ijt}}{p_{jt-1} w_{ijt-1}}\right)\right)}$. It is difficult to know the direction of the bias ex-ante as it depends upon the structural parameters of a simultaneous equation system consisting of $\Delta EXP_{it}$ and $NPA_{it}$ which are not known (see Basu, 2015). But one can think of alternative indices from the literature which are expected to have a lower bias, which is why we create alternative indices, as explained in the previous section. As we can see (figure 9), index-I is likely to have the highest simultaneity bias whereas index-3 is likely to have no simultaneity bias if we assume that commodity prices are exogenous.[19] The third index has no simultaneity bias because the weight is constant and is not caused by NPAs anymore. Index-1 is likely to have a higher simultaneity bias as it includes a change in weight as a regressor compared to the weight used in index-2. As a robustness exercise, we present in the appendix the results with

[19]The results in the online appendix confirms that the bias arises mainly from the simultaneity in weights; if we make the weights constant and use exogenous global commodity prices as an instrument, this does not change the coefficient associate with the inflation exposure index ($EX\Delta P_{it}1$) in a significant way.

the lags of these exposure indices, which are also likely to have a smaller simultaneity bias.

Hence, we argue that the alternative exposure indices developed in this paper help us understand the source and direction of a simultaneity bias and ultimately resolve it. But simultaneity is not the only source of non-zero covariance between the error term and our exposure indices. This can also arise from omitted correlated variables, as these would be in the error term. Since these are correlated omitted variables, they give rise to a correlation between the error term and the exposure indices, leading to a biased estimator. Although we have included the relevant variables in our regression, it would be hard to make a claim about the absence of omitted variables. But in our empirical framework, the coefficient of the inflation exposure index with constant weights obtained using commodity prices as an instrument is not likely to suffer from the omitted variable bias as well. This is because the weights are constant and hence not correlated with other variables, and commodity prices are assumed to be exogenous. Hence, we estimate these models with global commodity prices as instruments; these are given in the online appendix as the results are similar.

# 5 Results

## 5.1 Regression Results

In this section, we discuss the results of the regression that estimates the effects of a change in the nominal price and inflation exposure index on NPAs. We use three types of exposure indices: the log difference of the nominal price exposure index($\Delta EXP_{it}$); the inflation exposure index with time-varying weights ($EX\Delta P_{it}$); and the inflation exposure index with constant weights ($EX\Delta P_{it}1$). From the earlier discussion, it is clear that ($EX\Delta P_{it}1$) is likely to be the best estimator of the true effect of commodity prices on NPAs.

Table 4 shows the regression results with slippage as the dependent variable. The important feature to note from the table is that the effect of change in exposure on slippage is negative and significant for the regressions with all three indices. It is much stronger with the nominal inflation exposure index with constant weights than with the log difference of the nominal price exposure index and inflation exposure index with time-varying weights, as the bias is likely to be minimal for the nominal inflation exposure index with constant weights. It is clear that main source of endogeneity is from a change in sectoral exposure due to NPAs. The results also show that a 1% decrease in nominal exposure leads to a 0.12-0.5% increase in the slippage ratio.

Table 4: Regression: Slippage on Nominal Price and Inflation Exposure Indices

| | Model A | Model B | Model C |
|---|---|---|---|
| $\Delta EXP_{it}$ | -0.118*** | | |
| | (0.003) | | |
| $EX\Delta P_{it}$ | | -0.408*** | |
| | | (0.001) | |
| $EX\Delta P_{it}1$ | | | -0.500*** |
| | | | (0.000) |
| Bank Fixed Effects | Yes | Yes | Yes |
| Observations | 353 | 428 | 428 |
| R Square | 0.292 | 0.308 | 0.313 |

Notes: *, **, and *** denotes significance at the 10, 5, and 1% levels, respectively. $EXP_{it} = \sum_{j=1}^{m} p_{jt} w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. $EX\Delta P_{it} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ijt}$ for sector $j = 1, 2, .., m$. $EX\Delta P_{it}1 = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ij}$ for sector $j = 1, 2, .., m$. Where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$. We control for Indian GDP growth, interest rates, cost of funds and profit ratios for respective banks, and the GDP growth in low- and middle-income countries. The dependent variable is the slippage ratio, defined as new additions to non-performing assets divided by standard advances. Standard advances is the difference between gross advances and gross non-performing assets.

Table 5 shows the regression results with slippage+restructured as the dependent variable. The patterns for slippage+restructured are the same as in Table 4. The effect is much stronger with the nominal inflation exposure index with constant weights than with the log difference of the nominal price exposure index and inflation exposure index with time-varying weights. The results also show that a 1% decrease in nominal exposure leads to a 0.33-1.32% increase in the slippage+restructured ratio.

Table 5: Regression: Slippage+Restructured on Nominal Price and Inflation Exposure Indices

| | Model A | Model B | Model C |
|---|---|---|---|
| $\Delta EXP_{it}$ | -0.325*** | | |
| | (0.000) | | |
| $EX\Delta P_{it}$ | | -1.108*** | |
| | | (0.000) | |
| $EX\Delta P_{it}1$ | | | -1.324*** |
| | | | (0.000) |
| Bank Fixed Effects | Yes | Yes | Yes |
| Observations | 353 | 427 | 427 |
| R Square | 0.274 | 0.282 | 0.293 |

Notes: *, **, and *** denotes significance at the 10, 5, and 1% levels, respectively. $EXP_{it} = \sum_{j=1}^{m} p_{jt} w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. $EX\Delta P_{it} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ijt}$ for sector $j = 1, 2, .., m$. $EX\Delta P_{it}1 = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ij}$ for sector $j = 1, 2, .., m$. Where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$. We control for Indian GDP growth, interest rates, cost of funds and profit ratios for respective banks, and the GDP growth in low- and middle-income countries. The dependent variable is the slippage+restructured ratio, defined as the sum of new additions to non-performing assets and restructured assets divided by standard advances. Standard advances is difference between gross advances and gross non-performing assets.

The results presented in Tables 4 and 5 suggest that these models explain 30% of the variation in the slippage and slippage+restructured ratios. Another way to evaluate the explanatory power of these models would be to use the change in exposure to estimate the predicted change in slippage and compare it with the actual slippage. For example, the slippage for UCO Bank increased by 2.6% between 2014 and 2015, while its exposure (inflation index with constant weight) declined by 2%. Based on the coefficient estimated, this implies a 1% increase in the slippage ratio which is around 38% of the observed change in slippage. In the following year (2016), exposure declined by 1%; the net effect on slippage would be the sum of the effects of the decline in exposure in 2015 and 2016.

We capture this persistence in the effects of a change in exposure on NPAs through appropriate regressions in the next section and find strong evidence in favour of the persistent effects of a change in exposure on NPAs. This is expected given the mechanism - the decline in commodity prices increases NPAs as it makes firms economically unviable. But all firms will not default on their loans simultaneously; a significant proportion of the defaults is likely to occur with a time lag, depending upon the firm's ability to cope with this adverse shock. We find a similar pattern in the case of another major bank - Punjab National Bank (PNB). For PNB, slippage increased by 1.4% during 2014-15 and its exposure (inflation index with a constant weight) declined by 1%. This implies that 0.5 percentage point increase of the 1.4 percentage point increase in NPAs can be explained by the exposure index, which amounts to 36% of total increase in NPAs. The important point is that the specification adopted in our paper explains a significant amount of the variation in NPAs, which is important given the discourse related to the causes of NPAs has mostly focused on unobservable factors, with almost no supporting evidence.

We estimate several other models as robustness exercises, which are given in Tables D.1- D.6. Table D.1 contains results with lag exposure indices. Tables D.2 and D.3 contain results with real effective exchange rates as an additional control. Tables D.4 and D.5 estimate the model with lag slippage and lag slippage+restructured as controls.[20] Table D.6 presents the results with exposure indices created using inflation one period ahead. All the additional regressions give similar results, thus presenting overwhelming evidence to suggest that the decline in commodity prices is associated with an increase in NPAs for banks lending to the sector associated with that particular commodity.

Further, since these banks are too capital-constrained to lend, we expect them to

[20] These regressions may have an additional bias (Nickell (1981) due to the presence of a lagged dependent variable and the relatively short time dimension of the data. We do not pursue this further, as estimating the coefficient of the lagged dependent variable is not the focus of this paper.

reduce lending. Table 6 shows the regression results with growth of advances as the dependent variable. The results in Table 6 show that a 1% decrease in nominal exposure leads to a 0.40-1.89% decrease in the growth of advances. We find a similar pattern as with the growth in advances reported in Table 4 for the slippage ratio. The effect is much stronger with the nominal inflation exposure index than with the nominal price exposure index.

Table 6: Regression: Growth in Advances on Nominal Price and Inflation Exposure Indices

| | Model A | Model B | Model C |
|---|---|---|---|
| $\Delta EXP_{it}$ | 0.401*** | | |
| | (0.003) | | |
| $EX\Delta P_{it}$ | | 1.473*** | |
| | | (0.000) | |
| $EX\Delta P_{it}1$ | | | 1.884*** |
| | | | (0.000) |
| Bank Fixed Effects | Yes | Yes | Yes |
| Observations | 357 | 430 | 430 |
| R Square | 0.444 | 0.449 | 0.455 |

Notes: *, **, and *** denotes significance at the 10, 5, and 1% levels, respectively. $EXP_{it} = \sum_{j=1}^{m} p_{jt}w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. $EX\Delta P_{it} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1})w_{ijt}$ for sector $j = 1, 2, .., m$. $EX\Delta P_{it}1 = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1})w_{ij}$ for sector $j = 1, 2, .., m$. Where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$. We control for Indian GDP growth, interest rates, cost of funds, and the profit ratio for respective banks, and the GDP growth in low- and middle-income countries. The dependent variable is growth in advances.

We conclude this section by listing the main results. First, a 1% decrease in nominal exposure increases slippage by 0.12-0.50%, and the effect is highly significant. Second, a 1% decrease in nominal exposure increases the slippage+restructured ratio by 0.33-1.32%, and the effect is highly significant. Third, due to an increase in NPAs, significantly exposed banks are capital constrained, so they have significantly lower credit growth; a 1% decrease in nominal exposure leads to a 0.40-1.89% decrease in the growth of advances. If changes in NPAs lead to change in prices, then our exposure indices would become endogenous[21], as prices are part of these indices. The endogenous exposure indices would lead to biased coefficients and make our results untrustworthy. Although, it is highly unlikely that NPAs can cause change in prices, but hard to rule out the same theoretically. Hence, to rule out any endogeneity concerns based on reverse causality (NPAs causing prices), we estimate several models with global commodity prices as an instrumental variable for our exposure indices. It is not difficult to argue that global commodity prices are exogenous. Also, the same change in global commodity prices causes a differential change in the exposure of different banks, as the weights in the exposure index for banks vary across banks. (Results are provided in the online appendix of the paper.) The results are similar and the significant effect of a movement in commodity prices on NPAs is supported by these regressions.

The interesting result from these regressions is that the coefficients associated with the inflation exposure index with constant weights are almost the same with and without instruments. Hence, we argue that the bias mainly arises from changes in weights, which we resolve using a constant weight index. Also, we would like to clarify that index III may have a lower omitted variable bias than index I, mainly due to the constant weights. In the next section we explore the persistent effect of commodity prices on NPAs and the interdependence between the slippage and slippage+restructured ratios.

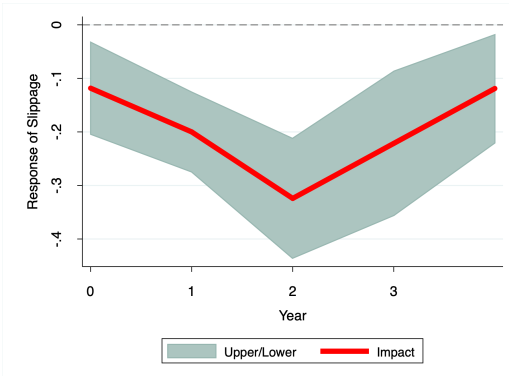
## 5.2 Evolution of NPAs Over Time Due to Changes in Commodity Prices

So far, we have used two separate measures of NPAs - slippage and slippage+restructured ratios- and have found that a decrease in commodity prices increases both measures. But these regressions are not able to tell us the joint dynamics of the two variables over time and their interdependence. It is not hard to assume interdependence between the measures, as banks may be inclined to first restructure assets and then reclassify them as

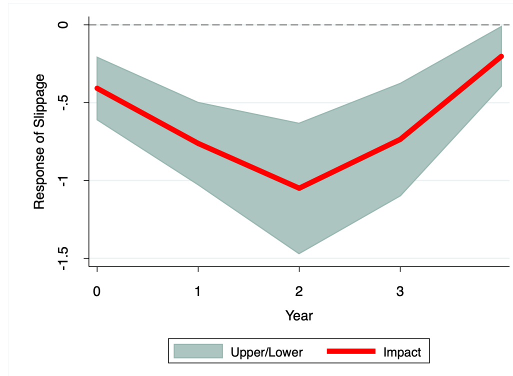
[21]Exogeneity of the independent variable is required for unbiased coefficients in linear regression models. Exposure indices are independent variable in our regressions. If the dependent variable can cause change in exposure indices, then they are not exogeneous, and are endogenous.

slippage, if nothing works out. Based on this, it is not difficult to argue that if the causal link between commodity prices and NPAs holds- then based on the bank's behaviour argued before- it must be the case that the decline in commodity prices have a larger effects on slippage+restructured compared to its effect on slippage in the beginning. To explore these, we estimate regressions in the local projection framework, i.e., we estimate the effects on slippage and slippage+restructured at different points in time (at $t, t+1, t+2...$), due to a change in exposure at time $t$. It is also clear from the above discussion and results that a commodity price crisis creates a twin balance sheet problem which affects borrowers as well as lenders. Such balance sheet crises are likely to have persistent effects; our regression in the local projection framework could help us estimate these persistent effects. Figure 10 presents the response of slippage due to a one-unit change in the nominal price exposure index and the nominal inflation exposure index.

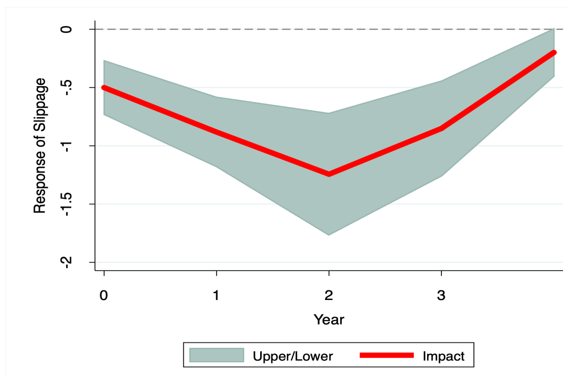
The maximum response to a slippage occurs after two years, and it is almost three times the impact response at $t = 0$. Further, the effect is higher for the nominal inflation exposure index than for the log difference of the nominal price exposure index. This is similar to what we find in our regressions and is driven by almost negligible bias associated with the nominal inflation exposure index with constant weights, as explained in section 4.2.1. At this point, it is worth mentioning that the estimation with the log difference nominal price exposure index is based on a smaller sample, because we take the first difference, so the two results are not directly comparable, but the much stronger effect could be due to the diminished bias as mentioned earlier. Figure 11 presents the response of the slippage+restructured ratio due to exogenous innovations in the nominal price exposure index and the nominal inflation exposure index. The pattern of the response of the slippage+restructured ratio is very different from the response of the slippage ratio shown in Figure 10. The response of slippage after two years is very similar to the response of slippage+restructured at impact, i.e., at $t = 0$. *This implies that the immediate effect of a commodity price crash is followed by a large increase in restructuring, which is later declared an addition to NPAs (slippage).*




(a) Due to 1 percentage point change in index-I at t=0



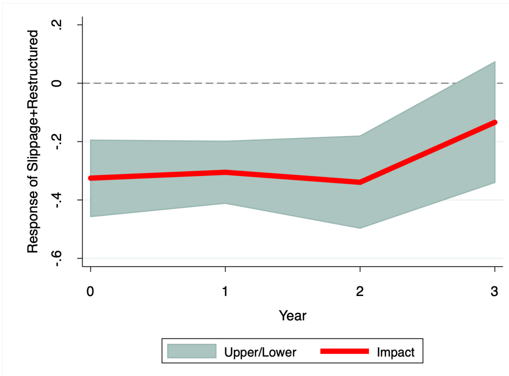

(b) Due to 1 percentage point change in index-II at t=0



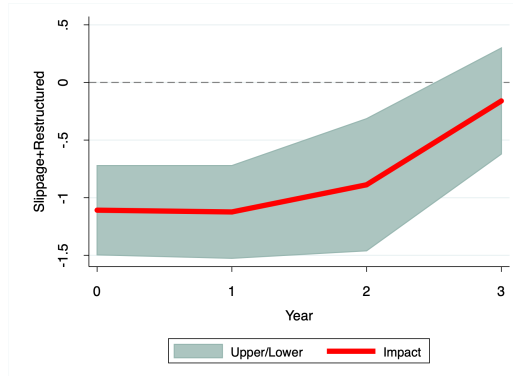

(c) Due to 1 percentage point change in index-III at t=0

Figure 10: Response of the Slippage Ratio

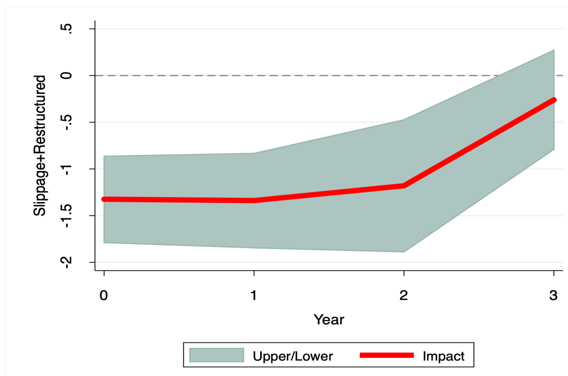
Notes: (a) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j \Delta EXP_{it} + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j$ For $j = 0, 1, 2, 3$. $EXP_{it} = \sum_{j=1}^m p_{jt} w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. (b) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j EX\Delta P_{it} + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j$ For $j = 0, 1, 2, 3$. $EX\Delta P_{it} = \sum_{j=1}^m log(p_{jt}/p_{jt-1}) w_{ijt}$ for sector $j = 1, 2, .., m$. (c) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j EX\Delta P_{it} 1 + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j$ For $j = 0, 1, 2, 3$. $EX\Delta P_{it1} = \sum_{j=1}^m log(p_{jt}/p_{jt-1}) w_{ij}$ for sector $j = 1, 2, .., m$. where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$ at time $t$. We control for Indian GDP growth, GDP growth in low- and middle-income countries, the interest rate in India, cost of funds and profit ratio for respective banks. The dependent variable is the slippage ratio, defined as new additions to non-performing assets divided by standard advances. Standard advance is the difference between gross advances and gross non-performing assets.




(a) Due to 1 percentage point change in index-I at t=0

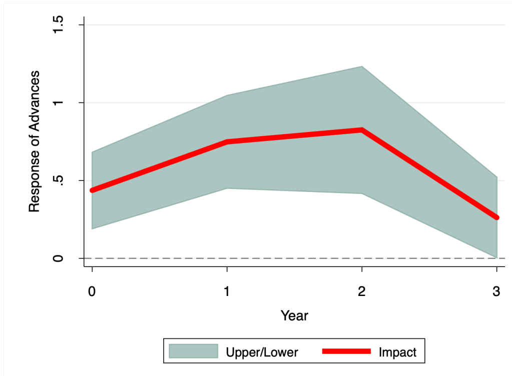



(b) Due to 1 percentage point change in index-II at t=0

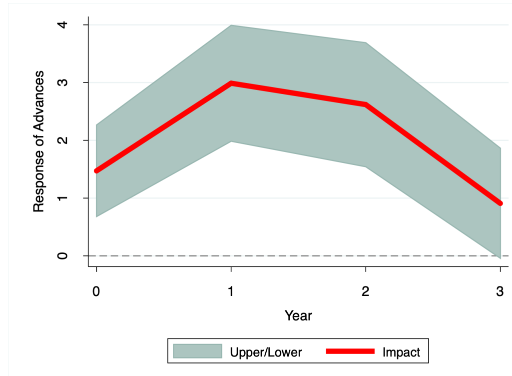



(c) Due to 1 percentage point change in index-III at t=0

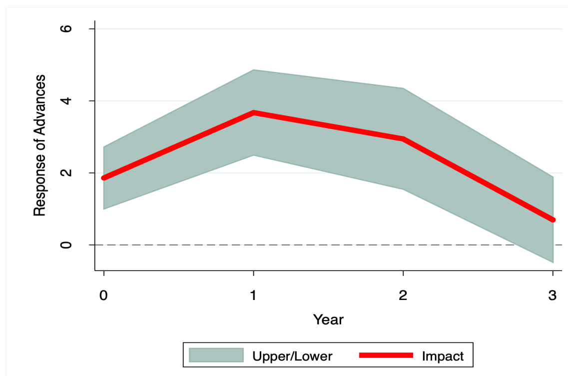
Figure 11: Response of the Slippage+Restructured Ratio
Notes: (a) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j \Delta EXP_{it} + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j$ For $j = 0, 1, 2, 3$. $EXP_{it} = \sum_{j=1}^{m} p_{jt} w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. (b) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j EX\Delta P_{it} + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j$ For $j = 0, 1, 2, 3$. $EX\Delta P_{it} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ijt}$ for sector $j = 1, 2, .., m$. (c) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j EX\Delta P_{it}1 + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j$ For $j = 0, 1, 2, 3$. $EX\Delta P_{it1} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ij}$ for sector $j = 1, 2, .., m$. where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$ at time $t$. We control for Indian GDP growth, interest rates, cost of funds, and profit ratios for respective banks, and for GDP growth in low- and middle-income countries. The dependent variable is the slippage+restructured ratio defined as the sum of new additions to non-performing and restructured assets divided by standard advances. Standard advances is the difference between gross advance and gross non-performing assets.




(a) Due to 1 percentage point change in index-I at t=0




(b) Due to 1 percentage point change in index-II at t=0




(c) Due to 1 percentage point change in index-III at t=0

Figure 12: Response of Growth in Advances

Notes: (a) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j \Delta EXP_{it} + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j$ For $j = 0, 1, 2, 3$. $EXP_{it} = \sum_{j=1}^{m} p_{jt} w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. (b) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j EX\Delta P_{it} + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j$ For $j = 0, 1, 2, 3$. $EX\Delta P_{it} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ijt}$ for sector $j = 1, 2, .., m$. (c) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j EX\Delta P_{it}1 + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j$ For $j = 0, 1, 2, 3$. $EX\Delta P_{it1} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ij}$ for sector $j = 1, 2, .., m$. where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$ at time $t$. We control for Indian GDP growth, interest rates, the cost of funds, and the profit ratio for respective banks, and for the GDP growth in low- and middle-income countries. The dependent variable is the growth of advances.

Figure 12 presents the response of a growth in advances due to an exogenous innovation in the nominal price exposure and nominal inflation exposure indices. The pattern of the response of the advances growth is similar to the response of the slippage ratio shown in Figure 10. The maximum impact takes place after a year or two, and is almost twice the impact response. This is as expected, as banks become capital constrained when these stressed assets are declared as slippages, because as long as these assets are termed restructured assets, very low or no provisioning is required; but as soon as the assets are termed a 'slippage', the full provisioning has to be made.

We conclude this section by listing the main findings. First, the effect of a change in nominal exposure on slippage is persistent and takes place with a time lag. At the time of the impact, a large share of the distressed assets is restructured. Second, credit growth follows a pattern similar to the declaration of NPAs.

# 6 Concluding Remarks and Policy Implications

This study has important policy implications for the banking system in India. After a significant improvement in the performance of public sector banks in the late 1990s and 2000s, their non-performing assets (NPAs) rose to very high levels by the second half of the 2010s. The worsening of bank balance sheets was accompanied by sluggish credit growth and a significant decline in GDP growth rate in India relative to the previous decade. It is important to understand more clearly the causes of this deterioration in bank balance sheets, which have had a lasting effect on the economy. A large portion of the debate on the ailments in India's banking sector has centered on the claims that poor governance in public sector banks and zombie lending were probable reasons - without adequate empirical evidence to support these assertions.[22]

These factors cannot explain the significant improvement in performance that occurred in the earlier period: it is hard to believe that management and governance practices in public sector banks deteriorated so quickly as to generate such a large magnitude

[22] In a forthcoming paper we argue that there is no statistical evidence of zombie lending in the metals sector, which experienced the highest amount of defaults by non-financial firms during 2017-20.

of NPAs. But even in the absence of systematic evidence, the following reasons have been ascribed to the rise in NPAs: public sector banks have been declared to be badly governed and less efficient, even though their performance metrics were similar to those of the new private sector banks by the end of the 2000s. Even more worrying is the fact that much of the discussion around banking reforms has been based on this inadequate or even faulty interpretation of the causes that led to the large public sector bank NPAs.

Much of the reaction to the emergence of large NPAs in public sector banks relates to the public ownership of these banks and poor governance, thereby leading to calls for large-scale privatisation (e.g. Gupta and Panagariya, 2022, most recently). Whereas the reform of the banking sector clearly needs to be a significant feature of growth-oriented economic reforms in the future - including the progressive privatisation of public sector banks - the design of which should be based on a proper analysis of bank functioning, and keeping in mind the development needs of the future.

The results in this paper suggest that there are external factors, not entirely within the control of banks, which led to a significant amount of NPAs, which had little to do with poor governance or zombie lending.[23] In other words, a large part of the difference in the NPAs in public banks versus private banks, which has been ascribed to governance problems in the former, can be explained by differences in the sectoral lending patterns of the two types of banks.[24] Sectors such as iron steel and other infrastructure lending typically involve large amounts of investments in large-scale projects. If lenders commit

[23]As argued earlier, it is difficult to test the bad governance hypothesis due to data limitations; hence the research design used in this paper cannot rule out governance issues also causing some NPAs. But these governance issues are omnipresent, including in private sector banks and non-financial firms, and it is the job of the regulator and law enforcement agencies to deal with these issues. Most importantly, as argued in this paper, the cause of NPAs is exogenous and independent of bad governance or zombie lending.

[24]Public sector banks usually have significantly higher exposure to commodity-sensitive sectors which seems risky. But we do not go into the normative debate about whether public sector banks should be doing so or not. The nationalisation of banks was done to ensure that public banks would take risks and lend to sectors which were important for nation-building but were not being served by private sector banks. Nonetheless, it can certainly be debated whether public sector banks should continue such funding.

to lending to these projects when investment proposals are judged to be economically and financially viable, it may be difficult for them to withdraw midway if the economic environment turns adverse, as happened during the 2010s. In particular, as we have shown, there was a downturn in the global prices of some key commodities due to the global economic slowdown after the North Atlantic Financial Crisis. *Hence, whereas the privatisation of public sector banks may be desirable for other reasons, it should not be based on their performance in the 2010s*. After all, a large proportion of new private sector banks introduced after the mid-1990s performed poorly and had to be bailed out or merged with larger banks, both public and private.[25]

This paper shows that NPAs in the banking sector are closely related to the fall in global commodity prices during 2011-16. Commodity price changes in 2008-09 had led to significant changes in NPAs, and when commodity prices crashed in 2011, NPAs started rising in the banking sector. Due to regulatory forbearance measures introduced in the banking sector, a significant proportion of these assets were possibly restructured at the time and declared to be 'non-performing' only after the Asset Quality Review in 2015. It can be argued that India is not a commodity exporter in the traditional sense, so there is no obvious channel for global commodity prices to have a large, significant effect on the Indian banking sector. We show, however, that the average profit ratios in commodity-sensitive sectors are highly correlated with global commodity prices. Thus, the effect on the banking sector occurs through the channel of the borrower's balance sheet, which subsequently translates into a worsening of the lender's balance sheet, leading to a twin balance sheet crisis. We also provide evidence of this channel through the regulatory filings of Indian banks.

Banks lend to several sectors with heterogeneous price movements, which makes the

[25]Bank failures which resulted in mergers with other banks in the 2000s include: Bank of Rajasthan merged with ICICI Bank in 2010; Lord Krishna Bank merged with Centurion Bank of Punjab in 2007, which subsequently merged with HDFC Bank in 2008; Bharat Overseas Bank merged with Indian Overseas Bank in 2007; United Western Bank merged with IDBI Bank in 2006; and Global Trust Bank (India) merged with the Oriental Bank of Commerce in 2004. So, while failing private sector banks did exit the industry, their costs were effectively borne by the public sector.

estimation of the effect of these price movements on NPAs difficult. To overcome this, we create a nominal price index and inflation exposure indices for banks, using novel data on banks' sectoral exposure and commodity prices, and show that these capture the heterogeneity in exposure to income shocks due to commodity price changes. We find that a 1% decline in nominal price exposure increases NPAs by 0.20-1.35% and that the effect is highly persistent and significant. These models explain 30% of the variation in NPAs (both the slippage and slippage+restructured ratios). Since public sector banks have greater exposure to commodity-sensitive sectors, they experienced a larger buildup in NPAs after the commodity price crash in 2011.

These results also suggest that adverse movements in commodity prices create stress in the banking system and affect financial intermediation, leading to adverse real consequences. It is important to mention that GDP growth declined significantly after 2017-18, when bank NPAs recorded their highest level in the last decade. NPAs eroded banking capital, which hampered their ability to lend, thus contributing to a decline in credit growth. It is not difficult to argue that lower credit growth contributed to the decline in GDP growth.

There are two possible ways to reduce the adverse impact of commodity prices shocks: first, non-financial firms should be encouraged to reduce their risk from commodity exposure by hedging these risks in the market. This requires the development and strengthening of commodity futures markets in the country. Second, the banking regulator (RBI) could advise (or require) banks to establish a commodity price buffer on the lines of a counter-cyclical capital buffer; banks would have to create a buffer during upswings in commodity prices which can be used during periods of downswings. Such a regulatory requirement would be analogous to the macro-prudential norms that are now routine in many jurisdictions. The first will reduce defaults due to commodity price risks and the second requirement will provide banks a cushion during a downturn in commodity prices and reduce the adverse effects on financial intermediation.

An important issue that needs further discussion and policy action relates to the framework for lending to large industrial and infrastructure projects. Such lending was earlier carried out by development finance institutions (DFIs) such as ICICI and IDBI, which were transformed into regular commercial banks in the mid-1990s. Since then commercial banks, particularly public sector banks, undertook this task. The original rationale for DFIs was that large projects are typically subject to higher risk, thus government-backed institutions were necessary to undertake the risk so as to promote industrialisation in the country. The government is in the process of setting up a new DFI, the National Bank for Financing Infrastructure and Development (NABFID), but it remains to be seen how it will function. Since the bond market will take some time to develop adequately, other means have to be found to enable banks and other financial institutions to undertake the large amounts of lending necessary to finance the growth process. Risk-mitigating measures, such as guarantees and other financial instruments must be considered to enable such financing.

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# Appendix

## A Data

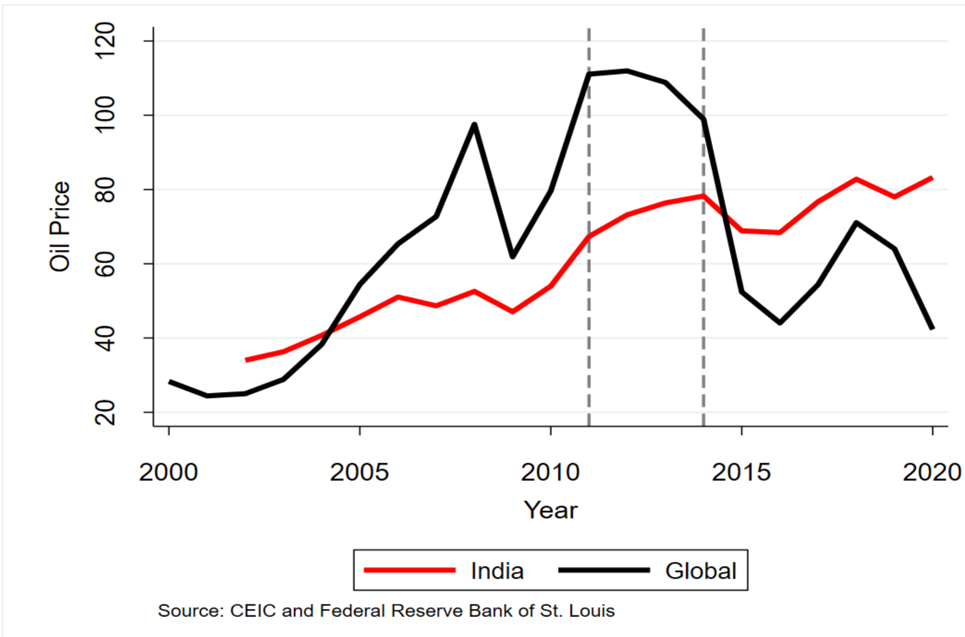
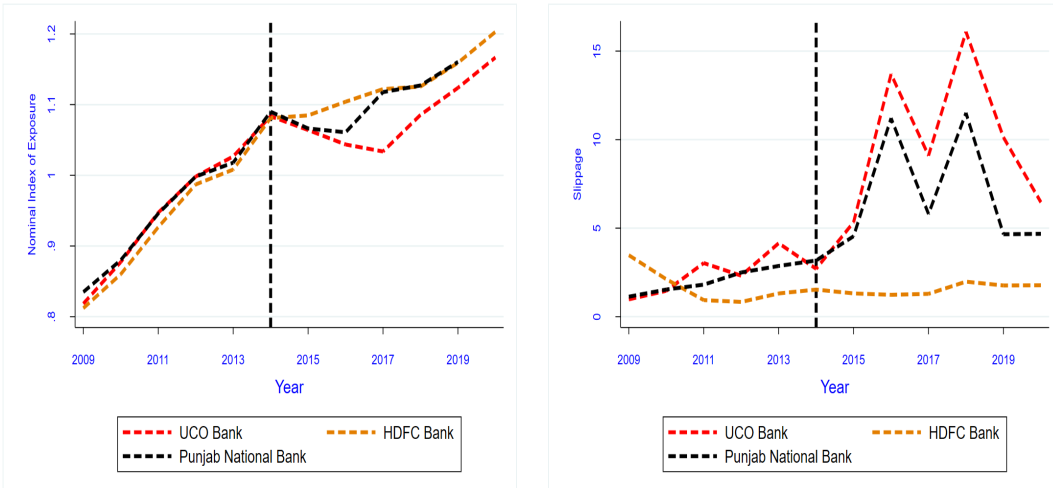



Figure A.1: Trends in Global and Indian Oil Prices, 2000-20
Notes: Global oil prices are in US dollars; Indian oil prices are the average of the daily retail prices in Mumbai. Source: Federal Reserve Bank of Saint Louis and CEIC.

# B Exposure and Non-Performing Assets




(a) Nominal Price Exposure

(b) Slippage Ratio

Figure B.1: Nominal Price Exposure and Slippage Ratios

Notes: $EXP_{it} = \sum_{j=1}^{m} p_{it} w_{ijt}$ for sector $j = 1, 2, ..., m$ where $p_{jt}$ is the price of the $jth$ commodity at time $t$, obtained from the wholesale price indices and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at the time $t$. The slippage ratio is defined as new additions to NPAs divided by standard advances. Standard advance is the difference between gross advances and gross NPAs.

# C Additional Regression Results

In section 4.2, we describe how we create an exposure index to capture the effects of weighted sectoral prices on bank NPAs. We show that a regression using the first index ($EXP_{it}$) suffers from endogeneity and thus we create two additional indices ($EXP_{it}, EXP_{it}1$). Although these indices help reduce the endogeneity bias, another obvious way to deal with the endogeneity is to use the lag of the log difference of the nominal price exposure index and the lag of the nominal inflation exposure indices in the regression.

The results from this are presented in Table C.1. The first three columns present the results of the normal fixed effect regression with the slippage ratio as the dependent variable. The last three columns give the results of the normal fixed effect regression with the slippage+restructured ratio as the dependent variable. Again, as we see from the first three columns of Table C.1, the effect on slippage is much stronger than in Table 4, due to both the log difference of the nominal price exposure index and the nominal inflation exposure index. The results in Table C.1 show that a 1% decrease in nominal exposure leads to a 0.20-1.16 % increase in the slippage+restructured ratio and to a 0.16-0.64 % increase in the slippage ratio.

We present additional regressions below with new control variables such as the real exchange rate and the lag of the slippage and slippage+restructured. We also present the regression results with a one-period ahead value of nominal prices and inflation exposure indices. These regressions also suggest that adverse movements in commodity prices lead to the creation of NPAs. It is likely that even though banks can foresee the likelihood of a default due to adverse movements in commodity prices, they can do very little to stop these defaults, that will increase NPA. Instead of reducing their loans to these troubled firms, banks may increase their loans to avoid defaults by these firms.

Table C.1: Regression: Slippage and Slippage+Restructured on Lag Nominal Price and Inflation Exposure Indices

| | Model A | Model B | Model C | Model D | Model E | Model F |
|---|---|---|---|---|---|---|
| $L.\Delta EXP_{it}$ | -0.157*** | | | -0.203*** | | |
| | (0.004) | | | (0.008) | | |
| $L.EX\Delta P_{it}$ | | -0.480*** | | | -0.802*** | |
| | | (0.007) | | | (0.003) | |
| $L.EX\Delta P_{it}1$ | | | -0.642*** | | | -1.156*** |
| | | | (0.001) | | | (0.000) |
| Bank Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 330 | 402 | 402 | 330 | 401 | 401 |
| R Square | 0.311 | 0.276 | 0.283 | 0.287 | 0.222 | 0.236 |

Notes: *, **, and *** denotes significance at the 10, 5, and 1% levels, respectively. $EXP_{it} = \sum_{j=1}^{m} p_{jt}w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. $EX\Delta P_{it} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1})w_{ijt}$ for sector $j = 1, 2, .., m$. $EX\Delta P_{it}1 = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1})w_{ij}$ for sector $j = 1, 2, .., m$. Where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$. The first three columns are the results of the normal fixed effect regression with the slippage ratio. The last three columns are the results of the normal fixed effect regression with the slippage+restructured ratio. We control for India's GDP growth, interest rates, and cost of funds and profit ratios for the respective banks, and GDP growth in low- and middle-income countries. The slippage ratio is defined as new additions to NPAs divided by standard advances. The slippage+restructured ratio is the sum of new additions to NPAs and restructured assets divided by standard advances. Standard advances is the difference between gross advances and gross NPAs.

Table C.2: Regression: Slippage on Nominal Price and Inflation Exposure Indices (with Real Exchange Rate as an Additional Control Variable)

| | Model A | Model B | Model C |
|---|---|---|---|
| $\Delta EXP_{it}$ | -0.0868** | | |
| | (0.035) | | |
| $EX\Delta P_{it}$ | | -0.266** | |
| | | (0.028) | |
| $EX\Delta P_{it}1$ | | | -0.344** |
| | | | (0.011) |
| Bank Fixed Effects | Yes | Yes | Yes |
| Observations | 353 | 428 | 428 |
| R Square | 0.306 | 0.335 | 0.338 |

Notes: *, **, and *** denotes significance at the 10, 5, and 1% levels, respectively. $EXP_{it} = \sum_{j=1}^{m} p_{jt} w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. $EX\Delta P_{it} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ijt}$ for sector $j = 1, 2, .., m$. $EX\Delta P_{it}1 = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ij}$ for sector $j = 1, 2, .., m$. Where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$. The columns show the results of the normal fixed effect regression. We control for India's GDP growth, interest rates, and real exchange rate, the cost of funds and profit ratios of the respective banks, and GDP growth in low- and middle-income countries. The dependent variable is the slippage ratio, defined as new additions to NPAs divided by standard advances. Standard advances is the difference between gross advances and gross NPAs.

Table C.3: Regression: Slippage+Restructured on Nominal Price and Inflation Exposure Indices (with Real Exchange Rate as an Additional Control)

| | Model A | Model B | Model C |
|---|---|---|---|
| $\Delta EXP_{it}$ | -0.264*** | | |
| | (0.000) | | |
| $EX\Delta P_{it}$ | | -0.868*** | |
| | | (0.000) | |
| $EX\Delta P_{it}1$ | | | -1.061*** |
| | | | (0.000) |
| Bank Fixed Effects | Yes | Yes | Yes |
| Observations | 353 | 427 | 427 |
| R Square | 0.298 | 0.314 | 0.321 |

Notes: *, **, and *** denotes significance at the 10, 5, and 1% levels, respectively. $EXP_{it} = \sum_{j=1}^{m} p_{jt}w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. $EX\Delta P_{it} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1})w_{ijt}$ for sector $j = 1, 2, .., m$. $EX\Delta P_{it}1 = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1})w_{ij}$ for sector $j = 1, 2, .., m$. Where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$. The columns show the results of the normal fixed effect regression. We control for India's GDP growth, interest rates, and real exchange rate, the cost of funds and profit ratios of the respective banks, and GDP growth in low- and middle-income countries. The dependent variable is the slippage+restructured ratio, defined as new additions to NPAs and restructured assets divided by standard advances. Standard advances is the difference between gross advances and gross NPAs.

Table C.4: Regression: Slippage on Nominal Price and Inflation Exposure Indices (with Lag Slippage as Control)

| | Model A | Model B | Model C |
|---|---|---|---|
| $\Delta EXP_{it}$ | -0.0899*** | | |
| | (0.006) | | |
| $EX\Delta P_{it}$ | | -0.310*** | |
| | | (0.000) | |
| $EX\Delta P_{it}1$ | | | -0.406*** |
| | | | (0.000) |
| $L.Slippage$ | 0.543*** | 0.595*** | 0.594*** |
| | (0.000) | (0.000) | (0.000) |
| Bank Fixed Effects | Yes | Yes | Yes |
| Observations | 352 | 424 | 424 |
| R Square | 0.389 | 0.405 | 0.411 |

Notes: *, **, and *** denotes significance at the 10, 5, and 1% levels, respectively. $EXP_{it} = \sum_{j=1}^{m} p_{jt} w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. $EX\Delta P_{it} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ijt}$ for sector $j = 1, 2, .., m$. $EX\Delta P_{it}1 = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ij}$ for sector $j = 1, 2, .., m$. Where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$. The columns show the results of the normal fixed effect regression. We control for India's GDP growth, interest rates, the cost of funds and profit ratios of respective banks, first lag of slippage, and GDP growth in low- and middle-income countries. The dependent variable is the slippage ratio, defined as new additions to NPAs divided by standard advances. Standard advances is the difference between gross advances and gross NPAs.

Table C.5: Regression: Slippage+Restructured on Nominal Price and Inflation Exposure Indices (with Lag Slippage+Restructured as Control)

| | Model A | Model B | Model C |
|---|---|---|---|
| $\Delta EXP_{it}$ | -0.171*** | | |
| | (0.001) | | |
| $EX\Delta P_{it}$ | | -0.479*** | |
| | | (0.001) | |
| $EX\Delta P_{it}1$ | | | -0.612*** |
| | | | (0.001) |
| $L.Slippage1$ | 0.6998*** | 0.722*** | 0.715*** |
| | (0.000) | (0.000) | (0.000) |
| Bank Fixed Effects | Yes | Yes | Yes |
| Observations | 352 | 421 | 421 |
| R Square | 0.549 | 0.572 | 0.576 |

Notes: *, **, and *** denotes significance at the 10, 5, and 1% levels, respectively. $EXP_{it} = \sum_{j=1}^{m} p_{jt} w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. $EX\Delta P_{it} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ijt}$ for sector $j = 1, 2, .., m$. $EX\Delta P_{it}1 = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ij}$ for sector $j = 1, 2, .., m$. Where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$. The columns show the results of the normal fixed effect regression. We control for India's GDP growth, interest rates, and lag slippage+restructured, the cost of funds and profit ratios of the respective banks, and GDP growth in low- and middle-income countries. The dependent variable is the slippage+restructured ratio, defined as the sum of new additions to NPAs and restructured assets divided by standard advances. Standard advances is the difference between gross advances and gross NPAs.

Table C.6: Regression: Slippage and Slippage+Restructured on Expected Inflation Exposure Indices

| | Model A | Model B | Model C | Model D |
|---|---|---|---|---|
| $EX\Delta P_{i(t+1)}$ | -0.282*** | | -0.565*** | |
| | (0.001) | | (0.000) | |
| $EX\Delta P_{i(t+1)}1$ | | -0.245*** | | -0.517*** |
| | | (0.002) | | (0.000) |
| Bank Fixed Effects | Yes | Yes | Yes | Yes |
| Observations | 428 | 428 | 427 | 427 |
| R Square | 0.322 | 0.315 | 0.275 | 0.268 |

Notes: *, **, and *** denotes significance at the 10, 5, and 1% levels, respectively. $EXP_{it} = \sum_{j=1}^{m} p_{jt} w_{ijt}$ for sector $j = 1, 2, .., m.$ $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. $EX\Delta P_{it} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ijt}$ for sector $j = 1, 2, .., m.$ $EX\Delta P_{it}1 = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ij}$ for sector $j = 1, 2, .., m.$ Where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$. The columns show the results of the normal fixed effect regression. The first two columns relate to slippage ratios and the last two columns to slippage+restructured ratios. The dependent variable is the slippage ratio, defined as new additions to NPAs divided by standard advances. Standard advances is the difference between gross advances and gross NPAs. The dependent variable is the slippage+restructured ratio, defined as the sum of new additions to NPAs and restructured assets divided by standard advances. We control for India's GDP growth, interest rates, and for the cost of funds and profit ratios for the respective banks, and GDP growth in low- and middle-income countries.

# Online Appendix

## D Results from Instrumental Variables

### D.1 Regression Using Instrumental Variables

The novelty of our work hinges on arriving at an unbiased estimate of the effect of a change in exposure on NPAs. The exposure index with constant weights has no simultaneity or omitted variable bias, which is caused by a change in weight. As argued above, commodity prices are very less likely to be endogenous. But even with the exposure index with constant weights, it would be difficult to claim there is no omitted variable bias. Hence, our regression also uses international commodity prices as an instrument for exposure indices and we estimate additional regression models given by:

$$NPA_{it} = \beta_0 + \beta_1(\Delta EXP_{it} = PC_1 + PC_2) + \theta' z_{it} + \gamma' x_t + \phi_i + \epsilon_{it}$$

where, $PC_1$ and $PC_2$ are the log differences of metals and food prices, respectively, and are used as instruments for $EXP_{it}$. As in earlier regression, $z_{it}$ are other bank-level controls, $x_t$ includes aggregate macro variables, and $\phi_i$ are the bank fixed effects.

We also estimate the above regression using $EX\Delta P_{it}$ and $EX\Delta P_{it}1$. We argue that the coefficient of the exposure index created using constant weights (Index-III) estimated using instruments is the most precise estimate of the effects in our framework, as it does not suffer from simultaneity or omitted variable biases.

#### Are Global Commodity Prices a Valid Instrument?

Global commodity prices need to satisfy the exclusion and relevance conditions to act as a valid instrument. Checking for relevance is straightforward, by looking at the correlation between commodity prices and the exposure indices; it turns out they have a high correlation.

Table D.1: Testing for Exclusion Restriction

| | Model A | Model B | Model C | Model D |
|---|---|---|---|---|
| $\Delta EXP_{it}$ | -0.334** | -0.334** | | |
| | (0.037) | (0.039) | | |
| D.LMetals | -0.0125 | -0.0134 | -0.00142 | -0.000979 |
| | (0.355) | (0.321) | (0.926) | (0.947) |
| D. LFood | | 0.00191 | | -0.000970 |
| | | (0.922) | | (0.960) |
| $\Delta EXP_{it}1$ | | | -0.536** | -0.536** |
| | | | (0.015) | (0.015) |
| India's Growth Rate | 0.383*** | 0.384*** | 0.305** | 0.305** |
| | (0.007) | (0.007) | (0.041) | (0.040) |
| Interest Rate | -1.324*** | -1.322*** | -1.316*** | -1.317*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Profit Ratio | 2.104*** | 2.104*** | 2.100*** | 2.101*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| Cost of Funds | -1.760*** | -1.755*** | -1.722*** | -1.724*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Low Income Growth Rate | -0.265** | -0.273** | -0.155 | -0.151 |
| | (0.012) | (0.018) | (0.195) | (0.212) |
| Constant | 5.799* | 5.798* | 5.612* | 5.612* |
| | (0.066) | (0.067) | (0.074) | (0.074) |
| Bank Fixed Effects | Yes | Yes | Yes | Yes |
| Observations | 398 | 398 | 398 | 398 |
| R Square | 0.334 | 0.334 | 0.339 | 0.339 |

Notes: *, **, and *** denotes significance at the 10, 5, and 1% levels, respectively. $EX\Delta P_{it} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1})w_{ijt}$ for sector $j = 1, 2, .., m$. $EX\Delta P_{it}1 = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1})w_{ij}$ for sector $j = 1, 2, .., m$. Where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the whole price indices and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$. The dependent variable is the slippage ratio, defined as new additions to non-performing assets divided by standard advances. Standard advances is the difference between gross advances and gross non-performing assets. D.LMetals and D.LFood are the log differences of the metal and food price index from the World Bank Pink Sheet.

Testing for the exclusion restriction is more difficult: satisfying this restriction would imply that commodity prices only affect NPAs through the exposure indices created in this paper. Hence, commodity prices should be insignificant in the presence of our exposure indices.[26] This test for the exclusion restriction[27] relies on the irrelevance of the instrument in the presence of the treatment variable, i.e., our exposure indices. We estimate model A of Table 3 again with commodity prices and our exposure indices.

As we can see from Table D.1, including our exposure index makes commodity prices insignificant in all the regressions. Moreover, as expected, the coefficient associated with the exposure index is much higher. This suggests that once we have exposure, commodity prices do not affect the slippage ratio, and therefore do not need to be in the original regression. This does not mean that commodity prices do not affect slippage; they affect slippage only through the exposure indices.

Further, using a formal test we show that commodity prices are a strong instrument as they have a very high first-stage F, thus our instruments satisfy both the exclusion and relevance criteria. Moreover, we do not expect commodity prices to be correlated with any other omitted variable in the above regression, as we control for growth in low- and middle-income countries. Therefore we believe this strategy indicates the causal impact of a change in exposure on slippage.

Table D.2 shows the regression results with the slippage ratio as the dependent variable. As we can see, the instruments are quite strong, as the first-stage F value is greater than 100 in both cases. Comparing these results with Table 4, provides some further insights. First, the estimates are higher with instrumental variable regression in the case of the first difference of the nominal exposure index and the inflation exposure with time-varying weights. Second, the estimates with and without instruments are the same for the nominal inflation exposure index with constant weights, because both the

[26] It is important to mention that these commodity prices may not be insignificant if they are correlated with the other omitted variables.

[27] One of the assumptions is that an instrument must meet the exclusion restriction, i.e., the instrument should not be correlated with the error term in the regression. Simply put, the instrument should not directly impact the dependent variable; rather, it should affect the dependent variable via the endogenous independent variable.

nominal inflation exposure index and the instrumental variable regression help get rid of endogenous changes in sectoral exposure. Further, as argued earlier, the bias is likely to be minimal for the nominal inflation exposure index with constant weights. The results in Table D.2 show that a 1% decrease in nominal exposure leads to a 0.20-0.5% increase in the slippage ratio.

Table D.2: Regression: Slippage on Nominal Price and Inflation Exposure Indices

| | Model A | Model B | Model C |
|---|---|---|---|
| $\Delta EXP_{it}$ | -0.203*** | | |
| | (0.000) | | |
| $EX\Delta P_{it}$ | | -0.501*** | |
| | | (0.005) | |
| $EX\Delta P_{it}1$ | | | -0.507*** |
| | | | (0.003) |
| Bank Fixed Effects | Yes | Yes | Yes |
| First Stage F | 109.0 | 138.2 | 196.2 |
| Observations | 350 | 425 | 425 |
| R Square | 0.281 | 0.310 | 0.317 |

Notes: *, **, and *** denotes significance at the 10, 5, and 1% levels, respectively. $EXP_{it} = \sum_{j=1}^{m} p_{jt}w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. $EX\Delta P_{it} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1})w_{ijt}$ for sector $j = 1, 2, .., m$. $EX\Delta P_{it}1 = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1})w_{ij}$ for sector $j = 1, 2, .., m$. Where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$. We use the log difference of metals and food prices as instruments. We control for India's GDP growth and interest rates, the cost of funds and profit ratios for the respective banks, and GDP growth in low- and middle-income countries. The dependent variable is the slippage ratio, defined as the sum of new additions to NPAs and restructured assets divided by standard advances. Standard advances is difference between gross advances and gross NPAs.

Table D.3: Regression: Slippage+Restructured on Nominal Price and Inflation Exposure Indices

| | Model A | Model B | Model C |
|---|---|---|---|
| $\Delta EXP_{it}$ | -0.546*** | | |
| | (0.000) | | |
| $EX\Delta P_{it}$ | | -1.385*** | |
| | | (0.000) | |
| $EX\Delta P_{it}1$ | | | -1.352*** |
| | | | (0.000) |
| Bank Fixed Effects | Yes | Yes | Yes |
| First Stage F | 109.0 | 137.8 | 195.7 |
| Observations | 350 | 424 | 424 |
| R Square | 0.242 | 0.289 | 0.306 |

Notes: *, **, and *** denotes significance at the 10, 5, and 1% levels, respectively. $EXP_{it} = \sum_{j=1}^{m} p_{jt} w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. $EX\Delta P_{it} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ijt}$ for sector $j = 1, 2, .., m$. $EX\Delta P_{it}1 = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ij}$ for sector $j = 1, 2, .., m$. Where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$. We use the log difference of metals and food prices as instruments. We control for India's GDP growth and interest rates, the cost of funds and profit ratios for the respective banks, and GDP growth in low- and middle-income countries. The dependent variable is the slippage+restructured ratio, defined as the sum of new additions to NPAs and restructured assets divided by standard advances. Standard advances is difference between gross advances and gross NPAs.

Table D.3 shows the regression results with the slippage+restructured ratio as the dependent variable. As we can see, the instruments are quite strong, as the first-stage F value is more than 100 in both cases. The patterns of the coefficients with slippage+restructured are the same as in Table D.2. First, the estimates are higher with instrumental variable regression in the case of the first difference of the nominal exposure index and inflation exposure with time-varying weights. Second, estimates with and without instruments are the same for the nominal inflation exposure index with constant weights. The results in Table D.3 show that a 1% decrease in nominal exposure leads to a 0.55-1.35% increase in the slippage+restructured ratio.

Also, since these banks were capital-constrained, we expect them to reduce their lending. Table D.4 shows the regression results with the growth of advances as the dependent variable. As we can see, the instruments are quite strong, as the first-stage F value is greater than 100 in both cases. The results in Table D.4 show that a 1% decrease in nominal exposure leads to a 0.84-1.65% decrease in the growth of advances.

Table D.4: Regression: Growth in Advances on Nominal Price and Inflation Exposure Indices

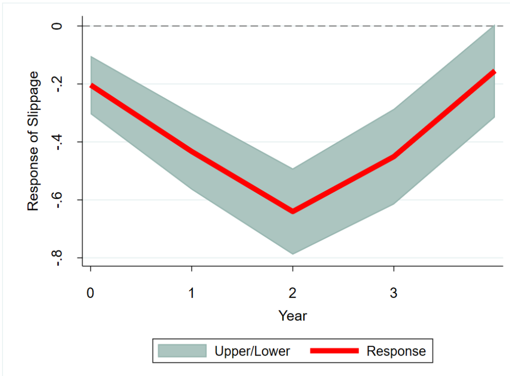
| | Model A | Model B | Model C |
|---|---|---|---|
| $\Delta EXP_{it}$ | 0.838*** | | |
| | (0.000) | | |
| $EX\Delta P_{it}$ | | 1.649*** | |
| | | (0.005) | |
| $EX\Delta P_{it}1$ | | | 1.654*** |
| | | | (0.004) |
| Bank Fixed Effects | Yes | Yes | Yes |
| First Stage F | 110.9 | 138.2 | 196.8 |
| Observations | 354 | 430 | 430 |
| R Square | 0.425 | 0.449 | 0.455 |

Notes: *, **, and *** denotes significance at the 10, 5, and 1% levels, respectively. $EXP_{it} = \sum_{j=1}^{m} p_{jt} w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. $EX\Delta P_{it} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ijt}$ for sector $j = 1, 2, .., m$. $EX\Delta P_{it}1 = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ij}$ for sector $j = 1, 2, .., m$. Where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$. We use log difference of metals and food prices as instruments. We control for India's GDP growth and interest rates, the cost of funds and profit ratios for respective banks, and GDP growth in low- and middle-income countries. The dependent variable is growth of advances.

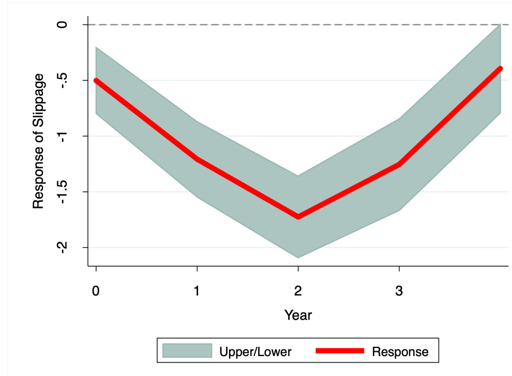
## D.2 Evolution of NPAs Over Time Using Instrumental Variables

The discussion in the paper gives evidence about the role of the commodity price crisis in creating a twin balance sheet problem which affects both borrowers as well as lenders. Such balance sheet crises are likely to have persistent effects, the results of which are presented in section 5.2 of the paper. Here, we give the results using instrumental variables. We estimate the response of three variables of interest, i.e., slippage, slippage+restructured, and credit growth due to exogenous innovation in the nominal price exposure index and the nominal inflation exposure indices. Figure D.2.1 present the response of slippage due to an exogenous innovation in the nominal price exposure index and the nominal inflation exposure indices. The maximum response to a slippage occurs after two years, and it is almost three times the response at impact (in the beginning). Further, the effect is higher for the nominal inflation exposure indices than for the log difference nominal price exposure index. These results are similar to the ones presented in the section 5.2 but magnitudes are slightly different. We do not attempt any statistical test for the differences from responses presented in section 5.2 but visually these responses do not lie outside the confidence band of responses presented in the section 5.2.

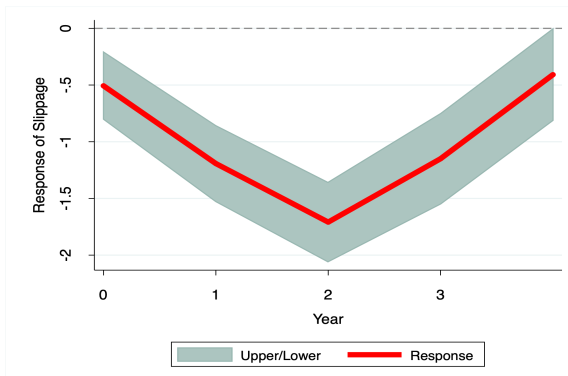
At this point, it is worth mentioning that the estimation with the log difference nominal price exposure index is with a smaller sample because we take the first difference, so the two results are not directly comparable, but the much stronger effect could be due to the diminished bias as mentioned earlier. Figure D.2.2 present the response of the slippage+restructured ratio due to exogenous innovations in the nominal price exposure index and the nominal inflation exposure indices. The pattern of the response of the slippage+restructured ratio is very different from the response of the slippage ratio shown in figure D.2.1. The response of slippage after two years is very similar to the response of slippage+restructured at impact, i.e., $t = 0$. This implies that the immediate effect of a commodity price crash is followed by a large increase in restructuring, which is later declared as an addition to non-performing assets. These are very similar to the findings reported in the section 5.2.




(a) Due to 1 percentage point change in Index-I



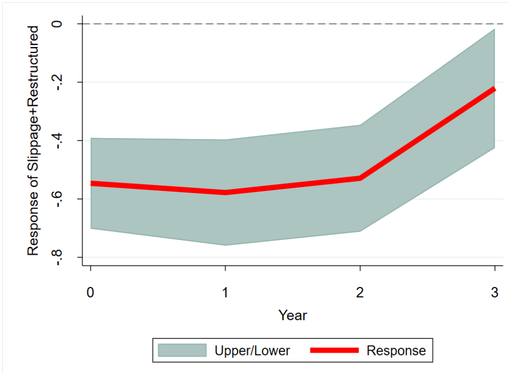

(b) Due to 1 percentage point change in Index-II

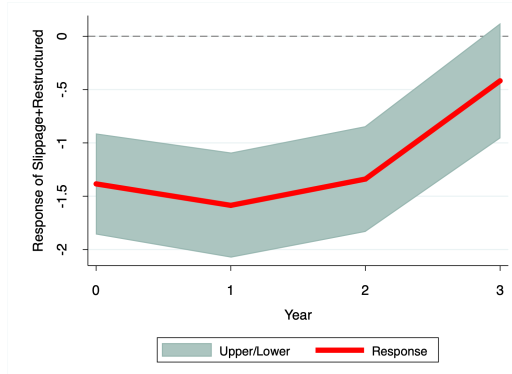



(c) Due to 1 percentage point change in Index-III

Figure D.1: Response of Slippage Ratio

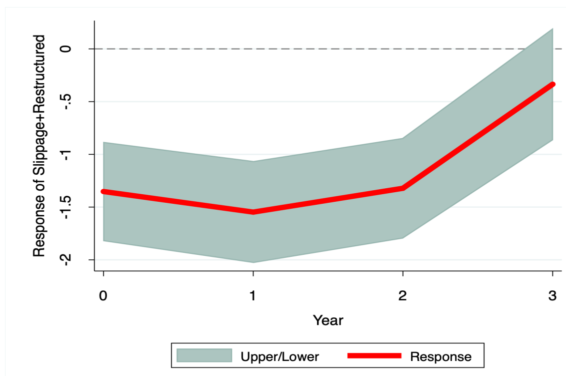
Notes: (a) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j(\Delta EXP_{it} = PC_1 + PC_2) + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j$ For $j = 0, 1, 2, 3$. $EXP_{it} = \sum_{j=1}^m p_{jt} w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. (b) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j(EX\Delta P_{it} = PC_1 + PC_2) + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j$ For $j = 0, 1, 2, 3$. $EX\Delta P_{it} = \sum_{j=1}^m log(p_{jt}/p_{jt-1}) w_{ijt}$ for sector $j = 1, 2, .., m$. (c) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j(EX\Delta P_{it}1 = PC_1 + PC_2) + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}$ For $j = 0, 1, 2, 3$. $EX\Delta P_{it1} = \sum_{j=1}^m log(p_{jt}/p_{jt-1}) w_{ij}$ for sector $j = 1, 2, .., m$. where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$ at time $t$. We use the log difference of metals and food prices as the instrument. We control for Indian GDP growth, GDP growth in low- and middle-income countries, the interest rate in India, cost of funds and profit ratio for respective banks. The dependent variable is the slippage ratio, defined as new additions to non-performing assets divided by standard advances. Standard advance is the difference between gross advances and gross non-performing assets.




(a) Due to 1 percentage point change in Index-I (at t=0)

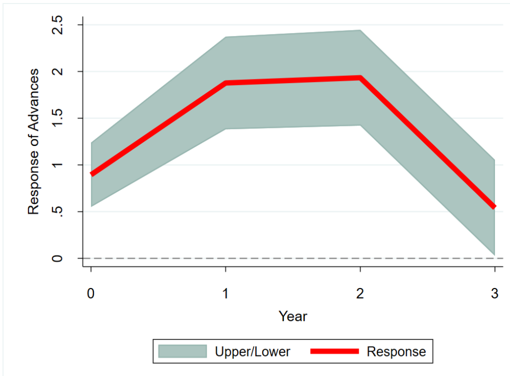
(b) Due to 1 percentage point change in Index-II (at t=0)




(c) Due to 1 percentage point change in Index-III (at t=0)

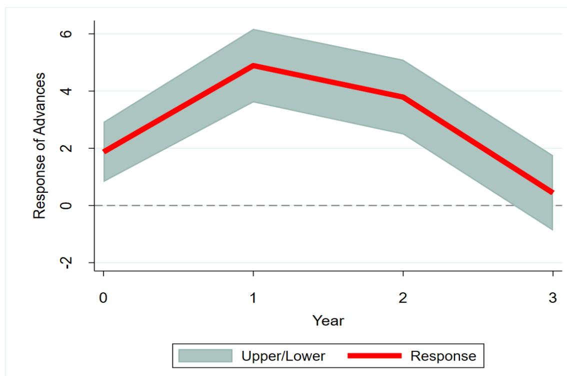
Figure D.2: Response of Slippage+Restructured Ratio

Notes: (a) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j(\Delta EXP_{it} = PC_1 + PC_2) + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j$ For $j = 0, 1, 2, 3$. $EXP_{it} = \sum_{j=1}^{m} p_{jt} w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. (b) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j(EX\Delta P_{it} = PC_1 + PC_2) + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j$ For $j = 0, 1, 2, 3$. $EX\Delta P_{it} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ijt}$ for sector $j = 1, 2, .., m$. (c) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j(EX\Delta P_{it}1 = PC_1 + PC_2) + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}$ For $j = 0, 1, 2, 3$. $EX\Delta P_{it1} = \sum_{j=1}^{m} log(p_{jt}/p_{jt-1}) w_{ij}$ for sector $j = 1, 2, .., m$. where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$ at time $t$. We use the log difference of metals and food prices as instruments. We control for Indian GDP growth, interest rates, cost of funds, and profit ratios for respective banks, and for GDP growth in low- and middle-income countries. The dependent variable is the slippage+restructured ratio defined as the sum of new additions to non-performing and restructured assets divided by standard advances. Standard advance is the difference of gross advance and gross non-performing assets.




(a) Due to 1 percentage point change in Index-I (at t=0)


(b) Due to 1 percentage point change in Index-II (at t=0)




(c) Due to 1 percentage point change in Index-III (at t=0)

Figure D.3: Response of Growth in Advances

Notes: (a) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j(\Delta EXP_{it} = PC_1 + PC_2) + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j$ For $j = 0, 1, 2, 3$. $EXP_{it} = \sum_{j=1}^m p_{jt} w_{ijt}$ for sector $j = 1, 2, .., m$. $\Delta EXP_{it}$ is the log difference of $EXP_{it}$. (b) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j(EX\Delta P_{it} = PC_1 + PC_2) + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}^j$ For $j = 0, 1, 2, 3$. $EX\Delta P_{it} = \sum_{j=1}^m log(p_{jt}/p_{jt-1}) w_{ijt}$ for sector $j = 1, 2, .., m$. (c) is $\beta_1^j$ from $NPA_{it+j} = \beta_0^j + \beta_1^j(EX\Delta P_{it}1 = PC_1 + PC_2) + \theta'^j z_{it} + \gamma'^j x_t + \phi_i^j + \epsilon_{it}$ For $j = 0, 1, 2, 3$. $EX\Delta P_{it1} = \sum_{j=1}^m log(p_{jt}/p_{jt-1}) w_{ij}$ for sector $j = 1, 2, .., m$. where $p_{jt}$ is the price of the $jth$ commodity at time $t$ obtained from the wholesale price indices and mapped to a bank's sectoral exposure. $w_{ijt}$ is the exposure of bank $i$ in sector $j$ at time $t$. $w_{ij}$ is the average exposure of bank $i$ in sector $j$ at time $t$. We use the log difference of metals and food prices as instruments. We control for Indian GDP growth, interest rates, cost of funds, and profit ratios for respective banks, and for GDP growth in low- and middle-income countries. The dependent variable is the growth of advances.

Figure D.2.3 presents the response of advances growth due to an exogenous innovation in the nominal price exposure and nominal inflation exposure indices. The pattern of the response of advances growth is similar to the response of the slippage ratio shown in figure D.2.1. The maximum impact takes place after a year or two, and it is almost two times the impact response. This is as expected, as banks become capital constrained when these are declared as slippages. This is because as long as these assets are termed restructured assets, very low or no provisioning is required; but as soon as the assets are declared as a 'slippage', the full required provisioning has to be made.

# E Banks' Fixed Effects

Table E1 is based on Model A (from the first column of Table 3 in our paper). The coefficient associated with the bank names gives the bank fixed effects, relative to Andhra Bank, which is considered the base here. For e.g., the coefficient associated with Axis Bank is -2.867, implying that Axis Bank had a 2.867 percentage point lower slippage than Andhra Bank. Similarly, the coefficient of Bank of Baroda is not statistically significant, which implies it had a similar slippage ratio as Andhra Bank.

Table E.1: Banks' Fixed Effects

| DV: Slippage Ratio | All Banks | DV: Slippage Ratio | All Banks |
|---|---|---|---|
| D. L Metals | -0.0314** | Jammu & Kashmir Bank Ltd. | -0.600** |
| Indian Growth Rate | 0.472*** | Karnataka Bank Ltd. | -0.435** |
| Domestic Interest Rate | -1.443*** | Karur Vysya Bank | -2.453*** |
| Profit Ratio | 2.149*** | Kotak Mahindra Bank Ltd. | -4.812*** |
| Cost of Funds | -1.824*** | Lakshmi Vilas Bank | 1.673*** |
| Low-Income Growth | -0.371*** | Oriental Bank of Commerce | 1.568*** |
| Andhra Bank | 0 | Punjab & Sind Bank | 0.934** |
| Axis Bank | -2.867*** | Punjab National Bank | 0.657*** |
| Bank of Baroda | 0.567 | RBL Bank Limited | -1.338*** |
| Bank of India | 1.946*** | South Indian Bank | -0.631* |
| Bank of Maharashtra | 1.119*** | State Bank of Bikaner & Jaipur | -1.162*** |
| Canara Bank | 1.155*** | State Bank of India | -0.624** |
| Central Bank of India | 2.969*** | State Bank of Mysore | 0.210** |
| City Union Bank Ltd. | -2.652*** | State Bank of Travancore | 1.890*** |
| Corporation Bank | 1.514*** | Syndicate Bank | 0.642** |
| DCB Bank Limited | -1.785*** | UCO Bank | 3.942*** |
| Dena Bank | 2.258*** | Union Bank of India | 0.325 |
| HDFC Bank | -4.706*** | United Bank of India | 4.210*** |
| ICICI Bank | -1.725*** | Vijaya Bank | 1.301*** |
| IDBI Bank Ltd. | 4.977*** | Yes Bank Ltd. | -1.006*** |
| Indian Bank | -0.778*** | Constant | 6.469** |
| Indian Overseas Bank | 3.400*** | | |
| IndusInd Bank | -4.579*** | Observations | 398 |

Notes: *, **, and *** denotes significance at the 10, 5, and 1% levels, respectively. The dependent variable (DV) is the slippage ratio, defined as new additions to NPAs divided by standard advances. Standard advances is the difference between gross advances and gross NPAs. D.LMetals is the log difference of the metal price index from the World Bank Pink Sheet.