NBER WORKING PAPER SERIES

MACROECONOMIC PERFORMANCE DURING COMMODITY PRICE BOOMS AND BUSTS

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Working Paper 18569
http://www.nber.org/papers/w18569

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
November 2012

Prepared for the IMF-CBRT Conference "Policy Responses to Commodity Price Movements", held on April 6-7, 2012. We are grateful to Juan Matamala for excellent research assistantship. We are also grateful to Pierre-Olivier Gourinchas and Ayhan Kose (the editors), two anonymous referees and our discussant Silvana Tenreyro for useful comments and suggestions. We thank Gustavo Adler, Cesar Calderón, Luis Catao, Gian Maria Milesi-Ferretti and Nikola Spatafora for sharing their data with us. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 18569
November 2012
JEL No. E52,E58,F31,F32,F36,F41

ABSTRACT

Fluctuations in commodity prices are often associated with macroeconomic volatility. But not all nations are created equal in this regard. The macro response to commodity booms and busts depends both on the structural characteristics of the economy and on the policy framework that is in place. In this paper we investigate the macro response of a group of commodity-producing nations in episodes of large commodity prices shocks. First we provide a theoretical framework to analyze how shocks to commodity prices affect the domestic economy. For this we use a simple open-economy model with nominal rigidities and financial frictions. Then we provide empirical evidence (using commodity price boom and bust episodes) that commodity price shocks have a significant impact on output and investment dynamics. Economies with more flexible exchange rate regimes exhibit less pronounced responses of output during these episodes. We also provide evidence that the impact of those shocks on investment tends to be larger for economies with less developed financial markets. Moreover, we find that international reserve accumulation, more stable political systems, and less open capital accounts tend to reduce the real exchange rate appreciation (depreciation) in episodes of commodity price booms (busts).

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I. Introduction

Booms in commodity prices imply significant challenges for macroeconomic policy in commodity-producing nations. Fluctuations in commodity prices are often associated with macroeconomic volatility. Using a small open economy real business cycle model, Mendoza (1995) estimates that roughly one-half of the variation in aggregate output in a sample of the G7 and 23 developing economies can be attributed to terms of trade shocks. Kose (2002) applies a similar framework and finds that terms of trade shocks can explain almost all of the variance in output in small open developing economies.

But not all nations are created equal in this regard. The macro response to commodity booms and busts depends both on the structural characteristics of the economy and the policy framework that is in place. In this paper we investigate the macro response of a group of commodity-producing nations in episodes of large commodity prices booms and busts. We center our analysis on the response of economic activity and the real exchange rate to commodity price shocks controlling for the role played by financial market depth, the exchange rate regime and other usual controls used in the literature.

Commodity price shocks are transmitted to the economy through different channels. One of them is fiscal policy. In Céspedes and Velasco (2011) we revisited the issue of fiscal pro-cyclicality in commodity republics, i.e. countries for which commodity-linked revenues represent a large portion of total government revenue. Given that the behavior of commodity prices is a main driver of fiscal policy outcomes in these countries, we focused on the behavior of fiscal variables across the commodity cycle.

But fiscal policy is not the only factor that matters. There are other channels through which terms of trade shocks (or shocks to commodity prices) affect the macroeconomic performance of a country. The theoretical and empirical literature has stressed the role played by the exchange rate regime. Under a fixed exchange rate regime, the domestic currency is pegged to another currency or to a basket of currencies while under a flexible exchange rate regime the nominal exchange rate is allowed to move freely in response to supply and demand conditions in the foreign exchange market. In the presence of nominal rigidities, a flexible exchange rate regime helps stabilize the economy in response to terms of trade shocks as the nominal exchange rate adjusts immediately to the real shock. The alternative under fixed rates is to wait until nominal wages and goods' prices adjust, increasing the volatility of output and employment.

The empirical evidence tends to support the view that more flexible exchange rate regimes tend to insulate the economy better from terms of trade shocks. Broda (2002), using a sample of developing countries, documents that in response to negative terms of trade shocks countries with fixed exchange regimes experience large and significant declines in real GDP and the real exchange rate depreciates slowly. The opposite occurs in the case of flexible exchange rate regimes. Edwards and Levy Yeyati (2003) find evidence that indicate that terms of trade shocks are amplified in countries that have more rigid exchange rate regimes. They also provide evidence of an asymmetric response to terms of trade shocks. In particular, they find that the output response is larger for negative shocks than for positive shocks. Finally, Aghion et al (2008) provide evidence that the impact on productivity growth of terms of trade shocks also depends on the nature of the exchange rate regime. They show that the impact is larger under a fixed exchange rate regime and close to zero under a flexible rate regime.

In this paper we characterize the response of different macroeconomic variables in the episodes of large commodity price shocks documented in Céspedes and Velasco (2011). First we review the different channels through which shocks to commodity prices affect the domestic economy using a simple open economy model with nominal rigidities and financial frictions. We provide a closed-form solution for the output response to a commodity price shock as a function of the degree of exchange rate flexibility and of financial market depth. As expected, the output response is smaller for more flexible exchange rate regimes. We also show that the output response to commodity price shocks is hump-shaped: it goes up as financial development rises from a low level, but it eventually goes down as financial development becomes sufficiently high.

Next, we provide empirical evidence regarding the role played by the exchange rate regime, the development of financial markets, international reserve accumulation, political stability and the degree of capital account openness of the economy in the transmission of commodity price shocks. We concentrate our analysis on the output and investment dynamics and the evolution of the real exchange rate in those episodes of large commodity price shocks.

We find that, consistent with the theoretical predictions, more flexible exchange rate regimes are associated with smaller responses of output during commodity price episodes. We also provide evidence that the impact of those shocks on output tends to be larger for economies with less developed financial markets. We find that higher financial depth tends to reduce the impact of commodity price shocks on investment. We also provide evidence that suggests that for the episodes before the 2000s, the presence of more developed financial markets mitigated the impact of commodity price shocks on credit.

Finally, we provide evidence that the rate of international reserve accumulation tends to reduce the appreciation of the real exchange rate in episodes of commodity price booms and busts. At a first glance, this last result may be explained by the fact that less flexible exchange rate regimes must accumulate international reserves in order to keep the parity. Nonetheless, when we control for the flexibility of the exchange rate regime the result still holds, suggesting an independent role for reserve accumulation.

We also find that countries with less open capital accounts and more stable political systems tend to exhibit a more depreciated real exchange rate. Interestingly, our results indicate that the impact of commodity price shocks on the real exchange rate is reduced when the political system is more stable. If government expenditure is more intensive in non-traded goods, this result may be connected to the one obtained in Céspedes and Velasco (2011), who showed that more stable political systems tend to reduce the impact of commodity price shocks on government expenditure.

The paper is organized as follows. In the next section we construct a simple model that captures the role of financial constraints, nominal rigidities and the exchange rate regime in the transmission of commodity price shocks. Then we turn to the empirical analysis. We first specify the commodity price indexes used in the analysis and lay out the precise definition of a boom and a bust. Then we present regression analysis on the determinants of output, investment, credit and exchange rate dynamics in our commodity boom episodes. A final section offers some preliminary conclusions.

II. A simple model

In this section we construct the simplest model that captures the role of financial constraints, nominal rigidities and the exchange rate regime in the transmission of commodity price shocks to the rest of the economy. The model has two periods, current and future;[1] two produced goods, foreign and domestic; and two kinds of people, capitalists and workers. It borrows from earlier work by Céspedes, Chang and Velasco (2003, 2004), and Velasco (2001).

Output of the domestic good is given by the following production function:

$$Y = K^{\alpha} L^{1-\alpha}, \tag{1}$$

where the capital stock K is given by history and labor L is supplied by workers. With this Cobb-Douglas technology, competition and profit maximization by firms causes the wage bill to be equal to a fixed share of nominal output

$$WL = (1-\alpha)PY, \tag{2}$$

where W is the nominal wage and P is the price of domestic output in terms of the domestic currency. If real wages are flexible, workers supply one unit of labor in equilibrium[2]:

$$L = 1 \tag{3}$$

In addition to the two goods that are produced, there is a natural resource endowment of size R that accrues to domestic capitalists. The price of this resource in terms of the foreign good (the dollar price of the resource, if you wish), is given by Q, which is given to the small home

[1] Current-period variables have no time subscripts. Future-period variables have a 1 as subscript.

[2] This can be derived from utility maximization by workers if their objective function is logarithmic in consumption and C.E.S. in labor effort. See Céspedes, Chang and Velasco (2004) and Velasco (2001).

economy. The natural resource is not consumed domestically. Therefore the dollar value of natural resource exports in the initial period is *QR*.

Workers consume domestic and foreign goods, with shares γ and $1-\gamma$ in total consumption. For simplicity, they have no access to borrowing and lending, and consume the whole wage bill:

$$WL = P^{\gamma} S^{1-\gamma} \; C, \tag{4}$$

where C is a basket of total consumption and $P^{\gamma}S^{1-\gamma}C$ is the price index corresponding to this basket. Notice that since the law of one price holds for foreign goods and their foreign currency (or dollar) price is normalized to one, then S the nominal exchange rate is their peso price. Define $E \equiv S/P$ as the relative price of foreign goods, or *real exchange rate*.

The action in the model primarily involves the capitalists. They consume in the second period only, and they consume only foreign goods. Hence, their objective is to maximize the dollar value of their net worth at the end of next period.[3] They do this by buying capital today, which they finance resorting to their net worth N and to foreign loans F. The capitalists' budget constraint is

$$I = N + EF_1, \tag{5}$$

where F_1 denotes the amount borrowed abroad to be repaid next period and I investment in real capital. Notice that capital is composed of domestic goods only. If no constraints on their ability to borrow are present, capitalists maximize their end-of-next period net worth by choosing an amount of investment such that the return to capital is equal to the expected cost of borrowing:

$$\frac{\alpha Y_1}{I} = (1+\rho)(\frac{E_1}{E}) \tag{6}$$

[3] The assumption that capitalists consume only foreign goods (in the second period) does not affect qualitatively the results. As it will become clear later, allowing capitalists to consume domestic goods in the second period will affect the market-clearing condition for the second period do not altering qualitatively our results.

But their ability to borrow may be constrained. In particular, we assume that capitalists cannot borrow more than a multiple λ of their net worth:

$$EF_1 \leq \lambda N, \tag{7}$$

a condition that may or may not bind in what follows. Combining this last equation with the budget constraint 5 we have

$$I \leq (1+\lambda)N , \tag{8}$$

which shows that investment can be no larger than a multiple of net worth.

At the beginning of each period, capitalists collect income from capital (equal to αY), receive their endowment R of the natural resource and repay old foreign debt, whose current home output value is EF. As a consequence, their net worth is

$$N = \alpha Y + E\left[QR - (1+\rho)F\right], \tag{9}$$

where ρ is the world real interest rate. Note that –holding real income constant— a real devaluation, defined as an increase in E, may increase or reduce net worth, depending on whether the expression $QR - (1+\rho)F$ is positive or negative.[4]

To close the model, markets for the domestic good must clear. In the current period that requires

$$Y = \gamma E^{1-\gamma} C + I + EX , \tag{10}$$

[4] Notice that we have assumed that all the natural resource endowment belongs to capitalists. Alternatively, a fraction of this endowment may belong to workers or the government (in a model with a government sector). In this case, the impact of terms of trade shocks on capitalists' net worth will feature an additional channel: revenues coming from domestic production associated to higher consumption and government expenditures. Obviously, given differences in preferences over domestic and foreign goods, the quantitative impact may be different depending on who owns the natural resource endowment. For simplicity we shut down this channel.

where X is the exogenous dollar value of exports.[5] Given that the next period is the terminal period and no investment takes place, we have

$$Y_1 = \gamma E_1^{1-\gamma} C_1 + E_1 X_1. \tag{11}$$

Finally, introduce money in the simplest way, using a cash-in-advance constraint on consumption

$$M \leq P^{\gamma} S^{1-\gamma} C, \tag{12}$$

which we will assume binds in what follows. Combining 2, 4, and cash-in-advance constraint 12 yields

$$M / P = (1-\alpha) Y . \tag{13}$$

To allow for an intermediate exchange rate regime (somewhere between strict fixing and floating), assume a policy rule so that the money supply follows

$$\frac{M / P}{\overline{M / P}} = \left(\frac{E}{\overline{E}}\right)^{-1/\phi} \tag{14}$$

where $\phi \geq 0$ and where a bar above a letter denotes the flexible price equilibrium. The case of $\phi = 0$ implies fixed exchange rates: money adjusts instantaneously to ensure that the real exchange rate is always equal to its flexible price level. Conversely, as $\phi \to \infty$ we have flexible rates: real balances are always equal to their flexible price level, regardless of what happens to the real exchange rate.

[5] This is similar to Krugman (1999), and can be justified by positing that the foreign intratemporal elasticity of substitution in consumption is one, but that foreigners' expenditure share on domestic goods is negligible.

This model can be reduced to an extremely simple system of equations. From market-clearing (expression 10) combined with 2 and 4 we have

$$\beta Y = I + EX \tag{15}$$

where $\beta \equiv 1 - \gamma(1-\alpha) > 0$.

Carrying out analogous substitutions using 2, 4 (led one period), 7 and 11 we have

$$\beta I = \alpha EX_1 / (1+\rho)\,, \tag{16}$$

which gives current investment as a function of (the present value of) expected future exports. This is the level of investment that would prevail if arbitrage were possible.

But arbitrage may not be possible if the financial constraint binds. To see exactly what shape that constraint takes, combine 8 and 9 and arrive at

$$I \leq (1+\lambda)\Big[\alpha Y + E\big[QR - (1+\rho)F\big]\Big] \tag{17}$$

That completes the presentation of the model. Which variables are endogenous or exogenous depends on whether wages and prices are flexible. With full nominal flexibility, output is exogenous[6], and 15 and either 16 or 17 pin down investment and the real exchange rate regardless of monetary or exchange rate policy. In that case 13 simply residually determines the quantity of real balances and 14 is irrelevant.

But if prices and wages are predetermined (at least in the initial period, where all the action is), then monetary and exchange rate policy matters, and unanticipated shocks to either exogenous variables or policy can have effects on output of the home good, as well as investment and the real exchange rate. In what follows we develop a simple diagrammatic approach to characterize what the sticky-price, sticky-wage equilibrium looks like.

[6] It is given by production function 2, evaluated at the inherited K and $L = 1$ as indicated by 3.

Our goal is to show all relevant determinants of short-run equilibrium in a diagram in *Y*,*E* space. Combining 14 and 16 we have the levels of output and the exchange rate that would prevail if arbitrage does indeed take place:

$$E = Y\left[\frac{X}{\beta} + \frac{\alpha}{\beta^2}\frac{X_1}{(1+\rho)}\right]^{-1} \tag{18}$$

We call this the AI (arbitraged investment) schedule, which slopes up in *Y*,*E* space.

In turn, putting together 15 and 18 to eliminate *I* we have the combinations of output and the exchange rate that are feasible if the financing constraint is indeed binding:

$$E \geq Y\frac{\beta - (1+\lambda)\alpha}{X + (1+\lambda)\left[QR - (1+\rho)F\right]} \tag{19}$$

We refer to this as the CF (constrained financing) schedule, which also slopes up in *Y*,*E* space.[7]

It is easy to see that a sufficient condition for schedule CF to be steeper than schedule AI is for λ to be small enough: if the multiple of their net worth capitalists can borrow is tiny, then CF lies everywhere above AI in *Y*,*E* space, and any equilibrium must be constrained.

Finally, money demand expression 12 and monetary rule 13 together yield

$$Y/\overline{Y} = \left(E/\overline{E}\right)^{-1/\phi} \tag{20}$$

We term this the ME (monetary equilibrium) schedule, which slopes down in *Y*,*E* space. Notice that under flexible exchange rates ($\phi \to \infty$) schedule ME becomes vertical and output is always

[7] For this to be the case we need $\beta > (1+\lambda)\alpha$, which we assume from now on.

at its flexible-price level. Conversely, under fixed exchange rates ($\phi = 0$), ME is horizontal and the real exchange rate is always at its (ex-ante) flexible-price level.

Let us now analyze possible equilibria. There are two candidates: unconstrained and constrained. Figure 1A shows the case of an unconstrained equilibrium. The AI schedule lies above the CF schedule. Equilibrium is at point A, where AI cuts ME. Note that in this case a (small) shock to the terms of trade does not affect the position of the equilibrium. The same is true of shocks to the initial level of debt. That is because Q and F only enter the CF schedule, which is irrelevant in this case. Notice, however, that a large adverse drop in Q or a large rise in F could cause the slope of the CF schedule to rise sufficiently, so that the equilibrium became constrained.

In the unconstrained equilibrium the level of external demand for the domestic good does matter for output and the real exchange rate. Figure 1B shows what happens if either current exports X or future exports X_1 go up. Schedule AI becomes flatter and now cuts ME at point B. Output of the domestic good goes up and the real exchange rate appreciates.

Alternatively, Figure 2A shows a constrained equilibrium. Now schedule AI lies below schedule CF. Equilibrium is at point A, where CF cuts ME. Note that output of the domestic good is lower and the exchange rate is more depreciated than it would have been if the equilibrium were unconstrained.

In this case the terms of trade do matter for the position of the equilibrium. In particular, a fall in Q causes the CF schedule to become steeper, reducing output and depreciating the real exchange rate. The intuition is that capitalists' net worth falls, and they can therefore borrow and invest less, so that output is lower. The same effects (qualitatively at least) occur if current exports X drop or initial debt F goes up. These are the cases depicted in Figure 2B.

To make the analysis of the effects of terms of trade shocks more systematic, and to identify interaction effects, we finally consider the linearized version of the constrained equilibrium.

Taking logs of both sides of constrained financing equation 19 (assuming strict equality) we have

$$\log E = \log Y + \log\left[\beta - (1+\lambda)\alpha\right] - \log\left[X + (1+\lambda)\left[QR - (1+\rho)F\right]\right] \qquad (21)$$

Taking the total differential of this expression, keeping both export demand and initial debt constant, we have

$$\frac{dE}{E} = \frac{dY}{Y} - \eta\frac{dQ}{Q}, \qquad (22)$$

where $\eta \equiv \dfrac{(1+\lambda)QR}{X + (1+\lambda)\left[QR - (1+\rho)F\right]}$.

Applying the same procedure to the monetary equilibrium equation (20) yields

$$\frac{dE}{E} = -\phi\frac{dY}{Y} \qquad (23)$$

Finally, combining equations 22 and 23 yields

$$\frac{dY}{Y} = \frac{\eta}{1+\phi}\frac{dQ}{Q}, \quad \text{where } \frac{\eta}{1+\phi} > 0 \qquad (24)$$

This equation summarizes the effects of terms of trade shocks on output of the domestic good. It is clear from this expression that the impact of those shocks on output will depend on the term $\frac{\eta}{1+\phi}$. In particular, the impact of a terms-of-trade shock on output of the domestic good is larger when ϕ is small and η is large.

Remember that a larger ϕ occurs when the exchange rate is relatively fixed. Therefore, for less flexible exchange rate regimes, the impact of terms of trade shocks on output is larger. In line with the implication of the Mundell-Fleming model we have that, with sticky wages and prices, flexibility in the exchange rate helps stabilize output.

The second key parameter is η. The value of η depends on initial debt in dollars, on the multiple of their net worth that capitalists can borrow and the importance of the natural resource revenues on the income of capitalists.

If initial debt in dollars is large, in which case η is large, terms of trade shocks have a stronger impact on current output of the domestic good. The intuition is that the associated real devaluation (appreciation) reduces (increases) their ability to borrow more sharply when there is a large debt denominated in foreign goods (dollars, say). This is because net worth falls (increases) more and therefore –in a financially constrained equilibrium— investment falls (increases) more as well. Notice that in this case, the more flexible the exchange rate has to be in order to stabilize output around the flexible-price equilibrium.[8]

Moreover, the effect of the terms of trade shocks on output is also larger when λ is larger, so that η rises. The more capitalists can borrow against their net worth, the larger the impact on investment and output of changes in the terms of trade, which affect net worth through the natural resource endowment.

However, recall that when λ gets to be very large the equilibrium is no longer constrained, and the terms of trade shocks cease to matter for short-term output. This suggests that the correlation between output volatility and terms of trade volatility is hump shaped: it goes up as financial development rises from a low level, but it eventually goes down as financial development becomes sufficiently high.[9]

For instance, take copper producers: a fall in the price of copper matters more for non-copper producers in Chile (medium financial development) than in Zambia (low financial development), but in Australia (high financial development) it matters less than in Chile.

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[8] Under the flexible-price equilibrium, output of the domestic good should be equal to the output level under the non-shock equilibrium.

[9] Given that the countries under empirical analysis are mainly middle-income economies, we expect to capture the negative portion of the relationship described.

Finally, notice also that the impact of terms of trade shocks on output is larger when *QR* is larger (so that η is larger as well).[10] This is because when the natural resource is a large part of net worth, then an increase in its price matters more for the ability of capitalists to borrow and invest. Continuing with the example of copper: the effect of a drop in the price of copper should be larger in Chile, which produces a great deal of copper, than in Argentina, which produces much less.

III. Empirical evidence

In this section we present empirical evidence on the effects of commodity price shocks on macroeconomic performance. We focus our analysis on episodes of large commodity price booms and busts. We define those episodes as periods in which an index of country-specific commodity prices surpasses or falls below its historical trend by a certain threshold margin.

In Céspedes and Velasco (2011) we construct a commodity price index for a group of 33 economies, using as weights the share of commodity *i*' production in total commodity production in country *j*. This strategy is an alternative to the common procedure of using as weights the share of commodity *i*' exports in total commodity exports in country *j*.

The advantage of our strategy is that it allows us to compute and update the weights beginning early last century. This is not possible with commodity export shares, which are only available from a much later date. This is relevant given that, as we will see later, a significant share of commodity price boom episodes took place in the late 1960s and 1970s.

The disadvantage of our strategy is that we must leave out some countries due to data restrictions. To get around this, we complement the production-based commodity index with an export-based commodity index along the lines of Spatafora and Tytell (2009), Deaton and Miller (1996) and Cashin, Céspedes, and Sahay (2004). In particular, we use a commodity price index constructed using the weights of the relevant commodity exports in total exports. We deflate this

[10] This last effect requires $X > (1+\lambda)^{-1}(1+\rho)F$, meaning that exports of the home good have to be sufficiently high relative to debt service.

commodity export price index by the producer price index for the United States. This alternative allows us to increase the number of countries in our empirical analysis to 59.

Following earlier work (Céspedes and Velasco (2011)), we define a commodity boom episode as a period during which our commodity price index reaches a level at least 25% above its trend. A commodity bust episode corresponds to a period during which the commodity price index reaches a level lower than 25% below its trend. An episode ends when the commodity price index comes back to a level lower (higher) than 10% above (below) its trend.

The trend is computed using a 50-year moving average in the case of the production-based index.[11] Given that the export-based commodity index is available since 1970, we construct a *pseudo* export-based commodity index for the period 1930-2008. Due to data availability, this pseudo index is constructed using a subset of the commodities used to construct the original export-based index. Also, the weights used to construct the index correspond to the original weights. Therefore, they correspond to the share of commodity *i*' exports in total exports in country *j* for the period 1999-2004. The pseudo index (available since 1930) is used exclusively to identify the episodes, using the same procedure discussed for the production-based index.[12]

Using the production-based commodity index we obtain 87 episodes for a total of 33 countries. In the case of the export-based commodity index we have 117 episodes for a total of 59 countries. For those countries with both indexes, the episodes we identify are quite similar (see tables 1 and 2).

Most of the commodity price boom episodes are concentrated around two main periods: one taking place in the 1970s and early 1980s, and another in the years immediately prior to 2008. The busts are concentrated around the 1998-1999 period. As an example, in figure 3 we show the two commodity price indexes we work with for Indonesia, Chile and Guatemala, mainly producers of energy, metals and food commodities respectively. The episodes we find are consistent with the episodes for boom and busts for energy, metal and food commodity prices

[11] The 50-year moving average in each year is computed averaging 40 years back and 10 years ahead. The commodity price trend for the 2000s is assumed to be equal to the commodity price trend for the year 2000.
[12] Nonetheless, the original export-based index is used in the regression analysis.

discussed in WEO (2012), which are dated around the early 1970s, the end of the 1990s and the 2000s.

Given than the most recent boom episodes are still ongoing we study the macroeconomic performance in the boom phase. In particular, we define an episode for our empirical purposes as the period that goes from the beginning to the peak in our commodity price index.[13] We assume that the peak of the last episode was 2008.[14]

A. Output, investment and credit performance during commodity price boom and bust episodes

The first objective of our analysis is to test the response of output, investment and credit to commodity price shocks, taking into account the potential role of the exchange rate regime and the degree of financial development as discussed in our theoretical section. For this purpose, we begin by constructing a measure of the output gap using the HP filter. In order to reduce the end point problem that arises with this method (and which may be particularly relevant for those episodes ending in 2008), we extend our GDP series from 2010 to 2016 using the latest WEO forecast of GDP growth for the countries in our sample. Given the potential problems that arise from this strategy, we also study the response of the rate of investment to GDP and domestic credit to the private sector (as a percentage of GDP) to commodity price shocks.

In our theoretical section we summarize the role of exchange rate flexibility through the parameter ϕ. Larger values for that parameter imply more exchange rate flexibility. Our empirical counterpart for that parameter comes from Ilzetzki, Reinhart and Rogoff (2008)'s exchange rate system classification. In our analysis we use 13 different categories constructed by these authors indexed from 1 to 13 according to the degree of exchange rate flexibility, with higher values indicating more flexibility.[15]

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[13] For the bust episodes we consider the dynamics during the whole episode.

[14] The variables real output, investment, real exchange rate, domestic credit to the private sector and international reserves come from the WDI. The sources of the remaining variables used in the empirical analysis are described in the main text.

[15] In the exchange rate clasification constructed by Ilzetzki, Reinhart and Rogoff there are 14 categories: no separate legal tender, pre announced peg or currency board arrangement, pre announced horizontal

In order to measure financial development we use a variable that has been related to financial depth: the rule of law index.[16] The rule of law index is an assessment of the law and order tradition of a country.[17] We follow this strategy in order to avoid potential endogeneity problems that could arise from using credit to the private sector (as % of GDP).

The set of regressions we study has the following structure:

$$\Delta y_i = f\left(\Delta COM_i, ERR_i, RL_i, POL_i, KAO_i\right),$$

where Δy_i is the average output gap (investment rate or domestic credit to the private sector) during episode *i* minus the average output gap (investment rate or domestic credit to the private sector) in the two years prior to the beginning of episode *i*; ΔCOM_i is the percent change in the average commodity price index during episode *i* with respect to the average commodity price index in the two years prior to the beginning of episode *i*; ERR_i is the exchange rate classification for the country during episode *i*; RL_i corresponds to our measure of financial depth (rule of law); POL_i is the political risk index that assess the political stability of the country *i* constructed by ICRG (where the higher the index, the lower the political risk); and KAO_i is a capital account openness measure taken from Chinn and Ito (2008) (where the higher the index, the more open the country is to cross-border capital transactions).

In the empirical analysis we allow for the interaction between the change in the commodity price index and the exchange rate regime in order to capture our theoretical discussion that suggests

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band that is narrower than or equal to +/-2%, de facto peg, pre announced crawling peg, pre announced crawling band that is narrower than or equal to +/-2%, de factor crawling peg, de facto crawling band that is narrower than or equal to +/-2%, pre announced crawling band that is wider than or equal to +/-2%, de facto crawling band that is narrower than or equal to +/-5%, moving band that is narrower than or equal to +/-2%, managed floating, freely floating and freely falling. In our analysis we ignore the freely falling category in a similar way than Aghion, Bacchetta, Ranciere, and Rogoff (2009). In one extreme, a no separate legal tender regime takes a value of 1 while in the other extreme a freely floating regime takes a value of 13.

[16] See La Porta et al (1997).

[17] The rule of law index is constructed by the International Country Risk Guide (ICRG). It ranges from 0 to 6, where a higher number is associated with stronger law and order tradition.

that higher exchange rate flexibility tends to reduce the impact of commodity price shocks on economic activity. The equation is estimated by weighted least squares.

Given the larger sample size of the export-based index, we report it first. The results are in table 3. Our results indicate that a commodity price increase is positively associated with economic activity in our sample of commodity price booms. Quantitatively, a 60% increase in the commodity price index (around the average increase during the boom episodes) increases output close to 1% with respect to trend output.[18]

The exchange rate regime is negatively associated to the output gap, which indicates that the more flexible exchange rate regimes are associated with more moderate output dynamics. In particular, according to our estimations, freely floating regimes in our sample experienced an output level (with respect to trend GDP) close to 2.5% lower than de facto peg regimes.[19] The interaction of the exchange rate classification variable and the change in the commodity price index is not significant in our specifications. Also, the depth of financial markets is associated to more stable output gap dynamics. These results are not affected when we exclude from the analysis the most recent boom episodes.

The second set of regressions we study replaces the output gap variable with the rate of investment to GDP (see table 4). It can be argued that the investment rate may be a better variable to study the interaction of financial constraints and commodity price shocks, so a closer look may be worthwhile. We find that an increase in the commodity price index is positively associated to the investment rate. In particular, an increase of 60% in the price index is associated to an increase of the investment rate of around 3.5 percentage points.

We do not find a significant impact of the exchange rate regime on the investment rate. This result may be reasonable given that we are using the investment rate as the variable of interest. If the exchange rate regime tends to stabilize output and investment levels by a similar magnitude,

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[18] We use for this computation the average for the statistically significant coefficients computed in table 3 for the response of changes in the output gap to changes in the commodity price index during the episode.
[19] A freely floating regime take a value of 13 while a de facto peg regime takes a value of 3. We use for this computation the average for the statistically significant coefficients computed in table 3 for the response of changes in the output gap to the exchange rate flexibility variable.

we should expect a non-significant coefficient when we estimate the effect of the exchange rate regime on the investment rate.

Interestingly, we do not find a significant direct impact of financial depth on the investment rate. Nonetheless, we do find a significant impact of the interaction term between the commodity price increase and our measure of financial depth (rule of law). According to these results, the investment rate of the countries with the highest financial depth in our sample is not affected by the commodity price shock. The impact of commodity price shocks is higher for countries with less developed financial market, consistent with our theoretical framework. The estimations that exclude the most recent boom episodes yield similar results to the ones already discussed.

Finally, we study credit dynamics during our commodity price episodes (see table 5). In particular, we study the determinants of the change in domestic credit to the private sector (as % of GDP) in these episodes. Our results are less significant than the previous ones. Nonetheless, they indicate that for episodes before the 2000s a commodity price increase has a positive impact on credit, but this effect is reduced by the interaction of the commodity price shock and financial market depth.

For the sample of commodity price episodes obtained using the production-based commodity price index the results are similar to those obtained using the export-based commodity price index. These results are reported in the first three panels of table 7.

B. Real exchange rate adjustment to commodity price shocks and international reserve accumulation

In this subsection we study how the real exchange rate adjusts to the commodity price increase during our boom and bust episodes. The mechanisms through which commodity price shocks affect the economy in general, and the real exchange rate in particular, are varied. In the theoretical section we provided a general framework to analyze the impact of those shocks in the economy. In this general open economy framework, a positive commodity price shock tends to appreciate the real exchange rate and the impact on the real exchange rate is larger when the exchange rate regime is more flexible.

In this empirical subsection we add one factor that has received significant attention, though there is little agreement on its effect: international reserves accumulation as a proxy for foreign exchange interventions.

Aizenman, Edwards and Riera-Crichton (2011) study whether active management of international reserves affects the transmission of international price shocks to real exchange rates, using a sample of Latin American countries. They provide evidence that indicates that active reserve management lowers the short-run impact of terms of trade shocks on the real exchange rate and affects its long-run adjustment. Adler and Tovar (2011), using a panel for 15 countries, find that sterilized interventions can slow the pace of appreciation, although the effect decreases rapidly with the degree of capital account openness. They document that interventions appear to be more effective when there are signs that the currency could already be overvalued.

We also control for the role played by the degree of capital account openness and political risk. Political risk is used as a proxy for the political economy dimension of macroeconomic adjustment to commodity price shocks, as discussed by Céspedes and Velasco (2011). In particular, in that work we study the impact of the political economy process on fiscal outcomes. As long as fiscal outcomes affect the exchange rate determination, there should be a link between political economy variables and the exchange rate dynamics.

Using the commodity price episodes described in the previous section we run the following regression:

$$\Delta RER_i = f\left(\Delta COM_i, \Delta R_i, ERR_i, RL_i, POL_i, KAO_i\right)$$

where ΔRER_i is the percent change of the average real exchange rate during the episode *i* with respect to the average real exchange rate in the two years prior to the beginning of episode *i*. A positive value for this variable means an appreciation of the real exchange rate. ΔR_i is the difference between average international reserves (as % of GDP) during the commodity boom episode and average international reserves (as % of GDP) in the two years prior to the beginning of episode *i*. The remaining variables correspond to the ones described in the previous subsection.

In our analysis we do not use foreign exchange interventions but rather changes in international reserves. We know that reserves vary not only due to foreign exchange interventions, but also due to valuation changes and income flows, and debt operations on behalf of other agents, among other reasons. However, this is likely to be a major problem in estimations using high frequency time series. This problem should be less intense in our episode approach.

Results are reported in table 6. The results indicate that there is a significant impact of the commodity terms of trade on the real exchange rate. For the whole sample, a ten percent increase in the commodity price index is associated with an appreciation of around 1.3 percent. This coefficient is in the lower range of the results estimated in previous studies (see Chen and Rogoff (2004), Cashin, Céspedes, and Sahay (2004), and Ricci, Milesi-Ferretti and Lee (2008), among others).

We find a significant impact of reserve accumulation on real exchange rate dynamics. Our estimations indicate that the accumulation of international reserves tends to reduce the appreciation of the real exchange rate. Acknowledging the endogeneity problem that arises in this estimation from the simultaneity between the intervention decision and the contemporaneous exchange rate, it is important to notice that that endogeneity problem leads to obtaining a small and incorrectly signed coefficient on contemporaneous interventions (see Kearns and Rigobon (2005)). This is not the case in our estimations.

The negative coefficient between the real exchange rate change and the accumulation of international reserves may be explained by the fact that less flexible exchange rate regimes must accumulate international reserves in order to keep the parity. We control for the flexibility of the exchange rate regime in order to determine if the significance of this result is reduced when controlling for the exchange rate regime classification. Nonetheless, the results hold. In particular, our results indicate that an accumulation of 10% of GDP in international reserves tends to depreciate the real exchange rate by 5%.

Moreover, we find that countries with less open capital accounts exhibit a more depreciated real exchange rate. Finally, countries with more stable political systems tend to exhibit a more depreciated real exchange rate. Interestingly, our results indicate that the interaction between political stability and the commodity price change is significant, indicating that the impact of commodity price shocks on the real exchange rate is reduced when the political system is more stable. If government expenditure is more intensive in non-traded goods, this result may be connected to the one obtained in Céspedes and Velasco (2011), which indicates that more stable political systems tend to reduce the impact of commodity price shocks on government expenditure.[20]

IV. Final remarks

In this paper we characterize the response of different macroeconomic variables during episodes of large commodity price shocks. These shocks represent a significant challenge for macroeconomic policy. Commodity price movements generate wealth effects, which in turn affect the exchange rate and aggregate demand. How to manage monetary and fiscal policies to reduce this macroeconomic volatility is therefore a key question.

As discussed by Céspedes and Velasco (2011), the implementation of a credible fiscal rule may help to reduce the impact of these shocks on output volatility. The right institutional setup also helps. Here we provide evidence that indicates that the impact of commodity price shocks on the real exchange rate is reduced when the political system is more stable. If due to political economy reasons –such as those discussed by Céspedes and Velasco (2011) and referenced therein— a more stable political system tends to reduce the impact of commodity price shocks on government expenditure, then it should also reduce the appreciation of the real exchange rate during those episodes.

The monetary policy regime can also play a crucial role. We find that more flexible exchange rate regimes tend to be associated with more stable output dynamics. But at the same time, international reserve accumulation tends to reduce the impact of commodity price shocks on the

[20] The results obtained using the production-based commodity price index are similar to the ones obtained using the export-based commodity price index. They are presented in the last panel of table 7.

real exchange rate. These two results together suggest that a mix of a more flexible exchange rate regime (associated to an inflation targeting regime) with exchange rate interventions should help reduce macroeconomic volatility.

De Gregorio and Labbé (2011) report similar findings. They construct a dynamic stochastic general equilibrium model of a small open emerging-market economy to analyze the effects of a commodity price shock on economic activity. They find that a monetary policy rule for the interest rate that responds to exchange rate movements in the context of a commodity price shock tends to reduce the volatility of exports, yet it increases the volatility of overall output and inflation. They also argue that the combination of a monetary policy rule that targets inflation, coupled with occasional exchange rate interventions, can lead to more stable inflation and output dynamics.

Alternatively, Frankel (2010) proposes a monetary policy regime for small countries where a single commodity makes up a large share of national production and exports: targeting the domestic-currency price of exports. Under this framework, a commodity price shock should be compensated by an appreciation of the nominal exchange rate in order to achieve the stabilization of export prices in domestic currency. Notice, however, that under this framework the competitiveness of other tradable goods industries could be reduced by the appreciation, giving rise to classic Dutch disease concern.

We also provide evidence that the impact of commodity price shocks on output and investment tends to be larger for economies with less developed financial markets. We find that financial depth tends to reduce the impact of commodity price shocks on investment. The role of financial market depth in the transmission of shocks is not new. What is new is its importance in countries subject to commodity price volatility.

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Figure 1A: Determination of Equilibrium in a Financially Unconstrained Economy

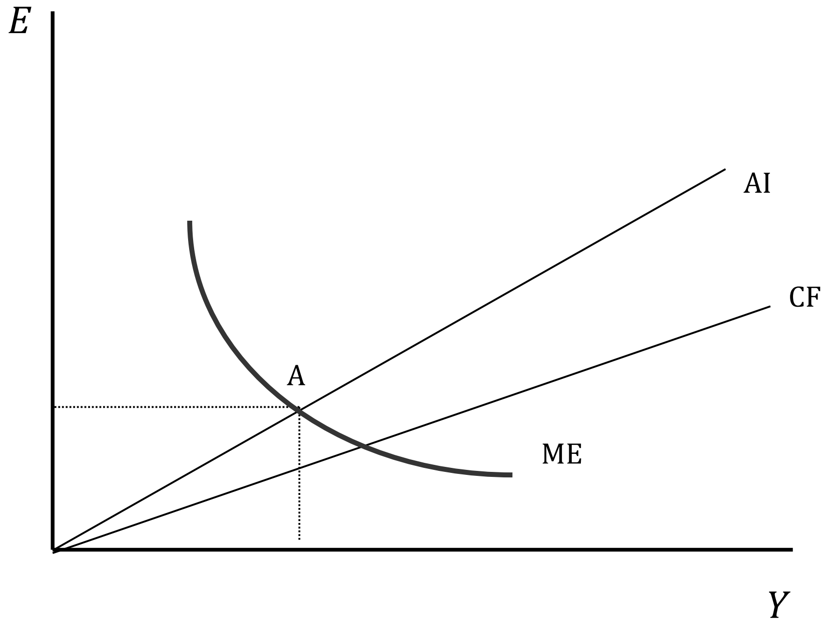

Figure 1B: Export Demand Increase in a Financially Unconstrained Economy

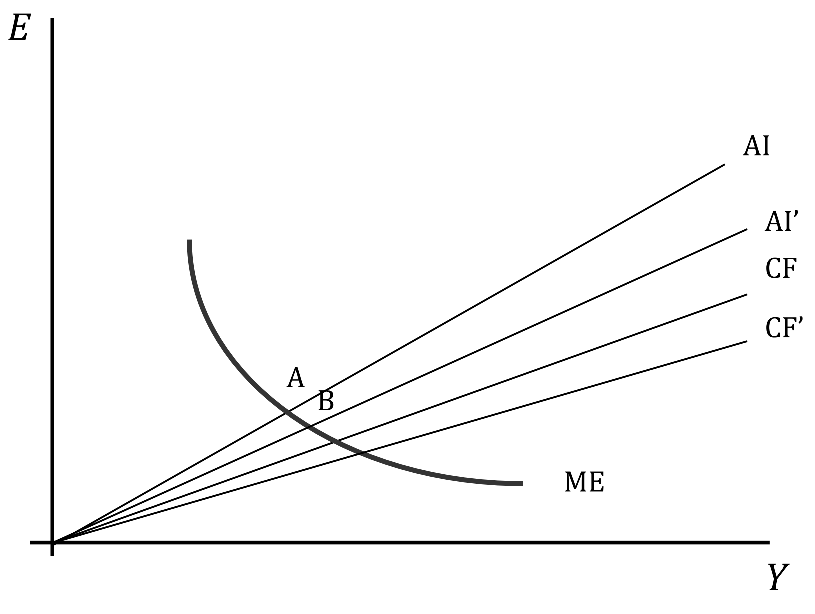

Figure 2A: Determination of Equilibrium in a Financially Constrained Economy

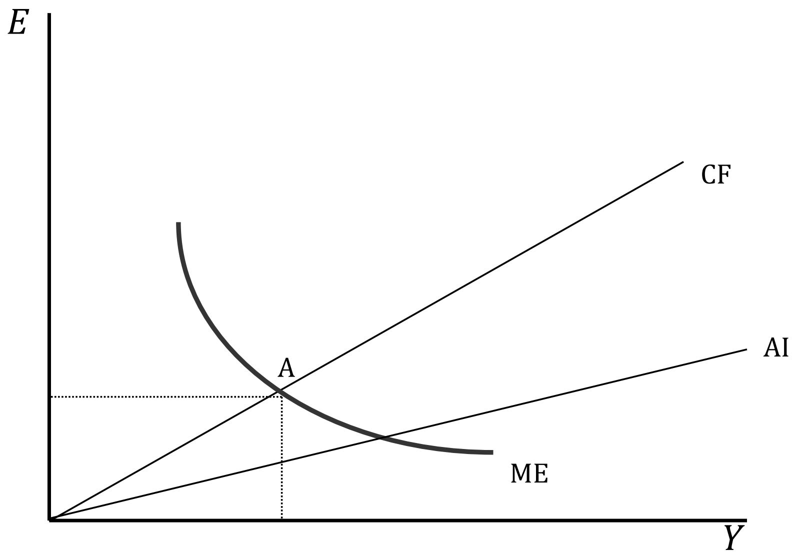

Figure 2B: Terms of Trade Drop in a Financially Constrained Economy

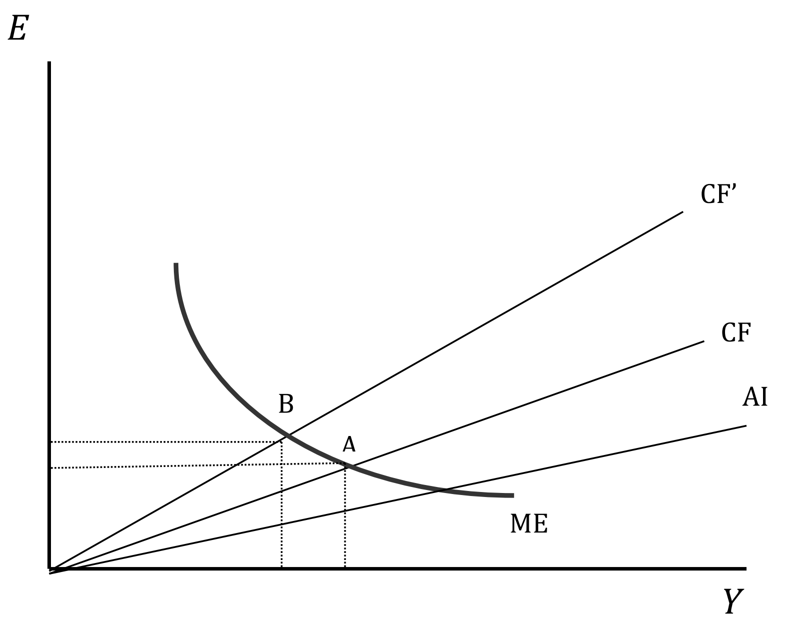

Figure 3: Commodity Price Episodes

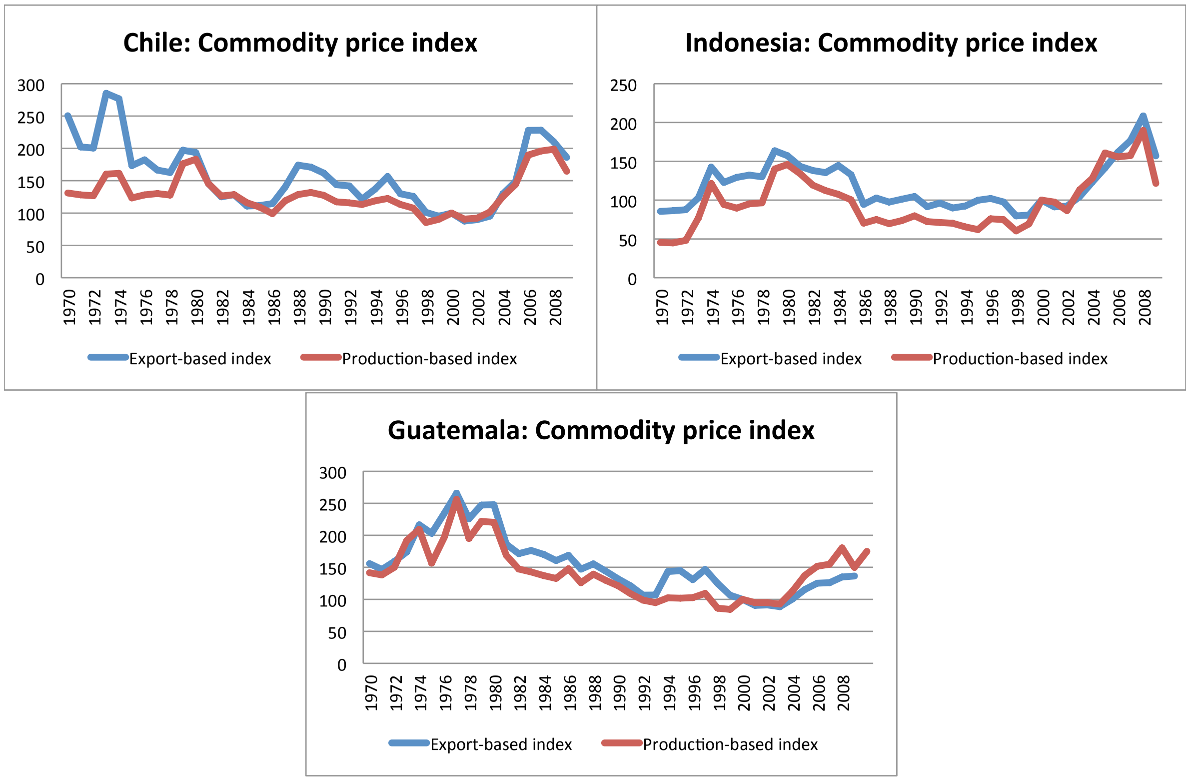

Table1a: Episodes Using Production-Based Index

Episode	Start	End	Duration	Maximum	Duration to Maximum	Commodity price index increase*
Booms						
Argentina	1973	1985	13	1980	8	36.2%
Argentina	2003	2009	7	2008	6	52.7%
Australia	1973	1985	13	1980	8	48.8%
Australia	2004	2009	6	2008	5	31.3%
Bolivia	1973	1985	13	1980	8	73.4%
Bolivia	2003	2009	7	2008	6	52.7%
Brazil	1973	1981	9	1980	8	29.2%
Brazil	2007	2009	3	2008	2	17.1%
Canada	1973	1985	13	1980	8	67.9%
Canada	2003	2009	7	2008	6	57.3%
Chile	1970	1983	14	1980	11	18.1%
Chile	2006	2009	4	2008	3	44.6%
Cameroon	1974	1985	12	1979	6	91.2%
Cameroon	2005	2009	5	2008	4	66.3%
Colombia	1973	1985	13	1980	8	67.8%
Colombia	2005	2009	5	2008	4	44.0%
Costa Rica	1977	1980	4	1980	4	28.0%
Denmark	2005	2009	5	2008	4	66.8%
Dominican Republic	1973	1977	5	1974	2	71.9%
Ecuador	1974	1985	12	1980	7	92.2%
Ecuador	2005	2009	5	2008	4	68.1%
Ghana	1977	1984	8	1980	4	40.9%
Ghana	1987	1988	2	1988	2	14.8%
Ghana	2007	2009	3	2008	2	28.0%
Guatemala	1973	1980	8	1977	5	40.3%
Indonesia	1974	1985	12	1980	7	78.5%
Indonesia	2003	2009	7	2008	6	64.0%
India	1973	1975	3	1974	2	110.6%
India	1979	1983	5	1980	2	52.4%
India	2006	2009	4	2008	3	30.5%
Iran	1974	1985	12	1980	7	226.2%
Iran	1990	1992	3	1990	1	17.6%
Iran	2003	2009	7	2008	6	77.8%
Jamaica	1974	1975	2	1974	1	40.7%
Kuwait	1974	1985	12	1980	7	270.7%
Kuwait	1990	1992	3	1990	1	18.5%
Kuwait	2004	2009	6	2008	5	86.1%
Mexico	1974	1985	12	1980	7	94.1%
Mexico	2004	2009	6	2008	5	73.9%
Malaysia	1974	1985	12	1980	7	112.1%
Malaysia	2003	2009	7	2008	6	64.5%
Nigeria	1974	1985	12	1980	7	155.1%
Nigeria	1990	1991	2	1990	1	16.5%
Nigeria	2004	2009	6	2008	5	82.4%
Norway	1974	1990	17	1980	7	103.9%
Norway	2004	2009	6	2008	5	71.4%
New Zealand	1977	1985	9	1980	4	82.3%
New Zealand	2003	2009	7	2008	6	40.6%
Peru	1974	1985	12	1980	7	69.9%
Peru	2005	2009	5	2008	4	60.0%
Paraguay	1973	1974	2	1973	1	26.2%
Paraguay	1979	1981	3	1980	2	26.9%
Russia	1973	1993	21	1980	8	124.6%
Russia	2000	2009	10	2008	9	114.0%
Saudi Arabia	1974	1985	12	1980	7	269.0%
Saudi Arabia	1990	1992	3	1990	1	18.9%
Saudi Arabia	2004	2009	6	2008	5	83.8%
Trinidad & Tobago	1974	1987	14	1980	7	222.8%
Trinidad & Tobago	1990	1993	4	1990	1	20.3%
Trinidad & Tobago	2000	2009	10	2008	9	119.3%
Uruguay	1977	1980	4	1980	4	84.5%
Venezuela	1973	1985	13	1980	8	235.4%
Venezuela	1990	1992	3	1990	1	15.4%
Venezuela	2004	2009	6	2008	5	79.2%
South Africa	1973	1990	18	1980	8	73.7%
South Africa	2006	2009	4	2008	3	28.5%
Average						74.1%

(*): Commodity price increase corresponds to the percent change in the average commodity price index during the episode (start to maximum) with respect to average commodity price index in the two years previous to the beginning of the episode.

Table1b: Episodes Using Production-Based Index

Episode	Start	End	Duration	Minimum	Duration to Minimum	Commodity price index fall*
Busts						
Argentina	1998	1999	2	1998	1	-12.5%
Bolivia	1998	1999	2	1998	1	-10.4%
Brazil	1998	2003	6	1998	1	-4.2%
Chile	1998	2003	6	1998	1	-15.5%
Cameroon	1998	1999	2	1998	1	-19.0%
Colombia	1998	1999	2	1998	1	-16.4%
Denmark	1998	1999	2	1998	1	-20.0%
Dominican Republic	1984	1987	4	1985	2	-16.8%
Ecuador	1998	1999	2	1998	1	-19.2%
Ghana	1998	2003	6	2001	4	-18.2%
Indonesia	1998	1999	2	1998	1	-15.9%
India	1998	2003	6	1999	2	-14.1%
Iran	1998	1999	2	1999	2	-17.9%
Kuwait	1998	1999	2	1998	1	-20.4%
Mexico	1998	1999	2	1998	1	-17.8%
Malaysia	1998	1999	2	1998	1	-14.7%
Nigeria	1998	1999	2	1998	1	-19.6%
Norway	1998	1999	2	1998	1	-16.7%
Peru	1998	1999	2	1998	1	-18.8%
Saudi Arabia	1998	1999	2	1998	1	-19.8%
Venezuela	1998	1999	2	1998	1	-18.7%
Average						-16.5%

(*): Commodity price fall corresponds to the percent change in the average commodity price index during the episode (start to minimum) with respect to average commodity price index in the two years previous to the beginning of the episode.

Table2a: Episodes Using Export-Based Index

Episode	Start	End	Duration	Maximum	Start to Maximum	Commodity price index increase*
Booms						
Argentina	1974	1985	12	1980	7	14.6%
Argentina	2005	2009	5	2008	4	20.5%
Australia	1974	1990	17	1980	7	16.1%
Australia	2006	2009	4	2008	3	33.0%
Algeria	1974	1993	20	1980	7	88.5%
Algeria	2000	2009	10	2008	9	127.2%
Australia	1974	1990	17	1980	7	16.1%
Australia	2006	2009	4	2008	3	33.0%
Bahrain	2004	2009	6	2008	5	79.3%
Belarus	2004	2009	6	2008	5	64.4%
Bolivia	1973	1992	20	1980	8	37.7%
Bolivia	2005	2008	4	2008	4	32.9%
Botswana	1979	1980	2	1980	2	23.4%
Botswana	2006	2008	3	2008	3	47.1%
Bulgaria	2005	2009	5	2008	4	67.1%
Canada	1974	1992	19	1980	7	34.8%
Canada	2003	2009	7	2008	6	47.3%
Chile	1979	1980	2	1980	2	18.7%
Chile	2006	2009	4	2008	3	59.5%
Cameroon	1974	1985	12	1979	6	89.9%
Cameroon	2005	2009	5	2008	4	41.9%
Colombia	1974	1987	14	1980	7	108.5%
Colombia	2005	2009	5	2008	4	46.3%
Cote d'Ivoire	1973	1981	9	1977	5	93.5%
Croatia	2004	2009	6	2008	5	43.5%
Denmark	1974	1985	12	1980	7	41.8%
Denmark	2006	2009	4	2008	3	27.6%
Dominican Republic	1974	1985	12	1980	7	96.8%
Dominican Republic	2006	2009	4	2008	3	27.0%
Ecuador	1974	1985	12	1979	6	82.5%
Ecuador	2006	2009	4	2008	3	43.2%
Egypt, Arab Rep.	1974	1985	12	1980	7	127.0%
Egypt, Arab Rep.	1990	1991	2	1990	1	12.8%
Egypt, Arab Rep.	2006	2009	4	2008	3	53.7%
El Salvador	1974	1981	8	1980	7	52.4%
Georgia	2006	2009	4	2008	3	31.0%
Ghana	1973	1988	16	1980	8	99.0%
Guatemala	1974	1981	8	1980	7	40.7%
Honduras	1976	1980	5	1977	2	18.1%
Indonesia	1974	1985	12	1980	7	46.5%
Indonesia	2004	2009	6	2008	5	65.1%
India	1974	1985	12	1980	7	18.9%
Iran	1974	1985	12	1980	7	201.9%
Iran	1990	1991	2	1990	1	21.0%
Iran	2004	2009	6	2008	5	88.7%
Kazakhstan	2005	2009	5	2008	4	69.7%
Kuwait	1974	1985	12	1980	7	192.7%
Kuwait	2004	2009	6	2008	5	88.2%
Lithuania	2004	2009	6	2008	5	55.0%
Mexico	1974	1985	12	1980	7	133.4%
Mexico	1990	1991	2	1990	1	14.8%
Mexico	2004	2009	6	2008	5	77.4%
Malaysia	1974	1985	12	1980	7	48.0%
Malaysia	2004	2009	6	2008	5	50.8%
Mongolia	2006	2009	4	2008	3	47.0%
Morocco	1974	1985	12	1979	6	49.4%
Morocco	2005	2009	5	2008	4	46.1%
Nigeria	1974	1985	12	1980	7	206.2%
Nigeria	1990	1992	3	1990	1	17.1%
Nigeria	2005	2009	5	2008	4	89.3%
Norway	1974	1992	19	1980	7	114.6%
Norway	2004	2009	6	2008	5	74.2%
New Zealand	1977	1991	15	1980	4	15.4%
Oman	1974	1987	14	1980	7	165.1%
Oman	1990	1992	3	1990	1	14.1%
Oman	2004	2009	6	2008	5	84.6%
Peru	1973	1984	12	1980	8	52.7%
Peru	2006	2009	4	2008	3	55.0%
Paraguay	1973	1974	2	1973	1	60.1%
Pakistan	1973	1975	3	1974	2	63.6%
Philippines	1974	1985	12	1980	7	23.0%
Philippines	2006	2009	4	2008	3	32.5%
Russia	1974	1992	19	1980	7	85.1%
Russia	2004	2009	6	2008	5	70.8%
Saudi Arabia	1974	1985	12	1980	7	210.5%
Saudi Arabia	1990	1992	3	1990	1	17.2%
Saudi Arabia	2004	2009	6	2008	5	89.6%
Thailand	1974	1981	8	1980	7	25.9%
Trinidad & Tobago	1974	1985	12	1980	7	135.2%
Trinidad & Tobago	2003	2009	7	2008	6	80.0%
Tunisia	1974	1985	12	1980	7	105.8%
Tunisia	1990	1991	2	1990	1	15.8%
Tunisia	2004	2009	6	2008	5	55.8%
Ukraine	2006	2009	4	2008	3	30.5%
United Arab Emirates	2004	2009	6	2008	5	84.9%
Uruguay	1977	1981	5	1980	4	16.0%
Venezuela	1974	1985	12	1980	7	191.6%
Venezuela	1990	1992	3	1990	1	13.8%
Venezuela	2004	2009	6	2008	5	86.0%
Vietnam	2005	2009	5	2008	4	61.0%
South Africa	1974	1985	12	1980	7	35.9%
South Africa	2006	2009	4	2008	3	32.8%
Average						63.7%

(*): Commodity price increase corresponds to the percent change in the average commodity price index during the episode (start to maximum) with respect to average commodity price index in the two years previous to the beginning of the episode.

Table2b: Episodes Using Export-Based Index

Episode	Start	End	Duration	Minimum	Duration to Minimum	Commodity price index fall*
Busts						
Argentina	1998	1999	2	1998	1	-23.1%
Bahrain	1998	1999	2	1998	1	-18.6%
Belarus	1998	1999	2	1998	1	-19.5%
Botswana	1998	2003	6	2001	4	-20.9%
Brazil	1999	2004	6	2001	3	-14.6%
Chile	1998	2003	6	2001	4	-25.8%
Cameroon	1998	1999	2	1998	1	-19.8%
Colombia	1998	1999	2	1998	1	-19.8%
Croatia	1998	1999	2	1998	1	-19.7%
Denmark	1998	1999	2	1998	1	-24.4%
Ecuador	1998	1999	2	1998	1	-16.0%
Egypt, Arab Rep.	1998	1999	2	1998	1	-20.5%
Ghana	1999	2005	7	2000	2	-10.4%
India	1998	2003	6	2001	4	-14.2%
Iran	1998	1999	2	1999	2	-20.6%
Kuwait	1998	1999	2	1998	1	-20.6%
Mexico	1998	1999	2	1998	1	-20.2%
Morocco	1998	1999	2	1998	1	-16.1%
Nigeria	1998	1999	2	1998	1	-20.6%
Norway	1998	1999	2	1998	1	-19.3%
Philippines	1999	2003	5	1999	1	-11.1%
Russia	1998	1999	2	1998	1	-20.0%
Saudi Arabia	1998	1999	2	1998	1	-20.6%
South Africa	1998	2003	6	1998	1	-14.6%
Venezuela	1998	1999	2	1998	1	-20.2%
Average						-18.8%

(*): Commodity price fall corresponds to the percent change in the average commodity price index during the episode (start to minimum) with respect to average commodity price index in the two years previous to the beginning of the episode.

Table 3: Output dynamics in commodity price boom and bust episodes

Explanatory variable	Dependent variable: change in output gap							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Commodity price index change	0.019 (2.33)**	0.016 (2.06)**	0.013 (1.58)	0.013 (1.64)*	0.012 (1.34)	0.021 (1.44)	0.012 (1.60)	0.006 (0.71)
Exchange rate flexibility		-0.002 (-2.01)**	-0.003 (-2.47)**	-0.003 (-2.49)**	-0.002 (-1.94)*	-0.002 (-1.40)*	-0.003 (-1.96)*	-0.004 (-2.64)**
Rule of Law			-0.005 (-2.15)**	-0.007 (-1.58)	-0.007 (-2.41)**	-0.005 (-2.15)**		-0.008 (-2.46)**
Politics				0.000 (0.51)				
Capital account openness					0.005 (1.37)			
Exchange rate flexibility*commodity price index change						-0.001 (-0.71)		
R2	0.06	0.08	0.11	0.12	0.14	0.12	0.09	0.16
Number of observations	117	107	106	106	83	106	69	70
F test	5.43**	3.67**	5.62***	4.22***	4.07***	4.35***	2.79*	6.50***
Sample	All	All	All	All	All	All	Excluding recent episodes	Excluding recent episodes

Al regressions are estimated using a constant, t test in parenthesis. Export-based commodity price index.
(***);(**);(*), significance levels at 1%,5% and 10% respectively.

Table 4: Investment dynamics in commodity price boom and bust episodes

Explanatory variable	Dependent variable: change in rate of investment as a percentage of GDP						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Commodity price index change	0.038 (2.77)***	0.045 (3.73)***	0.036 (2.65)***	0.098 (3.19)***	0.088 (2.52)**	0.044 (3.01)***	0.117 (3.85)***
Exchange rate flexibility	0.000 (0.16)		0.000 (0.08)		0.000 (0.15)		
Rule of Law		-0.003 (-1.26)	-0.004 (-1.29)	0.002 (0.59)	0.001 (0.41)	-0.005 (-1.53)	0.001 (0.21)
Rule of law*commodity price index change				-0.015 (-2.23)**	-0.015 (-1.96)*		-0.022 (-3.32)***
R2	0.14	0.21	0.15	0.24	0.19	0.24	0.33
Number of observations	93	101	93	101	93	65	65
F test	4.29***	8.00***	3.57**	7.10***	3.45**	6.75***	6.65***
Sample	All	All	All	All	All	Excluding recent episodes	Excluding recent episodes

Al regressions are estimated using a constant, t test in parenthesis. Export-based commodity price index.
(***);(**);(*), significance levels at 1%,5% and 10% respectively.

Table 5: Domestic credit dynamics in commodity price boom and bust episodes

Explanatory variable	Dependent variable: change in rate of domestic credit to private sector as a percentage of GDP (1)	(2)	(3)	(4)	(5)	(6)	(7)
Commodity price index change	0.004	0.013	0.012	0.050	0.045	0.006	0.063
	(0.37)	(1.23)	(1.02)	(1.90)*	(1.82)*	(0.55)	(2.63)**
Exchange rate flexibility	-0.004		-0.003		-0.003		-0.004
	(-1.57)		(-1.18)		(-1.27)		(-1.58)
Rule of Law		0.014	0.013	0.018	0.017	0.008	0.012
		(2.22)**	(2.07)*	(2.90)***	(2.68)***	(1.73)*	(2.32)**
Rule of law*commodity price index change				-0.011	-0.010		-0.020
				(-1.34)	(-1.21)		(-2.73)***
R2	0.02	0.05	0.06	0.06	0.07	0.04	0.12
Number of observations	105	113	104	113	104	75	68
F test	1.25	2.57*	2.16*	3.31**	2.48**	1.51	3.52**
Sample	All	All	All	All	All	Excluding recent episodes	Excluding recent episodes

Al regressions are estimated using a constant, t test in parenthesis. Export-based commodity price index.
(***);(**);(*), significance levels at 1%,5% and 10% respectively.

Table 6: Real exchange rate adjustment in commodity price boom and bust episodes

Explanatory variable	Dependent variable: change in real exchange rate (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Commodity price index change	0.121	0.125	0.126	0.124	0.141	0.155	0.140	0.470	0.446
	(2.41)**	(2.20)**	(2.47)**	(2.31)**	(2.71)***	(2.48)**	(2.48)**	(2.67)***	(2.34)**
Exchange rate flexibility		-0.007				-0.004	-0.002		
		(-1.31)				(-0.85)	(-0.29)		
Rule of Law			0.011						
			(0.98)						
International reserves change					-0.415	-0.426	-0.470	-0.291	-0.256
					(-2.56)**	(-2.09)**	(-2.61)**	(-1.83)*	(-0.87)
Capital account openness				0.030		0.023	0.033	0.030	0.038
				(2.22)**		(1.88)*	(2.39)**	(2.39)**	(2.35)**
Politics							-0.003	0.001	0.000
							(-1.83)*	(0.52)	(0.06)
Politics*Commodity price index change								-0.006	-0.006
								(-2.22)**	(-1.87)*
R2	0.12	0.14	0.13	0.20	0.17	0.26	0.26	0.31	0.37
Number of observations	108	100	107	89	105	78	87	86	61
F test	5.83**	3.40**	3.26**	5.14***	5.21***	2.97**	3.07**	2.63**	2.39**
Sample	All	All	All	All	All	All	All	All	Excluding recent episodes

Al regressions are estimated using a constant, t test in parenthesis. Export-based commodity price index.
(***);(**);(*), significance levels at 1%,5% and 10% respectively.

Table 7: Macroeconomic dynamics in commodity price boom and bust episodes

	Dependent variable											
	Change in output gap			Change in rate of investment as a percentage of GDP			Change in rate of domestic credit to private sector as a percentage of GDP			Change in real exchange rate		
Explanatory variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Commodity price index change	0.023	0.024	0.014	0.040	0.036	0.090	0.023	0.029	0.093	0.131	0.113	0.135
	(2.27)**	(2.16)**	(0.80)	(3.09)***	(2.26)**	(2.70)***	(1.71)*	(1.85)*	(2.25)**	(2.16)**	(2.13)**	(2.41)**
Exchange rate flexibility		-0.001	-0.001		0.000			0.003		-0.005		
		(-0.43)	(-0.43)*		(0.35)			(1.00)		(-0.81)		
Rule of Law		-0.009	-0.002	-0.003	-0.002	0.004	0.023	0.024	0.033			
		(-1.71)*	(-0.53)	(-0.86)	(-0.61)	(0.81)	(2.43)**	(2.34)**	(3.10)***			
Politics		0.001										
		(1.41)										
Capital account openness											0.038	0.032
											(2.50)**	(2.35)**
International reserves change												-0.438
												(-2.25)**
Exchange rate flexibility*commodity price index			0.001									
			(0.48)									
Rule of law*commodity price index change						-0.015			-0.021			
						(-1.85)*			(-1.85)*			
R2	0.07	0.09	0.07	0.18	0.14	0.22	0.09	0.09	0.1	0.04	0.22	0.26
Number of observations	87	81	81	74	70	74	84	79	84	80	82	78
F test	5.14**	2.11*	1.28	4.98***	1.86	4.70***	3.14**	1.98	3.30**	3.29**	5.67***	4.40***
Sample	All	All	All	All	All	All	All	All	All	All	All	All

Al regressions are estimated using a constant, t test in parenthesis. Production-based commodity price index.
(***);(**);(*), significance levels at 1%,5% and 10% respectively.