Real Exchange Rates, Commodity Prices and Structural Factors in Developing Countries

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REAL EXCHANGE RATES, COMMODITY PRICES AND STRUCTURAL FACTORS IN DEVELOPING COUNTRIES[1]

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Abstract

This paper provides new empirical evidence about the relationship that may exist between real exchange rates and commodity prices in developing countries that are specialized in the export of a main primary commodity. It investigates how structural factors like the exchange rate regime, the degree of financial and trade openness, the degree of export concentration and the type of the commodity exports affect the strength of the commodity price-real exchange rate dependence.

Keywords: Real exchange rates * commodity prices * exchange rate regime * financial openness * panel analysis.

JEL Classification: C32, C33, E31, F32, 011.

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1 Introduction

This paper provides new empirical evidence about the relationship that may exist between real exchange rates and commodity prices in developing countries that are specialized in the export of a main primary commodity. It is largely documented that for many developing countries that are dependent on the production of primary commodities, commodity price shocks may have important economic implications, either positive or negative[1]. As shown by the literature on the "Dutch disease"[2], the principal channel through which commodity price shocks may affect a country's economic performances is the real exchange rate. For that reason, the dependence of real exchange rates on commodity prices (or, more generally, on terms of trade) has been the subject of numerous empirical studies, that usually find that increases in the world price of commodity prices are associated with an appreciation of the real exchange rate[3]. With a very few exceptions, the focus of these studies is strictly limited to the estimation of the real exchange rate response to commodity price shocks. However, what determines the magnitude of the real exchange rate reaction is not examined in these studies. It is the purpose of our paper to fill this gap. We do that by exploring the role played by several structural factors in shaping the real exchange rate - commodity price relationship.

Our analysis focuses on five structural features : the exchange rate regime, the degree of financial openness, the degree of trade openness, the degree of export diversification and the type of the main commodity exported by the country. From a policy stand point, understanding the role of these factors is particularly important given that many developing countries have been or are faced with questions such as which exchange rate regime to choose, how and by how much open the capital account, and whether and how reduce the concentration of exports on a few products. As shown in the next Section, the choice of these factors is also dictated by theoretical considerations.

Despite its narrow focus, our analysis is at the cross-section of two important topics of the literature about the determinants of economic growth in developing countries. As reminded above, the first one is about the impact that commodity price shocks may have on the economic performances of developing countries that are specialized in the export

[1] For instance, the literature on the "Natural Resource Curse" suggests that increases in commodity prices have adverse, rather than positive, effects on the economic growth of commodity producing countries. For a recent survey on this topic, see Frankel (2010)

[2] The term "Dutch disease" usually refers to the decline in the production of several sectors that is caused by a favorable shock such as a large natural resource discovery or a rise in the world market price of a primary commodity. The main source of the decline in sectoral output is an appreciation of the real exchange rate. For a nice non-technical discussion of the "Dutch disease" phenomenon, see Brahmbhatt, Canuto, and Vostroknutova (2010). For more detailed analyses, see Corden (1984) and Corden and Neary (1982).

[3] Recent studies are Chen and Rogoff (2003), Broda (2004), Cashin, Cespedes, and Sahay (2004), Coudert, Couharde, and Mignon (2008) and Bodart, Candelon, and Carpantier (2011). Coudert, Couharde, and Mignon (2008) provides a comprehensive survey of these studies.

of primary products as many small African countries are. The second topic is about the influence of structural factors such as the exchange rate regime or the degree of financial openness on economic growth.

Existing empirical evidence on what determines the strength of the real exchange rate - commodity price relationship is very scarce. To our knowledge, it is almost limited to Broda (2004) who examines whether the response of real exchange rates to terms-of-trade shocks differ systematically across exchange rate regimes[4]. He shows that in response to a fall in terms-of-trade, there is a small and slow depreciation of the real exchange rate in developing countries with a currency peg but a large and immediate real exchange rate depreciation in country where the exchange rate is floating. His analysis also concludes that the response of the real exchange rate does not differ significantly across regimes when the terms-of-trade shock is positive. The role played by structural factors in shaping the relationship between real exchange rates and commodity prices is also evoked by Chen and Rogoff (2003) who estimate such a relationship for Australia, Canada and New Zealand. They find that the relation is strong for Australia and New Zealand but less robust for Canada, and they suggest that this difference is due to the fact that the Canadian dollar is de facto tied to the US dollar, while the Australia and NZ dollars are floating. A second explanation that they put forward is that commodities constitute a smaller share of the Canadian exports compared to Australia and New Zealand. Their tentative explanations are however not tested formally.

Admittedly, the issue that we intend to explore in this paper is empirically relevant only if there is enough variation across countries about the impact of commodity prices on real exchange rates. Evidence in support of our analysis is provided in Table 1 where we report, for 33 developing countries that produce a primary commodity that counts for at least 20 percent of their total exports, estimates of the long-run (cointegrating) relationship between their real exchange rate and the world market price of their main commodity export. The estimates of the long-run commodity price elasticity of the real exchange rate are significant for 17 countries. More importantly, we observe that they vary considerably across countries, ranging from -0.17 (Dominica Republic) to 10.39 (Ghana), with a median value of 0.21[5]. So we can proceed further with our analysis, whose purpose is thus to find out what factors explain these differences across countries.

[4]An analysis similar to that of Broda (2004) has been realized recently for 9 East Asian countries by Dai and Chia (2008). Edwards (2011) and Edwards and Yeyati (2003) also examine empirically the economic impact of terms of trade disturbances under alternative exchange rate regimes, but their evidence is limited to the impact on GDP growth.

[5]To our knowledge, the only published study that provides estimates of the commodity price elasticity of the real exchange rate for a large number of countries is Cashin, Cespedes, and Sahay (2004), who report long-run (cointegrating) elasticity estimates for 19 countries. Their elasticity estimates range from 0.16 to 2.03, with a median value of 0.42

Table 1: Data summary

	Comdty	Country	β coint	Currency Reg			Fin Opnss			Trade Opnss			Div		Cdty Type
				1	2	3	1	2	3	1	2	3	Wght	Cat	
1	Oil	Algeria	0.39	0	27	1	28	0	0	3	25	0	46.4	2	Energy
2	Oil	Bahrain	0.09	28	0	0	0	0	28	0	0	28	23.2	1	Energy
3	Coffee	Burundi	0.65***	4	23	1	28	0	0	24	4	0	54.5	3	Agri
4	Oil	Cameroon	0.03	28	0	0	18	10	0	14	14	0	40.7	2	Energy
5	Copper	Chile	0.07	2	25	1	18	3	7	1	27	0	29.7	1	Metal
6	Oil	Colombia	0.15	0	28	0	24	4	0	28	0	0	20.6	1	Energy
7	Cocoa	Cote d'Iv.	-0.13	28	0	0	18	10	0	0	26	2	34.5	2	Agri
8	Bananas	Dominica	-0.17***	28	0	0	8	20	0	0	0	28	27.8	1	Agri
9	Oil	Ecuador	0.20	10	7	11	0	24	4	0	28	0	38.6	2	Energy
10	Coffee	Ethiopia	0.00	10	18	0	28	0	0	24	4	0	47.4	2	Agri
11	Oil	Gabon	0.13*	28	0	0	12	16	0	0	9	19	74.3	3	Energy
12	Cocoa	Ghana	10.39***	0	13	15	26	2	0	8	12	8	33.7	2	Agri
13	Coffee	Honduras	0.78	5	22	1	9	19	0	0	14	14	23.5	1	Agri
14	Oil	Iran	1.59***	0	26	2	20	8	0	18	10	0	79.7	3	Energy
15	Tea	Kenya	2.95***	7	19	2	16	0	12	0	28	0	21.4	1	Agri
16	Oil	Kuwait	0.08**	5	23	0	0	0	28	0	6	22	58.7	3	Energy
17	Tobacco	Malawi	0.72***	3	12	13	27	1	0	0	26	2	58.5	3	Agri
18	Gold	Mali	1.14***	28	0	0	12	16	0	0	28	0	52.3	3	Metal
19	Fish	Mauritania	0.52**	0	28	0	27	1	0	0	9	19	33.8	2	Agri
20	Uranium	Niger	0.20***	28	0	0	12	16	0	13	15	0	40.5	2	Metal
21	Oil	Nigeria	0.48	0	18	10	15	13	0	5	22	1	95.5	3	Energy
22	Cotton	Pakistan	1.22**	2	26	0	28	0	0	28	0	0	21.1	1	Agri
23	Oil	Papua N. G.	0.06***	10	18	0	9	19	0	0	0	28	22.9	1	Energy
24	Soya	Paraguay	0.99***	0	25	3	10	9	9	4	13	11	32.7	2	Agri
25	Oil	Qatar	0.13***	28	0	0	0	0	28	0	20	8	46.1	2	Energy
26	Oil	Saudi Ar.	0.16	28	0	0	0	0	28	0	23	5	74.9	3	Energy
27	Oil	Sudan	-0.05	8	20	0	19	9	0	25	3	0	25.4	1	Energy
28	Oil	Syria	0.38*	0	28	0	28	0	0	5	23	0	54.4	3	Energy
29	Gold	Tanzania	1.87	0	25	3	25	3	0	4	24	0	22.5	1	Metal
30	Oil	UAE	0.05	27	1	0	0	0	28	0	1	27	37.8	2	Energy
31	Coffee	Uganda	0.22	3	16	9	14	4	10	25	3	0	40.7	2	Agri
32	Oil	Venezuela	0.21	3	13	12	5	15	8	2	26	0	64.4	3	Energy
33	Copper	Zambia	0.68***	1	4	23	16	0	12	0	28	0	59.7	3	Metal
Mean			0.79										43.6		
Med.			0.21										40.5		
All				352	465	107	500	222	202	231	471	222			

Notes. Beta cointegration coefficients are computed by FMOLS in a univariate setting on annual data. *, ** and *** hold for significance at 10%, 5% and 1%. Currency regime is a de facto classification into 3 categories from 1 (fix) to 3 (flexible). Since a country currency regime can change over time, figures correspond to the number of years in each regime. Financial openness, based on Kaopen index, is classified into 3 categories from 1 (closed) to 3 (open). Since financial openness can change over time, figures correspond to the number of years in each regime. Trade openness is computed by dividing the sum of exports and imports on GDP. Trade openness is classified into 3 categories from 1 (closed) to 3 (open). Since a country can change of category over time, figures correspond to the number of years in each category. The degree of diversification, proxied by the weight (in %) of the dominant commodity in the exports, is classified into 3 categories from 1 (high diversification) to 3 (low diversification). The weight average of the dominant commodity is by definition not changing over time. Commodity type refers to the nature of the commodity, from labor low intensive (energy) to labor high intensive (agricultural).

To achieve our analysis, we use panel data covering 33 small developing countries over the period 1980-2007. Our main findings can be summarized as follows. First, we find evidence that the real exchange rate of countries specialized in the production of a main primary commodity is related in the long-run to the international price of the main commodity that they export. Second, we find evidence suggesting that the long-run commodity price elasticity of the real exchange rate varies with the exchange rate regime, the degree of trade openness, the degree of export diversification and the type of the primary commodity that is exported. Conversely, our evidence suggests that the degree of financial openness does not affect the long-run response of real exchange rates to international commodity price disturbances.

The rest of the paper is structured as follows. In Section 2, we outline a simple theoretical model to illustrate how the exchange rate regime, the degree of financial and trade openness, the extent of export concentration and the type of commodity exported may affect the relation between a country's real exchange rate and the world market price of its primary commodity exports. Section 3 describes the data while the econometric methodology and the results are presented in Section 4. Conclusions and policy implications are drawn in Section 5.

2 Theoretical considerations

The purpose of this Section is to illustrate with a simple theoretical framework how structural factors like the exchange rate regime or the degree of financial openness may affect the relationship between the real exchange rate of a small commodity exporting country and the price of the main commodity exported by that country .

To do so, we present a model of a small open economy composed of a tradable and a non tradable sectors[6]. In addition of being quite standard, this model has the advantage of being simple enough to be analytically tractable but rich enough to provide interesting insights. The main features of the model are as follows. It is assumed that the economy produces two goods, a primary commodity that is not consumed locally, and a nontradable good that is only available to domestic consumer. Private agents can also consume an imported consumer good. They therefore derive their utility from the consumption of the nontradable good produced domestically and the imported good. Domestic agents take the world market price of the exported commodity and of the imported consumer good as given. As our empirical analysis is only concerned with the long-run relationship that may exist between real exchange rates and commodity prices, our model has no dynamics.[7]

[6]The model developed in this Section is derived from the model developed by Gregorio and Wolf (1994). For a detailed presentation of small open economy models with tradable and non tradable goods, see Dornbusch (1980) and Obstfeld and Rogoff (1996)

[7]As shown in details by Corden (1984), we are conscious that the conclusions delivered by small open

In what follow, the exported, nontradable and imported goods are denoted respectively by the suffix X, N, and M.

On the production side, it is assumed that the exported primary commodity (Y_x) is produced with a technology that combines labor (L_x) and capital (K_x). The production of the nontradable good (Y_n) however only requires labor (L_n). Labor is perfectly mobile across the two sectors but capital is specific to the exportable sector. The production function of the two goods is assumed to be Cobb-Douglas:

$$Y_x = a_x L_x^{\alpha} K_x^{1-\alpha} \quad (1)$$
$$Y_n = a_n L_n, \quad (2)$$

where a_x and a_n are exogenous productivity factors and $0 < \alpha < 1$.

As it is the case for many commodities, it is assumed that in the long run the domestic price of the exported good (P_x) is determined by the law of one price:

$$P_x = EP_x^*, \quad (3)$$

where E is the nominal exchange rate (defined as the number of units of domestic currency per one unit of the foreign currency) and P_x^* is the world market price of the commodity.

Let's denote w, the wage rate paid to labor, and r, the domestic rate of interest.

From standard profit maximization, we can derive the following expressions relating the price of each good to the price of the production factors:

$$P_x = \left(\frac{\psi_x}{a_x}\right) w^{\alpha} r^{1-\alpha} \quad (4)$$
$$P_n = \frac{w}{a_n}, \quad (5)$$

economy models about the determination of the real exchange rate are very much dependent on several assumptions, in particular those about the number of sectors, the technology of production in each sector and the degree of factor mobility across sectors and countries. These issues are however neglected here as our purpose is simply to have a framework that can illustrate how structural factors influence the determination of the real exchange rate.

where: $\psi_x = \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}$.

Let's now denote q, the real exchange rate defined as the ratio between the price of the nontradable good and the price of the exportable good. Combining Equation (4) and Equation (5), we obtain the following expression for q:

$$q = \frac{P_n}{P_x} = \left(P_x^{(1-\alpha)} a_x a_n^{-\alpha} \psi_x^{-1} r^{-(1-\alpha)}\right)^{\frac{1}{\alpha}}. \tag{6}$$

On the demand side, households consume two goods, the nontradable good produced domestically and an imported good. Individual preferences are given by a Cobb-Douglas utility function. Denoting C_n, the consumption of the nontradable good, and C_m, the consumption of the imported good, we have :

$$U = kC_n^{\phi} C_m^{1-\phi}, \tag{7}$$

where $k = \left(\phi^{\phi}(1-\phi)^{(1-\phi)}\right)^{-1}$ is a constant and $0 < \phi < 1$.

The consumer has thus constant expenditures shares ϕ and $(1-\phi)$ on the nontradable and the imported goods. Letting Z denote the consumer income, we thus have the following demand functions:

$$C_n = \phi \frac{Z}{P_n} \tag{8}$$

$$C_m = (1-\phi)\frac{Z}{P_m}, \tag{9}$$

where the domestic price of the imported good, P_m, is determined by the law of one price: $P_m = EP_m^*$, and the domestic economy takes P_m^* as given. As there is no government in our model, the consumer income is simply equal to nominal output: $Z = P_nY_n + P_xY_x$.

The model of the domestic economy is closed by the equilibrium conditions for the nontradable good market and the labour market, respectively:

$$C_n = Y_n \tag{10}$$

$$L = L_n + L_x, \tag{11}$$

where L, the labor supply, is fixed and exogenously given.

For later use, notice that by combining Equations (8) and (10) with the definition of Z, we can rewrite the expression for C_n and Z as follows:

$$
\begin{aligned}
C_n &= (\frac{\phi}{1-\phi})(\frac{P_x Y_x}{P_n}) &(12)\\
Z &= \frac{P_x Y_x}{1-\phi}. &(13)
\end{aligned}
$$

Notice also that it can be shown with some simple algebra that the labor market equilibrium condition implies that the labor demand from each sector can be expressed as a constant ratio of the total labor supply. To save space, only the expression for L_x is reported here:

$$L_x = \left(\frac{\alpha(1-\phi)+\phi}{\alpha(1-\phi)}\right)^{-1} L. \tag{14}$$

Using the above expressions, the joint equilibrium in the market of the nontradable good and the labor market is given by:

$$q = \alpha(\frac{a_x}{a_n})h^{(1-\alpha)}L^{(\alpha-1)}K_x^{(1-\alpha)}, \tag{15}$$

where $h = \frac{\alpha(1-\phi)+\phi}{\alpha(1-\phi)}$.

Regarding the foreign economy, it is assumed for simplicity that it produces only the final good M (Y_m^*), with a technology that combines labor (L_m^*) and the primary commodity (X_m)[8]:

$$Y_m^* = a_m {L_m^*}^{\gamma} X_m^{1-\gamma}, \tag{16}$$

with $0 < \gamma < 1$.

From the first order conditions of profit maximization, we obtain that the cost of one unit of the foreign consumer good is given by:

[8] As in Cashin, Cespedes and Sahay (2004), the foreign economy does not correspond to the rest of the world, which also includes other countries producing the primary commodity.

$$P_m^* = \left(\frac{\psi_m}{a_m}\right) w^{*\gamma} P_x^{*(1-\gamma)}, \tag{17}$$

where $\psi_m = \gamma^{-\gamma}(1-\gamma)^{-(1-\gamma)}$.

Finally, notice that the model can be reduced to four equations: Equation (6), which describes the equilibrium of the firm in the domestic economy; Equation (15), which represents the joint equilibrium of the labor market and the market for the nontradable good; Equation (17) which gives the equilibrium of the foreign producer; and Equation (3), which is the law of one price for the exportable good. These four equations determine: q, the real exchange rate price, P_x, the price of the primary commodity expressed in domestic currency, P_m^*, the world market price of the foreign consumer good and either E, r, or K_x depending on the assumptions that will be made regarding the exchange rate regime and the degree of international capital mobility.

So far, we have defined the real exchange rate as the relative price of the nontradable good in terms of the tradable good. As it is well known, the real exchange rate can be defined in many different ways[9] . It is for instance very common to define the real exchange rate as the ratio between the domestic consumer price index (P) and the foreign consumer price index expressed in the domestic currency (EP^*). Given that $P = {P_n}^{\phi}(EP_m^*)^{1-\phi}$ and $P^* = P_m^*$, we thus have:

$$q' = \frac{P}{EP^*} = {P_n}^{\phi}(EP_m^*)^{-\phi}. \tag{18}$$

It can easily be shown that the two real exchange rates are related as follows:

$$q' = q^{\phi}(P_x^*)^{\gamma\phi}(w_x^*)^{-\gamma\phi}(\tfrac{\psi_m}{a_m})^{-\phi}$$

and so we have:

$$\Sigma(q'; p_x^*) = \phi[\Sigma(q; p_x^*) + \gamma],$$

where the symbol Σ denotes an elasticity.

With the help of this simple framework, we now explore the role played by structural factors in the determination of the commodity price elasticity of the real exchange rate. We consider successively factors: the degree of financial openness, the exchange rate regime,

[9]For a discussion of the alternative definitions of the real exchange rates, see for instance Edwards (1989) and Chinn (2006).

the type of the exportable commodity, the degree of trade openness, and the degree of export diversification.

2.1 Financial openness

In the analysis that follows, financial openness is given by the degree of international capital mobility. To simplify the analysis, we assume in this Subsection that E is fixed (and set arbitrarily equal to 1).

We start by assuming that capital is perfectly mobile internationally. Under this assumption, the domestic rate of interest (r) is tied to the world interest rate (r^*) through the uncovered interest parity condition. With E fixed, we thus have: $r = r^*$, and the domestic economy takes the world interest rate as given. In this case, as shown in numerous papers (see for instance Gregorio and Wolf (1994) or Obstfeld and Rogoff (1996)), the real exchange rate is uniquely determined by Equation (6) and thus depends only on the productivity parameters and the world interest rate. Demand conditions have no impact on q. The intuition is straightforward. As P_x and r are given, it follows that the wage rate, w, is determined by Equation (4). Furthermore, as shown by Equation (5), the wage rate is the only determinant of the price of the nontradable good (P_n). As the real exchange rate is equal to the ratio between the price of the nontradable good and the price of the exportable good, it therefore depends only on P_x^*, a_x, a_n, and r^*. As it appears from Equation (6), an increase in the world market price of the exportable commodity leads to an increase (appreciation) of the real exchange rate: $\Sigma(q; p_x^*) = \frac{1-\alpha}{\alpha}$. Indeed, an increase in P_x leads to a more than proportional increase in the wage rate and the price of the nontradable good. We can also notice that the lower is α, the stronger is the response of q to a variation in P_x^*.

Let's now assume that capital is not mobile internationally. In this case, r is no longer exogenously given by the world interest rate but is determined endogenously from domestic conditions. The capital stock now becomes exogenous. In this case, q is determined by Equation (15) while Equation (6) is solved for r. It therefore appears that in response to a change in P_x, q remains unchanged. Indeed, as K_x is now fixed, the production of the tradable good, Y_x, becomes also fixed. The marginal productivity of capital and labor in the tradable sector is therefore fixed which implies that any increase in the price of the exportable good leads to a proportional increase in the domestic rate of interest and the wage rate. In turn, the price of the nontradable good increases in the same proportion, so leaving unchanged the real exchange rate. Alternatively, notice from Equation (12) that with Y_x given, the consumer demand of the nontradable good depends only on q. As Y_n is constant, the equilibrium condition for the nontradable good market requires that C_n be constant as well, which imposes that q be invariant.

When we use the alternative definition of the real exchange rate (q'), the reaction of the real exchange rate to a change in the world market price of the primary commodity is given by the following elasticities: (i) $\phi\left(\frac{1-\alpha}{\alpha} + \gamma\right)$ when there is perfect capital mobility and (ii)

$\phi\gamma$ in case of zero capital mobility.

The analysis in this Subsection therefore suggests that the response of the real exchange rate to a commodity price shock is more pronounced in more financially open economies.

2.2 Exchange rate regime

The response of the real exchange rate to a commodity price shock when the nominal exchange rate is fixed has been presented in the previous Subsection and we have seen that its response depends on the degree of international capital mobility. When the exchange rate is freely floating, it can be derived from Equations (3), (6) and (15) that the real exchange rate remains unchanged when there is a commodity price shock, whatever the degree of international capital mobility. The explanation is as follows. With E being now endogenous, the model can only be solved provided that r and K_x be exogenous. In this case, to maintain the equality between the marginal cost of capital and its marginal productivity, the price of the exportable good expressed in domestic currency must remain constant. As P_x is unchanged, w and P_n are in turn unchanged and so is q. Accordingly, in the case of an international commodity price shock, the only variable that is affected is the nominal exchange rate: as implied by the law of one price, E appreciates (depreciates) when P_x^* increases (decreases). Our results are therefore consistent with the widespread idea that a flexible exchange rate isolates the domestic economy from international shocks.

When we use the alternative definition of the real exchange rate (q'), the elasticity of q' with respect to p_x^* is equal to $\phi\gamma$ in floating exchange rate regimes, whether there is zero or perfect international capital mobility.

So, our model suggests that the exchange rate regime only matters when capital is perfectly mobile internationally. In this case, comparing the results of this Subsection with those of the previous Subsection reveals that the real exchange rate is less affected by a commodity price shock when the nominal exchange rate is floating rather than fixed.

2.3 Commodity type

In order to address whether the relationship between the real exchange rate and the world market price of the commodity differs according to the type of the commodity that is exported by the small country, we simply consider that what makes a particular commodity different from another one is its technology of production[10]. For instance, it seems reasonable to consider that the production of agricultural commodities is more labor intensive than the production of mineral commodities. We therefore limit our analysis about the impact of the commodity type by examining how the degree of labor intensity (α) affects

[10] An other way to investigate if the commodity type matters would be to consider that some commodities are available for consumption while others can only be used as intermediate goods

the elasticity between q (q') and P_x^*. From the analysis above, it turns out that when the exchange rate is flexible or when there is zero capital mobility, the elasticity is independent of α and thus invariant to the type of commodities exported by the country. Conversely, when the exchange rate is fixed and capital is perfectly mobile internationally, the elasticity is a negative function of α. Our model therefore suggests that the impact of international commodity price shocks on the real exchange rate will be lower for countries that are specialized in the export of a commodity whose production is more labor intensive (e.g. agricultural commodities) than for countries which produce capital-intensive commodities (e.g. mineral goods).

2.4 Degree of trade openness

In our model, the degree of trade openness can be captured by the parameter (ϕ), which measures the share of the nontradable good, compared to the foreign imported good, in total consumption. It follows from our model that the extent to which the real exchange rate is affected by world commodity price shocks does depend on the country's degree of trade openness only when the real exchange rate is given by q'. When those conditions hold, it appears that the higher is the degree of trade openess (the lower is ϕ), the lower is the appreciation (depreciation) of q' in response to a rise (fall) of world commodity prices.

2.5 Export diversification

In order to investigate whether the degree of export diversification affects the magnitude of the reaction of the real exchange rate to international commodity price shocks, we extend our model to include the production of a second tradable good. We assume that this new tradable good is a manufacturing good, produced but not consumed domestically. We also assume that the production of the manufacturing good (Y_d) involves two intermediate inputs, the primary commodity (X_d) and an intermediate input produced by the foreign economy (G_d^*):

$$Y_d = a_d {X_d}^{\beta} {G_d^*}^{1-\beta}. \tag{19}$$

It is straightforward to show that, in equilibrium, the price of the manufacturing good is determined as follows:

$$P_d = \frac{\psi_d}{a_d} {P_x}^{\beta} {P_f}^{1-\beta}, \tag{20}$$

where P_f is the price of the foreign intermediate good in domestic currency with $P_f = EP_f^*$, and $\psi_d = \beta^{-\beta}(1-\beta)^{-(1-\beta)}$.

In this new framework, we redefine the real exchange rate q as the ratio between the price of the nontradable good and a composite price of the two exportable goods, $\tilde{q} = \frac{P_n}{P_t}$, where $P_t = {P_x}^{\epsilon} {P_d}^{(1-\epsilon)}$.

In what follows, the analysis is limited to the case when the exchange rate is fixed and capital is perfectly mobile internationally. Under these assumptions, we obtain through several straightforward substitutions that the elasticity of $\tilde{q}$ with respect to P_x^* is given by:

$$\Sigma(\tilde{q}; p_x^*) = \left(\frac{1-\alpha}{\alpha}\right) + (1-\beta)(1-\epsilon).$$

This elasticity is then larger than the corresponding elasticity obtained in the model with one exportable good. So our model does indicate that the degree of export diversification may influence the magnitude of the real exchange rate variation in response to a world commodity price shock. In particular, our model implies that when commodity prices increase (decrease), countries whose exports are largely diversified should register a stronger appreciation (depreciation) of their real exchange rate than countries whose exports are weakly diversified. This results comes from the fact that variation in P_x leads to a less than proportional variation in P_d (see Equation (20)).

Notice that the inclusion of a second good does not affect the expression of q' and so, the elasticity $\Sigma(q'; p_x^*)$ is independent of the degree of export diversification.

3 Data

In our empirical investigation, we focus on developing and emerging countries that are specialized in the export of a main commodity. We examine whether their real exchange rate is related to the world market price of their main commodity export and whether the relationship is dependent on structural factors. To address those questions, we use annual data covering the period 1980-2007[11]. The selection of the countries and the dataset are discussed in this Section. Data sources are provided in the Appendix.

3.1 Selection of countries and commodities

Our dataset is composed only of countries that are specialized in the export of a leading commodity. Using the results of Bodart, Candelon, and Carpantier (2011), we consider that a country is specialized in the export of a main commodity if that commodity accounts for at least 20 percent of its total exports[12]. From an initial sample of 65 developing and

[11]The end of the sample period is set in 2007 because data on the classification of exchange rate regimes are only available until 2007.

[12]Bodart, Candelon, and Carpantier (2011) finds that a commodity specialization of at least 20 percent is necessary to have cointegration between the real exchange rate and the international price of the leading

emerging countries that, according to the IMF, are considered as commodity producing countries[13], we found 33 countries that satisfy that criteria. The selected countries are listed in Table 1. We indicate in front of each country what is its main commodity export and what is the share of that commodity in the total exports of the country[14]. One can notice that our dataset is mainly composed of African and Latin american countries and include 12 different commodities. More details about the selection of countries are given in the Appendix.

3.2 Real exchange rates and commodity prices

In line with many studies on the determination of the real exchange rate, the exchange rate series is the IMF's real effective exchange rate based on consumer prices. As in Cashin, Cespedes, and Sahay (2004), commodity prices are expressed in real terms, by deflating the US dollar price of each commodity by the IMF's index (of the unit value) of manufactured exports (MUV)[15]. Real exchange rates ($REER$) and real commodity prices ($COMP$) are indices with base January 1995=100.

3.3 Structural factors

Each structural factor is given by a three-category variable. We adopted this three-way classification because it permits to assess more accurately the impact of extreme regimes than a two-way classification. In that respect, increasing the number of categories would not be very useful, and it would complicate the econometric estimation.

Exchange rate regime (EXR). As in Broda (2004), we classify the exchange rate regime in three categories: Fixed, Intermediate, and Floating. Our classification is established using mainly the six-way exchange rate regime classification of Ilzetski, Reinhart, and Rogoff (2008), which is an update of the Reinhart and Rogoff (2004) classification. Fixed regimes include countries with currency pegs and narrow currency bands. Countries with crawling pegs, wide currency bands or managed floats are included in the intermediate category. The floating category includes countries with freely floating exchange rates. The regimes vary across countries and over time. Table 1, columns 5 to 7, report the number of years that each country has spent in every category. Additional details can be found in the Appendix.

Financial openness (KAO). Using the financial openness index of Chinn and Ito (2006) (hereafter ChI), we classify the countries in 3 categories: Closed, Intermediate, and Open.

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commodity export

[13]It is the same set of countries as in Cashin, Cespedes, and Sahay (2004), to which we added oil producing countries.

[14]The share is measured as an annual average over the period 1988-2007.

[15]MUV is the unit value index (in US dollars) of manufacturing exports from 20 developed countries with country weights based on the countries' total 1995 exports of manufactures (base 1995=100). The MUV index deflator is taken from the IMF's IFS database.

The Closed category includes countries for which the ChI financial openness index is below -1.1. Countries with a financial openness index comprised between -1.1 and 1.0 are included in the Intermediate category, while the Open category includes countries with an index above 1.0. The thresholds used to build our three-way classification are based on the quantile distribution of the Chin-Ito index and follows closely the classification established by Beine, Lodigiani, and Vermeulen (2009). Notice that each country financial openness index is varying over time and Table 1, columns 8 to 10, report the number of years that each country has spent in every category.

Trade openness ($TRADE$). The trade openness variable is also designed as a three-way dummy variable: Closed, Intermediate, and Open. It is based on the GDP ratio of the sum of the total exports and imports of a country. Using the quartiles, we classified a country as closed if its trade ratio was in the first quartile ($<$ 42.7%). The Intermediate category includes the countries whose trade ratio is in the second or third quartiles ($42,7\% < x \leq 88.6\%$), while a country was classified as open to trade if its trade ratio was in the largest quartile ($>$ 88.6%). Table 1, columns 11 to 13, report the number of years that each country has spent in every category.

Export diversification (DIV). We distinguish between three categories of export diversification: High, Intermediate, and Low. To determine each category, we used the data about the export share of the main commodity export (as reported in Table 1) and we divided the cross-country distribution in three quantiles. The High diversification category includes countries for which the share of the main commodity in total exports lies between 20% and 31%. Countries with a share lying between 31% and 50% are included in the Intermediate category while those with a share higher than 50% are considered as weakly diversified (Low category). As the commodity export ratio is computed as an average over the period $1988 - 2008$, the index of export diversification is constant though time and only varies across country units. Ten countries have a High specialization index, twelve countries have an Intermediate specialization index, and eleven countries, most of them being oil producing countries, have a Low specialization index.

Commodity type ($TYPE$). The twelve different commodities that we have in our data set (see Table 1) are regrouped in three categories: Energy (oil), Metals (cooper, gold and uranium), and Agriculture (banana, coffee, cocoa, cotton, fish, soya, tea, and tobacco). Sixteen countries are the Energy category, five countries are in the Metal category, and twelve countries are in the Agriculture category.

In what follows, for ease of convenience, we use the notations CAT_1, CAT_2, and CAT_3 to identify the three categories of each structural variable. The values of CAT_1, CAT_2, and CAT_3 that correspond to EXR, KAO, $TRADE$, DIV, and $TYPE$ are respectively as follows: CAT_1 = (Fixed, Closed, Closed, High, Energy), CAT_2 = (Intermediate, Intermediate, Intermediate, Intermediate, Metals) and CAT_3 = (Floating, Open, Open, Low, Agriculture).

4 Empirical analysis

Panel econometric techniques are well suited to conduct our empirical investigation .

4.1 Preliminary analysis

Before proceeding to the estimation of the relationship between real exchange rates and commodity prices, a preliminary analysis of the data is required. We start testing whether the real exchange rate and commodity prices series are cross-sectional dependent or not. Recent papers show indeed that the consistency of standard panel estimators as well as the size of basic tests (in particular unit root, cointegration) are affected by cross-sectional dependence. We report in Table 2 Panel A the outcomes of the Pesaran (2004) test, which consists in testing for the presence of cross-sectional dependence versus its absence. It appears that the null hypothesis of cross-sectional independence is strongly rejected by the test. Accordingly, our empirical analysis relies only on panel econometric methods that are robust to cross-sectional dependence.

Secondly, we look at the non stationarity of the real exchange rates and commodity prices series. Three tests are performed[16]. According to the results reported in Table 2 Panel B, the three tests fail to reject the null of a unit root in the panel data on real exchange rates and commodity prices at usual nominal size , i.e. 5%.

Third, we test whether real exchange rates and commodity prices are cointegrated. To obtain outcomes that are robust to cross-sectional dependence, we use the version of the standard cointegration test of Pedroni (1999) that was developed recently by Fachin (2007). In Table 2 Panel C, we report both mean and median t-tests, with and without time dummies. The evidence is mixed, as the null hypothesis of no cointegration is rejected by the mean t-tests, but not by the median t-tests. According to the results on individual countries reported in Table 1, it seems nevertheless that the presence of a cointegration relationship between real exchange rates and commodity prices cannot be rejected for 17 out of 33 countries. On the basis of this additional evidence, we consider in the rest of our analysis that real exchange rates and commodity prices are panel cointegrated.

The next step in our empirical analysis is to estimate the following cointegration relationship between real exchange rates and commodity prices:

$$REER_{i,t} = a + bCOMP_{i,t} + e_{i,t} \tag{21}$$

[16]For a description of the tests, see Bodart, Candelon, and Carpantier (2011)

Table 2: Cross-sectional dependence, panel unit root and panel cointegration tests

A- Cross-sectional dependence test				
	test value	p-value	Dependence?	
	45.039	0.00000	Yes	
B- Panel unit root tests				
UR	test value	block rule	crit val (5%)	crit val (10%)
Real exchange rates				
LLC	-12.58	SC	-15.39	-14.27
		MV	-15.78	-14.53
IPS	-2.102	SC	-2.434	-2.409
		MV	-2.50	-2.37
INVN	-0.2043	SC	-2.687	-2.451
		MV	-4.63	-3.29
Commodity prices				
LLC	-9.175	SC	-15.23	-14.66
		MV	-16.27	-13.52
IPS	-1.760	SC	-2.597	-2.461
		MV	-2.58	-2.43
INVN	4.466	SC	-3.18	-3.01
		MV	-6.11	-3.94
C- Panel cointegration tests				
	test value		p-values	
		basic bootstrap	FDB1	FDB2
		With common time dummies		
Mean CADF	-3.13	2.00	1.00	2.00
Median CADF	-2.80	22.00	20.00	19.00
		Without common time dummies		
Mean CADF	-3.01	4.00	4.00	5.00
Median CADF	-2.84	20.00	17.00	18.00

Notes. The cross-sectional dependence test follows Pesaran (2004). The Pesaran test is based on fixed effects models. The null of the Pesaran test is the absence of cross sectional dependence. The panel unit root tests follow the sub-sampling based approach of Choi and Chue (2007). Real exchange rates and commodity prices are in logarithms. An intercept and a trend have been considered in all the experiments. "SC" and "MV" hold for Stochastic Calibration and Minimum Volatility, respectively, two alternative block selection rules. The minimum and maximum block sizes for the MV rule are 0.4 and 0.6, respectively. An asterisk indicates the rejection of the null of panel unit root (no rejection in our results). The panel cointegration tests are Fachin (2007)'s versions of Pedroni (1999)'s tests. Real exchange rates and commodity prices are in logarithms. An intercept and a trend have been considered in all the tests. Block size selection for the cointegration test is based on 0.1T. "FDB1" and "FDB2" hold for Fast Double Bootstraps of types 1 and 2 (see Davidson and MacKinnon (2006)). P-values are in percent.

where $REER_{i,t}$ is the (log) real exchange rate of country i at time t, and $COMP_{i,t}$ is the (log) real price at time t of the leading commodity exported by country i.

Several techniques have been proposed to estimate such a long run relationship, the most popular being DOLS and FMOLS. Nevertheless Bai, Kao, and Ng (2009) (BKN hereafter) prove that traditional estimators are biased in presence of cross-sectional dependence generated by unobserved global stochastic trends. They introduce common factors to control for cross unit dependence, and thus propose an iterative procedure to extract the common factor and to estimate the equation simultaneously. The results are reported in Table 3 column 1. It turns out that the price of the dominant commodity has a long-run impact on the real exchange rate with an elasticity of 12.5% which is in line with the Bodart, Candelon, and Carpantier (2011)'s analysis, the only one so far to implement the BKN approach in this context.

4.2 Estimates of the impact of structural factors

Once this preliminary analysis achieved, let us now turn to the paper's core, i.e. how the selected structural factors might affect the long-run commodity price elasticity of the real exchange rate. To this aim, Equation (21) is augmented by an interaction term between the commodity price variable and the three-way variable representing each structural factor (see Section 3). In practice, we explore the impact of each structural factor by interacting the commodity price variable with two dummy variables, a dummy D_2 (that takes the value 1 when observations are in the 2nd category (CAT_2) and zero otherwise) and a dummy D_3 (that takes the value 1 when observations are in the 3rd category (CAT_3) and zero otherwise). Let us note that we did not include a D_1 dummy to avoid the linear dependence between the interaction terms and the variable $COMP_{i,t}$. The category defined by D_1 will thus be considered as the baseline. This gives the following relationship:

$$REER_{i,t} = a + bCOMP_{i,t} + c_1(D_{j,2,t} * COMP_{i,t}) + c_2(D_{j,3,t} * COMP_{i,t}) + e_{i,t} \qquad (22)$$

The estimation of Equation (22) thus amounts to estimate the long-run relationship between real exchange rates and commodity prices, conditional on each factor. The impact of each factor on the long-run commodity price elasticity of the real exchange rate is determined by testing the hypothesis that each c_j $(j = 1, 2)$ is significantly different from zero ($H0$: $cj = 0$).

The estimation outcomes of Equation (22) are reported in Table 3 columns (2) to (6). Before analyzing the impact of the structural factors on the real exchange rate-commodity price relationship, let us make two remarks. First, it is noticeable that the baseline coefficient b only varies marginally from one specification to the other, lying between 0.101 and

0.162, highlighting hence the robustness of the elasticity estimate. Second, intermediate category variables always appear as non significant. It thus confirms that splitting the structural factors in 3 regimes is sufficient to apprehend their potential roles, and that the elasticity estimate deviates significantly from the one obtained in the baseline model only when the structural factor takes an "extreme" value, that is a value in the CAT_3 category.

Table 3: Estimation results

coef.	(1)	(2)	(3)	(4)	(5)	(6)
b	0.125***	0.137***	0.129***	0.139***	0.101**	0.162***
	(0.022)	(0.022)	(0.023)	(0.023)	(0.041)	(0.027)
$c_{EXR,2}$		-0.008				
		(0.007)				
$c_{EXR,3}$		-0.044***				
		(0.009)				
$c_{KAO,2}$			-0.005			
			(0.005)			
$c_{KAO,3}$			0.001			
			(0.010)			
$c_{TRADE,2}$				-0.008		
				(0.006)		
$c_{TRADE,3}$				-0.019**		
				(0.009)		
$c_{DIV,2}$					-0.006	
					(0.054)	
$c_{DIV,3}$					0.132**	
					(0.055)	
$c_{TYPE,2}$						0.028
						(0.057)
$c_{TYPE,3}$						-0.100*
						(0.056)

Notes. Standard errors are reported in parentheses. *, ** and *** stand for significance at 10%, 5% and 1%, respectively.

As concerns the effects of the structural factors, outcomes from the regressions confirm our theoretical predictions, i.e. a flexible exchange rate, large trade openness and a high degree of export diversification[17] decreases the elasticity between the real effective exchange rate and the price of the main exported raw commodity. Regarding the impact of the exchange rate regime, our results question the empirical evidences of Chen and Rogoff (2003) and

[17]Table 3 row 9 reports that a weak diversification increases significantly the elasticity.

Broda (2004) who, conversely, find that the impact of world commodity prices on the real exchange rate is weaker when the exchange rate is fixed. We also find that when the exported commodity is an agricultural good, the elasticity becomes higher, corroborating our finding that real exchange rate and commodity prices are strongly linked for labor intensive activity sectors. Interestingly, column (3) does not show any effect of financial openness. This result, which does not match the predictions of theoretical models, may be due to the difficulty to measure properly this structural variable. However, to our knowledge, the Chinn and Ito (2006) index remains the most accurate and used measure of financial openness.

4.3 Robustness check

In order to evaluate the robustness of our findings, three investigations are performed. Since the construction of the dummy variables representing the degree of trade openness and the degree of export diversification is obviously ad hoc, we first replicate the analysis of the previous section using an alternative construction of the variables $TRADE$ and DIV[18]. Instead of using quartiles to classify trade values into three categories, we now use quintiles. We then classify a country as Closed if its trade ratio is in the first quintile ($< 38.0\%$) and Open if it is in the largest quintile ($> 94.0\%$) . The Intermediate category includes the countries whose trade ratio is in the second, third and fourth quintiles. The new trade dummy variable is denoted $TRADE^n$. Similarly, the new DIV^n dummy is built upon quartiles. A country is then in the High diversification category if the share of the exports of its main commodity in total exports is in the first quartile ($< 38\%$) while it is in the Low diversification category if the commodity exports share is in the fourth quartile ($> 94.0\%$). When the commodity export ratio lies in the second and third quartiles, the country is classified in the Intermediate diversification category. Results obtained with these new variables are reported in Table 4. It appears that they are qualitatively comparable to those obtained previously (Table 3 columns (4) and (5)).

Since our sample includes several African countries belonging to the CFA Franc Zone (Cameroon, Ivory Coast, Gabon, Mali and Niger), we next investigate whether our results are influenced by the 50 percent devaluation of the CFA Franc that took place in January 1994. We do so by adding in our specification a 1994 dummy which is equal to 1 for CFA countries in 1994 and which is equal to zero otherwise[19]. The new results are reported in Table 5. One can observe that the estimators are very close to those obtained in Table 3, so supporting again the robustness of our conclusions.

[18] As regards the construction of the variables representing the degree of flexibility of the exchange rate regime and the degree of financial openness, since it is taken from existing studies, we consider that it is less subject to debate

[19] The BKN methodology has a preliminary step where the series are first regressed on a constant and a trend. In order to test the robustness of our results to the 1994 devaluation in CFA countries, we add the 1994 dummy to the regressors in the preliminary regression.

Table 4: Robustness check: modification of the trade openness and export diversification dummies

	b	$c_{i,2}$	$c_{i,3}$
$i = TRADE^n$	0.161*** (0.023)	-0.013** (0.006)	-0.023** (0.009)
$i = DIV^n$	0.125*** (0.045)	0.004 (0.054)	0.134** (0.060)

Notes. Standard errors in parentheses. *, ** and *** stand for significance at 10%, 5% and 1%, respectively.

Table 5: Robustness check: accounting for the January 1994 devaluation of the CFA Franc

coef.	(1)	(2)	(3)	(4)	(5)	(6)
b	0.1405***	0.130***	0.1100***	0.1489***	0.1136***	0.1535***
	(0.022)	(0.021)	(0.027)	(0.023)	(0.041)	(0.027)
$c_{EXR,2}$		-0.006372				
		(0.007)				
$c_{EXR,3}$		-0.04277 ***				
		(0.009)				
$c_{KAO,2}$			0.002692			
			(0.005)			
$c_{KAO,3}$			0.01206			
			(0.010)			
$c_{TRADE,2}$				-0.008557		
				(0.006)		
$c_{TRADE,3}$				-0.01842 **		
				(0.009)		
$c_{DIV,2}$					-0.02766	
					(0.054)	
$c_{DIV,3}$					0.08265	
					(0.055)	
$c_{TYPE,2}$						0.02532
						(0.057)
$c_{TYPE,3}$						-0.09739*
						(0.056)

Notes. Standard errors are reported in parentheses. *, ** and *** stand for significance at 10%, 5% and 1%, respectively.

Finally, we conduct the analysis by region. We split our sample of countries in two groups, Sub-Saharan Africa and Latin Americia. Estimations (1) to (6) are repeated separately for each group and the results are reported in Panels A and B of Table 6. Overall, the results obtained for each group are qualitatively similar to those in the full sample (see Table 3). The real exchange rate is positively related to world commodity prices in both regions, and the relationship is shaped by almost the same structural factors. There are however two noticeable differences. First, the impact of the degree of financial openness is positive and statistically significant for Africa while it is non significant in Latin America and in the full sample. For Africa, this means that the higher is international capital mobility, the higher is the commodity price elasticity of the real exchange rate. Second, the results regarding the impact of the commodity type are different between Africa and Latin America and they are also different from the results in the full sample. For Africa, the impact is not significant. A possible explanation of this result is the low diversification of commodity exports as half of the countries in the Sub-Saharan panel have an agricultural commodity as their main commodity export.

5 Conclusions

As it is demonstrated by the literature on the "Dutch" disease, commodity prices are potentially an important determinant of the real exchange rate of countries that produce and export primary commodities. For that reason, the dependence of real exchange rates on commodity prices (or, more generally, on terms of trade) has been the focus of numerous empirical studies. In most of these studies, the empirical evidence consists only of econometric estimates of the real exchange rate response to commodity price shocks. What determines the magnitude of the real exchange rate reaction is however not investigated. This issue is the main subject of this paper. We first showed with a simple theoretical framework that several structural or institutional characteristics may contribute to shape the relationship that exists in the long-run between a country's real exchange rate and the world price of the main commodity that it exports. We emphasized the role of five structural factors: the exchange rate regime, the degree of trade openness, the degree of export diversification, the type of the commodity export, and the degree of financial openness. We then subjected the role of these factors to econometric scrutiny by conducting an empirical investigation involving 33 developing countries specialized in the export of a main primary commodity.

Using panel cointegration methods robust to cross-sectional dependence, we found that four of the five factors, namely the exchange rate regime, the degree of trade openness, the degree of export diversification and the type of the commodity exported, have a significant impact on the long-run commodity price elasticity of the real exchange rate. More precisely, we report that the elasticity is reduced when a country operates a floating exchange rate (rather than a fixed exchange rate). It is also smaller when the country is strongly opened

Table 6: Robustness check: Estimations by region

			A - Sub-Saharan African countries			
coef.	(1)	(2)	(3)	(4)	(5)	(6)
b	0.210***	0.151***	0.163***	0.155***	0.039	0.157***
	(0.036)	(0.027)	(0.029)	(0.030)	(0.046)	(0.037)
$c_{EXR,2}$		0.003				
		(0.010)				
$c_{EXR,3}$		-0.068***				
		(0.012)				
$c_{KAO,2}$			0.010*			
			(0.006)			
$c_{KAO,3}$			0.040***			
			(0.012)			
$c_{TRADE,2}$				0.004		
				(0.008)		
$c_{TRADE,3}$				-0.030**		
				(0.012)		
$c_{DIV,2}$					0.030	
					(0.079)	
$c_{DIV,3}$					0.221***	
					(0.061)	
$c_{TYPE,2}$						-0.046
						(0.082)
$c_{TYPE,3}$						0.016
						(0.064)
			B - Latin American countries			
coef.	(1)	(2)	(3)	(4)	(5)	(6)
b	0.089***	0.120***	0.102***	0.224***	-	0.122***
	(0.028)	(0.031)	(0.034)	(0.031)	-	(0.034)
$c_{EXR,2}$		-0.006				
		(0.012)				
$c_{EXR,3}$		-0.029**				
		(0.013)				
$c_{KAO,2}$			0.006			
			(0.008)			
$c_{KAO,3}$			0.013			
			(0.014)			
$c_{TRADE,2}$				-0.063***		
				(0.008)		
$c_{TRADE,3}$				-0.058***		
				(0.012)		
$c_{DIV,2}$					-	
					-	
$c_{DIV,3}$					-	
					-	
$c_{TYPE,2}$						0.211**
						(0.088)
$c_{TYPE,3}$						0.145
						(0.104)

Notes. Countries included in Panel A are Burundi, Cameroon, Cote d'Ivoire, Ethiopia, Gabon, Ghana, Kenya, Malawi, Mali, Mauritania, Niger, Nigeria, Sudan, Tanzania, Uganda and Zambia. Countries included in Panel B are Chile, Colombia, Dominica, Ecuador, Honduras, Paraguay and Venezuela. Standard errors are reported in parentheses. *, ** and *** stand for significance at 10%, 5% and 1%, respectively.

to external trade (rather than closed) and when its exports are highly diversified (rather than specialized on a few products). We also find that the elasticity is smaller when the primary commodity is an agricultural good, but is higher when it is oil. Conversely, it appears from our analysis that the degree of financial openness does not influence significantly the extent to which real exchange rates and world commodity prices are related in the long-run.

The analysis by regions show some differences with these main results. The first difference concerns the impact of the commodity type in the determination of the real exchange rate-commodity pricer relationship. For Sub-saharan African countries, the type of the main exported commodity does not matter and, in Latin America, the elasticity is smaller when the primary commodity is oil and higher when it is metals. Second, it appears that for Africa, the degree of financial openness is a significant determinant of the long-run commodity price elasticity of the real exchange rate.

Our results have several policy implications. They suggest in particular that countries which are concerned by the adverse impact that world commodity price fluctuations may have on their competitiveness, in other words countries that wish to reduce "Dutch disease" effects, should adopt a floating exchange rate instead of a fixed exchange rate. They also suggest that developing countries whose exports are concentrated on a few primary commodities can reduce the dependance of their real exchange rate on world commodity prices by having more diversified exports. According to our results, diversification towards agricultural products would isolate further the real exchange rate from world commodity price shocks. Countries can also protect their competitiveness from fluctuations in world commodity prices by being more opened to external trade. Finally, Sub-Saharan African countries could attenuate the dependence o f their real exchange rate on world commodity prices by being less opened to international capital flows.

Appendix: description of the data

To proceed to the selection of the countries included in our dataset, we recovered from the UN Comtrade database the annual US$ export value of 42 commodities for 65 countries over the period 1988-2007. The initial set of 65 countries corresponds to the sample of developing and emerging countries selected by Cashin, Cespedes, and Sahay (2004) on the basis of the International Monetary Fund classification of developing countries according to the composition of their export earnings, to which we added oil producing countries. For each country, we computed the 1988-2007 annual average of the US$ export receipt of each individual commodity and we expressed the resulting value as a share of the total US$ export receipts of the country. We then kept the countries for which at least one commodity had a share in total exports of at least 20 percent. From the resulting list of countries, we removed Mozambique because the export share of its aluminium exports was more than 50% after 2001 but about zero before 2000. A few other countries were excluded from our analysis because of the unavailability of data for all the variables of our model.

Real exchange rates are IMF real effective exchange rates based on consumer prices[20]. The data are extracted from the IMF's Information Notice System (INS) database.

Commodity prices are taken from the International Financial Statistics (IFS) database of the IMF. Two series, Tobacco and Gold, were not available in IFS and were taken from Datastream (with respective codes: USI76M.ZA and GOLDBLN). Details about each series are provided in Table 7.

Data on exchange rate regimes are taken from two databases. The first database, IRR, is provided by Ilzetski, Reinhart, and Rogoff (2008) and is an update of the Reinhart and Rogoff (2004) exchange rate regime classification. The IRR exchange rate regime classification is a de facto classification based on market-determined exchange rates. It provides monthly and annual classification data over the period 1940-2007. Classification by 6 and 15 categories are available. The second database, LYS, was established by Levy-Yeyati and Sturzenegger (2005) on the basis of data on nominal exchange rates volatility and international reserves volatility (de facto classification). It covers 183 countries for the period 1974-2004. Classification by 3 and 5 categories are available. Both databases have advantages and weaknesses. One advantage of the LYS database is to provide a 3-category classification, but it has no data for 2005 and later. On the contrary, the IRR database covers the period 1980-2007, but it has only 6- and 15-category classifications. Our paper uses mainly the IRR 6-regime classification to benefit from the longest time coverage (1980-2007). It contains however missing values. When possible, we solved this problem by replacing the missing value by the value found in the LYS 3-category classification. When no data were available in the LYS database, we replaced the missing value by the

[20]See Desruelle and Zanello (1997) for details regarding the construction of the real effective exchange rates.

value of the previous year. We converted the IRR 6-regime classification into 3 exchange rate regime categories as follows: our Fixed Regime category corresponds to IRR category 1; our Intermediate Regime category corresponds to categories 2 and 3 of IRR; and our Flexible Regime category includes categories 4, 5 and 6 of IRR.

The financial openness dummy variable used in our analysis is based upon the financial openness index of Chinn and Ito (2006). The Chinn-Ito index measures the degree of openness of a country's capital account. It is based on binary dummy variables that codify the tabulation of restrictions on cross-border financial transactions reported in the International Monetary Fund's *Annual Report on Exchange Arrangements and Exchange Restrictions*. This index is thus a de jure measure of financial openness. The index is not smoothly distributed. Values range between -1.9 and 2.6, with about one third of the observations having a value of -1.13. Three values were missing in the Chinn-Ito database: Dominica in 1980 and 1981 and Sudan in 2006. We filled the gaps by setting the 1980 and 1981 Dominica indices equal to the 1982 Dominica index, and by setting the 2006 Sudan index equal to the 2005 Sudan index (which is the same as the 2007 index).

GDP, export and import data used to construct the trade openness dummy variable are all taken from the World Bank. All the data are in current US$.

Table 7: Description of the commodity price series

Commodity	Source	Description
Bananas	IFS	Central American and Ecuador, first class quality tropical pack, Chiquita, Dole and Del Monte, U.S. importer's price FOB U.S. ports (Sopisco News, Guayaquil). $/Mt
Cocoa beans	IFS	International Cocoa Organization cash price. Average of the three nearest active futures trading months in the New York Cocoa Exchange at noon and the London Terminal market at closing time, CIF U.S. and European ports (The Financial Times, London). $/Mt
Coffee	IFS	International Coffee Organization, Other Mild Arabicas New York cash price. Average of El Salvador central standard, Guatemala prime washed and Mexico prime washed, prompt shipment, ex-dock New York. Cts/lb
Copper	IFS	London Metal Exchange, grade A cathodes, spot price, CIF European ports (Wall Street Journal, New York and Metals Week, New York). Prior to July 1986, higher grade, wirebars, or cathodes. $/Mt
Cotton	IFS	Cotton, Liverpool Index A, cif Liverpool US cent/pound
Fish	IFS	Fresh Norwegian Salmon, farm bred, export price (NorStat). US$/kg
Gold	DS	Gold Bullion LBM US$/Troy Ounce
Oil	IFS	U.S., West Texas Intermediate 40o API, spot price, FOB Midland Texas (New York Mercantile Exchange, New York). (In 1983-1984 Platt's Oilgram Price Report, New York). $/bbl
Soya	IFS	Soybean U.S., cif Rotterdam US$ per Metric Ton
Tea	IFS	Mombasa auction price for best PF1, Kenyan Tea. Replaces London auction price beginning July 1998. Cts/Kg
Tobacco	DS	Tobacco, US (all markets), mid month curn
Uranium	IFS	Metal Bulletin Nuexco Exchange Uranium (U3O8 restricted) price. $/lb

Notes."IFS" refers to International Financial Statistics from the IMF. "DS" refers to Datastream. "LME" refers to London Metal Exchange. "bbl" refers to barrel (42 US Gallons). "API" refers to American Petroleum Institute.

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