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Do Terms of Trade Drive Real Exchange Rates? Comparing Oil and Commodity Currencies

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DO TERMS OF TRADE DRIVE REAL EXCHANGE RATES?
COMPARING OIL AND COMMODITY CURRENCIES

NON-TECHNICAL SUMMARY

Commodity terms of trade, defined as commodity prices deflated by the unit value of manufactured exports, were on a downward trend over several decades, before rising since the start of the 2000s. This overall trend is observed on average, even if developments are fairly different between oil and non-oil commodities. This paper investigates whether terms of trade have an impact on real exchange rates for two country samples: commodity exporters and oil exporters. More specifically, we ask two questions. Firstly, is the effect of terms of trade on the real exchange rate different in oil-exporting countries compared to other commodity producers? Secondly, to what extent exchange rate misalignments are linked to exchange rate regimes and to the anchor currency?

To answer these questions, we estimate two long-term relationships for the real effective exchange rate: the first relationship takes into account various economic fundamentals, including commodity terms of trade, while the second involves terms of trade alone. We use panel cointegration techniques over the 1980-2007 period, for our two samples of countries: 52 commodity exporters and 16 oil exporters.

Several findings emerge from our analysis. Firstly, real exchange rates co-move with commodity prices in the long run, as they are cointegrated, confirming results in previous studies. We also highlight the same type of relationships for oil-exporting countries, even if the response of their real exchange rates to oil price is somewhat smaller. Secondly, we identify common patterns in the real exchange rates of commodity and oil exporters. As most commodity prices were on a downward trend in the 1980s and the 1990s, commodity currencies tended to depreciate. This is also true, though to a lesser extent, for oil-currencies. Thirdly, we find that pegged currencies are highly dependent on the behaviour of their anchor. USD-pegged currencies were dragged down by the dollar fall and appear undervalued at the end of the period, whereas EUR-pegged currencies were being pushed upwards by the euro appreciation. Fluctuations in anchor currencies have been so wild that they may have dwarfed the impact of economic fundamentals on pegged exchange rates.

ABSTRACT

This paper investigates whether terms of trade have an impact on real exchange rates for commodity exporters and oil exporters. To this end, we estimate a long term relationship between the real effective exchange rate and economic fundamentals, including the commodity terms of trade. The estimation relies on panel cointegration techniques and covers annual data from 1980 to 2007. Our results show that real exchange rates co-move with commodity prices in the long run and respond to oil price somewhat less than to commodity prices. We also find that some pegged currencies have been driven away from their equilibria by wild fluctuations in the key currencies, on which they are anchored.

Keywords: commodities, oil, terms of trade, equilibrium real exchange rates, anchor currencies, panel cointegration.

JEL: C23, F31, O13.

LES TERMES DE L'ÉCHANGE EXPLIQUENT-ILS LES TAUX DE CHANGE RÉELS ?
UNE COMPARAISON ENTRE PAYS EXPORTATEURS DE
PÉTROLE ET EXPORTATEURS DE MATIÈRES PREMIÈRES

RÉSUMÉ NON TECHNIQUE

Les termes de l'échange des matières premières (définis par les prix relatifs des matières premières par rapport à ceux des produits manufacturés) étaient sur le déclin depuis plusieurs décennies, avant de se redresser au début des années 2000. Cette évolution est vérifiée globalement, même si les prix ont évolué différemment selon les matières premières, et notamment entre les produits pétroliers et les autres. L'objet de cet article est d'examiner le rôle joué par les termes de l'échange dans la formation des taux de change réels de deux groupes de pays : les pays exportateurs de matières premières et les pays exportateurs de pétrole. Plus précisément, nous cherchons à répondre aux deux questions suivantes. Premièrement, la réponse du taux de change réel aux termes de l'échange diffère-t-elle entre les pays exportateurs de pétrole et les pays exportateurs de matières premières ? Deuxièmement, dans quelle mesure les mésalignements de taux de change sont-ils liés au régime de change et à la monnaie d'ancrage ?

Pour répondre à ces interrogations, nous estimons deux relations de long terme du taux de change effectif réel : une première relation prenant en compte plusieurs fondamentaux, y compris les termes de l'échange, et une seconde relation incluant uniquement les termes de l'échange. Les estimations reposent sur la cointégration en panel et sont effectuées sur la période 1980-2007 pour deux groupes de pays : 52 pays exportateurs de matières premières et 16 pays exportateurs de pétrole.

Plusieurs résultats ressortent de notre analyse. Premièrement, nous mettons en évidence une relation de cointégration entre les taux de change effectifs réels et les prix des matières premières et confirmons ainsi les résultats d'études antérieures. Nous montrons également l'existence d'une relation de cointégration dans le cas des pays exportateurs de pétrole, l'élasticité de long terme des taux de change effectifs réels au prix du pétrole étant toutefois plus faible que celle estimée dans le cas des pays exportateurs de matières premières. Deuxièmement, nous mettons en avant l'existence de dynamiques communes dans les taux de change réels des pays exportateurs de matières premières et exportateurs de pétrole. Ainsi, dans la mesure où la plupart des prix des matières premières évoluaient selon une tendance décroissante dans les années 1980 et 1990, les taux de change d'équilibre des pays exportateurs de matières premières ont eu tendance à se déprécier. Ceci est également valable, dans une moindre mesure, pour les pays exportateurs de pétrole. Troisièmement, nous montrons que les monnaies en changes fixes sont très dépendantes de l'évolution de la devise sur lesquelles elles sont ancrées. Les monnaies ancrées sur le dollar, qui se sont dépréciées en raison de la baisse du dollar, sont sous-évaluées en fin de période, alors que les devises ancrées sur l'euro ont été tirées à la hausse par l'appréciation de la devise européenne. Les fluctuations des monnaies d'ancrage elles mêmes ont été si importantes

qu'elles ont peut être éclipsé l'impact des fondamentaux économiques sur les devises des pays ancrés.

RESUME COURT

L'objet de cet article est d'analyser l'impact des termes de l'échange sur les taux de change réels de deux groupes de pays : les pays exportateurs de matières premières et les pays exportateurs de pétrole. A cette fin, nous estimons une relation de long terme entre les taux de change effectifs réels et un certain nombre de fondamentaux, comprenant les termes de l'échange. L'estimation économétrique repose sur la cointégration en données de panel et couvre la période 1980-2007. Nos résultats confirment que les taux de change réels évoluent à long terme avec les prix des matières premières et répondent également au prix du pétrole avec toutefois une élasticité plus faible. Nous montrons en outre que certaines monnaies en changes fixes se sont éloignées de leur niveau d'équilibre en raison des fluctuations importantes enregistrées par les devises auxquelles elles sont ancrées.

Mots Clés : matières premières, pétrole, termes de l'échange, taux de change réel d'équilibre, monnaies d'ancrage, cointégration en panel.

Classement JEL : C23, F31, O13.

DO TERMS OF TRADE DRIVE REAL EXCHANGE RATES?
COMPARING OIL AND COMMODITY CURRENCIES

Virginie Coudert^{*}, Cécile Couharde^{**} and Valérie Mignon^{***}

1. INTRODUCTION

Despite the poor predictive power of exchange rate models (Meese and Rogoff, 1983), real exchange rates are not expected to move totally randomly. They do react to some macroeconomic variables, as recently evidenced by Engle, Mark and West (2007), and appear to be linked to fundamentals in the medium run. A wide strand of economic literature has been devoted to finding these medium-run relationships since the seminal papers by MacDonald (1997) and Clark and MacDonald (1998, 2000). The emphasis has often been put on productivity differentials (Chinn and Johnston, 1997; Bénassy-Quéré *et al.*, 2008a, 2008b), and foreign assets (Gagnon, 1996; Isard and Faruquee, 1998). The impact of terms of trade has also been acknowledged for a long time (De Gregorio and Wolf, 1994; Edwards, 1994).

Commodity terms of trade have recently attracted renewed interest due to their wild fluctuations. Indeed, commodity prices are generally found to drive real exchange rate fluctuations in commodity-exporting countries (Chen and Rogoff, 2003; Cashin *et al.*, 2004) and econometric models of real equilibrium exchange rates often include this series among their explanatory variables (Isard, 2007; Ricci *et al.*, 2008). Oil prices are also considered to affect exchange rates, in advanced countries (Chen and Chen, 2007; Bénassy-Quéré *et al.*, 2007; Coudert *et al.*, 2007...), as well as in oil-exporting countries themselves. A number of studies have focused on the effect of oil price on a single oil-producing country (e.g. Rautava, 2004 for Russia; Egert and Leonard, 2007 for Kazakhstan), while few papers have searched for a general effect of oil price on these countries, using cross-country estimations (Korhonen and Juurikkala, 2007).

The aim of this paper is to look into the relationship between real exchange rates and commodity prices. We try to answer two questions. Firstly, is the effect of terms of trade different in oil-exporting countries compared to other commodity producers? Generally, these countries are dealt with separately. Wealth effects coming from oil revenues have long been acknowledged to bear implications for exchange rates (Krugman, 1983; Golub, 1983). It is also true that an exhaustible resource has a specific impact on the whole economy (see for example, Bems and de Carvalho Filho, 2008) and on non-oil sectors (Corden and Neary, 1982; Corden, 1984). However, there are some common features for all

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“commodity currencies” such as a world market for fixing their prices, which is a key factor for exchange rate pass-through and no study has really compared the empirical impact of a commodity shock on the two types of countries. Secondly, another important issue is linked to the huge fluctuations in commodity prices and the fear that they may pave the way to misalignments of pegged currencies in commodity-exporting countries. This is a major cause for concern in the Gulf countries. For example, the two-fold increase in the oil price from 2000 to 2007, should have caused a real appreciation of their currencies. As exchange rates are fixed against the US dollar, the adjustment was made through unsettling inflationary pressures. Here we try to analyse the link between exchange rate regimes, anchor currencies and these current misalignments.

To answer these questions, we estimate a long term relationship between the real effective exchange rate and economic fundamentals, including the commodity terms of trade. To this end, we rely on panel cointegration techniques over the 1980-2007 period, for two samples of countries: 52 commodity exporters and 16 oil exporters.

The rest of the paper is organised as follows. Section 2 surveys the theoretical and empirical literature. Section 3 describes empirical issues on the data. Section 4 gives the results of the estimations. Section 5 derives the misalignments and discusses the trends in terms of trade and real equilibrium exchange rates over the whole sample. Section 6 investigates the links between real exchange rates of pegged currencies and the behaviour of their anchor currencies. Section 7 concludes.

2. LITERATURE SURVEY

Generally speaking, commodity terms of trade are thought to have a positive impact on real exchange rates: their rise should make the exporting country’s real exchange rate appreciate. The currencies of exporting countries that follow this pattern are often called “commodity currencies”. There may be some specificity for “oil-exporting countries”, as huge oil revenues more strongly affect their wealth, spending and savings.

2.1. Theoretical mechanisms at work

The impact of terms of trade on the real exchange rate is generally studied within the framework of two-sector models (natural resources or tradable and non tradable sectors), such as in Neary (1988), De Gregorio and Wolf (1994), Chen and Rogoff (2003) and Cashin *et al.* (2004).¹ Another set of models, specially aimed at oil-exporting countries and designed to evidence a possible “Dutch disease”, includes a third sector, which produces non-resource tradable goods.

In both kinds of models, by definition, tradable goods are subject to international competition; hence, their prices are determined by world demand and supply. The country is supposed to be small enough, so that it is not able to influence world prices. Most models

¹ Tokarick (2008) recently makes a helpful comparison of these models.

assume that domestic agents do not consume the tradable goods produced in their own country, but only non-tradables and imported tradables (De Gregorio and Wolf, 1994; Cashin *et al.* 2004). As usual, non tradables are not subject to international competition, and therefore their prices depend only on domestic demand and supply.

Neary (1988) sketches out a very general model that takes into account all the effects that the commodity price may have on the real exchange rate. The real exchange rate response depends on all the price elasticities of supply and demand in the nontraded sectors, as well as on the income elasticity of demand. This comprehensive framework can be easily simplified, by leaving aside demand effects. This is justified because the bulk of commodity production is generally meant to be exported in most developing and emerging countries. A reasonable assumption is therefore that the commodity is not consumed locally (De Gregorio and Wolf, 1994; Cashin *et al.*, 2004). Under this hypothesis, changes in commodity price do not give rise to direct demand effects, all effects come from the supply side. This simplified framework enables us to focus on the supply effects of commodity terms of trade, which are likely to be much stronger.

When commodity prices increase on the world markets, wages may rise in the commodity sector of the producing country without loss of profitability. Under the assumption of labour mobility, the pay rise can spread to the other sectors, which raises the whole level of prices in the country. This mechanism is close to a “Balassa-Samuelson” effect. This latter effect also assumes that the price of tradables is fixed internationally by the law of one price. It states that the productivity gains made in the tradable sector trigger wage rises, that spread to the whole economy and make the real exchange rate appreciate (Balassa, 1964). A simple framework to catch this effect is given by Cashin *et al.* (2004). The model depicts a two-sector home economy composed by an exporting sector (X) producing a “primary commodity” aimed at being exported, and a non-tradable sector (N). The foreign country produces three types of goods: non tradables (N^*), an intermediate one (I^*) and a tradable one (T^*), produced by assembling the intermediate good and the imported primary commodity. The real exchange rate (RER) is defined as usual:

$$RER = \frac{EP}{P^*} \quad (1)$$

where E is the exchange rate, expressed as the number of foreign currencies per one unit of domestic currency (when E increases, the exchange rate appreciates), P is the domestic consumer price index (CPI), and P^* the CPI in the foreign country. The RER can be expressed as a function of terms of trade:

$$RER = \left[\frac{A_X A_N^*}{A_N A_I^*} \right]^\gamma ToT \quad (2)$$

where A_k and A_k^* are sector k 's productivity respectively in the home country and in the foreign country, $ToT = \frac{P_X}{P_T}$ are terms of trade defined as the home country's export price to import price ratio, and γ is the share of non-tradables in the consumers' basket.

In this simple model, a change in terms of trade prompts a one-to-one variation in the real exchange rate. Chen and Rogoff (2003) give a more general formulation with a coefficient different from one on the terms of trade. Their model also rules out demand effects, the consumption basket being fixed; but having two factors of production instead of one allows them to leave behind the proportional relationship between the price of non tradables and the export price.

Therefore, a more general formulation of the real exchange rate could be a function of terms of trade and relative productivity:

$$rer = \alpha tot + \gamma(a_X - a_N + a_N^* - a_I^*) \quad (3)$$

where lower case letters stand for the same variables taken in logarithm, and α is a parameter contained between 0 and 1.

2.2 Specificities of oil-exporting countries

Oil being a commodity, its real price should have the same effects on the exchange rate as other commodities. However, the relationship between oil price and appreciation of exchange rates has been studied in wider models. Following an increase in oil price, first, the real appreciation of the currency may bring about a decline of the manufacturing sector, referred to as the "Dutch disease". Secondly, wealth effects could arise because of the current account surplus.

"Dutch disease" models show that an increase in the natural resource price or output gives rise to a real exchange rate appreciation, which in turn reduces the profitability of the manufacturing sector and leads to lower long-run growth in oil-exporting countries (Corden, 1984). The deindustrialization directly stems from a resource movement: the oil sector expands to the detriment of the others sectors. There is also a spending effect: rising revenues in the oil sector increase aggregate demand. As part of the demand is meant at domestically produced services, service prices rise, whereas prices of oil and manufacturing goods, being determined abroad, are not affected. This triggers a real exchange rate appreciation. This mechanism occurs if there is no labour mobility between sectors, for it hinders the adjustment in the supply of services to the shift in demand. However, if labour mobility allows the supply of services to adjust, workers move from the other sectors, forcing all sectors to raise their wages as well. Since the tradable sectors cannot offset the pay rise by raising their prices, their profits drop. This induces a decline in manufacturing output and employment (Corden and Neary, 1982). However, as recognized by Neary

(1988), the Dutch disease effect may be dampened if the resource sector has production links with the rest of economy. In this case, the resource sector growth is able to encourage production of non traded goods, which may offset the trend towards real appreciation.

In practice, although concerns were raised in the 1980s, nowadays, the existence of a Dutch disease is still a controversial issue. For example in Canada, the decline in the manufacturing sector is considered coming from a standard long-term deindustrialization trend, and not from oil exports (Bayoumi and Mühleisen, 2006). In developing countries, Dutch disease seems only to appear under specific conditions such as weak institutions or a poor educational system (Egert and Leonard, 2007). In the early 2000s, Gulf countries do not seem to be affected by a Dutch disease either: their economies were booming; their real exchange rates did not appreciate much, even when the oil price soared. Although Gulf exports are still mainly oil products (between 50% in the United Arab Emirates and 93% in Kuwait), several of these countries, such as Bahrain and the UAE, have succeeded in diversifying their economies, lowering their dependency on oil exports. Policy responses such as the constitution of sovereign funds have helped to stabilize the effects of oil price on the economy. Migration and remittances sent abroad by foreign workers also tend to dampen the effects of natural resource abundance on the real exchange rate (Razgallah, 2008).

Sharp fluctuations in the oil price also provoke significant shifts in the wealth of nations and can then induce large current account imbalances. The surge in oil prices at the beginning of the 2000s has made oil-exporting countries the group of countries with the largest current account surplus.² This has prompted renewed interest in the relationship between oil prices and global imbalances and how exchange rates could contribute to the adjustment.

This issue was already discussed at the beginning of the 1980s by Krugman (1983) and Golub (1983). Both authors develop a three-country model (the US, Germany, standing for the whole European Union (EU) and an OPEC country, also standing for the whole area)³, where an increase in oil prices generates wealth transfers and portfolio reallocations, leading to adjustments in exchange rates to clear asset markets. Their findings show that financial factors dominate in the short run. The direction of change in the dollar/mark exchange rate depends on the portfolio preferences of oil-exporting countries. In the long run, however, the impact of oil prices on this bilateral exchange rate is determined by real factors and more specifically by the trade shares of the different areas. The factors at stake involve the relative dependence of the US and the EU on OPEC oil, the OPEC's import

² Bems and de Carvalho Filho (2008) explain the level of external savings in economies with exhaustible resources by precautionary savings, when the only source of uncertainty is the price of the exhaustible resource. Using a small open economy modeling framework, the authors show that the precautionary motive increases the optimal level of (external) savings by 2.5 percent of GDP in the median country in a sample of 11 oil-exporting countries.

³ Golub (1983) also envisages a fourth country, adding the United Kingdom.

pattern and the magnitude of OPEC's absorption. More recently, Coudert *et al.* (2007) investigate the relationship between oil prices and the US dollar real effective exchange rate. Their results show that causality runs from oil prices to the exchange rate and that the link between the two variables is transmitted through the US net foreign asset position. This evidences the importance of the wealth effects and justifies the use of net foreign assets as an explanatory variable in the determination of the real equilibrium exchange rate.

2.3 Empirical findings on the link between RER and terms of trade

2.3.1 Commodity-exporting countries

Some recent papers evidence the link between the real effective exchange rate (REER) and commodity terms of trade. The long run elasticity between the two variables is generally found around 0.5, which means that a 10% rise in the commodity terms of trade implies a 5% appreciation of the REER in the long run. Table 1 summarizes the key results of the main papers.

Chen and Rogoff (2003) focus on three "commodity currencies" issued by large advanced countries: Australia, Canada and New Zealand. They find that commodity prices have a strong effect on their real exchange rates, especially in Australia and New Zealand; the result is weaker for Canada, because of its more diversified export structure. Cashin *et al.* (2004) examine 58 commodity-exporting countries and find that commodity terms of trade affect the real exchange rate in about a third of them. Ricci *et al.* (2008) estimate a panel cointegration relationship between fundamentals and REER in a sample of 48 countries, industrialized or emerging. Among their explanatory variables, they include commodity terms of trade.⁴ The model is designed for the IMF to assess currency misalignments for the main countries in the world, whether they export or import commodities. Therefore, the status of the commodity terms of trade is not the same as in the other studies focusing on commodity-exporting countries.

⁴ Calculated as the ratio of commodity export price to commodity import price, both terms of the ratio being an average weighted by the commodities specifically exported and imported by each country.

Table 1. Results of empirical studies explaining the REER by commodity prices for commodity-exporting countries

Authors	Sample	Explanatory variables	Results Long run elasticity to commodity price (LRE)
Amano and van Norden (1995)	Canada Monthly, 1973-1992	Commodity energy ToT; commodity non-energy ToT; interest rate differential	Cointegration LRE = 0.8 (non energy)
Chen and Rogoff (2003)	3 OECD countries: Australia, Canada, New Zealand. Quarterly, 1984-2001	Commodity prices	Significant for 2 countries out of 3 LRE = 0.7 to 1.0
MacDonald and Ricci (2003)	South Africa Quarterly, 1970-2001	Real commodity price; relative GDP per capita , interest rate differential, trade openness; fiscal balance; net foreign assets	LRE = 0.5
Cashin <i>et al.</i> (2004)	58 countries Annual, 1980-2001	Commodity ToT	Cointegration for 19 out of 58, LRE = 0.1 to 2 median 0.42
Ricci <i>et al.</i> (2008)	48 countries industrialized and emerging Annual, 1980-2004	Commodity ToT; net foreign assets; productivity differentials; government consumption; trade restriction; price controls	Panel cointegration LRE = 0.6

2.3.2 Oil-exporting countries

The empirical literature also evidences a significant effect of oil price on oil-exporting countries' real exchange rates. Table 2 summarizes the results of some recent papers. Most papers focus on a single country. There are few cross-country studies⁵, except the ones by Korhonen and Juurikkala (2007) and Habib and Kalamova (2007). Korhonen and Juurikkala (2007) study a sample including OPEC and three oil-producing Commonwealth of Independent States (CIS) countries from 1975 to 2005. They find that the price of oil has a significant, positive effect on real exchange rates for this group of countries. The elasticity of the REER with respect to the oil price is estimated to be between 0.4 and 0.5, but may be larger depending on the specification; real GDP per capita in purchasing power parity (PPP) does not have a clear effect on the REER. This latter result contrasts with the

⁵ Chen and Chen (2007) investigate the long-run relationship between real oil prices and real exchange rates for a sample of G7 countries by using a panel framework.

consensus view of real exchange rates determinants. According to the authors, it may come from the difficulty to disentangle the separate effects of productivity and oil price, as an increase in oil price is somewhat analogous to a Balassa-Samuelson effect: relative productivity (at new relative prices) rises in this tradable sector, which pushes up wages and prices in other sectors of the economy. Habib and Kalamova (2007) focus on three oil-exporting countries (Russia, Norway, Saudi Arabia) and study cointegration on a single-country basis. They find a long-run relationship between real oil-price and real exchange rate only for Russia.

Table 2. Results of empirical studies explaining the REER by oil prices for oil-exporting countries

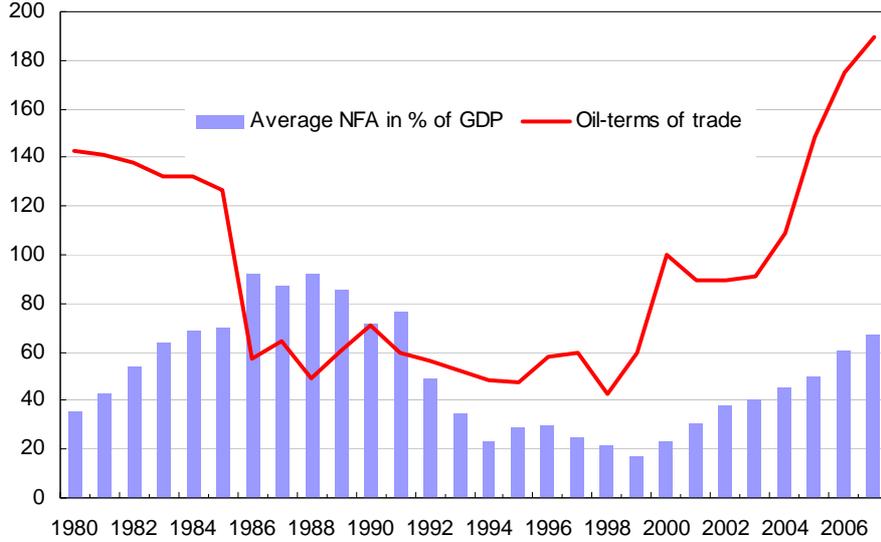
Authors	Sample	Explanatory variables	Results Long run elasticity to real oil price (LRE)
Spatafora and Stavrev (2003)	Russia Quarterly 1995-2002	Oil price; industrial productivity relative to trade partners ; post-1998 crisis dummy	LRE = 0.31
Koranchelian (2005)	Algeria Annual 1970-2003	Real oil price; real GDP per capita relative to trade partners	LRE = 0.2
Bayoumi and Mühleisen (2006)	Canada Quarterly 1972-2005	Real price of Canadian energy commodities relative to the US\$; real price of Canadian non-energy commodities relative to the US	LRE = 0.26
Bhattacharya and Dhaneshwar (2006)	Congo Annual 1972-2004	Real oil price	LRE = 0.2
Zalduendo (2006)	Venezuela Annual 1950- 2004	Real oil price; real GDP per capita relative to trade partners; differential of real interest rates	LRE = 1.0 (for REER based on official rates) LRE = 0.44 (for REER based on parallel market rates)
Korhonen and Juurikkala (2007)	OPEC +3 CIS 1975-2005	Real oil price; GDP per capita	Panel-Cointegration LRE = 0.4, 0.5
Habib and Kalamova (2007)	Russia, Norway, Saudi Arabia	Real oil price; GDP per capita	Cointegration only for Russia, LRE = 0.29
Oomes and Kalcheva (2007)	Russia 1997-2005	Oil price; industrial output per worker relative to euro area and US; government consumption: in % of GDP; net international reserves; a corruption index	LRE = 0.5
Chami <i>et al.</i> (2007)	Yemen Quarterly 1996- 2004	Oil price; government expenditure in % of GDP; real per capita GDP relative to trade partners; oil production; oil export, net foreign assets, in % of GDP	Oil price non significant

Overall, taking a look at the results of the papers reviewed in Tables 1 and 2, it follows that the REER long-run elasticity with respect to the terms of trade is often lower for oil-exporting countries than for commodity-exporting countries. This may be due to (i) greater fluctuations in the oil price than in commodity price (Figure 4) and (ii) pegged exchange rates that prevent the nominal adjustment from happening.

3. EMPIRICAL ISSUES AND DATA

In order to investigate the relationship between terms of trade and real exchange rates, we follow a BEER (Behavioural Equilibrium Exchange Rate) approach of the equilibrium real exchange rate as in MacDonald (1997, 2000), Clark and MacDonald (1998) or Bénassy-Quéré *et al.* (2008a, 2008b) for instance. The real equilibrium exchange rate is estimated as a function of a Balassa-Samuelson effect (proxied by the PPP GDP per capita), the country's net foreign assets and its terms of trade. Most previous papers on commodity currencies do not retain the net foreign asset position, although this variable is considered to be crucial for oil economies (see Section 2.2). In addition, net foreign assets were submitted to large swings over the period, especially in oil-exporting countries (Figure 1) and we expect these fluctuations to have exerted pressures on their real exchange rates. Net foreign assets are also evidenced to have a significant effect on exchange rates on the long run for different sets of countries (Isard, 2007; Bénassy-Quéré *et al.*, 2008a, 2008b; Coudert and Couharde, 2008).

**Figure 1. Oil-exporting countries' net foreign assets (NFA) in % of GDP
and oil terms of trade (index 100 = year 2000)**



Note: Net foreign assets are an average for the 16 countries in the sample (for the list of countries and sources, see Section 3.1). Oil terms of trade are crude oil price divided by OECD manufacturing export price.

This leads us to estimate a long-run relationship between the real effective exchange rate (REER) and the fundamentals mentioned above:

$$reer_{it} = \gamma_{0i}^A + \gamma_1^A y_{it} + \gamma_2^A nfa_{it} + \gamma_3^A tot_{it} + \eta_{it}^A \quad (\text{Model (A)})$$

where $reer_{it}$ is country i 's real effective exchange rate, y_{it} its PPP GDP per capita relative to other countries, nfa_{it} its net foreign asset position in percentage of GDP and tot_{it} its terms of trade. η_{it} is an error term and γ_{0i} accounts for country-fixed effects. The real exchange rates and the PPP GDPs per capita are expressed in effective terms. All variables are taken in logarithms, except the net foreign asset position.

In order to assess the role of terms of trade, we compare the previous model, which we call Model (A), with a simpler one only based on the terms of trade, referred to as Model (B):

$$reer_{it} = \gamma_{0i}^B + \gamma_3^B tot_{it} + \eta_{it}^B \quad (\text{Model (B)})$$

3.1 The sample of countries

We use yearly data from 1980 to 2007. To assess if terms of trade have a different impact on countries producing oil or other commodities, the estimations are successively run on two samples:⁶

- 52 commodity-exporting countries. These are the same countries as in Cashin *et al.* (2004) less Nicaragua, for data availability (see Appendix A). Moreover five countries have been moved to the second considered sample since they are oil-exporting countries (Ecuador, Indonesia, Mexico, Norway and Syrian Arab Republic).
- 16 oil-exporting countries. This sample includes 11 OPEC countries (Algeria, Angola, Indonesia, Iran, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia Republic, United Arab Emirates, Venezuela), 2 other Gulf countries (Bahrain and Oman), as well as 3 other leading oil exporters, namely Mexico, Norway and the Syrian Arab Republic.⁷

3.2 The real effective exchange rate

Constructing a genuine real effective exchange rate for every country in the sample is not possible, because trade data by partners are not available for all the countries. Therefore, we use a proxy calculated as an exchange rate against a world basket of currencies. We apply the usual definition of a REER:

$$reer_i = \sum_{j=1, j \neq i}^n w_{ij} (s_{\$j} - p_j) - (s_{\$i} - p_i) \quad (4)$$

where w_{ij} are the weights put on currency j for country i 's REER, $s_{\$j}$ (resp. $s_{\$i}$) is currency j (resp. i)'s bilateral exchange rate against USD (number of units of national currency per USD), p_j (resp. p_i) is country j (resp. i)'s consumer price index (CPI), and n is the number of partner countries. All variables are based 100 in a basis year and taken in logarithms.

⁶ The list of countries and their main commodity exports (Table A2) are given in Appendix A.

⁷ Note that Kilian, Rebucci and Spatafora (2007) consider 26 oil exporters. Here, we excluded CIS countries since their price and exchange rate data are not relevant before the transition. We only focus on major countries.

Usually, the weights w_{ij} depend on country i 's trade partners. Here we define them as country j 's share in the world gross domestic product (GDP) in USD, which is calculated excluding country i :⁸

$$w_{ij} = GDP_j / \sum_{k=1, k \neq i}^n GDP_k \quad (5)$$

We have:

$$w_{ij} = w_j / (1 - w_i) \text{ for } i \neq j ; w_{ii} = 0$$

where w_j is country j 's share in the world GDP expressed in current USD,

$$w_j = GDP_j / \sum_{k=1}^n GDP_k .$$

Therefore, the weights w_{ij} are very close to the j 's share in the world GDP, for every country i . This nearly amounts to defining an exchange rate against a world basket of currency.

Let us define RWB the real exchange rate against USD of a world basket of currencies, weighted by their share in world GDP:

$$RWB = \sum_{k=1}^n w_k (s_{\$k} - (p_k - p_{us})) \quad (6)$$

This gives us a very simple formulation of our REER:

$$reer_i = [RWB - (s_{\$i} - (p_i - p_{us}))] / (1 - w_i) \quad (7)$$

In this approach, the REER stands for the value of currencies relatively to a world sample of countries, whether they are trade partners or not. This is not the case in a standard REER,⁹ which is expressed only relatively to trade partners.

⁸ As previously mentioned, we do not rely on share in world trade since trade data by partners are not available for all the considered countries. Moreover, for some countries of our sample, GDP data are less volatile than trade data on the whole period.

⁹ A way of checking these REERs is to compare them with the standard REERs calculated by the IMF that are available for 83 countries in IFS. If we take a look at their correlations with our series, we find an average coefficient of 0.85, with a median of 0.94, which is quite satisfying.

The sample of partners includes 132 countries, that correspond to all countries for which exchange rate and price data are available over the period 1980-2007, except CEECs and CIS countries. We excluded the latter group of countries because we consider that their price and exchange rate data are not relevant before transition. The country list is given in Appendix A. The shares in the world GDP are calculated on average over the period 1980-2007, using the GDP in USD, from IMF's WEO database. The weights are given in Table A1 in Appendix A. Exchange rates are extracted from IMF's WEO database and CPI series are taken from IFS, completed by WEO for some countries.

3.3 Explanatory variables

The *Balassa-Samuelson effect* is proxied by the PPP GDP per capita relatively to the partners. The weights applied to calculate the relative PPP GDP are the same w_{ij} as for the real effective exchange rates. PPP GDP are taken from the WEO database.

Net foreign assets (NFA) are taken from Lane and Milesi-Ferretti's database.¹⁰ They are divided by GDP in USD, extracted from the WEO database. We have updated the database after 2004 by cumulating the current accounts in USD to the previous NFA position. We have also done this for the few missing data in the sample.

Commodity terms of trade are calculated in the same way as in Cashin *et al.* (2004). For the 52 commodity producing countries, terms of trade are a weighted average price of the 3 main commodities exported by the country deflated by the unit value of industrial countries' manufactured exports. Terms of trade are therefore expressed as:

$$ToT_{it} = \sum_{k=1}^3 share_i^k p_t^k / pex_{IND,t}^{MANUF} \quad (8)$$

where $share_i^k$ is the share of commodity k among the 3 main commodity exports of country i , p_t^k is the price of commodity k in the world market, $pex_{IND,t}^{MANUF}$ is the unit value of manufactured exports of industrialised countries, taken from the WEO. The weights of each commodity in the countries' exports are taken from Cashin *et al.* (2004) and are reproduced on Table A2 in Appendix A. All commodity price data are from IFS database.

For the 16 oil-exporting countries, terms of trade are set equal to the crude oil price divided by the same deflator $pex_{IND,t}^{MANUF}$: $ToT_{it}^{Oil} = p_t^{Oil} / pex_{IND,t}^{MANUF}$.

¹⁰ <http://www.imf.org/external/pubs/ft/wp/2006/data/wp0669.zip>. See Lane and Milesi-Ferretti (2007).

4. ESTIMATION RESULTS

4.1 Preliminary steps

4.1.1 Panel unit root and cointegration tests

We first test for the existence of a unit root in the different variables using various panel unit root tests (Table B1 in Appendix B). Levin and Lin (1992, 1993)¹¹, Breitung (2000) and Hadri (2000) tests are based on a common unit root process. The first two tests (Levin-Lin and Breitung) take the unit root as the null hypothesis, while the Hadri test relies on the null of no unit root. The hypothesis that the autoregressive parameters are common across individuals is a rather restrictive assumption on the dynamics of the series under the alternative hypothesis. For this reason, we also consider two other tests. The IPS (Im, Pesaran and Shin, 2003) test allows for heterogeneity in the value of the autoregressive coefficient under the alternative hypothesis. Thus, under the alternative hypothesis, some series may be characterized by a unit root, while some others can be stationary. Like IPS, the Maddala and Wu (1999) test (MW) is not based on the restrictive assumption that the autoregressive coefficient is the same across countries. This test is a non-parametric Fisher-type test that combines the p-values from individual unit root tests. Results in Table B1 indicate that all series can be considered as unit root processes at conventional significance levels.

Given that all series are $I(1)$, we now proceed to panel cointegration tests. We consider two categories of tests. The first one includes the seven tests proposed by Pedroni (1999, 2004). These tests are based on the null hypothesis of no cointegration. Some heterogeneity is introduced under the alternative hypothesis since there exists a cointegrating relationship for each country, and this relationship is not necessarily the same for each country. Among the seven Pedroni's tests, four are based on the within dimension (panel cointegration tests) and three on the between dimension (group mean panel cointegration tests). Group mean panel cointegration statistics are more general in the sense that they allow for heterogeneous coefficients under the alternative hypothesis. The second type of tests has been developed by Kao (1999). As for the Pedroni's tests, they are based on the null hypothesis of no cointegration. However, they are less general than the Pedroni's tests since cointegrating vectors are supposed to be homogenous across individuals.

Tables B2 and B3 in Appendix B respectively display the results of Pedroni's and Kao's tests. Since we are especially interested in the link between the exchange rate and terms of trade, we investigate the existence of two cointegrating relationships: a relationship between the exchange rate and its three fundamentals (Model (A)) and a bivariate relationship between the exchange rate and terms of trade (Model (B)).¹² While being

¹¹ See also Levin, Lin and Chu (2002).

¹² Moreover, the use of Model (B) allows us to compare our results with Cashin *et al.* (2004) since they considered that the exchange rate is only determined by terms of trade.

somewhat mixed¹³, the results are globally in favour of the existence of a cointegrating relationship. Indeed, for both groups of countries, the null hypothesis of no cointegration between the four considered variables (Model (A)) is rejected according to four Pedroni's tests. This result is confirmed by Kao's test which also rejects the null hypothesis. Turning to the bivariate relationship between the exchange rate and terms of trade (Model (B)), these variables are cointegrated according to five Pedroni's tests for both commodity and oil-exporting countries. It should however be noted that, according to Kao's test, terms of trade and the real exchange rate are not cointegrated for oil-exporting countries. Nevertheless, this last result may be due to the fact that this test is too restrictive since it assumes that the cointegrating vector is the same for all individuals.

On the whole, these results tend to show that a cointegrating relationship exists between (i) the exchange rate and its three determinants (terms of trade, PPP GDP per capita and net foreign asset position) and (ii) the exchange rate and terms of trade.

4.1.2 Causality and impulse response functions

Another preliminary step is to disentangle the causality between the exchange rate and the economic fundamentals. Are economic fundamentals influencing the exchange rate or is it the other round? This question is especially tricky for the terms of trade. Indeed, terms of trade involving manufactured goods may be caused by exchange rate movements; but this seems to be hardly the case for commodity terms of trade. As commodities are non-differentiated goods which are uniquely priced on the world market, all countries can be considered as price-takers, for most commodities. Therefore, a country's exchange rate is not likely to influence the world price. For this reason, commodity terms of trade are often assumed to be exogenous to the exchange rate. However, Clements and Fry (2007) challenge this conventional view, by evidencing some spillovers between commodity prices and the "commodity currencies", in three large advanced commodity-exporting countries: Australia, New Zealand and Canada.

To check the direction of causality in our sample, we estimate a panel VAR in levels between our four variables¹⁴, the number of lags being chosen according to the Schwarz information criterion. Results of Granger causality tests are given in Table 3.¹⁵ They illustrate a causality running from terms of trade to the exchange rate for both commodity and oil-exporting countries. The causality is bidirectional for oil-exporting countries since

¹³ Note that it is frequently the case; see Bénassy-Quéré *et al.* (2008a, 2008b) for instance.

¹⁴ To account for specific country events and correct for possible induced biases, we have introduced dummies, when the yearly variation of the real exchange rates exceeded 50% in absolute value, and also to account for the CFA Franc devaluation in 1994. There are two types of dummies: those that stand for huge depreciations, generally due to major exchange rate crises or wars, and those that account for huge appreciations, which always stem from hyperinflation. Table A3 in Appendix A reports the considered dummies and corresponding events.

¹⁵ This table reports p-values of the test based on averaging standard individual Wald statistics of Granger non causality tests (see Hurlin, 2005).

the exchange rate also causes terms of trade. Concerning commodity-exporting countries, our results showing the exogeneity of terms of trade are consistent with those of Cashin *et al.* (2004): it is the real exchange rate that adjusts to restore the long run equilibrium with commodity prices.

Table 3. Granger causality tests (p-values)

X \ Y	logQ	logy	NFA	LogTOT
<i>Commodity-exporting countries</i>				
reer		0***	0***	0.14
y	0.48		0.24	0.09*
nfa	0***	0.14		0.17
tot	0***	0***	0.02**	
<i>Oil-exporting countries</i>				
reer		0.01**	0***	0***
y	0.68		0.03**	0.25
nfa	0.48	0.99		0.68
tot	0***	0.39	0***	

Note: This table reports the p-values corresponding to the null hypothesis of no causality from X (in line) to Y (in column). * (resp. **, ***): rejection of the null hypothesis at the 10% (resp. 5%, 1%) significance level.

The interactions between exchange rates and fundamentals can be illustrated by an impulse-response analysis (see Figures 2 and 3). We proceed to the calculation of the generalized impulse-responses as described in Pesaran and Shin (1998).¹⁶ Figure 2 shows that the exchange rate of commodity-exporting countries positively reacts to a shock on terms of trade and to a shock on the net foreign asset position (*i.e.* an increasing in the terms of trade or in the NFA position leads to an exchange-rate appreciation).¹⁷ Moreover, there is a slight reaction of terms of trade to a shock on the exchange rate or on the net foreign asset position for short horizons. Turning to Figure 3, a shock on terms of trade clearly leads to an appreciation of the exchange rate as expected. On the whole, these preliminary results put forward the key role played by terms of trade on the exchange rate determination.

¹⁶ Compared to the traditional Cholesky decomposition, these generalized functions do not require orthogonalization of shocks and are invariant to the ordering of the variables in the VAR.

¹⁷ Note that the magnitudes of responses are indicated on the graphs. For example, following a shock on terms of trade of one standard deviation, the REER responds by a maximum 2.8% appreciation after 3 years.

Figure 2. Impulse-response functions, commodity-exporting countries

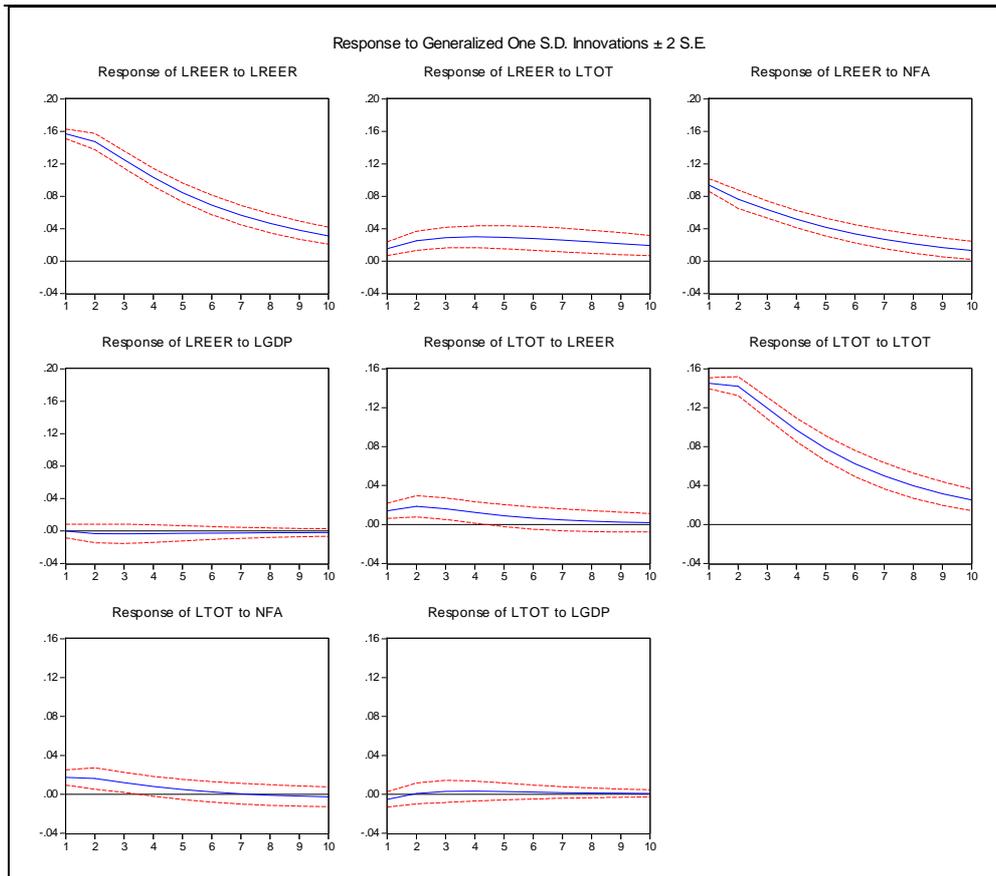
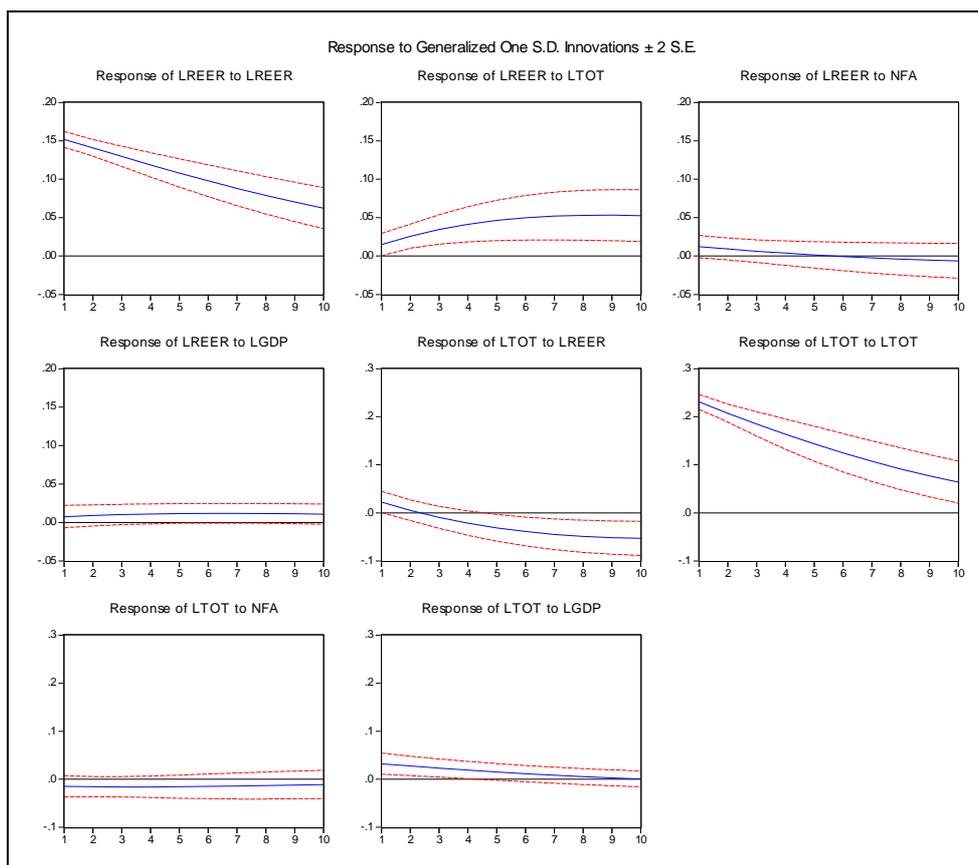


Figure 3. Impulse-response functions, oil-exporting countries



4.2 Long-run relationship between exchange rates and fundamentals

We now estimate the panel cointegrating relationships for our two groups of countries. Since OLS estimates are biased and dependent on nuisance parameters, we use the Dynamic OLS (DOLS) method introduced by Kao and Chiang (2000) and Mark and Sul (2003) in the context of panel cointegration.¹⁸ Roughly speaking, the DOLS procedure consists in augmenting the cointegrating relationship with lead and lagged differences of the regressors to control for the endogenous feedback effect.

¹⁸ Other procedures exist, such as the Fully-Modified OLS (FM-OLS) method proposed by Phillips and Hansen (1990). Compared to the FM-OLS estimator, the DOLS one has the same asymptotic distribution, but presents smaller size distortions (see the simulations made by Kao and Chiang, 2000).

Table 4 reports the estimated cointegrating vectors for the two considered models: the model with the three explanatory variables (Model (A)) and the model which only contains terms of trade (Model (B)).

Table 4. Cointegrating vectors (DOLS estimation)

	logY	NFA	logTOT
<i>Commodity- exporting countries</i>			
Model (A)	0.0425	0.0028	0.4010
Model (B)			0.6484
<i>Oil-exporting countries</i>			
Model (A)	0.4746	0.0002	0.2237
Model (B)			0.2624

All the coefficients are correctly signed. Indeed, a rise in the terms of trade, the NFA position or the relative productivity leads to an exchange rate appreciation in both samples. For commodity-exporting countries, the respective size of coefficients shows that terms of trade are the main determinant of the real exchange rate. Other things equal, a 10 percent rise in the terms of trade leads to a real appreciation of 4.0 to 6.5% for commodity-exporting countries. The key role of commodity prices for the real exchange rates of these countries is consistent with Cashin *et al.* (2004)'s findings.

For oil-exporting countries, our results also confirm that higher oil price leads to real exchange rate appreciation. The long-run elasticity is found somewhat lower, between 0.2 and 0.3, than for the first group of countries; however, it is in the range of the estimations in the literature, as shown in Table 2. Turning to the other determinants, the main difference lies in the impact of the productivity variable, as the Balassa-Samuelson effect is found very weak for commodity exporters but quite strong for oil-exporting countries.

5. EQUILIBRIUM EXCHANGE RATES AND CURRENCY MISALIGNMENTS

Various concepts of equilibrium exchange rates can be derived from the estimation of the cointegrating relationship (see MacDonald, 2000; Driver and Westaway, 2004; Bénassy-Quéré *et al.*, 2008b). Here we consider the long run equilibrium, such as the economic fundamentals in the cointegrating relationship are at their long-term level.¹⁹ This is especially justified by the high volatility in terms of trade (or commodity prices). Therefore, the equilibrium exchange rate can be written as follows:

$$\overline{reer}_{it}^A = \hat{\gamma}_0^A + \hat{\gamma}_1^A \bar{y}_{it} + \hat{\gamma}_2^A \bar{nfa}_{it} + \hat{\gamma}_3^A \bar{tot}_{it} \quad (9)$$

¹⁹ We have also derived the medium run equilibrium, which refers to a cointegrating relationship in which the economic fundamentals are at their observed values. Results are similar to those corresponding to the long run equilibrium and are available upon request to the authors.

where the bars on the variables stand for their long term value (calculated by a Hodrick-Prescott filter) and the hats on the parameters, for their estimated value given by the cointegration relationship in Model (A). We do the same for Model (B).

5.1 Commodity and oil terms of trade and real equilibrium exchange rates

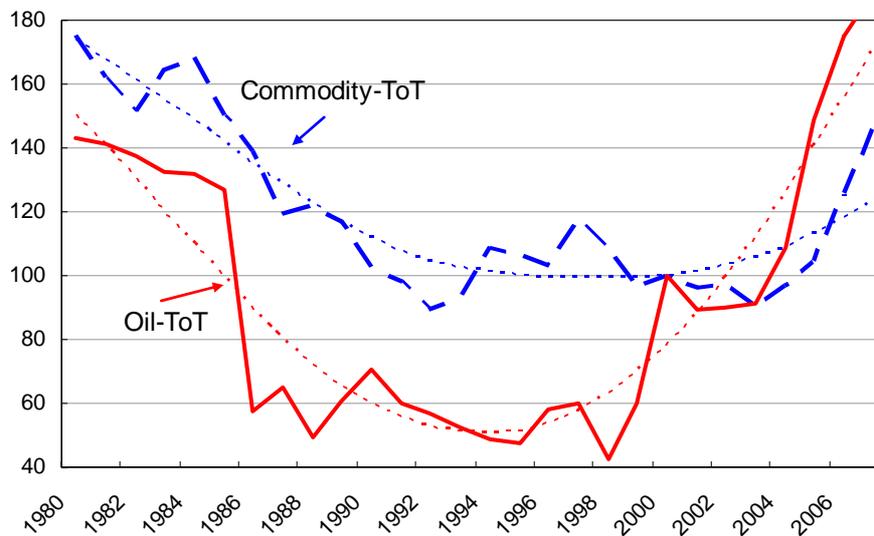
As terms of trade are the key determinant of REERs, their evolutions are transmitted into movements in real equilibrium exchange rates. Figures C1 and C2 in Appendix C help to see this link, by displaying the real effective exchange rate, the equilibrium exchange rate and terms of trade for each country.²⁰

On average, commodity terms of trade were on a downward trend over several decades, before rising from 2002 to 2007. This is also true for oil exporters, even if the latter upturn was stronger for these countries and also came a little earlier. This common average pattern is visible on Figure 4, which plots terms of trade for the two groups of countries, displaying the raw figures as well as their long-run trends calculated by a Hodrick-Prescott filter. Actually, aside from their rally from 2002 to 2007, real commodity prices have been sliding down gradually all over the period. They are still below their levels of the beginning of the 1980s, which were yet also well below the ones of the 1970s. This is more striking if we consider the filtered series, which rightly wipe off the surge at the end of the period.

These large swings in terms of trade are also apparent in REERs. First, their two-decade decline at the beginning of the period has resulted in long-run REER depreciations in commodity-exporting countries. Second, the upturn in terms of trade in the early 2000s has reversed the trend and triggered a REER appreciation, though smaller than the previous depreciation, and not in all countries.

²⁰ To avoid too many figures, we only report the equilibrium exchange rates derived from Model (A).

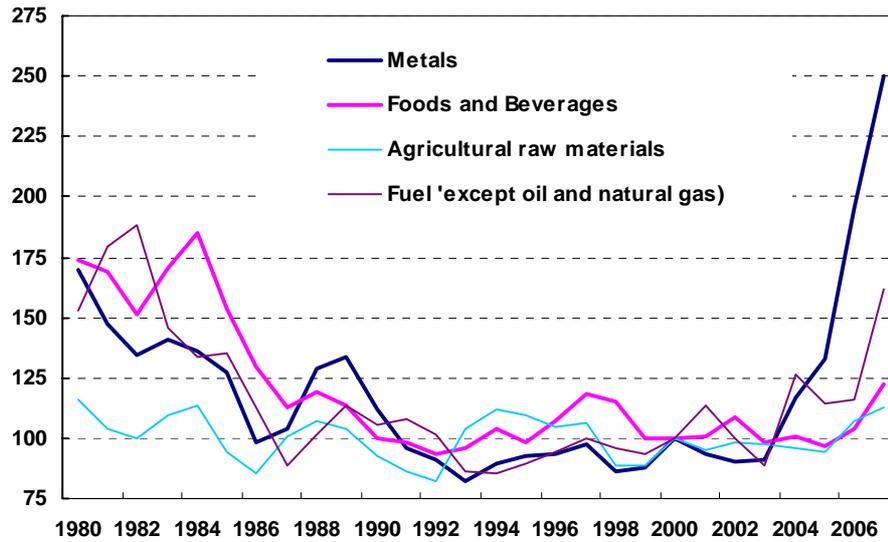
Figure 4. Commodity terms of trade (ToT), oil terms of trade, and their long-run trends (index 100 = year 2000)



Note: Commodity terms of trade are an average of the 52 countries' commodity-terms of trade (see Appendix A for the list of countries). Oil terms of trade are crude oil price divided by OECD manufacturing export price. Bold lines: observed series; dotted lines: Hodrick-Prescott filtered series.

Despite this common pattern, commodity prices strongly vary across goods. Agricultural raw material prices were particularly sluggish all over the period. Even in the latter period when all commodity prices surged, goods such as tea or cotton did not rise much. On the contrary, at that time, metal prices rocketed, as prices for copper, iron ore, lead, nickel, tin, zinc more than tripled in USD from 2000 to 2007. Food products and beverages also increased, although somewhat less dramatically (Figure 5).

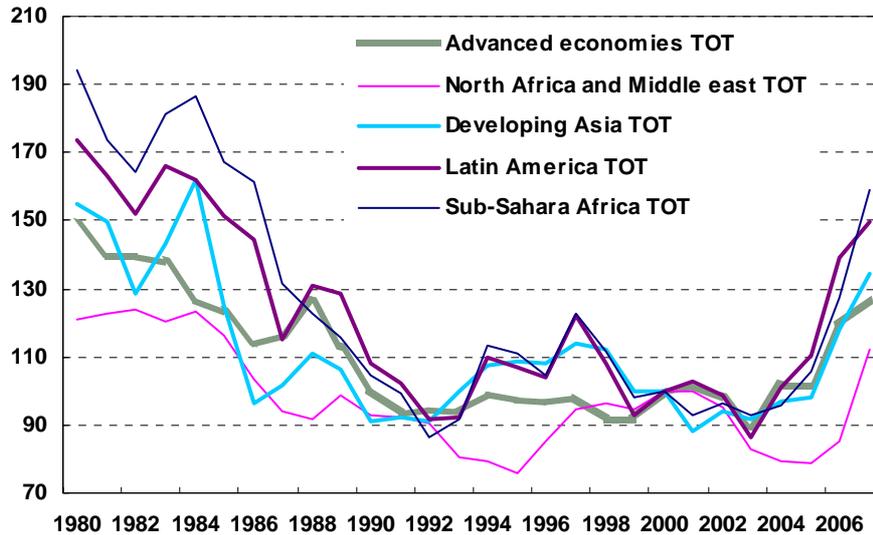
**Figure 5. Commodity terms of trade, by type of commodities
(index 100 = year 2000)**



Note: Agricultural and raw materials include timber, cotton, wool, rubber, and hides. Metals include copper, aluminium, iron ore, tin, nickel, zinc, and lead. Food and beverage include cereal, vegetable oils, meat, seafood, sugar, bananas, coffee, tea, and cocoa. Here fuel only includes coal and phosphate rock.

These uneven evolutions in commodity prices across goods have resulted in different REERs evolutions between countries, according to their export structure. Sub-Saharan Africa and Latin America countries have been the most affected by the large fluctuations in commodity prices; they mainly export both metals and food products, whereas developing Asia and advanced economies mostly export food and agricultural raw materials (Figure 6).

**Figure 6. Commodity-terms of trade by region
(index 100 = year 2000)**



Note: Commodity terms of trade are an average of the 52 commodity-exporting countries' terms of trade by region (see Appendix A for the list of countries).

Looking back on the historical evolution, the surge in commodity prices from 2002 to 2007 stands out by its magnitude, its duration, and also because it was broadly spread all over oil and non-oil products. This episode has resulted in the appreciation of some commodity currencies. A cause for concern is the impact that it may have had on currency misalignments of these countries, particularly in 2007 when commodity prices have reached their highest levels.

5.2 A comparison of misalignments in 2007

Currency misalignments m_{it}^K are defined as the deviations of the observed real effective exchange rates from their equilibrium values estimated by one of the two models:

$$m_{it}^K = reer_{it} - \overline{reer}_{it}^K \quad (10)$$

Tables 5 and 6 report the misalignments calculated by Models (A) and (B) for year 2007 (the last point of our sample). For commodity-exporting countries (Table 5), both models yield roughly similar misalignments in 2007. Terms of trade being found the major determinant of real exchange rates in the sample, adding other variables in Model (A) does not change the results dramatically. Around half of commodity exporters have undervalued currencies in 2007. The other currencies, which are found overvalued, can be split into two groups. The first one includes the four developed countries of the panel. The Australian

dollar, the Icelandic krona and the New Zealand dollar are found overvalued, whereas the Canadian dollar is very close to its equilibrium value. The second group relates to CFA countries. For all CFA countries, but Niger, the CFA Franc is overvalued at the end of the period. For the seven considered CFA countries, the real exchange rate has been appreciating since the beginning of the 2000s. However, their terms of trade follow different patterns according to the exported commodity: a continuous downward trend for cotton exporters like the Central African Republic and Mali; a recent reversal of the downward trend for cocoa exporters such as Cameroon and Cote d'Ivoire. At the same time, the rocketing price of uranium sharply drove up Niger's terms of trade at the end of the period, which explains why the CFA Franc is found undervalued in Niger.

Turning to oil exporters, estimated misalignments point to large exchange rate undervaluation in both models for 8 countries out of 16, only five currencies being close to their equilibrium value and three overvalued (Table 6). The undervaluation is more pronounced in Model (B), because of the stronger coefficient on terms of trade in this model. In the group of GCC²¹ currencies, two main exceptions have to be highlighted: currencies of Qatar and United Arab Emirates are slightly overvalued. This result is consistent with the findings of Kamar and Ben Naceur (2007) who show that, among the group of GCC countries, these two countries are quite different from the others. Indeed, while the real exchange rates of Bahrain, Kuwait, Oman and Saudi Arabia are positively correlated, the Qatar riyal and the UAE dirham are, respectively, weakly and negatively correlated with these four currencies. Kamar and Ben Naceur (2007) highlighted that these divergences require further coordination and policy harmonization among the GCC countries in the perspective of achieving a monetary union in the area. Turning to the other oil exporters, Latin American currencies and the Norwegian krone are close to their equilibrium value; the highest overvalued currency is that of Angola.

²¹ Gulf Cooperation Council.

Table 5. Commodity-exporting countries. Misalignments in 2007 (in %)

Country	Model (A)	Model (B)	Country	Model (A)	Model (B)
Argentina	-17.55	-12.99	Mauritius	-12.77	-9.44
<i>Australia</i>	10.33	6.44	Morocco	-7.05	0.81
Bangladesh	-7.09	-5.72	Mozambique	-24.75	-13.65
Bolivia	-34.11	-30.18	Myanmar	-49.78	-46.46
Brazil	1.79	2.92	<i>New Zealand</i>	21.86	19.52
Burundi	-18.88	-33.91	Niger	-26.63	-27.67
Cameroon	13.43	22.40	Pakistan	-17.82	-15.24
<i>Canada</i>	2.11	5.91	Papua New Guinea	-38.17	-32.23
Central African Republic	21.53	24.76	Paraguay	-25.82	-24.01
Chile	-23.94	-22.38	Peru	-15.82	-11.53
Colombia	10.57	10.72	Philippines	-22.44	-19.39
Costa Rica	3.52	5.15	Senegal	10.96	19.05
Cote d'Ivoire	14.35	32.27	South Africa	-24.15	-22.56
Dominica	13.56	-16.38	Sri Lanka	5.45	3.57
Ethiopia			St. Vincent & Grens.	19.46	-9.01
	3.09	6.44	Sudan	39.16	54.28
Ghana	-49.63	-53.64	Suriname	4.60	3.64
Guatemala	20.30	24.02	Tanzania	-40.15	-32.76
Honduras	17.19	25.16	Thailand	-14.28	-12.57
<i>Iceland</i>	35.58	26.58	Togo	25.38	30.41
India	-0.85	-0.95	Tunisia	-10.56	-11.78
Kenya	42.53	50.22	Turkey	52.36	49.44
Madagascar	-4.90	-0.15	Uganda	-18.33	-15.95
Malawi	-43.03	-44.08	Uruguay	5.05	8.04
Malaysia	-38.24	-27.66	Zambia	11.97	36.69
Mali	9.92	17.13	Zimbabwe	-36.43	-25.13
Mauritania	-34.47	-40.79			

Note: A positive (resp. negative) sign denotes an overvaluation (resp. undervaluation). In *italics*: industrial countries.

Table 6. Oil-exporting countries. Misalignments in 2007 (in %)

Country	Model (A)	Model (B)
Algeria	-32.19	-43.44
Angola	58.27	43.63
Bahrain	-41.35	-43.26
Indonesia	11.79	1.59
Iran, I.R. Of	-33.85	-39.38
Kuwait	-11.40	-18.90
Libya	-66.35	-85.19
Mexico	-0.06	-5.59
Nigeria	5.80	1.34
Norway	-1.27	-5.49
Oman	-39.73	-43.32
Qatar	3.12	2.66
Saudi Arabia	-40.32	-48.83
Syrian Arab Republic	-9.27	-22.99
United Arab Emirates (UAE)	10.27	2.97
Venezuela, Rep. Bol.	5.07	-3.19

Note: A positive (resp. negative) sign denotes an overvaluation (resp. undervaluation). In *italics*: industrial country. In **bold**: GCC countries.

5.3 Misalignments across exchange rate regimes

We now try to determine if pegged currencies are more misaligned than others. On the one hand, floating currencies may be driven out of their fundamental values by speculation on the forex market. On the other hand, a peg certainly hinders the adjustment of REER to its equilibrium, as all the adjustment has to be made through prices, known to be rigid in the short run. This is especially true in the downward sense, as prices are rigid downwards, which makes pegged currencies more prone to overvaluation. Coudert and Couharde (2008) evidence this bias by studying a large sample of 152 countries. For doing that, they study real exchange rates in levels, measured as relative price levels between countries. Here we cannot replicate this type of analysis, as we rely upon exchange rate variations. As average misalignments are set to zero for each country, floating or pegged currencies on the whole period cannot be discriminated. Therefore, we have to focus on specific periods of time. In this framework, we take a look at the misalignments found for 2007 and see if they are linked to the exchange rate regime.

At first glance, there seems to be no systematic link between exchange rate regimes and the misalignments found for 2007 (Tables 5 and 6). Some floating currencies such as the Turkish lira or the Icelandic krona are strongly overvalued; others like the South African rand or the Mauritanian currency are undervalued, whereas pegged currencies are either undervalued or overvalued.

To investigate the link more precisely, we proceed in two steps. First, we identify pegged currencies in 2007. We do it by constructing a coarse indicator of exchange rate flexibility in the spirit of Calvo and Reinhart (2000). We consider an exchange rate to be fixed against the US dollar if its monthly variation falls into the interval $[-1\%, 1\%]$ more than 90% of the time during the year; it is considered intermediate or floating otherwise. The same classification is done with the exchange rate against the euro. The pegged currencies identified in this way and their anchor currency, USD or EUR, are listed in Table 7. All the pegs in oil-exporting currencies are towards the USD, whereas some commodity-exporting countries peg their currencies against the EUR, as they have adopted the CFA Franc.

Table 7. List of the pegged currencies in 2007 among the commodity and oil-exporting countries and their anchor currencies

Commodity-exporting		Oil-exporting
USD	EUR	USD
Bangladesh	Cameroon	Angola
Bolivia	Central African Republic	Bahrain
Costa Rica	Cote d'Ivoire	Iran, I.R. of
Dominica	Mali	Oman
Guatemala	Morocco	Qatar
Honduras	Niger	Saudi Arabia
Malawi	Senegal	Syrian Arab Republic
Pakistan	Togo	United Arab Emirates
Peru		Venezuela
St. Vincent & Grenadines		
Sudan		
Suriname		

Note: Pegs against a currency, USD or EUR, are defined by at least 90% of monthly variations in nominal exchange rates kept in the interval $[-1\%, 1\%]$.

Second, we calculate misalignments of all the countries in the sample, splitting them by exchange rate regimes. The average misalignments for 2007 are displayed on Table 8. On the whole, the table confirms our first idea that there is no link between the exchange rate regime and the currency misalignment in this particular year. Pegged currencies are either undervalued if they are pegged to the USD or overvalued when pegged to the EUR.

Table 8. Average misalignments in 2007 by exchange rate regimes, in %

	Floats or intermediate	Pegged	Pegged versus	
			USD	EUR
Model (A)	-10.2	-0.9	-4.2	7.7
Model (B)	-9.9	-1.8	-8.2	14.9
<i>Number of countries</i>	39	29	21	8

Hence, what really matters seems to be the anchor currency, not the exchange rate regime. USD pegged currencies are undervalued by 4.2 to 8.2%, while currencies pegged to the EUR are overvalued by 7.7 to 14.9% depending upon the considered model. This may be due to the fact that the USD was on a declining trend at that time, whereas the EUR was strengthening.

6. MISALIGNMENTS AND ANCHOR CURRENCY FLUCTUATIONS

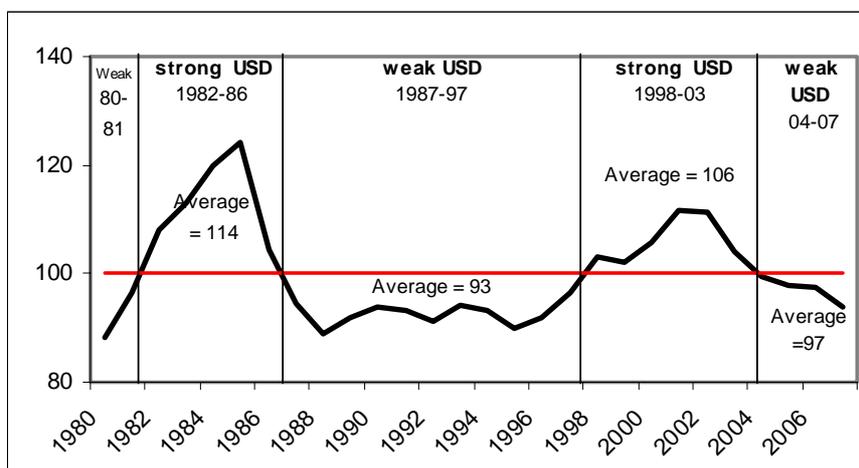
Most currencies pegged to the USD are found undervalued in 2007, while the dollar was declining, whereas currencies pegged to the EUR are overvalued. Fluctuations in key currencies may therefore explain the REERs of pegged currencies. This is not surprising, given the huge fluctuations exhibited by the EUR and the USD recently. The EUR roughly doubled its value against the dollar between 2000 and 2007. Hence, the nominal exchange rate of any currency pegged to the euro appreciated by 100% against the USD during that period. As the bulk of the movements in real exchange rates stems from the nominal side, to be pegged to the EUR or to the USD makes a big difference in the real effective exchange rate.

This incites us to investigate more precisely the link between currency misalignments and the behaviour of the key currencies on which they are anchored. We want to check the hypothesis that the dollar anchorage leads to an undervaluation of USD-pegged currencies when the dollar is weak against all currencies, while it leads to an overvaluation when the USD is strong. We also check the same hypothesis for the EUR-pegged currencies. We proceed in three steps: (i) we identify the periods when the USD was “weak” or “strong”, and do the same for the EUR; (ii) we identify the countries that pegged their currency all over the period to the USD or the EUR; (iii) we calculate the mean misalignments of the pegged currencies over these different periods.

6.1 Decomposition of the periods between “weak anchor currency” or “strong anchor currency”

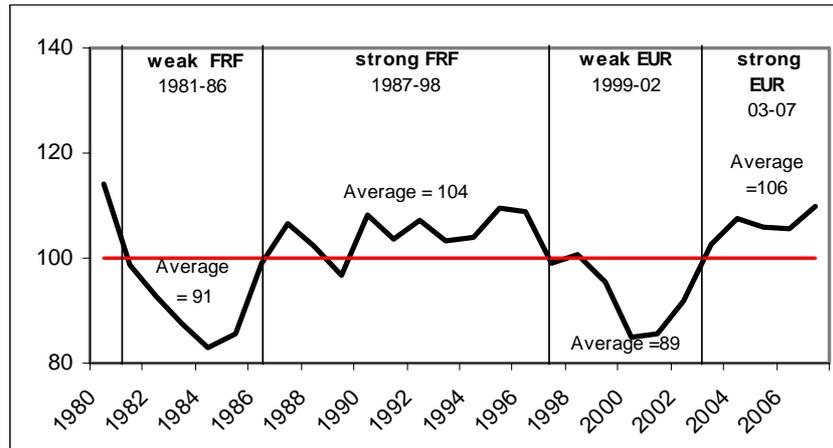
The period under review 1980-2007 is decomposed according to the strength of the USD. We take the average of the USD REER over the whole period as a benchmark. When the USD is above this benchmark, we consider the period as a “strong dollar” period; when it is below, it is considered as a “weak dollar” period. The dollar is found to be weak in 1980-81, 1987-97, 2004-07, and strong in 1982-86, 1998-2003 (Figure 7). This simple method yields satisfactory results, in the sense that it matches the stylized facts, that are common knowledge about dollar fluctuations.

Figure 7. USD real effective exchange rate (base100 = average 1980-2007)



Concerning currencies pegged to the EUR over the whole period, all of them belong to the CFA zone. The Franc CFA was linked to the French Franc up to the introduction of the EUR in 1999. Hence, prior to this date, we replace the EUR by the French Franc (FRF). Following the same method as for the USD, we find that the EUR was weak in 1981-86, 1999-2002, and strong in 1980, 1987-98, 2003-07 (Figure 8). Not surprisingly, these periods roughly mirror those defined for the USD.

Figure 8. EUR real effective exchange rate (base100 = average 1980-2007)



6.2 Listing the pegged currencies

We follow the chronology given by Ilzetzi, Reinhart and Rogoff (2008) in order to identify the pegs lasting all over the period for our considered countries. Table 9 gives the list of countries that maintained a peg over the whole period 1980-2007. Five oil-exporting countries as well as two small commodity-exporting countries have pegged their currencies to the USD. The EUR-peggers are the CFA countries.

Table 9. List of the pegged currencies over the period 1980-2007 among the commodity and oil-exporting countries and their anchor currencies

Commodity-exporting		Oil-exporting
USD	EUR	USD
Dominica	Cameroon	Bahrain
St. Vincent & Grenadines	Central African Republic	Oman
	Cote d'Ivoire	Qatar
	Mali	Saudi Arabia
	Niger	United Arab Emirates
	Senegal	
	Togo	

Source : Ilzetzi, Reinhart and Rogoff (2008).

6.3 Average misalignments according to anchor currencies

We now calculate mean misalignments of pegged currencies during periods when the anchor currency is weak or strong. Table 10 displays the results and compares them to the whole sample of currencies. Each period of strong USD is associated with an average overvaluation of USD-pegged currencies. The reverse is true for periods of weak dollar. On average across these periods, USD-pegged currencies are overvalued by 7% when the USD is high, and undervalued by 4.4% when the USD is low. The undervaluation is higher at the end of the period, especially in 2007, while the USD was sharply declining.

This kind of evolution is also discernible for all currencies in the sample (last column), though to a lesser extent. A straightforward explanation for this phenomenon stems from the leading international role of the dollar. Our set of USD-pegged currencies is rather restrictive, in the sense that it only includes currencies that were strictly pegged to the USD over the entire period 1980-2007. In reality, if we exclude CFA countries, all currencies in the sample followed the USD, more or less, at least for some years during the whole period. This could have taken different forms such as genuine pegs, crawling pegs, or even tightly managed floats. In this background, it is not surprising that their REERs, and therefore their misalignments, also followed the USD evolution.

Table 10. Average misalignments for USD-pegged commodity and oil currencies by sub-periods, in %

Period	Behaviour of the USD	USD-pegged currencies			All countries
		Model (A)	Model (B)	Average *	Average*
1980-1981	Weak USD	-7.7	1.0	-3.4	4.3
1982-1986	Strong USD	10.9	16.9	13.9	11.0
1987-1997	Weak USD	-1.8	-0.3	-1.1	-0.1
1998-2003	Strong USD	3.4	-1.1	1.2	-3.6
2004-2007	Weak USD	-9.8	-19.2	-14.5	-10.2
2007	Weak USD	-10.8	-21.8	-16.3	-8.1
Total 1980-2007	Weak USD	-4.4	-4.6	-4.5	-2.0
Total 1980-2007	Strong USD	6.8	7.1	7.0	3.1

Note. * Average misalignment between Model (A) and Model (B). USD-pegged countries are: Dominica, St. Vincent & Grenadines, Bahrain, Oman, Qatar, Saudi Arabia, United Arab Emirates.

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The same phenomenon is observed for EUR-pegged commodity currencies (Table 11), which belong to the CFA zone. Every sub-period when the anchor currency was weak is linked to an undervaluation, and vice-versa, except for the first period, which is not very significant being reduced to one year. On average, when the EUR is weak, CFA currencies are undervalued by 8.8% and when the EUR is strong, they are overvalued by 4.9%.

Here, contrary to the previous table, the whole sample of currencies follows a quite different pattern, completely independent of the EUR evolution. This is not surprising as very few countries in the sample outside the CFA zone tried to stabilize their parity against the euro. In contrast, this highlights the specific behaviour of the EUR-pegged currencies relatively to their anchor.

Table 11. Average misalignments for EUR-pegged commodity currencies by sub-periods, in %

Period	Behavior of the EUR	<i>EUR-pegged currencies</i>			<i>All countries</i>
		Model (A)	Model (B)	Average *	<i>Average*</i>
<i>1980</i>	<i>Strong EUR</i>	<i>1.2</i>	<i>-2.2</i>	<i>-0.5</i>	<i>6.0</i>
1981-1986	Weak EUR	-13.8	-17.2	-15.5	7.2
1987-1998	Strong EUR	2.8	1.8	2.3	0.1
1999-2002	Weak EUR	0.1	2.2	1.1	-4.5
2003-2007	Strong EUR	9.6	15.0	12.3	-6.5
2007	Strong EUR	9.9	16.9	13.4	-3.4
Total 1980-2007	Weak EUR	-8.3	-9.4	-8.8	2.5
Total 1980-2007	Strong EUR	4.6	5.2	4.9	-6.5

Note. * Average misalignment between Model (A) and Model (B). EUR-pegged countries are: Cameroon, Central African Republic, Cote d'Ivoire, Mali, Niger, Senegal, Togo.

Overall, to be pegged to the USD or to the EUR is a key factor to explain currency misalignments. In other words, commodity terms of trade and other fundamentals do drive the REER evolution, as shown in Section 4; however, there is always an unexplained part, a residual, called “misalignment”; in the case of pegged currencies, the behaviour of the anchor currency seems to explain this residual. Indeed, the fluctuations in key currencies have been wild in the last decades. This may have impacted pegged currencies, even more than fundamentals themselves.

6.4 Two illustrations: the USD-pegged Gulf currencies and CFA countries

The impact of the anchor currency is especially a cause for concern in the Gulf economies. For Bahrain, Oman, Saudi Arabia and, to a lesser extent, Kuwait²², the real exchange rate declines over the whole period (Figures C2 in Appendix C). The equilibrium REER roughly follows the same trend, in line with the declining terms of trade up to the start of the 2000s. From 2000 to 2007, the equilibrium exchange rate appreciates with the rise in oil price. However, the observed REER continue to decline, which is due to the dollar fall from 2002. These two divergent trends between the observed and the equilibrium REER have resulted in an undervaluation of these currencies since the end of the 1990s.

The situation is very different in CFA countries, whose currencies are pegged to the euro (Figures C1 in Appendix C). Their real exchange rate has tended to appreciate since the beginning of the 2000s, following the rising trend of the euro, but their equilibrium exchange rate has not followed this trend. This comes from (i) the sluggish rise (or the decline) in their long-run terms of trade that has not been sufficient to offset the appreciating euro, and (ii) the subdued productivity growth.

7. CONCLUSION

In this paper, we revisit the relationship between commodity prices and real exchange rates for a large sample of countries over the 1980 to 2007 period. Firstly, we show that real exchange rates co-move with commodity prices in the long run, as they are cointegrated, confirming results in previous studies. We also evidence the same type of relationship for oil-exporting countries, even if the response of their real exchange rates to oil price is somewhat smaller.

Secondly, we identify common patterns in the real exchange rates of commodity and oil exporters. As most commodity prices were on a downward trend in the 1980s and the 1990s, commodity currencies tended to depreciate. This is also true though to a lesser extent for oil currencies. From the start of the 2000s up to 2007, the upturn in commodity and oil terms of trade reversed the depreciation trend.

Thirdly, we find that pegged currencies are highly dependent on the behaviour of their anchor. For example, from 2002 to 2007, USD-pegged currencies were dragged down by the dollar fall and appear undervalued at the end of the period, whereas EUR-pegged currencies were being pushed upwards by the euro appreciation. We evidence this phenomenon for each sub-period when splitting the sample according to the strength of the dollar or the euro. In other words, even if commodity terms of trade do drive the evolution of the REER, the unexplained part of the relationship, called “misalignment”, still depends on the behaviour of the anchor currency. Indeed, the wild fluctuations in key currencies in the last decades may have dwarfed the impact of economic fundamentals on pegged exchange rates.

²² Kuwait pegged its currency against the USD until March 2007.

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Appendix A: Country samples

List of the 52 commodity-exporting countries:

Argentina, Australia, Bangladesh, Bolivia, Brazil, Burundi, Cameroon, Canada, Central African Republic, Chile, Colombia, Costa Rica, Côte d'Ivoire, Dominica, Ethiopia, Ghana, Guatemala, Honduras, Iceland, India, Kenya, Madagascar, Malawi, Malaysia, Mali, Mauritius, Morocco, Mozambique, Myanmar, New Zealand, Niger, Norway, Pakistan, Papua New Guinea, Paraguay, Philippines, Peru, Senegal, South Africa, Sri Lanka, St. Vincent and Grenadines, Sudan, Suriname, Tanzania, Thailand, Togo, Tunisia, Turkey, Uganda, Uruguay, Zambia, Zimbabwe.

This list is the same considered by Cashin *et al.* (2004), except that we have left out (i) 5 countries that we consider as oil-exporting countries: Ecuador, Indonesia, Mexico, Syrian Arab Republic and Norway, and (ii) Nicaragua, for which official exchange rate leads to a 1000% appreciation at the beginning of the period, and parallel exchange rate was not available.

List of the 16 oil-exporting countries:

Algeria, Angola, Bahrain, Indonesia, Iran, Kuwait, Libya, Mexico, Nigeria, Norway, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, Venezuela.

We have included all OPEC members except Iraq, because of the war, and Ecuador where dollarization took place in 2001. We have added two Gulf countries: Bahrain and Oman, and three other major oil exporters: Mexico, Norway and Syrian Arab Republic. A few large oil-exporting countries have not been retained: (i) Russia and Kazakhstan, because data are not relevant before the transition and we needed a balanced panel; (ii) Malaysia, which exports mainly non-oil commodities and is therefore in the group of commodity-exporting countries; (iii) the UK and Brazil whose oil exports are less than 10% of their total exports in 2005; and (iv) Canada that has been exporting oil only recently (since 2000) compared to our sample period (1980-2007).

List of the 132 countries considered for constructing the real effective exchange rates:

Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bhutan, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Central African Rep., Chad, Chile, China, P.R., Mainland, China, P.R.: Hong Kong, Colombia, Congo, Dem. Rep. of Congo, Republic of Costa Rica, Cote d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Ethiopia, Finland, France, Gabon, Gambia, Georgia, Germany, Ghana, Greece, Grenada, Guatemala, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary, Iceland, India, Indonesia, Iran, I. R. of Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Korea, Kuwait, Kyrgyz Republic, Lao People's Dem. Rep., Latvia, Lesotho, Libya, Lithuania, Luxembourg, Macedonia, Madagascar, Malawi, Malaysia, Maldives, Mali, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman,

Pakistan, Panama, Papua New Guinea Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russia, Rwanda, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent & Grens, Sudan, Suriname, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Tanzania, Thailand, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Venezuela Rep. Bol., Yemen, Republic of Zambia, Zimbabwe.

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Table A1. Share of the 132 countries in the basket of currencies, in %

Algeria	0.271	Dominica	0.001	Lesotho	0.003	Saudi Arabia	0.737
Angola	0.044	Dominican Rep	0.054	Libya	0.149	Senegal	0.023
Argentina	0.832	Ecuador	0.084	Luxembourg	0.065	Seychelles	0.002
Australia	1.476	Egypt	0.295	Madagascar	0.017	Sierra Leone	0.005
Austria	0.723	El Salvador	0.032	Malawi	0.008	Singapore	0.229
Bahamas	0.015	Ethiopia	0.046	Malaysia	0.280	South Africa	0.544
Bahrain	0.026	Finland	0.482	Maldives	0.001	Spain	2.146
Bangladesh	0.154	France	5.259	Mali	0.011	Sri Lanka	0.048
Barbados	0.008	Gabon	0.023	Mauritania	0.006	St. Kitts and N.	0.001
Belgium	0.878	Gambia	0.002	Mauritius	0.013	St. Lucia	0.002
Belize	0.002	Germany	7.095	Mexico	1.582	St. Vincent&Gre	0.001
Benin	0.009	Ghana	0.057	Mongolia	0.012	Sudan	0.058
Bhutan	0.001	Greece	0.466	Morocco	0.139	Suriname	0.006
Bolivia	0.026	Grenada	0.001	Mozambique	0.018	Swaziland	0.006
Botswana	0.017	Guatemala	0.058	Myanmar	0.037	Sweden	0.951
Brazil	2.110	Guinea-Bissau	0.001	Namibia	0.014	Switzerland	0.971
Burkina Faso	0.013	Guyana	0.002	Nepal	0.019	Syrian Arab R.	0.093
Burundi	0.005	Haiti	0.011	Netherlands	1.393	Tanzania	0.039
Cambodia	0.008	Honduras	0.025	New Zealand	0.211	Thailand	0.419
Cameroon	0.054	Iceland	0.030	Nicaragua	0.014	Togo	0.006
Canada	2.572	India	1.592	Niger	0.010	Tonga	0.001
Central African	0.005	Indonesia	0.715	Nigeria	0.211	Trinidad and T.	0.035
Chad	0.007	Iran. I.R. Of	0.565	Norway	0.581	Tunisia	0.068
Chile	0.220	Ireland	0.284	Oman	0.062	Turkey	0.862
China	3.289	Israel	0.306	Pakistan	0.260	Uganda	0.027
China mainland							
China H.K.	0.425	Italy	4.295	Panama	0.036	UAE	0.217
Colombia	0.305	Kuwait	0.141	Papua New G.	0.017	UK	4.664
Congo.	0.045	Jamaica	0.024	Paraguay	0.029	United States	29.847
Congo. Dem.							
Congo. Rep.	0.012	Japan	13.709	Peru	0.187	Uruguay	0.057
Costa rica	0.040	Jordan	0.031	Philippines	0.254	Venezuela	0.381
Cote d Ivoire	0.050	Kenya	0.056	Portugal	0.360	Yemen Rep.	0.047
Cyprus	0.031	Korea	1.371	Qatar	0.055	Zambia	0.018
Denmark	0.598	Lao people's D.	0.007	Rwanda	0.009	Zimbabwe	0.037

Note: Shares are calculated as share in the total GDP in USD on average over the period 1980-2007.

Table A2. Commodities exported by the 52 commodity-exporting countries in the sample

Country	Principal exports			Share in commodity exports in %		
	1	2	3	1	2	3
Argentina	Soy meal	Wheat	Maize	18	13	11
Australia	Coal	Gold	Aluminum	22	14	12
Bangladesh	Shrimp	Tea	Fish	76	15	8
Bolivia	Zinc	Tin	Gold	27	18	13
Brazil	Iron	Coffee	Aluminum	21	15	10
Burundi	Coffee	Gold	Tea	59	35	2
Cameroon	Cocoa	Hardwood logs	Aluminum	23	22	14
Canada	Softwood sawn	Aluminum	Wheat	28	14	12
Central African	Cotton	Coffee	Softwood logs	82	9	5
Chile	Copper	Fish	Fishmeal	70	9	6
Colombia	Coffee	Coal	Bananas	48	19	18
Costa Rica	Bananas	Coffee	Fish	43	33	5
Côte d'Ivoire	Cocoa	Coffee	Cotton	65	14	6
Dominica	Bananas	Tobacco	Rien	98	1	0
Ethiopia	Coffee	Hides	Cotton	91	5	2
Ghana	Cocoa	Gold	Aluminum	61	24	7
Guatemala	Coffee	Sugar	Bananas	47	24	14
Honduras	Coffee	Bananas	Shrimp	47	30	6
Iceland	Fish	Aluminum	Shrimp	73	20	7
India	Rice	Shrimp	Soy meal	18	15	12
Kenya	Tea	Coffee	Fish	53	30	5
Madagascar	Coffee	Shrimp	Sugar	42	40	6
Malawi	Tobacco	Tea	Sugar	78	8	7
Malaysia	Palm oil	Natural rubber	Hardwood logs	44	15	15
Mali	Cotton	Gold	Rien	88	12	0
Mauritania	Iron	Fish	Gold	65	34	1
Mauritius	Sugar	Wheat	Rien	97	1	0
Morocco	Phosphate rock	Fish	Lead	55	14	7
Mozambique	Cotton	Sugar	Maize	33	19	9
Myanmar	Hardwood logs	Rice	Shrimp	60	18	7
New Zealand	Lamb	Beef	Wool	20	17	14
Niger	Uranium	Tobacco	Rien	96	3	0
Pakistan	Rice	Cotton	Sugar	46	28	13
Papua New G.	Copper	Gold	Palm oil	23	23	20
Paraguay	Soybeans	Cotton	Soy meal	44	26	9
Philippines	Coconut oil	Copper	Bananas	29	21	12
Peru	Copper	Fishmeal	Gold	28	19	15
Senegal	Phosphate rock	Groundnut oil	Fish	29	29	16

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South Africa	Gold	Coal	Iron	46	20	5
Sri Lanka	Tea	Natural Rubber	Tobacco	78	9	6
St. Vincent &G	Bananas	Wheat	Rice	60	23	17
Sudan	Cotton	Gold	Sugar	45	12	12
Suriname	Aluminum	Rice	Nickel	80	8	5
Tanzania	Coffee	Tobacco	Cotton	27	18	17
Thailand	Rice	Natural rubber	Shrimp	26	24	23
Togo	Phosphate rock	Cotton	Coffee	44	40	9
Tunisia	Tobacco	Phosphate rock	Shrimp	23	21	20
Turkey	Tobacco	Wheat	Sugar	34	16	14
Uganda	Coffee	Fish	Gold	71	8	4
Uruguay	Beef	Rice	Fish	36	27	13
Zambia	Copper	Sugar	Rien	97	2	0
Zimbabwe	Tobacco	Cotton	Nickel	58	8	8

Note: Shares are calculated for the period 1991-1999.

Source: Cashin *et al.* (2004), Table 1, pages 246-247, excluding oil-exporting countries.

Table A3. Country-specific dummies

Country	Depreciation	Appreciation	
Algeria	1991		Start of the civil war
Angola	1994, 1995, 1999	1997	Civil war
Argentina	1982, 2002	1990	1982: Falklands war; 1990: hyperinflation; 2002: exchange rate crisis
Costa Rica	1981		Exchange rate crisis (exit form the USD peg)
Ethiopia	1993		
Ghana	1984	1981	1981: suspension of the constitution; 1985: exchange rate crisis
Honduras	1990		Exchange rate crisis
Indonesia	1998		Exchange rate crisis
Iran, I.R. Of	1985		War against Iraq 1980-1988
Libya	2002		Exchange rate crisis
Mozambique	1987		Exchange rate crisis
Myanmar	1990		
Peru		1989	Hyperinflation
Sudan	1992		Civil war 1983-2005
Suriname	1990		Political crisis (leader's demission)
Syrian Arab Republic	1988, 1989		Exchange rate crisis, devaluation of the official exchange rate
Tanzania	1987		Exchange rate crisis, devaluation of the official exchange rate
Uganda	1984, 1991	1981, 1983	1981: fixed exchange rate and strong inflation; 1983: devaluation but > inflation; 1984, 1991: exchange rate crises, devaluation
Uruguay	1983		Exchange rate crisis
Zambia	1986		Exchange rate crisis
Zimbabwe	2003, 2004	2002, 2007	Since 2002: political crisis (election tampering), hyperinflation

Appendix B - Panel unit root and cointegration tests

Table B1. Panel unit root tests

	Levin and Lin	Breitung	Hadri	IPS	MW
<i>Commodity-exporting countries</i>					
LogQ	0.81 (0.79)	4.30 (0.99)	9.68 ^{***} (0)	-0.90 (0.18)	117.07 (0.18)
LogY	2.03 (0.97)	2.49 (0.99)	15.16 ^{***} (0)	3.21 (0.99)	104.09 (0.48)
NFA	2.68 (0.99)	1.37 (0.92)	13.95 ^{***} (0)	-0.78 (0.21)	91.67 (0.80)
LogTOT	3.37 (0.99)	7.32 (1)	13.53 ^{***} (0)	3.33 (0.99)	95.39 (0.71)
<i>Oil-exporting countries</i>					
LogQ	-0.39 (0.35)	-1.17 (0.12)	7.54 ^{***} (0)	-0.59 (0.28)	38.05 (0.21)
LogY	-0.06 (0.47)	3.16 (0.99)	8.79 ^{***} (0)	0.87 (0.80)	34.63 (0.34)
NFA	2.03 (0.98)	3.95 (1)	7.24 ^{***} (0)	2.57 (0.99)	23.05 (0.88)
LogTOT	2.74 (0.98)	3.89 (0.99)	10.77 ^{***} (0)	2.03 (0.98)	10.80 (0.99)

Note: p-values are given in parentheses. * (resp. **, ***): rejection of the null hypothesis at the 10% (resp. 5%, 1%) significance level.

Table B2. Pedroni's panel cointegration tests

	<i>Panel cointegration tests</i>				<i>Group mean cointegration tests</i>		
	<i>v-stat</i>	<i>rho-stat</i>	<i>PP-stat</i>	<i>ADF-stat</i>	<i>rho-stat</i>	<i>PP-stat</i>	<i>ADF-stat</i>
<i>Commodity-exporting countries</i>							
(A)	-1.33 (0.16)	-0.31 (0.37)	-2.53 [*] (0.01)	-2.64 [*] (0.01)	2.76 ^{***} (0)	-1.26 (0.18)	-1.99 ^{**} (0.05)
(B)	1.08 (0.22)	-2.20 ^{**} (0.03)	-4.50 ^{***} (0)	-5.12 ^{***} (0)	1.46 (0.13)	-2.26 ^{**} (0.03)	-3.84 ^{***} (0)
<i>Oil-exporting countries</i>							
(A)	-0.34 (0.37)	2.25 ^{**} (0.03)	-1.35 (0.15)	-2.14 ^{**} (0.03)	3.97 ^{***} (0)	-0.15 (0.39)	-1.76 [*] (0.08)
(B)	-1.21 (0.19)	1.96 ^{**} (0.05)	1.85 [*] (0.07)	1.39 (0.14)	2.67 ^{***} (0.01)	2.59 ^{***} (0.01)	1.82 [*] (0.07)

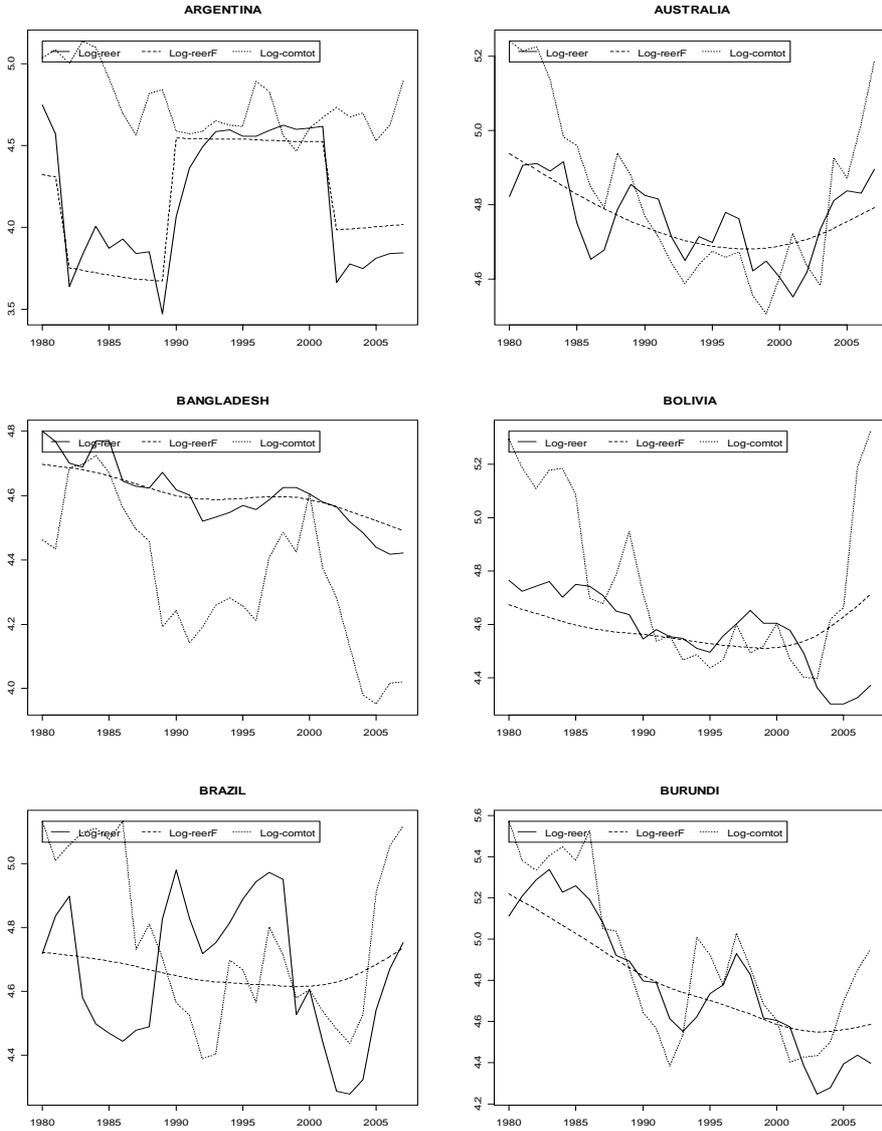
Note: p-values are given in parentheses. * (resp. **, ***): rejection of the null hypothesis at the 10% (resp. 5%, 1%) significance level. (A): complete model (with logY, NFA and logTOT as regressors). (B): model with only logTOT as regressor.

Table B3. Kao's panel cointegration tests

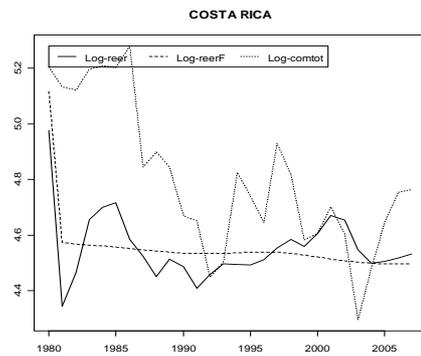
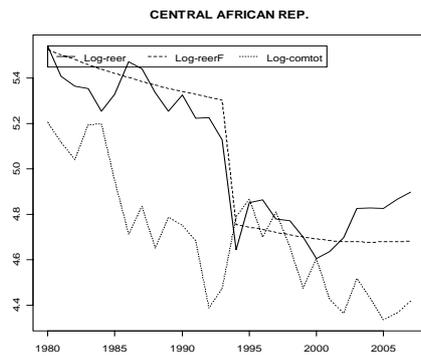
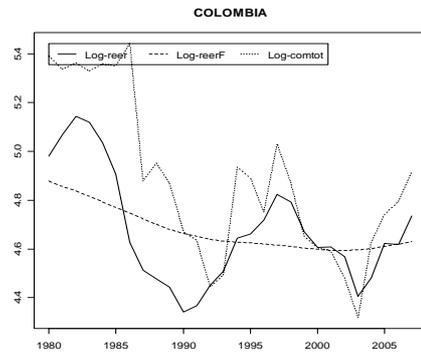
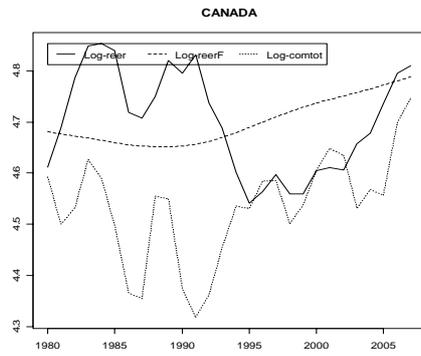
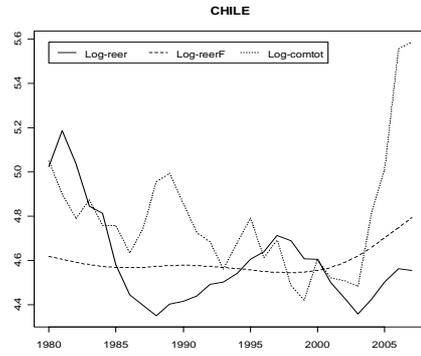
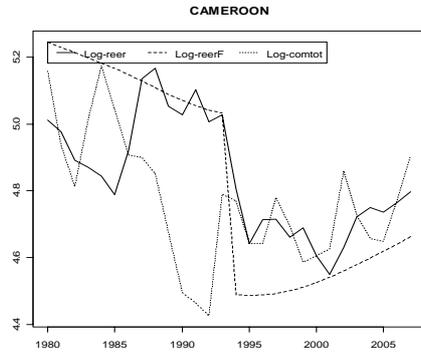
	Commodity- exporting countries	Oil-exporting countries
(A)	-5.23 ^{***} (0)	-1.81 ^{**} (0.03)
(B)	-3.57 ^{***} (0)	-0.76 (0.22)

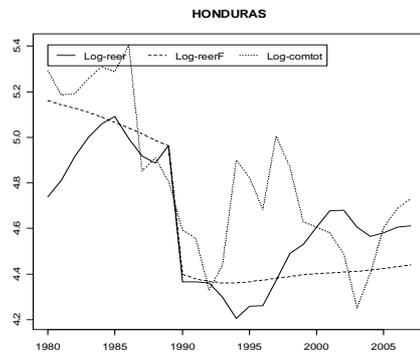
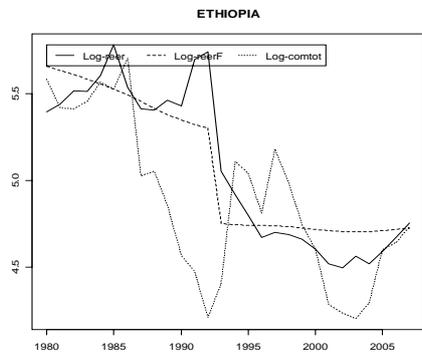
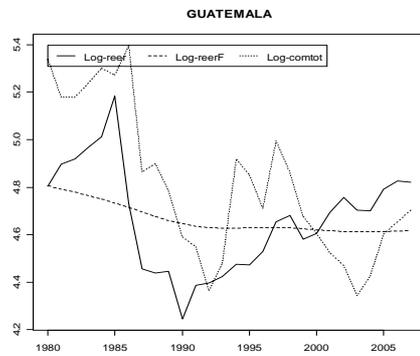
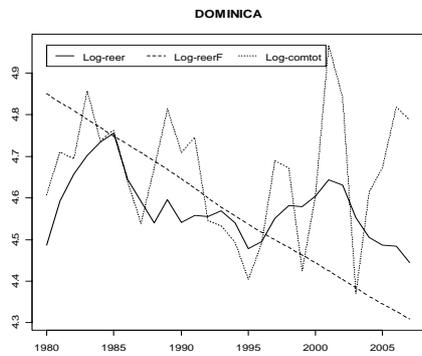
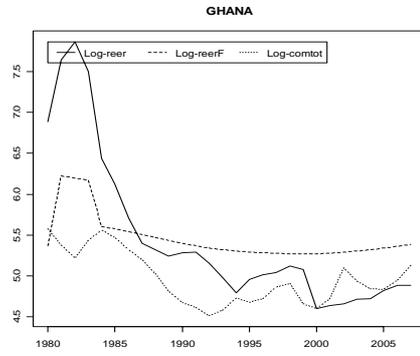
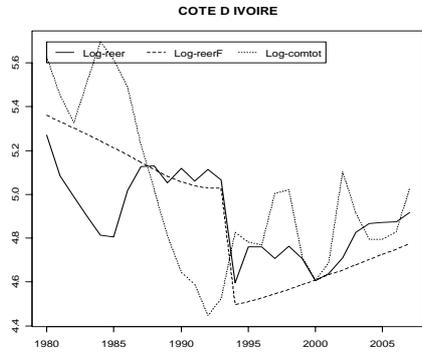
Note: p-values are given in parentheses. * (resp. **, ***): rejection of the null hypothesis at the 10% (resp. 5%, 1%) significance level. (A): complete model (with logY, NFA and logTOT as regressors). (B): model with only logTOT as regressor.

Appendix C - Figures C1. Real exchange rates, equilibrium exchange rates (Model (A)) and terms of trade - Commodity-exporting countries

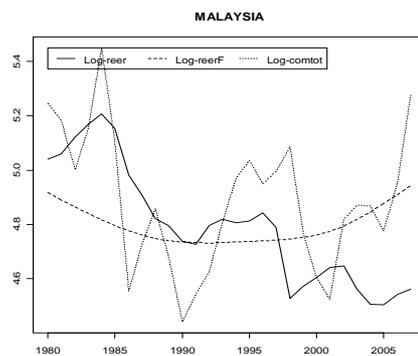
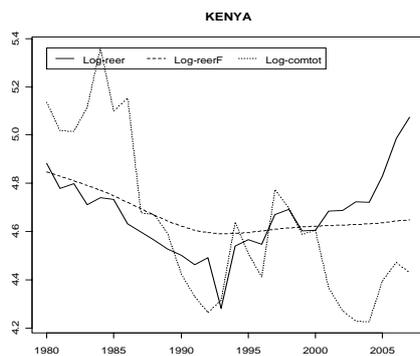
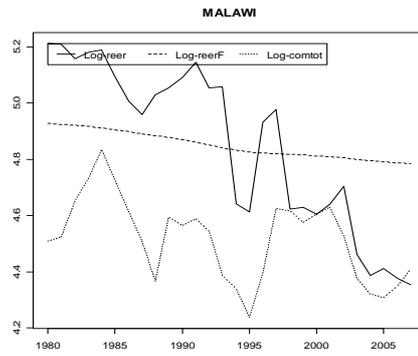
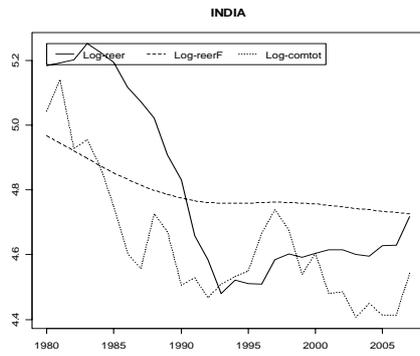
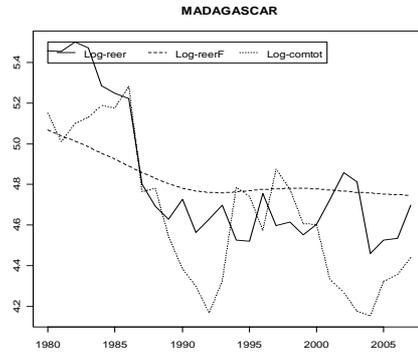
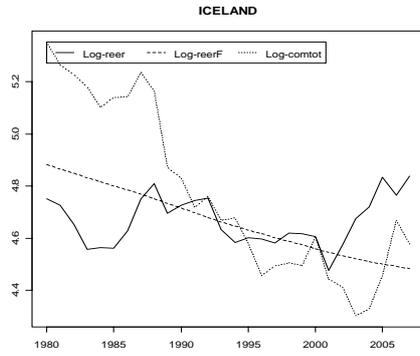


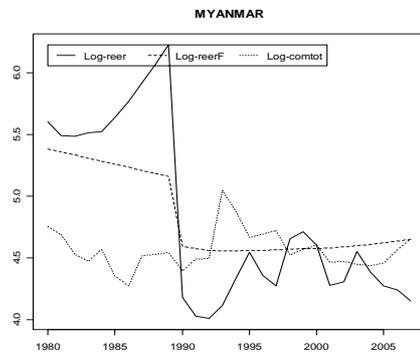
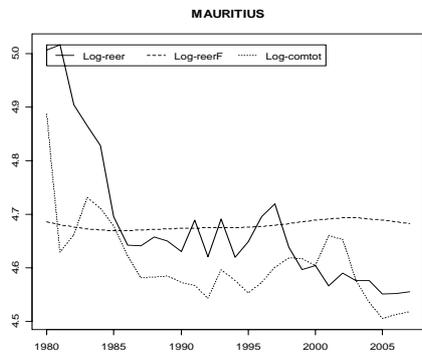
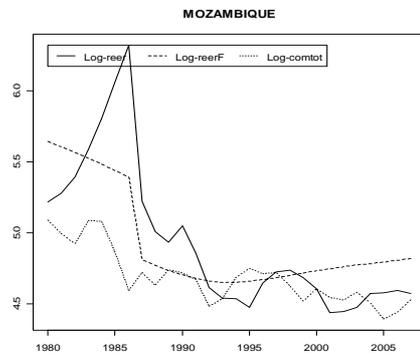
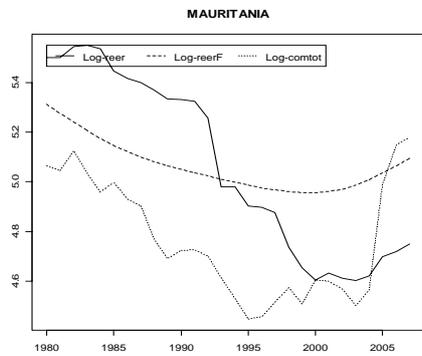
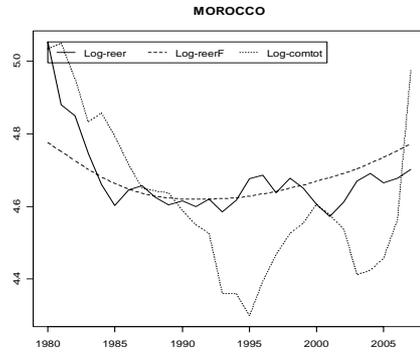
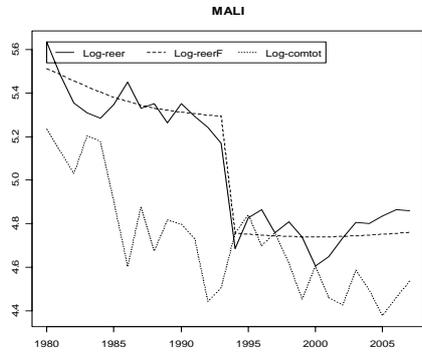
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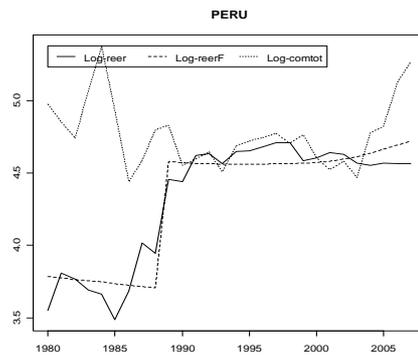
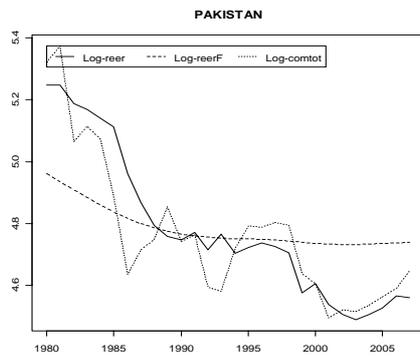
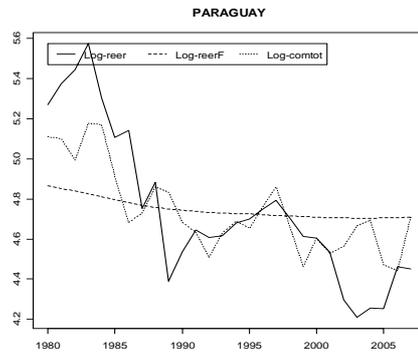
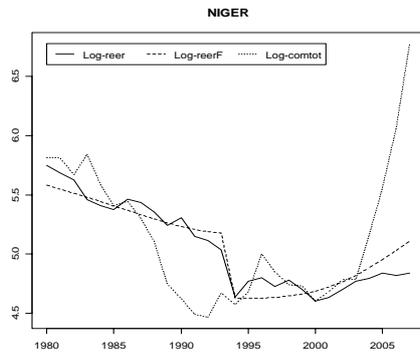
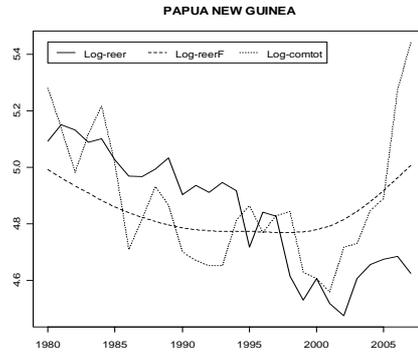
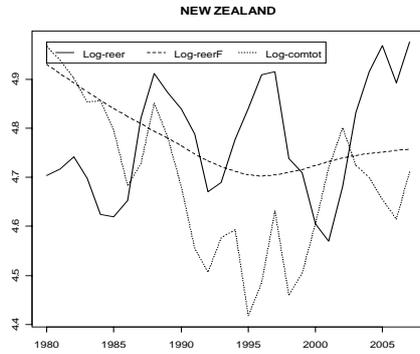


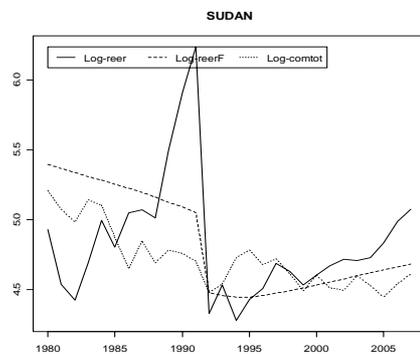
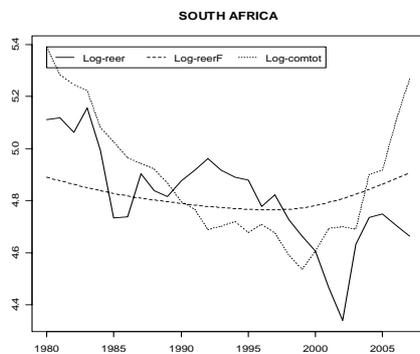
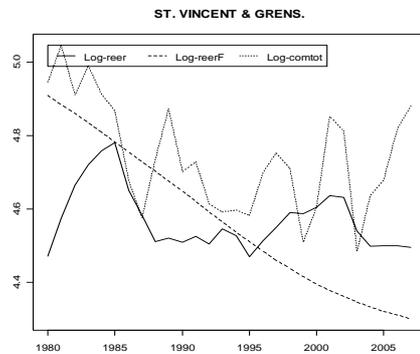
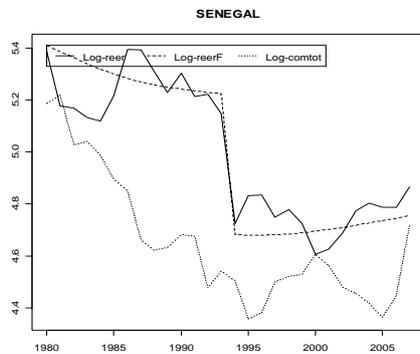
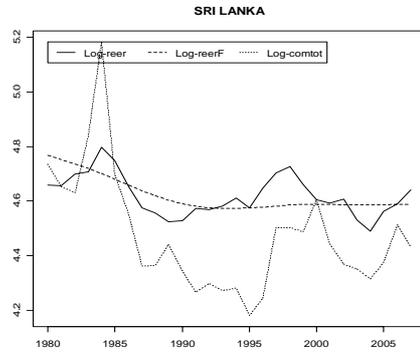
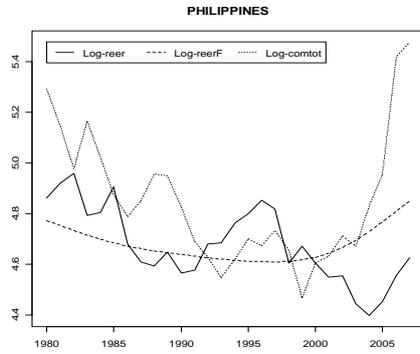
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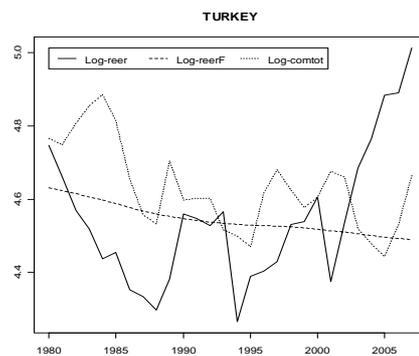
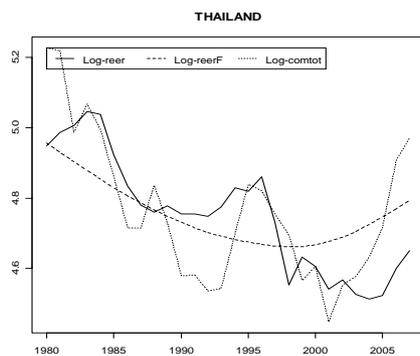
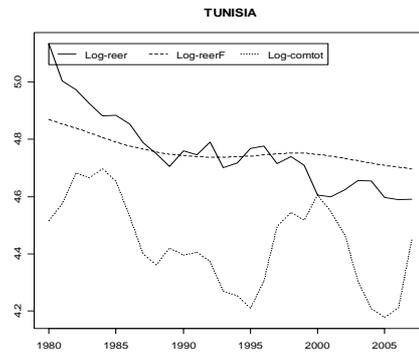
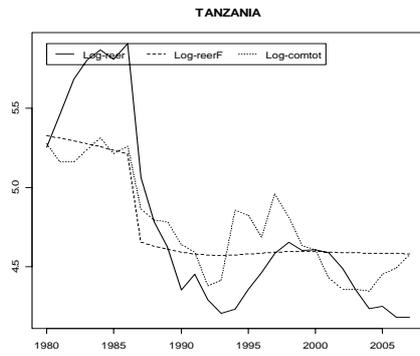
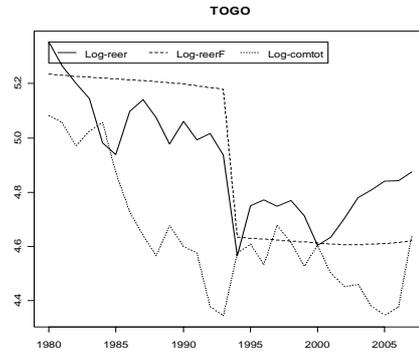
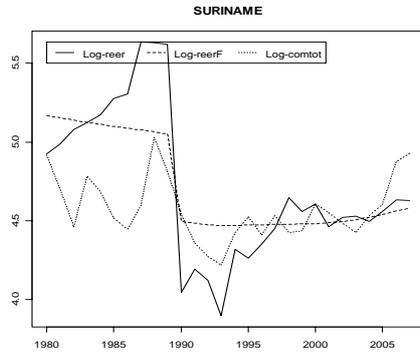


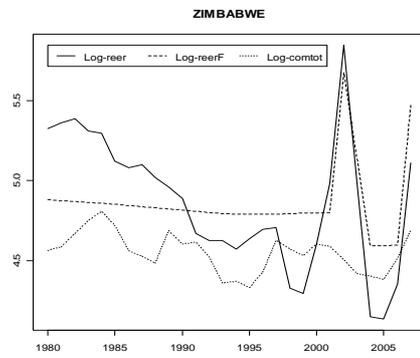
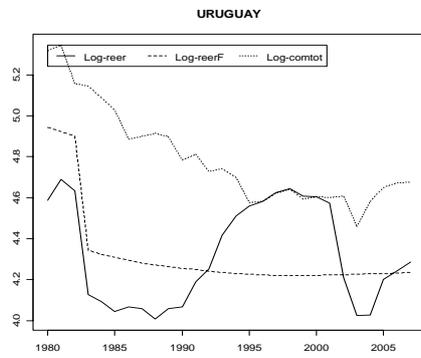
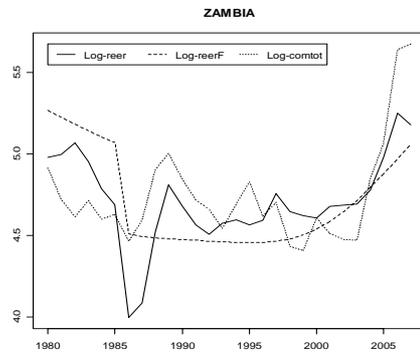
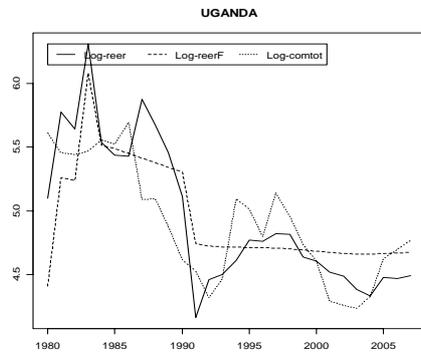
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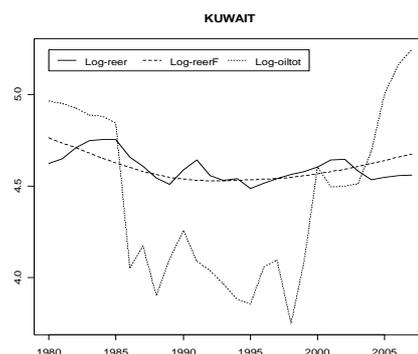
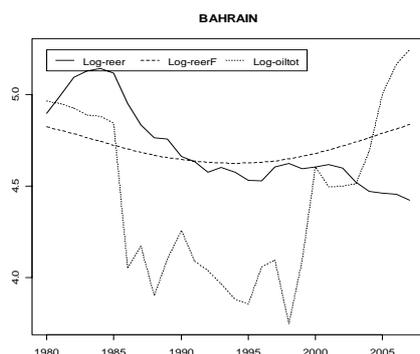
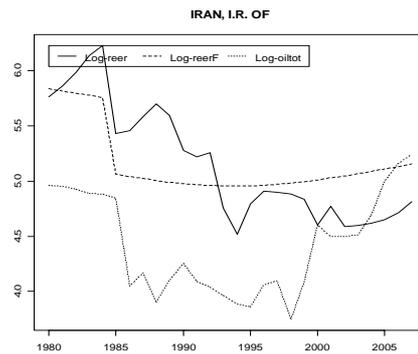
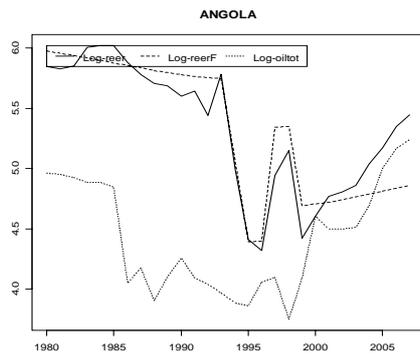
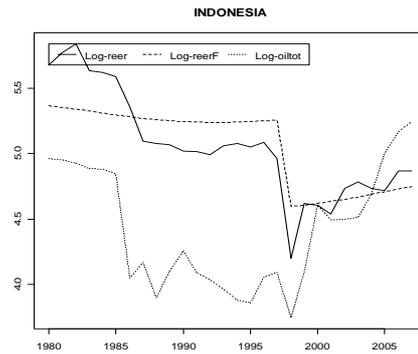
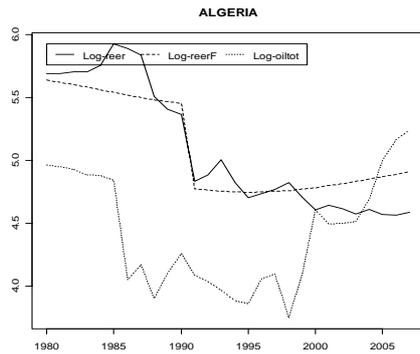


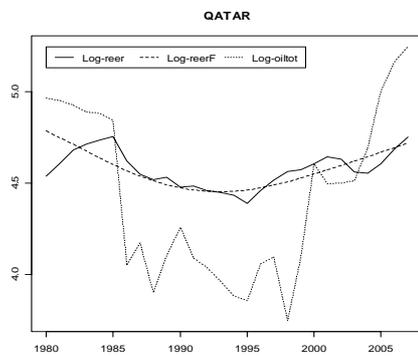
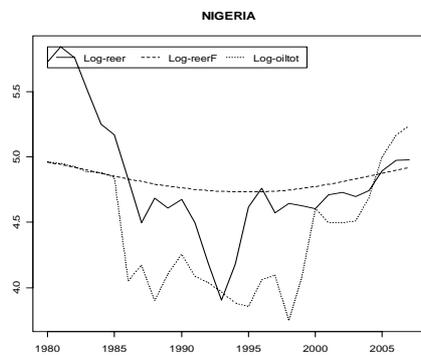
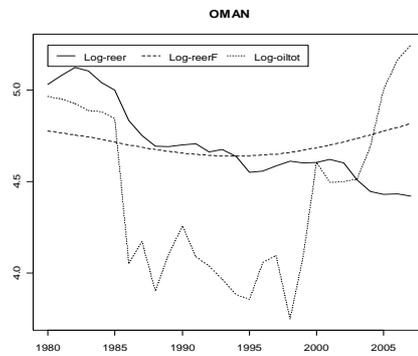
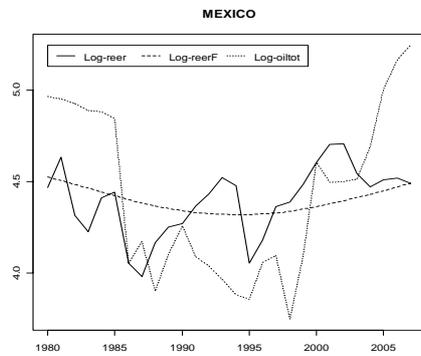
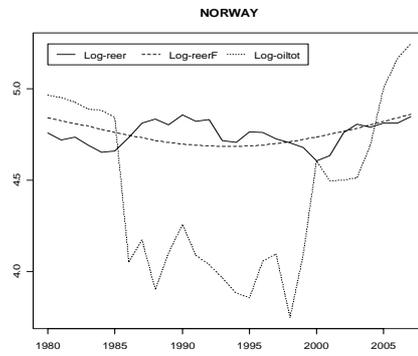
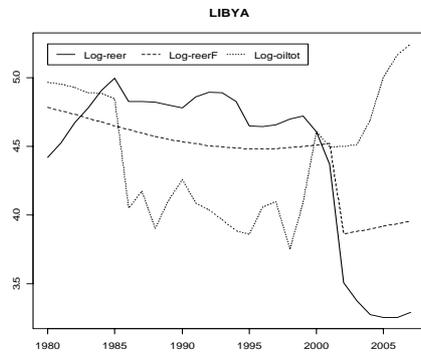
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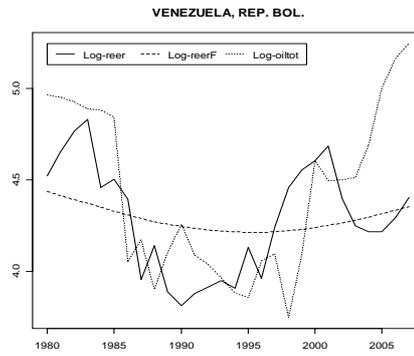
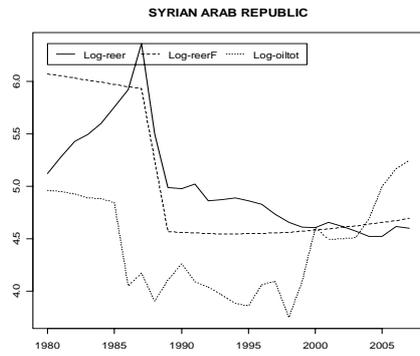
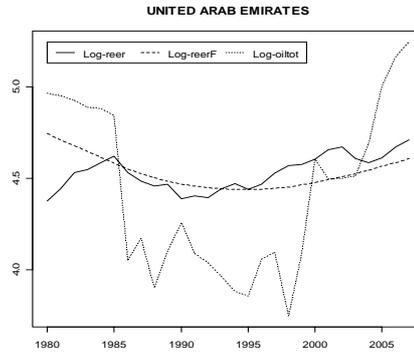
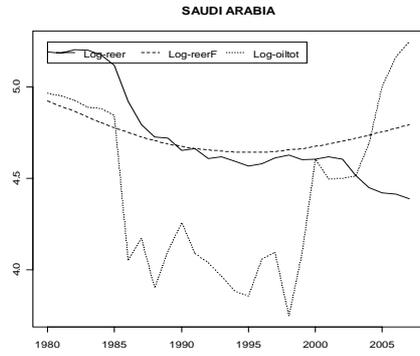


**Appendix C - Figures C2. Real exchange rates, equilibrium exchange rates
(Model (A)) and terms of trade – Oil-exporting countries**





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