WP/09/281

IMF Working Paper

Exchange Rate Assessments: Methodologies for Oil Exporting Countries

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INTERNATIONAL MONETARY FUND

 WP/09/281

IMF Working Paper

Research Department

Exchange Rate Assessments: Methodologies for Oil Exporting Countries

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December 2009

Abstract

Are the current account fluctuations in oil-exporting countries "excessive"? How should their real exchange rate respond to the evolution of external (and domestic) fundamentals? This paper proposes methodologies tailored to the specific features of oil-exporting countries that help address these questions. Price-based methodologies (based on the time series of real effective exchange rates) identify a strong link between the real exchange rate and the terms of trade, but have relatively limited explanatory power. On the other hand, an empirical model of the current account, which fits oil exporting countries' data well, and an intertemporal model that takes into account the stock of oil reserves provide useful benchmarks for oil exporters' external balances.

JEL Classification Numbers: C53, F31, F37

Keywords: Oil exporting countries, current account, real exchange rates, misalignment

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[1] We are grateful to Paul Cashin, Sarma Jayanthi, Jaewoo Lee, Jungjin Lee, Gian Maria Milesi-Ferretti, Jonathan Ostry, Ratna Sahay, Alun Thomas and participants on the IMF Research Department brown bag for helpful comments and suggestions. Any errors are our own.

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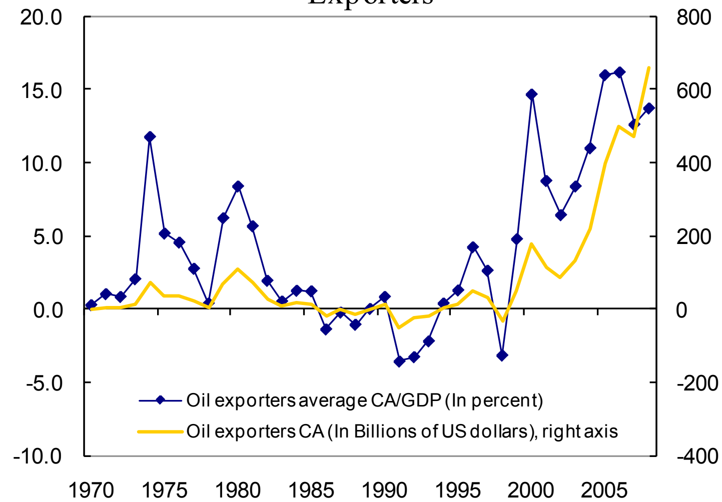
I. Introduction

In recent years, large current account balances (both deficits and surpluses) have become more common and the sum of the absolute value of global current account balances has increased as a share of world GDP (e.g. Faruqee and Lee, 2008). The widening of current accounts has spurred scores of papers and a stimulating debate within both academia and policy making institutions about the determinants and consequences of global imbalances, and whether policy action should aim at narrowing them (e.g., Bernanke, 2005, Blanchard, 2007, Obstfeld and Rogoff, 2005).

Figure 1. Current Account Behavior for Oil Exporters



While many papers in the global imbalances debate contrast external deficits in the U.S. with surpluses in East Asian countries, the current account surpluses of oil-exporting countries have also widened significantly, as oil prices soared in recent years. The average current account surplus of oil exporters increased from about 2½ percent of GDP to almost 15 percent between 2002 and 2008 (text chart). During this same period, the total current account surplus of oil exporters increased from less than $90 billion (0.3 percent of world GDP) to more than $650 billion (1.1 percent of world GDP).[2] With the decline in oil prices since the second semester of 2008, the current account balances of oil exporting countries are likely to narrow substantially in 2009.

The size and the volatility of current account balances in oil exporting countries bring to prominence questions about their role in the global imbalances and the appropriate macroeconomic policy response for oil-exporting countries to fluctuations in oil prices and global economic activity. Are these current account fluctuations "excessive"? How should the real exchange rate respond to the evolution of external (and domestic) fundamentals?

The large literature on exchange rate assessments for advanced and emerging market economies aims at answering this type of question, but it typically does not cover oil-exporting countries or does not take into account their particularities (e.g. Clark and others, 1994; Williamson, 1994;

[2] The oil exporters are Algeria, Angola, Azerbaijan, Kingdom of Bahrain, Republic of Congo, Ecuador, Equatorial Guinea, Gabon, I.R. of Iran, Kazakhstan, Kuwait, Libya, Nigeria, Norway, Oman, Qatar, Russia, Saudi Arabia, Syrian Arab Republic, Turkmenistan, United Arab Emirates, Rep. Bolívariana de Venezuela, and Republic of Yemen.

Isard and Faruqee, 1998; Lee and others, 2007. For the performance of those models, see Abiad and others, 2009). This paper aims to fill this gap by proposing methodologies adequate to the specifics of oil-exporting countries.

Existing methodologies can be broadly classified into three basic approaches:

- **price-based** approaches (often referred to as Behavioral Equilibrium Exchange Rate approaches) provide reduced form econometric estimates of the equilibrium real exchange rate that incorporate among other variables, the effects of net foreign asset accumulation, differentials in sectoral productivity (Balassa-Samuelson effect), the size of government and terms of trade shocks;
- **quantity-based** approaches (often referred to as Fundamental Equilibrium Exchange Rate approaches) estimate medium-term current account benchmarks as a function of medium-term characteristics of the economy (such as its fiscal position, relative income, dependency ratio, population growth);
- **balance-sheet-based** approaches determine the current account that is consistent with a benchmark or desired net foreign assets position.

Oil exporters can differ from other advanced and emerging market countries along multiple dimensions. For example:

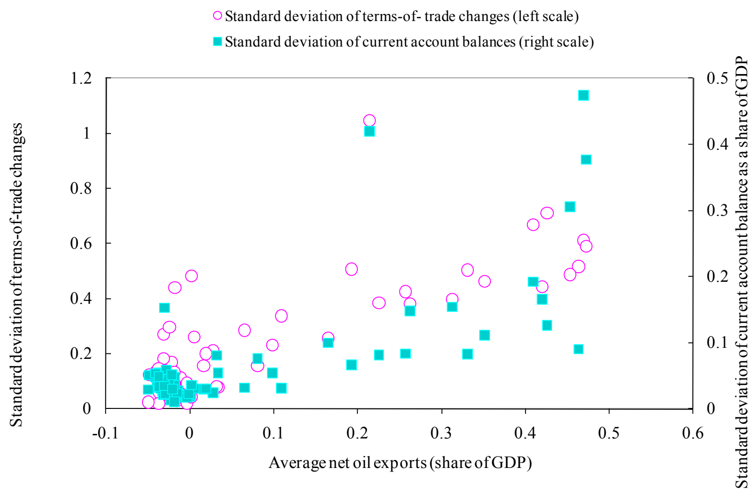
- The fiscal balance in oil-exporting countries is typically dominated by swings in fiscal revenues related to oil exports[3] and is hence strongly correlated with the current account and more volatile than for non-oil-exporters.
- Because oil revenues accrue from the sale of an *exhaustible* resource, transfers from one generation to another play an important role in ensuring intergenerational equity.[4] To avoid sharp decreases in absorption once oil exports decline, exhaustible-resource countries aim to accumulate foreign assets and use income from such assets to offset future decreases in the stream of oil income. Such intergenerational transfers are more important for countries that expect to deplete their exhaustible resource endowment within a relatively short timeframe. As a result, oil exporters can be expected to exhibit large CA surpluses and higher net foreign asset positions (NFA).

[3]Among other revenue sources, oil-related revenues include royalties on oil exploration, export taxes, oil companies' corporate income taxes, and dividends of state-owned oil companies.

[4]See Bems and de Carvalho Filho (2009); and Thomas, Kim, and Aslam (2008).

- Oil-exporting countries are in general exposed to wider fluctuations in their external accounts, because their exports, by definition, are relatively undiversified and oil prices fluctuate more widely than the prices of other goods. Such volatility is directly reflected in the higher volatility of their terms of trade, current accounts as a percent of GDP, and income more generally (see figure below).[5]

Figure 2. Oil Dependency and Volatility, 1970-2006



- As documented by the 'resource curse' literature,[6] per capita output growth in oil exporting countries is systematically lower than in a sample of oil-importing advanced and emerging countries. At the same time, oil exporting countries exhibit lower dependency ratios and higher population growth rates.

- Finally, the paper pays special attention to data requirements and limitations of the available statistical record for oil-exporting countries.

The structure of the rest of the paper is as follows: Section II presents the price based approach; section III presents the quantity based approach; section IV presents the balance sheet based approach; and section V concludes.

[5] See Ghosh and Ostry (1997), Baxter and Kouparitsas (2006) and Bems and De Carvalho Filho (2009).

[6] See Sachs and Warner (2001).

II. Price Based Methodologies

Price-based approaches for exchange rate assessment directly estimate an equilibrium real exchange rate for each country as a function of underlying fundamentals, such as the terms of trade and relative productivity differentials between the tradable and nontradable sectors (i.e. the Balassa-Samuelson variable). For the purpose of forming exchange rate assessments, the adjustment to bring the exchange rate to the level consistent with medium-term fundamentals is then calculated as the difference between the estimated equilibrium real exchange rate and its current value.

Regression-based approaches typically assume that exchange rate misalignments average out over time. This may be true for some countries over several decades, but certainly not for others (particularly if the available sample for that country is short). Judgment by the analyst can be introduced by choosing either a period for which one can assume that the real exchange rate was in synch with its fundamental determinants, or by excluding periods dominated by special circumstances.

A. Regression model setup

The literature has proposed many fundamental determinants of the equilibrium real exchange rate. This paper uses the set of fundamentals adopted in the recent work by Lee and others (2008). These are listed below, discussing their relationship to the real exchange rate in the context of oil-exporting countries:

- *Commodity terms of trade.* Higher commodity terms of trade through real income or wealth effects are expected to boost domestic consumption which would bid up the relative price of non-tradable goods (i.e. cause a real appreciation).[7] This effect is likely to be strong in oil exporters.

- *Productivity differentials.* The Balassa-Samuelson effect refers to the phenomenon whereby a higher productivity growth in the tradable sector bids up wages in the non-tradable sector, resulting in a higher relative price of non-tradables (i.e. a real appreciation). The measurement of the differentials in productivity growth across sectors requires information on sectoral output and employment, and an assumption about the tradability of each sector's output. Data availability is an issue, however, so we proxy productivity differentials with the ratio of GDP per capita, measured in PPP terms, relative to the GDP per capita of the United States (henceforth, *relative income*), as we do not have sectoral productivity variables for oil-exporting countries. This measure may be problematic—for example, oil-exporting countries' relative income is likely to reflect oil

[7] For the construction of the commodity terms of trade variable, see Lee et al. (2008). For the relationship between commodity prices and exchange rates, see Chen and Rogoff (2003).

price fluctuations to a much larger extent than relative productivity between the traded and the nontraded goods' sector.

- *Net foreign assets.* An increase in NFA is generally associated with higher wealth and investment income, thereby affording a more appreciated real exchange rate. However, the relationship between NFA and the real exchange rate is much less clear-cut for oil-exporting countries. In particular, in these countries an increase in net foreign assets may only reflect the transformation of underground oil wealth into financial assets, and hence no increase in net wealth. Therefore, a more appropriate measure of "fundamentals" would be the sum of net foreign assets and underground oil wealth.[8] In addition, only a few oil exporting countries publish their International Investment Position (IIP) (and typically for only a few recent years), and lack of data severely hampers estimation of NFA positions for those countries than do not publish official estimates. [9]

- *Government consumption.* The theoretical effect of higher government consumption on the real exchange rate depends on whether government consumption tilts domestic demand towards or away from non-tradable goods. In general, the literature argues that government consumption disproportionately increases demand for non-tradable goods, thus contributing to a real appreciation. [10]

- *Trade restriction index.* Trade restrictions lead to higher domestic prices and more appreciated exchange rates. The measure of trade restrictions used in this exercise draws and extends the data from Wacziarg and Welch (2003).

- *Price controls.* Because price controls cap the prices of some goods, they can be associated with a lower CPI and a more depreciated real exchange rate. To capture such effects, the share of administered prices in the CPI basket is used – this proxy for prevalence of price controls is expected to be negatively correlated with real appreciation. Unfortunately, this variable (constructed by the EBRD) is available exclusively for transition economies, and therefore cannot be used to explain the real exchange rate of oil-exporting countries.[11] This is a serious limitation, because some oil-exporting

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[8] Morsy (2009) finds a small negative effect of oil wealth on the current account of oil countries.

[9] The source for the NFA data is the External Wealth of Nations (EWN II) dataset described in Lane and Milesi-Ferretti (2007).

[10] The source for government consumption data is OECD, Annual National Income Accounts where available and a combination of IFS and WEO data for all the other countries, and this variable is expressed as deviation from trading partner averages.

[11] The share of administered prices is constructed by the EBRD as the number of categories with administered prices out 15 categories (http://www.ebrd.com/country/sector/econo/stats/index.htm and http://www.ebrd.com/country/sector/econo/stats/sci.xls)

countries have extensive price controls, which are very likely to affect the time series of domestic prices and (given mostly pegged exchange rates) the real exchange rate.

For the price-based approaches, the focus is on the long-run equilibrium value for the real exchange rate and how it depends on fundamentals. Because for each country there are no more than three decades of data, the estimation explores the panel dimension.

B. Econometric results

The first step in our econometric analysis is to establish whether there is a long-run relationship between the real exchange rate and its proposed fundamentals. That is the case if those variables have unit roots and there is a linear combination of those variables which does not exhibit unit root behavior, i.e. if real exchange rates are cointegrated with their fundamentals.[12]

Panel unit root tests underscore strong evidence that ratios of net foreign asset to GDP and trade; government consumption to GDP and commodity terms of trade have unit roots, and some evidence that there are unit roots in the log of REER and relative income. (Appendix Table 1A presents evidence from univariate unit root tests, performed country-by-country; Appendix Table 1B presents estimates of panel unit root test by Im, Pesaran and Shin, 2003).

For the sample of advanced and emerging countries analyzed by Lee and others (2008), we find evidence in favor of panel cointegration for the real exchange rate specification including NFA to trade, terms of trade, government consumption and relative income, as the Pedroni (1999) tests reject the null of no cointegration for 3 out of 7 statistics (Appendix Table 2, column 1).

The inclusion of oil-exporting countries, however, causes the tests to fail to reject the null for the specification with NFA to trade (column 2), which suggests that we ought to treat oil exporting countries separately in this context.

We then restrict the sample to 10 oil-exporting countries for which we have at least 25 years of data. In that sample, we fail to reject the null of no cointegration for the specifications including *relative income* (columns a-c), while we reject the null for those specifications excluding that variable (columns d-g). One might take this as evidence that relative income is a poor proxy for Balassa-Samuelson effects, and more so for oil-exporting coutries. Moreover, we find the

[12] For the unit root and cointegration tests we use a sample with countries with at least 25 years of data, which include 10 oil-exporting and 33 emerging and advanced oil-importing countries. The 10 oil countries are: Algeria, Ecuador, Kuwait, Norway, Oman, Qatar, Saudi Arabia, Trinidad and Tobago, United Arab Emirates, and República Bolivariana de Venezuela. The 33 advanced and emerging oil-importing countries are Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, Colombia, Denmark, Finland, France, Germany, Greece, Hong Kong, India, Ireland, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, New Zealand, Pakistan, Philippines, Portugal, Singapore, South Africa, Spain, Sweden, Taiwan Province of China, United Kingdom, and United States.

strongest evidence against the null of no cointegration for the bivariate cointegrating vector including real exchange rate and terms of trade (column g).

Assuming panel cointegration, we estimate the coefficients of the cointegrating vector, using panel and group-mean based methods that extend Stock and Watson (1993)'s DOLS.

The equation estimated is:

$$\ln(reer_{it}) = \mu_i + \theta_i Y_{it} + \beta_i x_{it} + d_i\left(L\right)\Delta Y_{it} + v_{it}$$

where μ_i are country fixed-effects that are needed because the real exchange rate is an index number; Y_{it} are the fundamentals that are cointegrated with the (log) real exchange rate; x_{it} are exogenous variables; $d_i(L)$ is a two-sided polynomial on the lag operator (i.e. the equation includes the lags and leads of the differences of the Y variables).

The Panel DOLS model assumes homogeneous coefficients within groups, i.e. for each country i, $\theta_i = \theta_J$ where $J = \{OIL, NOIL\}$. Because this method pools the data of all countries, it allows for the inclusion of countries with shorter time series, which permits a sample of 16 oil-exporters and 44 other countries. In Table 1, columns 1-3, we present estimates for the full sample, whereas in columns 4-7, for the sample to oil-exporting countries. In summary, the results show that a 10 percent improvement in the commodity terms of trade is associated with an equilibrium REER appreciation of about 3 to 4 percent for oil exporting countries, and while estimates or the sample of other countries have larger point estimates, we cannot reject the null of similar effects across groups; and that we find a much smaller effect of government consumption for oil-exporting countries than for other countries, and a negative effect of net foreign assets.

The Group-mean DOLS method (Pedroni, 2001) consists of estimating a dynamic OLS (DOLS) model for each country individually, and averaging the coefficients across all countries or within groups. It does not restrict the individual country coefficients, and allows for heterogeneous slopes and trends across groups, which is relevant when comparing oil-exporting and oil-importing countries. We report group means of θ (i.e. $\bar{\theta}_{OIL} = \sum_{i \in OIL} \theta_i$ and $\bar{\theta}_{NOIL} = \sum_{i \notin OIL} \theta_i$) in Table 1 columns (a) through (g), based on a restricted sample of 10 oil-exporting and 33 oil-importing countries with at least 25 observations:

- A 10 percent improvement in the commodity terms of trade is associated with an equilibrium REER appreciation of about 3.5 to 5 percent for oil exporting countries, in most cases indistinguishable from estimates for other countries.

- An increase in government consumption (relative to trading partners) of one percent of GDP is associated with an equilibrium REER appreciation of about 2¾-3¼ percent for all countries, and we cannot reject the null hypothesis of similar group means for oil-exporting and other countries;[13]

- An improvement in relative income of 1 percentage point is associated with an equilibrium REER appreciation of about 1½ percentage points, with no statistically significant difference across groups, but we discount this result because we cannot reject the null of no panel cointegration for the oil-exporting countries sample in the specifications including this variable.

- The coefficient on net foreign assets is negative for oil-exporting countries. This result can be explained by the poor quality of the NFA data for those countries as well as the conceptual problems with interpreting increases in net foreign assets as increases in overall wealth.

C. Robustness

Looking at the results from individual for oil countries that underscore the group mean estimates reported in column (f), we find that:

- commodity terms of trade is statistically significant (in 9 out of 10), with the expected sign in all 10 oil-exporting countries, ranging from about 0.11 (Oman) to 1.07 (Algeria);

- government consumption is statistically significant and positive for 4 out of 10 countries (Algeria, Norway, Qatar and United Arab Emirates), and statistically significant and negative for 2 out of 10 countries (Oman and Saudi Arabia).

D. Implementation

This regression-based approach focuses on estimating the long-run relation between real exchange rates and fundamentals, without accounting for short-term factors. The real exchange rate consistent with underlying fundamentals can be calculated on the basis of the current value of exchange rate fundamentals (i.e. $ERER_{it}^{1} = \hat{\theta} Y_{it}$), or on the basis of expected medium-term or trend values of fundamentals (i.e. $ERER_{it}^{2} = \hat{\theta} E_{t}[Y_{it+k}]$).

In sum, time-series methods based on the behavior of the real effective exchange rate in oil exporters identify a strong link between the real exchange rates and the terms of trade, but yield overall mixed results in terms of significance of other explanatory variables as well as overall fit. The weakness of these results is not too surprising, considering the daunting data limitations faced in the analysis—in particular, lack of data on NFA, productivity variables, and the scope and time variation of price controls.

[14] In Isard and Faruqee (1998) and Lee and others (2008) the methodology is called "macroeconomic balance (MB) approach."

Table 1. ERER Regression: Long-Run Coefficients (1980-2007), **Panel DOLS estimates**

	Panel DOLS						
Sample	ALL (1)	ALL (2)	ALL (3)	OIL (4)	OIL (5)	OIL (6)	OIL (7)
Commodity terms of trade							
Oil-exporting countries	.321***	.348***	.368***	.343***	.365***	.279***	.299***
Other countries	.514***	.471**	.471**				
P-value H0: equal slopes	0.3383	0.5687	0.633				
Government consumption to GDP							
Oil-exporting countries	0.445	0.397	.556*	0.380	.54*	-0.0224	
Other countries	2.12***	2.16***	2.16***				
P-value H0: equal slopes	0.001	0.001	0.003				
Net foreign assets to trade							
Oil-exporting countries	-.0108*						
Other countries	.0351**						
P-value H0: equal slopes	0.006						
Net foreign assets to GDP							
Oil-exporting countries		-.0296**	-.0354***	-.0299**	-.0359***		
Other countries		0.0243	0.0242				
P-value H0: equal slopes		0.083	0.054				
Relative income							
Oil-exporting countries	0.160	.184*		.185*			
Relative productivity differentials							
Other countries	.22***	.219***	.223***		0.461		
Number of countries	60	60	60	16	16	16	16
Number of observations	1109	1113	1113	320	320	339	341
Rejects H0: no panel cointegration?	Yes	Yes	Yes	No	Yes	Yes	Yes

Notes: The equation estimated is: $\ln(reer_{it}) = \mu_i + \theta_i Y_{it} + \beta_i x_{it} + d_i(L)\Delta Y_{it} + v_{it}$ where $d_i(L)$ are symmetrical polynomials of order 1 (i.e. $d_i(L)\Delta Y_{it}$ includes one lead and one lag of ΔY_{it}). The Panel DOLS model assumes homogeneous coefficients within groups, i.e. for each country *i*, $\theta_i = \theta_J$ where *J ={OIL, NOIL}*. The tests for panel cointegration are presented in Appendix Table 2. Additional variables not reported in the specification are: country fixed effects, dummies for Indonesia, Malaysia and Thailand pre 1986; Argentina under the Convertibility Plan (1991-2001); Russia 1999-2000; Libya pre 2002 (International Monetary Fund, 2003); and Algeria pre 1992 (International Monetary Fund, 1993). (*) denotes statistical significance at the 10% significance level; (**) at the 5% level; and (***) at the 1% level. For sample composition, please refer to Appendix Table 3.

Table 1. ERER Regression: Long-Run Coefficients (1980-2007), **Group Mean DOLS estimates** (concluded)

	Group-mean DOLS						
	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Commodity terms of trade							
Oil-exporting countries	0.457 ***	0.453 ***	0.372 ***	0.459 ***	0.429 ***	0.501 ***	0.401 ***
Other countries	0.456 ***	0.332 **	0.246 ***	0.353 ***	0.353	0.342 ***	0.730 ***
P-value H0: equal slopes	*0.496*	*0.261*	*0.036*	*0.192*	*0.453*	*0.023*	*0.007*
Government consumption to GDP							
Oil-exporting countries	3.116 ***	2.777 ***	2.942 ***	2.718 ***	2.499 ***	2.825 ***	
Other countries	3.128 ***	2.986 ***	3.242 ***	2.348 ***	2.683 ***	3.264 ***	
P-value H0: equal slopes	*0.491*	*0.455*	*0.382*	*0.198*	*0.338*	*0.252*	
Net foreign assets to trade							
Oil-exporting countries	-0.022 ***			-0.008 ***			
Other countries	-0.022 ***			-0.001 **			
P-value H0: equal slopes	*0.478*			*0.000*			
Net foreign assets to GDP							
Oil-exporting countries		-0.329 ***			-0.157 ***		
Other countries		0.159 ***			0.229 ***		
P-value H0: equal slopes		*0.000*			*0.000*		
Relative income							
Oil-exporting countries	1.452	1.371	1.803 ***				
Other countries	1.97 ***	1.488 ***	2.129 ***				
P-value H0: equal slopes	*0.348*	*0.494*	*0.222*				
Number of oil-exporting countries	10	10	10	10	10	10	10
Number of other countries	33	33	33	33	33	33	33
Rejects H0: no panel cointegration?	Weakly	No	No	Yes	Yes	Yes	Yes

Notes: The equation estimated is: $\ln(reer_{it}) = \mu_i + \theta_i Y_{it} + \beta_i x_{it} + d_i(L)\Delta Y_{it} + v_{it}$ where $d_i(L)$ are symmetrical polynomials of order 1 (i.e. $d_i(L)\Delta Y_{it}$ includes one lead and one lag of ΔY_{it}). The Group-mean DOLS does not restrict the individual country coefficients and reports group means of θ (i.e. $\bar{\theta}_{OIL} = \sum_{i \in OIL} \theta_i$ and $\bar{\theta}_{NOIL} = \sum_{i \notin OIL} \theta_i$). The tests for panel cointegration are presented in Appendix Table 2.

(*) denotes statistical significance at the 10% significance level; (**) at the 5% level; and (***) at the 1% level. For sample composition, please refer to Appendix Table 3.

III. Quantity Based Methodologies

Quantity-based approaches for the assessment of exchange rates and external balances are based on the equilibrium relationship between current account balances and a set of fundamentals (measured, when relevant, as differences from trading partners' averages).[14] These fundamentals include variables such as the fiscal balance, demographics, the oil balance, net foreign assets to GDP, and economic growth, which are all robust determinants of the current account balance.[15]

We take as benchmark the current account regression model presented in Lee and others (2008). To incorporate oil exporters to this framework, some adaptations are required: (1) in order to separate the effects of oil revenues and fiscal policy conduct on the current account, the relevant fiscal variable should be the non-oil fiscal balance; (2) to capture intergenerational transfers and the delayed response of consumption and investment to changes in oil income, we estimate a specific oil-balance coefficient for oil exporters, as well as for those exporters with more limited reserves; and (3) to capture differences in current account persistence, we estimate a specific lagged current account coefficient for oil exporters. The analysis also includes tests for differences in the other coefficients.

There are two important caveats to the results. The first is the limited availability and problematic quality of historical data for several oil exporters—in particular, the measurement of the non-oil fiscal balance is fraught with difficulties because the definition of the "oil sector" can differ across countries. Second, the non-oil sector in oil-exporting countries may include oil-related activities, such as petrochemicals and fertilizers. This may imply a stronger link between the current account and oil prices than direct oil sales would suggest and hence a higher positive coefficient on the oil balance in the current account regression.

Regression results are reported in Table 2 below.[16] Column (1) presents coefficients for the baseline current account regression in Lee and others (2008). The regression sample comprises developed and emerging market countries but excludes oil exporters, with the exception of Norway and Algeria. It spans the period 1969 to 2007, with each observation corresponding to a four-year average, with the exception of the last period (2005 through 2007). Column (2) presents results for the entire sample of countries, which also includes oil

[14] In Isard and Faruqee (1998) and Lee and others (2008) the methodology is called "macroeconomic balance (MB) approach."

[15] Cá Zorzi, Chudik and Dieppe (2009) and Bussière, Ca' Zorzi, Chudík and Dieppe (2009) estimate a similar model for current account determination using Bayesian Averaging of Classical Estimates (BACE) methods on annual data.

[16] The regression sample excludes Angola, Republic of Congo, Equatorial Guinea, Gabon, and Nigeria, based on average size and GDP per capita during the sample period.

exporters. Column (3) excludes the lagged current account variable. Finally, column (4) displays the specification where lagged net foreign assets substitute for the lagged current account. Estimated coefficients are, in general, statistically and economically significant and have expected signs and plausible magnitudes. Furthermore, the fit of the regression is very good (less so for the specifications without the lagged current account), especially in light of the fact that fixed country effects are not included.

For the discussion below, we focus on the results in column (2) since the specification with the lagged current account seems to perform better than the ones without it (columns 3-4) in terms of lower root mean square error and higher adjusted R-squared.

Focusing first on those variables that have similar effects on the current account balance in both groups of countries, the estimates imply that the effects of the dependency ratio (ratio of population above age 65 to population between ages 30 and 64), population growth and per capita GDP growth are statistically and economically indistinguishable across oil exporters and importers. A higher dependency ratio reduces the current account balance; a 1 percentage point increase in the population growth rate relative to trading partners lowers the current account by about 0.9–1.6 percent of GDP; and a 1 percentage point increase in per capita GDP growth relative to trading partners lowers the current account in developing countries by about 0.04-0.15 percent of GDP.

As for the impact of other variables on the current account, there are statistically and economically significant differences between oil exporters and other countries:

- A 1 percentage point improvement in the (non-oil) fiscal balance is associated with a 0.4 percentage point increase in the current account balance in percent of GDP for oil exporters, and to an increase of about 0.12 percentage point for other countries. This difference is statistically significant at the 5 percent level. This result is consistent with evidence that, in less financially developed countries, the relation between fiscal balance and the current account balance is stronger.[17]

- The current account balance responds more strongly to the oil balance in oil exporters than in oil importers. This result is consistent with the notion that, because oil is an exhaustible resource, the propensity to save out of an oil price windfall is higher. Also, oil typically plays a more central economic role in oil exporters than in oil importers—as a result, the same oil price shock implies a larger change in income for oil exporters. With adjustment costs to consumption and investment, the response of the current account to an oil price shock is likely to be larger for oil exporters, at least in the short run.

[17] When we instrument non-oil fiscal balance with its own lag, the coefficient for non-oil fiscal balance for oil exporting countries becomes even larger.

- Among oil exporters, we expected that the response of the current account to the oil balance would be stronger in countries with lower oil and gas reserves (such as Algeria and Norway), consistent with the fact that their oil revenues are more temporary than for other exporters, however we could not find significant differences between oil exporting countries with lower reserves and the other ones.

- For oil exporters, the coefficient on lagged net foreign assets to GDP comes insignificant and with a negative signal (column 4), whereas for oil importers it is positive and statistically significant. However, the quality of the data on net foreign assets is very poor for most oil-exporting countries, so the imprecise estimate may reflect measurement error problems.

An increase in relative income – defined here as the ratio of country j per capita GDP adjusted to purchasing power parity (the PPPPC variable at the WEO) to the United States figure – raises the current account balance significantly more in oil countries than in other countries—an oil-exporting country with income half the level in the United States will have, on average, a current account balance that is 3–4 percentage points of GDP smaller than that of a country with income equal to the U.S. level (the difference is ½–1 percentage point for other countries).[18] A possible explanation for this effect is that among oil countries, there is a correlation between high income levels and a large share of future income from the more volatile exhaustible resource sector (for instance, Figure 4 in Bems and de Carvalho Filho, 2009). In that case, the oil countries with higher income levels are also the ones expected to have more precautionary savings and larger CA surpluses.

In conclusion, the estimation results are broadly consistent with the theoretical predictions. Oil-exporting countries are likely to run large external surpluses, particularly at times of peaks in production and high oil prices. This is consistent with the need to smooth consumption over time and between generations, in light of the exhaustible resource nature of oil, as well as with the partly transitory nature of oil revenue booms and the presence of adjustment costs and capacity constraints to consumption and investment.

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[18] This difference in the effect of relative income is entirely due to variation in relative income within countries, is robust to exclusion of new oil countries as Kazakhstan and Republic of Azerbaijan, but it fades away if the sample excludes only Kuwait and Qatar, the countries with the highest average current account balance to GDP in the sample.

Table 2. Determinants of the current account in the medium-run: 1969-2007.

Sample	Lee and others (2008)	Including oil exporters		
	(1)	(2)	(3)	(4)
Non-oil fiscal balance				
MB countries	0.149	0.119	0.270	0.253
	(0.0401)	(0.0435)	(0.0655)	(0.0601)
Oil countries		0.385	0.233	0.202
		(0.112)	(0.163)	(0.229)
P-value H0: equal slopes		*0.044*	*0.853*	*0.846*
Oil balance				
MB countries	0.167	0.170	0.266	0.277
	(0.0646)	(0.0718)	(0.123)	(0.115)
Norway and Algeria	0.186	0.534	0.593	0.586
	(0.097)	(0.0858)	(0.0766)	(0.122)
Oil countries		0.462	0.578	0.553
		(0.0621)	(0.0835)	(0.094)
P-value H0: equal slopes		*0.006*	*0.044*	*0.070*
Relative income				
Other countries	0.020	0.016	0.001	0.008
	(0.0095)	(0.0154)	(0.0245)	(0.0247)
Oil countries		0.074	0.090	0.121
		(0.0308)	(0.0161)	(0.036)
P-value H0: equal slopes		*0.038*	*0.002*	*0.001*
Lagged current account				
Other countries	0.479	0.469		
	(0.0648)	(0.0711)		
Oil countries		0.593		
		(0.0429)		
P-value H0: equal slopes		*0.132*		
Lagged net foreign assets				
Other countries				0.023
				(0.0117)
Oil countries				-0.009
				(0.00956)
P-value H0: equal slopes				*0.037*
Relative growth				
Developing countries	-0.152	-0.031	-0.506	-0.381
	(0.0887)	(0.0927)	(0.181)	(0.139)
Dependency ratio	-0.151	-0.175	-0.081	-0.153
	(0.0477)	(0.0905)	(0.126)	(0.106)
Population growth	-0.935	-1.430	-1.340	-1.260
	(0.442)	(0.874)	(0.885)	(1.21)
Asia X Year>=1996, excl PAK	0.033	0.030	0.056	0.043
	(0.00552)	(0.00611)	(0.0105)	(0.00955)
Financial center	0.025	0.029	0.042	0.032
	(0.00486)	(0.00654)	(0.016)	(0.0134)
Observations	420	510	561	501
Number of countries	51	64	64	64
RMSE	0.0278	0.0495	0.0644	0.0638
R-squared	0.6610	0.7380	0.5340	0.5450

Notes: The sample spans from 1969 to 2007, with each observation corresponding to a four-year average, with the exception of the last period (2005 through 2007). Oil countries included in the regression are: Algeria, Azerbaijan, Kingdom of Bahrain, I.R. of Iran, Kazakhstan, Kuwait, Libya, Oman, Qatar, Russia, Saudi Arabia, United Arab Emirates, and Rep. Bolívariana de Venezuela. Standard errors are reported in brackets.

IV. BALANCE SHEET-BASED METHODOLOGIES

Balance sheet based methodologies for real exchange rate assessments seek to determine the required real exchange rate change that would bring a country's net foreign asset position (NFA) to a desired or benchmark level. For instance, the external sustainability (ES) approach usually sets the NFA position of the most current year as the desired benchmark (see Lee et al., 2008). Alternatively, the benchmark NFA may be set to accommodate country-specific factors such as temporary income shocks.

This section generalizes the balance sheet-based methodology to allow for trends in NFA for countries where temporary income plays an important role. That is the case for oil-exporting countries. Not only most movements in oil prices seem to be transitory (e.g. Barnett and Vivanco, 2003), but because oil reserves are finite and exhaustible, the whole stream of oil revenue from beginning of exploration through depletion can be seen as transitory from a longer-term perspective.

The exercise derives a path for future NFA based on some rule for intertemporal allocation of the temporary income. Once temporary income is exhausted, NFA converge to a benchmark level, which depends on factors such as the initial NFA, parameters characterizing temporary income, and the intertemporal allocation rule for the temporary income. In this framework, the NFA-stabilizing current account can vary with the time horizon of interest.

A. Theoretical Background

Consider the aggregate intertemporal per-period budget constraint, on which the balance sheet based approaches are based:

$$C_t + B_t = (1+i)B_{t-1} + Y_t + Z_t, \tag{1}$$

where Y_t is *conventional* output, growing at $(1+g)(1+\pi)$, with g representing real output growth rate and π representing inflation rate; C_t represents domestic absorption; B_t stands for end-of period stock of net foreign assets that will earn a nominal return of $(1+i)=(1+r)(1+\pi)$ in period t+1, where r is real net return and B_0 is given;[19] and $Z_t \geq 0$ is temporary income, exhausted from some period $T > t$ onwards.

Since equation (1) contains two unknowns, C_t and B_t, determination of the path for net foreign assets requires an additional restriction. We impose such a restriction by introducing an *allocation rule* – based on optimization of discounted utility in an intertemporal current

[19] It is straightforward to extend the model to allow for exogenous time-varying growth rates and asset returns.

account model – for the domestic absorption of *non-conventional* income, consisting of temporary income and income from net foreign assets. The restriction takes the following form:

$$C_t - Y_t = d * \mathrm{PV}\left(\pi, B_{t-1}, r, \{Z_s\}_{s=t}^{T}\right), \tag{2}$$

where the left-hand side represents domestic per-period absorption of non-conventional income and the right hand size is an *annuity*, expressed as a product of an allocation rule, d, and present value of non-conventional income.

After substituting the restriction in (2) into the aggregate budget constraint, we can solve for the sequence of CA balances as:

$$CA_t \equiv B_t - B_{t-1} = iB_{t-1} + Z_t - d * \mathrm{PV}\left(\pi, B_{t-1}, r, \{Z_s\}_{s=t}^{T}\right). \tag{3}$$

The current account is equal to the difference between the period's non-conventional income, $iB_t + Z_t$, and the annuity payment.

B. Allocation Rules

The imposition of an allocation rule on the income from nonrenewable resources can be justified on the grounds of intertemporal optimization. We examine annuity payments that are kept (i) constant in real terms; (ii) proportional to the population size and represent maximization of per capita consumption; or (iii) proportional to the size of economy activity (as could be justified on the grounds of a government optimization problem.

To formalize the three rules, real output growth is decomposed into two components: $(1+g) = (1+n)(1+a)$, where n is population growth rate and a represents other sources of long-run growth, such as productivity. The three allocation rules can then be expressed as follows:

- *Constant real annuity, $d = r$.* The annuity is equal to the net return on the present discounted value of the non-conventional income. With this rule domestic absorption in all periods exceeds conventional output by the same constant real amount. Part of the temporary income is saved and reallocated for absorption in future periods. As a result, the economy runs current account surpluses and net foreign asset position is increasing until $t > T$. Subsequently both NFA and CA balances, as a share of GDP, converge to zero.

- *Constant real per capita annuity, $d = r - n$.* In this case, domestic per capita absorption exceeds conventional per capita output by a constant. With positive population growth, the prescribed annuity is smaller and current account balances are larger than under 'constant real annuity'. Intuitively, if population is increasing, this rule imposes additional savings at present so as to support the same real per capita consumption in the future. The opposite forces are at work, if the size of population is declining. NFA as a share of GDP increases until $t > T$ and subsequently converges to zero.

- Constant real annuity-to-conventional-output ratio, $d = r - g$. In this case, the ratio of domestic-absorption-to-conventional-output is a constant and exceeds unity. To support the constant ratio in a growing economy, resources need to be reallocated from present to future absorption. Consequently, the NFA position increases during periods with temporary income and economy runs CA surpluses. Once temporary income is exhausted, this allocation rule collapses to the ES approach, i.e., NFA, as a share of GDP, is stabilized at some endogenous level and current account is proportional to the level of NFA (see Lee at al. (2008) for a more detailed discussion).

C. Determinants of Current Account Balances

What effect does the choice of the model's exogenous inputs—the size and lifespan of the temporary income, real rate of return, population and productivity growth rates, inflation rate and initial NFA position—have on the *path* of current account balances during periods with temporary income? Keeping other parameters constant, the effect of each of model's inputs can be summarized as follows:

- *Size of temporary income, $\{Z_s\}_{s=t}^{T}$.* An uniform per-period increase in the size of the temporary income increases CA balances, since for all allocation rules only a fraction of the temporary income is absorbed concurrently and the rest is saved to supplement absorption in periods with lower aggregate income.

- *Lifespan of temporary income, T.* The opposite is the case when the size of temporary income is increased by extending the lifespan of the temporary resource. The extended lifespan of the temporary income component leads to smaller external savings, since in each period less of the temporary wealth needs to be transferred to the post-exhaustion periods. At the limit, as $T \to +\infty$, annuity in each period equals the temporary income and no intertemporal resource reallocation is necessary.

- *Real rate of return, r.* With respect to the interest rate there are two factors at play. A higher interest rate lowers the net present value of the future exhaustible resource wealth, but at the same time increases the rate of return on the wealth. As $T \rightarrow +\infty$, the two effects cancel out, but otherwise the latter effect dominates. As a result, for all three allocation rules a higher interest rate increases the annuity and decreases the CA balance. The magnitude of this effect diminishes with the lifespan of exhaustible resources, T.

- *Population growth rate, n.* Population growth affects CA balances through two channels. First, when the distribution rule depends on *n*, population growth directly affects the size of the redistributed exhaustible resource income. In particular, a higher population growth rate leads to higher CA balances, as more of the exhaustible resource needs to be saved for the more populated future periods. The same applies to the income from NFA. Second, since population growth contributes to output growth, in all but the initial period the denominator in the CA/GDP ratio is affected. A positive growth rate increases the denominator and thus decreases CA balances. As a result, the overall effect depends on the allocation rule and can vary over time. In the case of a 'constant real annuity', the effect of population growth on external savings works only thought the 'denominator' effect and is therefore weakly negative. With the other two allocation rules, the overall effect on CA balances is positive in the initial period but subsequently, as the compounded 'denominator' effect grows, can turn negative.

- *Productivity growth rate, a.* The intuition behind the results is identical to the case of population growth. When productivity growth is not part of the allocation rule, i.e., the case of 'constant real annuity' and 'constant per capita real annuity', the overall effect on CA balances is weakly negative. In the case of 'constant annuity-to-conventional-output ratio' the overall effect is positive initially, but subsequently can turn negative.

- *Inflation rate,* π. Since all allocation rules are based in real rather than nominal considerations, inflation rate has no *direct* effect the intertemporal allocation of temporary income. However, as in the ES approach, the absolute size of the CA balances consistent with stabilizing NFA at some given level are proportional to the rate of inflation. For example, if NFA is eventually stabilized at some positive value, the higher the rate of inflation the larger the CA surpluses.

- *Initial net foreign asset position,* B_{t-1}. In the ES approach, the CA balance consistent with stabilizing the NFA/GDP ratio at the initial level is proportional to the NFA position. In particular, with positive output growth, a more negative initial NFA position can support a larger CA deficit and vice versa if initial NFA position is positive. The same relationship is at work in the extended ES framework, albeit with added complication that, depending on the allocation rule, NFA/GDP initially increases and is eventually stabilized at some level that exceeds the initial one or, alternatively, converges to zero.

D. Implementation

To illustrate the extended ES methodology, this section applies it to Russia. As an oil and gas exporting country, Russia represents a case where the exhaustible nature of a significant part of aggregate income makes temporary accumulation in NFA desirable. Taking WEO projections for Russia as a starting point, we derive the path for NFA-stabilizing CA balances in the extended ES framework and compare results with a static ES exercise.

Implementation of the extended ES approach follows two steps. The first step expands the static exercise to a dynamic setting using WEO projections for real output growth and US inflation over the 2008-2013 period. Beyond the horizon of WEO projections constant output growth and inflation are assumed. For convenience relevant time-series data are summarized in Table 3. Also required is an assumption about the real rate of return on foreign assets, which needs to exceed economy's growth rate and is therefore assumed to take a relatively high value of $r = 0.06$.

The second step introduces temporary income from oil and gas extraction into the exercise. We use WEO projections for oil and gas exports as a proxy for the share of temporary income in GDP.[20] After 2013, both the price and the extraction quantity of each resource are assumed to stay constant until exhaustion. The lifespan for each resource is calculated using data on proven reserves from British Petroleum (2008), according to which oil in Russia will be exhausted in 20 years and gas in 77 years. To obtain results for the case of constant per capita annuity, we also need data on population growth. Here again WEO projections are used for the near term and average UN projection for subsequent years.

Table 3: Time-series data for the dynamic ES exercise

Year \ Variable	Real GDP growth, percent	U.S. CPI inflation, percent	Income from oil, percent of GDP	Income from gas, percent of GDP	Population growth rate
2008	7.0	4.2	17.1	4.7	-0.5
2009	5.5	1.8	15.4	5.1	-0.5
2010	6.0	1.7	15.2	3.8	-0.5
2011	6.0	2.1	14.6	3.3	-0.5
2012	5.7	2.1	14.0	2.9	-0.5
2013	5.5	2.1	13.4	2.5	-0.5
2014+	5.5	2.1	decreasing, exausted in 2027	decreasing, exausted in 2084	-0.7

Sources: IMF WEO (Fall 2008), British Petroleum (2008) and UN populations statistics.

[20] 'Value added' shares would be more appropriate but are not available. Projections for gas exports were obtained directly from the Russia desk.

The NFA-stabilizing 2013 CA from the static ES approach is reported in the first row of Table 2. The required data inputs for the estimate are real medium term output growth rate in Russia, medium term inflation rate in the U.S. and NFA/GDP ratio for Russia, which at the end of 2007 was -8.9 percent.[21] The second row of Table 2 reports results for a dynamic version of the same exercise. Any deviations from the NFA-stabilizing 2013 CA are caused by deviations in short run growth rates and inflation rates from the medium term projections. Since such deviations are small, the resulting sequence of NFA-stabilizing CA balances differs only marginally from the static medium-term estimate for Russia.

The last three rows of Table 4 show results from the extended ES approach with temporary income from oil and gas extraction. Under all considered allocation rules the prescribed path of NFA-stabilizing CA balances implies additional savings during periods with the exhaustible income. Due to the high medium-term output growth rate, such savings are the largest when the annuity payment is kept constant relative to output. However, it can be argued that this particular allocation rule is of limited economic relevance, especially when the stabilizing long-run ratio for NFA is large and positive. While for negative values of NFA a constant NFA/GDP ratio can be motivated as a borrowing constraint, there is little economic content in imposing a constant ratio when NFA is positive. Nevertheless, this allocation rule can be viewed as an upper bound for NFA-stabilizing CA balances.

Table 4: NFA-stabilizing CA balances under various ES specifications

ES specification \ Year	2008	2009	2010	2011	2012	2013	2020
Static ES	n/a	n/a	n/a	n/a	n/a	-0.6	n/a
Dynamic ES: Constant annuity/output ratio (No temporary oil or gas income)	-0.7	-0.8	-0.6	-0.6	-0.6	-0.6	-0.6
Dynamic ES: Constant annuity/output ratio	20.0	20.6	20.3	20.5	20.9	21.3	24.4
Dynamic ES: Constant real per capital annuity	5.7	5.5	5.2	5.1	5.1	5.0	6.5
Dynamic ES: Constant real annuity	7.2	7.0	6.6	6.6	6.5	6.5	7.6

Sources: Fall 2008 CGER and authors' calculations.

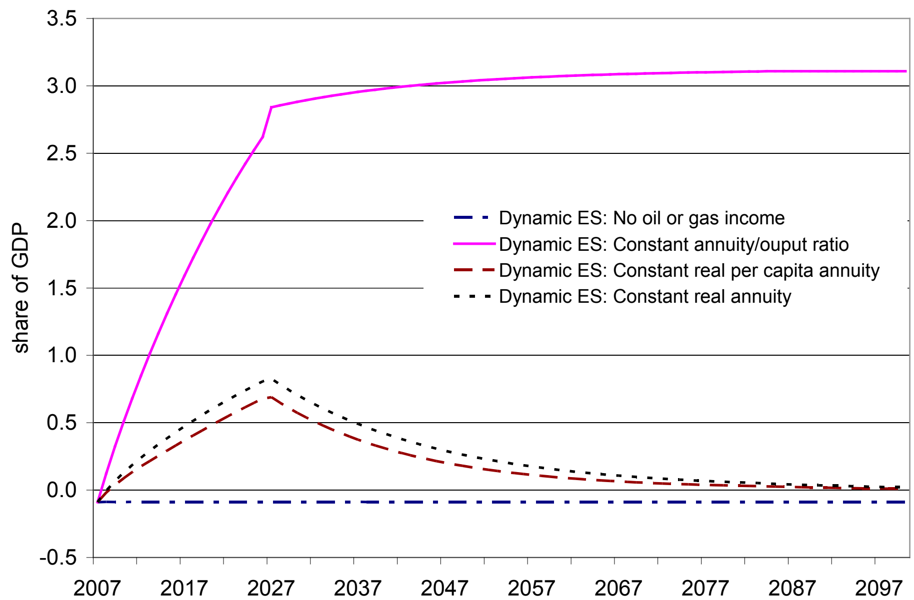
The other two allocation rules prescribe considerably smaller CA surpluses. Since projected population growth rates are negative, a constant per capita annuity implies a resource transfer from future to current generations and hence induces smaller CA surpluses than a constant real annuity. A positive population growth rate would reverse this result.

Finally, Figure 2 reports the path of NFA under the considered allocations rules. In the dynamic ES without temporary oil and gas income, the NFA/GDP ratio is stabilized at the

[21] For details of this calculations see Lee et al., 2008.

end-of-2007 level.[22] Addition of the temporary income introduces an increasing trend in the ratio. Once such income is exhausted, NFA/GDP ratio stabilizes at some endogenous level that exceeds its initial value or converges to zero, depending on the allocation rule.

Figure 3: Evolution of NFA under various ES specifications



[22] There are some minor deviations, as implied by non-constant CA balances in the second row of Table 2.

V. Concluding Remarks

Oil exporting countries are different from other countries in several dimensions: their fiscal balance is dominated by fluctuations in oil revenues; the exhaustible nature of oil revenues brings to the fore issues of intergenerational consumption smoothing; they are by definition less diversified; and their exports are typically more volatile than exports of other countries.

Some data challenges are also particularly severe to oil-exporting countries. Most oil exporting countries do not publish international investment position so their NFA figures are limited to estimates from balance of payment flows. Although such issues cannot always be resolved in a satisfactory manner, we take them into account when interpreting our results.

This paper proposes three methodologies for exchange rate assessment tailored to the peculiarities of oil-exporting countries:

- The price-based approaches for real exchange rate assessment directly estimate an equilibrium real exchange rate as a function of underlying fundamentals. This approach requires that a set of underlying fundamentals be cointegrated with the real exchange rate. We generally find a robust link between the real exchange rate and the terms of trade, but results on the link between the real exchange rate and other fundamentals are less robust, and the overall fit of the regression is modest. These weak results most likely reflect the severe data limitations for this type of analysis (including lack of data on relative productivity, net foreign assets, and price controls).

- The quantity-based approach estimates a medium-term current account benchmark based on medium-term characteristics of the economy such as its fiscal position, relative income, dependency ratio and population growth. We argue that it is crucial that models of the medium-term current account use the fiscal balance net of oil revenues (non-oil fiscal balance) because the overall fiscal balance is highly correlated with and driven by the oil balance, which is also a current account determinant. We find that the current account of oil exporters is more responsive to the non-oil fiscal balance than for other countries; that an increase in relative income raises the current account balance significantly more in oil countries than in other countries; that the current account balance responds more strongly to the oil balance, at least in the short run; and other medium-term fundamentals, such as population growth and the dependency ratio, have similar effects on the current account for oil exporters and other economies.

- The balance-sheet approaches for real exchange rate assessment seek to determine the external sector balance that would bring net foreign asset position (NFA) to a desired or benchmark level. For oil exporting countries this approach needs to allow for long-term trends in NFA that help accommodate the temporary nature of exhaustible resources as well as significant fluctuations in the price of such resources. Our extended balance sheet approach builds on two key ingredients. First, an estimate for the size and lifespan of the temporary exhaustible income, expressed relative to the conventional economy activity. Second, a rule for the intertemporal distribution of the exhaustible resource income. We find that, due to the sizable temporary income, oil exporters should run larger current account surpluses than prescribed by an exercise that targets a benchmark NFA level. The exact assessment is sensitive to the time-path of exhaustible resource income as well as to the rule for its intertemporal allocation. Finally, external sector assessment for oil countries should be based on a longer-term time horizon than for other economies.

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Appendix I: Implementation of quantity-based approaches to real exchange rate assessment

The final step in the quantity-based approach to real exchange rate assessment involves a calculation of the real exchange rate adjustment that would close the gap between the estimated current account norm and the underlying current account of each economy. This is done by dividing the distance to the current account norm by the current account (trade balance) elasticity to the real exchange rate.

The current account elasticity to the real exchange rate for an oil exporting country depends on the shares of oil and non-oil exports and imports to GDP, as well as the elasticity of non-oil exports and imports relative to the REER.

To derive it, note that oil exports are priced in terms of the foreign good and the oil export supply response to a change in the real exchange rate is close to zero.[23] Then:

$$TB = X^n + \frac{1}{q}X^o - \frac{1}{q}M ,$$

where *TB* is the trade balance expressed in terms of the domestic good; X^n are non-oil exports of; X^o are exports of oil; q is the real exchange rate denoted as the amount of the foreign goods needed to purchase a unit of domestic good (i.e. an increase in q represents a real appreciation).

Taking the derivative of the trade balance with respect to the real exchange rate and rearranging terms, then:

$$\frac{\partial TB}{(\partial q / q)} = X^n \eta_x^n - \frac{1}{q}X^o + \left(\frac{1}{q}M\right)(1-\eta_m) ,$$

where η_x^n and η_m are the elasticity of non-oil exports and imports with respect to the real exchange rate respectively ($\eta_x^n < 0$ and $\eta_m > 0$).

Dividing through by GDP, we have:

$$\frac{\partial TB}{(\partial q / q)} \frac{1}{GDP} = s_n \eta_x^n - s_o + s_m (1-\eta_m) ,$$

[23] International Monetary Fund (2006) finds that the relative price supply elasticity for oil exporters is insignificant.

where s_n, s_o and s_m refer to the share of non-commodity and non-oil exports, commodity and oil exports and imports in GDP respectively.

This formula implies that for given export and import elasticities, the impact of the real exchange rate on the current account balance will be proportional to openness: the more open the economy, the smaller is the required real exchange rate adjustment to correct a given current account imbalance.

Under balanced trade, $s_n + s_o = s_m$, and we can write the elasticity of the trade balance with respect to the real exchange rate as:

$$\left.\frac{\partial TB}{(\partial q/q)}\frac{1}{GDP}\right|_{TB=0} = s_m\left[\frac{s_n}{s_n+s_o}\eta_x^n - \frac{s_o}{s_n+s_o} + (1-\eta_m)\right]$$

For a country that does not export oil, $s_o = 0$, and the elasticity of the trade balance with respect to the real exchange rate, under balance trade, is:

$$\left.\frac{\partial TB}{(\partial q/q)}\frac{1}{GDP}\right|_{TB=0}^{s_o=0} = s_m\left(1+\eta_x^n - \eta_m\right)$$

and, since the real exchange rate is defined as $1/q$, and the condition for a depreciation to have a positive impact in the trade balance (Marshall-Lerner condition) is satisfied if $1+\eta_x^n-\eta_m<0$ or more familiarly, if the sum of price elasticity of exports and imports (in absolute value) must be greater than 1.

For a country that exports only oil, $s_n = 0$, the same elasticity reduces to:

$$\left.\frac{\partial TB}{(\partial q/q)}\frac{1}{GDP}\right|_{TB=0}^{s_o=0} = -s_m\eta_m,$$

Therefore for a country that only exports oil, the Marshall-Lerner condition is satisfied as long as $|\eta_m|>0$.

For a given set of elasticities with respect to the real exchange rate, the sensitivity of the trade balance to GDP with respect to the real exchange rate will be more negative than for an oil importing countries when:

$$\left.\frac{\partial TB}{(\partial q/q)}\frac{1}{GDP}\right|_{TB=0} < \left.\frac{\partial TB}{(\partial q/q)}\frac{1}{GDP}\right|_{TB=0}^{s_o=0} \Leftrightarrow s_o\left(1+\eta_x^n\right)>0$$

This condition will hold when the absolute value of the price elasticity of non-oil exports is less than one, i.e. $\left|\eta_x^n\right| < 1$

The required exchange rate adjustment for each country needs to be made multilaterally consistent, since there can only be *n-1* independent exchange rates among *n* currencies. To guarantee multilateral consistency, all exchange rates are adjusted equally or proportionately (see Isard and Faruqee, 1998 for a discussion of the multilateral consistency issue).

Appendix II. Unit root and cointegration tests

Appendix Table 1A. Unit Root Test on Real Exchange Rate and Fundamentals (1980-2007)

P-Value for null hypothesis of unit root

	Levels						Differences					
Country	REER	G/Y	TT	NFA/Y	NFA/Trade	Rel. Income	REER	G/Y	TT	NFA/Y	NFA/Trade	Rel. Income
Oil exporting countries												
Algeria	0.534	0.843	0.980	1.000	0.992	0.961	0.480	0.007	0.004	0.479	0.074	0.027
Cameroon	0.386	0.046	0.972	0.996	0.991	0.515	0.362	0.361	0.001	0.652	0.432	0.509
Ecuador	0.382	0.006	0.958	0.684	0.882	0.679	0.673	0.172	0.004	0.113	0.129	0.602
Indonesia	0.644	0.864	0.800	0.832	0.914	0.546	0.217	0.092	0.008	0.187	0.149	0.444
Iran, Islamic Republic of	0.838	0.071	0.962	0.935	0.894	0.531	0.503	0.003	0.004	0.493	0.666	0.023
Kuwait	0.401	0.732	0.968	0.460	0.521	0.161	0.009	0.069	0.003	0.561	0.606	0.186
Nigeria	0.703	0.343	0.962	0.859	0.860	0.763	0.178	0.120	0.004	0.005	0.055	0.460
Norway	0.904	0.980	0.993	0.720	0.830	0.495	0.046	0.012	0.002	0.290	0.353	0.535
Oman	0.287	0.148	0.953	0.955	0.927	0.114	0.096	0.082	0.007	0.143	0.117	0.066
Qatar	0.853	0.063	0.961	0.115	0.104	0.649	0.035	0.157	0.005	0.570	0.086	0.613
Saudi Arabia	0.415	0.221	0.991	0.831	0.436	0.209	0.395	0.572	0.002	0.662	0.624	0.012
Syrian Arab Republic	0.270	0.904	0.834	0.802	0.111	0.001	0.263	0.084	0.050	0.004	0.347	0.278
Trinidad and Tobago	0.596	0.746	0.962	1.000	0.949	0.038	0.000	0.340	0.004	0.534	0.100	0.652
United Arab Emirates	0.437	0.745	0.957	0.143	0.034	0.115	0.150	0.161	0.009	0.360	0.231	0.378
Venezuela, Rep. Bol.	0.020	0.368	0.983	0.872	0.548	0.758	0.571	0.173	0.002	0.482	0.257	0.594
Rejections at 5%												
Oil importing countries	0.070	0.047	0.000	0.070	0.070	0.163	0.209	0.209	0.674	0.093	0.047	0.163
Oil exporting countries	0.067	0.133	0.000	0.000	0.067	0.133	0.267	0.200	1.000	0.133	0.000	0.200

Notes: P-values for the null hypothesis of unit root are calculated by Stata routine *dfuller* assuming 3 lags and a trend. The results for 43 individual oil importing advanced and emerging countries are available from the authors upon request.

Appendix Table 1B.
Panel Unit Root Tests

	Im, Pesaram and Shin (2003) tests H0: for all countries, unit root			
	Z tbar	p-value	Z t-tilde bar	p-value
Log of Real Effective Exchange Rates				
10 Oil countries	-0.797	0.21	0.104	0.54
33 Oil importers	-1.629	0.05	0.325	0.63
Net Foreign Assets to GDP				
10 Oil countries	1.449	0.93	1.967	0.98
33 Oil importers	1.900	0.97	3.109	1.00
Net Foreign Assets to Trade				
10 Oil countries	-0.178	0.43	0.657	0.74
33 Oil importers	-0.099	0.46	1.463	0.93
Government Consumption to GDP				
10 Oil countries	-0.636	0.26	0.407	0.66
33 Oil importers	-0.856	0.20	0.824	0.79
Commodity Terms of Trade				
10 Oil countries	4.491	1.00	4.489	1.00
33 Oil importers	7.389	1.00	7.698	1.00
Relative Income				
10 Oil countries	-2.417	0.01	-0.847	0.20
33 Oil importers	0.203	0.58	2.095	0.98

Notes: The criterium to select countries for the panel unit root tests was availability of at least 20 years of data for the variables of interest in the 1980-2007 period. The 10 oil countries are: Algeria, Ecuador, Kuwait, Norway, Oman, Qatar, Saudi Arabia, Trinidad and Tobago, United Arab Emirates, and República Bolivariana de Venezuela. The 33 advanced and emerging oil-importing countries are Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, Colombia, Denmark, Finland, France, Germany, Greece, Hong Kong S.A.R, India, Ireland, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, New Zealand, Pakistan, Philippines, Portugal, Singapore, South Africa, Spain, Sweden, Taiwan, Province of China, United Kingdom and United States.

The panel unit root tests were performed with the RATS routine *ipshin*, using 3 lags.

Appendix Table 2. Panel cointegration tests

	(1)	(2)	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Sample	NON-OIL	ALL	OIL	OIL	OIL	OIL	OIL	OIL	OIL
Variables included									
Log of REER	yes	yes	yes	yes	yes	yes	yes	yes	yes
Commodity Terms of Trade	yes	yes	yes	yes	yes	yes	yes	yes	yes
Government Consumption to GDP	yes	yes	yes	yes	yes	yes	yes	yes	
Net Foreign Assets to Trade	yes		yes			yes			
Net Foreign Assets to GDP				yes			yes		
Relative Income	yes	yes	yes	yes	yes				
Pedroni (1999) tests				*H0: No panel cointegration*					
panel v-stat	0.36	1.30	0.77	0.92	0.54	1.32	1.35	1.39	2.28
panel rho-stat	2.68	3.00	1.22	1.23	1.11	0.67	0.39	-0.09	-1.37 *
panel pp-stat	-1.27 *	-0.58	-0.97	-0.98	-0.31	-1.35 *	-1.69 **	-1.67 **	-2.45 **
panel adf-stat	-3.37 **	-1.02	-1.70 **	-1.15	-0.25	-3.43 **	-1.94 **	-2.21 **	-2.99 **
group rho-stat	4.29	4.86	2.37	2.31	2.24	1.90	1.60	1.19	0.19
group pp-stat	-0.94	0.02	-0.52	-0.70	0.23	-0.73	-1.16	-0.95	-1.56 *
group adf-stat	-3.05 **	-1.84 **	-1.63 *	-1.10	-0.29	-3.50 **	-2.07 **	-2.10 **	-2.64 **
Number of countries	33	43	10	10	10	10	10	10	10
Number of observations	1075	1075	250	250	250	250	250	250	250

The panel cointegrations tests were performed with the RATS routine *pancoint*, using a maximum lag of 4 and heterogeneous trends. (*) denotes rejection of the null of no cointegration at the 10% significance level; (**) denotes rejection of the null of no cointegration at the 5% level.

Appendix Table 3.

Sample composition

Table 1, Panel DOLS regressions	Oil countries	Algeria, Azerbaijan, Ecuador, Indonesia, Islamic Republic of Iran, Kazakhstan, Kuwait, Libya, Norway, Oman, Qatar, Russia, Saudi Arabia, Trinidad and Tobago, United Arab Emirates, and República Bolivariana de Venezuela.
	Other countries	Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, People's Republic of China, Colombia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong S.A.R., Hungary, India, Ireland, Italy, Japan, Korea, Malaysia, Mexico, Morocco, Netherlands, New Zealand, Pakistan, Peru, Philippines, Poland, Portugal, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Taiwan, Province of China, Thailand, Turkey, United Kingdom and United States.
Table 1, Group-Mean DOLS regressions	Oil countries	Algeria, Ecuador, Kuwait, Norway, Oman, Qatar, Saudi Arabia, Trinidad and Tobago, United Arab Emirates, and República Bolivariana de Venezuela.
	Other countries	Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, Colombia, Denmark, Finland, France, Germany, Greece, Hong Kong S.A.R., India, Ireland, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, New Zealand, Pakistan, Philippines, Portugal, Singapore, South Africa, Spain, Sweden, Taiwan, Province of China, United Kingdom and United States.
Table 2	Oil countries	Algeria, Azerbaijan, Kingdom of Bahrain, I.R. of Iran, Kazakhstan, Kuwait, Libya, Oman, Qatar, Russia, Saudi Arabia, United Arab Emirates, and Rep. Bolívariana de Venezuela.
	Other countries	Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Croatia, Czech Republic, Denmark, Egypt, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Malaysia, Mexico, Morocco, Netherlands, New Zealand, Norway, Pakistan, Peru, Philippines, Poland, Portugal, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Taiwan, Thailand, Tunisia, Turkey, UK, USA