BOFIT Discussion Papers
8 • 2007

Iikka Korhonen and Tuuli Juurikkala

Equilibrium exchange rates in oil-dependent countries

SUOMEN PANKKI • FINLANDS BANK

EUROJÄRJESTELMÄ
EUROSYSTEMET

Bank of Finland, BOFIT
Institute for Economies in Transition

BOFIT Personnel 2007

Economists

Mr Pekka Sutela, head
Russian economy and economic policy
Russia's international economic relations
China in the world economy
Pekka.Sutela@bof.fi

Ms Tuuli Juurikkala, economist
Russian economy and economic policy
Private sector development
Tuuli.Juurikkala@bof.fi

Mr Juuso Kaaresvirta, economist
Chinese economy and economic policy
Juuso.Kaaresvirta@bof.fi

Ms Tuuli Koivu, economist
Chinese economy and economic policy
Editor-in-Chief of *BOFIT China Review*
Tuuli.Koivu@bof.fi

Mr Iikka Korhonen, research supervisor
Exchange rate policies in transition economies
Monetary policy in transition economies
Editor-in-Chief of *BOFIT Discussion Papers*
Iikka.Korhonen@bof.fi

Ms Seija Lainela, economist
Russian economy and economic policy
Editor-in-Chief of *BOFIT Weekly*
Seija.Lainela@bof.fi

Mr Aaron Mehrotra, economist
Chinese economy and economic policy
Monetary policy in transition economies
Aaron.Mehrotra@bof.fi

Mr Simon Ollus, economist
Russian economy and economic policy
Russian industrial policy
Simon.Ollus@bof.fi

Mr Jouko Rautava, economist
Russian and Chinese economies and economic policies
Editor-in-Chief of *BOFIT Russia Review* and
BOFIT Online
Jouko.Rautava@bof.fi

Ms Heli Simola, economist
Economic relations between Russia and Finland
Russia's impact on the Finnish economy
Heli.Simola@bof.fi

Ms Laura Solanko, economist
Russian regional issues
Public economics
Laura.Solanko@bof.fi

Ms Merja Tekoniemi, economist
Russian regional issues
Merja.Tekoniemi@bof.fi

On leave of absence

Mr **Vesa Korhonen**, email: Vesa.Korhonen@formin.fi
Mr **Jian-Guang Shen**, email: JGShen@imf.org

Information Services

Mr Timo Harell, editor
Press monitoring
Timo.Harell@bof.fi

Ms Liisa Mannila, department secretary
Department coordinator
Publications traffic
Liisa.Mannila@bof.fi

Ms Päivi Määttä, information specialist
Information services
Paivi.Maatta@bof.fi

Ms Tiina Saajasto, information specialist
Information services
Tiina.Saajasto@bof.fi

Contact us

Bank of Finland
BOFIT – Institute for Economies in Transition
PO Box 160

Phone: +358 10 831 2268
Fax: +358 10 831 2294
E-mail: bofit@bof.fi

BOFIT Discussion Papers
Editor-in-Chief Iikka Korhonen

BOFIT Discussion Papers 8/2007
30.3.2007

Iikka Korhonen and Tuuli Juurikkala: Equilibrium exchange rates in oil-dependent countries

ISBN 978-952-462-863-1
ISSN 1456-5889
(online)

Multiprint Oy
Helsinki 2007

Contents

Iikka Korhonen and Tuuli Juurikkala

Equilibrium exchange rates in oil-dependent countries

Abstract

We assess the determinants of equilibrium real exchange rates in a sample of oil-dependent countries. Our basic data cover OPEC countries from 1975 to 2005. We also include three oil-producing Commonwealth of Independent States (CIS) countries in our robustness analysis. Utilising several estimation techniques, including pooled mean group and mean group estimators, we find that the price of oil has a clear, statistically significant effect on real exchange rates in our group of oil-producing countries. Higher oil price lead to appreciation of the real exchange rate. Elasticity of the real exchange rate with respect to the oil price is typically between 0.4 and 0.5, but may be larger depending on the specification. Real per capita GDP, on the other hand, does not appear to have a clear effect on real exchange rate. This latter result contrasts starkly with the consensus view of real exchange rates determinants, emphasising the unique position of oil-dependent countries.

Key words: equilibrium exchange rate, pooled mean group estimator, resource dependency
JEL codes: F31, F41, P24, Q43

Iikka Korhonen and Tuuli Juurikkala

Equilibrium exchange rates in oil-dependent countries

Tiivistelmä

Tässä keskustelualoitteessa tutkitaan reaaliseen tasapainovaluuttakurssiin vaikuttavia tekijöitä öljyn vientituloista riippuvaisissa maissa. Perusaineisto kattaa OPEC-maat vuosien 1975 ja 2005 välisenä aikana. Tutkimuksessa käytetään myös IVY-maiden dataa. Useita estimointimenetelmiä käyttämällä havaitaan, että öljyllä on selvä ja tilastollisesti merkitsevä vaikutus reaalisiin valuuttakursseihin tutkimissamme maissa. Öljyn hinnan nousu vahvistaa valuuttakurssia. Reaalisen valuuttakurssin jousto öljyn hinnan suhteen on yleensä 0,4–0,5, mutta joissakin spesifikaatioissa suurempi. Henkeä kohden laskettu reaalinen bruttokansantuote ei sen sijaan näytä vaikuttavan reaaliseen valuuttakurssiin. Tämä tulos poikkeaa monien aiempien tutkimuksien tuloksista ja saattaa johtua öljyntuottajamaiden muista eroavasta rakenteesta.

Asiasanat: tasapainovaluuttakurssi, pooled mean group -estimaattori, luonnonvarariippuvuus

1 Introduction

We focus in this paper on how the real price of oil affects the equilibrium exchange rate of oil-dependent countries. As oil and related products essentially constitute practically the sole source of export revenue for most of the countries examined here, oil prices can be inferred to affect terms of trade and the real exchange rate. In addition, the real price of oil has been quite volatile during recent decades, so we should expect to see large macroeconomic effects from oil price changes in these countries.

We consider a dozen countries that depend heavily on exports of oil, natural gas and oil products. We augment a core sample of nine OPEC members with three Commonwealth of Independent States (CIS) countries in our robustness analysis. The empirical analysis uses a sample extending from 1975 to 2005 for the OPEC states and 1993 to 2005 for the CIS countries.

In the empirical analysis we do not rely on any one theory of exchange rate determination, but instead adopt BEER (Behavioural Equilibrium Exchange Rate) approach, where usually a number of plausible variables are introduced as determinants of real exchange rate. In our application relationship of these variables with the real exchange rate is assessed e.g. with the help of panel co-integration methods. Our preferred method is the pooled mean group (PMG) estimator proposed by Pesaran et al (1996), but we also employ a mean group estimator and ordinary fixed effects.

In our estimation framework the real oil price has a direct effect on the equilibrium exchange rate, and, more importantly, that oil price is the only variable with a consistent and statistically significant effect on real exchange rate in oil-producing countries. While coefficient estimates differ from one estimation methodology to another, estimates tend to cluster around 0.5 (the coefficient may be larger in some specifications). In other words, a 10% increase in the real price of oil leads to appreciation of about 5% in the equilibrium exchange rate of a typical oil-producing country.

The study is structured as follows. In the next section, we provide a short literature survey on the topic. We then assess the time series properties of our data. Section 4 provides our main econometric analysis and section 5 concludes.

2 Literature survey

The real exchange rate (*RER*) is generally defined as the nominal exchange rate adjusted for price level differences between countries. Formally, the real exchange rate (in period t) is denoted as RER_t, the nominal exchange rate E_t (in units of home currency per one unit of foreign currency), the domestic price level P_t, and the price level in a foreign country P_t*. Thus, *RER* may be expressed as

$$RER_t = E_t \frac{P_t^*}{P_t}. \qquad (1)$$

Under our definition, an increase in real exchange rate index means depreciation. We first compare the bilateral real exchange rate of sample oil-dependent countries against the US dollar. We also consider the real effective exchange rate (*REER*) calculated as a weighted average of individual bilateral real exchange rates. The weights here represent the shares of different countries in the home country's foreign trade. *REER* is defined here so that upward movement means appreciation.

A number of studies discuss the determinants of equilibrium exchange rates in developing or emerging market countries (e.g. Baffes et al., 1999; Edwards, 1989, 1994; Montiel, 1999). Montiel (1999) argues that the long-run equilibrium real exchange rate emerges from macroeconomic equilibrium in an economy where policy and exogenous variables are sustainable in the long run. He suggests a number of variables that might be associated with the long-run equilibrium real exchange rate, including variables relating to the Balassa-Samuelson effect.

The Balassa-Samuelson theorem presupposes that purchasing power parity (PPP) applies to the market for traded goods and that the ratio of prices of traded and non-traded goods may develop differently for different countries. Specifically, productivity growth in poorer countries is higher in the traded-goods sector than in the non-traded goods sector, as the potential for productivity growth in the traded-goods sector of poorer countries is higher than in more affluent countries. *Ceteris paribus* poorer countries tend to grow faster than richer ones. The theorem further assumes that productivity in the non-traded sector rises more slowly, but wages are the same in both sectors. In such case, the real exchange rate appreciates in the country with higher growth even if the PPP holds for the traded sector. Here, we proxy the productivity differential with the per capita GDP differential.

Other variables may also influence a country's equilibrium exchange rate. Lane and Milesi-Ferretti (2002) find, as predicted by theory, that countries with lower international net asset positions tend to have weaker currencies. A decrease in the net foreign asset position (say, from an increase in foreign debt) increases that country's debt servicing costs. To obtain foreign currency to cover the new costs, the country must export more. To achieve this, its real exchange rate must depreciate.

A number of papers consider equilibrium exchange rates in commodity-dependent countries. Chen and Rogoff (2003) focus on three OECD countries that rely heavily on commodity exports: Australia, Canada and New Zealand. They find US dollar prices for their commodity exports have a strong effect on real exchange rates, especially in Australia and New Zealand. The result is weaker for Canada, perhaps because of its somewhat more diversified export structure. Cashin et al (2004) examine 58 commodity-exporting countries and find that real commodity prices have an effect on real exchange rates in about a third of them. The approach in the Cashin study can be distinguished from ours in two important respects. First, they study each country separately, while we pool country data in a panel. Second, they exclude countries that predominantly export oil.

Koranchelian (2005) and Zalduendo (2006) look at the effects of oil price on the real exchange rate in an oil-dependent country (Algeria and Venezuela, respectively). Koranchelian (2005) finds that both Balassa-Samuelson effect and real oil price affect the equilibrium real exchange rate of Algeria. She calculates the Algerian currency's deviation from an estimated equilibrium exchange rate value. Similarly, Zalduendo (2006) finds within a vector error correction model that oil prices and productivity have an effect on the real equilibrium exchange rate in Venezuela. Long-run elasticity of real effective exchange rate with respect to the real oil price is somewhat over one. However, the trend depreciation of the real exchange rate has been determined also by the steadily deteriorating productivity differential (relative per capita GDP against the main trading partners). The initial estimations are done with official exchange rate data. Estimates with parallel market exchange rates produce qualitatively similar results, but, for example, the long-run elasticity of real effective exchange rate with respect the oil price is now approximately 0.5. As we show below, this is quite close to our results for the larger country sample.

Kalcheva and Oomes (2007) assess whether Russia suffers from Dutch disease, and find within a co-integration framework that the elasticity of real exchange rate with respect to the oil price is very close to 0.5, irrespective of the exact specification.

Finally, Issa et al. (2006) study how energy prices affect the Canadian dollar. Before 1993, they find higher energy prices led to depreciating currency. After 1993, however, energy prices had the opposite effect, i.e. higher prices led to appreciation of the Canadian dollar. The 1993 breakpoint corresponds to Canada's shift from net importer to net exporter of energy products. The value of its energy exports has grown ever since.

Overall, the literature indicates that commodity prices have an effect on the real exchange rates of commodity-exporting countries. This result holds even for developed countries such as Australia and New Zealand. Our literature survey also suggests that the effects of oil prices on exchange rate have been studied relatively little. We aim to contribute to this part of the literature.

3 Data

Our data are drawn from the World Bank's World Development Indicators database. We use three series for real exchange rate: real exchange rate calculated against the US dollar (*rerusdcpi* and *rerusddef*) and the real effective exchange rate (*reer*). *Rerusdcpi* is calculated from the nominal exchange rate series and consumer price index in the US and the country in question. For *rerusddef*, GDP deflators are used. While the real effective exchange rate is better suited to empirical work, it is not available for all countries here. Also, using the three different real exchange rate series serves as a robustness check. All the real exchange rate series are in natural logarithms. Real oil price is the price of one barrel of Brent oil expressed in US dollars, deflated by the US consumer price index. Also *oil* is in natural logarithm form.

In accordance with the literature reviewed in the previous section, the control variable for real exchange rate is per capita GDP (measured as the log-difference between the country's per capita GDP in PPP-based constant 2000 US dollars and per capita GDP in the US). Both theory and previous empirical work lead us to expect higher per capita GDP relative to the US to be associated with a stronger currency.[1]

[1] We initially included net foreign asset position as a control variable in this study. However, it was statistically insignificant in practically all specifications and/or had a sign not predicted by theory. Therefore, we have omitted net foreign asset position in these estimations.

For our main panel, we use annual data from nine countries,[2] spanning the years 1975 to 2005. We have fairly balanced data for all these countries, although per capita GDP series for Kuwait are not available for 1990-1994.

By definition, equilibrium exchange rates are long-term phenomena; actual exchange rates may fluctuate around their equilibrium values for a long period. Given the nature of the time series and our focus on the long-term relationships between variables, it is important to select the most appropriate econometric techniques.

To do this, we first try to establish whether or not our time series are stationary. This has bearing on the methods chosen for the actual econometric work. Table 1 reports results from five different panel unit root tests with three different null hypotheses. The first is the LLC test where the null hypothesis is the unit root (with the assumption that the cross-sectional units share a common unit root process). The second group includes several tests (IPS, ADF-FCHI, PP-FCHI) with null of unit root assume that the cross-sectional units have individual unit root process. The last test is the Hadri test (Hadri, 2000), where the Z-stat has a null hypothesis of no unit root (but assumes a common unit root process for all cross-sectional units).

There are only two cases out of four where all tests point to the same conclusion as to whether a time series is stationary. For the real exchange rate based on GDP deflator and the real effective exchange rate, results of the first four tests are consistent with Hadri’s Z-stat and do not reject the null of non-stationarity. For the CPI-deflated real exchange rate series, the first four tests reject the null hypothesis of non-stationarity, contradicting Hadri's test. Given our rather short sample (31 years), it is not particularly surprising that some real exchange rates are found to be non-stationary. In empirical research, testing for the existence of purchasing power parity, usually several decades worth of data are necessary to confirm that the real exchange rate of a country is stationary. Hadri’s Z-stat rejects the null of stationarity in every case, while two of the other tests reject the null of non-stationarity for *gdp*.

Therefore, one of our real exchange series (*rerusdcpi*) is perhaps stationary, and the same applies to *gdp*.

Finally, we perform unit root tests for the real price of oil. It appears to be non-stationary. As a result, we choose to utilise several estimation methods to account for the possibility that our variables may be stationary or non-stationary.

[2] Algeria, Ecuador, Gabon, Indonesia, Iran, Kuwait, Nigeria, Saudi Arabia and Venezuela.

Table 1 Panel unit root tests, sample of 9 OPEC countries (1975-2005)

	Levin, Lin & Chiu (LLC)	Im, Pesaran & Shin (IPS)	Augmented Dickey-Fuller – Fisher Chi-square (ADF-FCHI)	Phillips-Perron – Fisher Chi-square (PP-FCHI)	Hadri's Z-stat
rerusdcpi	-5.521***	-2.901***	51.892***	26.712*	6.614***
rerusddef	-0.428	0.532	10.647	11.930	9.923***
reer	-0.689	0.494	9.510	7.511	5.039***
gdp	-2.727***	-1.310*	23.486	14.745	6.429***
	Augmented Dickey-Fuller	Phillips-Perron	Kwiatkowski-Phillips-Schmidt-Shin	Ng-Perron	
oil	-1.443	-1.474	0.397	-4.108	

***, ** and * signify that the null hypothesis is rejected at the 1%, 5% or 10% confidence level, respectively.
All tests include a constant.

4 Estimation

As we are not completely sure whether our variables are stationary or non-stationary, we estimate the relationship between real exchange rate and the other variables with several methods. Utilising multiple methods also provides a robustness check. We start with simple panel estimation methods and then proceed to Pooled Mean Group (PMG) estimator.

To control for country-specific factors, we first estimate a fixed effects model. The results for *rerusdcpi* are presented in Table 2 and for *rerusddef* in Table 3. Real exchange rate appreciation with a GDP deflator is only a fraction of CPI-based appreciation. GDP deflators typically give greater weight to traded items than the CPI as they include goods used by non-household sectors of the economy (e.g. investment goods). Results for *reer* (real effective exchange rate) appear in Table 4. For *rerusdcpi* and *rerusddef*, an upward movement means depreciation, i.e. a negative coefficient of *realoil* means that higher oil price leads to real exchange rate appreciation. For *reer*, upward movement means appreciation.

All three tables indicate that a higher oil price always causes appreciation and the effect is significant in all specifications. Elasticity of the real exchange rate with respect to oil varies from one specification to another. As *rersuddef* and *reer* are broader measures of the real exchange rate, we attach greater importance to the results where they are used. When cross-section specific trends are included in the specifications, the coefficient of *realoil* is generally between 0.4 and 0.5.

The results for per capita GDP depend on whether we include fixed effects and cross-section specific trends. The reason for this is that there is a clear downward trend in per capita GDP in eight of the nine countries in our sample during the 1975-2005 period.[3] This is also seen in cross-section specific trends, which are nearly always statistically significant. The coefficient of the *gdp* variable also changes from the fixed effects analysis when trends are included in the specification, because we already control to a great extent for per capita GDP movements in our country-specific trend variables.

Further robustness checks using a different data set are reported in Appendix . Using a shorter data sample (with three countries added) seems to produce only spurious results.[4]

Table 2 Pooled least squares estimates with CPI-based real exchange rate against the USD as dependent variable, sample of 9 OPEC countries (1975-2005)

	1	2	3
	Fixed effects	Cross-section specific trends	Cross-section specific trends and fixed effects
gdp	-0.270**	0.320***	0.333**
oil	-0.404***	-0.190***	-0.115*
AL	FE	trend 0.033***	FE and trend 0.055***
EC	FE	trend 0.037***	FE and trend 0.028***
GA	FE	trend 0.029***	FE and trend 0.043***
IND	FE	trend 0.045***	FE and trend 0.044***
IR	FE	trend 0.021***	FE and trend 0.041***
KUW	FE	trend 0.012**	FE and trend 0.021**
NIG	FE	trend 0.057***	FE and trend 0.052***
SA	FE	trend 0.019***	FE and trend 0.046***
VE	FE	trend 0.025***	FE and trend 0.019**
R^2	0.24	0.45	0.54
N	273	273	273

***, ** and * signify that the coefficient is different from zero at the 1%, 5% or 10% confidence level, respectively.

[3] Indonesia is the sole exception to this rule.
[4] Due to data limitations, we only run the pooled least squares (i.e. no MG or PMG estimations) with the shorter sample.

Table 3 Pooled least squares estimates with GDP-deflator-based real exchange rate against the USD as dependent variable, sample of 9 OPEC countries (1975-2005)

	1	2	3
	Fixed effects	Cross-section specific trends	Cross-section specific trends and fixed effects
gdp	-0.330	0.618***	0.442***
oil	-0.800***	-0.480***	-0.391***
AL	FE	trend 0.051***	FE and trend 0.023***
EC	FE	trend 0.028**	FE and trend 0.291***
GA	FE	trend 0.046***	FE and trend 0.022***
IND	FE	trend 0.074***	FE and trend 0.012
IR	FE	trend 0.043***	FE and trend 0.022***
KUW	FE	trend 0.016	FE and trend 0.016*
NIG	FE	trend 0.106***	FE and trend 0.049***
SA	FE	trend 0.023**	FE and trend 0.023**
VE	FE	trend 0.046***	FE and trend 0.018**
R^2	0.44	0.25	0.92
N	273	273	273

***, ** and * signify that the coefficient is different from zero at the 1%, 5% or 10% confidence level, respectively.

Table 4. Pooled least squares estimates with real effective exchange rate as dependent variable, sample of 7 OPEC countries (1975-2005)

	1	2	3
	Fixed effects	Cross-section specific trends	Cross-section specific trends and fixed effects
gdp	-1.795***	0.647***	-1.486***
oil	0.751***	0.296***	0.466***
AL	FE	trend -0.031***	FE and trend -0.048***
EC	FE	trend -0.011	FE and trend -0.001
GA	FE	trend -0.034***	FE and trend -0.030***
IR	FE	trend -0.021**	FE and trend -0.036***
NIG	FE	trend 0.030***	FE and trend -0.037***
SA	FE	trend -0.067***	FE and trend -0.036***
VE	FE	trend -0.061***	FE and trend 0.001
R^2	0.59	0.15	0.72
N	186	186	186

***, ** and * signify that the coefficient is different from zero at the 1%, 5% or 10% confidence level, respectively.

Next, we estimate the long-term relationship between the variables with the Pooled Mean Group estimator. First proposed by Pesaran et al (1996), the PMG estimator has the advantage that only long-run coefficients are constrained to be the same across cross-sections (in our case, countries), while short-run responses can be different.[5] For purposes of robustness check, we also utilise a mean group (MG) estimator.

Table 5 gives results of the PMG and MG estimations. In columns 1 and 3, we include both intercept and trend, while in columns 2 and 4 we utilise only intercept. In our PMG estimations, elasticity of the real exchange rate with respect to the oil price is between 0.4 and 0.5. Quite remarkably, we can see that for our sample of OPEC countries, the Balassa-Samuelson effect has no statistical support. The Hausmann test implies that we can pool data from the different cross-sections together. In Table 6, we use a different dependent variable, i.e. the real effective exchange rate. When both constant and trend are included in the specification, long-run elasticity of the real effective exchange rate with respect to the real price of oil is almost exactly 0.4. It rises above one when only a constant is included.

Therefore, real oil price always has a positive effect on real exchange rate, i.e. a higher oil price leads to real exchange rate appreciation. This result is very robust for different specifications. Moreover, the elasticity of real exchange rate is almost always in the interval between 0.4 and 0.5.[6] Previous literature found that real commodity prices influence real exchange rates in commodity-exporting countries. We confirm this result for our group of oil-exporting countries.

Table 5 PMG and MG estimation with GDP deflator based real exchange rate against the USD as dependent variable, sample of 9 OPEC countries (1975-2005)

	1 PMG	2 PMG	3 MG	4 MG
gdp	0.025	-0.006	0.540	-1.529
oil	-0.422***	-0.529***	-0.479***	-0.744***
error correction term	-0.424***	-0.302***		
control variables	intercept, trend	intercept	intercept, trend	intercept
Joint Hausmann test (p-value)	0.81 (0.67)	1.55 (0.46)		

***, ** and * signify that the coefficient is different from zero at the 1%, 5% or 10% confidence level, respectively.

[5] In fact, one can also choose to restrict only some long-run coefficients to be the same, and allow others to differ across cross-sections. We will not follow this approach in this paper.

Table 6 PMG estimation with real effective exchange rate as dependent variable, sample of 9 OPEC countries (1975-2005)

	1 PMG	2 PMG	3 MG	4 MG
Gdp	-2.283***	-1.585*	0.797	-3.856
Oil	0.371***	1.346***	0.853*	1.096**
error correction term	-0.367**	-0.128		
Control variables	intercept, trend	intercept	intercept, trend	intercept
Joint Hausmann test (p-value)	3.11 (0.21)	8.39 (0.02)		

5 Concluding remarks

We confirmed that real oil price has a statistically significant positive effect on the real exchange rate of oil-producing countries using several estimation methodologies and variable definitions. On the other hand, we found little evidence for the Balassa-Samuelson effect in our sample of oil-producing countries. Taken together, these results imply that the oil price may drive many macroeconomic variables in oil-dependent economies. Thus, ignoring this effect may lead to erroneous conclusions.

While exact estimates of long-run elasticity of the real exchange rate with respect to the real price of oil seem to depend on the specification, most of our estimates cluster close to 0.5. This result is independent from the choice of real exchange rate variable. Moreover, the estimated coefficients are statistically significant. Interestingly, Zalduendo (2006) estimates similar results for Venezuela and Kalcheva and Oomes (2007) for Russia. It seems that our nine OPEC countries are sufficiently homogenous that we may employ panel data methodology. When we try to expand the data sample to the CIS countries, however, we lose data along the time dimension, rendering the results very unstable. Kalcheva and Oomes avoid this problem by using monthly data.

[6] The exception is the specification where the *reer* equation is estimated without a trend. In this case, the Hausmann test rejects pooling anyway.

Our results have obvious policy relevance. When the oil price increases, the equilibrium real exchange rate of oil-producing countries appreciates. Unless authorities let the nominal exchange rate appreciate in response, inflation will tend to accelerate. In such a situation, authorities can not maintain a weaker level of exchange rate and keep inflation down for any extended period of time.

References

Cashin, Paul, Céspedes, Luis F. and Sahay, Ratna (2004), "Commodity currencies and the real exchange rate," *Journal of Development Economics*, Vol. 75, 239-268.

Chen, Yu-chin and Rogoff, Kenneth (2003), "Commodity currencies," *Journal of International Economics*, Vol. 60, 133-160.

Clark, Peter B. and MacDonald, Ronald (1998), "Exchange rates and economic fundamentals – A methodological comparison of BEERs and FEERs," IMF Working Paper 98/67, Washington D.C.

Edwards, Sebastian, (1994), "Real and monetary determinants of real exchange rate behavior: Theory and evidence from developing countries," in *Estimating Equilibrium Exchange Rates*, Williamson, John (ed.), Washington D.C., Institute for International Economics.

Hadri, Kaddour (2000), "Testing for stationarity in heterogeneous panel data," *The Econometrics Journal*, Vol. 3, 148-161.

Haque, Nadeem, Pesaran, Hashem, and Sharma, Sunil (2000), "Neglected heterogeneity and dynamics in cross-country savings regressions," in *Panel Data Econometrics – Future Direction: Papers in Honour of Professor Pietro Balestra*, J. Krishnakumar and E. Ronchetti (eds.), Elsevier Science, 2000, Chapter 3, 53-82.

Issa, Ramzi, Lafrance, Robert, and Murray, John (2006), "The Turning Black Tide: Energy Prices and the Canadian Dollar," Bank of Canada Working Paper 2006-29.

Kalcheva, Katerina and Oomes, Nienke (2007), "Dutch Disease: Does Russia Have the Symptoms?" forthcoming BOFIT Discussion Paper 6/2007.

Koranchelian, Taline (2005), "The equilibrium real exchange rate in a commodity exporting country: Algeria's experience", IMF Working Paper 05/135, Washington D.C.

Lane, Philip R. and Milesi-Ferretti, Gian Maria (2001), "The external wealth of nations: measures of foreign assets and liabilities for industrial and developing countries," *Journal of International Economics*, Vol. 55, 263-294.

Lane, Philip R. and Milesi-Ferretti, Gian Maria (2002), "External wealth, the trade balance and the real exchange rate," *European Economic Review*, Vol. 46, 1049-1071.

MacDonald, Ronald (1999), "What do we really know about real exchange rates?" in Ronald MacDonald and Jerome L. Stein (eds.), *Equilibrium Exchange Rates*. Boston, Kluwer Academic Publishers.

Montiel, Peter (1999), "Determinants of the long-run equilibrium exchange rate: an analytical model", in Hinkle, Lawrence and Montiel, Peter (eds.), *Exchange Rate Mis-*

alignment: Concepts and Measurement for Developing Countries, World Bank, Oxford University Press, Oxford.

Pesaran, Hashem, Smith, Ron, and Im, K., (1996), "Dynamic linear models for heterogenous panels," in *The Econometrics of Panel Data*, L. Mátyás and P. Sevestre (eds.), 145-195, Kluwer Academic Publishers, Dordrecht.

Pesaran, Hashem, Shin, Yongcheol, and Smith, Ron, (1999), "Pooled mean group estimation of dynamic heterogeneous panels," *Journal of the American Statistical Association*, vol. 94, 621-634.

Zalduendo, Juan (2006), "Determinants of Venezuela's equilibrium real exchange rate", IMF Working Paper 06/74, Washington D.C.

Appendix

Robustness tests

In this appendix, we report results from the robustness tests involving (in addition to our main sample of nine OPEC countries) three countries from the Commonwealth of Independent States (CIS), i.e. Azerbaijan, Kazakhstan and Russia. Since the latter three countries were once part of the Soviet Union, i.e. a centrally planned economy, there are no comparable data for pre-1992 period. Moreover, as data from 1992 is spotty at best for these countries, we start our sample from 1993. Given the brevity of these time series, our robustness tests must be treated with caution.

Our results are presented in Tables A.1 and A.2. As to the specifications with cross-section specific trends, the results show little qualitative change from the longer sample. For the fixed effects, however, oil now has a positive sign contrary to our main results. Taken together, we consider the results for the shorter sample to be spurious. Even though we are able to expand the dataset by adding more cross-sections, it does not make up for the loss of periods.

Table A.1. Pooled least squares estimates with CPI-based real exchange rate against the USD as dependent variable, sample of 9 OPEC and 3 CIS countries (1993-2005)

	1	2	3
	Fixed effects	Cross-section specific trends	Cross-section specific trends and fixed effects
gdp	0.107	0.136	1.025***
oil	0.174**	-0.004	-0.030
AL	FE	trend 0.028***	FE and trend 0.042*
AZ	FE	trend 0.012	FE and trend -0.064**
EC	FE	trend 0.019**	FE and trend 0.020
GA	FE	trend 0.023***	FE and trend 0.057**
IND	FE	trend 0.028***	FE and trend 0.057**
IR	FE	trend 0.028***	FE and trend 0.011
KUW	FE	trend 0.008**	FE and trend 0.017
KZ	FE	trend 0.010	FE and trend -0.049*
NIG	FE	trend 0.027*	FE and trend 0.072***
SA	FE	trend 0.017***	FE and trend 0.046*
RU	FE	trend 0.005	FE and trend -0.042*
VE	FE	trend 0.010	FE and trend 0.016
R^2	0.30	0.34	0.44
N	151	151	151

***, ** and * signify that the coefficient is different from zero at the 1%, 5% or 10% confidence level, respectively.

Table A.2. Pooled least squares estimates with GDP deflator -based real exchange rate against the USD as dependent variable, sample of 9 OPEC and 3 CIS countries (1993-2005)

	1	2	3
	Fixed effects	Cross-section specific trends	Fixed effects and cross-section specific trends
Gdp	-0.421	0.247*	0.883**
oil	0.066	-0.185	-0.280**
AL	FE	trend 0.026**	FE and trend 0.013
AZ	FE	trend 0.016	FE and trend -0.104***
EC	FE	trend 0.044***	FE and trend 0.282***
GA	FE	trend 0.022**	FE and trend 0.047*
IND	FE	trend 0.030**	FE and trend 0.037
IR	FE	trend 0.030***	FE and trend 0.004
KUW	FE	trend 0.010*	FE and trend 0.007
KZ	FE	trend 0.015	FE and trend -0.051*
NIG	FE	trend 0.041**	FE and trend 0.083***
SA	FE	trend 0.011*	FE and trend 0.018
RU	FE	trend 0.010	FE and trend -0.019
VE	FE	trend 0.017*	FE and trend 0.011
R^2	0.14	0.21	0.64
N	152	152	152

***, ** and * signify that the coefficient is different from zero at the 1%, 5% or 10% confidence level, respectively.

Bank of Finland
BOFIT – Institute for Economies in Transition
PO Box 160
FIN-00101 Helsinki

☎ + 358 10 831 2268
bofit@bof.fi
http://www.bof.fi/bofit