

Essays in International Macroeconomics

Inaugural-Dissertation
zur Erlangung des Grades eines Doktors
der Wirtschafts- und Sozialwissenschaften
der Wirtschafts- und Sozialwissenschaftlichen Fakultät der
Christian-Albrechts-Universität zu Kiel

vorgelegt von

Doctorandus
Annette Kamps
aus Heidelberg

Frankfurt am Main 2008

Gedruckt mit Genehmigung der
Wirtschafts- und Sozialwissenschaftlichen Fakultät der
Christian–Albrechts–Universität zu Kiel

Dekan: Prof. Dr. Helmut Herwartz
Erstberichterstattender: Prof. Dennis J. Snower, Ph.D.
Zweitberichterstattende: Prof. Dr. Claudia Buch

Tag der Abgabe der Arbeit: 30. Oktober 2007
Tag der mündlichen Prüfung: 16. April 2008

Acknowledgements

Many persons have guided and assisted me through the production process of this dissertation. First of all, I would like to thank my supervisors Prof. Dennis Snower (Ph.D.) and Prof. Dr. Claudia Buch for their advice and willingness to supervise this dissertation project. I am very grateful to my former colleagues at the Kiel Institute for the World Economy for helpful comments on draft chapters of this dissertation and moral support. I would like to mention in particular Joachim Benner, Dora Borbély, Alfred Boss, Kai Carstensen, Joerg Doepke, Klaus-Jürgen Gern, Melanie Grosse, Felix Hammermann, Regine Henke, Christophe Kamps, Jörn Kleinert, Carsten-Patrick Meier, Frank Oskamp, Christian Pierdzioch, Joachim Scheide, Andrea Schertler, Julius Spatz and Hubert Strauss.

The idea for several chapters of this dissertation originated when I worked first as an intern and later as a consultant in the Directorate General International and European Relations of the European Central Bank. I would like to thank Francesco Mazzaferro, Head of the EU Neighbouring Regions Division, and Adalbert Winkler, Deputy Head of this Division, for their support and for giving me the opportunity to focus my stays at the ECB on topics both relevant for the ECB and suitable for my dissertation project. I am especially indebted to my supervisors Oscar Calvo-Gonzalez and Roland Beck for their cooperation.

I dedicate this dissertation to my husband Christophe and to our children Simon and Sarah.

Frankfurt am Main, August 2008

Annette Kamps

List of Contents

1. Introduction.....	1
2. The Euro as Invoicing Currency in International Trade.....	13
2.1. Theoretical Literature.....	15
2.2. Stylized Facts and the Empirical Literature.....	19
2.3. Empirical Findings.....	25
2.3.1. The Invoicing Database.....	25
2.3.2. The Explanatory Variables.....	29
2.3.3. Empirical Methods.....	30
2.3.4. The Empirical Model for US. Dollar Export Invoicing.....	31
2.3.5. The Empirical Model for Euro Export Invoicing.....	36
2.3.6. The Empirical Model for Home Currency Export Invoicing.....	40
2.3.7. The Empirical Model for Home Currency Import Invoicing.....	42
2.3.8. Robustness and Goodness-of-Fit of the Model.....	44
2.4. Conclusion.....	46
2.5. References.....	48
2.6. Appendix.....	51
3. Petrodollars and Imports of Oil Exporting Countries.....	63
3.1. The Literature.....	65
3.2. Empirical Findings.....	68
3.2.1. The Data.....	68
3.2.2. Estimation Methodology.....	73
3.2.3. Estimation Results.....	76
3.2.4. Robustness of Estimation Results.....	80
3.3. Impact on Global Imbalances.....	85
3.3.1. Simulation of a 10 U.S. Dollar Increase in the Price of Oil.....	86
3.3.2. Simulation of a 10 Percent Appreciation.....	89
3.4. Conclusion.....	90
3.5. References.....	92
3.6. Appendix.....	94
4. Has Russian GDP Growth Become Less Dependent on Oil? A Cointegration VAR approach.....	99
4.1. The Literature.....	102
4.2. Empirical Findings.....	107
4.2.1. The Data.....	107
4.2.2. Unit Root and Cointegration Tests.....	107
4.2.3. Estimation Results.....	110
4.3. An Error Correction Model for Russian Imports.....	117
4.4. Conclusion.....	118
4.5. References.....	119
4.6. Appendix.....	121
5. The International Transmission of Monetary Shocks: Evidence for Selected OECD Countries.....	124
5.1. Theoretical Background.....	125
5.2. Empirical Analysis.....	129
5.2.1. The Econometric Model.....	129
5.2.2. Empirical Results.....	130
5.3. Conclusion.....	133
5.4. References.....	135
5.5. Appendix.....	137

List of Tables

<i>Table 1.1:</i> Share of Euro and U.S. Dollar Invoicing in Exports	4
<i>Table 2.1:</i> Trade Invoicing Comparison with Hartmann (1998)	28
<i>Table 2.2:</i> U.S. Dollar Export Invoicing.....	34
<i>Table 2.3:</i> Euro Export Invoicing	38
<i>Table 2.4:</i> Home Currency Export Invoicing	41
<i>Table 2.5:</i> Home Currency Import Invoicing.....	43
<i>Table A2.1:</i> U.S. Dollar, Euro and Home Currency Invoicing in the Exports and Imports of 42 Countries.....	52
<i>Table A2.2:</i> Share of Differentiated Goods in Exports and Imports.....	60
<i>Table A2.3:</i> U.S. Dollar Import Invoicing	61
<i>Table A2.4:</i> Euro Import Invoicing.....	62
<i>Table 3.1:</i> Petrodollar Recycling, 2002 – 2005	64
<i>Table 3.2:</i> Panel Unit Root Tests	74
<i>Table 3.3:</i> Pedroni cointegration tests	75
<i>Table 3.4:</i> Estimation of Import Demand in Oil Exporting Countries	77
<i>Table 3.5:</i> Overview of different estimation specifications.....	83
<i>Table 3.6:</i> The impact of a 10 dollar rise in the oil price on the United States	87
<i>Table 3.7:</i> The impact of a 10 dollar rise in the oil price on the euro area.....	88
<i>Table A3.1:</i> Data Availability	94
<i>Table A3.2:</i> Development of major economic variables	95
<i>Table A3.3:</i> De facto exchange rate arrangements.....	95
<i>Table A3.4:</i> Country Specific Diagnostic Results	96
<i>Table 4.1:</i> Unit Root Tests.....	108
<i>Table 4.2:</i> Rank determination with simulated asymptotic trace test distributions.....	109
<i>Table 4.3:</i> Estimation Results	111
<i>Table A4.1:</i> Test for variable exclusion.....	121
<i>Table A4.2:</i> Test for weak exogeneity	121
<i>Table A4.3:</i> Lag Length Determination	121
<i>Table A4.4:</i> Tests for misspecification	121
<i>Table 5.1:</i> Forecast-Error-Variance Decomposition for German and Japanese Output	142
<i>Table 5.2:</i> Forecast-Error-Variance Decomposition for Dutch and Austrian Output	142

List of Figures

<i>Figure 1.1: Current Account Balances as Share of World GDP</i>	6
<i>Figure 1.2: Oil Prices and Russian GDP Growth</i>	10
<i>Figure 2.1: Average share of currencies used in exports and imports by region</i>	26
<i>Figure 3.1: Share of exports to oil exporting countries</i>	88
<i>Figure 3.2: Oil Exporters' Share in the U.S. Trade Deficit and U.S. Exports 2006</i>	89
<i>Figure A3.1: Robustness over Countries</i>	97
<i>Figure A3.2: Robustness over Maximum Lag Length</i>	98
<i>Figure 4.1: Real GDP growth and oil prices</i>	100
<i>Figure 4.2: The real effective exchange rate and real import growth</i>	100
<i>Figure 4.3: Import Leakage</i>	106
<i>Figure 4.4: Recursive Estimation of the Coefficient of oil for the GDP equation</i>	112
<i>Figure 4.5: Recursive Estimation of the Coefficient of REER for the GDP equation</i>	113
<i>Figure 4.6: Permanent oil price shock</i>	115
<i>Figure 4.7: Temporary oil price shock</i>	116
<i>Figure A4.1: Test for structural breaks</i>	122
<i>Figure A4.2: The full model recursive estimations</i>	122
<i>Figure A4.3: Test of Beta Constancy</i>	122
<i>Figure A4.4: Impulse Responses of the unrestricted VAR model</i>	123
<i>Figure A5.1: Impulse Responses United States/Germany</i>	138
<i>Figure A5.2: Impulse Responses United States/Japan</i>	139
<i>Figure A5.3: Impulse Responses Germany/Netherlands</i>	140
<i>Figure A5.4: Impulse Responses Germany/Austria</i>	141

1 Introduction

This dissertation contributes to several fields of international macroeconomics which have received a lot of attention recently. Chapter 2 of this study analyses *the choice of invoicing currency in international trade*. In international macroeconomics the transmission via exchange rates and trade has traditionally been based on the assumption of producer currency pricing. The exchange rate transmission via expenditure switching effects and the so called “beggar-thy-neighbour” policy depend on the assumption that export prices expressed in the currency of the importing country fluctuate with the exchange rate. Both the traditional Mundell-Fleming model (Mundell 1962, Fleming 1962), but also the basic New Open Economy Macroeconomics model developed by Obstfeld and Rogoff (1995) are based on this assumption. However, empirically the transmission of the exchange rate in international trade is not as unambiguous as most of the theoretical literature has assumed so far. This is why, when international linkages through the trade channel are analysed, it is important to first establish a pattern of currency invoicing. The currency in which trade is invoiced is crucial as it determines whether and to which extent the economy and the trade of a country react to exchange rate movements. Recent theoretical contributions to the New Open Economy Macroeconomics literature have explored the implications of alternative invoicing assumptions on the international transmission of business cycles (e.g. Bacchetta and van Wincoop 2003). Exporters might wish to avoid expenditure switching effects because they fear that a competing product becomes cheaper in another currency due to exchange rate movements. Therefore they might choose to set the price of their export good in the currency of the importing country (local currency pricing) or in a third currency (vehicle currency pricing) because their competitors also price in this currency and the relative price to the competing product is not affected by exchange rate movements. Existing empirical evidence for a few countries suggests that local currency pricing (often also referred to as pricing to market) and vehicle currency pricing are important empirically. For some goods, e.g. oil, all trade is invoiced in a vehicle currency, in general the U.S. dollar. The second chapter of this study presents a new dataset and new evidence on the invoicing pattern in international trade for a large panel of countries. It goes into detail explaining the motivation to set prices in different currencies, with a special focus on the role of the euro as invoicing currency.

Another development in international macroeconomics is the renewed interest in the effects of oil prices on the global economy. Chapters 3 and 4 of this study focus on the impact of oil prices on oil-exporting countries, a topic which has received far less attention than the impact on industrial countries. Chapter 3 analyses *the import behaviour of oil exporting countries*

and its potential role in the resolution of global current account imbalances. While the world economy seems to have coped well with the most recent oil price increase the major focus has shifted to global imbalances. The United States which has always been at the centre of the discussion on oil price shocks is running high current account deficits. At the same time, oil exporting countries are running high current account surpluses. It is often argued that because oil exporting countries are running high current account surpluses they can contribute to the reduction of global imbalances especially if they let their currencies appreciate. However, as their major export good oil is almost exclusively invoiced in U.S. dollar, expenditure switching effects of the appreciation can only work via imports. Accordingly, this study analyses whether increased import demand in oil exporting countries can significantly contribute to reducing global imbalances. It is analysed whether increased import demand in oil exporting countries due to higher oil revenues can compensate for the negative terms of trade shock hitting oil importing countries.

Chapter 4 analyses *the effect of oil price changes on the economy of the world's largest oil exporting country, Russia.* While previous studies focused on the analysis of oil importing industrial countries among others due to data availability issues, this study shows the dynamic reaction of the economy of an oil exporting country to an oil price shock. Particular attention is paid to the long-run, as oil price increases might lead to Dutch Disease phenomena in oil exporting countries. The main reason is that oil price increases may lead to a substantial appreciation of the real exchange rate. This in turn may entail expenditure switching away from domestic goods towards foreign imported goods and may, thus, hurt the non-oil tradable sector in oil exporting countries. On the other hand, an appreciation of the real exchange rate has beneficial effects as it helps to dampen the stimulus from rising oil prices and to avoid an overheating of the economy.

The fifth chapter looks at the *international transmission of monetary policy shocks*, paying particular attention to the question whether countries with flexible exchange rates react differently to monetary shocks than countries with fixed exchange rates. One important transmission channel is the trade channel which comes into effect when the exchange rate of two countries and relative prices of domestic and foreign goods are affected by monetary policy. This trade channel comes only into effect if 1) exchange rates are free to adjust and 2) the invoicing pattern of trade is such that relative prices of foreign to domestic products are affected at all by exchange rate movements. In other words, the trade channel is operational under producer currency pricing but not under local currency pricing. The remainder of the Introduction gives a more detailed summary of the individual chapters of this study.

The Euro as Invoicing Currency in International Trade

What determines the choice of currency in which international trade is invoiced? This question has attracted the attention of economists worldwide for decades but the limited availability of data has meant that little is actually known beyond a number of broad stylised facts. Chapter two of this study presents a newly constructed dataset on currency invoicing in trade for 42 countries and analyses the main determinants of the choice of invoicing currency. A special contribution of this chapter is to explore the use of the euro in invoicing of international trade and to compare the role of the euro and the role of the U.S. dollar as world vehicle currencies.

Until recently it was commonly assumed in the theoretical literature that exporters preferred to set prices in their own currency. However, another important phenomenon to consider is the business practice of “pricing to market.” This term captures the behaviour of monopolistic firms that, exploiting their ability to take advantage of differences in demand elasticities across countries, are able to set different prices in different national markets. In principle, exporters could price to market regardless of whether they invoice in their own currency (known as “producer currency pricing”) or in the currency of the local market where the products are sold (“local currency pricing”). However, the combined effect of flexible exchange rates and the menu costs of changing nominal prices imply that exporters facing a competitive local market may opt to use the local currency in their pricing so as to avoid that exchange rate fluctuations result in a loss of competitiveness. The combination of market power and nominal rigidities has brought the issue of the choice of invoicing currency to centre stage, not least since full local currency pricing of imports would also imply no passthrough from the exchange rate to domestic inflation for the importing country, at least in the short run. The choice of the currency in which international trade is invoiced, thus, has important implications both at the micro- and macroeconomic level. At the firm level, the profit maximization of firms engaged in international trade is affected by their choice of currency while at the macroeconomic level the currency of invoicing in international trade affects business cycle correlations between countries and the transmission mechanism of monetary policy.

Table 1: Share of euro and U.S. dollar invoicing in exports

	Euro Area		Other European Countries		Asia Pacific	
	euro	USD	euro	USD	euro	USD
2000	41.3	40.4	49.4	36.6	6.3	74.6
2001	45.2	38.8	47.1	37.1	3.1	78.2
2002	50.6	34.0	53.5	35.2	4.1	79.1
2003	55.5	31.2	56.9	30.4	4.4	76.4
2004	58.0	30.6	56.0	30.4	8.8	75.9

Note : Data describes unweighted average of available data for countries as described in chapter 2.

The question of what determines the choice of currency in international trade has become all the more topical given the increase seen during recent years in the use of the euro in international trade by a number of countries, primarily EU Member States and EU acceding and accession countries (Table 1). There is also some evidence that the increase in the use of the euro may partly reflect the growing role of the euro as a vehicle currency, i.e. a currency used between two counterparties outside the country or area of issuance of the currency.

The theoretical literature on the choice of currency invoicing is quite extensive.¹ The most important finding is that the sensitivity of foreign demand to prices matters, which can be approximated by the homogeneity or differentiation of the product. When demand is sensitive to prices the market share of the exporting country, or more specifically, the currency used by the competitors matters. When the optimal currency choice depends on the currency used by competitors, herding in the same currency is optimal. Also, currencies of countries with monetary stability are more likely to be chosen as invoicing currency.

The main finding of chapter two is that the euro is increasingly used as invoicing currency both for bilateral trade and for vehicle currency invoicing. This is particularly true for the countries with the prospect of adopting the euro at some point in the future. The membership or prospective membership of the EU leading to the future introduction of the euro and whether the country is in a hard peg with the euro play a decisive role in the choice of the euro as invoicing currency in its trade. The introduction of the common currency in the euro area increased the invoicing in euro at the expense of the U.S. dollar. The increased invoicing in euro can be found for vehicle currency pricing as well as for producer and local currency pricing. The role of the euro as vehicle currency seems to be limited, however, when compared to the U.S. dollar. The estimation results show that higher monetary instability reflected in a high inflation differential, and a low differentiation of exports lead to less euro invoicing, while the contrary is true for the U.S. dollar, which supports the impression that the U.S. dollar is the preferred vehicle currency. There are some signs for the role of the euro as

¹ See for example Bacchetta and van Wincoop (2005), Goldberg and Tille (2005), Donnenfeld and Zilcha (1991) and Friberg (1997).

vehicle currency, however. Countries with no forward market for their currency are not only more likely to invoice in U.S. dollar but also to invoice in euro. Also, if a country exhibits high exchange rate volatility vis-à-vis the euro it is more likely to invoice in euro.

This chapter significantly contributes to the literature in several aspects. First and foremost, a large new dataset on the invoicing currency in international trade of 42 countries is created. With this extensive dataset a panel analysis is performed with a special focus on the role of the euro while previous studies focused on the role of the U.S. dollar (Goldberg and Tille (2005)) and the domestic currency (country studies on Canada, Sweden and the Netherlands)². The estimation results for this large panel of countries generalise findings that have so far only been found in individual country studies and at the same time they give new insights into the prospects of the euro as vehicle currency.

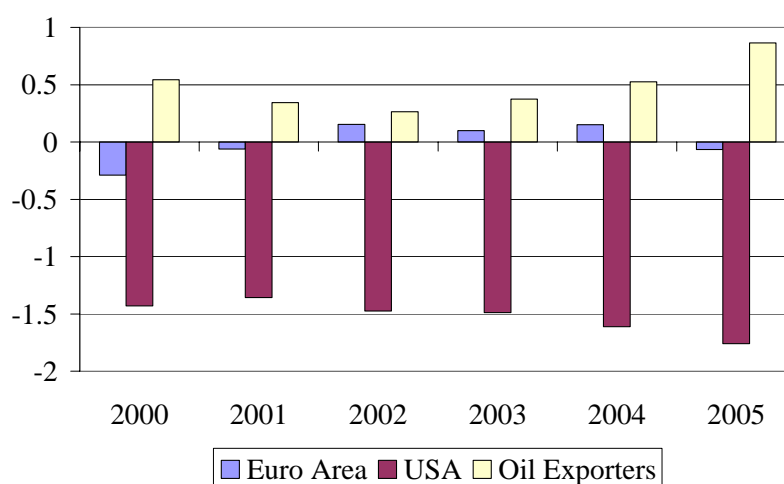
Petrodollars and Imports of Oil Exporting Countries

The third chapter deals with the impact of oil prices on global imbalances. The pricing of oil is a particularly good and prominent example of a market that is dominated by one vehicle currency, namely the U.S. dollar. Increasing oil prices and current account surpluses of oil exporting countries have brought these countries to the centre of interest. Oil prices have risen sharply since 1999. This seems to have exacerbated global imbalances. High oil prices have worsened the current account deficit in the United States through higher oil import bills. At the same time, oil exporting countries benefited from the higher oil prices and used their export revenue windfalls to accumulate financial assets or to buy foreign goods. However, additional import spending seems to fall short of the export revenue windfall. Thus, while the current account deficit in the United States widens, oil exporting countries are running record current account surpluses. Is there a mechanism to dampen this commodity price effect and are there second round effects in this world commodity price channel? If additional oil revenues in oil exporting countries are spent on importing goods, there could be a redistribution of oil revenues. This is particular likely if the real exchange rate of oil exporting countries reacts with an appreciation to this positive terms of trade shock. This way oil exporting countries would not only import more due to their increased wealth through the higher oil prices but also due to the fact that foreign goods become cheaper relative to domestic goods. Could this reduce the negative effect of high oil prices on industrial economies and how does the economy in the oil exporting countries react? The imports of oil exporting countries are likely to be invoiced in vehicle currency (the U.S. dollar) or in

² See Donnenfeld and Haug (2003) for a study on Canadian import invoicing, Wilander (2004) for a study on Swedish export pricing and Silva (2004) for a study on invoicing in Dutch Trade.

producer currency (the currency of the exporting country). Therefore the pass-through from exchange rate movements into import prices is likely to be very high. This is a case where the expenditure switching mechanism can fully unfold and exchange rates adjust to reduce disequilibria.

Figure 1.1: Current Account Balances as Share of World GDP



Note: Oil exporters includes countries as described in chapter 3.

Source: IMF (2006), own calculations.

This has led to increased interest in the effect of higher oil prices on global imbalances.³ There were voices to be heard in the international community that oil exporting countries should be made to participate in reducing global imbalances by increasing their import demand. First and foremost it was stated that oil exporting countries should let their exchange rates float which would lead to real appreciations and help reduce global imbalances by stimulating demand for foreign products in oil exporting countries. There are several questions arising from this statement. First of all, the direct impact of oil prices on import demand should be analyzed. How much do imports in oil exporting countries increase due to the higher oil revenues and the increased wealth? A further question is whether and to which extent a real appreciation stimulates imports in these countries. Third, it is important to look at other factors influencing import behaviour in oil exporting countries. In particular what distinguishes oil exporting countries' import behaviour from that of industrial countries? Finally, the possible import increase should be put into the perspective of global imbalances. How much can oil exporting countries contribute at all to reducing global imbalances?

³ See for example IMF World Economic Outlook (2006), Federal Reserve Bank of San Francisco (2006), U.S. Department of the Treasury (2006).

This chapter focuses on the trade channel of petrodollar recycling. Especially in times of high oil prices the use or “recycling” of these petrodollars attracts interest. Oil exporting countries can also spend their oil revenues in the domestic economy. However, as the production in most oil exporting countries is not well diversified, the domestic economy cannot absorb all oil revenues. This is particularly true in times of high oil price increases when the domestic economy is unable to adjust to the higher demand in the short run. Therefore a large share of the petrodollars is recycled abroad. Apart from the trade channel there are two financial channels of petrodollar recycling. The first is the asset accumulation channel. Oil exporting countries use part of their oil revenues to accumulate foreign reserves. In 2005 portfolio investment seems to have replaced reserve accumulation as most important source of capital outflow. The majority of the capital outflows are going to the United States. The second financial channel is the debt reduction channel. Many oil exporting countries accumulated a stock of debt in the past part of which is international debt. Lately, especially Russia used a large share of its petrodollars to repay outstanding international debt liabilities. These two financial channels are often linked to the question of who is financing the U.S. current account deficit. Chapter 3, however, focuses on the trade channel of petrodollar recycling. While foreign asset accumulation serves to finance global imbalances, increased trade could serve to correct global imbalances.

The literature on trade in oil exporting countries so far has focused on the current account and terms of trade effects. Oil price increases are found to have positive effects on the current account in oil exporting countries (IMF 2005). This study separates the effects of the oil price increase and the real exchange rate on real imports in oil exporting countries. The behaviour of real imports is analysed rather than the current account which includes nominal imports and exports. The literature on import demand equations is substantial. Focus has, however, usually been on industrial countries. In large country panels only a small number of oil exporting countries is considered. Also, the special characteristics of oil exporting countries are not taken into account in these panel studies on import demand. In general, studies (e.g. Goldstein and Kahn 1985, Clarida 1994, Reinhart 1995, Senhadji 1998) find a positive long-run relationship between imports and the measure of the real exchange rate (often composed of the real effective exchange rate or the terms of trade). For industrial countries estimates have been close to unity (or above), while estimates for developing countries were usually found to be much smaller, implying that for substantial expenditure switching to take place large exchange rate movements are needed. While these studies focus on real import demand, they do not include special features that are likely to be important determinants of import

demand in oil exporting countries. In particular, the fiscal side is always excluded because for countries not depending on a single commodity, the fiscal sector usually plays a negligible role in foreign demand. For oil exporting countries, however, import demand can be influenced by fiscal policy as the decision on spending or saving oil export revenues plays a crucial role for import demand.

In chapter 3 an empirical model of the import demand of oil exporting countries is set up. The analysis is based on a panel cointegration model including 24 oil exporting countries for the period from 1980 to 2005. Estimation results show that import demand in the region depends positively on domestic demand and exports, the real exchange rate and the price of oil. Fiscal balances reduce the demand for imports. The long run elasticities of imports with respect to the oil price and with respect to the real exchange rate are both found to be around 0.2. With higher oil prices and a real appreciation imports in the region are significantly expanded. However, the impact on global imbalances seems to be limited. While an oil price increase leads to higher spending on the oil bill of oil importing countries the positive second round effects of higher exports to oil exporting countries cannot compensate for this negative impact on the current account. For the United States only around 7 percent of the increase in the oil bill are compensated for by higher exports to the region of oil exporting countries. In contrast, the Euro area's oil bill increase is compensated for by almost 40 percent. Due to the structure of trade the euro area rather than the United States benefits from the increased demand in the region. Also, the share of oil exporting countries' imports in overall trade is relatively small. Even though these countries are running record current account surpluses at the moment, their import demand only plays a minor role in the global system of current accounts. Thus, for the moment the role of oil exporting countries in reducing global imbalances seems to be rather limited.

This analysis of the import demand in oil exporting countries contributes to the literature in several ways. First of all, the special characteristics of the oil exporting countries are taken into account in the estimation. In particular, fiscal policy, which plays a major role in oil exporting countries because in many countries the oil producing sector is state-owned or subject to large royalties, is included in the model. Furthermore, the study distinguishes between price effects of oil price increases and wealth effects of oil price increases by looking at real imports rather than at the current account (including nominal imports). A real effective exchange rate approximation is calculated for all the countries as an approximation for the real exchange rate rather than including the terms of trade which are often used in the import demand literature. The terms of trade is not a good approximation for the real exchange rate in

oil exporting countries as imports and exports are unlikely to be substitutes and the terms of trade include price effects of the major export good oil. Another innovation of the analysis is that this study is based on a cointegration analysis which establishes long run relationships between the oil price, the real exchange rate and import demand.

Has Russian GDP Growth Become Less Dependent on Oil?

While the previous chapter focused on the international transmission of commodity prices on oil exporting countries and the second round transmission channel of trade through petrodollar recycling, chapter four takes a closer look at the commodity price channel for the overall economy of an oil exporting country. Traditionally, studies on the impact of oil prices on the economy have focused on the effect of higher oil prices on oil importing countries, in particular, the largest oil importing country, the United States (Hamilton 1996, 2003). While there is ample evidence on the negative effect of oil prices on GDP of oil importing countries the positive effect on GDP of oil exporting countries is more controversial. In a study on OECD countries Bjørnland (2000) finds that Norway benefits from oil price increases while the United Kingdom is negatively affected. Especially in the long-run, the possible negative effects of Dutch Disease phenomena in countries relying on commodities as the major source of export revenue have to be taken into account. Oil revenue windfalls might result into real appreciations and resource shifts to the oil exporting sector leaving the non-oil industrial sector uncompetitive.

The fourth chapter of this study presents a country study of the largest oil exporting country Russia and analyses whether an increase in oil prices has a positive effect on Russian GDP in the long-run.⁴ While the previous chapter focused on the external impact oil exporting countries have on global imbalances with increasing oil prices and real exchange rate movements, this chapter focuses on the domestic effects of oil prices on the Russian economy. In particular, it is analysed whether Russia's dependence on oil decreased with increased trade openness, increased diversification of the economy and last but not least the introduction of the oil stabilization fund in 2004. Almost all of the economies exporting oil are highly dependent on the price of their main export good. In the panel of oil exporting countries, Russia seems to be among the countries with the highest diversification of the economy.⁵ The question then is, whether Russia has achieved higher independence from oil prices in recent years.

⁴ With a share of 1.7 percent in world GDP in nominal USD dollars for the year 2005, Russia's economy is more than twice as large as the second and third largest oil exporting economies Saudi Arabia and Norway.

⁵ According to official numbers, the share of mining (petroleum and gas production) in GDP was only 10.4 percent of GDP in 2005. According to estimations of the World Bank (2004) these numbers underestimate the

Figure 1.2: Oil Prices and Russian GDP Growth

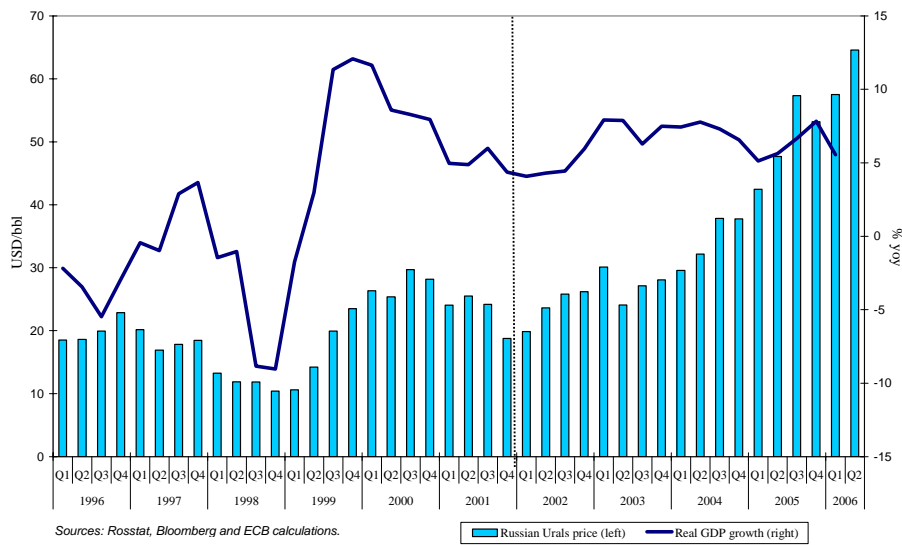


Figure 2 shows the oil price and Russian GDP growth from 1996 to 2006. At first sight the figure suggests that the relationship between oil prices and Russian GDP has become weaker over time. However, simple bivariate correlations can be misleading and the empirical analysis shows that this is the case. Simple correlations do not take into account feedback of the endogenous variables and they might fail to include the effect of variables which play a major role for the analysis. The major candidate for such a variable is the real exchange rate. Rising oil prices can trigger real appreciations in the long-run and these appreciations can reduce the positive impact of oil prices on the economy. Another question regarding the Russian economy is, whether high oil prices lead to a real appreciation in the long-run dampening the positive direct effect of oil on the economy.

Against the backdrop of the prominent role of the oil and gas sector in the country's exports and, to a lesser extent, in GDP one would expect a close relationship between Russia's GDP growth and oil prices. Indeed, empirical studies have found a significant impact of the oil price on Russian GDP growth with long-run elasticities ranging from 0.15 to 0.2 percent.⁶ To shed light on the question of Russia's dependency on oil a Vector Error Correction Model (VECM) is estimated. In particular, I set up a model including GDP, the real exchange rate, the price of oil and real government revenues. The analysis of the cointegration coefficients suggests that Russia's dependency on oil has not become smaller but has stayed more or less constant over time. When considering the long-run impulse response functions of a permanent

true share of oil in Russia's production process. The true share is rather somewhere between 20 and 30 percent (according to the World Bank the true share according to input output calculations amounted to 20 percent in 2000).

⁶ See for example IMF (2002) in which the magnitude of this effect depends on policy reactions, and Rautava (2004).

increase in the oil price an elasticity of 0.24 is found. This figure compares with other estimates for Russia's long-run elasticity with respect to oil even though most of these studies use different and sometimes less sophisticated estimation methods. In particular, most previous studies did not account for the exchange rate effects of oil price increases. Rising oil prices stimulate Russian GDP growth while an endogenous real appreciation resulting from the higher oil prices in the long run offsets the positive effect on GDP to some extent.

The contribution of this study is to provide a systematic analysis of the long-run effects of oil price changes on the Russian economy, the world's largest oil exporting country, while most of the existing literature has focused on the effects of oil price changes on oil importing industrialised countries. It provides a cointegration analysis which takes into account that only a relatively small sample is available. In addition, an extensive sensitivity analysis is carried out in order to show that the main estimation results are robust and stable over time.

The International Transmission of Monetary Policy Shocks

The fifth chapter presents a study on the different transmission channels of monetary policy. This paper examines the international transmission of monetary policy shocks both in the context of flexible exchange-rate regimes and in the case where one country adopts unilaterally fixed exchange rates. There are two potential transmission mechanisms of monetary policy. The first is the financial channel via the interest rate parity and a co-movement of interest rates. The other channel is the trade channel which comes into effect when the relative exchange rates of two countries and relative prices of domestic and foreign goods are affected by monetary policy. While the financial channel transmission of monetary policy works via the interest rate parity and takes place as long as economies are financially liberalized, the trade channel comes only into effect when 1) exchange rates are free to adjust and 2) the invoicing pattern of trade is such that relative prices of foreign to domestic products are affected at all by exchange rate movements. Chapter five analyses in a two country set up the effect of a contractionary monetary shock in one country on the economy of the second country. In the context of fixed exchange-rate regimes analysed with the example of Germany and Austria and the Netherlands one would expect a negative effect on the economies of Austria and the Netherlands when Germany conducts a contractionary monetary policy, e.g. by raising interest rates. For these countries the German Mark acted as a more or less fixed anchor before the introduction of the European Monetary Union so that the contractionary shock translated directly into their economies. As a consequence we would expect a decline of output in these countries synchronized with a decline in German output.

With a Vector Autoregression (VAR) analysis I show that there is, indeed, a negative reaction of output for all countries following an interest rate increase in Germany.

In the context of flexible exchange rates the contractionary monetary policy in one country need not have contractionary effects on the economy of the second country. Exchange rates can adjust. In particular the exchange rate of the second economy can depreciate to create expectations of an appreciation for the interest rate parity to hold. In this way exports of the second economy could become cheaper relative to products of the country conducting the contractionary monetary policy. The second country could, thus, profit from an expenditure switching effect towards its exports. If the exports of the second country are priced in local currency (or “priced to market”) this mechanism would, however, not take place. The estimation results of the exercise including the United States, which raises the interest rates, and Germany and Japan which react to this contractionary policy of the U.S. show that the contractionary effect of the depressed demand of the United States seems to prevail. Even for these countries with flexible exchange rates a synchronized decline in output with the U.S. can be observed. This could also be due to the fact that exports of Germany and Japan are likely to be invoiced in local currency (the U.S. dollar) so that the positive effects of an exchange rate depreciation are limited. The contribution of this paper is that it compares transmission effects between countries with a flexible exchange rate regime and countries with a fixed exchange rate regime highlighting possible differences in the adjustment to monetary policy shocks.

2 The Euro as Invoicing Currency in International Trade

The choice of the currency in which international trade is invoiced has important implications both at the micro- and macroeconomic level. At the firm level, the profit maximization of firms engaged in international trade is clearly affected by their choice of currency while at the macroeconomic level the currency of invoicing in international trade affects business cycle correlations between countries and the transmission mechanism of monetary policy. The consequences of currency invoicing on the pass-through of the exchange rate have been analysed in a series of theoretical and empirical papers and are at the core of the New Open Economy Macroeconomics literature. While traditional macroeconomics assumed that the price of exports is set in the currency of the exporter so that exchange rate fluctuations lead to expenditure switching away from the appreciating currency's goods, the new macroeconomic literature allows for the possibility of pricing to market, where prices are set in the local currency and do not fluctuate with the exchange rate.¹ While the early literature just assumed that exporters prefer to price in their own currency to avoid price uncertainty (monetary habitat), the more recent theoretical literature models the choice of currency invoicing as a decision between price uncertainty and quantity uncertainty. Exporters pricing in their own currency know the price they will receive, but the quantity they sell is uncertain because the price in the local market fluctuates with the exchange rate. When the demand for the exporter's good is very sensitive to price changes, the exporter may prefer to set the price in the currency of the competitors.

The choice of currency invoicing is, thus, central both for profit maximization at the firm level and for the transmission of monetary policy. Due to a lack of data there have been, however, only a few econometric studies on the choice of invoicing currency so far. These studies consist almost exclusively of country specific evidence on Canada, the Netherlands and Sweden.² The use of a macroeconomic multi-country database is, however, important to show the general applicability of the results as compared to single country studies. Goldberg and Tille (2005) give first empirical findings on a broader set of countries. They mainly focus on the role of the U.S. dollar as invoicing currency, though. The dataset compiled for this paper is considerably larger. It consists of 35 countries and more than 150 observations for

¹ Betts and Devereux were among the first to include PTM into a NOEM model (1996, 2000).

² Donnenfeld and Haug (2003) analyse Canadian import invoicing, Wilander (2004) examines Swedish trade and Silva (2004) performs an analysis on Dutch invoicing data.

invoicing in U.S. dollar and of 29 countries and around 150 observations for invoicing in euro. Most data concerning EU countries have been collected by the European System of Central Banks (ESCB). Early data for EU countries and data on non-EU countries was assembled from different national sources like central banks and statistical offices.³ Besides the new dataset, the main innovation of this paper is that it has a special focus on the role of the euro as vehicle currency. In particular, I analyse whether the launch of the third stage of Economic and Monetary Union (EMU) changed the invoicing patterns in international trade and the potential role of the euro as a vehicle currency. I also shed a light on the question whether an increasing share in euro invoicing is due to economic fundamentals or to the prospects of eventually adopting the euro by most Central and Eastern European Countries.

The main finding is that the membership or prospective membership of the EU leading to the future introduction of the euro and whether the country is in a hard peg with the euro play a decisive role in the choice of the euro as invoicing currency in its trade. The introduction of the common currency in the euro area increased the invoicing in euro at the expense of the U.S. dollar. The increased invoicing in euro can be found both for vehicle currency pricing and for producer and local currency pricing. The role of the euro as vehicle currency seems to be limited, however, when compared to the U.S. dollar. The estimation results show that higher monetary instability reflected in a high inflation differential, and a low differentiation of exports lead to less euro invoicing, while the contrary is true for the U.S. dollar, which supports the impression that the U.S. dollar is the preferred vehicle currency. There are some signs for the role of the euro as vehicle currency, however. Countries with no forward market for their currency are not only more likely to invoice in U.S. dollar but also to invoice in euro. Also, if a country exhibits high exchange rate volatility vis-à-vis the euro it is more likely to invoice in euro. All in all, the euro is increasingly used as invoicing currency both for bilateral trade and for vehicle currency invoicing. This is particularly true for the countries with the prospect of adopting the euro at some point in the future.

³ For an overview of the data and its sources see the section on data description as well as Table A2.1 of the appendix.

2.1 Theoretical Literature

The main focus of the early literature on currency invoicing in international trade focused primarily on transactions costs and the stability and attractiveness of the major currencies. Already in 1968, Swoboda established that the U.S. dollar could be considered a vehicle currency as it was used in trade even if the U.S. was not involved. Swoboda (1968) argued that highly liquid currencies with low transactions costs will be chosen as medium of exchange. In the same way McKinnon (1979) argues that homogenous goods and primary commodities are likely to be invoiced in a single vehicle currency with low transaction costs. Setting the prices of these goods in one currency increases the international comparability of these prices and the transparency of the market. The advantage of a vehicle currency like the U.S. dollar, McKinnon argues, is also due to its long history and familiarity. Similar lines of reasoning can be found in Magee and Rao (1980). They make a distinction between strong and weak currencies according to low and high inflation currencies. The intuition behind this being that in trade between low inflation industrial and high inflation developing countries, the low inflation currency of the industrial country dominates. Also, for trade in primary products a vehicle currency might be optimal. The importance of the choice between different currencies came back into the economic discussion when major exchange rates became flexible after the breakdown of Breton Woods in 1973. The first question of interest was then, who was to bear the exchange rate risk in trade when exchange rates were flexible. It was assumed that a risk-averse exporter preferred to invoice in his own currency - producer currency pricing (PCP). This was then considered the dominant strategy as the exporter was the one who initiated and first set the trade contract. Also, importers were assumed to be more indifferent towards the pricing strategy as imports tend to be a lower proportion of importer's spending than export sales are for exporter's revenues (Page 1977, 1981). Viaene and de Vries (1992) take strategic bargaining considerations into account and introduce a forward market. In their model, exporters and importers bargain over the invoicing currency. Both are assumed to prefer their own currency, respectively. Viaene and de Vries find that the dominance of the exporter's currency can be due either to the first mover advantage of the exporting firm or to the monopoly power of the exporter who is more likely to have bargaining power as the firm faces a wide spread demand and not many competitors. Summing up the early literature, the main findings are that traders seek to avoid currency risk

by using their own currency and that, in trade between industrialised countries exporters are in general more likely to be able to avoid the currency risk.

When currencies are free to fluctuate there is, however, not only the issue of price uncertainty but also *demand uncertainty*. If prices are set before the exchange rate fluctuations are known and orders are placed after the shock to the exchange rate⁴ then the exporter faces demand uncertainty if he prices in his own currency (PCP) as the “seller does not know the effective price at the time the importer will make its purchases” (Baron 1976, p.427). There is, thus, *price uncertainty* when exports are priced in the local currency (LCP) as the exporter does not know which price (in his own currency) he will receive and *demand uncertainty* when the exporter chooses producer currency pricing (PCP). McKinnon (1979) provides the intuition on what could be the decisive factor in the choice between price and demand uncertainty. He distinguishes two types of tradables. For a differentiated good a firm can set the market price as it faces a downward sloping demand curve, while for homogenous goods the exporter is a price taker and more likely not to choose the own currency. There are therefore two distinctive sets of determinants for invoicing. One reason to choose a specific currency of invoicing can be to avoid demand uncertainty due to exchange rate fluctuations (LCP is chosen). The choice of LCP is therefore determined by *microeconomic considerations* concerning the demand and cost structure of the exporting firm as will be illustrated in the following. If an exporter is more concerned about price uncertainty because the demand for his goods is less price sensitive *macroeconomic considerations* as discussed before and further formalized in the theoretical literature will play the decisive role.

Donnenfeld and Zilcha (1991) present a first formal model in which a firm’s choice of invoicing currency is analysed. They are also among the first to develop a model on the microeconomic level in which the firm optimizes its profits.⁵ The main finding of Donnenfeld and Zilcha is that LCP is optimal for the exporting firm if the total revenue curve is concave in the foreign price. This is the case when the sensitivity of demand with respect to prices is not much higher the higher the price level.⁶ That is, if the price is set in producer currency and increases (in foreign currency) due to an appreciation of the exporting firm’s currency, profits

⁴ This is the assumption usually made in the theoretical literature.

⁵ Giovannini (1988) presents a similar model; his emphasis is, however, not on the firm’s invoicing decision.

⁶ When the “elasticity of the slope of demand for exports is not too large” (Donnenfeld and Haug 2003, p.335)

will fall because demand will be reduced by more than the increase in profits due to the higher price received. In the case of a depreciation, demand is not extended enough to compensate for the lower price the exporting firm receives, because demand is less sensitive to the price at the lower price level. If this is the case, higher variability in foreign prices, which comes with higher volatility in the exchange rate under PCP, lowers expected profits. Thus, under these conditions, high exchange rate volatility would lead the exporting firm to choose LCP.

Friberg (1997) extends the literature by including into the model a forward currency market and the possibility to set prices in a third currency: vehicle currency pricing (VCP). As in Donnenfeld and Zilcha the choice of the optimal currency setting is closely linked to the price elasticity of foreign demand. The second best currency pricing strategy depends on the relative exchange rate volatilities. If the exchange rate towards the vehicle currency exhibits low volatility compared to the bilateral exchange rate of the exporter and importer, VCP is preferred and vice versa.

Johnson and Pick (1997) elaborate on the Donnenfeld and Zilcha model by including the possibility of VCP and introducing competition from other countries' exporters. Like in Donnenfeld and Zilcha the exporting firm has power of price discrimination, but it now faces competition from another exporting firm (this is mostly the case in commodity markets where there are two sorts or brands of goods). Now, even under LCP the demand for the firm's product is uncertain because the competitors might not price in local currency. In such a case fixing the relative price of the competing products can be important to the exporters so they might choose a common vehicle currency.

This finding of choosing the currency of the competitor is also common to a number of other studies. In particular, Bacchetta and van Wincoop (2002) use a NOEM model to analyse the optimal pricing strategy of exporters.⁷ In a very elaborate general equilibrium framework that also takes into account exchange rate dependent costs they derive similar conclusions to those of Donnenfeld and Zilcha. The driving factors for exporters to care about their relative prices are the demand sensitivity of costs and the price sensitivity of demand. It can be said that the higher the product differentiation, the lower the price sensitivity of demand. Exporters

⁷ One of the main assumptions in NOEM is that prices are sticky. Hence, in the short run the exporter's price can only stay the same under exchange rate movements if it is set in the local currency. This explains the close relationship between the PTM literature and the currency invoicing literature.

will, thus, prefer to invoice in their own currency if their products are highly differentiated, while they will pay attention to holding their relative prices constant if their products are less differentiated. This does not mean that less differentiated products are always invoiced in LCP, however. Bacchetta and van Wincoop build into their model the market share of the exporting country in the foreign market – that is, the share of the market that is accounted for by firms from a particular country or monetary area. Demand risk is minimized by invoicing in the currency that is most “similar” to the average invoicing currency chosen by competitors (Bacchetta and van Wincoop 2002, p. 15). For a monetary union, it is the market share of the entire currency union that matters and not the market share of an individual country. Exports of a monetary union are therefore more likely to be priced in producer currency, and imports to a monetary union more likely to be priced in local currency, because the monetary union’s market share is more likely to be dominant.

Goldberg and Tille (2005) call this behaviour of choosing the currency of the competitor a “herding effect”. In their partial equilibrium three country model a dominant share of a currency other than the one of the exporter or the importer can make vehicle currency pricing the optimal choice. This herding effect takes place for industries with homogeneous goods where producers aim at keeping their prices relative to the competitors stable. Goldberg (2005) elaborates on this model by including a covariance between marginal cost and exchange rates. There is then also a “hedging motive” to choose a currency so that the exchange rate is correlated in such a way to shocks to exporters’ costs that marginal costs are positively correlated with marginal revenue.

The most elaborate model so far was introduced by Devereux, Engel and Storegaard (2003). Using a two-country dynamic general equilibrium model with sticky prices, these authors analyse the implications of endogenous exchange rate pass-through. Their results show that the degree of pass-through depends on the relative stability of monetary policy; countries with relatively low monetary volatility experience low rates of exchange rate pass-through. The reason is that firms in both countries have an incentive to set their prices in the currency of the country with the low monetary volatility.⁸ As a consequence, the country with low monetary volatility is shielded against exchange rate movements.

⁸ This result is comparable to the general equilibrium model by Bacchetta and van Wincoop (2002) where they find that inflationary currencies are less likely to be used as invoicing currency.

Engel (2005) analyses the export pricing behaviour of firms in a static model, both in an environment with flexible and with fixed prices. He shows that the choice between producer currency pricing and local currency pricing is independent of the degree of sluggishness in price adjustment. Under flexible price adjustment, producer currency pricing is optimal if the variance of the export price in the firm's own currency is less than the variance of the price in the local currency of the importer. The same holds in an environment of fixed prices.

Summing up the theoretical literature, the most important finding is that the optimal pricing strategies are very sensitive to the set of assumptions. In particular, the level of risk aversion and the existence of forward markets to hedge exchange rate risks matter for the results. First and foremost, however, the sensitivity of foreign demand to prices matters, which can be approximated by the homogeneity or differentiation of the product. When demand is sensitive to prices the market share of the exporting country, or more specifically, the currency used by the competitors matters. When the optimal currency choice depends on the currency used by competitors, herding in the same currency is optimal. Also, currencies of countries with monetary stability are more likely to be chosen as invoicing currency.

2.2 Stylized Facts and the Empirical Literature

Data on currency invoicing has been very scarce to date. This is the reason why many studies rely on simple and often static comparisons of data and anecdotal evidence. Other studies analyse the pass-through of exchange rates to import and export prices because this data is more readily available. The data on exchange rate pass-through can provide some evidence on PCP and LCP. If the pass-through is complete as assumed by most early models this indicates full PCP, whereas zero pass-through stands for LCP as prices do not react to the exchange rate. To my best knowledge, there are only four econometric studies on currency invoicing. The first one is Donnenfeld and Haug (2003) who present an analysis on Canadian import invoicing. Wilander (2004) and Silva (2004) are yet unpublished studies on the invoicing practices in Swedish exports and Dutch Trade respectively. These three studies use industry specific micro data on a disaggregated level. The most comprehensive study on the determinants of currency invoicing in terms of empirical data is Goldberg and Tille (2005). Here, aggregated data on invoicing practices is collected for 25 countries. Donnenfeld and

Haug (2003) and Wilander (2004) use multinomial logit (probit) models for their analysis, while Silva (2004) uses fixed and random effects and GLS estimations. Goldberg and Tille (2005) perform a cross section regression.

Before I elaborate on the econometric findings of these formal econometric invoicing studies, I present an overview of the early literature and conclusions drawn from the exchange rate pass-through (ERPT) literature.⁹ In 1968 Swoboda established the vehicle currency hypothesis claiming that the use of a currency in trade was mainly determined by transactions costs. The dominant role of the U.S. dollar was taken as evidence. The first empirical finding on local versus producer currency pricing by Grassman (1973) regarding Swedish foreign trade was that Swedish exports are mostly invoiced in Swedish kronas and Swedish imports are mostly invoiced in the exporter's currency, while the U.S. dollar was not often used as invoicing currency. These findings contradicted the vehicle currency hypothesis and were later generalized and called Grassman's law. This law states that PCP is dominant for manufacturing trade between industrialized countries. Trade in primary products is mostly denominated in U.S. dollar, while trade between developing and industrialized countries is predominantly invoiced in the industrialized country's currency. The intuition behind Grassman's law is that a firm with more bargaining power will choose its own currency to avoid exchange rate risk.¹⁰

There is anecdotal evidence linking the use of a currency to the level of product differentiation. Tavlas (1991) finds that PCP is more likely if products are differentiated. He gives this as an explanation why invoicing in Deutschmark increased from 1980 to 1987 even though Germany reduced its trade with developing countries which per se would lead to a reduction in PCP. Oi, Otani and Shirota (2004) who discuss possible influences on Japanese export invoicing strategies find that the Yen is more often used in industries with differentiated products like the automobile industry. Sasaki (2002) and Sato (2003) find in an exchange rate pass-through analysis that PTM elasticities are highest in Japanese exports to the USA. Sasaki draws the conclusion that this is due to the U.S. market and U.S. products

⁹ There are several empirical studies on the exchange rate pass through (ERPT) which are closely related to the invoicing literature. There are two studies on the ERPT into Japanese export prices (Sasaki 2002, Sato 2003), one on the ERPT into Korean exports by Fukuda and Ono (2004) and one study by the Bank of Finland on the ERPT in Finnish trade. Campa and Goldberg (2005) present a study on ERPT in 25 OECD countries.

¹⁰ For overviews on stylized facts regarding currency invoicing see also Bilson (1983) and Hartmann (1998).

being more competitive than the Japanese market and Japanese products, so that Japanese exporters are forced to price in local currency or in a vehicle currency, notably the U.S. dollar in the Asian Region. In their ERPT analysis on Korea, Fukuda and Ono (2004) highlight the importance of market share. Exporters would want to price their goods in the currency of the competitor to reduce quantity uncertainty, because then demand for their product is less sensitive to exchange rate movements. If the market share of local firms is small and the competitors are other foreign firms as is the case in some import goods to Korea, then pricing in a vehicle currency can be optimal. These findings confirm the theoretical results that firms prefer to price in their own currency so that they do not bear the exchange rate risk if they have market power and demand is more insensitive to their prices, while they prefer to use the same currency as their competitors (either LCP or VCP) in case they do not have market power and the demand for their product is very price sensitive.

There is also some evidence that monetary stability and financial institutions play a role. Tavlas (1997) provides some support for the dominance of stable currencies. Germany has had a very stable currency and monetary policy for a long time and German imports and exports were mostly invoiced in DEM before EMU. The DEM was also the only currency apart from the U.S. dollar which was used more often in trade than the share of world trade would indicate and thus might be called a vehicle currency (Page 1977, 1981). Tavlas argues that the currency also has a store of value function and thus currencies with low inflation and inflation variability will be preferred as invoicing currency. However, Campa and Goldberg (2005) find in their ERPT analysis that inflation and monetary growth cannot explain cross-country differences.

Most models in the ERPT literature make an explicit assumption as to whether all exports are either invoiced in the local currency (LCP and PTM) or in the producer currency (PCP). Under complete LCP or VCP there is zero pass through from exchange rates to export prices; while under PCP there is full pass-through to export prices. Freystätter (2003) and Campa and Goldberg (2005) provide econometric evidence on the incomplete pass through of exchange rates. Campa and Goldberg (2005) show in a country study for 25 OECD countries that neither complete LCP nor complete PCP is plausible which stands in contrast to the theoretical literature where mixed exchange rate strategies are mostly sub optimal.

The first econometric analysis on the currency choice of Canadian imports was performed by Donnenfeld and Haug (2003). They claim to find support for the finding by Donnenfeld and Zilcha (1991) that higher exchange rate risk promotes the use of LCP and discourages the use of PCP and VCP. Their results are, however, fragile as almost all estimates are statistically insignificant.¹¹ They run a multinomial logit model on the choice of currency in different industries in Canada. Their explanatory variables consist of exchange rate risk, a distance variable and the size of the partner country. Out of 24 estimations on local currency pricing (2 estimations on 12 industry levels, one including trade with the U.S., one excluding trade with the U.S.) only two estimates for exchange rate volatility are significant¹² and show a positive relationship between LCP and exchange rate volatility. As discussed above, high exchange rate risk only leads to LCP if the products are not highly differentiated. Even though Donnenfeld and Haug (2003) have a dataset on the industry level, they do not test for the effect of product differentiation in the industry. In the theoretical models, distance plays a role only in so far as it increases the exchange rate risk. They do, however, find some significant results for the positive relationship between distance and LCP. If, as is the case for Donnenfeld and Haug (2003), there is not sufficient support for the impact of the exchange rate risk on LCP, then the evidence of a substantial influence of distance on LCP cannot be due to the increased exchange rate risk as motivated by the theory.¹³ Donnenfeld and Haug (2003) find a negative relationship between the exporter's country size and invoicing in a third currency (VCP). In this study, country size is interpreted as a sign for market power with the following reasoning: The larger the country, the larger the size of the firm, the more market power for the firm.¹⁴ Thus, a firm from a large country is more likely to price in own currency and less likely to price in a vehicle currency.

Wilander (2004) performs a similar econometric analysis on currency invoicing in Swedish exports by industry¹⁵ for the years 1999 to 2002. His findings on exchange rate risk are, however, contrary to the evidence of Donnenfeld of Haug (2003). In particular, he finds a

¹¹ They do find, however, some significant results for the positive relationship between the exporter's country size (and therefore possibly market power) and the invoicing in PCP.

¹² One at the 5 percent, one at the 10 percent significance level.

¹³ See Donnenfeld and Zilcha (1991).

¹⁴ This argumentation is, thus, essentially different from the "herding effect" as discussed by Bacchetta and van Wincoop.

¹⁵ Very large firms like Ikea are excluded from this analysis.

negative relationship between exchange rate volatility and local currency pricing. There are two possible reasons for this. First of all, he uses exchange rate volatility as the measure of exchange rate risk, whereas Donnenfeld and Haug (2003) use a mixture of forward and ex-post future spot rate. Second, his analysis is on Swedish *exports* while Donnenfeld and Haug's analysis is on Canadian *imports* data. Wilander (2004) finds that local currency pricing is promoted by low inflation, by the presence of a stable financial market, and the absence of capital controls and a black market. His hypothesis that less differentiated products are less likely to be invoiced in the producer currency is not explicitly tested, but the pattern in the Swedish exports, where the paper and pulp industry invoices only around 25 percent of its exports in Swedish kronas as compared to around 60 percent in the motor vehicle industry, seems to point into that direction. The amount of LCP is, however not higher in the industries with less differentiated products. On the contrary, LCP is highest in the motor vehicles industry.

In his analysis on Dutch invoicing practices, Silva (2004) finds evidence contrary to Grassman's law, which states that exports are predominantly invoiced in the currency of the exporter. He finds that for Dutch exports to industrialized countries, the currency of the trading partner, and not the Dutch guilder, was dominant. Furthermore, the strength of a currency, the depth of the financial market and the absence of high inflationary tendencies enhance the use of a country's currency. Exchange rate volatility and exchange rate expectations do not prove to be decisive in the choice of the invoicing currency. Silva (2004) does not find evidence for the use of a vehicle currency in commodity trade. He gives as a reason that his sample is predominantly composed of OECD countries, thus, not including traditional exporters of raw materials.

As described in the previous section, there are, however, convincing arguments why a vehicle currency should be used in trade with primary commodities. First and foremost, primary commodities are homogenous goods, so that the exporters of these commodities do care about the price of the competitors and are therefore likely to choose a common currency. Furthermore, in official markets there are transaction costs considerations. Especially information cost is an important factor why commodity exporters would want to price in the same vehicle currency to make prices more comparable. Goldberg and Tille (2005) highlight

the importance of organized exchange and reference pricing¹⁶ in the role of the U.S. dollar as invoicing currency. They find that the dollar's use in these markets can explain most of the dominance of the U.S. dollar as vehicle currency. They also point out that the declining importance of organized exchanges and referenced prices could be the reason for the U.S. dollar's declining importance as a vehicle currency.

What does the literature say about the dominance of the U.S. dollar as a vehicle currency? In 1991, Black (1991) found evidence that the U.S. dollar lost attractiveness as invoicing currency while the DEM gained somewhat in importance during the 1980s. A similar result is found by Tavlas (1991) who claims that the DEM gained importance between 1980 and 1987. Wilander (2004) finds that the euro was more often used as vehicle currency from 1999 to 2002, while this was not at the cost of the U.S. dollar but rather there was less invoicing in producer's currency (the Swedish krona). Goldberg and Tille (2005) observe that the U.S. dollar is still the dominant currency with U.S. exports and imports to Latin America, China, Mexico, and most small countries being almost exclusively invoiced in U.S. dollar. While U.S. exports to other countries are exclusively invoiced in U.S. dollar, exports to Germany, the UK and Japan are to a small amount invoiced in local currency. Goldberg and Tille (2005) also find evidence for a strong role of the U.S. dollar as vehicle currency, especially in Korea, Thailand, Japan, Australia, the UK¹⁷ and Greece. They find, however, a declining importance of the U.S. dollar as vehicle currency due to a reduction in organized trade. In her analysis on accession countries Goldberg (2005) argues that the accession countries are using the euro to a degree that is higher than optimal given their trade partners' composition of trade and the variance and covariance of macroeconomic conditions vis-à-vis the trading partners.

Altogether it has to be said that empirical evidence is still very scarce due to the lack of internationally comparable data. To get more robust results on the determinants of invoicing strategies and the possible development of the euro as an invoicing currency, I considerably expand the data base of Goldberg and Tille (2005).

¹⁶ Reference pricing refers to goods which are not necessarily centrally traded, but for which there are common price quotations for example in insider journals. Goldberg and Tille (2005) use an index created by Rauch (1999). For further details see next section.

¹⁷ While UK *exports* to non-U.S. countries do not exhibit this strong bias to the use of the dollar as vehicle currency, this pattern can be observed with UK *imports* from non-U.S. countries.

2.3 Empirical Findings

The main reason why there has not been more empirical research on the invoicing currency in trade is the scarcity of the data. As discussed in the previous section there are only a few econometric studies on the choice of invoicing currency and these include only evidence on Canada, the Netherlands and Sweden. While these studies are very valuable as country studies it is necessary to take in the broader picture of as many countries as possible. Goldberg and Tille (2005) give first empirical findings on a broader set of countries. My dataset is much larger¹⁸ and I will focus on the role of the euro as invoicing currency. While I also consider U.S. dollar invoicing, I will put it into a framework where the launch of the euro plays a decisive role.

2.3.1 The Invoicing Database

Annual aggregated data on currency invoicing is taken from national central banks, statistical offices and from a survey by the ECB.¹⁹ For an overview of the complete set of invoicing data see Figure 2.1 and Table A2.1 of the Appendix. The currency of invoicing is in most cases approximated by the currency of settlement.²⁰ In some countries data was collected by the central banks with a reporting system covering cross-border payments (e.g. the Netherlands until 2002), other countries conduct a survey (e.g. Germany). In some countries the data on invoicing is an approximation retrieved from the currency structure of foreign exchange receipts and payments (e.g. Slovakia). If a distinction is possible, data for trade in goods is chosen as compared to trade in services.²¹ For the very rare case that there is no distinction between exports and imports only overall trade is reported, this is taken as an

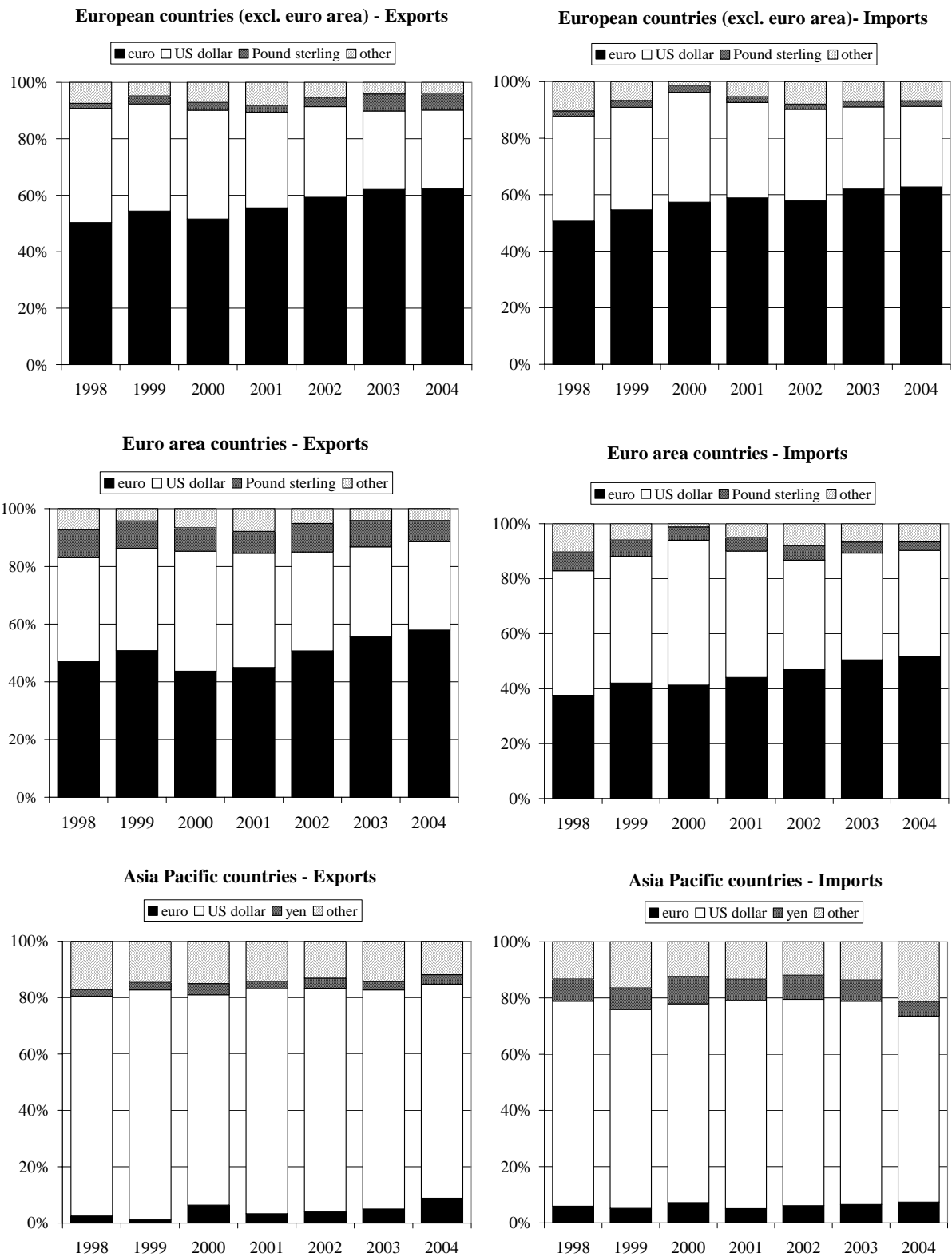
¹⁸ While Goldberg and Tille (2005) use data on 25 countries for one point in time, my dataset consists of 42 countries and more than 150 observations.

¹⁹ For details see Table A2.1 of the Appendix. Data from the “ECB data request” is data collected by the European Central Bank (ECB). For details see also *Review of the International Role of the Euro* published by the ECB (2005) in December 2005.

²⁰ For some data it is unclear whether reference is to currency of invoicing or settlement. However, the differences in the two are likely to be negligible according to Page (1977, 1981). For convenience, I will hereafter refer to invoicing data, bearing in mind the above qualifications.

²¹ For most of the EU countries data on services exists. This data is not included in this paper. It is available in the *Review of the International Role of the Euro* published by the ECB (2005) in December 2005.

Figure 2.1: Average share of currencies used in exports and imports by region



Note: Before 1999 euro stands for the euro area legacy currencies. Other (currencies) is calculated as residual.
 Source: See Appendix A1, data for euro area based on extra-euro area trade, own calculations.

approximation for both export and import invoicing.²² Before 1999 invoicing in euro is defined as invoicing in the euro area legacy currencies.²³ Altogether the database includes data on 42 countries. Some data is available already for a longer time period. I cover an estimation period from 1994 until 2004. The dataset is, however, unbalanced over time so that for some countries there are up to 10 observations and for others only 1.

As can be seen from Figure 2.1, the use of invoicing currencies differs considerably between regions.²⁴ The U.S. dollar is by far the dominant currency in the Asia Pacific region, while the euro has become the dominant invoicing currency for trade of EU-25 and candidate countries (excluding euro area countries). The share of euro invoicing has increased over time, both for EU-25 countries and for extra euro area trade of euro area countries. This seems to be at the cost of U.S. dollar invoicing. The British Pound (GBP) and the Japanese Yen (JPY) only play a minor role for currency invoicing in trade.

To assess the development of the invoicing practices in world trade I compare the new data on invoicing currencies with the projections of currency invoicing by Hartmann (1998). In his study Hartmann considers different scenarios implying different shares of euro invoicing. The column in Table 2.1 labelled “Hartmann (EU-11) 1992” gives the share of euro invoicing he projected for 1999 based on the assumption that countries have the same share of home currency invoicing as in 1992 (58%). Comparing this number to the number resulting from the new dataset for 1999 (column three), it can be seen that it is very similar to the projections made for the start of the monetary union under the assumption of no change in behaviour (1992). The column labelled “Hartmann (EU-11) like USA” gives the share of euro invoicing Hartmann projects in his most optimistic scenario based on the assumption that EMU countries increase their share of home currency invoicing to U.S. levels (92%). In this case he projects that the share of euro invoicing would rise to 25 percent.²⁵ The data provided in this paper shows that the share of euro invoicing in 2004 was higher than this number (27.7) even though the share of home currency invoicing remained at around 60 percent in EMU countries and thus was still much lower than in the U.S. Since the increase in the share of the euro is not

²² This is the case only for Slovakia, data from Latvia for the years 1994 to 2000 and for Malaysia for the years 1999 to 2003.

²³ For some countries only data on the share of some legacy currencies (mainly the DEM) is available.

²⁴ Unfortunately, there is no data at all for Latin America. Presumably, the U.S. dollar is by far the dominant currency of invoicing in this region.

²⁵ For a detailed description of this scenario see Hartmann (1998, p. 435).

due to its use as home currency it must be due to the use of the euro as vehicle currency. In particular, the use of the euro as vehicle currency in Central and Eastern European trade is much higher than Hartmann expected.²⁶

Table 2.1: Trade Invoicing Comparison with Hartmann (1998)

	Hartmann (EU-11) 1992	Hartmann (EU-11) like USA	1999 ^a (EU-12)	2004 ^b (EU-12)
USD invoicing in "extra-EMU" world exports (in %)	55.7	/	55.4	49.1
Euro invoicing in "extra-EMU" world exports (in %)	18.8	25	20.8	27.7

Sources: Hartmann (1998), 1999 and 2004 author's calculations.

Note: The author's calculations of the 1999 and 2004 shares are based on real data coverage of 67 percent of "extra-EMU" world exports for euro invoicing and 58 percent for U.S. dollar invoicing. The remaining share of trade was estimated by taking the invoicing share of Portugal as approximation for the remaining EMU countries without data coverage (Austria, Finland and Ireland). As the data coverage for European countries is very high and there is no data at all for Latin America, the rest of the not covered trade was approximated using the share of currency invoicing of Thailand. This should be on the lower side of possible euro invoicing.

^a For 1999, if data for 1999 was unavailable the data points closest to 1999 were taken.

^b For 2004, if data for 2004 was unavailable the latest available data was taken.

When comparing the share of euro invoicing to the share of U.S. dollar invoicing in Table 2.1 it is evident that the dollar is still the dominant currency in world trade and that the euro is not likely to challenge the leading role of the U.S. dollar in the foreseeable future. However, there is evidence not only of the increasing importance of the euro as world currency but of the slightly diminishing role of the U.S. dollar. The following empirical analysis tries to shed some light on the role of the U.S. dollar and euro as vehicle currencies and how these are interacting. While the new dataset is a very important benchmark for the analysis of currency invoicing in international trade, the main shortcomings of the dataset are that for such a broad set of countries no bilateral data on currency invoicing is available. This is a problem insofar as the distinction between PCP, VCP and LCP becomes difficult and for most countries

²⁶ Hartmann (1998) assumes a subdued scenario for interregional trade in the Central and Eastern European Countries. He already mentions, however, that a resurgence of trade in the region "may give a boost to the euro" (p. 440).

impossible.²⁷ In the following analysis, I control for this by including each country's share of exports to and imports from the U.S. for the U.S. dollar invoicing regressions and from the euro area for the Euro invoicing regressions. In a further step, I conduct an analysis on home currency invoicing with a reduced dataset for all those countries where data is available.

2.3.2 The Explanatory Variables

First of all, some explanatory variables concerning bilateral trade are created. To control for the exports and imports to and from the U.S. and the euro area I include the respective shares of exports and imports of a country's total exports and imports. The data are taken from the IMF Direction of Trade Statistics. This database is also used to create a measure of market power created as the share of a country's total exports to world exports, which should reflect the size of a country's firm. Following the approach in Goldberg and Tille (2005), to take into account the share of trade in differentiated products a variable is created according to the Rauch (1999) definitions.²⁸ The data on commodities is taken from the UN Comtrade database. The definition of the group of products is very precise in the sense that it does not only divide into aggregated groups of commodities and non commodities, but it is detailed up to the fourth digit code of the SITC.²⁹ The share of exports and imports of differentiated products in total exports and imports is calculated for the year 2004.³⁰

To capture the influence of exchange rate risk, I set up a variable on exchange rate volatility. I construct a four-month moving average standard deviation of the nominal exchange rates of a country's currency vis-à-vis the U.S. dollar and vis-à-vis the euro (vis-à-vis the DEM before the introduction of the euro in 1999) respectively. As variable describing a country's monetary stability I use the inflation differential to the U.S and to the euro area (to

²⁷ Most countries just provide data on invoicing in U.S. dollar and Euro. For all non-U.S and non euro area countries this leaves the possibility that the invoicing is in vehicle currency, in LCP (for exports going to the U.S and the euro area) or in PCP (for imports coming from the U.S. and the euro area).

²⁸ Rauch (1999) classifies all commodities by "looking them up in International Commodity Markets Handbook and The Knight- Ridder CRB Commodity Yearbook (to check for organized exchanges) and Commodity Prices (to check for reference prices, e.g., price quotations published in trade journals such as Chemical Marketing Reporter)." Products belonging to one of these categories are "organized exchange" or "reference price" goods, all others are differentiated goods.

²⁹ Codes are taken from <http://www.macalester.edu/research/economics/PAGE/HAVEMAN/Trade.Resources/TradeData.html#Rauch> and are based on the liberal classification of Rauch (1999).

³⁰ The share is assumed to be constant over time as the structure of trade is not likely to change from one year to another. See Table A2.2 of the Appendix.

Germany before 1999). Monthly data for both the inflation and the nominal exchange rates are taken from the IMF International Financial Statistics database.

I then specify a set of dummy variables. In particular, I construct a dummy that takes on the value of 1 for all countries which are either part of the European Union in 2005 (EU-25) or are formally recognized as EU candidate countries and 0 otherwise.³¹ In addition, to take into account structural changes due to the introduction of the euro, I create a step dummy that takes on the value of 1 from 2002 on. This is when the euro currency was introduced and the use of the national legacy currencies was discontinued.³² To mirror the availability of a currency on the forward market a dummy is created that takes on the value 1 for all those countries (currencies) which had a forward market in 1999.³³ Two other dummies are created that take on the value 1 for all those years in which a country had a hard peg either to the U.S dollar or to the euro respectively.³⁴ For a complete list of variables see the Appendix.

2.3.3 Empirical Methods

As my dataset covers both a cross-sectional and a time-series dimension, I estimate a panel model. The first estimation method I use is a one-way random-effects GLS panel. The random effects model is preferred to the fixed effects model as country specific constants would result in a considerable loss of degrees of freedom. More importantly, I also want to consider time-invariant explanatory variables, which is not possible in a fixed effects model. The Breusch-Pagan Lagrange Multiplier test for a zero variance of the individual errors could be rejected for every estimation. This implies that my dataset cannot be pooled. At the same time I choose a one-way as compared to a two-way random effects model because my panel is highly unbalanced on the time dimension. To test whether the estimators are biased I perform a Hausman test comparing the coefficients of the fixed and the random effects estimation. The null hypothesis of no systematic differences cannot be rejected in almost all of the cases, so

³¹ This dummy variable is not time-variant as it tries to capture the group of countries that have been, throughout the period under consideration, part of the EU or widely seen as prospective members of the EU.

³² I also experimented with having the dummy take on the value of 1 starting in 1999. This leads to very similar results. There are, however, only a few observations before 1999. This is why the 2002 dummy is preferred.

³³ The choice of the year 1999 is somewhat ad hoc, but it is chosen to coincide with the introduction of the forward market for the euro in 1999.

³⁴ In particular, this is for the euro (DEM before 1999): Estonia (from 1992), Bulgaria (from 1998) and Lithuania (from 2002). For the U.S. dollar: Lithuania (from 1994 to 2001) and Malaysia (from 1999).

that the random effects coefficient estimates should be consistent and asymptotically efficient. As a second estimation method I report the results for a fixed effects estimation to show the robustness of the results. The third estimation method I use is a Prais-Winsten estimation with panel corrected standard errors. This controls for possible heteroscedasticity across the panel and panel specific autocorrelation. The last estimation method I apply is a Prais-Winsten regression with importance weights. As the dataset includes data on very diverse economies, it is interesting to see whether the inclusion of the GDP of the country as importance weight makes a difference to the estimation results. While it would also be interesting to estimate a logit or probit model, the nature of the new dataset makes it a sub-optimal choice as there would be a loss of observations both over time and over countries as only a few countries report both the share of U.S. dollar and of euro invoicing and even less report the share of own currency invoicing. Likewise, the limited time dimension of the panel does not allow for a study of the dynamics of the panel. This would have been an interesting analysis especially with respect to the possible persistence of currency invoicing.

2.3.4 The Empirical Model for U.S. Dollar Export Invoicing

I first examine the cross-sectional and intertemporal variation in U.S. Dollar (USD) invoicing for exports of around 30 countries over a period from 1994 to 2004. The data is highly unbalanced as for some countries there is only 1 observation while for others there are up to 10 observations. The most general one-way random effects model I estimate is the following:

$$\begin{aligned} usdex_{it} = & \beta_1 + \beta_2 shexus_{it} + \beta_3 eurinst_i + \beta_4 euroint_{it} + \beta_5 rauex_i + \beta_6 usexvol_{it} + \beta_7 usinf_{it} \\ & + \beta_8 fmdum_i + \beta_9 usdpeg_{it} + u_{it}, \end{aligned} \quad (2.1)$$

where $i = 1, \dots, 30$, $t = 1, \dots, 10$ (highly unbalanced) and $u_{it} = v_i + e_{it}$, where v_i is the random error attributable to countries and e_{it} is a white noise residual. In this specification $usdex$ is the share of exports invoiced in U.S. dollar in percentage terms and $shexus$ stands for the share of a country's exports to the U.S. relative to a country's total exports. I expect a country to have a higher share of U.S. dollar invoicing the higher the share of trade with the U.S.³⁵

³⁵ In this sense the variable should capture all local currency pricing to the U.S.

Eurinst is a 0/1 dummy taking on the value 1 for all EU-25 and candidate countries while *euoint* is a 0/1 dummy taking on the value 1 for all observations from 2002 onwards mirroring the introduction of the euro currency and the discontinuation of the legacy currencies. These two dummies should reflect whether being a (prospective or actual) member of the EU, even for those who are not yet participating in the monetary union, makes a difference in their choice of invoicing currency. The second dummy tries to capture the individual effect attributable to the introduction of the common currency. I expect both variables to have a negative impact on USD invoicing. In particular, the “herding effect” brought forward by Bacchetta and van Wincoop (2002) and Goldberg and Tille (2005) implies that because a monetary union has a higher “country” share than the individual country before, invoicing in that currency is more likely and makes the use of the USD less likely.

The impact of the variable *usexvol* is ambiguous. As discussed at large in the previous section, the evidence on the impact of exchange rate risk is very ambiguous. In particular the influence depends on the level of product differentiation. While for differentiated products, an exporter would want to avoid a foreign currency to limit the fluctuations of the price he receives, for less differentiated products the exporter wants to limit his quantity uncertainty and tends to set prices in the same currency as the competitor.

As I cannot distinguish between differentiated goods at the industry level, I set up a variable capturing a country’s share of differentiated trade. *Rauex* is the time invariant share of a country’s differentiated products in total exports.³⁶ This variable is constructed to account for the possibility of different pricing strategies for differentiated and non-differentiated goods, the exporter being more likely to want to keep its relative prices stable in the case that his exports are non-differentiated.³⁷ The most likely assumption is that there is a natural herding in USD (also reflected in the goods traded in world markets or goods with a referenced price). Thus, *rauex* is expected to have a negative influence on USD invoicing since the higher the share of differentiated goods the more likely the exporter can set the price in the own currency.

³⁶ Defined as total exports minus exports of goods priced on world markets and referenced goods. For a more detailed description see the section on data description.

³⁷ For a more detailed explanation see the section on the theoretical literature.

Usinf reflects the monetary stability of a country. A high inflation differential with respect to the U.S. stands for economic instability, which makes the use of that country's currency less likely. The forward market dummy *fmdum* reflects the presence of a forward market. If a forward market for their currency exists, exporters are more likely to be able to use their own currency as the importer can hedge the exchange rate risk. I take the presence of a forward market (already in 1999) as a sign that this country's currency is available easily and at low cost. The existence of a forward market implies more invoicing in that currency (PCP) and less invoicing in USD (VCP). *Usdpeg* is a 0/1 dummy that takes on the value 1 for periods where a country's currency is in a hard peg with the USD.

Table 2.2 summarizes the results of the regression. As discussed in the section on methodology the table reports several estimation methods as a robustness check. When discussing the regression results the main focus will be on the random effects regression while always checking for possible discrepancies to the other estimations. Since the dependent variable is expressed in percentage points, the coefficients of the dummy variables can be directly added or subtracted. The coefficients of the other variables have to be multiplied with the value of the variable to give the percentage point impact.³⁸

Both in the random effects and in the fixed effects specification the share of exports going to the U.S. does not have a significant impact on USD currency invoicing. This is likely due to the fact that for most countries the use of the U.S. dollar as a vehicle currency is much more important than its use in bilateral trade with the U.S.³⁹ Being part of the EU, as defined above, significantly reduces the average share of exports invoiced in U.S. dollar (by around 35 percentage points). Likewise, the introduction of the euro currency in 2002 reduced export invoicing in USD by around 4 percentage points. This could point at some substitution of vehicle currency use from USD to the euro. It could, however, also be that countries of the euro area which previously relied more on USD invoicing are now able to invoice in their own currency. We will see more evidence on the role of the euro as vehicle currency in the sections on euro invoicing.

³⁸ The constant need not be between 0 and 100. The economic interpretation being that it is the share of invoicing in the currency given the explanatory variables take on their average value. Thus, as is the case for euro invoicing, the constant can take on a negative value.

³⁹ In an alternative specification, I include the exports by Asian countries not only to the U.S. but also those going to the East Asian Dollar Block. This variable then has a significant positive impact on U.S. dollar

Table 2.2:

U.S. Dollar Export Invoicing

Dependent variable: share of exports invoiced in U.S. Dollar (in percentage points)

Regression	random	fixed	PW ^a	weighted ^b
Constant	94.95*** (9.39)	49.21*** (18.79)	92.29*** (19.38)	96.80*** (18.35)
Share of exports to U.S	0.04 (0.23)	0.04 (0.18)	0.17*** (2.64)	0.16*** (4.15)
EU-25 and candidates	-36.16*** (-5.58)		-22.20*** (-5.56)	-20.05*** (-14.95)
Introduction of the euro (2002)	-4.56*** (-6.38)	-4.63*** (-6.32)	-2.71*** (-3.24)	-2.00*** (-4.58)
Share of differentiated exports	-0.35* (-1.81)		-0.51*** (-5.34)	-0.46*** (-3.92)
Exchange rate volatility to U.S.	-23.40 (-0.82)	-22.15 (-0.76)	-14.37 (-0.42)	32.61 (1.22)
Inflation differential to U.S.	0.32*** (5.39)	0.32*** (5.27)	0.17** (2.45)	-0.02 (-0.15)
Forward market	-5.63 (-1.13)		-8.01*** (-3.15)	-16.70*** (-2.98)
Peg to USD	9.56*** (2.70)	9.33** (2.61)	9.67*** (2.69)	6.38 (0.34)
Number of observations	176	176	176	176
Number of countries	36	36	36	36
Wald chi2	188.7		655.0	2474.0
R squared overall	0.69	0.03	0.94	0.98

Absolute value of z statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

^a Prais-Winston regression with heteroscedastic panel corrected standard errors and panel specific AR1.^b Prais-Winston regression with het. panel corrected standard errors. Importance weighted with GDP.

The share of differentiated products in exports has a significantly negative effect on the share of exports invoiced in USD for all estimations. This confirms the findings of Goldberg and Tille (2005). The product differentiation does matter as expected by the theory. The exchange rate risk, however, does not have a significant impact on the invoicing decision in any estimation and, as expected, yields ambiguous results.⁴⁰ It could be that the exchange rate

invoicing while not affecting the other results. As the trade between East Asian Dollar Block countries still has to be considered as vehicle currency invoicing this confirms the role of the U.S. dollar as vehicle currency.

⁴⁰ Goldberg (2005) suggests for example that rather than on the exchange rate volatility the invoicing decision depends on a covariance between marginal cost and exchange rates.

volatility is not significant because the effect of exchange rate uncertainty depends on the degree of product differentiation. To test for this I include an interaction variable of exchange rate volatility and the share of differentiated products. This variable is, however, also highly insignificant.⁴¹ Countries with a hard peg to the USD should have a 9 percentage points higher share of exports invoiced in USD. All the dummy variables are straightforward in their interpretation as they take on the value of one for all data points included in that group. This means that the coefficients for dummy variables directly show the impact of belonging to this group on the dependent variable, while the size of the coefficients for the other variables does not necessarily say something about their importance as they have to be multiplied with the variable. Thus, the coefficient of the share of differentiated products seems to be very small. However, a country like Germany with around 70 percent of its exports being differentiated should *ceteris paribus* have around 25 percentage points less USD invoicing compared to a country like Algeria with almost no differentiated exports.

The financial stability of a country also matters for the choice of currency in trade. High inflation differentials to the U.S. significantly increase USD invoicing.⁴² A country like Indonesia with an average inflation differential to the U.S. of around 6 percentage points (from 2000 to 2004) should on average invoice around 2 percentage points more of its exports in U.S. dollar than a country with the same inflation rate as the U.S. The existence of a forward market for the country's currency reduces the invoicing in USD by around 5 percentage points. This result is, however, only statistically significant in some of the equations. In other specifications not reported in the table, the measure of market power, that is a country's export share in total world exports, was also included. While this did not change the other results, neither the market power of a single country nor the market power of the whole euro area were found to be significant. The same is true if GDP is taken as a measure of a country's market power. It is not significant in any of the estimations.⁴³

⁴¹ I also experimented with including adaptive exchange rate expectations modelled as the 4 year average of the exchange rate, but this variable was insignificant. Likewise, the spread with the U.S. dollar was also insignificant. Results are available on request.

⁴² In the case of the inflation differential variable (as for exchange rate volatility), extreme data points are excluded because in relation to these extreme points, other country and time specific differences are likely to be dominated. Also, I did not want my estimations to be driven by some extreme data points. This is only the case for Indonesia in 1998.

⁴³ This is the case not only for the U.S. dollar estimations, but also for the estimations for euro and home currency invoicing. Likewise, I experimented with including inflation volatility and money volatility as measures

I also perform estimations on U.S dollar import invoicing. While from a theoretical point of view the currency of import invoicing reflects the choice of the exporter rather than the importer on the micro level, the macro level evidence of the importing country's characteristics still give interesting insights. In general, the results of the export invoicing estimation are confirmed. In particular, the results concerning the importance of the variables related to membership in the EU and introduction of the euro give qualitatively the same results. The exchange rate volatility is still insignificant as is the share of imports coming from the U.S., while the forward market dummy is this time inconclusive (see Table A2.3 of the Appendix). Highly differentiated goods are again significantly less likely to be invoiced in U.S. dollar. High inflation differentials to the U.S again increase the share of imports in USD. Of course from the theoretical point of view, it does make a difference whether the exporter or the importer exhibits high inflation differentials, but as the invoicing in USD is interpreted as vehicle currency invoicing it just shows that when either the exporting or the importing country's currency are instable, pricing in vehicle currency is more likely. While the role of the euro as vehicle currency is not easy to infer from these estimation results, I have a closer look at this in the following section.

2.3.5 The Empirical Model for Euro Export Invoicing

The estimation is structured in the same way as the USD invoicing estimations:⁴⁴

$$eurex_{it} = \beta_1 + \beta_2 shexeur_{it} + \beta_3 eurinst_i + \beta_4 euroint_{it} + \beta_5 rauex_i + \beta_6 eurexvol_{it} + \beta_7 euroinf_{it} + \beta_8 fmdum_i + \beta_9 eurpeg_{it} + u_{it}, \quad (2.2)$$

where *eurex* is the share of exports invoiced in euro and *shexeur* the share of exports going to the euro area, *eurexvol* the exchange rate volatility vis-à-vis the euro, *euroinf* the inflation differential to the euro area and *eurpeg* is a 0/1 dummy variable that takes on the value 1 for all those periods in which a country had a hard peg vis-à-vis the euro.

of financial stability. While the qualitative results were quite similar, these variables were not significant in any specification.

⁴⁴ The euro area countries are left out in the euro invoicing estimation, of course. This data will be part of the home invoicing estimations.

Table 2.3 presents an overview of the estimation results. It shows that being part of or a candidate for the EU increases euro export invoicing by around 17 percentage points. When comparing this coefficient with the coefficient on *eurinst* in the USD estimations, we can see that it is smaller. The explanation for this is straightforward, as in the euro specification the share of exports going to the euro area does have a significant positive effect as expected.⁴⁵ This does already show that unlike the USD which is mainly used as vehicle currency, the use of the euro might rather be concentrated in bilateral trade. It is also interesting to see that being part of Europe does seem to have an impact on euro invoicing which is not necessarily linked to the higher trade share of these countries with Europe.⁴⁶ The introduction of the common currency increased the share of exports invoiced in euro as compared to the share of exports invoiced in legacy currencies before by around 6 percentage points. This coefficient is comparable to the reduction of U.S. dollar invoicing which comes with the introduction of the euro in the USD export invoicing equation.

How important is the role of the euro as vehicle currency? The table reveals that the share of the differentiated products (*rauex*) has a significant and *positive* impact on euro export invoicing. This is an interesting finding in the question on whether the euro is used as a vehicle currency. If the euro were substantially used as a third currency in trade, less differentiated goods would be more likely to be invoiced in euro and products with higher differentiation would be invoiced in euro to a lesser amount.⁴⁷ The contrary is the case, and the results, thus, just reflect the lower share of U.S. dollar invoicing for more differentiated products. Or to put it the other way around, it reflects the higher share of USD vehicle currency pricing in less differentiated products like primary commodities.

⁴⁵ A country like Estonia with around 40 percent of its exports going to the euro area has an around 20 percentage points higher invoicing in euro in addition of the around 16 percentage points due belonging to the EU.

⁴⁶ I also experimented with including a geographical measure of distance. The geographical distance in combination with *shexeur* and *eurinst* is not significant. Only when either *shexeur* or *eurinst* are excluded is the measure of distance significant. The other results do not change qualitatively. This analysis was performed to control for possible collinearity between the share of exports and the dummy for being part of or a prospective member of the EU25. As both variables are significant, however, this should not be a problem but can be kept in mind when interpreting the *ceteris paribus* impact of the two variables.

⁴⁷ The impact should still be negative even if it reflects bilateral trade with the euro area (for which I try to control), as it should make local currency pricing (the exports to the euro area invoiced in euro) less likely.

Table 2.3:

Euro Export Invoicing

Dependent variable: share of exports invoiced in euro (in percentage points)

Regression	random	fixed	PW ^a	weighted ^b
Constant	-20.59* (-1.92)	20.78*** (4.35)	-28.66*** (-5.73)	-2.44 (-0.29)
Share of exports to euro area	0.47*** (4.66)	0.31** (2.53)	0.67*** (9.24)	0.44** (2.37)
EU-25 and candidates	16.99** (2.4)		15.50*** (4.17)	7.28 (0.93)
Introduction of the euro (2002)	6.34*** (7.43)	6.27*** (7.33)	4.20*** (4.82)	1.73** (2.05)
Share of differentiated exports	0.49** (2.45)		0.52*** (4.38)	0.17** (2.54)
Exchange rate volatility to euro	70.26* (1.95)	80.41** (2.23)	18.95 (0.53)	37.65 (0.98)
Inflation differential to euro area	-0.30*** (-4.53)	-0.33*** (-4.91)	-0.18*** (-3.06)	-0.07 (-0.32)
Forward market	-7.59 (-1.34)		2.92 (1.09)	-8.78 (-1.52)
Peg to euro	12.95*** (3.53)	13.64*** (3.53)	8.54** (2.56)	15.54 (0.99)
Number of observations	152	152	152	152
Number of countries	29	29	29	29
Wald chi2	234.4		894.8	105.1
R squared overall	0.76	0.47	0.93	0.76

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

^a Prais-Winston regression with heteroscedastic panel corrected standard errors and panel specific AR1.

^b Prais-Winston regression with het. panel corrected standard errors. Importance weighted with GDP.

The possible role of the euro as vehicle currency could also be reflected as a higher share of euro invoicing for an economy which displays high exchange rate volatility and high financial instability. The impact of the exchange rate volatility is significantly positive unlike in the case for U.S. dollar invoicing, although this finding is not stable over the different estimation methodologies. This result confirms that the findings for exchange rate risk are quite ambiguous.⁴⁸ At the same time it gives some evidence for the theoretical argument that a more stable currency is preferred. There is, thus, a role for the euro as a vehicle currency in

⁴⁸ Silva (2004) also points out this lack of evidence on the impact of exchange rate risk.

trade between countries with high exchange rate volatility. At the same time, if a country exhibits monetary instability it should be more likely to invoice in a vehicle currency, so that there should be a positive impact of inflation differentials on euro invoicing if the euro were used as a vehicle currency. The inflation differential with the euro area does have a significantly *negative* impact on euro export invoicing, however. This shows that if countries choose a vehicle currency, the choice is most likely the USD. This is then a convincing argument against a leading role of the euro as compared to the U.S. dollar. It could, however, be argued that the estimation results only reflect the choice between USD and euro invoicing, while the euro might be preferred in the choice between own currency and vehicle currency. When setting the share of export invoicing in relation to the (approximated) share of home currency invoicing leaving out USD invoicing, the inflation differential has an insignificantly *positive* impact on euro invoicing. It is also interesting to see that in this estimation the share of exports going to the euro area, being part or a candidate of the European Union, the introduction of the euro and the dummy for a hard peg to the euro still have significant positive effects. The share of differentiated products does still have a positive, albeit insignificant effect on euro invoicing. Another interesting finding is, that countries without a forward market are – in this specification significantly so – more likely to invoice in euro.⁴⁹ Thus, there does seem to be a case for the euro as vehicle currency even though in comparison with the U.S. dollar the role of the euro as vehicle currency seems to be limited.

The estimation results for euro import invoicing (see Table A2.4 of the appendix) confirm the finding that the euro is not extensively used as a vehicle currency as compared to the U.S. dollar, but that there are signs of a growing role of the euro as vehicle currency.⁵⁰ Altogether it can be said that the findings of the euro import invoicing estimation are compatible both with the export estimation and with the results for U.S. dollar import invoicing. They indicate that the role of the euro as vehicle currency is still rather limited, especially in comparison with the role of the U.S. dollar as a vehicle currency. There are, however, strong signs of an

⁴⁹ The latter results have to be interpreted with the utmost care, however, as the transformation of data cannot be performed consistently due to a lack of bilateral data. Especially the variables including relative trade shares are critical, while the interpretation of the inflation differentials and the forward market dummy should be unproblematic. Results are available on request.

⁵⁰ For the import specification the forward market dummy is significantly negative in some of the estimations, implying that for a country with a forward market there is less euro invoicing. This shows that the euro is used as a vehicle currency for countries lacking a forward market. Other results are qualitatively the same as in the export estimations.

increasing importance of the euro both at the cost of the U.S. dollar as vehicle currency and at the cost of local currencies.

2.3.6 The Empirical Model for Home Currency Export Invoicing (PCP)

Unlike the estimations for U.S. dollar and euro invoicing, this estimation is a straightforward test of the PCP theory, as it tests the extent to which exports are denominated in a country's own currency. The observations are mainly based on the home invoicing of euro area countries in extra-euro area trade. The specification of the PCP invoicing equation is as follows:

$$homex_{it} = \beta_1 + \beta_2 mp_{it} + \beta_3 eurinst_i + \beta_4 euroint_{it} + \beta_5 rauex_i + \beta_6 usinf_{it} + \beta_7 fmdum_{it} + u_{it}, \quad (2.3)$$

where *homex* is the share of exports invoiced in the exporter's home currency (PCP) and *mp* is the country's export share in world exports, taken to be an indicator for market power.⁵¹

Table 2.4 shows that being part of or candidate for the European Union significantly increases the share of PCP in exports by around 15 percentage points. The market power of the exporting economy also plays a significant role. The higher the share of a country's exports in world exports, the more likely it is to invoice in its own currency. This could of course also indicate that a country pertaining to a monetary union is more likely to invoice its (extra-union) exports in home currency already due to the fact that the common market power is higher.⁵² The introduction of the euro currency does have a separate significantly positive impact on home invoicing. This is because out of the 19 countries for which data is available 9 countries are part of the euro area.

⁵¹ For the euro area countries *mp* is the share of extra euro area exports to world exports

⁵² This effect does, however, not seem to be very high, yet. In an alternative specification I tested for the influence of the individual countries' market shares. They are also found to be significant and deliver comparable results.

Table 2.4:

Home Currency Export Invoicing

Dependent variable: share of exports invoiced in producer currency (in percentage points)

Regression	random	fixed	PW ^a	weighted ^b
Constant	-22.79** (-2.00)	26.77*** (12.64)	-50.10*** (-6.32)	-34.34*** (-4.80)
Share of exports in world exports	0.49*** (2.60)	0.41** (2.12)	0.22 (1.45)	0.36*** (5.66)
EU-25 and candidates	14.58** (2.42)		14.53*** (2.99)	14.63*** (18.98)
Introduction of the euro (2002)	4.66*** (4.57)	4.75*** (4.71)	4.76*** (3.61)	2.41*** (5.65)
Share of differentiated exports	0.25 (1.22)		0.50*** (4.66)	0.28*** (3.16)
Exchange rate volatility to U.S.	17.67 (0.44)	21.44 (0.54)	10.73 (0.28)	-31.12 (-1.44)
Inflation differential to U.S.	-0.11 (-0.94)	-0.06 (-0.49)	-0.11 (-1.05)	0.00 (0.04)
Forward market	30.66*** (4.00)		48.56*** (12.25)	47.85*** (21.18)
Number of observations	92	92	92	92
Number of countries	19	19	19	19
Wald chi2	98.2		1251.1	49591.3
R squared overall	0.76	0.54	0.95	0.97

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

^a Prais-Winston regression with heteroscedastic panel corrected standard errors and panel specific AR1.

^b Prais-Winston regression with het. panel corrected standard errors. Importance weighted with GDP.

The share of differentiated products has a positive sign as expected and is significant in most of the specifications. The inflation differential on the other hand is always insignificant, albeit mostly with the expected sign. The reason why the results are not so significant can partly be attributed to the fact that for the home specification there are much fewer observations and the cross section is much smaller. Another reason could be that the euro area countries don't exhibit strong divergence in terms of inflation differentials with the U.S. If a country has a developed financial system as modelled with the forward market dummy it is

more likely to invoice its exports in the own currency.⁵³ The volatility of the exchange rate towards the U.S. dollar does not have any significant impact.

2.3.7 The Empirical Model for Home Currency Import Invoicing (LCP)

In the most general specification I expect the market power of the importing country, i.e. the share of a country's exports in total world exports, the share of differentiated products imported and the monetary stability of the importing country to be significant.⁵⁴ The most general specification has the following structure:

$$homeim_{it} = \beta_1 + \beta_2 mp_{it} + \beta_3 eurinst_i + \beta_4 euroint_{it} + \beta_5 rauim_i + \beta_6 usinf_{it} + \beta_7 fmdum_{it} + u_{it}, \quad (2.4)$$

where *homeim* stands for imports invoiced in the importer's home currency (LCP).

As can be seen from Table 2.5, the market power of the importer has a significantly positive influence on home currency invoicing in all regressions. Thus, the higher the market power of an economy, the more likely it is that this country's imports are invoiced in the home currency.⁵⁵ In the alternative specification, where only the market share of the individual country is included, this variable is not always significant. There is, therefore, a weak indication that the monetary union does increase the likelihood of imports being invoiced in the union's currency as herding in euro becomes more likely.

⁵³ I also experimented with including the private credit to GDP ratio as a measure of financial development. For the home export invoicing estimations this variable is insignificant as was the case for vehicle currency invoicing in U.S. dollar and euro. Only for the home import invoicing estimation does the coefficient become significantly positive (as expected) when the forward market dummy is excluded due to possible collinearity. This does not change the other results.

⁵⁴ Ideally, the characteristics of the exporting country would also be included. Due to the lack of bilateral invoicing data, this is difficult to determine. Alternatively one could include a trade weighted average of the exporting countries' market power (to one importing country) and monetary stability. Goldberg and Tille (2005) experiment with this and do not get satisfactory results.

⁵⁵ Alternatively, the size of the country could also be included. I chose the share of exports in relation to world exports as a proxy, however, as Rey (2001) states that the use of vehicle currencies cannot be explained by a large GDP but by high trade flows.

Table 2.5:

Home Currency Import Invoicing

Dependent variable: share of imports invoiced in local currency (in percentage points)

Regression	random	fixed	PW ^a	weighted ^b
Constant	-31.52*** (-2.68)	18.47*** (11.76)	-47.85*** (-10.43)	-33.02*** (-5.44)
Share of exports in world exports	0.83*** (5.37)	0.62*** (3.81)	0.98*** (4.74)	0.75*** (7.36)
EU-25 and candidates	7.8 (1.46)		9.02*** (2.73)	9.71*** (6.14)
Introduction of the euro (2002)	3.84*** (4.73)	4.00*** (5.15)	2.03** (2.00)	3.72*** (6.94)
Share of differentiated imports	0.51* (1.94)		0.80*** (8.64)	0.53*** (10.32)
Exchange rate volatility to U.S.	16.6 (0.52)	21.14 (0.69)	12.53 (0.63)	98.45*** (4.32)
Inflation differential to U.S.	-0.01 (-0.15)	0.01 (0.13)	-0.06 (-1.32)	-0.39** (-2.34)
Forward market	19.72*** (3.26)		20.05*** (5.39)	20.74*** (3.18)
Number of observations	103	103	103	103
Number of countries	19	19	19	19
Wald chi2	136.1		1290.1	2654.4
R squared overall	0.83	0.69	0.96	0.96

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

^a Prais-Winston regression with heteroscedastic panel corrected standard errors and panel specific AR1.

^b Prais-Winston regression with het. panel corrected standard errors. Importance weighted with GDP.

Being part of or a candidate of the EU again increases the share of home currency invoicing. This result is, however, not significant for all specifications. The results for the introduction of the euro are significantly positive. Around 4 percentage points more imports have been invoiced in home currency since 2002. The inflation differential variable is inconclusive and the effects of the exchange rate volatility are again insignificant. Although the coefficients are positive, there is, thus, no evidence that high exchange rate volatility increases local currency pricing.

The share of differentiated products is significant for the home import invoicing estimation. From a theoretical perspective we expect that if a product is highly differentiated the exporter is more likely to choose PCP as he does not care so much about relative prices. I would therefore expect *rauim* to have a negative impact on LCP. It has a significantly positive

impact, however. How can this phenomenon be explained? The share of differentiated goods was found to significantly reduce invoicing in U.S. dollar as vehicle currency. Apparently, this reflects only the choice of a vehicle currency, though, whereas the theory also makes a strong argument for its role in the choice between PCP and LCP. In the estimation of the share of imports invoiced in the importer's home currency (LCP), I find that the more differentiated the products the more likely it is that they are invoiced in the local – i.e., importer's – currency, while we would have expected them to be invoiced in the exporter's currency instead. As the dataset mainly refers to euro area countries, this unexpected result may simply reflect that the lower the share of organized traded and referenced goods, the lower the invoicing in U.S. dollar. Thus, the higher the share of differentiated products, the more likely the product is invoiced in euro – which in this specification is the home currency for half the countries. While the home export invoicing estimations suggest a positive impact of the degree of product differentiation on the use of the own currency, there is, thus, no clear support for the theory of the importance of differentiated products with respect to PCP and LCP. The only conclusion that can be drawn is that the level of product differentiation plays a role for the decision on vehicle currency invoicing and that apparently the role of the euro in this respect is still fairly limited.

2.3.8 Robustness and Goodness-of-Fit of the Model

In addition to the inclusion of a wide range of specifications to show that the significance level and the coefficients are quite stable over different specifications, I also perform Hausman tests to compare the coefficients of the random effects and the fixed effects model and find that they are not systematically different.⁵⁶ As the time invariant variables drop out for the fixed effects estimations the Hausman test may not be proof enough for the validity of the random effects estimations. I therefore also report the fixed effects specifications. They deliver the same qualitative results for the time varying variables. To control for heteroscedasticity across the cross section and for autocorrelation I also present estimation

⁵⁶ Only for euro import invoicing can the null hypothesis of no systematic difference be rejected. This does not change the qualitative results of the estimation, however.

results for a Prais-Winston regression with panel corrected standard errors.⁵⁷ Almost all variables which are found to be significant in the random effects model are also significant for this specification and insignificant results stay insignificant. Only for the exchange rate volatility variables and the forward market dummy is there some change in the significance pattern as compared to the reference estimations. The estimation method for which results diverge the most is the importance weighted Prais-Winston regression. In this case it is not surprising that the results vary a bit as the GDP weights of the countries do differ considerably. On the contrary, it is very reassuring to see that this regression also confirms the general findings of the other regressions.

As another test for robustness I ran regressions including a dummy for every year to control for omitted variable bias. This does not change the results significantly, either. Furthermore, I experimented with including different sets of variables as mentioned in the above analysis. Not all variables which were found to be insignificant are reported as they did not change the main results. As an indicator of the explanatory power of my model I include the pseudo R squared adjusted for the overall estimation as reported by stata. Although one has to interpret this R squared with caution, it indicates, that the model does have quite good explanatory power. The main contribution of the explanatory power stems from the variables reflecting the prospective future adoption of the euro. In particular, whether a country belongs to or is a candidate for the EU –, the introduction of the common currency and the share of trade with the euro area (for the euro invoicing estimations). However, even when leaving out these variables, the remaining parameters still have a significant and quite high overall explanatory power.

⁵⁷ I also estimated an alternative feasible GLS estimation with heteroscedasticity robust errors. Likewise, I estimate a random effects model with serial correlation robust standard errors especially constructed for unbalanced data by Baltagi and Wu (1999). Again, this does not qualitatively change the estimation results. The results for these estimations are not included in the paper as they are both qualitatively and quantitatively almost identical.

2.4 Conclusion

This paper provides empirical evidence on the determinants of currency invoicing in international trade, a topic which has received little attention so far due to data limitations. This study presents a newly constructed dataset on currency invoicing in trade for 42 countries. The paper contributes to the literature by exploring the use of the euro in invoicing of international trade. It provides a comparison of the role of the euro and the role of the U.S. dollar as world vehicle currencies.

The main findings of this analysis are that the membership or prospective membership of a country in the EU plays a decisive role in the choice of the euro as invoicing currency in its trade. At the same time, the introduction of the common currency in the euro area increased the invoicing in euro at the expense of the U.S. dollar. This effect goes hand in hand with the finding that higher market power defined as a country's total exports in relation to world exports leads to increased invoicing in home currency for the countries of the euro area. The paper finds ambiguous evidence for the importance of exchange rate risk as a determinant of currency invoicing. Neither for the estimations of home currency invoicing nor for U.S. dollar invoicing is there increased invoicing in the vehicle currency and less home currency invoicing with higher exchange rate risk. Only for the euro invoicing estimations, there is a higher incidence of euro vehicle currency invoicing when a country's currency is volatile. There is, thus, some evidence for an increased role of the euro as a vehicle currency. The role of the euro as vehicle currency in trade seems to be limited, however, when compared to the U.S. dollar. The estimation results support the hypothesis that monetary instability reflected in high inflation differentials increases the invoicing in vehicle currency. But this relationship is only found for vehicle currency invoicing in U.S. dollar in the case when monetary unstable countries are involved. At the same time, while a low level of product differentiation increases vehicle currency pricing in U.S. dollar, this mainly seems to reflect the trade in organized and referenced priced goods. The data only provides partial support for the theoretical hypothesis that producer currency invoicing is likely if exports are highly differentiated, however. Summing up, it can be said that the U.S. dollar is still the dominant vehicle currency as compared to the euro. There are, however, some indications that the role of the euro as invoicing currency increased as the euro replaced the legacy currencies.

The use of this new and extensive dataset made a thorough econometric analysis of the determinants of currency invoicing possible. Data limitations, nevertheless, have to be borne in mind when interpreting the results. Industry specific country data and data on bilateral trade, if available for each of the countries in the data set, would help to refine the analysis. Also, once the time horizon of available data will be longer, research could focus on the dynamics of the invoicing process, including the question of inertia of invoicing strategies.

2.5 References

- Bacchetta, Philippe, and Eric van Wincoop (2002). A theory of the Currency Denomination of International Trade. NBER Working Paper 9039. National Bureau of Economic Research, Cambridge, MA, forthcoming *Journal of International Economics*.
- Bacchetta, Phillippe, and Eric van Wincoop (2003). Why Do Consumer Prices React less than Import Prices to Exchange Rates? *Journal of the European Economic Association* 1 (2-3):662-670.
- Baron, David P. (1976). Fluctuating exchange rates and the pricing of exports. *Economic Inquiry* 14: 425-438.
- Betts, Caroline M., and Michael B. Devereux (1996). The Exchange Rate in a Model of Pricing-to-Market. *European Economic Review* 40 (3): 1007–1021.
- Betts, Caroline M., and Michael B. Devereux (2000). Exchange Rate Dynamics in a Model of Pricing-to-Market. *Journal of International Economics* 50 (1): 1007–1021.
- Baltagi, B.H., and P.X. Wu (1999). Unequally Spaced Panel Data Regressions with AR (1) Disturbances. *Econometric Theory* 15: 814-823.
- Bilson John F.O. (1983). The choice of an invoice currency in international transactions. In: Bhandari, J., Putnam, B. (Eds.), *Economic Interdependence and Flexible Exchange Rates*. MIT Press, Cambridge, MA: 384–401.
- Black, Stanley W. (1991). Transactions costs and vehicle currencies. *Journal of International Money and Finance* 10: 512–526.
- Campa, José M., and Linda S. Goldberg (2005). Exchange Rate Pass-Through into Import Prices. *The Review of Economics and Statistics* 87 (4): 679-690.
- Chari, V.V., Patrick J. Kehoe and Ellen R. McGrattan (2002). Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rates? *Review of Economic Studies* 69: 533–563.
- Chrystal, Alex K. (1979). Some Evidence in Defense of the Vehicle Currency Hypothesis. *Economics Letters* 3: 267-270.
- Devereux, Michael, Charles Engel, Peter E. Storegaard. (2004). Endogenous Exchange Rate Pass-Through when Nominal Prices are set in Advance. *Journal of International Economics* 63 (2): 263–291.
- Donnenfeld, Shabtai, and Alfred Haug (2003). Currency Invoicing in International Trade: an Empirical Investigation. *Review of International Economics* 11 (2): 332–345.
- Donnenfeld, Shabtai, and Itzhak Zilcha (1991). Pricing of Exports and Exchange Rate Uncertainty. *International Economic Review* 32 (4): 1009–1022.
- European Central Bank (2005). *Review of the International Role of the Euro*. December. Frankfurt am Main.
- Engel, Charles (2002). Expenditure Switching and Exchange Rate Policy. *NBER Macroeconomics Annual* 17: 231-272, Cambridge, MA.

- Freystätter, Hanna (2003). Price setting Behavior in an Open Economy and the Determination of Finnish Foreign Trade Prices. Bank of Finland Studies E:25. Helsinki.
- Friberg, Richard (1998). In which currency should exporters set their prices? *Journal of International Economics* 45: 59–76.
- Fukuda, Shin-ichi, and Masanori Ono (2004). The Choice of Invoicing Currency under Uncertainty: Theory and Evidence from Korea. CIRJE Discussion Paper F-271. Center for International Research on the Japanese Economy, Tokyo.
- Giovannini, Alberto (1988). Exchange Rates and Traded Goods Prices. *Journal of International Economics* 24: 45–68.
- Goldberg, Linda S. (2005). Trade Invoicing in the Accession Countries: Are They Suited to the Euro? NBER Working Paper 11653. National Bureau of Economic Research, Cambridge, MA.
- Goldberg, Linda S., and Cedric Tille (2005). Vehicle Currency Use in International Trade. NBER Working Paper 11127. National Bureau of Economic Research, Cambridge, MA.
- Grassman, Sven (1973). Currency Distribution and Forward Cover in Foreign Trade. *Journal of International Economics* 6: 215–221.
- Hartmann, Philipp (1998). The Currency of Denomination of World Trade after European Monetary Union. *Journal of the Japanese and International Economics* 12: 424–454.
- Johnson, Martin, and Daniel Pick (1997). Currency Quandary: The Choice of the Invoicing Currency under Exchange-Rate Uncertainty. *Review of International Economics* 5 (1): 118–128.
- Levina, Irina, and Oleg Zamulin (2004). Foreign Currency Pricing. Center for Economic and Financial Research, CEFIR Working Paper 31, Moscow.
- Magee, Stephen P., and Ramesh K. S. Rao (1980). Vehicle and Nonvehicle Currencies in International Trade. *The American Economic Review* 70(2): 368–373.
- McKinnon, Ronald (1979). *Money and International Exchange: The Convertible Currency System*. Oxford University Press, New York.
- McKinnon, Ronald, and Gunther Schnabl (2004). The East Asian Dollar Standard, Fear of Floating, and Original Sin. *Review of Development Economics* 8 (3): 331–360.
- Mile, Ibolya, Exchange rate policy of Hungary on the way to European Union membership. PhD-thesis, Gerhard Mercator University of Duisburg, Duisburg, 2003. Internet Version: <http://www.ub.uni-duisburg.de/ETD-db/theses/available/duett-08282003-181101/unrestricted/milediss.pdf>, January 2005.
- Murray, John, and James Powell (2002). Dollarization in Canada: The Buck Stops There. Bank of Canada Technical Report 90. Ottawa.
- Obstfeld, Maurice, and Kenneth Rogoff (1995). Exchange Rate Dynamics Redux. *Journal of Political Economy* 103: 624–660.
- Oi, Hiroyuki, Akira Otani, and Toyoichirou Shirota (2004). *Monetary and Economic Studies* 22 (1): 27–63.

- Page, S. (1977). Currency of Invoicing in Merchandise Trade. *National Institute Economic Review* 81 (3): 77–81.
- Page, S. (1981). The choice of invoicing currency in merchandise trade. *National Institute Economic Review* 98: 60–72.
- Rauch, James (1999). Networks versus markets in international trade. *Journal of International Economics* 48: 7–35.
- Rey, Hélène (2001). International Trade and Currency Exchange. *Review of Economic Studies* 68 (2): 443–464.
- Sasaki, Yuri N. (2002). Pricing-to-Market Behavior: Japanese Exports to the US, Asia, and the EU. *Review of International Economics* 10 (1): 140–150.
- Sato, Kiyotaka (2003). Currency Invoicing in Japanese Exports to East Asia: Implications for Yen Internationalization. *Asian Economic Journal* 17 (2): 129–154.
- Silva, Jorge (2004). Determinants of the Choice of Invoicing Currency: From Dutch Guilders to Euros in Dutch Goods Trade. Tilburg University. Mimeo.
- Swoboda, Alexander (1968). The Euro-Dollar Market: An Interpretation. *Essays in International Finance* 64. Princeton University.
- Tavlas, George S. (1991). On the International Use of Currencies: The Case of the Deutsche Mark. *Essays in International Finance* 181. Princeton University.
- Tavlas, George S. (1997). The International Use of the U.S. Dollar: An Optimum Currency Area Perspective. *The World Economy: The Leading Journal on International Economic Relations* 20 (6): 709–747.
- Viaene, Jean-Marie, and Itzhak Zilcha (1998). The Behavior of Competitive Exporting Firms under Multiple Uncertainty. *International Economic Review* 39 (3): 591–609.
- Viaene, Jean-Marie, and Casper G. de Vries (1992). On the Design of Invoicing Practices in International Trade. *Open Economies Review* 3: 133–142.
- Wilander, Fredrik (2004). *An Empirical Analysis of the Currency Denomination in International Trade*. Stockholm School of Economics. Mimeo.
- Yun, Seong-Hun (2005). An Essay on Invoicing Currency Practices for Korean Exports. The Bank of Korea Economic Papers, September 2005.

2.6 Appendix

Invoicing (Database see Appendix Table A2.1)

eurex	share of exports invoiced in euro (in %)
eurim	share of imports invoiced in euro (in %)
homex	share of exports invoiced in home currency (in %)
homeim	share of imports invoiced in home currency (in %)
usdex	share of exports invoiced in U.S. dollar (in %)
usdim	share of imports invoiced in U.S. dollar (in %)

Trade Share (IMF Direction of Trade Statistics)

mp	market power, measured as country's export share in total world exports
shexeur	country's share of exports to the euro area as share of total country exports (in %)
shexus	country's share of exports to the U.S. as share of total country exports (in %)
shimeur	country's share of imports from the euro area as share of total country imports (in %)
shimus	country's share of imports from the U.S. as share of total country imports (in %)
shimdum	0/1 dummy, taking on the value of 1 if share of imports from the euro area is higher than 50 percent

Rauch Index (UN Comtrade Statistics)

raux	share of country's differentiated exports in country's total exports (measured with SITC rev. 2 four digits codes)
rauim	share of country's differentiated imports in country's total imports (measured with SITC rev. 2 four digits codes)

Membership of the EU and euro currency introduction

eurinst	0/1 dummy, taking on the value of 1 when a country is a member of the EU-25 or an official candidate country (Bulgaria, Croatia, Romania).
euoint	0/1 dummy, taking on the value of 1 for the year 2002 and thereafter. Introduction of the euro currency and discontinuation of the legacy currencies.

Financial Stability (IMF International Financial Statistics)

credit	private credit to GDP ratio
eurexvol	volatility of country's exchange rate vis-à-vis the euro (four month moving average of standard deviation)
eurinf	country's inflation differential with the euro area (before 1999 with Germany)
eurpeg	0/1 dummy, taking on the value of 1 when a country has a hard peg vis-à-vis the euro
fmdum	dummy taking on the value of 1 all those countries with a forward market for their exchange rate in 1999 (Bloomberg statistics)
usdpeg	0/1 dummy, taking on the value of 1 when a country has a hard peg vis-à-vis the U.S. dollar
usexvol	volatility of country's exchange rate vis-à-vis the euro (four month moving average of standard deviation)
usinf	country's inflation differential with the U.S.

Table A2.1:
U.S. Dollar, Euro and Home Currency Invoicing in the Exports and Imports of 42 Countries

		Exports in Goods			Imports in Goods		
		EUR	USD	home	EUR	USD	home
EUROPE							
<i>Euro Area</i>							
Belgium ^a	2000	42		42	43.6		43.6
	2001	46.7		46.7	47.2		47.2
	2002	53.5	32.5	53.5	53.6	34.6	53.6
	2003	56.6	30.8	56.6	57.7	32.9	57.7
	2004	57.7	29.6	57.7	55.5	35.1	55.5
France	1999	52.2	35.5	52.2	40.6	48.4	40.6
	2000	44.6	42.6	44.6	32.9	57.2	32.9
	2001	47.1	41.0	47.1	44.4	45.7	44.4
	2002	51.0	37.0	51.0	46.9	45.2	46.8
	2003	52.7	33.6	52.7	45.3	46.9	45.3
Germany ^b	2002	49.0	31.6	49.0	48.0	34.5	48.0
	2003	63.0	24.1	63.0	55.2	33.9	55.2
	2004	61.1	24.1	61.1	52.8	35.9	52.8
Greece	2001	23.5	67.7	23.5	29.3	61.5	29.3
	2002	39.3	52.6	39.3	35.8	57.1	35.8
	2003	47.3	45.9	47.3	39.6	54.7	39.6
	2004	44.3	51.2	44.3	40.6	55.3	40.6
Italy	2001	52.7		52.7	40.8		40.8
	2002	54.1		54.1	44.2		44.2
	2003	58.2		58.5	44.5		44.5
	2004	59.7		59.7	44.5		44.5
Luxembourg ^a	2000	42.0		42	43.6		43.6
	2001	46.7		46.7	47.2		47.2
	2002	46.0	38.3	46.0	31.6	47.5	31.6
	2003	51.2	26.6	51.2	41.6	36.9	41.6
	2004	62.7	22.1	62.7	49.4	36.3	49.4
Netherlands	1998	51.5	32	51.5	41.9	44.3	41.9
	1999	51.8	32	51.8	41.5	45.6	41.5
	2000	44.7	41.3	44.7	37	52.8	37
	2001	47.8	39.2	47.8	41.1	48.5	41.1
	2002	52.0	35.2	52.0	48.0	43.8	48.0
Portugal	2000	40.1		40.1	47		47
	2001	43.5		43.5	53.6		53.6
	2002	48.4	33.0	48.4	57.5	35.2	57.5
	2003	53.6	27.6	53.6	59.2	31.1	59.2
	2004	57.6	27.4	57.6	58.8	32.6	58.8
Spain	1998	48.9	40.1	48.9	42.1	46.4	42.1
	1999	50.2	39.1	50.2	45.3	44.4	45.3
	2000	49.0	40.9	49.0	44.0	48.2	44.0
	2001	52.0	38.4	52.0	49.7	43.7	49.7
	2002	57.5	32.4	57.5	55.9	38.9	55.9
	2003	61.7	29.3	61.7	61.1	34.9	61.1
	2004	62.6	29.1	62.6	61.1	35.5	61.1

Table 2.1 continued

		Exports in Goods			Imports in Goods		
		EUR	USD	home	EUR	USD	home
<i>Other EU</i>							
25							
Cyprus	2003	30.2	34.1		44.9	33.4	
	2004	32.0	28.6		52.9	30.2	
Czech Rep. ^c	1999	71.2	13.1		67.3	18.8	
	2000	69.2	14.4		66.9	20.5	
	2001	68.7	14.1	10.3	66.6	19.7	7.7
	2002	68.2	14.7	10.2	66.7	19.5	8.7
	2003	70.3	13.5	9.6	67.6	18.3	9.3
	2004	72.4	12.0		68.8	18.5	
Denmark	1999	30.0	19.7		32.6	20.6	
	2000	29.3	25.4		32.6	24.1	
	2001	32.6	25.6		35.3	24.3	
	2002	35.9	22.0		37.4	19.3	
	2003	35.2	19.5		32.4	17.4	
	2004	34.3	19.5		33.1	17.0	
Estonia ^d	2002	65.1			59.0		
	2003	70.3	9.0		61.5	22.0	
	2004	72.2	9.4		62.5	21.9	
Hungary ^e	1992	52.4	37.5		53.3	33.8	
	1993	50.6	40.3		48.3	40.1	
	1994	55.2	34.3		53.5	34.3	
	1995	59.6	31		55.2	33.1	
	1996	62.6	27.4		55.8	32.9	
	1997	60.5	28.7		57	29.4	
	1998	65.1	28.5		61.6	27	
	1999	74.4	21.2	0.4	70.6	22.5	2.1
	2000	78.6	17.5	0.3	69.8	23.2	2.6
	2001	79.4	15.7	1.0	70.5	21.7	3.4
	2002	83.2	12.2	1.4	73.3	18.5	4.0
	2003	85.0	10.1	1.8	72.4	17.7	5.4
2004	84.8	9.6	2.3	70.8	18.8	6.3	
Latvia	2000	28.5	46.9		40.2	42.4	
	2001	34.1	41.4		44.5	37.3	
	2002	40.4	36.2		51.9	29.7	
	2003	41.6	38.3		49.6	34.0	
	2004	47.9	35.2		52.7	34.9	
Lithuania	1996				25	62.2	2.0
	1997				28	60.3	1.3
	1998				33	55.9	0.7
	1999	28.5	62.5	1.4	34.3	58.8	1.4
	2000	32.3	60.7	1.2	38.3	57.5	1.5
	2001	40.1	54.3	1.3	42.9	52.9	1.2
	2002	48.2	46.3	1.4	46.0	49.2	1.3
	2003	51.7	43.6	1.4	53.0	42.0	1.5
	2004	53.0	42.0	1.6	54.7	39.3	2.4
	2005	54.8	40.8	1.4	61.0	34.2	1.3

Table 2.1 continued

		Exports in Goods			Imports in Goods		
		EUR	USD	home	EUR	USD	home
Poland	1994	48.1	41.2		48.1	41.2	
	1995	44.2	49.1		49.3	41.0	
	1996	43.6	49.4		51.5	39.5	
	1997	44.0	48.5		53.3	38.0	
	1998	51.2	40.0	2.7	58.3	32.3	1.5
	1999	53.7	36.3	4.1	57.2	32.1	3.4
	2000	54.8	36.2	3.5	54.9	34.8	3.9
	2001	57.2	33.8	4.1	57.7	32.9	4.6
	2002	60.1	29.9	4.9	59.6	28.6	6.5
	2003	64.9	25.2	5.1	60.2	27.2	8.3
	2004	69.3	21.4	5.1	61.7	26.1	8.5
Slovakia	1999	58.3	28.4				
	2000	58.5	30.0				
	2001	61.3	26.4				
	2002	63.7	23.2				
	2003	69.8	19.0				
Slovenia	2000	85.0	10.4		77.0	17.9	
	2001	85.0	10.3		79.0	15.7	
	2002	87.0			83.0		
	2003	87.2	9.5		82.4	14.2	
	2004	88.1	8.1		83.3	13.2	
UK	1999	19	27	53	23	30	40
	2000	21	29	46	19	34	42
	2001	23	29	46	19	38	40
	2002	21	26	51	27	37	33
<i>EU candidates</i>							
Bulgaria	1998	31.5	65.9		42.1	53.5	
	1999	36.7	60.4		46.8	48.9	
	2000	37.5	60		46.9	50.1	
	2001	48.1	49		55.5	41.8	
	2002	52.4	44.4		60.1	37.1	
	2003	60.7	36.4		62.7	34.7	
	2004	62.2	35.2		63.6	34.1	
Croatia	1998	61	36		72	24	
	1999	62	33		72	24	
	2000	60	36		70	26	
	2001	63.0	32.9		72.7	24.4	
	2002	69.4	27.6		77.1	20.2	
	2003	72.0	24.2		78.0	18.6	
	2004	68.5	27.7		78.0	18.3	
Romania	1999	50.5	45.2		57.1	37.7	
	2000	51	42.8		60.4	33.7	
	2001	55.7	39.5		60.6	35.1	
	2002	58.6	36.4		65.6	30.3	
	2003	63.8	30.6		67.9	28.3	
	2004	66.3	28.5		70.8	25.6	
	2005	64.3	31.5		71.1	25.7	
Turkey	2002	46.7	44.9	0.9	37.0	56.7	0.3
	2003	49.3	42.6	1.1	39.7	55.1	0.2
	2004	49.3	42.9	1.0	40.3	55.0	0.2

Table 2.1 continued

		Exports in Goods			Imports in Goods		
		EUR	USD	home	EUR	USD	home
<i>Other European Countries</i>							
The former Yugoslav Republic of Macedonia	1998	54.7	43.8		58.4	39.9	
	1999	59.4	39.1		62.0	36.3	
	2000	54.7	43.8		54.6	43.7	
	2001	61.0	37.6		63.7	34.6	
	2002	66.4	32.2		67.6	30.4	
	2003	67.4	31.2		70.6	27.9	
	2004	75.5	22.9		75.3	23.2	
Serbia and Montenegro	2002		20.0			30.0	
	2003		15.0			27.0	
Ukraine	2001	2.6	76.0				
	2002	4.7	75.7		10.8	73.3	
	2003	5.7	75.4	0.4	14.6	74.1	0.4
	2004	7.6	78.0	0.4	14.1	76.9	0.4
AFRICA							
Algeria	2003	0.48	99.0		50.8		
	2004	0.58	99.0		48.0		
Morocco	2003				55.0		
South Africa	2003	17.0	52.0	25.0			
Tunisia	1995	45.4			46.6		
	1996	45.5			49.1		
	1997	49.1			45.9		
	1998	56.9			48.5		
	1999	47.7			65.6		
	2000	46.2			50.4		
	2001	52.3			55.6		
ASIA PAZIFIC							
<i>Australia</i>	1997	0.8	63.0	33.8	7.8	51.7	24.9
	1998	0.9	66	30.8	7.8	52.5	24.3
	1999	0.7	64.2	32.1	8.3	49.7	28.6
	2000	0.5	68.4	28.6	7.1	51.4	28.3
	2001	0.7	68.8	27.7	9.2	49.5	30.7
	2002	1.4	67.9	27.6	8.7	50.1	30.6
	2003	1.4	67.5	27.8	9.4	47.9	32.6
India	1998	7.1			8.1		
Indonesia	1991	4.5	89.7	0.0	10.8	70.6	0.0
	1992				11.1	72.1	0.0
	1993				9.0	73.3	0.0
	1994	0.7	95.7	0.1	8.9	74.7	0.1
	1995	0.5	83.5	0.0	6.6	77.7	0.2
	1996	0.5	90.4		6.6	81.5	0.2
	1997	1.2	91.9	1.7	6.6	78.7	0.5

Table 2.1 continued

		Exports in Goods			Imports in Goods		
		EUR	USD	home	EUR	USD	home
Indonesia	1998	0.8	93.7	0.2	8.4	77.4	0.3
	1999	1.2	92.9	0.0	4.1	83.3	0.6
	2000	1.5	92.7	0.0	4.5	79.9	1.0
	2001	2.2	91.0	0.0	5.8	80.0	0.6
	2002	2.1	91.4	0.1	5.8	79.6	0.4
	2003	1.5	92.8	0.0	5.8	80.3	0.4
	2004	1.2	93.6	0.0	5.7	82.5	0.4
Israel	2000	24.6	62.6				
	2004	23.9	64.7				
Japan	1992		46.6	40.1		74.5	17
	1993		48.4	39.9		72.4	20.9
	1994		48.3	39.7		73.9	19.2
	1995		52.0	36.8		69.6	23.5
	1996		53.2	35.6		72.3	20.6
	1997		52.5	35.8		72.4	20.8
	1998		51.2	36.0		71.5	21.8
	2000	7.6	52.4	36.1	2.3	70.7	23.5
	2001	8	52.8	34.9	3	70	23.4
	2002	8.6	51.7	35.8	4.4	68.3	24.9
	2003	9.6	48.0	38.4	4.5	68.7	24.6
South Korea ^f	1990	2.1	88		4.1	79.1	
	1995	2.4	88.1		3.8	79.4	
	1996	2.2	89.1		3.6	81.0	
	2000	1.8	84.8		1.9	80.4	
	2001	4.5	87.4		4.0	82.2	
	2002	5.8	86.8		5.4	80.6	
	2003	7.6	84.6		6.1	78.3	
Malaysia	1995	3.2	61.7	18.7	8.2	1.2	
	1996	2.8	66	17.8	6.8	1	
	2000		90				
Pakistan	2001	1.6	92.6		3.5	84.2	
	2002	3.5	92.3		7.0	84.6	
	2003	6.9	89.4		9.0	82.8	
Thailand	1993	1	91.8	0.9	5.1	74.3	0.6
	1994	0.8	90.5	1.6	4.6	77.1	0.7
	1995	0.5	91.0	2.4	3.6	80.7	0.5
	1996	0.5	91.7	1.3	3.5	80.1	0.8
	1997	0.4	92.0	2.1	3.5	80.4	1.7
	1998	0.7	90.6	2.6	2.9	80.7	1.7
	1999	1.7	87.6	3.7	3.0	79.2	2.2
	2000	1.8	87.0	3.9	3.0	79.0	2.4
	2001	2.8	85.7	4.0	5.1	77.9	3.5
	2002	3.2	84.7	4.3	5.3	77.2	4.4
	2003	2.7	84.4	5.0	4.3	76.0	5.6
NORTH AMERICA							
Canada	2001		70	23			
US	2003				2.0	90.3	90.3

See below for sources and notes.

Table 2.1 continued: Sources and Notes

Country	Type of Data	Source and Notes
EUROPE		
<i>Euro Area</i>		
Belgium	Exports and imports, goods and services	ECB data request to National Central Banks. ^a Data before 2002 refers to Belgo-Luxembourg economic union.
France	Exports and imports, goods and services	ECB data request to National Central Banks.
Germany	Exports and imports, only goods	ECB data request to National Central Banks. ^b Data for Germany reflect the average value of data collected in surveys carried out in the first and third quarters of 2002, 2003 and 2004 on behalf of the Deutsche Bundesbank.
Greece	Exports and imports, goods and services	ECB data request to National Central Banks.
Italy	Exports and imports, goods and services	ECB data request to National Central Banks.
Luxembourg	Exports and imports, goods and services	ECB data request to National Central Banks. ^a Data before 2002 refers to Belgo-Luxembourg economic union.
Netherlands	Exports and imports, goods and services	Dutch National Bank, Data Request. Currency practices in Dutch exports and imports (1975-2002), DNB Quarterly March 2004.
Portugal	Exports and imports, goods and services	ECB data request to National Central Banks.
Spain	Exports and imports, goods and services	ECB data request to National Central Banks.
<i>Other EU-25</i>		
Cyprus	Exports and imports, only goods	ECB data request to National Central Banks.
Czech Republic	Exports and imports, only goods	ECB data request to National Central Banks. ^c Goods data for 2004 refer to the first quarter of 2004 as a result in changes in the way data are collected from May 2004 onwards.
Denmark	Exports and imports, goods and services	ECB data request to National Central Banks

Estonia	Exports and imports, goods and services	ECB data request to National Central Banks. ^d Goods data for 2004 refer to the first quarter of 2004 as a result in changes in the way data are collected from May 2004 onwards.
Hungary	Exports and imports, goods and services	ECB data request to National Central Banks. ^e Please note break in the series, data for 1992 to 1999: Ibolya Mile: Exchange rate policy of Hungary on the way to European Union membership.
Latvia	Exports and imports, goods and services	ECB data request to National Central Banks.
Lithuania	Exports and imports, goods and services	ECB data request to National Central Banks. Before 2000: Data only available for imports of goods from Igor Vetlov: The Monetary Transmission Mechanism in Lithuania, Eesti Pank publication (approximation for euro share as he quotes EU currencies): http://www.bankofestonia.info/pub/en/dokumentid/publikatsioonid/seeriad/muud_uuringud/_2004/_3.pdf
Poland	Exports and imports, only goods	ECB data request to National Central Banks. Data before 2002: Only data on goods. Bank of Poland, various issues of Annual Reports. http://www.nbp.pl/en/publikacje/r_roczny/rocznik2001_en.pdf
Slovakia	Overall Trade	Bank of Slovakia, Report on Monetary Developments in the SR in 2003. Currency structure of foreign exchange receipts and payments.
Slovenia	Exports and imports, goods and services	ECB data request to National Central Banks. Data before 2002: Banka Slovenije, Annual Report 2001.
UK	Exports and imports, only goods	HM Revenue & Customs [formerly H M Customs and Excise]. Bilateral trade data available. Warning issued that data may not be reliable.
<i>EU candidates</i>		
Bulgaria	Exports and imports, only goods	ECB special data request. Bulgarian National Bank, Customs declarations data, supplemented with NSI data and processed by the BNB. Data are coordinated with the National Statistical Institute of Bulgaria.
Croatia	Exports and imports, only goods	Bank of Croatia, various issues of Annual Reports. Data before 2001 refers to overall trade only.
Romania	Exports and imports, goods; services (only starting with 2005 data)	National Authority for Customs, National Bank of Romania.
Turkey	Exports and imports	Turkish undersecretariat of the Prime Ministry for Foreign Trade
<i>Other European Countries</i>		
F.Y.R.of Macedonia	Exports and imports	State Statistical Office of the Republic of Macedonia
Serbia & Montenegro	Exports and imports	Bank of Serbia and Montenegro, Annual Report 2003 and 2002. Data only for USD invoicing.

Ukraine	Exports and imports	Bank of Ukraine. Balance of Payments Report. Data for 2002 on bilateral basis.
AFRICA		
Algeria	Exports and imports	ECB special data request. Bank of Algeria. Only euro no USD invoicing for imports.
Morocco	Only imports	Article in “Al Bayane”: Les scénarii d’impact du renchérissement de l’euro sur l’économie marocaine. http://www.albayane.ma/Detail.asp?article_id=41798 . Article from 3/28/2004.
South Africa	Only exports	Budget Review. http://www.treasury.gov.za/documents/budget/2004/review/Chapter%202.pdf
Tunisia	Exports and imports	ECB special data request. Banque Centrale de Tunisie. Data on services available for imports.
ASIA PACIFIC		
<i>Australia</i>	Exports and Imports	Bank of Australia. Data available on industry level. Australian Bureau of Statistics. Australia Now. International Merchandise Trade, Australia 1998 and 2003.
India	Exports and imports	Bank of India. Annual Report 1998/99. Bank of India Story. Box VI.4: Euro and India. Only euro data.
Indonesia	Exports and imports	Bank of Indonesia, Balance of Payments Statistics; data transformed to represent overall trade (not only non-oil trade). http://www.bi.go.id/web/en/Data+Statistik/
Israel	Overall trade	Bank of Israel, Press Release April 23 2000.
Japan	Exports and imports	Japan Customs, http://www.mof.go.jp/english/if/if043f.htm , and McKinnon and Schnabl (2004).
South Korea	Exports and imports	Monthly Statistics of Korea and McKinnon and Schnabl (2004) and Yun (2005). ^f Data for 2001 approximation.
Malaysia	Exports and imports	Ngiam Kee Jin: Financial and Monetary Cooperation in East Asia: The Singapore Perspective. Data for 2000: Treasury Malaysia: The Performance of the Malaysian Economy.
Pakistan	Exports and imports	Bank of Pakistan, Annual report 2003. http://www.sbp.org.pk/reports/annual/index.htm
Thailand	Exports and imports	Bank of Thailand, bilateral data. http://www.bot.or.th/BOThomepage/databank/EconData/EconData_e.htm
NORTH AMERICA		
Canada	Only exports	Murray and Powell (2002), Dollarization in Canada. Bank of Canada Technical Report No. 90.
United States	Only imports	Bureau of Labor Statistics. Special data request.

Table A2.2:
Share of Differentiated Goods in Exports and Imports

	Year	Exports	Imports	
EUROPE				
<i>Euro Area</i>				
	Belgium	2004	55.0	64.9
	Germany	2004	72.9	69.5
	Spain	2003	67.0	64.0
	France	2004	66.1	67.5
	Greece	2004	49.6	61.9
	Italy	2004	73.9	62.7
	Luxemburg	2004	56.7	62.3
	Netherlands	2004	51.3	62.6
	Portugal	2004	66.2	65.3
<i>Other EU 25</i>				
	Cyprus	2004	64.4	69.8
	Czech Republic	2004	72.6	70.8
	Denmark	2004	64.9	71.4
	Estonia	2004	70.6	67.0
	Hungary	2003	73.6	76.3
	Latvia	2004	63.6	66.0
	Lithuania	2003	46.2	63.2
	Poland	2004	66.9	67.5
	Slovenia	2004	69.4	65.8
	Slovakia	2004	63.0	66.5
	United Kingdom	2004	66.7	76.5
<i>EU candidates</i>				
	Bulgaria	2004	49.9	75.9
	Croatia	2004	59.8	66.7
	Romania	2004	64.1	66.6
	Turkey	2004	68.0	46.8
<i>Other European Countries</i>				
	Macedonia	2004	52.6	53.8
	Serbia Montenegro	2004	47.8	55.2
	Ukraine	2003	31.0	40.5
AFRICA				
	Algeria	2004	0.3	58.8
	Morocco	2004	44.8	28.7
	Tunisia	2004	59.1	64.6
	South Africa	2004	30.4	68.4
ASIA PAZIFIC				
	Australia	2004	38.1	75.9
	Indonesia	2004	37.6	39.8
	India	2003	47.0	39.5
	Israel	2004	47.0	72.0
	Japan	2004	72.8	56.2
	Korea	2004	62.8	52.2
	Malaysia	2004	46.0	74.4
	Pakistan	2004	69.5	35.6
	Thailand	2003	55.0	62.3
NORTH AMERICA				
	Canada	2004	54.9	77.5
	United States	2004	64.1	75.3

Source: UN Comtrade database; own calculations based on Rauch (1999) index.

Table A2.3:

U.S. Dollar Import Invoicing

Dependent variable: share of imports invoiced in U.S. Dollar (in percentage points)

Regression	random	fixed	PW ^a	weighted ^b
Constant	108.21*** (8.82)	48.27*** (25.82)	99.99*** (15.66)	106.78*** (40.34)
Share of imports from U.S	0.08 (0.40)	-0.01 (-0.06)	0.21 (1.21)	0.05 (0.53)
EU-25 and candidates	-16.31*** (-2.68)		-14.62*** (-2.72)	-16.48*** (-13.43)
Introduction of the euro (2002)	-3.63*** (-5.01)	-3.91*** (-5.29)	-2.04*** (-2.59)	-2.41*** (-3.72)
Share of differentiated imports	-0.97*** (-3.66)		-0.73*** (-4.07)	-0.80*** (-19.08)
Exchange rate volatility to U.S.	0.96 (0.04)	2.36 (0.11)	8.70 (0.45)	3.52 (0.18)
Inflation differential to U.S.	0.22*** (4.76)	0.21*** (4.67)	0.16*** (3.58)	0.17** (2.45)
Forward market	4.18 (1.03)		-4.11* (-1.76)	-0.3 (-0.27)
Peg to USD	12.19*** (5.59)	11.86*** (5.40)	10.58*** (4.33)	10.16 (1.49)
Number of observations	160	160	160	160
Number of countries	31	31	31	31
Wald chi2	232.7		531.9	2860.8
R squared overall	0.77	0.02	0.97	0.99

Absolute value of z statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

^a Prais-Winston regression with heteroscedastic panel corrected standard errors and panel specific AR1.^b Prais-Winston regression with het. panel corrected standard errors. Importance weighted with GDP.

Table A2.4:

Euro Import Invoicing

Dependent variable: share of imports invoiced in euro (in percentage points)

Regression	random	fixed	PW ^a	weighted ^b
Constant	-1.16 (-0.10)	25.53*** (4.84)	-1.00 (-0.26)	5.37 (1.32)
Share of imports from euro area	0.60*** (5.44)	0.27* (1.96)	0.95*** (11.98)	0.92*** (4.91)
EU-25 and candidates	13.99** (2.45)		12.84*** (3.40)	0.21 (0.03)
Introduction of the euro (2002)	5.24*** (6.19)	5.28*** (6.40)	2.17** (2.37)	2.56*** (4.12)
Share of differentiated imports	0.20 (0.80)		-0.09 (-1.21)	-0.29*** (-9.67)
Exchange rate volatility to euro	42.42 (1.21)	50.46 (1.48)	-26.69 (-0.89)	44.71 (1.50)
Inflation differential to euro area	-0.28*** (-4.67)	-0.28*** (-4.87)	-0.16*** (-3.28)	-0.18 (-1.49)
Forward market	-12.95*** (-2.78)		-1.09 (-0.48)	-1.32 (-0.34)
Peg to euro	12.83*** (4.52)	13.95*** (4.83)	8.43*** (3.05)	26.09** (2.23)
Number of observations	154	154	154	154
Number of countries	30	30	30	30
Wald chi2	254.7		918.7	630.0
R squared overall	0.77	0.48	0.87	0.90

Absolute value of z statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

^a Prais-Winston regression with heteroscedastic panel corrected standard errors and panel specific AR1.^b Prais-Winston regression with het. panel corrected standard errors. Importance weighted with GDP.

3 Petrodollars and Imports of Oil Exporting Countries

Oil prices have risen sharply since 1999. This seems to have exacerbated global imbalances. High oil prices have worsened the current account deficit in the United States through higher oil import bills. At the same time, oil exporting countries benefited from the higher oil prices and used their export revenue windfalls among others to buy foreign products. However, additional import spending seems to fall short of the export revenue windfall. Thus, while the current account deficit in the United States widens, oil exporting countries are running record current account surpluses. This has led to increased interest in the effect of higher oil prices on global imbalances.¹ There were voices to be heard in the international community that oil exporting countries should be made to participate in reducing global imbalances by increasing their import demand. First and foremost it was stated that oil exporting countries should let their exchange rates float which would lead to real appreciations and help reduce global imbalances by stimulating demand for foreign products in oil exporting countries. There are several questions arising from this statement. First of all, the direct impact of oil prices on import demand should be analyzed. How much do imports in oil exporting countries increase due to the higher oil revenues and the increased wealth? A further question is whether and to which extent a real appreciation stimulates imports in these countries. Third, it is important to look at other factors influencing import behaviour in oil exporting countries. In particular what distinguishes oil exporting countries' import behaviour from that of industrial countries? Finally, the possible import increase should be put into the perspective of global imbalances. How much can oil exporting countries contribute at all to reducing global imbalances?

The aim of this paper is to focus on the trade channel of petrodollar recycling.² Especially in times of high oil prices the use or "recycling" of these petrodollars attracts interest. Table 3.1 gives an overview of petrodollar recycling for the period from 2002 to 2005. Oil exporting countries can also spend their oil revenues in the domestic economy. However, as most of the oil exporting countries focus on the production of oil, the domestic economy cannot absorb all oil revenues. This is particularly true in times of high oil price increases when the domestic economy is unable to adjust to the higher demand in the short run.

¹ See for example IMF World Economic Outlook (2006), Federal Reserve Bank of San Francisco (2006), U.S. Department of the Treasury (2006).

² The export revenues oil exporting countries gain with their oil exports are often referred to as petrodollars. It should be noted that throughout this study the word petrodollars is used in a neutral way to describe revenues earned by oil exports.

Table 3.1: Petrodollar Recycling, 2002 - 2005

Country	Exports ^a	Oil export revenues			Foreign reserves			Imports ^b			Government debt to GDP ^c		
	(mn bbl)	(bn U.S. dollar)			(bn U.S. dollar)			(bn U.S. dollar)			(percent)		
	2005	2002	2005	Δ	2002	2005 ^d	Δ	2002	2005	Δ	2002	2005	Δ
Algeria	1.8	18.1	45.6	27	23.5	54.6	31.1	12.01	19.50	7.5	53.5	28.53	-24.9
Angola	1.2	7.2	21.6	14	0.8	2.6	1.8	3.61	8.28	4.7	79.1	37.65	-41.5
Bahrain	na	2.5	3.6	1	1.4	1.7	0.3	3.01	3.44	0.4	41.6	53.21	11.6
Congo, Rep. of	0.3	1.9	4.1	2	0.03	0.78	0.8	1.04	2.08	1.0	200.9	98.73	-102.2
Ecuador	0.4	1.8	4.2	2	1.0	2.1	1.1	5.94	8.10	2.2	65.2	44.33	-20.9
Equatorial Guinea	0.4	2.0	7.0	5	0.6	2.9	2.4	0.48	1.81	1.3	10.2	3.59	-6.6
Gabon	0.2	1.8	4.2	2	0.1	0.7	0.6	0.70	1.01	0.3	66.0	47.27	-18.7
Iran, I.R. of	2.4	23.0	48.8	26	21.6	33.8	12.2	22.04	40.97	18.9	7.9	8.77	0.8
Kazakhstan	1.2	4.9	17.0	12	5.0	18.4	13.4	7.86	17.60	9.7	20.1	14.25	-5.8
Kuwait	2.4	14.0	42.1	28	9.3	9.5	0.2	8.11	13.52	5.4	32.4	16.93	-15.5
Libya	1.7	8.9	27.4	18	14.5	31.9	17.4	6.78	9.50	2.7	33.7	1.22	-32.5
Nigeria	2.6	14.8	41.6	27	7.4	24.0	16.6	12.56	20.48	7.9	67.2	20.65	-46.6
Norway	2.8	24.8	45.9	21	32.1	42.5	10.4	35.71	56.82	21.1	36.1	46.44	10.3
Oman	0.8	7.4	13.2	6	3.2	3.6	0.4	5.64	8.83	3.2	17.4	10.84	-6.6
Qatar	1.0	4.6	10.7	6	1.6	4.5	2.9	3.65	9.89	6.2	47.1	25.03	-22.0
Russia	6.8	40.3	117.2	77	44.7	162.3	117.6	60.97	125.30	64.3	44.1	33.85	-10.2
Saudi Arabia	9.1	63.7	162.2	98	20.8	23.5	2.7	29.66	54.58	24.9	96.9	39.59	-57.3
Sudan	0.4	1.7	3.9	2	0.1	1.9	1.8	2.02	5.62	3.6	161.2	106.81	-54.4
Syrian Arab Rep.	0.5	3.8	1.8	-2	9.9	11.3	1.4	4.27	5.71	1.4	60.1	60.20	0.1
Turkmenistan	0.1	0.8	2.0	1	na	na	na	1.83	2.95	1.1	19.1	6.07	-13.0
Trinidad and Tobago	0.2	1.2	4.8	4	1.9	4.8	2.9	2.66	3.71	1.1	33.9	20.90	-13.0
United Arab Emirates	2.4	16.6	43.5	27	15.2	19.9	4.7	37.53	80.80	43.3	22.4	28.14	5.8
Venezuela	2.5	21.5	48.1	27	na	na	na	13.36	23.95	10.6	44.9	36.39	-8.6
Yemen	0.4	2.9	5.4	2	4.4	5.8	1.4	2.87	4.08	1.2	11.6	14.50	2.9
Total	41.3	290.3	725.9	435.6	219.1	463.1	244.04	284.3	528.5	244.2	na	na	na

Notes: ^a Approximation of export volumes given as oil production minus oil consumption. ^b nominal import value. ^c Gross Central Government Debt. For Angola, Congo, Ecuador, Iran, Kazakhstan, Kuwait, Nigeria, Russia, Turkmenistan, United Arab Emirates and Venezuela numbers are for Total Debt Outstanding at Year End (IMF WEO). ^d Includes IMF staff estimates and projections for Angola, Bahrain, Congo, Ecuador, Equatorial Guinea, Gabon, Oman, Sudan, Syrian Arab Republic, Trinidad and Tobago and Yemen. Data for Oman and Syrian Arab Republic is 2004 data. Δ stands for the change in absolute numbers. na stands for not available.

Sources: BP (2006), Department of the Treasury (2006), IMF (2006).

Therefore a large share of the petrodollars is recycled abroad. Apart from the trade channel there are two financial channels of petrodollar recycling. The first is the asset accumulation channel. Oil exporting countries use part of their oil revenues to accumulate foreign reserves. In 2005 portfolio investment seems to have replaced reserve accumulation as most important source of capital outflow. The majority of the capital outflows are going to the United States. The second financial channel is the debt reduction channel. Many oil exporting countries accumulated a stock of debt in the past part of which is international debt. Lately, especially Russia used a large share of its petrodollars to repay outstanding international debt liabilities.³ These two financial channels are often linked to the question of who is financing the U.S. current account deficit.

This paper, however, focuses on the trade channel of petrodollar recycling. Foreign asset accumulation only serves to finance global imbalances, while increased trade could serve to correct global imbalances. How much of petrodollars are recycled in increased demand for

³ Only in the year 2005 Russia spent the equivalent of 3.33 billion U.S. dollar on early debt repayment to the IMF and the equivalent of 15.1 billion U.S. dollar for first debt repayments to the Paris Club countries..

foreign products? In the following, I briefly discuss the literature on import demand equations in general and on import behaviour of oil exporting countries in particular. In a next step I set up an empirical model of the import demand of oil exporting countries. The analysis is based on a panel cointegration model including 24 oil exporting countries for the period from 1980 to 2005. The results are extensively tested for their robustness before drawing conclusions on the impact of oil exporters' import demand on global imbalances. Estimation results show that import demand of oil exporting countries depends positively on domestic demand and exports, the real exchange rate and the price of oil. Fiscal balances reduce the demand for imports. With higher oil prices and a real appreciation imports in these countries are significantly expanded. The impact on global imbalances is, however, limited. Due to the structure of trade the euro area rather than the United States benefits from the increased demand in the region.

3.1 The Literature

How do the real exchange rate and the oil price affect the import behaviour of oil exporting countries? Import demand is driven by real demand and the relative price of domestic versus foreign goods (and services). Every import demand equation therefore contains an activity variable and a relative price variable. Most of the early studies on import equations were performed for industrial countries.⁴ In a comparison of import demand estimations for seven industrial countries Thursby and Thursby (1984) found that only models including lagged dependent variables show a good performance. Using cointegration methods taking into account long-run relationships Clarida (1994) sets a benchmark model for import equations. The general findings of the empirical import demand literature is that the import demand elasticity with respect to the income or activity variable is higher than unity. This is contrary to predictions of the theory. In particular, an income elasticity of higher than unity would imply a gradually increasing share of imports in GDP. Ultimately this would mean that all income would be spent on imports. In an attempt to explain the puzzle of higher than unity income elasticities of imports, Barrell and Déés (2005) included a measure of foreign direct investment as an additional indicator of openness and globalization. This measure proves to have a significantly positive impact on import demand. In addition, it helps reduce income

⁴ For an overview of the early literature see Goldstein and Kahn (1985).

elasticities to 1.2 and brings them, thus, closer to unity.⁵ Their sample comprises the 22 countries with the highest share in merchandise imports in the world.⁶

In her analysis on 12 developing countries Reinhart (1995) finds results similar to Clarida (1994) concerning the long run elasticity of imports with respect to the income variable. When comparing the elasticity for industrial countries which is estimated at around 2 and the elasticity for developing countries estimated at 1.2 she comes to the conclusion that in the long-run this constellation would lead to deteriorating trade balances in industrial countries and would work for the benefit of developing countries. Her elasticities with respect to the relative prices of imports are in most cases significant and lower than Clarida's estimates and well below unity, which means that large swings in the real exchange rates are necessary to bring about changes in the trade pattern.

Many studies have followed this example and have estimated import equations for different countries. Senhadji (1998) presents a study on the import demand function of 77 countries.⁷ He finds that most of the coefficients have the expected sign and are significant. He uses as the activity variable GDP minus exports. The elasticity with respect to this measure of income is relatively small for the oil exporting countries. It is below unity for all exporting countries and even below 0.1 for the case of Norway.⁸ Maybe the elasticity is so low because for these countries the main source of income is export revenues.

With a longer time dimension Harb (2005) presents a study of 40 countries. He finds that for most countries, income and price variables have a significant effect on import demand and that the elasticities are higher in developing countries than in industrial countries.⁹ The only oil exporting countries included in his sample are Norway, Syria and Venezuela, however. And for these countries the estimation results for the impact of the relative prices on import demand are inconclusive.

For the impact of oil prices on imports one has to look at the literature on oil exporting countries. In 2006 the IMF (2006) conducted an analysis on the import behaviour of oil exporting countries. This study asks the question whether the observation that the simple

⁵ Although it is still significantly different from unity.

⁶ This sample does not include any of the oil exporting countries as none of these countries have such high import shares.

⁷ His sample includes some oil exporting countries; in particular, Algeria, Congo, Gabon, Nigeria, Norway, Sudan, and Trinidad and Tobago.

⁸ When comparing his two estimation methods, he comes to the conclusion that Fully Modified Ordinary Least Squares (FMOLS) outperforms simple ordinary least squares (OLS) estimations.

⁹ This finding is contrary to Reinhart's finding of lower income elasticities for developing countries.

marginal propensity to import out of oil revenues¹⁰ seems to have decreased since the 1970s mirrors the behaviour of oil exporting countries to spend oil revenues more cautiously. To test whether the simple propensity to import of around 24 percent for the OPEC countries, 15 percent for the Gulf Cooperation Council (GCC) countries and 31 percent for the non-OPEC oil exporting countries are similar to the past they estimate an error correction import function for several oil exporting countries. In an out of sample forecasting exercise it is found that the spending on imports in OPEC countries is only slightly lower than implied by past behaviour and that only the spending of the GCC countries seems to be significantly more conservative.

In a next step the IMF (2006) study also sets up a global, multiregion VAR model to estimate the impact of higher oil prices on the current account balances of several countries. As a reaction to a permanent 10 US dollar increase in oil prices the analysis finds a significant but short lived deterioration of the current account for oil importing countries and an increase in fuel exporters' current account by around 2 percent (of own GDP). It is stated that higher oil prices slow down growth and lead to real depreciations in oil importing countries while output growth is enhanced and oil price hikes lead to real appreciations in oil exporting countries. The impulse response functions of these reactions are, however, highly insignificant. The significant reaction of the current account might therefore only mirror price effects resulting from the oil price changes. It depends on volume effects and the Marshall-Lerner condition whether current accounts deteriorate in oil importing countries and whether the current account of oil exporting countries improves with increasing oil prices. In this case the reaction of the current accounts seems to be quite unambiguous because the demand for oil is in general very price inelastic and there are therefore almost no quantity adjustments to higher oil prices.

In the import demand literature no study focuses on the specific characteristics of oil exporting countries. In country by country studies, only very few oil exporting countries are included. In the literature on oil exporting countries many studies analyse the reactions of the current account to changes in the oil price or in the terms of trade. This way it is impossible to tell whether reactions of the current account are only driven by price effects due to higher export prices. I disentangle the price effects and the wealth effects by estimating the reaction of real imports to the exchange rate and to the price of oil. In particular, I estimated separate effects for the oil price and a measure of the real exchange rate which takes into account the

¹⁰ Defined as the change in the current account (change in imports net of non-oil exports, investment income, and transfers) over the change in oil revenues (oil exports).

fact that exports and imports of oil exporting countries are no substitutes. At the same time I control for the specific characteristics of the oil exporting countries by including a measure of the fiscal balance as oil exporting countries are forced to use fiscal policies to guard against the high volatility of their export revenues.

3.2 Empirical Findings

This section presents empirical evidence on the import demand of oil exporting countries for a panel of 24 oil exporting countries based on a panel cointegration model. The challenge of estimating import demand functions for oil exporting countries is twofold. First of all, data is not as readily available as for industrial countries. On a quarterly basis there is no data for a large cross section of oil exporting countries available. The next problem is to find a specification suitable for the specific characteristics of oil exporting countries. Oil exporting countries are likely to differ from industrial countries because their economies are in general not well diversified and highly dependent on the oil sector. At the same time, these countries know that their most important source of revenue is finite, so that they have to put aside revenues for future generations. In addition, most of the oil industry in oil exporting countries is state owned or at least partially state own. This gives the state a central role in influencing import demand in oil exporting countries. In particular, the government balance is likely to play a role in determining import demand. The following estimation tries to make the best of the data available by using panel estimation methods. Also, the estimations control for the role of government by including a measure of government balances.

3.2.1 The Data

The estimations are based on annual data for a balanced panel of 24 oil exporting countries for the period from 1980 to 2005. The sample of countries consists of Algeria, Angola, Bahrain, Republic of Congo, Ecuador, Equatorial Guinea, Gabon, Islamic Republic of Iran, Kazakhstan, Kuwait, Libya, Nigeria, Norway, Oman, Qatar, Russia, Saudi Arabia, Sudan, Syrian Arab Republic, Trinidad and Tobago, Turkmenistan, United Arab Emirates, Venezuela and Yemen. The sample includes all countries listed as “Fuel Exporters” in the September 2006 edition of the IMF World Economic Outlook with the addition of Norway and Kazakhstan and without Azerbaijan. The definition is based on the criteria that the main

source of exports consists of fuel, i.e. over the past five years the average share of fuel exports in total exports exceeds 40 percent and that the average value of exports exceeds 500 million U.S. dollar. Kazakhstan is included even though it is not possible to verify whether it meets these criteria. Azerbaijan which would also qualify is excluded from the sample because of the unavailability of data on fiscal balances. Note that this panel does not include all members of the Organization of Petroleum Exporting Countries (OPEC). For Iraq¹¹ the data quality is not sufficiently high and Indonesia's oil trade balance turned negative in 2004. Other large oil exporters such as Canada, Mexico, and the United Kingdom are not part of the sample because oil is not their main source of export revenues.

Table A3.1 in the appendix gives an overview of source and the availability of data. The variable to be explained is real imports. Other studies such as the IMF (2006) have analysed the behaviour of the current account of oil exporting countries. Because the price of oil and the exchange rate create price effects in the current account from which I want to abstract my main focus will be on the reaction of real imports. For this purpose real imports (in 2000 constant prices) are taken from the IMF World Economic Outlook database. National Accounts data is taken as opposed to Balance of Payments data due to better comparability with the explanatory variables.¹²

The first explanatory variable is a variable capturing real demand. It includes real domestic demand (including private consumption, investment, government consumption and investment, and changes in inventories) and real exports. Therefore a variable including domestic demand and exports is created. Goldstein and Kahn (1985) label the use of domestic demand as explanatory variable for imports the real expenditure approach. More recently and in the theoretical literature the approach is referred to as the absorption approach.¹³ In addition to domestic demand real exports are included. Especially for oil exporting countries, the inclusion of exports as explanatory variable can be justified because their oil export revenues make up a big part of their income. While the price effect of export revenues will be estimated separately with the inclusion of the oil price, the volume of exports could also play a role. The data for the domestic demand and exports is taken from the national accounts and it is

¹¹ Iraq would also qualify as fuel exporter according to the above definition.

¹² It should be noted that imports from the balance of payments statistics are the basis for the statistics on imports in the national accounts. These concepts can differ because they take different concepts as basis. National accounts data is based on the time it arises (accrual principle) and the Balance of Payments statistics are based on the transactions when payment is effected. In general, the two concepts differ only marginally.

¹³ Theoretical models using this approach are among others Backus, Kehoe, Kydland (1994); Chari, Kehoe and McGrattan (2002)

therefore appropriate to estimate real imports taken from the national accounts. As can be seen in Table A3.1 in the appendix for some countries national accounts data for components of GDP is not available over the whole period. For these countries real imports are approximated by the volume of imports taken from the BoP.¹⁴ For Sudan and Kazakhstan no real data on components of GDP is available. For these countries the nominal national accounts data for imports is deflated with import prices from the balance of payments.¹⁵

An alternative approach is to use gross domestic product (GDP) as the activity variable in the estimation of import demand. This approach is labelled income approach by Goldstein and Kahn (1985). This variable is often more readily available and it measures the total income of an economy. Some authors, e.g. Senhadji (1998), also use GDP excluding exports as an activity variable. For this large variety in the possibilities to specify the activity variable for import demand there seems to be no theoretical guidance on what variable is most appropriate to use as activity variable. The focus of this study will be on domestic demand and exports. Because of the different possibilities in specifying this variable, estimations with all of the concepts are performed and it is shown that the use of a different activity measure does not change the results. The activity variable is expected to have a positive impact on real import demand. With higher domestic demand the demand for imports will also rise. With higher real exports the oil exporting countries have more revenues to spend on foreign products.

The second explanatory variable is a measure of the real exchange rate. This study builds on the real effective exchange rate as a measure of the real exchange rate. This exchange rate which takes into account the relative trading shares is not available for all the countries in the sample.¹⁶ Therefore, I calculated an approximation of the real effective exchange rate. This approximation is based on the bilateral nominal exchange rates of each country with the United States and the Euro Area deflated with the relative consumer price indices weighted with the relative import shares from these regions. In this specification all fluctuation in the real exchange rate is assumed to come from fluctuations in the real exchange rates with respect to the United States and the Euro Area. This approximation captures on average around half of the countries' import flows. It should be a very good approximation of the real effective exchange rate because many countries have a fixed exchange rate vis-à-vis the U.S.

¹⁴ For Turkmenistan only the value of non-oil imports is available.

¹⁵ Where the base year of the price index between BoP and national accounts GDP differs the data is transformed to have the same base year.

¹⁶ The real effective exchange rate from the IMF WEO data source is only available for the following countries: Algeria, Bahrain, Republic of Congo, Ecuador, Equatorial Guinea, Gabon, Iran, Nigeria, Norway, Russia, Saudi Arabia, Trinidad and Tobago and Venezuela. See Table A3.1 of data availability in appendix.

dollar (e.g. Asia) and the euro (e.g. Eastern Europe). Also, a comparison of this approximation and the real effective exchange rate of the IMF for those countries where data is available proved that the approximation performs well.¹⁷ The share of imports is chosen as this is believed to be the relevant trade share as compared to the share of overall trade as the focus of the analysis is on imports. Another consideration is that the exports of oil exporting countries are almost exclusively invoiced in U.S. dollar so that nominal exchange rate fluctuations vis-à-vis the United States do not play a role for the demand of exports (besides the fact that the demand for oil is very price inelastic in any case).¹⁸ Thus, exports of oil exporting countries are likely not to depend on the real exchange rate. This should not be the case for imports. Even though there is almost no data available, it is likely that imports to oil exporting countries are invoiced in the currency of the producer (trading partner of oil exporters' imports). The case of Algeria where data on the structure of currency invoicing in trade is available supports this claim.¹⁹ Thus, fluctuations in the real effective exchange rate of imports should lead to a direct expenditure switching effect; in the case of an appreciation away from domestic products towards foreign products. As reported below in the section on robustness, I also experimented with including an approximation of the real effective exchange rate where the assumption is that the real exchange rate with all trading partners outside the US and the Euro Area stays constant and therefore the fluctuations of the real effective exchange rate are less pronounced.²⁰ The results indicate that using different real exchange rate approximations yields very similar results.

One problem when estimating an import demand function for oil exporting countries is how to take into account the special role of oil on import demand. It is therefore interesting to see whether standard measures of the real exchange rate can perform equally well when put into the context of oil exporting countries. Many studies including the IMF (2006) study on import behaviour of oil exporting countries use the terms of trade as a measure of the real exchange rate. However, for our purpose it is crucial to distinguish between relative price effects and wealth effects. Price effects are exchange rate effects that make the import good cheaper (or more expensive) relative to the domestic good. In this sense, movements of the exchange rate lead to expenditure switching effects towards the relatively cheaper good. Using the terms of

¹⁷ The correlation between the approximation and the IMF real effective exchange rate is 92 percent on average.

¹⁸ Iran has proposed to introduce an Iranian Oil Bourse where contracts are invoiced in euro rather than U.S. dollar. So far, the project has been postponed several times, however.

¹⁹ For exports almost all trade is invoiced in U.S. dollar (as very high share of oil). For imports around 50 are invoiced in euro which is not much lower than the relative import share with the euro area.

²⁰ In the comparison with the real effective exchange rate available from the IMF this exchange rate approximation showed less correlation than the base approximation described above.

trade as a real exchange rate measure, the relative price is based on import and export prices, i.e. imports and exports are assumed to be substitutes. While the terms of trade are in general quite a good approximation of this price effect it does not make sense to set import prices relative to export prices for oil exporting countries as imports and exports are no substitutes. Thus, the terms of trade would not be a good measure of the relative price effect but rather show the wealth effect of the very volatile price of their main export good oil.²¹

The third explanatory variable is the price of oil in U.S. dollar. Data is taken from the IMF WEO series. This oil price is an average of three sorts of oil, namely Brent, West Texas Intermediate, and the Dubai Fateh. The basic specification with the nominal U.S. dollar oil price is chosen because it is the main point of reference when talking about oil price fluctuations. As discussed below in the section on robustness, I also performed estimations with two different concepts of real oil prices. The first one is the real U.S. dollar price of oil, where the nominal price of oil is deflated with the U.S. CPI. The second concept is a real oil price for which the nominal oil price is converted to local currency using the nominal exchange rate towards the U.S. dollar and then deflated with each country's CPI. The oil price is expected to have a positive impact on real imports. For oil exporting countries higher oil prices translate into higher export revenues so that more resources can be spent on imports. In addition, all existing oil resources can be evaluated at higher prices. The resulting higher wealth should also stimulate import demand.

The fourth explanatory variable is the share of government balances in nominal GDP. Where available the general government balance is used, otherwise the central government balance is used.²² As this variable is reported as share of GDP and not in logarithmic terms like all other variables the coefficient of this variable cannot directly be interpreted as elasticity. This variable is expected to have a negative effect on import demand. As suggested above, oil revenues can be used either for import demand, for demand of financial assets or for the reduction of debt. The latter would mean that the countries run a fiscal surplus.²³

²¹ This is not to say that in the long run oil prices could not have an impact on the real exchange rate. For the link between oil prices and the real exchange rate see the discussion and analysis in the section on Russia's oil dependency. On the link between terms of trade and the real exchange rate see for example Cashin, Cespedes and Sahay (2004). They find that for a third of the 58 commodity exporting countries they analyse the commodity price has a significant long run effect on the real exchange rate. However, only Ecuador, Norway, Sudan and the Syrian Arab Republic from our sample are considered.

²² This is the case for Algeria, Congo and Gabon, Bahrain and Saudi Arabia. For Nigeria, Trinidad and Tobago and Venezuela some periods in the early 80s are approximated with the central government balances.

²³ The variable could therefore be endogenous and linked to the oil price. Possible problems with multicollinearity might arise in the estimation. The coefficients should therefore be interpreted with caution. There are two reasons why the specification is still chosen in this way. First of all, the correlation between the

Indeed many countries such as Norway and Russia even have an own stabilisation fund to channel excess liquidity from increasing oil revenues in this fund. Therefore, if funds are spent on increasing the fiscal surplus, fewer resources are used to demand imports.

3.2.2 Estimation Methodology

In the following analysis I will show that it is appropriate to conduct a panel cointegration analysis for our model. First, panel unit root tests are conducted to test for the stationarity of the variables. In a second step, panel cointegration tests are performed. The test results suggest that there are long run cointegration relationships between the variables of the model. The main focus of this study will, thus, be on the long run determinants of oil exporters' import demand.

Panel Unit Root Tests

This section analyses the property of the variables over time. First of all, the question whether the variables in the panel are stationary or exhibit a high degree of time persistence will be explored. When finding nonstationary variables in the panel it is analysed whether there are variables with a similar stochastic trend so that a long run cointegration relationship can be established. To this end some of the standard panel unit root and cointegration tests are discussed and results presented.

The first question when discussing unit root and cointegration tests for this panel is whether the assumption of asymptotic behaviour will hold at all due to the relatively short time and cross section dimension of the panel. Hlouskova and Wagner (2006) discuss the performance of several panel unit root and stationarity tests.²⁴ In their discussion on the different unit root tests Hlouskova and Wagner (2006) distinguish between two groups of tests, namely those which assume homogenous behaviour, i.e. the first order serial correlation coefficient is required to be identical in all units and those based on the heterogeneous alternative where tests are based on individual time series unit root tests which are combined in an appropriate way to form group-mean computations. For the assumption of homogeneity, the Levin, Lin

fiscal variable and the oil price is only around 45 percent. Second, both variables prove to be significant which would not be the case if multicollinearity was a serious problem.

²⁴ Their main finding is that the stationarity tests proposed by Hadri (2000) and Hadri and Larsson (2005) do not exhibit a good performance. According to their analysis, the null hypothesis of stationarity is almost always (wrongly) rejected. Own estimation results for this panel not reported confirm this behaviour. The Hadri test would also reject stationarity for all variables in differences, thus, suggesting that the variables are integrated of order two.

and Chu (2002) and the Breitung (2000) test show the best performances. Problems arise for short samples when the time dimension is not sufficiently large. They come to the conclusion, however, that the estimation results exhibit satisfactory behaviour when T is larger than 25 and at the same time larger than the cross section dimension. As this is the case for the present panel, results of the unit root tests should be reliable and give a good impression of the characteristics of the variables. The tests for heterogeneous unit root tests based on group-mean estimates perform equally well. For our purpose the Im, Pesaran and Shin (2003) test can be used as our panel is balanced.

Table 3.2: Panel Unit Root Tests

	Im, Pesaran, and Shin		Levin-Lin-Chu		Breitung		Fisher PP	
	t-stat	p-value	t-stat	p-value	t-stat	p-value	t-stat	p-value
Variables in levels								
imports	0.2	0.58	1.9	0.97	2.8	1.00	34.5	0.93
exdd	1.1	0.87	1.5	0.94	2.1	0.98	25.6	0.99
reer	-0.8	0.20	1.9	0.97	1.1	0.85	44.5	0.62
oil	9.1	1.00	2.4	0.99	12.7	1.00	0.5	1.00
fiscal	-1.1	0.14	0.5	0.71	0.2	0.58	96.4	0.00
Variables in differences								
imports	-4.9	0.00	-0.7	0.24	-6.2	0.00	444.1	0.00
exdd	-3.7	0.00	-1.2	0.11	-4.7	0.00	260.2	0.00
reer	-5.5	0.00	-4.7	0.00	-6.3	0.00	215.9	0.00
oil	-9.4	0.00	-4.3	0.00	-17.1	0.00	949.3	0.00
fiscal	-9.6	0.00	-3.6	0.00	-10.6	0.00	972.8	0.00

Source: Author's estimations.

Table 3.2 reports the results of the unit root tests. All tests cannot reject the null hypothesis of a unit root for the variables in levels, while they do reject the null of a unit root for the variables in differences.²⁵ Our variables should, thus, all be integrated of order 1.

Panel Cointegration Tests

To find out whether these I (1) variables possess a common stochastic trend the tests suggested by Pedroni (1999) are performed. These are cointegration tests for which information is pooled in such a way that the short run dynamics and the fixed effects are allowed to be heterogeneous over countries while common long-run relationships are assumed in the panel. The null hypothesis is that for each member of the panel the variables of interest are not cointegrated. As can be seen from Table 3.3 five out of seven cointegration tests can reject the null hypothesis of no cointegration at the 1 percent significance level while the panel v and panel ρ statistic fail to reject it.

²⁵ Only the Levin-Lin-Chu test cannot reject the null of unit roots for the differences of imports and of domestic demand and exports.

Table 3.3: Pedroni cointegration tests

	t-statistic
Panel v-stat	0.75934
Panel rho-stat	0.7178
Panel pp-stat	-2.61762***
Panel adf-stat	-3.14538***
Group rho-stat	2.38183***
Group pp-stat	-2.54379***
Group adf-stat	-3.79910***

The tests are divided into two subgroups. The panel statistics are based on tests where the residuals of the regression are pooled along the within dimension of the panel. The second type group statistics is based on pooling along the between dimension and are thus simply the group mean statistics of the individual time-series statistics. Pedroni (2004) finds that for small time and cross section dimensions, the panel ADF and the group ADF tests perform best.²⁶ There is therefore sufficiently strong evidence for cointegration in the panel.

Panel Cointegration Models

After showing that the variables in the panel exhibit unit roots and that there are long run relationships between the variables we can proceed in estimating a panel long run relationship. Given the data restrictions the choice of the methodology crucially depends on the assumption of slope homogeneity of the coefficients. Estimating the panel with fixed effects assumes slope homogeneity and puts a restriction not only on the long run coefficient but also the short run dynamics and the adjustment processes are restricted to be the same across countries. For a panel of oil exporting countries this assumption seems to be too strong as the panel includes economies as different as Norway, Oman and Venezuela. The alternative would be to run separate regressions for each country. The shortcoming of this estimation methodology is that it requires sufficient data on the time dimension. For most of the countries included in this panel it is, however, impossible to increase the time frequency from annual data to quarterly data and no data prior to 1980 exists. The time dimension is, thus, not long enough to perform country by country estimations. An alternative suggested by Pesaran et al. (1999) is the estimation of the Pooled Mean Group Estimator (PMGE). This maximum likelihood estimator allows the short run dynamics and the speed of adjustment to differ

²⁶ The power of the unit root tests sharply increases with a larger T dimension. For samples of this size the empirical power of the test is just below 50 percent.

across countries and only restricts the long-run coefficients to be the same across countries. It seems reasonable to assume that oil exporting countries have the same economic behaviour concerning their import behaviour in the long run and to leave the short run dynamics and the adjustment process to equilibrium unrestricted. An alternative, simpler estimation method also proposed by Pesaran et al. is the Mean Group Estimator (MGE) where the estimates are not pooled but only averages of the country by country estimations are calculated. While this estimator is always consistent it does not take advantage of the possible poolability of the data and is therefore inefficient. The PMGE is efficient when compared to the MGE. To test whether the PMGE is also consistent a Hausman (1987) test comparing MGE and PMGE and testing for slope homogeneity has to be performed.

An alternative for the PMG estimation is the estimation with fully-modified ordinary least squares (FMOLS) as proposed by Pedroni (2004). This estimator provides superconsistent estimates for the long-run parameters. In general it is found that the FMOLS needs less restrictive assumptions and performs well even for small panels. Pedroni (2004) shows that the group mean FMOLS estimation method performs well even for small T and small N. For our panel which has a time dimension (T) of 26 years and a cross section dimension (N) of 24 countries the above mentioned estimation methods should be appropriate. Indeed, both Pedroni (2004) and Pesaran et al. (1999) use panels with similar dimensions for their estimations.²⁷

3.2.3 Estimation Results

The long-run import function for oil exporting countries is assumed to be given by:

$$im_{it} = \theta_{0i} + \theta_{1i} exdd_{it} + \theta_{2i} reer_{it} + \theta_{3i} oil_{it} + \theta_{4i} fisc_{it} + u_{it} \quad (3.1)$$

$$i = 1, 2, \dots, 24 \text{ and } t = 1, 2, \dots, 26,$$

where *im* is the logarithm of real imports, *exdd* is the logarithm of the sum of real domestic demand and real exports, *reer* is the logarithm of the real effective exchange rate, *oil* is the logarithm of the US dollar price of oil and *fisc* is the government balance in percent of nominal GDP as described in the data section. As discussed above we would expect θ_{1i} and θ_{2i} to be close to unity from a theoretical point of view while previous empirical studies point to

²⁷ Pesaran, Shin and Smith (1999) use a panel with N=24 and T=32 and Pedroni simulates panel results with at the lowest N=10 and T=10. For the PMGE it is also important that the condition holds that the time dimension is larger than the cross section dimension. This is the case for this panel.

θ_{1i} higher than 1 and θ_{2i} lower than 1. The coefficient for oil θ_{3it} is expected to be positive and the coefficient of government balances θ_{4it} is expected to have a negative sign. From the previous tests on unit roots we conclude that our variables are I(1) and cointegrated.

The import equation can be written as an autoregressive distributed lag (ARDL) equation in general terms (with one lag short run dynamics as an example):

$$\begin{aligned} im_{it} = & \mu_i + \delta_{10i} exdd_{it} + \delta_{11i} exdd_{i,t-1} + \delta_{20i} reer_{it} + \delta_{21i} reer_{i,t-1} + \delta_{30i} oil_{it} + \\ & \delta_{31i} oil_{i,t-1} + \delta_{40i} fisc_{it} + \delta_{41i} fisc_{i,t-1} + \lambda_i im_{i,t-1} + \varepsilon_{it} \end{aligned} \quad (2)$$

The error correction form of the autoregressive distributed lag (ARDL) equation is given as

$$\begin{aligned} \Delta im_{it} = & \Phi_i (im_{i,t-1} - \theta_{0i} - \theta_{1i} exdd_{it} - \theta_{2i} reer_{it} - \theta_{3i} oil_{it} - \theta_{4i} fisc_{it}) - \\ & \delta_{11i} \Delta exdd_{it} + \delta_{21i} \Delta reer_{it} - \delta_{31i} \Delta oil_{it} - \delta_{41i} \Delta fisc_{it} - \varepsilon_{it} \end{aligned} \quad (3)$$

where $\theta_{0i} = \mu_i / (1 - \lambda_i)$, $\theta_{1i} = (\delta_{10i} + \delta_{11i}) / (1 - \lambda_i)$, $\theta_{2i} = (\delta_{20i} + \delta_{21i}) / (1 - \lambda_i)$, $\theta_{3i} = (\delta_{30i} + \delta_{31i}) / (1 - \lambda_i)$, $\theta_{4i} = (\delta_{40i} + \delta_{41i}) / (1 - \lambda_i)$ and $\Phi_i = - (1 - \lambda_i)$.

The lag structure is determined by the Akaike selection criterion. The maximum lag length is chosen to be two and then the optimum lag length for each variable for each country is chosen individually by the Akaike criterion. Table 3.4 shows the estimation results.

Table 3.4: Estimation of Import Demand in Oil Exporting Countries

Regression	FMOLS	PMGE
EXDD	1.28*** (56.41)	1.65*** (28.68)
REER	0.18*** (10.8)	0.18*** (7.98)
OIL	0.09*** (5.94)	0.25*** (6.76)
FISC	-0.00*** (-3.30)	-0.01*** (-7.22)
Phi		-0.21*** (-4.33)
Hausman-test		3.28 (0.51)
Number of observations	624	624
Absolute value of t statistics in parentheses (p-value for Hausman test)		
* significant at 10%; ** significant at 5%; *** significant at 1%		

All coefficients are significant at the 1 percent significance level and have the predicted sign. At the same time, the Hausman test cannot reject the null hypothesis that the PMG estimator is significantly different from the consistent MG estimator. The main focus of our

analysis will, thus, be on the PMGE estimation results. In addition, FMOLS results are reported as robustness because they are superconsistent and therefore a good robustness check. As can be seen in Table 3.4, the coefficient for the variable *exdd* which includes real domestic demand and real exports is 1.28 for the FMOLS and 1.65 for the PMGE. This coefficient is comparable with findings for the real activity coefficient in many other studies for industrial countries. The coefficient for real demand including real exports is higher than the coefficient only including domestic demand (1.2).²⁸ However, for oil exporting countries, the volume of exports needs to be included as an explanatory variable as much of their purchasing power comes from export revenues.²⁹ It is reassuring to see that this real activity variable has a highly significant and positive effect on real import demand.

The main focus of this study is, however, on the price effects both of the real exchange rate and of the oil price. As can be seen in Table 3.4, the real effective exchange rate (*reer*) has a significantly positive impact on imports. A 10 percent appreciation of the real exchange rate for imports leads to a 1.8 percent increase in imports in the long run. This elasticity is rather on the lower side. Theory predicts an elasticity of unity in the long run. One reason for this low elasticity might be the relatively low substitutability of imports and domestically-produced goods. Especially for oil exporting countries, a large share of imports are luxury goods produced only abroad, e.g. luxury cars. Some import goods seem to be substitutes of domestically-produced goods, however, because in the extreme case of no substitutability no expenditure switching would take place and the coefficient of the real exchange rate measure would be zero. Table A3.2 in the appendix summarizes the growth rates of the main variables in oil exporting countries. It can be seen that real exchange rate fluctuations have been rather small in the past. Only for the CIS countries sizeable fluctuations can be observed. The main reason for this phenomenon is that most of the oil exporting countries do not only have a fixed exchange rate regime so that nominal exchange rate fluctuations are kept small, but they also do not allow local prices to adjust freely. The latter restrictions most likely prevent more pronounced real appreciations that the Balassa-Samuelson effect would predict.³⁰

The coefficient for oil has a significantly positive impact on import demand. Through higher export revenues import demand is stimulated. In addition there can be a significant

²⁸ This specification was estimated as an additional robustness check.

²⁹ It is, however, important to distinguish between quantity and price effects of export revenues. The volume of exports only reflects the quantity of oil exports. This is likely to be relatively stable comparable to domestic demand. In contrast to prices which are likely to be highly volatile and which are the source of fluctuations in export revenues in the short and medium run.

³⁰ The Balassa Samuelson effect states that countries in a catching up process (like countries in transition) exhibit higher inflation rates than industrial countries.

wealth effect through the higher value of existing oil reserves if the oil price change is perceived as permanent. The overall wealth effect is quite large even though the coefficient looks rather small with 0.25. In the long run a 10 percent increase in the oil price leads to 2.5 percent more imports. In the past years the oil price more than doubled. Only from 2004 to 2005 the oil price increased by more than 40 percent. This shows the dimension of the impact the oil price can have on imports.

The size of the effect of the fiscal variable on imports in the long run cannot directly be read from the coefficient as this is not reported in logarithms but as share of nominal GDP. The qualitative estimation results show, however, that the fiscal balance has a significant negative effect on import demand. This shows that some of the revenue increases due to higher oil prices are kept as a reserve for times of lower oil prices so that fiscal policy can be countercyclical to movements in the oil price. Many countries such as Russia or Norway have oil stabilization funds. These funds can indeed have a negative effect on import demand as our results show. To claim that oil exporting countries should not keep their petrodollars in funds but to use them to minimize global imbalances is, however, unjustified. This study shows that the oil price does have a significant positive effect on import demand. The nature of the oil price which is highly volatile as well as the nature of petroleum as an export product which is scarce, make it necessary for oil exporting countries to build up some reserves for times of low oil prices and for future generations.

The main focus of the analysis is on the estimation results of the PMGE estimations. For this long run cointegration estimation the adjustment coefficient Φ is crucial because it describes the speed of adjustment with which the system reacts to shocks to come back to the steady state relationship between the variables. This coefficient is significant and negative as it should be for the overall panel. It is estimated for each country individually. For the majority of countries this adjustment coefficient is significantly negative.³¹ It is not surprising that there are some insignificant adjustment coefficients given the small sample size. The size of the average coefficient of adjustment can be interpreted in such a way that the estimated speed of convergence is about 20 percent per year and that the system is close to equilibrium in around five years. Most of the countries have an adjustment coefficient close to 0.2. The highest speed of adjustment to equilibrium can be found for Russia. The coefficient of 0.78 is

³¹ For Saudi Arabia the optimum lag length criterion selects a lag length of 0 so that a static model is estimated. In 19 countries the coefficient is negative, only in 4 countries is the coefficient positive (and not significant). In 10 countries the coefficient is highly significant. 8 countries show t-statistics between 1 and 2.

similar to the error correction coefficient in the country analysis of Russia (0.65).³² Russian imports seem to adjust quickly to shocks. The contrary is true for imports of Iran and Oman. Here, adjustment takes around 10 years. Reasons for these different speeds in adjustment could be found in the respective trade openness of the countries.

Table A3.4 shows some tests on the functional form of the group specific estimates. It is important to see how well specified the model is on a country-by-country basis before the more efficient PMGE procedure should be implemented. The results presented are reassuring. Only three countries exhibit signs of serial correlation, three countries show signs of functional form misspecification, in one country signs of non-normality and in one country signs of heteroscedasticity of the residuals can be found. On average almost 90 percent of the change in the logarithm of imports is explained. Some long run elasticities estimated on this country-by-country basis are found to be insignificant. When judging these diagnostic results it should, however, always be kept in mind that the estimation over such a short horizon is likely to render some estimates insignificant or unstable. This is precisely, why the analysis is not based on a country-by-country study but on the PMG estimation. In addition, when comparing these results with an analysis of OECD countries it should be noted that it is not unsurprising that the data quality and diversity of oil exporting countries does not allow for even more robust results. On the contrary, as the next section will show, the estimation results are surprisingly robust over different specifications.

3.2.4 Robustness of the Estimation Results

The panel of oil exporting countries is extremely diverse; therefore it is important to check the estimation results for robustness. The first check of robustness was the estimation of FMOLS parallel to the estimation of PMGE. As a next step I check whether the stepwise exclusion of a country (group) has a significant effect on the size and significance of the coefficient. Figure A3.1 in the appendix shows the coefficients of *exdd*, *reer* and the price of oil respectively. On the x axis the country groups which are excluded are listed.

The coefficient for domestic demand and exports is very robust. It is almost the same for all the specifications. Only for the specification without the Middle East the coefficient is a little bit lower. This has to be read in such a way that the coefficient for the countries of the Middle

³² See chapter 4 for details. Even though this coefficient is estimated for quarterly data, the slightly lower coefficient for the quarterly estimation leads to a similar adjustment process within one year.

East is higher than for the overall panel.³³ The intuition behind this result is straightforward. These economies are highly dependent on oil and often hardly have any domestic industry outside the oil production process. With increased domestic demand most of the demand is therefore channelled to foreign products because the domestic industry is slow to adjust to the additional demand.

The coefficient of the real exchange rate seems to be less robust when compared to the coefficient of *exdd*. It should be kept in mind, however, that the reaction to the real exchange rate is more likely to differ across countries already because of the different exchange rate regimes which have been in place over the sample period. Yet, it is reassuring to note that even with reduced degrees of freedom due to the smaller sample when excluding country regions the coefficient is highly significant for all specifications. It also hardly fluctuates with all the country regions. Only when excluding the countries of the CIS the coefficient increases somewhat. It is important to keep in mind that for the countries of the CIS the data quality before 1995 is very poor. Especially the approximation of the real exchange rate is extremely poor for the beginning of the sample period.³⁴ The reason to include the countries of the CIS nevertheless is not only that Russia is one of the major economies in the sample, but also that the CIS countries are almost the only countries with a relatively flexible exchange rate regime.³⁵ Fluctuations of the real exchange rate in the other economies have been more subdued in the past due to nominal exchange rate restrictions. Especially when discussing a possible step to let the currencies of the oil exporting countries float freely it is crucial to compare the effect this could have on their import demand to the countries that have had flexible exchange rate regimes already over the current sample period.

The coefficient for the panel without the CIS countries is higher, i.e. the coefficient for the CIS countries would be lower if it could be estimated individually.³⁶ The CIS countries have such a large effect on the size of the coefficient because their real exchange rates are the main ones to fluctuate. The discussion on the real exchange rate coefficient can show two things. First, there is an even higher potential for the impact of the real exchange rate on oil exporting countries for all the countries that are currently in a fixed peg. Second, this effect should not

³³ It would not be efficient to estimate the panel for each country group individually because of the limited time dimension and degrees of freedom of the panel.

³⁴ It can be argued indeed that there should be no approximation of the real exchange rate for these countries during this time period as they were extremely closed economies and capital was not allowed to fluctuate freely.

³⁵ For a list of exchange rate regimes in oil exporting countries see Table A3.3 of the appendix.

³⁶ When comparing the coefficient for the overall panel with the coefficient for the long run elasticity of the real exchange rate for Russia in the section on Russia's dependence on oil, it can be seen that the two do not differ considerably. This is an additional proof of robustness.

be overestimated, however, as the experience of the CIS countries shows that the effect might become smaller when exchange rate fluctuations become larger. The next section will show that neither interpretation of the coefficient leads to fundamentally different interpretations of the impact of the real exchange rate of oil exporting countries for global imbalances in the long run.

The coefficient of the oil price is robust over countries. The relatively higher impact of the oil price in the Middle East can be explained by the big share of oil exports in overall GDP. These countries are therefore especially dependent on their oil revenues and more likely to show more pronounced reactions to the oil price. Also, as argued above, the domestic industry mostly cannot absorb additional demand created by the increased wealth due to higher oil prices so that the additional demand is channelled to foreign products. The contrary is true for a country like Russia which is such a big economy that even though it is highly dependent on the price of oil, it still has a sizeable industry outside the oil sector which can also absorb additional demand created by higher oil revenues.

The next robustness check is to see whether the estimation results are robust to changes in the lag length. The lag length is chosen with the optimum lag selection criterion of the Augmented Dickey Fuller test. The results do not change when instead of the ADF test, the Schwartz or the Hannan Quinn lag selection criterion is chosen. The maximum lag length is chosen to be two for the standard specification. Figure A3.2 of the appendix shows that the estimation results are robust to different maximum lag lengths. A maximum lag length higher than 3 is not chosen because of the reduced degrees of freedom and also because a higher lag length seems rather implausible economically as the data is on an annual basis.

As another robustness test different versions of the explanatory variables are included. Different concepts of the activity variable as explained above, as well as different concepts of the real exchange rate are included and estimations were also performed with a real oil price. For an overview of the results of the different estimation specifications see Table 3.5. Estimations for both the real oil price deflated with the U.S. CPI and the real oil price converted to local currency using the nominal exchange rate and deflated with each country's CPI are shown. The reason to include the nominal oil price in the main specification is simply a matter of better interpretability as stated above. Including the real oil price does not change the estimation results. The coefficient of the oil price is 0.18 for the U.S. real oil price and 0.20 for the country specific real oil price. The coefficient is, thus, only marginally smaller than in the estimation with nominal oil prices.

Table 3.5: Overview of different estimation specifications

Dependent variable: Imports Regression		basis	1a	1b	1c	2a	2b	3a	3b
Activity variable	Domestic Demand plus Exports	1.65*** (28.69)				1.41*** (26.18)	1.68*** (36.24)	1.60*** (34.48)	1.44*** (34.22)
	GDP		1.10*** (22.18)						
	Domestic Demand only exports			1.22*** (44.9)	0.72*** (26.91)				
Real exchange rate	reera (all US Euro Area)	0.18*** (7.98)	0.32*** (11.29)	0.22*** (10.83)	0.17*** (5.81)			0.16*** (6.82)	0.33*** (13.34)
	reer (incl. WEO)					0.30*** (11.33)			
	reera (no other fluct.)						0.23*** (7.76)		
Oil price	nominal	0.25*** (6.76)	0.24*** (6.16)	0.14*** (5.57)	0.38*** (8.67)	0.21*** (6.13)	0.21*** (6.84)		
	real US							0.18*** (7.68)	
	real country specific								0.20*** (9.32)
Government balance		-0.01*** (-7.22)	0.00 (1.61)	0.00*** (3.87)	-0.01** (-2.19)	-0.01*** (-4.45)	-0.01*** (-8.33)	-0.01*** (-5.59)	-0.01*** (-0.74)
Phi		-0.23*** (-4.33)	-0.42*** (-5.32)	-0.36*** (-4.62)	-0.44*** (-5.14)	-0.23*** (-4.55)	-0.28*** (-4.63)	-0.27*** (-5.27)	-0.25*** (-3.75)
Hausman-test		3.28 (0.51)	3.00 (0.56)	4.07 0.40	4.69 (0.32)	3.18 (0.53)	14.35 (0.01)	5.82 (0.21)	5.84 (0.21)

Absolute value of t statistics in parentheses (p-value for Hausman test)

* significant at 10%; ** significant at 5%; *** significant at 1%

Including different approximations of the real exchange rate does not change the results either. One concept includes the IMF WEO real effective exchange rate where available (*reer (incl. WEO)*) and only fills the non available data with the approximation of the real exchange rate for imports. The other specification is the approximation of the real exchange rate which assumes that all exchange rates other than the bilateral real exchange rates vis-à-vis the U.S. dollar and the euro stay constant (*reera (no other fluct)*). This way the real exchange rate fluctuates much less on average than with the assumption used for the standard estimation that all fluctuation comes from the real exchange rate vis-à-vis the U.S. dollar and the euro, i.e. that all other bilateral exchange rates fluctuate in the same way on average (*reera (all US Euro Area)*). From a theoretical point of view it is not clear which approximation is more appropriate. When comparing the two different concepts of approximation with the IMF WEO real effective exchange rate for those countries where data exists led me to choose the second concept over the first as it follows the data from the IMF more closely. However, even the estimation with other approximations of the real exchange rate led to almost identical results.

Another robustness test is to extend the dataset which is in full only available until 2005 with preliminary and forecasted data of the WEO database for the year 2006.³⁷ Estimations with this extended dataset also provide almost identical coefficients.³⁸ This exercise was performed to judge whether recent developments would change the estimation results. This is not the case. Another issue is whether the estimation suffers from an omitted variable bias. The overall power of the estimation equation and the good fit and good robustness of the model do not point to such a bias. It is not possible to include all variables that come to mind into the estimation because this would reduce the degrees of freedom in such a way that the estimation is no longer possible. One channel for petrodollar recycling should, however, not be left unmentioned. While the focus of this study is the recycling of petrodollars through trade other studies focus on the financial channel. It is very difficult to measure the financial flows and the foreign assets of oil exporting countries as many of these are acquired through financial centres in London or similar. One specification to check the robustness of our results was to include the net foreign asset position as an explanatory variable.³⁹ Net foreign assets have a significantly negative effect on imports. All resources taken for financial assets are not free

³⁷ IMF World Economic Outlook, September 2006.

³⁸ Detailed results are available on request.

³⁹ The data is taken from the dataset by Lane and Milesi-Ferretti (2006). The variable was included as share of nominal GDP. In this specification the fiscal balance could not be included at the same time due to reduced number of degrees of freedom.

for use to buy imports. This coefficient should, however, be interpreted with caution due to the data problems mentioned above. The main reason why this estimation was performed was to show that the results for the other coefficients do not change. This is the case as the coefficients are almost the same as with the specification without the financial variable.

3.3 Impact on Global Imbalances

The group of oil exporting countries considered in this panel makes up only 5.6 percent of world GDP.⁴⁰ Nevertheless, these countries are increasingly given a role as players in the global imbalances debate. In April 2006 at the G8 meeting in St. Petersburg it was argued that oil exporting countries should let their exchange rates float so as to appreciate and have increased demand for foreign products help reduce global imbalances.⁴¹ The idea behind this is that with increasing oil prices and increasing oil revenues in these countries some of the extra gain should be spent abroad especially as higher oil prices increase the current account deficit of oil importing countries already through the price effect.⁴² It is often argued that oil exporting countries have replaced other advanced countries excluding the United States as countries with the highest current account surplus. In the following exercise I want to show that even though both oil prices and the real exchange rate have a considerable effect on imports of oil exporting countries, the overall effect on global imbalances is bound to be almost negligible. To get an intuition on the exact amount of trade flows the next section performs a simulation exercise on the impact of a 10 US dollar increase in the oil price and a 10 percent appreciation of the real effective exchange rate.

A 10 dollar increase in the price of oil is often discussed as a benchmark scenario. From the approximate level of 50 US dollars in 2005, a 10 dollar increase is a 20 percent increase in the price of oil. According to our long run elasticity of 0.25 a 20 percent increase in the price of oil would lead to a 5 percent increase in real imports. A 10 percent appreciation of the real exchange rate given the long run elasticity of approximately 0.2 would result in a 2 percent increase in real imports. While this has a considerable impact for each oil exporting country,

⁴⁰ In nominal GDP numbers for the year 2005.

⁴¹ For example Krueger (2006): “The oil exporters’ large surpluses—and their increase in wealth—provide a rare opportunity to tackle some long-standing domestic problems, and at the same time—as an important by-product—make a major contribution to the reduction of global imbalances. [...] Oil-importers, too, need flexibility both in their exchange rate regimes and elsewhere in the economy if they are to minimize the impact of oil price rises on their economies.”

⁴² Nsouli, Saleh M., Director Offices in Europe, IMF (2006): “Indeed, oil exporters’ imports may come partly to offset the initial oil price-driven revenue inflow in their current account. If those imports come from oil-importing countries, they also help reduce the pressure on oil importers’ current accounts.”

to find out how this increase in real imports affects global imbalances a number of assumptions have to be set.

As discussed in the introduction the focus of this study is on real effects rather than on price effects. This is why the impact of the real exchange rate and the oil price on real imports has been analysed. In the worldwide discussion on global imbalances, the current account balances, in particular the current account deficit of the United States is the main focus of attention, however. Therefore I will transform the effect on real imports into changes in the current account balances of the trading partners. For this exercise a set of simplifying assumptions can transform real import changes into value changes in the trade balance. First of all, it is assumed that oil demand is completely inelastic.⁴³ Second, there are no changes in the nominal exchange rate.⁴⁴ That is, the real appreciation comes only through relative price differences or higher price increases in the oil exporting countries than in their trading partners. This assumption is not binding for the analysis of the US current account deficit as the US dollar value of exports of the US to oil exporting countries shows only volume effects and not value effects (as their exports are priced in US dollar). The same is true when the assumption holds that all exporters to the oil exporting countries invoice in producer currency, i.e. no nominal exchange rate movements influence the value of the exports going to the region of oil exporting countries. Another assumption is that export prices of the trading partners are not subject to inflation, i.e. real changes equal nominal changes. These assumptions might seem very restrictive but they are not at all crucial for the overall qualitative result of the analysis, rather they serve to make the analysis as simple and straightforward - leaving out all effects outside the direct transmission mechanism - as possible.

3.3.1 Simulation of a 10 U.S. dollar increase in the price of oil

First of all, the impact of a 10 US dollar increase in the oil price is analysed. A simple oil bill calculation is based on the assumption of an oil price increase from 50 US dollar to 60 US dollar (20 percent increase). Current account and trade balance data are taken from the World Economic Outlook of the IMF for the year 2005.

⁴³ This assumption is quite plausible as the demand for oil is very price inelastic.

⁴⁴ The assumptions should hold both for the oil price increase and the real exchange rate increase simulation.

Table 3.6 shows the implications of a 10 US dollar increase in the price of oil for the United States. First of all, it should be noted that the increase in the oil price has a direct (and considerable) negative impact on the U.S. current account balance through the higher oil bill.⁴⁵

Table 3.6: The impact of a 10 dollar rise in the oil price on the United States

	Hypothetical Oil Price (in \$ per barrel)	Oil Bill (in billion \$)	Exports to Oil Exporting Countries (in billion \$)	% point compensation in Current Account	Share of Bill Increase compensated for by export increase
Starting point	50.0	224.1	62.6		
Increase	60.0	268.9	65.8		
in dollar	10.0	44.8	3.1		
in percent	20	20	5.0	0.03	7.0

Source: IMF WEO, IMF DTS, BP (2006), own calculations.

Assuming that the geographic import structure of the oil exporting countries does not change, the 20 percent increase in the oil price translates into a 5 percent increase of oil exporting countries' imports from the U.S. or a 5 percent increase of U.S. exports to the oil exporting countries. Calculated as a percentage point change from the 2005 level of the current account deficit, this translates into a 0.03 percentage point compensation for the otherwise worsening current account balance. Or transformed into a the share of the bill increase due to the oil price increase that is compensated for by the higher exports to oil exporting countries, this is a 7 percent compensation. This calculation illustrates that higher oil prices cannot be compensated for by higher exports to the region benefiting from the oil price increase, at least not for the United States.

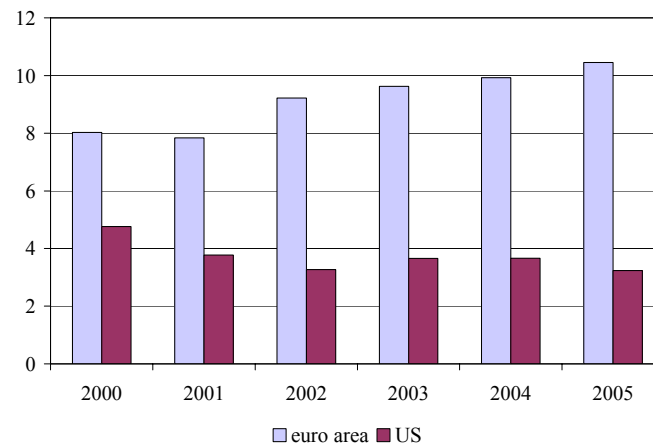
Figure 3.1 shows the geographical distribution of exports of the United States and the euro area.⁴⁶ The figure shows that not only is the share of euro area exports almost three times as high in 2005 as the share of U.S. exports to the region of oil exporting countries, but the euro area gradually increased their trade share with the region while the United States does not seem to participate in this increased demand from the region of oil exporting countries. This is the case even though the oil exporting countries depreciated on average in real terms by

⁴⁵ It is assumed that there is no quantity adjustment in the demand of oil. This assumption is quite plausible as the demand for oil is very price inelastic.

⁴⁶ For the euro area the share is the share of exports relative to extra euro area trade. All euro area data is for the composition of the European Monetary Union as of 2006, i.e. excluding Slovenia.

around 7 percent against the euro while they appreciated against the U.S. dollar by around 23 percent.⁴⁷

Figure 3.1: Share of exports to oil exporting countries



Source: IMF Direction of Trade Statistics (DTS). Author's Calculations.

How does the oil bill calculation of the euro area compare to that of the United States? When comparing the euro area oil bill to the oil bill of the United States it should first of all be noted that – although the United States is an oil producer – the oil bill of the U.S. is still slightly higher than for the euro area, i.e. the U.S. is likely to suffer more from increasing oil prices. It can also be seen that the euro area exports almost five times more in absolute terms to the region of oil exporting countries. With similar oil bill increases due to a 10 U.S. dollar increase of the oil price, the compensation of higher exports to the region is, thus, five times as high as for the United States. As can be seen from Table 3.7, for the euro area almost 40 percent of the oil bill increase is compensated for by higher exports to the region of oil exporting countries.

Table 3.7: The impact of a 10 dollar rise in the oil price on the euro area

	Hypothetical Oil Price (in \$ per barrel)	Oil Bill (in billion \$)	Exports to Oil Exporting Countries (in billion \$)	% point compensation in Current Account	Share of Bill Increase compensated for by export increase
Starting point	50.0	202.8	294.6		
Increase	60.0	243.4	309.3		
in dollar	10.0	40.6	14.7		
in percent	20	20	5.0	0.15	36.32

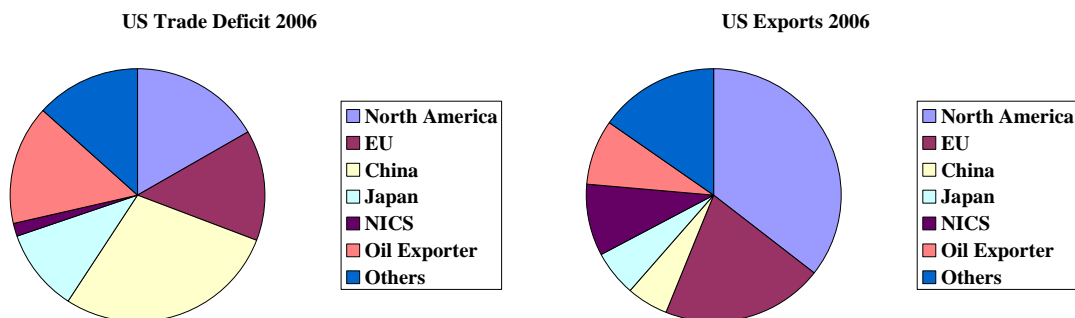
Source: IMF WEO, IMF DTS, BP (2006), own calculations.

⁴⁷ These numbers are calculated for the period from 2000 to 2005 from a weighted average of oil exporting countries. In nominal terms oil exporting countries depreciated by around 30 percent against the euro and by around 8 percent against the USD.

3.3.2 Simulation of a 10 percent real appreciation

A 10 percent real appreciation leads to a 2 percent increase in real imports in the long run. As discussed above, this effect could also be slightly higher when abstracting from the CIS countries or when using different estimation specifications. This exercise shows that the overall impact on global imbalances would be almost negligible. The improvement of the U.S. current account deficit would amount to 0.01 percentage points⁴⁸ while the improvement of the euro area current account would amount to 0.06 percentage points. Even if the elasticity was four times as large the improvement in the current account balances would still be minimal, especially for the United States.

Figure 3.2: Oil Exporters' Share in the U.S. Trade Deficit and U.S. Exports 2006



Note: Oil Exporter includes OPEC countries without Indonesia and in addition of Russia and Algeria. North America consists of Canada and Mexico; NICS are the Newly Industrialised Countries (Hong Kong, Korea, Singapore, and Taiwan). The data includes data up to November 2006.

Source: U.S. Bureau of Economic Analysis (2007), own calculations.

In Figure 3.2 it can be seen that the bilateral U.S. trade deficit with the oil exporting countries is approximately of the same size than the bilateral trade deficit with North America⁴⁹ and the EU. However, the share of exports going to the oil exporting countries is not very high when compared to other regions. Given that imports from the region consist almost exclusively of oil which is invoiced in U.S. dollar, the adjustment mechanism of the exchange rate and the expenditure switching mechanism can work only for exports going to oil exporting countries. The effect is, thus, bound to be very low.

Therefore, the role of the oil exporting countries in global imbalances seems to be rather limited so far. This is not to say that the impact of considerable real appreciations that could well be higher than 10 percent per year would not be felt in the world economy. But given the geographical trade structure of the United States and the euro area, considerable real

⁴⁸ Using a current account deficit of -6.35 of GDP as a starting point.

⁴⁹ In the definition of the Bureau of Economic Analysis, North America includes Canada and Mexico.

appreciations of oil exporting countries are more likely to benefit the euro area rather than the U.S leaving global imbalances unresolved.

3.4 Conclusion

The aim of this paper was to analyse the determinants of oil exporting countries' import behaviour and to put the results of the analysis into a global perspective. The estimation results show that real imports are driven by real domestic demand and real exports, by the real effective exchange rate, by the oil price and by fiscal balances in the long run. Higher domestic demands and higher real exports lead to additional demand for foreign products. The elasticity for oil exporting countries is higher than for industrialised countries as most of the oil exporting countries heavily rely on the oil industry in all production fields and can therefore not satisfy increased demand with domestic products. The fiscal balances have a negative effect on imports in the long run. This is the case because most of the oil exporting countries have oil stabilisation funds to safeguard against too high volatility in the oil price and to accumulate some funds for future generations which cannot profit from the oil revenues to such an extent as resources are limited.

Real appreciations also lead to an increase in imports in the long run. The elasticity of 0.2 seems to be on the lower side when compared to estimates for other countries. When excluding the countries of the CIS from the panel or using alternative approximations of the real exchange rate this elasticity could also be somewhat higher. Most of the oil exporting countries have fixed exchange rate arrangements so that the fluctuations of the real exchange rate have been subdued in the past years. However, even the considerable real appreciations that could be expected if all currencies in oil exporting countries were free to float and if prices were no longer regulated in these economies are not likely to trigger an improvement of global imbalances. Also, the impact of the increased import demand would on the contrary rather benefit the euro area and not the United States due to their respective geographical structure of trade.

An increase in the oil price is accompanied by increased demand for foreign products in oil exporting countries in the long run. This direct wealth effect through higher oil export revenues increases imports of oil exporting countries considerably following oil price increases. However, the negative effect the higher oil price has on the current account balances of oil importing countries like the United States and the euro area cannot be

compensated. For the United States only 7 percent of the higher oil bill is compensated by increased exports to oil exporting countries while almost 40 percent of the increase is compensated for the euro area.

Overall this study sheds some light on the import behaviour of oil exporting countries. Even though these countries are quite heterogeneous in their economies they still seem to exhibit some common behaviour in the long run adjustments to movements of the real exchange rate and the oil price. Their reaction to domestic demand and real export increases and to fluctuations in the exchange rate are even comparable to those of industrialised countries. The overall impact of oil exporting countries import demand on global imbalances is almost negligible, however. Even though their imports are likely to stay very dynamic in the medium term future, the size of their economies is just too small for them to play a leading role in the resolution of global imbalances. In addition, increases in demand for foreign products mainly benefit the euro area rather than the United States due to the geographical structure of trade. Future research could benefit from better data quality and longer time series.

3.5 References

- Backus, David K., Patrick J. Kehoe, and Finn E. Kydland (1994). Dynamics of the Trade Balance and the Terms of Trade: The J-Curve? *The American Economic Review*, Vol. 84 (1), pp. 84-103.
- Barrell, Ray and Dirk Willem te Velde (2002) European Integration and Manufactures Import Demand: An Empirical Investigation of ten European Countries. *German Economic Review* Vol. 3(3), pp 263-293.
- Barrell, Ray and Stephane Déés. (2005). World Trade and Global Integration in Production Processes: a Re-assessment of Import Demand Equations. ECB Working Paper No. 503.
- BP (2006). Statistical Review of World Energy 2006. Online available: <http://www.bp.com/home.do?categoryId=1>
- Breitung, Jörg (2002). Nonparametric Tests for Unit Roots and Cointegration, *Journal of Econometrics*, Vol. 108, pp. 343-363
- Cashin, Paul, Luis Felipe Céspedes, and Ratna Sahay (2004). Commodity Currencies and the Real Exchange Rate. *Journal of Development Economics* Vol. 75, pp. 239-268.
- Chari, V.V., Patrick J. Kehoe, and Ellen R. McGrattan (2002). Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rates? *Review of Economic Studies* Vol. 69, pp. 533-563.
- Clarida, Richard H. (1994). Cointegration, Aggregate Consumption, and the Demand for Imports: A Structural Econometric Investigation. *American Economic Review*, Vol. 84 (1), pp 298-308.
- Federal Reserve Bank of San Francisco (2006). Oil Prices and the U.S. Trade Deficit. FRBSF Economic Letter No. 2006/24, 22 September 2006, San Francisco.
- Goldstein, Morris and Mohsin S. Kahn (1985). Income and Price Effects in Foreign Trade. *Handbook of International Economics* Vol. II edited by R.W. Jones and P.B. Kenen.
- Hadri, Kaddour (2000). Testing for Stationarity in Heterogeneous Panel Data. *Econometrics Journal* 3, pp. 148-161.
- Hadri, Kaddour and Rolf Larsson (2005). Testing for stationarity in heterogeneous panel data where the time dimension is finite. *The Econometrics Journal* 8, pp. 55-69
- Hlouskova, Jaroslava and Martin Wagner (2006). The Performance of Panel Unit Root and Stationarity Tests: Results from a Large Scale Simulation Study. *Econometric Review* 25 (1), pp. 85-116.
- Harb, Nasri (2005). Import demand in heterogeneous panel setting. *Applied Economics*, No. 37, pp 2407-2415.
- Hausman, Jerry (1978). Specification Tests in Econometrics. *Econometrica* Vol. 46, pp. 1251-1271.
- Im, K.S., Hashem Pesaran, and Yongcheol Shin (2003). Testing for Unit Roots in Heterogeneous Panels. *Journal of Econometrics* 115(1): 53-74.

- IMF (2004) De facto classification of Exchange Rate Regimes. Online available on: <http://www.imf.org/external/np/mfd/er/2004/eng/0604.htm>.
- IMF (2006). World Economic Outlook September 2006. Washington DC.
- Kee, Hiau Looi, Alessandro Nicita and Marcelo Olarreaga (2004). Import Demand Elasticities and Trade Distortions. World Bank Policy Research Paper WPS3452, Washington DC.
- Krueger, Anne (2006). Remarks at the G8-B-MENA Meeting. 21 May 2006, Sharm El-Sheikh, Egypt. Online available: <http://www.imf.org/external/np/speeches/2006/052106.htm>.
- Lane, Philip and Gian-Maria Milesi-Ferretti (2006). The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities, 1970-2004. IMF Working Paper No. 06/69. Washington DC.
- Levin, Andrew, C. Lin, and C. Chu (2002). Unit Roots in Panel Data: Asymptotic and Finite-Sample Properties. *Journal of Econometrics* Vol. 108, pp.1-24.
- Nsouli, Saleh M., Director Offices in Europe, IMF (2006). Petrodollar Recycling and Global Imbalances. Speech at the CESifo's Summer Conference in Berlin, March 23-24 2006.
- Pedroni, Peter (1999). Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors. *Oxford Bulletin of Economics and Statistics*, Special Issue.
- Pedroni, Peter (2000). Fully-Modified OLS for Heterogeneous Cointegrated Panels. *Advances in Econometrics*, Vol. 15, pp. 93-130.
- Pedroni, Peter (2004). Panel Cointegration; Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the Purchasing Power Parity Hypothesis. *Econometric Theory* 20, pp. 597-325.
- Pesaran, Hashem M., Yongcheol Shin, and Ron P. Smith (1999). Pooled Mean Group Estimates of Dynamic Heterogeneous Panels. *Journal of the American Statistical Association* Vol. 94 (446), pp. 621-634.
- Rebucci, Alessandro and Nikola Spatafora. (2006). Oil Prices and Global Imbalances. In *IMF World Economic Outlook* (April 2006), pp. 71-96. Washington, DC: International Monetary Fund.
- Reinhart, Carmen (1995). Devaluation, Relative Prices, and International Trade. *IMF Staff Papers* Vol. 42 (2).
- Senhadji, Abdelhak (1998). Time-series estimation of structural import demand equations: a cross-country analysis. *IMF Staff Papers* Vol. 45(2), pp. 236-68.
- Thursby, Jerry and Marie Thursby (1984). How Reliable are Simple, Single Equation Specifications of Import Demand? *The Review of Economics and Statistics*, Vol. 66 (1), pp. 120-128.
- U.S. Bureau of Economic Analysis (2007). News, Wednesday, January 10, 2007. U.S. International Trade in Goods and Services November 2006. Online available: <http://www.bea.gov/bea/newsrelarchive/2007/trad1106.pdf>
- U.S. Department of the Treasury and of International Affairs (2006). Petrodollars and Global Imbalances. Office of International Affairs Occasional Paper No. 1, Washington DC.

3.6 Appendix

Table A3.1: Data Availability

Variable	Source	Type	Start date	End date	Countries	Notes
imports	IMF WEO	national accounts data	1980	2005	All countries except listed below	real imports in constant 2000 prices.
	IMF WEO	national accounts/ BoP data	1990	2005	Congo, Ecuador, Libya, Oman, Qatar, Yemen.	approximation for missing national accounts data with BoP data
			1997	2005	Turkmenistan	approximation for missing data with BoP data
BoP imports	IMF WEO	BoP data	1980	2005	Kazakhstan and Sudan	
domestic demand and exports	IMF WEO	national accounts/ BoP data	1980	2005	All countries except listed above	approximation for missing data with BoP data
reer	IMF WEO	real effective exchange rate	1980	2005	Algeria, Bahrain, Congo, Ecuador, Equatorial Guinea, Gabon, Iran, Nigeria, Russia, Saudi Arabia, Trinidad and Tobago, Venezuela and Norway	Data for Equatorial Guinea only available from 1985, for Russia only from 1994
reer approximation	author's calculation with IMF WEO and DTS data	CPI, nominal exchange rates and Direction of Trade (DTS)	1980	2005	All countries	approximation with relative exchange rates to USD and euro deflated with relative prices and weighted by import trade shares
oil	IMF WEO	average of three sorts (in USD)	1980	2005	All countries	
real U.S. oil	IMF WEO	author's calculations	1980	2005	All countries	nominal oil price deflated with U.S. CPI
real country specific oil	IMF WEO	author's calculations	1980	2005	All countries	nominal oil price deflated with each country's CPI and nominal exchange rate towards the USD
fiscal	IMF WEO	general government balances	1980	2005	All countries except listed below	As share of nominal GDP. For Nigeria, Trinidad and Tobago and Venezuela approximation with central government balances for early 1980s.
	IMF WEO	central government balances			Algeria, Bahrain, Gabon, Saudi Arabia	

Table A3.2: Development of major economic variables

	gdp	im	exdd	reera	oil	fisc
All countries						
(1980 - 2006)	3.8	7.1	4.0	2.9	5.4	-1.9
(1980 - 1995)	2.0	4.2	1.8	3.8	-2.8	-4.4
(1996 - 2006)	6.3	11.0	7.1	1.5	16.5	1.7
(1980 - 2006)						
African Countries	4.5	8.2	4.9	1.0	5.4	-2.7
Middle East	4.2	5.8	4.3	1.6	5.4	-1.9
CIS	2.4	4.2	2.3	15.5	5.4	-2.6
Latin America/Caribbean	2.6	11.8	3.0	0.0	5.4	-1.8
Europe (Norway)	2.9	3.9	3.1	0.2	5.4	6.2

Note: All variables except for *fisc* are averages of growth rates. *Fisc* is the average share of the general government balance to nominal GDP.

Source: IMF World Economic Outlook (2006) and IFS (2006), author's calculations.

Table A3.3: De facto exchange rate arrangements

Country	Exchange rate arrangement	Reference Currency/Anchor
Algeria	managed float	no explicitly stated nominal anchor
Angola	managed float	no explicitly stated nominal anchor
Bahrain	conventional fixed peg	U.S. dollar
Congo, Rep. of	exchange rate with no separate legal tender	Franc zone CAEMC ^a
Ecuador	exchange rate with no separate legal tender	U.S. dollar
Equatorial Guinea	exchange rate with no separate legal tender	Franc zone CAEMC ^a
Gabon	exchange rate with no separate legal tender	Franc zone CAEMC ^a
Iran, I.R. of	managed float	monetary aggregate target
Kazakhstan	managed float	no explicitly stated nominal anchor
Kuwait	conventional fixed peg	U.S. dollar ^b
Libya	conventional fixed peg	SDR basket
Nigeria	managed float	no explicitly stated nominal anchor
Norway	independently floating	inflation targeting
Oman	conventional fixed peg	U.S. dollar
Qatar	conventional fixed peg	U.S. dollar
Russia	managed float	no explicitly stated nominal anchor
Saudi Arabia	conventional fixed peg	U.S. dollar
Sudan	managed float	monetary aggregate target
Syrian Arab Rep.	conventional fixed peg	U.S. dollar
Turkmenistan	conventional fixed peg	U.S. dollar
Trinidad and Tobago	managed float	no explicitly stated nominal anchor
United Arab Emirates	conventional fixed peg	U.S. dollar
Venezuela	conventional fixed peg	U.S. dollar ^c
Yemen	independently floating	monetary aggregate target

Notes: ^a African Economic and Monetary Community ^b Peg with a 3.5 percent margin. Before 2003 the Kuwaiti Dinar was pegged against a basket of currencies. ^c before 2004 crawling peg, since 2005 the euro is also included in foreign exchange interventions.

Source: IMF (2004) De facto classification of Exchange Rate Regimes.

Table A3.4: Country Specific Diagnostic Results

Country	Ch-SC ¹	CH-FF ²	CH-NO ³	CH-HE ⁴	RBARSQ ⁵
Algeria	0.01	0.00	0.92	0.30	0.87
Angola	0.31	2.78	0.04	0.17	0.85
Bahrain	7.37	1.28	0.69	0.80	0.91
Congo, Rep. of	0.11	4.85	1.18	0.32	0.74
Ecuador	0.91	2.13	1.03	0.44	0.91
Equatorial Guinea	0.22	0.48	0.71	0.09	0.92
Gabon	5.80	0.01	0.64	0.92	0.89
Iran, I.R. of	0.98	0.12	1.70	0.84	0.91
Kazakhstan	0.31	8.53	1.31	0.02	0.97
Kuwait	1.65	0.96	1.03	0.81	0.97
Libya	2.14	3.26	3.28	0.00	0.87
Nigeria	0.00	6.26	0.19	0.13	0.94
Norway	2.38	0.80	0.21	2.00	0.78
Oman	1.96	2.88	0.12	1.02	0.98
Qatar	0.06	2.07	1.48	0.01	0.84
Russia	0.17	0.30	4.26	0.07	0.89
Saudi Arabia	1.81	0.20	2.51	0.35	0.97
Sudan	1.50	2.64	1.26	0.00	0.74
Syrian Arab Rep.	9.53	0.03	0.53	0.95	0.82
Turkmenistan	3.22	19.76	4.24	8.11	0.90
Trinidad and Tobago	0.00	3.27	5.57	0.00	0.88
United Arab Emirates	0.44	0.07	0.36	1.05	0.88
Venezuela	0.85	2.45	0.58	2.21	0.91
Yemen	0.43	4.20	0.75	0.05	0.95

Note: 1. Godfrey's test of residual correlation

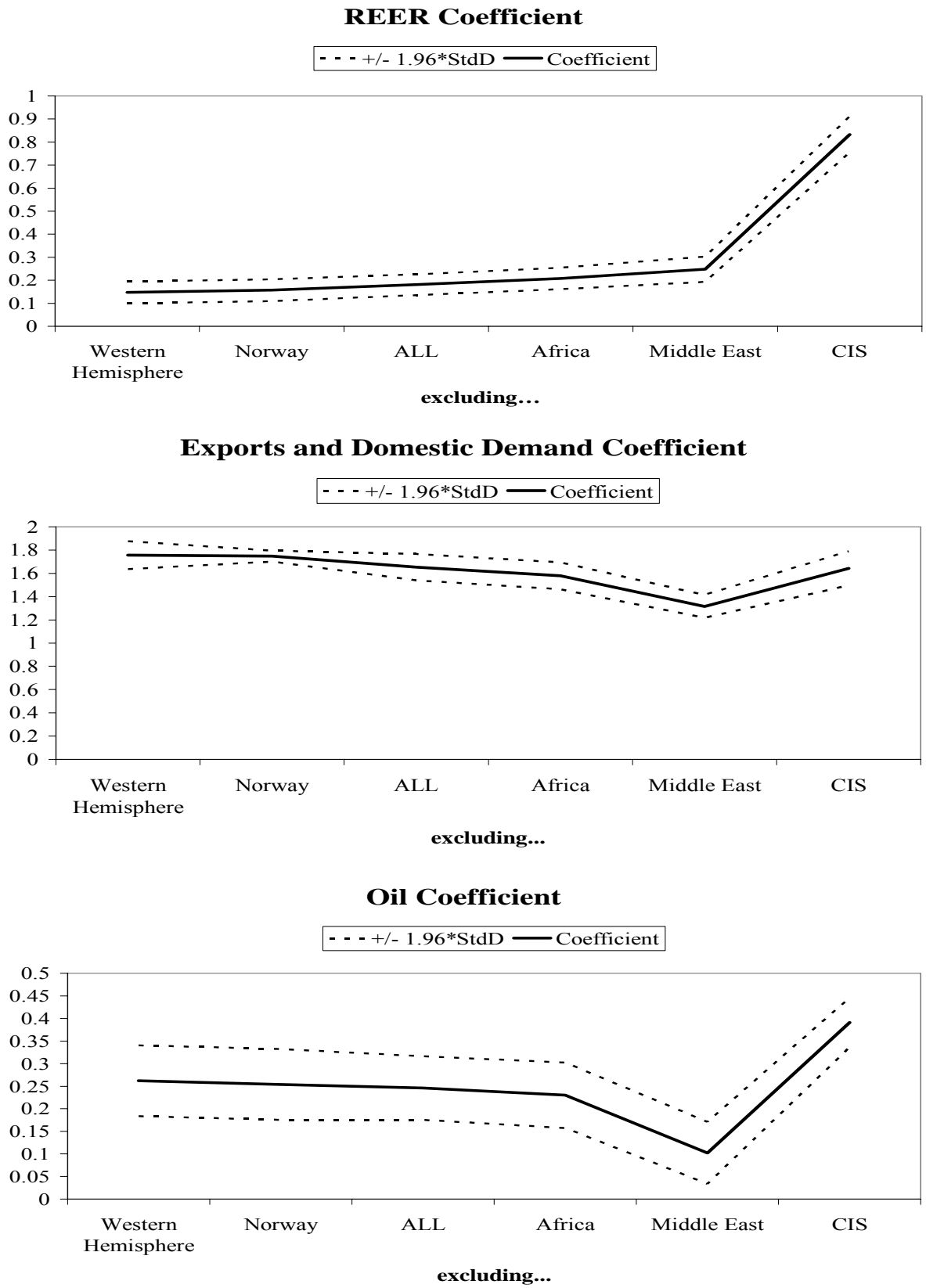
2. Ramsey's RESET test of functional form

3. Jarque-Bera test of normality of residuals.

4. Lagrange multiplier test of homoscedasticity.

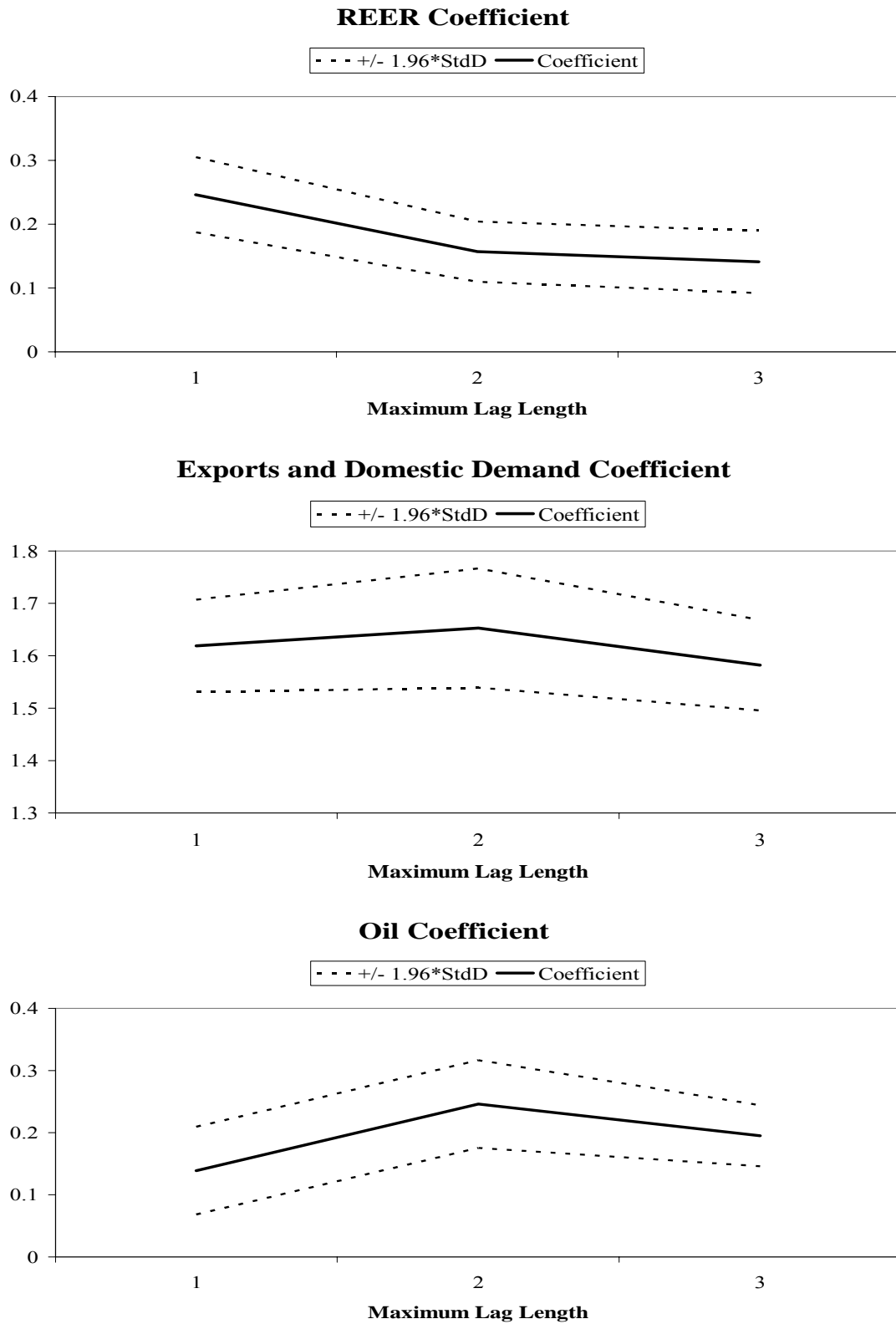
5. Adjusted R².

Figure A3.1: Robustness over Countries



Source: Author's estimations.

Figure A3.2: Robustness over Maximum Lag Length



Source: Author's estimations

4 Has Russian GDP growth become less dependent on oil? A Cointegration VAR Approach

In the group of oil exporting countries, Russia is by far the largest economy.¹ The previous section focused on the effect of the import behaviour of oil exporting countries on global imbalances. Almost all of the economies exporting oil are highly dependent on the price of their main export good – oil. In the panel of oil exporting countries, Russia seems to be among the countries with the highest diversification of the economy.² The question then is, whether Russia has achieved higher independence from oil prices in recent years. There are several reasons why this could be the case. First of all, the experience of high volatilities in the price of oil might have led to a more prudent fiscal policy. In particular, starting in 2004 an oil stabilization fund similar to the one in Norway was established for the Russian economy to smooth out the effects of the volatility in oil prices on the Russian economy. Second, Russia's economy could have become less dependent on oil due to increased diversification of the economy. Sometimes it is also argued that oil prices have increased so sharply that the Russian economy just cannot absorb all the additional revenues due to capacity constraints so that a large part of the additional revenues is spent on foreign products (imports). This would limit the positive effect high oil prices can have on Russian GDP (at least in the short run). Another question is, whether high oil prices lead to a real appreciation in the long-run dampening the positive effect of oil on the economy.

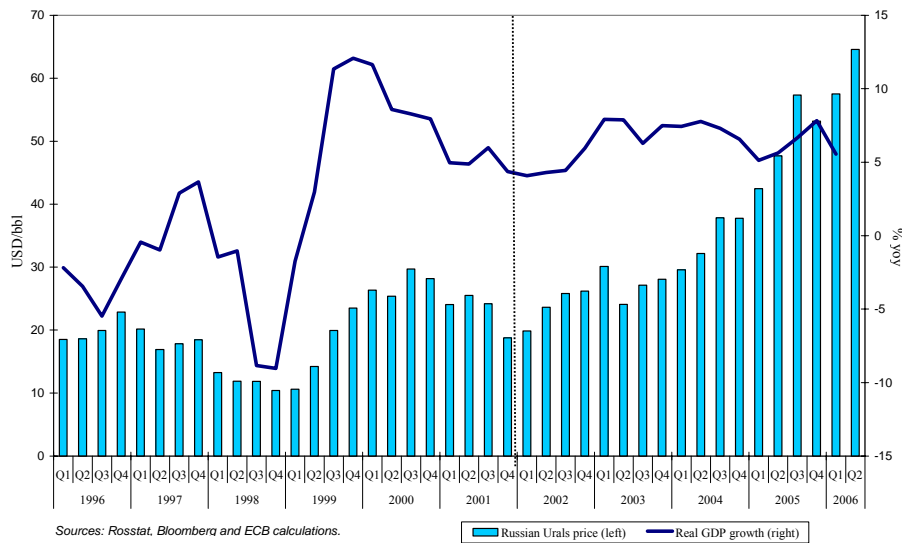
Against the backdrop of the prominent role of the oil and gas sector in the country's exports and, to a lesser extent, in GDP one would expect a close relationship between Russia's GDP growth and oil prices. Indeed, empirical studies have found a significant impact of changes in the price of oil on Russian GDP growth with long-run elasticities ranging from 0.15 to 0.2.³ When looking at the simple correlations between GDP growth and the oil price since 2002, the continued steep increase of oil prices does not appear to have translated into even higher GDP growth in Russia. The simple correlation suggests that Russia's GDP growth de-coupled from oil prices since early 2002 and, even more pronounced, since 2004 (see Figure 4.1).

¹ With a share of 1.7 percent in world GDP in nominal USD dollars for the year 2005, Russia's economy is more than twice as large as the second and third largest oil exporting economies Saudi Arabia and Norway.

² According to official numbers, the share of mining (petroleum and gas production) in GDP was only 10.4 percent in 2005. According to the World Bank (2004) these numbers underestimate the true share of oil in Russia's production process. The true share is rather somewhere between 20 and 30 percent (according to the World Bank the true share according to input output calculations amounted to 20 percent in 2000).

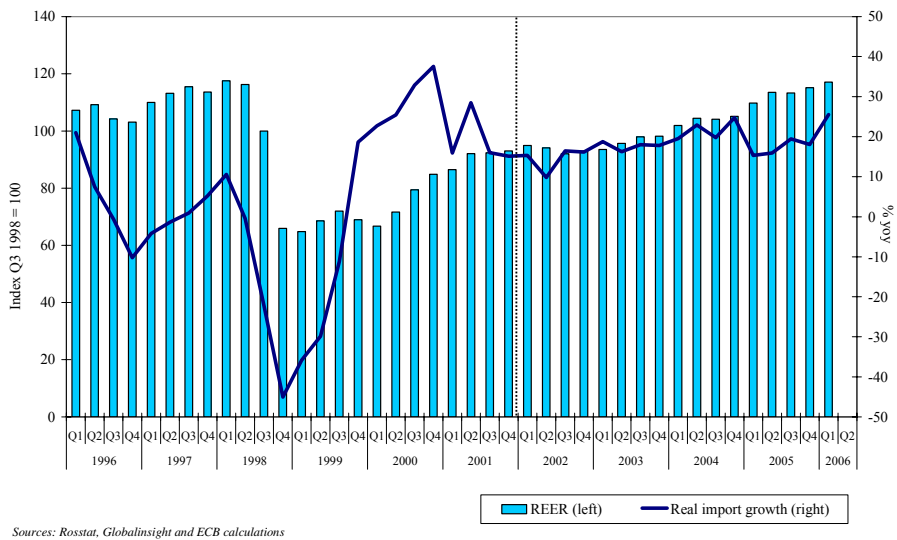
³ See for example IMF (2002) in which the magnitude of this effect depends on policy reactions, and Rautava (2004).

Figure 4.1: Real GDP growth and oil prices



One might expect that this de-coupling may be due to strong import growth which may have been stimulated by the real appreciation of the rouble as argued above. However, the simple correlation between real import growth and the real effective exchange rate also appears to have weakened (Figure 4.2).

Figure 4.2: The real effective exchange rate and real import growth



Since simple correlations do not capture the impact of other variables, the decline of the simple correlation between real GDP growth and the oil price on the one hand, and between real import growth and the real effective exchange rate on the other hand does neither imply that the oil price has no longer an impact on Russia's GDP growth nor that Russian imports are no longer stimulated by real appreciation. Only an econometric analysis that 1) controls

for other relevant variables and 2) allows also for feed back between the variables and their lagged values can shed light on these issues. For example, as stated above, rising oil prices may not only stimulate GDP growth in Russia but may lead at the same time to an appreciation of the real exchange rate offsetting the oil stimulus to some extent. Likewise, real import growth may depend not only on the real exchange rate, but also on oil prices through wealth effects.

To shed some light on the question of Russia's dependency on oil a Vector Error Correction Model (VECM) is estimated. In particular, I set up a model including GDP, the real exchange rate, the price of oil and real government revenues. The analysis of the cointegration coefficients suggests that Russia's dependency on oil has not become smaller but has stayed more or less constant over time. However, when comparing the long run effects the overall reaction of the model including the reaction of all endogenous variables has to be taken into account. When considering the long-run impulse response functions of a permanent increase in the oil price an elasticity of 0.24 is found. This figure compares with other estimates for Russia's long-run elasticity with respect to oil even though most of these studies use different and sometimes less sophisticated estimation methods. Rising oil prices stimulate Russian GDP growth while an endogenous real appreciation resulting from the higher oil prices in the long run seems to offset the positive effect on GDP to some extent.

The study most closely related to this analysis is Rautava (2004). He finds a significant cointegration long-run relationship between Russian GDP growth and oil prices and the real exchange rate. His analysis suggests that Russia reacts to a 1 percent increase in the oil price with a 0.22 percent increase in GDP and to a 1 percent real appreciation with a 0.24 percent decrease in GDP. These numbers represent the long-run *ceteris paribus* reactions of GDP, however. As suggested above, the endogenous reaction of other variables e.g. of the real exchange rate to changes in the price of oil might, however, offset some of the effect. The analysis of Rautava (2004) is, thus, a very good study of the *ceteris paribus* effects of oil prices and the real exchange rate on Russian GDP. The present study provides more refined estimations in several ways. First of all, the estimation in Rautava (2004) is based only on a very short time series (1995:1 until 2002:4). Yet most of his results have only asymptotic validity. This seems to be very short when setting up a long-run cointegration relationship. The present study uses a longer time-horizon (1995:1 until 2006:1) and because this can still be considered a relatively short sample, this study controls for this fact by simulating the small-sample rank test statistics instead of relying on the asymptotic behaviour of the test

results. The next important contribution of this paper is that while Rautava presents only long-run coefficients, this study presents simulations of shocks to the price in oil. In particular, impulse response functions are presented including error bands that are calculated with a bootstrap routine. This way, the long run reaction of GDP taking into account the endogenous reaction of all other variables in the system can be shown.

An analysis of Russia's import behaviour shows results comparable to those in the section on oil exporting countries' import behaviour. Imports are significantly stimulated by higher oil prices and an appreciation of the real exchange rate.⁴ This estimate shows that imports which are predominantly priced in the currency of the producer are indeed subject to expenditure switching. The channel through which the real exchange rate has a negative effect on GDP is therefore the demand for imports.

The study is ordered in the following way. First, I give a short review of the literature. Both the literature relating to the particular characteristics of Russia and the possible link between the oil price and the real exchange rate in oil exporting countries is briefly discussed. In a next step the Vector Error Correction Model (VECM) is set up and estimated in a recursive way to analyse the development of the coefficients over time. Then, the behaviour of the overall model is analysed with impulse response functions including bootstrap error bands. To shed some more light on the reason why the real exchange rate has a negative effect on GDP, the reaction of imports to a change in the oil price and the real exchange rate is estimated in an Error Correction Model (ECM) for Russian real imports.

4.1 The Literature

In this section a short review of the issues concerning Russia's dependence on oil are given. In particular, first other studies on the impact of oil prices on the economy of OECD economies and of Russia are presented. Then, the impact of fiscal policy on the Russian economy is shortly discussed. In a next step a short summary on the link between the oil price and the real exchange rates in oil exporting countries is presented. This is linked to the presentation of some ideas regarding possible Dutch Disease phenomena and the question of the competitiveness of the Russian economy. Finally, some thoughts about the pass-through of the exchange rate to domestic prices are presented with a discussion on the invoicing

⁴ In particular, the elasticity of imports with respect to the oil price is 0.1 percent. The elasticity of imports with respect to the real exchange rate is 0.7.

pattern of Russian Trade and how this affects the overall impact of the exchange rate on Russian GDP.

Most of the studies on the macroeconomic effects of oil shocks focus on the reaction of GDP and inflation in OECD countries. Evidence suggests that for OECD countries the relationship between oil prices and macroeconomic development has become weaker over time. Hutchison (1993) finds that the effect of an oil price hike on GDP in the USA and Japan after 1980 is only one quarter of the effect of the late 1970s. He concludes, thus, that the USA and Japan have become better insulated from oil price disturbances. Similarly, Hamilton (1996) comes to the conclusion that oil price increases have smaller macroeconomic effects on the United States after 1973 than before 1973. Bjørnland (2000) finds that for the USA, Germany and the UK, oil price shocks have a significant negative effect on output, while they have a positive (albeit insignificant) effect on Norway. In 2003 Hamilton (2003) confirms his earlier findings that the effect of oil prices on GDP in the United States has declined over time.

Aivazian et al. (2003) analyse the short-term dynamics of the Russian economy. They find a significant positive effect of oil prices on Russian GDP in the magnitude of 0.26 percent and a significant negative effect of the nominal exchange rate on Russian GDP in the magnitude of 0.29. Their focus is, however, on the short-term and they do not show the behaviour of these coefficients over time. The study most related to this paper is given by an analysis on the impact of oil prices and the real exchange rate on the Russian economy by Rautava (2004). In his VAR cointegration analysis with data covering the period from 1995 to 2002, Rautava finds a positive long-run relationship between oil prices and GDP and oil prices and real revenues. At the same time the exchange rate has a significant negative impact on GDP both in the long run and in the short run. He finds that the coefficients for the long-run cointegration relationship are stable over time. The coefficient of oil is around 0.2, while the coefficient of the real exchange rate is around - 0.27. The author does not provide any impulse responses for this analysis. In a next step Rautava estimates an Error Correction Model to look at the short run dynamics and finds that a 10 percent increase in the oil price contributes directly to 0.5 percent GDP growth, while fiscal revenues are increased by 3.9 percent. Most studies preceding Rautava (2004) analysed the effect of oil prices without taking into account a dynamic reaction of GDP (IMF 2001).

The role of fiscal policy increased with the introduction of the oil stabilization fund in January 2004. The fund was established to absorb excessive liquidity, reduce inflationary

pressure and insulate the economy from volatility of raw material export earnings (Ministry of Finance 2006). Originally, the Fund was supposed to accumulate revenues from all tax revenues for Ural oil prices exceeding 20 US dollar per barrel. The cut-off price was revised upwards to \$27 per barrel in April 2006. If the balance of the fund exceeds 500 billion roubles, the Fund may be used “to cover the federal budget deficit and for other purposes” (Ministry of Finance 2006). As capital of the Fund exceeded 500 billion roubles in 2005, the following transactions took place: The equivalent of 3.33 billion U.S. dollar was spent on early debt repayment to the IMF and the equivalent of 15.1 billion U.S. dollar for first debt repayments to the Paris Club countries.⁵ The Fund’s objective is to invest in foreign sovereign debt securities.⁶ In the beginning of 2007 the fund reached a volume of 2346 billion roubles an equivalent of 88.7 billion U.S. dollar at the exchange rate of January 2007 (RIAN (2007)).

According to the IMF (2005), there are three ways in which the fiscal authorities can react to increases in oil revenues. 1) Decrease non-oil revenues for example with a tax rate cut.⁷ 2) Increase government expenditure 3) Decrease the public deficit or run a surplus. According to the IMF in 2003 large windfall revenues led to decreases in non-oil taxation. Reducing the non-oil tax rate could have stimulating effects for the economy. From 2004 on most increases were saved in the oil stabilization fund, resulting in large fiscal surpluses. Thus, not all revenues were fuelled into the economy and the oil stimulus accordingly could have become smaller. However, it is stated that fiscal policy has “taken away steam” only in a limited way. Similarly, Spilimbergo (2005)⁸ finds that the fiscal balance assuming constant oil prices worsened since 2001. Accordingly, although fiscal policy was countercyclical, it was not countercyclical enough and a large oil stimulus reached the economy. One reason could be that the oil windfalls rose to levels well above the 500 billion rouble cap below which all revenues are earmarked for the stabilization fund.

Regarding the relationship between oil prices and the real exchange rate, there seems to be increasing evidence that oil prices play a significant role for real exchange rates of oil exporting countries. Most studies follow the approach by Cashin et al. (2002, 2004) who find evidence for a long-run relationship between real exchange rates and commodity prices for one third of their panel of 58 commodity exporting countries. Koranchelian (2005) finds a

⁵ Furthermore, an equivalent of 4.3 billion U.S. dollar was paid to Vnesheconombank for loans provided to the Ministry of Finance in 1998-1999 for servicing the state debt of Russian Federation; an equivalent of 1 billion U.S. dollar was transferred to the Russian Pension Fund.

⁶ The share of currencies is 45 percent U.S. dollar, 45 percent euro and 10 percent GBP.

⁷ We abstract from possible revenue increases due to a potentially increasing tax base.

⁸ The IMF country report is partly based on Spilimbergo (2005), however the country report provides less details.

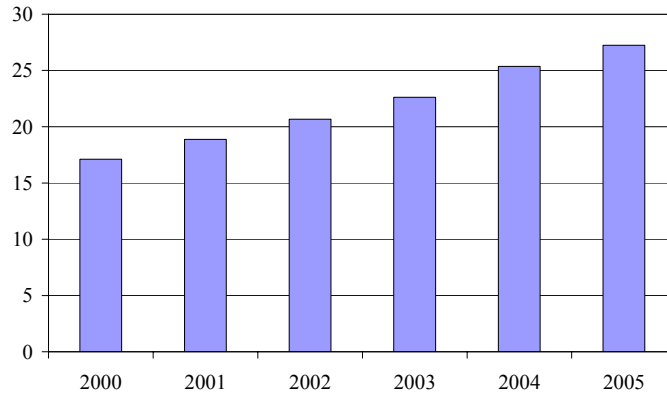
long run elasticity of the real exchange rate with respect to the oil price of 0.24 for Algeria. Other studies like Habib and Kalamova (2006) find a positive effect of the oil price on the real exchange rate also for oil exporting countries with fixed exchange rate arrangements. Sosunov and Zamulin (2006) show in a theoretical model that oil prices can help explain the real appreciation of the rouble from 1998 to 2005 when the oil price increase is perceived to be permanent. From a theoretical point of view it should not matter whether real appreciations are brought about by nominal appreciations or by relatively higher prices in the domestic economy as compared to the world economy (or relatively higher prices of nontradable goods as compared to the non-oil tradable goods). When this leads to resources being shifted away from the non-oil tradable sector the phenomenon is called Dutch Disease in the context of natural resource windfalls.⁹ Another way to check for possible signs of Dutch Disease is to look at the diversification of the economy. According to Gianella and Chanteloup (2005) the Russian economy shows no signs of diversification. They claim that the export composition in value terms is increasingly dominated by commodities. This dominance is, however, likely due to price effects. Beck et al. (2007) find that in volume terms the share of oil production in output increased only marginally. Another way of judging whether the economy shows signs of Dutch Disease is to look at the competitiveness of the tradable sector and the equilibrium exchange rate. While Égert (2005) finds that the real exchange rate started to become overvalued and the Russian economy therefore less competitive, the IMF (2006) and Beck et al. (2007) consider the Russian economy still to be competitive. In particular, the market share of Russian non-oil exports in world exports did not decrease with the recent appreciation. Also, the real exchange rate appreciation seems to be justified by Russia's productivity gains relative to the U.S. and the euro area. This short summary of the evidence on Dutch Disease serves to put the discussion on the possible negative impact of the exchange rate on the Russian economy in context. Given the above evidence it is relatively safe to say that so far, Russia does not seem to suffer from symptoms of Dutch Disease but rather that the appreciation of the real exchange rate is a natural process accompanying the transition process and the high oil price increases.

In what way does the exchange rate dampen the positive effect of the oil price on the economy? The IMF (2005) claims that with oil revenues at these high levels, the Russian economy faces capacity constraints in form of transportation bottlenecks. Additional revenue

⁹ There are many studies which discuss the phenomenon of Dutch Disease in oil exporting countries. Lately for example Égert and Leonard (2006) find no evidence of Dutch Disease in Kazakhstan. They find that all real appreciation comes about by nominal exchange rate adjustments and not by higher prices in the nontradable sector.

cannot be absorbed in the domestic economy and is spent on imports instead. In this way, the import leakages, i.e. real imports in percent of real domestic demand, increased from 17 percent in 2000 to 27 percent in 2005 (see Figure 4.3).

Figure 4.3: Import Leakage



Note: Import leakage is defined as share of real imports in real domestic demand. *Source:* Rosstat (2006), own calculations

Gianella and Chanteloup (2006) analyse Russia's trade elasticities. They ask the question whether the Russian economy reacts "normally" to exchange rate movements. Often, the "normal" reaction is based on the assumption of producer currency pricing. However, this assumption is not likely to hold for Russia. Although there is no data available for the Russian Federation, the assumption is that Russian exports are predominantly invoiced in U.S. dollar while Russian imports are invoiced in U.S. dollar but also the currency of the producer, i.e. in euro for imports coming from the euro area.¹⁰ The currency in which trade is invoiced has significant implications for the transmission of exchange rate movements into the economy, in particular, the expenditure switching effect. The pass-through of the exchange rate to import prices can give an impression on the invoicing structure of Russian trade. Gianella and Chanteloup (2006) find that the pass-through of the nominal exchange rate into export and import prices is not complete. For exports which are very unlikely to be invoiced in Russian rouble, the pass through is particularly low. They argue consequently that exchange rate pass-through takes place predominantly through imports. Thus, imports are also more likely to be subject to expenditure switching effects with movements in the exchange rate. This means that if oil price increases are accompanied by a real appreciation imports might increase by more than might be expected from increased oil revenues because they get relatively cheaper.

¹⁰ Butorina (1999) claims that 80 percent of Russian trade is invoiced in U.S. Dollar. The source of the data is, however, not clear. In the foreign currency securities invested in the oil stabilization fund the decided allocation is USD 45%, EUR 45% and GBP 10%.

As a consequence this might dampen the transmission from higher oil prices into higher GDP growth in Russia. How much the oil price increase stimulates import demand and whether the introduction of the oil stabilization fund changed the impact the oil price has on the Russian economy will be discussed in the following.

4.2 Empirical Findings

For the estimation of Russia's dependence on the price of oil two models are set up. A first model incorporates the feedback between all endogenous variables included into a Vector Error Correction Model. The second model estimates a long run relationship between imports and the price of oil and the real exchange rate.

4.2.1 The Data

The estimations are based on quarterly national accounts data published by Russia's State Statistics Committee (Rosstat) both for real GDP and for real import demand. These variables are seasonally adjusted. Data for federal government revenues is taken from the IMF International Financial Statistics (IFS). The consumer price index is used as a deflator to compute real revenue figures. Data for the real effective exchange rate is also taken from the IMF IFS. It is calculated as the nominal exchange rate adjusted for relative consumer price changes and weighted by the relative trade weights. The price for North Sea Brent oil in dollars per barrel is also taken from the IFS. The oil price is considered as exogenously given.¹¹ The use of Ural prices which are more representative for Russian oil exports instead of North Sea Brent does not change the results.¹² All variables are in logarithmic terms.

4.2.2 Unit Root and Cointegration Tests

The first question to answer as was the case in the section of oil exporters' import demand is whether the variables are stationary or whether they are integrated of some order. To test for stationarity several unit root tests are performed. For an overview see Table 4.1.

¹¹ In contrast to the study by Rautava the oil price is not included as a moving average. Including the oil price as a moving average could distort the results as lags are already included in the dynamic structure of the VAR.

¹² The correlation between the two is close to unity.

Table 4.1: Unit Root Tests

Unit Root Tests											
	ADF		PP		KPSS		NP		ERS		Degree of integration
	Levels	First differences	Levels	First differences	Levels	First differences	Levels	First differences	Levels	First differences	
GDP	0.45	-3.129**	-1.51	-5.478***	0.772***	0.431*	1.19	-19.188***	129.07	1.407***	I(1)
Real Revenues	-1.79	-4.233***	-2.65	-10.276***	0.81***	0.15	0.94	-17.001**	235.49	6.043	I(1)
REER	-1.64	-3.708***	-1.73	-4.112***	0.162	0.136	-9.429**	-18.548**	4.63	1.265***	I(1)
Oil	-0.54	-2.693*	-2.01	-5.158***	0.672**	0.141	0.92	-20.12***	25.93	1.215***	I(1)
Imports	0.14	-3.719***	0.48	-5.296***	0.608**	0.29	1.62	-19.894***	38.68	1.384***	I(1)
Domestic Demand and Exports	1.81	-2.35	1.80	-7.73***	0.772**	0.431*	-63.162***	-0.01	247.45	3.09*	I(1)/I(2)

Note: ***, **, * denote statistical significance at the 1, 5, and 10 percent level, respectively. The null hypothesis is "no unit root" except for KPSS. Here, the null hypothesis is stationarity.

The unit root tests show that for almost all tests the null hypothesis of a unit root can be rejected. When looking at the unit root tests for the differenced variables, the results are a bit more mixed. For most of the tests the hypothesis of a unit root in the differences cannot be rejected. Only for some tests there is indication of a further unit root. It is, thus, reasonable to assume that the variables are integrated of order one.¹³ To find out whether these I(1) variables are cointegrated and exhibit a common long run relationship, several methods are applied to check for the rank of the cointegration matrix. In a first step the Johansen (1988, 1991) trace test is performed in the following way:

$$H_0(r_0): \text{rank}(\Pi)=r_0 \text{ versus } H_1(r_0): \text{rank}(\Pi)=k, r_0=0,1,2. \quad (4.1)$$

Where Π denotes the ($k \times k$) matrix of the coefficients for the lagged dependent variable, and k denotes the number of equations in the system. First, the null hypothesis of a zero cointegration rank is tested. If this null hypothesis cannot be rejected, a VAR in differences should be estimated as the variables exhibit unit roots without being cointegrated. At the other extreme, the rejection of the rank of 2 would imply that the variables are (trend-) stationary in levels and the estimation of a VAR in levels would be appropriate.

Table 4.2: Rank determination with simulated asymptotic trace test distributions

p-r	r	Eig.Value	Trace	Trace*	Frac95	P-Value	P-Value*
3	0	0.694	93.116	70.613	41.752	0.00	0.00
2	1	0.609	43.412	30.868	25.253	0.00	0.008
1	2	0.091	4.013	3.077	12.478	0.689	0.815

Note: p-r is the number of unit roots, r is the rank, and star denotes the simulated trace test statistics.

As simulation studies have shown that for small samples the asymptotic distribution of the rank test may not be a good approximation, the small sample correction of the trace test derived in Johansen (2002) is implemented. As can be seen in Table 4.2, taking into account the small sample property of the model does not change the implications for the rank determination. The rank of the cointegration matrix is set at two. Both trace tests reject 3 and 2 unit roots, but not 1 unit root. There should therefore be two long-run cointegration relationships and it is appropriate to estimate a restricted VAR, i.e. a Vector Error Correction Model.¹⁴

A number of other specification tests are performed to test for the appropriateness of the model. Tests for variable exclusion show that at the chosen rank of 2, the exclusion of every

¹³ Unit root tests only give an econometric description of the data. Especially for this relatively short sample, there should be strong economic intuition behind the choice of the order of integration. Thus, I will not consider the possibility of order 2 integration.

¹⁴ Recursive estimations of the trace test support the view that the number of cointegration relations is constant over time.

single variable can be rejected at the five percent level (see Table A4.1 of the appendix). Tests for weak exogeneity show that for all variables excluding the oil price weak exogeneity can be excluded at the 1 percent significance level (see Table A4.2 of the appendix). To determine the lag length several lag length criteria are consulted. The simple log likelihood ratio test suggests the inclusion of as many lags as possible. Given the short nature of the sample, the lag length criteria correcting for the loss of degrees of freedom, i.e. Schwarz and Hannan-Quinn, suggest a lag length of 3 (see Table A4.3 of the appendix).

The first cointegration relationship describes the fiscal revenues. For the sake of brevity, this cointegration relationship of the government real revenue equation is not discussed in detail. In this equation the long-run effect of the real exchange rate is restricted to be zero while both real GDP and the oil price have a positive long-run effect on real revenues (this effect is not significant for oil, however). Although the first cointegration relationship is part of the model, the main interest of the analysis is on the reaction of GDP. The second cointegration relationship describes the long run GDP equation. We expect oil prices to have a positive impact on real GDP in the long run; the real exchange rate is expected to have a negative impact on GDP in the long run. Fiscal revenues are considered to have no impact on GDP in the long run.¹⁵ As will be shown in the following, the choice of these just identifying restrictions in the cointegration relationship has no implications on the long-run impulse response functions.

4.2.3 Estimation Results

Focusing on the first cointegration equation for real GDP, a significant positive relationship between the oil price and real GDP as well as a significant negative relationship between the real effective exchange rate and real GDP is found. The estimation equation can be described in the following way:

$$\Delta Y_t = \Pi_y Y_{t-1} + \Gamma_{y1} \Delta Y_{t-1} + \Gamma_{y2} \Delta Y_{t-2} + \Pi_x X_{t-1} + \Gamma_{x1} \Delta X_{t-1} + \Gamma_{x2} \Delta X_{t-2} + \Phi D_t + \varepsilon_t \quad (4.2)$$

where Δ is the difference operator and the vector of endogenous variables Y can be expressed as $Y=[gdp_t, reer_t, realrev_t]'$. The vector of exogenous Variables X includes the price of oil and a constant restricted to the cointegration relationship. The vector of dummies D includes two dummies for the periods 1998:3 and 1998:4 capturing the effects of the 1998 crisis. Tests for

¹⁵ The determination of the set of restrictions on the model is taken from economic intuition following the approach by Rautava (2004). This restriction of the impact of the fiscal variable on GDP to be zero does not seem to be too restrictive. There can still be a role for fiscal stabilization through anti-cyclical policy in the short run. Over the long run, the effect should, however, not be felt assuming non-distortionary taxation.

misspecification show that the model should have a good fit (see Table A4.4 of the appendix). The autocorrelation tests show that for the Ljung Box test, autocorrelation could only be rejected at the 1 percent significance level. However, The Lagrange Multiplier tests for first and fourth order autocorrelation show no sign of autocorrelation. Furthermore, the residuals are free of heteroscedasticity and seem to be normally distributed.¹⁶

Table 4.3: Estimation Results

BETA(transposed)					
	REER	Revenues	GDP	Brent	const
Beta(1)	0.00 (na)	1.000 (na)	-4.051 (-2.473)	-1.070 (-1.713)	30.664 (2.72)
Beta(2)	1.159 (5.25)	0.00 (na)	1.000 (na)	-0.686 (-6.40)	-1.175 (-12.52)
ALPHA					
	Alpha(1)	Alpha(2)			
DREER	-0.003 (-0.609)	-0.058 (-3.022)			
DReven	-0.201 (-4.348)	0.105 (0.64)			
DGDP	0.007 (3.39)	-0.046 (-6.644)			

Table 4.3 shows the estimation results for the matrices based on 2 cointegrating vectors. Beta 1 shows the cointegration relationship of real revenues. Both GDP and oil (brent) have a positive effect on revenues.¹⁷ The effect of the oil price is, however, not significant at standard significance levels. As mentioned above, the main focus will be on the cointegration relationship of GDP. In this cointegration relationship oil has a significant positive effect on GDP with a coefficient of 0.69 while the real exchange rate has a significant negative impact on GDP with a coefficient of 1.16. In the table the zero restrictions on the coefficients can be seen. As these restrictions are just identifying, there are no t-statistics for these zero coefficients and the normalizations. Alpha shows the speed of adjustment back to the steady state. It can be seen that for shocks to the GDP equation, the real exchange rate and GDP adjust to move back to equilibrium.¹⁸ The speed of adjustment seems to be rather slow.

Recursive Estimations

Recursive estimation of the model as introduced by Hansen and Johansen (1999) is performed to analyse the development of the coefficients over time. When estimating a model it has to be kept in mind that the estimated parameters measure average effects. Given the strong

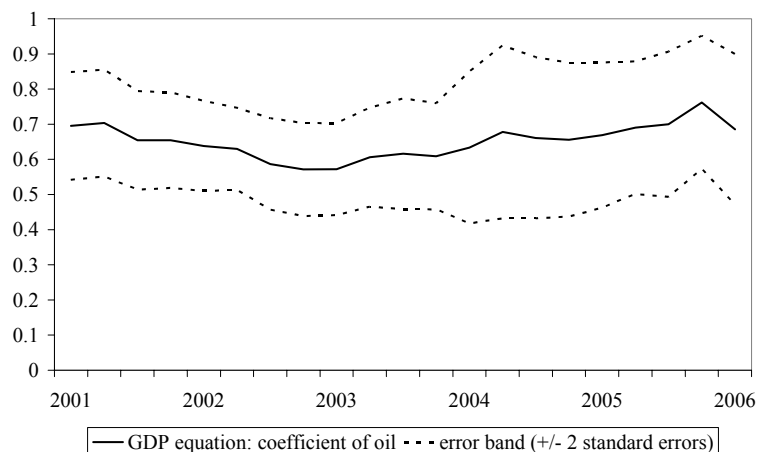
¹⁶ Although the residuals are normally distributed, the model can deal with non-normality of the residuals. In particular, the error bands for the impulse response functions are bootstrapped and are therefore not subject to any non-normality bias.

¹⁷ It should be noted that the coefficient as depicted in the table has the opposite sign. Bringing the coefficient to the other side of the equation to find out the impact on the normalized variable would change the sign.

¹⁸ I.e. they have a significant negative coefficient.

movements in the oil price in recent years, as well as potential structural changes e.g. due to the establishment of an oil stabilization fund, it is therefore necessary to check for parameter nonconstancy. At the same time, identifying structural breaks would be interesting to see whether Russia's dependency on oil has become weaker. Starting from a base sample,¹⁹ the estimations are performed recursively for increasing samples. There are two different ways of doing this. In one all the parameters are reestimated in each step, in the other only the long-run parameters are reestimated. The recursive estimations are, thus, performed for the full and the concentrated model, where adjustment exclusively takes place towards the long run equilibrium relations. The full model, including all the short run adjustment, provides very similar results but is more unstable in the beginning of the estimation period due to the relatively short baseline sample and reduced degrees of freedom as compared to the concentrated model. This can be seen for example in the recursive test of the likelihood function. This test is similar to a Chow structural break test for single equation models. As can be seen in Figure A4.1 of the appendix, the full (X) model shows some signs of instability in the very beginning of the estimation period. This is not unusual due to the short structure of the model. The likelihood function of the concentrated (R1) model on the other hand clearly cannot reject the null hypothesis of no structural break at the five percent level (the 1 line represents the 95 confidence interval).

Figure 4.4: Recursive Estimation of the Coefficient of oil for the GDP equation



Source: Author's estimations

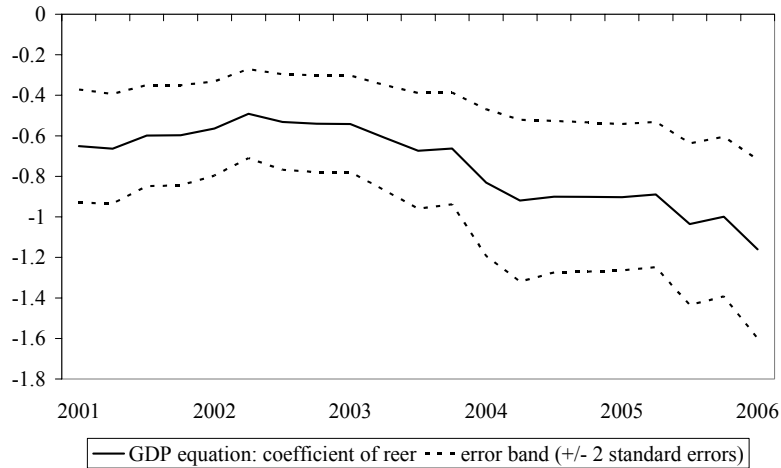
The recursive estimations in Figures 4.4 and 4.5 depict the concentrated model.²⁰ As can be seen in Figure 4.4 the coefficient of the oil price stays more or less the same over time. The

¹⁹ In the current model the base sample runs from 1995:1 to 2000:4.

²⁰ The recursive estimations of the two models provide very similar results. For the recursive estimations of the full model see Figure A4.2 of the appendix. For the full model, the coefficient of oil in the GDP equation seems to have become even larger over time.

resulting recursive coefficient of oil confirms that the relationship between GDP and oil prices does not seem to have become weaker in recent years. On the other hand, the coefficient for the real exchange rate seems to have an increasingly negative effect on Russian GDP growth. Running the model over the whole sample period still seems to be appropriate, however, as the tests for constancy of the β coefficients cannot be rejected.²¹

Figure 4.5: Recursive Estimation of the Coefficient of REER for the GDP equation



Source: Author's estimations

The above finding is compatible with flat GDP growth since 2001 as the real exchange rate – endogenously responding to the rise in oil prices - appreciated during that period and the negative impact of the real exchange rate on GDP growth seems to have become stronger (see Figure 4.5). This shows that looking at partial correlations without accounting for the effect of third variables can be misleading.

The Impulse Response Analysis

To find out more about the reaction of GDP to oil prices in the long run and to see to what extent the real exchange rate reacts to the oil price, the following section analyzes the dynamic properties of the estimated VECM. For this purpose the reaction of each variable to a 1 percent shock in the price of oil is simulated. There are several ways of calculating the error bands for the impulse responses. The construction can be based on analytical derivatives, on Monte Carlo simulations or on the bootstrap methodology. The error bands for this exercise are created with a bootstrap procedure, where the errors of the estimated model are randomly reshuffled and used to construct new bootstrap endogenous variables. The parameters are then re-estimated from the generated data and impulse response functions are calculated. This

²¹ Figure A4.3 of the appendix displays the test for Beta constancy. Note that the fluctuations in the test statistics do not necessarily signify non-constancy. The test has to be read in such a way that all test statistics below 1 (the 95 confidence interval) can reject the null hypothesis of no constancy in the parameter.

procedure is repeated a large number of times (500 times in this application) and the resulting distribution is taken to calculate the appropriate error bands. Error bands calculated with this bootstrap routine are robust against non-normality of the residuals.²² In this study the confidence interval is chosen at the 95 percent confidence interval.²³

As shown in the Figure 4.6, the output response to a permanent shock in the oil price is positive and statistically significant. The cumulative effect of a one percent increase in oil prices on GDP, which takes into account the endogenous reaction of all the other variables, is estimated to be around 0.24 percent (as compared to the 0.7 *ceteris paribus* effect of the oil price on GDP). This number is comparable with the long run impact of oil prices on Russian GDP found in other studies.²⁴ The impulse response of the real exchange rate suggests that - in the long run - the real exchange rate reacts with an appreciation to a positive shock in the oil price. This finding confirms that the overall impact of a positive oil price shock on GDP is dampened by an intrinsic real appreciation. The significant real depreciation in the short run (3 quarters) could be explained by the fact that rising oil prices directly lead to higher inflation in the economy of Russia's trading partners through higher import prices, while the domestic energy prices in Russia are still kept at below-market prices. In the longer run, the second round effects of higher inflation in Russia due to rising wages and increased wealth appear to prevail and lead to a real appreciation of the rouble.²⁵ The impulse response of real revenues shows that a permanent positive shock to the oil price increases real revenues in the long run. The long-run elasticity is above unity implying that besides the direct positive effect due to increased revenues through taxation on oil, revenues also increases due to the overall improvement of the economic situation. As a robustness check Figure A4.4 of the appendix shows the impulse responses of the unrestricted model. Although the elasticities for all variables seem to be lower for the unrestricted VAR model, the overall significant positive impact of oil on GDP, the real exchange rate and real revenues is confirmed.²⁶

²² Note that the point estimate of the impulse response does not necessary have to be at the centre of the error bands due to possible non-normality of the residuals. In this study the residuals seem to be normally distributed as confirmed by the test for normality described above.

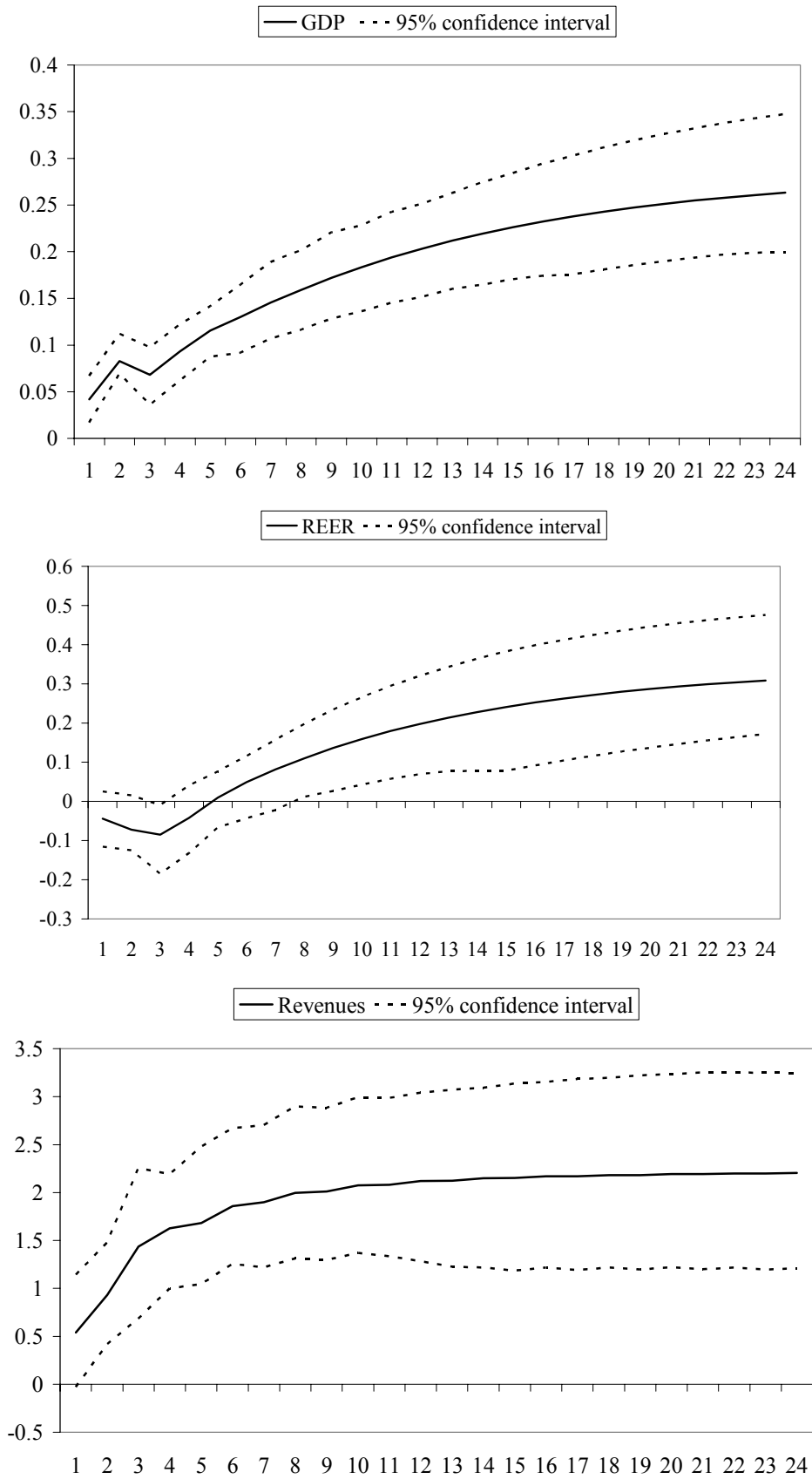
²³ In the empirical VAR literature typically either 95 percent or 68 percent confidence intervals are reported. While for this analysis the more precise 95 percent confidence interval is reported, Sims and Zha (1999) argue that the use of 68 percent confidence intervals can also be justified.

²⁴ For example, the IMF (2002) finds an elasticity of similar magnitude.

²⁵ Habib and Kalamova (2006) find similar results for Russia.

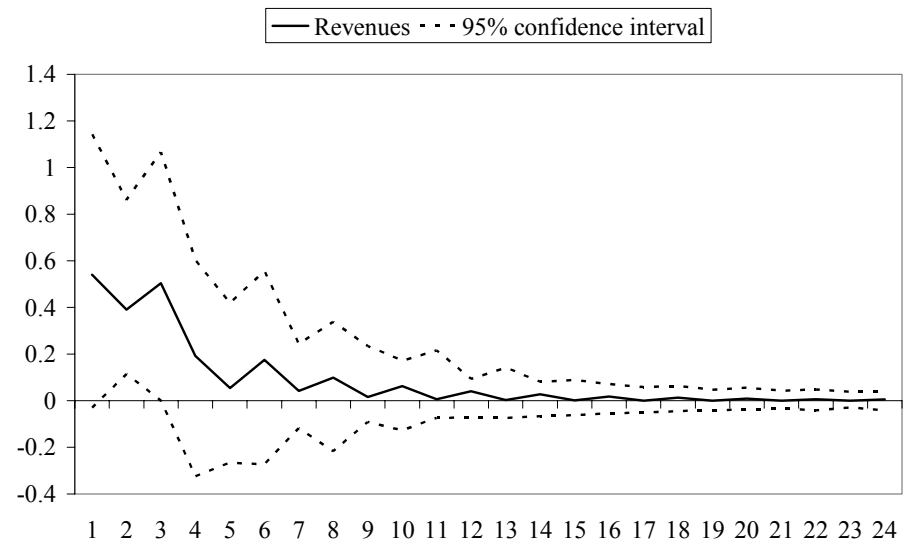
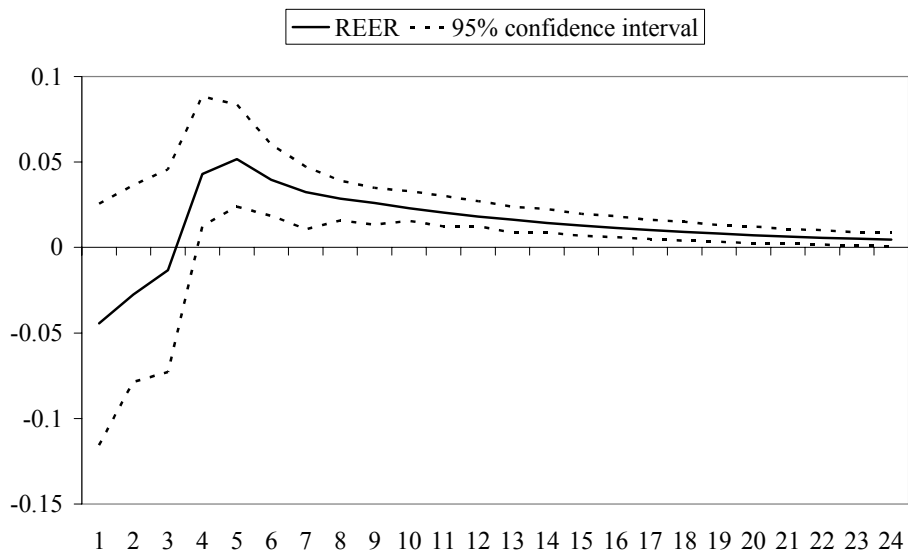
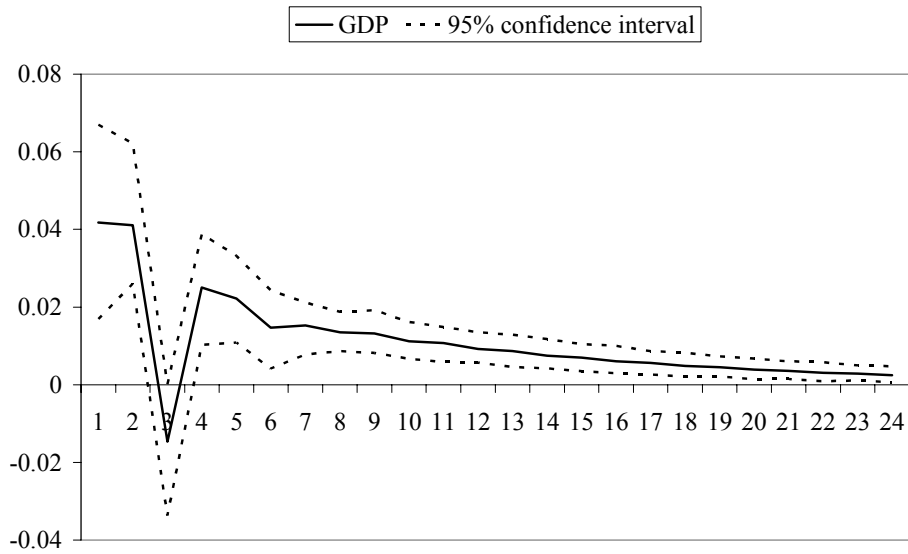
²⁶ Note that the results of the unrestricted VAR analysis are only discussed as a robustness test. Given the results of the rank tests which are adjusted for short samples, there is very strong evidence of two cointegration relationships.

Figure 4.6: Permanent oil price shock



Note: Point estimates with bootstrapped error bands.

Figure 4.7: Temporary oil price shock



Note: Point estimates with bootstrapped error bands.

Figure 4.7 presents the impulse responses of the variables to a temporary shock to the oil price. While the responses are relatively more volatile and the amount of the response is as expected much lower, the impulse responses of the temporary shock show rather persistent effects of an oil price shock of around 4 years on GDP and the real exchange rate. This strong persistence is not surprising given the low speed of adjustment as described above.

As robustness test the model was also estimated using different specifications. Using Russian Ural oil prices instead of North Sea Brent does not change the estimates qualitatively. The model is robust regarding the choice of cointegration relationships. The impulse responses and long-run elasticities of GDP and the real exchange rate are almost identical regardless of the number of cointegration relations. Likewise, the choice of the identifying restrictions does not affect the impulse responses either.

4.3 An Error Correction Model for Russian Imports

To find out more about the reasons for the negative reaction of GDP with respect to the real exchange rate I take a closer look at the import behaviour of the Russian economy. The expenditure switching effect of the exchange rate is likely to be felt predominantly for imports as Russian exports are mainly invoiced in vehicle or in local currency and thus not subject to fluctuations in the exchange rate as described above.²⁷ I would expect imports to increase following a real appreciation.

The following error correction model (ECM) for real imports is estimated for quarterly data from 1995 Q1 to 2006 Q1:

$$\Delta im_t = -4.97 - 0.65[im_{t-1} - (1.28 exdd_{t-1} + 0.70 reer_{t-1} + 0.11 oil_{t-1})] + short-run dynamics + dummies \quad (4.3)$$

(-4.07) (-4.50) (4.13) (4.28) (2.57)

$$R^2 \text{ adj} = 0.92; DW = 2.06; AR(1) = 0.84; AR(4) = 0.68; AR(8) = 0.53$$

where *im* stands for real imports of goods and services, *exdd* stands for real exports plus real domestic demand, *oil* is the US dollar price of oil and *short-run dynamics* includes the differences of the explanatory variables at the lag level chosen by the optimum lag length selection criteria of Akaike, Schwarz and Hannan Quinn up to a maximum lag length of 6.²⁸

²⁷ At the same time, the demand for oil as a major export good is likely to be highly price inelastic. For more details concerning Russia's non-oil export trade elasticities see Gianella and Chanteloup (2005) and Algieri (2004).

²⁸ As the data for Russia is available on a quarterly basis, the maximum lag length of 6 in this dataset is comparable to the maximum lag length of 2 for the annual dataset of the oil exporter panel.

Dummies includes two dummies for the periods of 1998:3 and 1998:4 capturing the effect of the 1998 crisis. The short-run dynamics are not listed in details.²⁹

In this specification the long-run elasticity of imports with respect to exports and domestic demand is 1.3 which is comparable with estimates for other countries.³⁰ The long-run elasticity with respect to the real exchange rate is 0.7 suggesting that Russian imports which are almost exclusively invoiced in foreign currency such as the euro indeed respond considerably to changes of the real effective exchange rate.³¹ The long-run elasticity with respect to the oil price is 0.1. Thus, some of the increase in oil revenues due to higher oil prices seems to be spent on imports. The elasticities for the activity variable and for the oil price compare with the long-run elasticities found in the panel of all oil exporting countries. The elasticity with respect to the exchange rate is higher than for the panel estimations. One reason could be that for this analysis the real effective exchange rate of overall trade and not only of imports is used. This overall exchange rate is likely to show less fluctuation (precisely because pass through into export prices would be small), so that the same appreciation in this version of the exchange rate provokes more pronounced reactions of imports. It should also be mentioned that for this specification of Russia's import demand the fiscal variable proved to be insignificant for the long-run relationship.³² This might be a sign that the stabilisation fund so far has not changed the behaviour of the Russian economy in a significant way. Already in the analysis of Russia's GDP dependence on oil over time, no structural break could be found for the introduction of the oil stabilization fund. This can be interpreted in a positive way that the introduction of the stabilization fund did not reduce the positive impact high oil prices had on the Russian economy. At the same time, international worries that the establishment of such a fund would significantly reduce Russia's willingness to import also prove to be ungrounded. The oil stabilization fund, thus, seems to be an efficient tool in saving for future generations without harming current economic development.

4.4 Conclusion

Summing up the presented econometric findings, it appears that GDP growth in Russia is still benefiting from high oil prices. Indeed, Russia's GDP growth appears to be still as dependent on the oil price as it used to be while real appreciation - endogenously triggered by rising oil

²⁹ Details are available from the author on request.

³⁰ See discussion in chapter 3.

³¹ These estimates compares with the 1.6 demand elasticity and the 0.5 price elasticity of Russian imports in Gianella and Chanteloup (2005).

³² The inclusion of the fiscal variable did not lead to significant changes of the long-run elasticities of the other variables.

prices - is increasingly acting as a “buffer” by stimulating imports. The introduction of the oil stabilization fund in 2004 does not seem to have taken away the positive impulses of the oil price on GDP. On the other hand, GDP growth did not follow the explosive development of oil prices one to one as the economy has increasingly been affected by the appreciating real exchange rate. This appreciation significantly stimulates imports and, thus, puts some restraint on GDP growth. The appreciation of the real exchange rate seems to be brought about among others by rising oil prices. So far, this development is, however, a natural process following a positive terms of trade shock and accompanying the transition of the economy to a full market economy. Further research on the welfare implications of the oil price and the real exchange rate on the Russian economy could be interesting.

4.5 References

- Algieri, Bernadina (2004). Price and Income Elasticities of Russian Exports. *The European Journal of Comparative Economics* Vol. 1(2), pp. 175-193.
- Aivazian, S.A., S.V. Borisova, E.A. Lakalin, and V.L. Makarov (2003). Econometric Modelling of the Russian Economy. *Acta Applicandae Mathematicae* Vol. 78, pp. 3-19.
- Beck, Roland, Annette Kamps, and Elitza Mileva (2007). Long-Term Growth Prospects of the Russian Economy, ECB mimeo, January 2007.
- Bjørnland, Hilde Christiane (2000). The Dynamic Effects of Aggregate Demand, Supply and Oil Price Shocks – a Comparative Study. *The Manchester School*, Vol. 68 (5), pp. 578-607.
- Butorina, Olga. (1999). Euro and Russia. Moscow State Institute of International Relations. Online available from the website <http://www.ecu-activities.be/>: http://www.ecu-activities.be/documents/publications/publication/1999_1/butorina.html
- Cashin, Paul, Luis Felipe Céspedes, and Ratna Sahay (2002). Keynes, Cocoa, and Copper: In Search of Commodity Currencies. IMF Working Paper 02/223, Washington.
- Cashin, Paul, Luis Felipe Céspedes, and Ratna Sahay (2004). Commodity Currencies and the Real Exchange Rate. *Journal of Development Economics* Vol. 75, pp. 239-268.
- CATS, Cointegration Analysis: Version 2. Add-on for RATS. Written by Jonathan G. Dennis, Katarina Juselius, Søren Johansen and Henrik Hansen of the University of Copenhagen.
- Égert, Balázs (2005). Equilibrium exchange rates in South Eastern Europe, Russia, Ukraine and Turkey: Healthy or (Dutch) diseased? *Economic Systems* Vol. 29(2), pages 205-241.
- Égert, Balázs and Carol S. Leonard (2006). The Dutch Disease in Kazakhstan: An Empirical Investigation. OENB Focus on European Integration 2/06, Vienna.
- Gianella, Christian and Corinne Chanteloup (2006). Assessing Russia’s non-fuel trade elasticities: does the Russian Economy react “normally” to exchange rate movements? OECD Economics Department Working Paper No. 510. Paris.
- Habib, Maurizio and Margarita Kalamova (2006). The oil price and real exchange rates of oil exporting countries. ECB mimeo, Frankfurt.

- Hamilton, James D. (1996). This is what happened to the oil price-macroeconomy relationship. *Journal of Monetary Economics* Vol. 38, pp. 215-220.
- Hamilton, James D. (2003). What is an oil shock? *Journal of Econometrics* Vol. 113, pp. 363-398.
- Hansen, Henrik and Søren Johansen (1999). Some tests for parameter constancy in cointegrated VAR-models. *Econometrics Journal* Vol. 2, pp. 306-333.
- Hutchison, Michael (1993). Structural change and the macroeconomic effects of oil shocks: empirical evidence from the United States and Japan. *Journal of International Money and Finance* Vol. 12, pp. 587-606.
- IMF (2006). Country Report No. 06/429, December 2005, Washington.
- IMF (2005). Country Report No. 05/377, October 2005, Washington.
- IMF (2002). Country Report No. 02/74, April 2002, Washington.
- Jiménez-Rodríguez, Rebeca and Marcelon Sánchez (2004). Oil Price Shocks and Real GDP Growth. Evidence for Some OECD Countries. ECB Working Paper No. 362, Frankfurt.
- Johansen, Søren (1988). Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamics and Control* 12(2-3), pp. 231-254.
- Johansen, Søren (1991). Estimation and Hypothesis Testing of Cointegrating Vectors in Gaussian Vector Autoregressive Models. *Econometrica* 59 (6), pp. 1551-1580.
- Johansen, Søren (2002). A Small Sample Correction of the Test for Cointegrating Rank in the Vector Autoregressive Model, *Econometrica* Vol. 70, pp. 1929-1961.
- Koranchelian, Taline (2005). The Equilibrium Real Exchange Rate in a Commodity Exporting Country: Algeria's Experience. IMF Working Paper 05/135.
- Ministry of Finance (2006). Stabilization fund of the Russian Federation. Online available: http://www1.minfin.ru/stabfond_eng/about_eng.pdf, January 2007.
- Rautava, Jouko (2004). The role of oil prices and the real exchange rate in Russia's economy – a cointegration approach. *Journal of Comparative Economics* Vol. 32, pp. 315-327.
- RIAN (2007). Russian News and Information Agency. Russia's Stabilization Fund up 7% month-on-month Jan. 1, 10 January, Moscow. Online available as of January 23: <http://en.rian.ru/business/20070110/58838072.html>
- Rosstat (2006). Main Indicators of the System of National Accounts. Online available: <http://www.gks.ru/wps/portal/english>.
- Juselius, Katarina (2003). The Cointegrated VAR Model: Econometric Methodology and Macroeconomic Applications. University of Copenhagen. Online available: <http://www.econ.ku.dk/okokj/plan03.htm>.
- Sims, Christophe A. and Tao Zha (1999). Error Bands for Impulse Responses. *Econometrica* Vol. 67(5), pp. 1113-1155.
- Sosunov, Kirill and Oleg Zamulin (2006). Can Oil Prices Explain the Real Appreciation of the Russian Ruble in 1998-2005? CEFIR/NES Working Paper No. 83, September 2006.
- Spilimbergo, Antonio (2005). Measuring the Performance of Fiscal Policy in Russia. IMF Working Paper No. 05/241. Washington.
- World Bank (2004), Russian Economic Report No. 7, February 2004, The World Bank, Moscow, Russia.

4.6 Appendix

Table A4.1: Test for variable exclusion

r	DGF	5% C.V.	REER	Revenues	GDP	Brent	constant
1	1	3.841	1.719	10.304	4.952	0.002	5.226
			[0.190]	[0.001]	[0.026]	[0.964]	[0.022]
2	2	5.991	18.466	30.045	7.808	7.580	13.181
			[0.000]	[0.000]	[0.020]	[0.023]	[0.001]

Note : LR-test, Chi-Square (r), P-values in brackets.

Table A4.2: Test for weak exogeneity

r	DGF	5% C.V.	REER	Revenues	GDP
1	1	3.841	0.172	8.436	1.965
			[0.678]	[0.004]	[0.161]
2	2	5.991	11.037	15.999	27.746
			[0.004]	[0.000]	[0.000]

Note : LR-test, Chi-Square (r), P-values in brackets.

Table A4.3: Lag Length Determination

lags	Log-like	Schwarz	Hannan-Quinn
5	452.976	-16.009	-17.950
4	439.201	-16.427	-18.044
3	428.321	-16.989	-18.283
2	395.420	-16.451	-17.421
1	378.641	-16.719	-17.366

Note: Effective Sample: 1996:2 to 2006:1

Table A4.4: Tests for misspecification

Tests for Autocorrelation

Ljung-Box(10):	ChiSqr(66) =	91.802 [0.020]
LM(1):	ChiSqr(9) =	8.363 [0.498]
LM(2):	ChiSqr(9) =	7.941 [0.540]

Test for Normality: ChiSqr(6) = 3.671 [0.721]

Test for ARCH:

LM(1):	ChiSqr(36) =	22.439 [0.962]
LM(2):	ChiSqr(72) =	78.637 [0.277]

Figure A4.1: Test for structural breaks

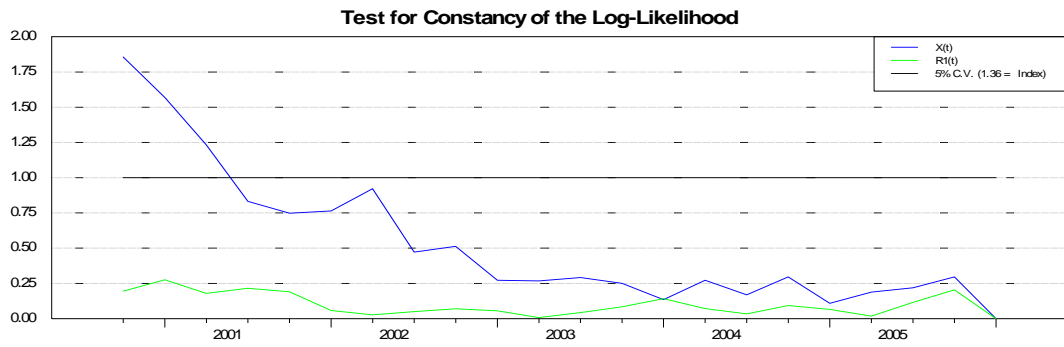


Figure A4.2: The full model recursive estimations

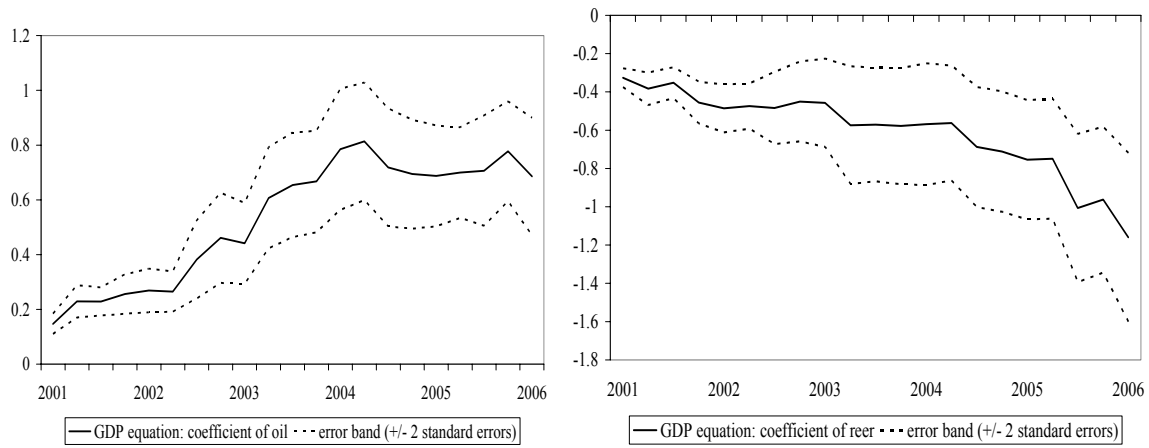


Figure A4.3: Test of Beta Constancy

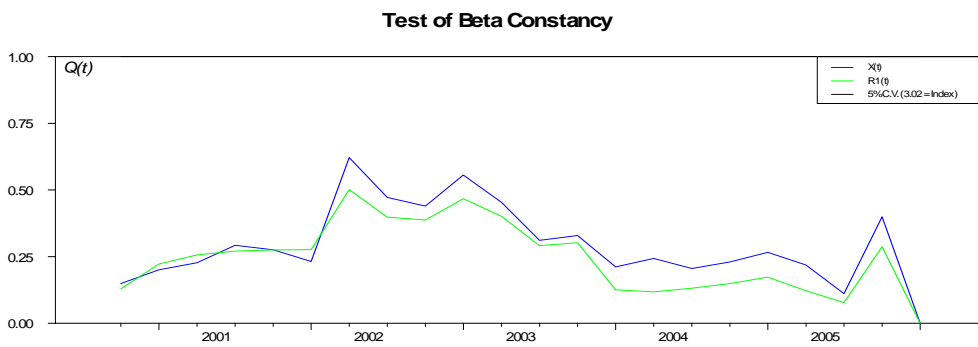
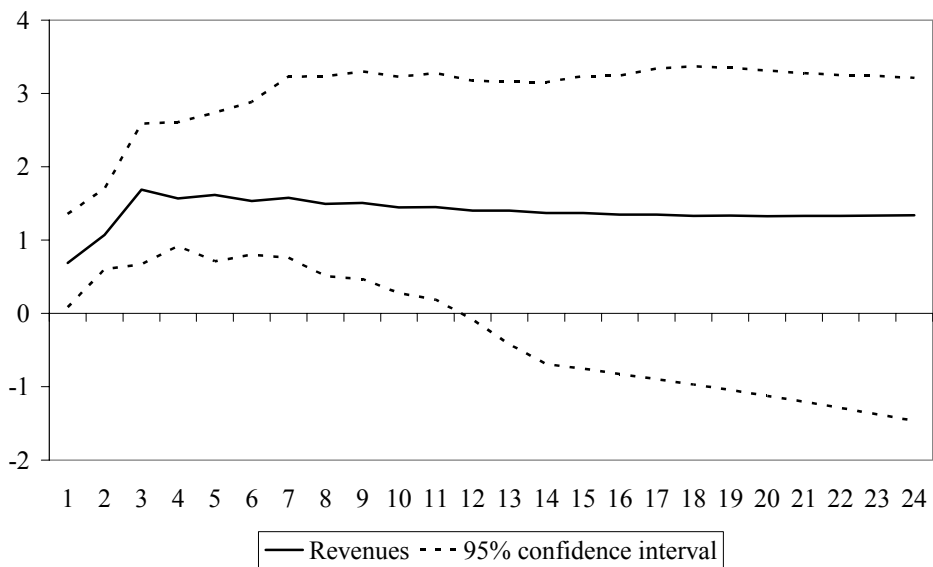
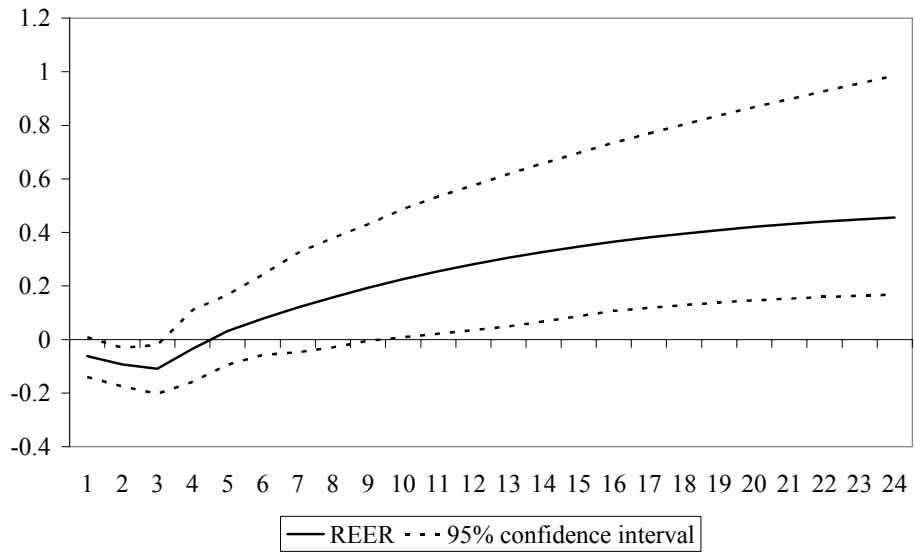
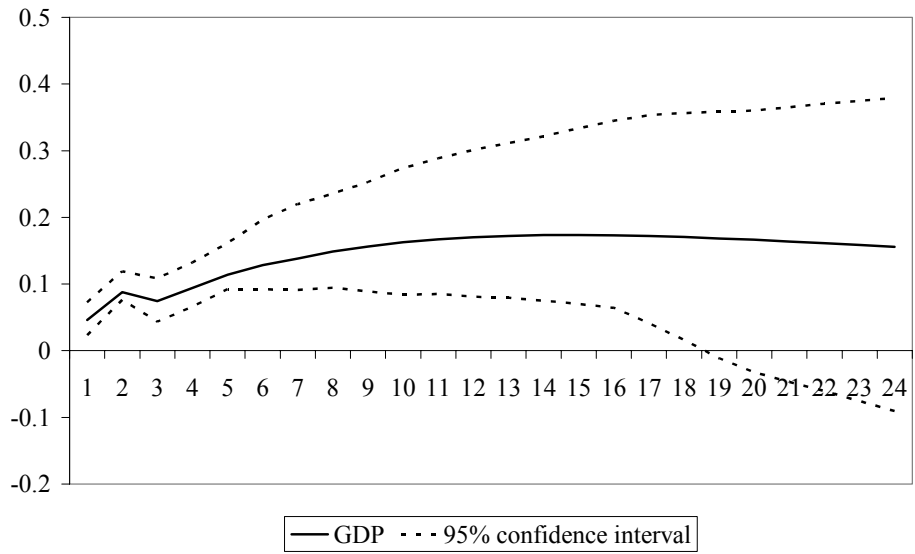


Figure A4.4: Impulse Responses of the unrestricted VAR model



5 The International Transmission of Monetary Shocks: Evidence for Selected OECD Countries*

This paper examines the international transmission of monetary policy shocks both in the context of flexible exchange-rate regimes and in the case where one country adopts unilaterally fixed exchange rates. Do other OECD countries undergo a recession because there is an unanticipated interest rate increase in the United States or do they profit from the increased competitiveness through the appreciation of the dollar? Are countries with a flexible exchange rate able to isolate from international monetary policy shocks and do they conduct independent monetary policies or is there a positive correlation between interest rates? Even though these questions have long been discussed theoretically, they still remain controversial.

The traditional Mundell-Fleming model established a framework for a straightforward analysis of macro policy transmission. It does not provide unambiguous results, however. In the Mundell-Fleming framework this ambiguity is mostly explained by differences in capital mobility - high capital mobility making a positive foreign output reaction to an increase of home interest rates more likely. While capital markets have become almost perfectly integrated, empirical results show that production in most countries seems to be correlated positively even though the standard Mundell-Fleming would suggest an asymmetric transmission of monetary policy shocks under flexible exchange rates and high capital mobility.

This paper investigates whether there is a mismatch between traditional theory and empirical evidence and whether more elaborate models of the New Open Economies Macroeconomics (NOEM) provide an alternative framework that better fits the empirical findings. In the second section the paper gives a short summary of the most important theoretical models used for analyzing international monetary transmission. In the third section, I estimate a Vector Autoregression (VAR) model to provide empirical evidence on the direction of output movements following an international monetary policy shock. To find out whether the exchange-rate regime affects the direction of business cycle transmission, I analyze two sets of countries. The first group of countries, which include the United States, Germany and Japan, follow a flexible exchange-rate regime. In the second set, which comprises Germany, the Netherlands and Austria, exchange rates are unilaterally fixed over the period analyzed. The fourth section concludes by summarizing the main findings.

* This chapter previously appeared in *Applied Economics Quarterly* Supplement, Issue 54, 2003, pp. 125-42 (under my maiden name Kuhn). Reprint permission kindly granted by Duncker & Humblot, Berlin.

5.1 Theoretical Background

When analyzing the international transmission of monetary shocks in an open economy the Mundell-Fleming model is the standard theoretical framework. In the early 1960s, Mundell (1962) and Fleming (1962) independently developed a model to describe the international transmission of national macro policies. At that time, when exchange rates were still fixed under the Bretton Woods system, their major concern was to determine whether countries were able to use their national monetary policies to bolster shocks to the economy. They found that, if exchange rates are fixed and capital mobility is high, central banks of small countries cannot conduct independent monetary policies. Instead, the interest rates are bound by the world interest rate.

After the breakdown of the Bretton Woods system, the standard Mundell-Fleming model had to be adjusted to take into account movements of the exchange rates. Dornbusch (1976) introduced rational expectations of the exchange rate into the model and thus provided the basis for a large body of research on exchange rates. In this Mundell-Fleming-Dornbusch (MFD) framework economies are linked via the exchange rate. An unexpected increase in the interest rate of one country in this model, say the United States, leads to capital inflows into the US resulting in an appreciation of the dollar. As a consequence for uncovered interest rate parity to hold this appreciation has to be so strong that it generates the expectations of a future depreciation of the dollar. This is the so-called overshooting effect. In this sticky price model the interest rate increase has an impact on real variables in the short run. US output is bound to fall as a reaction to the contractionary policy. The impact on foreign output is ambiguous, however. The reduction in US output lowers aggregate demand and thus dampens foreign output – the so-called income absorption effect. The expenditure switching effect on the other hand brings about an increase in foreign output: As prices cannot adjust in the short run, the nominal appreciation leads to a proportional real appreciation¹ making US products more expensive than foreign ones. Demand is switched in favor of foreign products. The early MFD model put more emphasis on the exchange rate mechanism, claiming that the latter effect prevailed, so that an increase in the US interest rate unambiguously led to a rise in foreign output and thus an asymmetric movement in the output of both economies. Wohltmann and Clausen (2001) claim, however, that only a country with low interest rate sensitivity of

¹ This appreciation is both in nominal and real terms when prices are sticky. Kollmann (2001) finds that real exchange rates follow the nominal exchange rate almost one to one, contrary to what the Real Business Cycles theory that postulates flexible prices predicts.

demand can benefit from the expenditure switching effect. For a country with a high interest rate sensitivity of demand, the negative effect of the crowding out through higher real interest rates dominates the improvement of the trade balance.²

In a system of credibly fixed exchange rates real interest rates have to be equal because the expected change in the exchange rate is zero. After an unanticipated increase of the US interest rate, the foreign interest rate has to increase by the same amount, thus directly passing through the contractionary impulse to the foreign economy. In this case the output in both economies contracts and they exhibit symmetric movements. The standard MFD model therefore predicts a symmetric output reaction in the case of fixed exchange rates and an asymmetric (or ambiguous) reaction in the case of freely floating exchange rates.

Do these results carry over to the modern micro-founded models of the NOEM?³ Obstfeld and Rogoff (1995) introduced a monopolistic supply side into their Redux model. The most fundamental innovation of the Obstfeld-Rogoff (OR) model was, however, the introduction of micro foundations by incorporating individual utility maximization. This extends the standard MFD model to an analysis of wealth and welfare effects. Even if one is not interested in these effects per se, they still have to be taken into account when analyzing output effects because they change individuals' behavior and reaction to monetary shocks. In this framework, the real interest rates are determined by the inter-temporal rate of preference of the representative consumer. In two economies with identical goods and identical preferences the real interest rate thus always has to be the same across countries.

In the Redux model, a permanent increase in the nominal interest rate of one country raises the real world interest rate in the short run – while the real interest rate in the long run is bound by the rate of time preference. At the same time the home currency appreciates. This appreciation leads to a current account deficit via the expenditure switching effect. However - this is where the story starts to differ from the standard MFD model -, it also decreases home's long run wealth. With the current account deficit, home loses claims on future output to the foreign country (wealth effect). Because home now faces relatively lower wealth it substitutes labor for leisure (welfare effect) – increasing the output of goods. This lowers the price of domestic goods in the long run leading to a deterioration of the terms of trade, which makes an overshooting appreciation unnecessary. As a result, the nominal exchange rate

² Clausen (2001:18) suggests that the structure of aggregate demand may be responsible for different interest rate sensitivities of demand. If a high share of aggregate demand in the foreign country is interest-sensitive investment, an increase in the world interest rate is more likely to lead to a contraction in foreign output.

³ For a literary survey on the NOEM see Lane (2001).

immediately reaches its new long run equilibrium as in the case with completely flexible prices. The consequences for real variables, however, are very different.

Through the introduction of wealth into the model, a permanent increase in the nominal interest rate⁴ can have long run effects on real variables. The main mechanism at work here is consumption smoothing. A reduction in wealth induced by an appreciation of the home currency leads to a permanently lower level of consumption. However, consumption smoothing leads consumption to fall by less than income in the time after the shock, so that the additional demand has to be satisfied with foreign products. Home demands more goods from foreign during the period of the appreciation. With this current account deficit they lose claims to the foreign country. Altogether, a rise in interest rates leads to temporarily higher world interest rates and lowers the international demand for goods. *Consumption* is decreasing in both countries, the effect on foreign *output* is ambiguous, however. Because of the appreciation of the currency some world demand is shifted from home to foreign products, so that the output effect on foreign can be positive. This would then mean that we have an (ambiguous) asymmetric output effect for the two economies as in the case of the standard MFD model.⁵ The OR Redux model, thus, still reaches the same results concerning the effects of monetary policy on output abroad. But the results do differ in their quality as there are different transmission mechanisms and there is no overshooting of the exchange rate. Also, it opened a whole world of possible transmission and interaction channels that is being incorporated in the new body of literature based on the OR model. In the following I will shortly elaborate on the different assumptions that determine the direction of the output effect.

As in the MFD model, asymmetric output effects depend on the relative strength of the expenditure switching mechanism through the exchange rate.⁶ There are, however, extensions of the OR model that challenge this standard expenditure switching mechanism. Betts and Devereux (2000a, 2000b) augment the model by introducing the idea of pricing-to-market. In their model not all goods are priced in the currency of the seller. Instead, part of the goods are priced in the currency of the buyer. In the case of full pricing-to-market, there is no exchange rate pass-through to export prices. There is, therefore, no additional demand for exports and

⁴ In the OR model monetary policy is modeled by changes in the stock of money. A reduction in the money supply leads to an increase in the interest rate. I leave out this step in my analysis.

⁵ In their analysis Obstfeld and Rogoff stress the fact, that even though output effects may be well defined, the effects on welfare do not necessarily provide the same conclusions. In this case, foreign output might be higher than domestic output, but the increased amount of labor necessary to produce this output might actually decrease welfare in foreign and vice versa.

⁶ The expenditure switching effect is higher – an asymmetric output reaction more likely – the higher international capital mobility.

monopolist producers do not expand their production, instead they increase their profits because of a higher mark-up. In this case the only transmission channel for foreign output is the lower overall demand due to the higher world interest rate. This model, thus, predicts symmetric movements in foreign and home output.

Tille (2001) also challenges the standard expenditure switching effect by allowing for different elasticities of substitution across and within countries in the OR framework.⁷ When there is a rise in home interest rates followed by an appreciation of the home currency, the demand for foreign output only increases if foreign goods are substitutes to home goods. Otherwise, the overall effect of the higher world interest rate will prevail and dampen foreign activity, so that there is a symmetric output reaction in the home and the foreign country.⁸

So far, I have considered symmetric movements in output due to a lack of expenditure switching. Another interesting case is when the most important transmission channel is no longer the exchange rate, but when the co-movement of international interest rates causes a positive output correlation. Borondo (2000) develops an extension of the OR model in which central banks follow a specific interest rate rule stabilizing the price level. Through this rule, the interest rate becomes endogenous. In the case of a shock to the home interest rate rule, the currency appreciates and the terms of trade improve in favor of the home country. Import prices and with them the foreign consumer price level increase. This causes the foreign central bank to raise interest rates as well. The interest rate increase along with the overall reduced demand from the home country more than offset the positive expenditure effect, so that we end up with a symmetric output movement.

In summary, the standard MFD model predicts an asymmetric movement of home and foreign output as a reaction to an unanticipated increase in the home interest rate in an environment of flexible exchange rates. Even though this framework also allows for ambiguous results, the emphasis on the exchange rate channel makes the asymmetric reaction of home and foreign output the most likely result. This ambiguity with a bias towards asymmetric reactions carries over to the Redux model. Extended versions of the NOEM, however, provide a theoretical background that can explain symmetric output movements.

⁷ Low substitutability between home and foreign goods is particularly likely for a small country whose production is highly specialized.

⁸ Hau (2000) developed another way of allowing for a smaller expenditure switching effect by taking into account nontradable goods and home bias. For an overview see also Borondo (2001).

5.2 Empirical Analysis

As a framework for the empirical analysis, I use a Vector Autoregression (VAR), because it sets a minimum of identifying restrictions and does not confine the analysis to a specific theoretical model.⁹ I estimate the reduced form equations of a structural form VAR that describes the economy. To ensure that structural disturbances are mutually uncorrelated I identify the model using a Choleski decomposition. The ordering of the variables sets the restrictions on contemporaneous transmissions of shocks and thus identifies them.

5.2.1 The Econometric Model

The model closely follows Eichenbaum and Evans (1995). It is made up of monthly data¹⁰ for seasonally adjusted industrial production, nominal interest rates, the consumer price indexes and bilateral real exchange rates.¹¹ All variables are in logarithms except for the interest rates. The real exchange rate is calculated by subtracting the relative consumer price index from the nominal exchange rate. Following Eichenbaum and Evans (1995), I order industrial production and prices first. More specifically, in this VAR model, I impose the recursive ordering $\{y, p, y^*, p^*, i, i^*, q\}$, where y is home industrial production, p is the home consumer price index, i is the home interest rate and q stands for the real exchange rate. Foreign variables are denoted with an asterisk.

This ordering is the only restriction that has to be imposed and it can also be questioned.¹² It seems plausible, however, that real output should not respond to interest rates within the same month. At the same time, the restriction that prices do not react immediately to changes in the interest rate is based on the assumption of sticky prices. Home variables are put ahead of foreign variables because in my two groups of countries the home country is always the large country and thus more likely to have a contemporaneous impact on the foreign (small) country. For the same reason I also put the home interest rate ahead of the foreign one, contrary to Eichenbaum and Evans (1995). This does not change the results qualitatively,

⁹ There are, however, also critics of this approach. Rudebusch (1998) criticizes, that the VAR modeling heavily relies on the assumption that shocks to monetary policy are exogenous and that they cannot mirror the behavior of a (more realistic) endogenous monetary setting (see Christiano et al. (1999) for a survey on different identification assumptions). While researchers are looking for feasible alternatives, the VAR model is still used as the econometric model for analyzing monetary policy transmissions (see for example Kim (2001)).

¹⁰ All data are from International Financial Statistics (IFS).

¹¹ I do not consider the ratio of nonborrowed to total reserves which Eichenbaum and Evans (1995) used as a monetary aggregate for the United States. Leaving out this aggregate does not qualitatively change the results of the model.

¹² A whole body of literature about structural VAR models is concerned with finding theoretical arguments for imposing different restrictions also on long-run relationships between the variables. Authors like Bernanke (1986) and Sims (1986) and Leeper et al. (1996) adopt alternative approaches regarding the restrictions of the model. Clarida and Gali (1994) use a structural VAR in a NOEM framework.

however. The lag order of the variables is chosen to be 6, in accordance with Eichenbaum and Evans (1995).^{13,14}

With this VAR model, I investigate the impact of an unanticipated interest rate hike in one country on output in a number of other countries. The first group of countries analyzed are the United States, Germany, and Japan. These countries have adopted floating exchange-rate regimes since the breakdown of the Bretton Woods system. The sample period is 1974:01 to 2002:05. The second group of countries comprises Germany, the Netherlands, and Austria. The latter two countries have had their exchange rates fixed vis-à-vis the D-Mark.¹⁵ Here, the sample period is 1974:01 to 1998:12, because these countries have had the same monetary policy conducted by the European Central Bank since 1999. I include two dummy variables for German reunification to take into account the structural break that occurred in Germany in the beginning of the 1990s.¹⁶

5.2.2 Empirical Results

In the following I present the impulse responses for a shock to the home interest rate. To assess the statistical significance of these results it is essential to include the appropriate error bands to the impulse responses into the analysis. I use error bands computed by a Monte Carlo Integration following Sims and Zha (1999). The authors suggest that the use of conventional one or two standard error bands can be misleading as impulse responses have highly asymmetrical distributions. As a result, they suggest using fractiles with 0.16 and 0.84 instead of the one standard deviation band and fractiles of 0.025 and 0.975 rather than two standard deviations.

I am interested in the co-movements of home and foreign output after a shock to the home interest rate. The results are summarized in Figures 1 to 4. In a first step, I check whether the unanticipated interest rate increase at home has the expected effects on home variables. Figure 1 and Figure 2 (column ‘i-US’, row ‘Y-US’) show the impact of the shock to the US federal funds rate on industrial production in the United States. I find that, in line with theoretical predictions, output of the home country is reduced by this “contractionary shock”.

¹³ The analysis of several information criteria proved to be inconclusive, suggesting between 3 and 13 lags.

¹⁴ A test for cointegration in the VAR suggested that there might be about 2 cointegration relations in the model. I refrained from estimating a Vector Error Correction model, however, following Sims, Stock, and Watson (1990) who claim that this is unnecessary as the cointegration relation is implicitly estimated in the general VAR model.

¹⁵ In the exchange rate classification database by Levy-Yeyati and Sturzenegger (2002) which considers “de facto” exchange rates these economies are identified as fixed exchange-rate systems. In a more refined distinction of the database the Netherlands are sometimes listed as following a “dirty or crawling” peg.

¹⁶ These are two 0/1 dummies. The first one takes the value of one during the period of 1991:01 and 1992:12 and the second one takes the value of one during the period of 1993:01 and 1993:03 (Sachverständigenrat 2001).

The same result holds in the case where Germany is the home country (Figure 3: i-D, Y-D; Figure 4: i-D, Y-D).¹⁷

Concerning the reaction of foreign output, I find, that industrial production in Germany and Japan fall following the unanticipated increase in the federal funds rate (Figure 1: i-US, Y-D; Figure 2: i-US, Y-J).¹⁸ Surprisingly, I get the same results, when looking at the reaction of Dutch and Austrian industrial production to an increase in the German interest rate (Figure 3: i-D, Y-NL; Figure 4: i-D, Y-A). One should have expected different co-movements as these countries belong to a different exchange-rate system. Thus, I ask, whether the impact of the exchange rate transmission mechanism is maybe not as big as predicted by theory.

As discussed in Section 2, the transmission of the exchange rate works via an expenditure switching process. The reaction of the D-Mark and Yen exchange rates vis-à-vis the dollar are similar to what Eichenbaum and Evans (1995) labeled a “delayed overshooting”. The dollar appreciates against both currencies and – in contrast to the predictions of the Dornbusch (1976) model – the appreciation continues for an extended period of time (Figure 1: i-US, q; Figure 2: i-US, q).¹⁹ So why, then, does this depreciation of the D-Mark and the Yen not lead to a positive impulse for the relevant industrial production? There are two reasons why this transmission mechanism as described by the standard theory might fail. First, the exchange rate movement could leave foreign output unchanged because the depreciation of the foreign currency does not have the expected positive impact on foreign output. From the impulse responses I can indeed observe that a shock to the real exchange rate does not seem to have any significant impact on either German or Japanese output (Figure 1: q, Y-D; Figure 2: q, Y-J). This could be due to pricing-to-market as described in Section 2. Second, a positive expenditure switching effect on output could be outweighed by a more than proportional negative effect of a higher world interest rate.

To determine which variables have the highest power of explanation for the movement in foreign output, I conduct a forecast-error-variance decomposition. The power of explanation of the autoregressive part of the model becomes lower as the other variables gain importance

¹⁷ Surprisingly, home prices increase after the interest rate hike. This price puzzle has also been observed by other studies. It has been suggested by Holstein (1999), that this reaction might be due to central banks’ anticipation of an impending rise in prices. However, this explanation does not go along well with the theory and the VAR modeling in which monetary policy has to be completely exogenous and the shock to the interest rate has to be completely unanticipated. We experimented with including the HWWA index for world commodities into the model, as we suspected a misspecification. Including this index made the reaction of prices close to statistically insignificant.

¹⁸ In Japan, however, the fall in production is statistically not significantly different from zero.

¹⁹ Pierdzioch (2003) shows that adding noise trading to a pricing-to-market NOEM model helps to explain both nominal and real “delayed” overshooting.

with time. For German output, the explanatory power of the federal funds rate rises to more than 28 percent after four years (Table 1). Surprisingly, the U.S. interest rate seems to have more impact on German output than the German interest rate, which can only explain 13 percent of the fluctuation in German output after four years. Another important message for my analysis is the almost negligible explanatory power of exchange rate movements. This is an indicator for the fact that the exchange rate transmission mechanism may be less important than expected.²⁰ The forecast-error-variance decomposition for Japan provides a slightly different picture. Here, neither the exchange rate nor the interest rates seem to provide much explanatory power for the movement in Japanese industrial production. This is probably due to the fact that the traditional monetary transmission mechanism in Japan has been disturbed since the bursting of the bubble in the beginning of the nineties. If we run the regression only up to the year 1990, the federal funds rate has very high and the exchange rate some explanatory power (Table 1).

These results suggest that the foreign interest rate is quite essential in explaining output abroad, while the transmission channel does not seem to be the exchange rate as suggested by the standard MFD theory. Rather, there is a significant co-movement in interest rates, which could be the reason for the symmetric output reaction. The impulse responses for the Netherlands and Austria give an idea of the importance of this direct transmission via the co-movement of interest rates.²¹ With unilaterally fixed exchange rates the small country cannot follow an independent monetary policy. Therefore, the national interest rates have to move proportionally for the uncovered interest rate parity to hold. The empirical results confirm this theoretical finding. Dutch and Austrian interest rates move almost proportionally to the German interest rate (Figure 3: i-D, i-D; i-D, i-NL, Figure 4: i-D, i-D; i-D, i-A). These findings fit in well with what standard theory predicts and they provide a good explanation for symmetric output movements.

If I compare these results with the ones I get for the supposedly flexible exchange-rate systems, I can see that the symmetric co-movements in output can probably be attributed to the strong co-movements in interest rates.²² They do not move proportionally (Figure 1: i-US, i-US; i-US, i-D; Figure 2: i-US, i-US, i-US, i-J), however, so that some of the adjustment has

²⁰ Already in 1989, Baxter and Stockman (1989) challenge theoretical models that predict a strong influence of the exchange rate on real economic variables, the so-called “Exchange Rate Disconnect Puzzle”. Flood and Rose (1995) confirm their finding that output volatility does not change much across exchange-rate systems.

²¹ See also Table 2 for the forecast-error-variance decomposition for Dutch and Austrian Output.

²² Monacelli (2001) provides a NOEM theoretical background in which the model delivers positive cross-country correlations of interest rates even for the case of flexible exchange-rate systems. However, in his framework, the output correlation is still negative due to the expenditure switching mechanism.

to come from the exchange rate. One reason for the co-movement in interest rates could be that countries do not conduct completely independent monetary policies even under a flexible exchange-rate regime. Instead, central banks include exchange rates into their calculations to stabilize the price level. They raise home interest rates as a reaction to a foreign interest rate hike because the depreciation of the exchange rate would otherwise put upward pressure on prices due to an increase in import prices.

Summarizing, I find that the reason for the strong positive correlation between home and foreign output as a reaction to a shock to the home interest rate can be ascribed to two facts. First, there is a more important channel of transmission than the exchange rate. Even in a flexible exchange-rate system, the interest rates perform most of the adjustment necessary to keep the interest rate parity intact. Second, even though the shock to the interest rate leads to a movement in the real exchange rate, this exchange rate movement does not have the expected expansionary impact on foreign output.

5.3 Conclusion

In this paper I estimate a VAR model to examine the international transmission of monetary shocks. I compare these results with what different theoretical models predict. The Mundell-Fleming model suggests that there should be an asymmetric transmission of monetary shocks with flexible exchange rates and a symmetric transmission with fixed exchange rates. The transmission channels at work are the world real interest rate or co-movement in interest rates for both regimes and the exchange rate for the flexible exchange-rate regimes. A rise of the interest rate in one country leads to higher world interest rates and depresses *ceteris paribus* economic activity in both countries so that they exhibit a symmetric output decline. For the case of flexible exchange rates, the lower aggregate demand can be more than offset by an increased demand of home for foreign products due to the appreciation of the home currency. Although the Obstfeld-Rogoff (1995) Redux model puts more emphasis on individual utility maximization and on different transmission channels, it mainly reaches the same results concerning output co-movements.

The empirical result show, however, that there is no asymmetric co-movement of output, neither for flexible nor for fixed exchange rates. German as well as Japanese output fall after an unanticipated increase in the federal funds rate. The same negative output reaction can be observed for the Netherlands and Austria when there is a positive shock to German interest rates. Whereas the latter reaction is what can be expected from the theory, one could have expected the results for the flexible exchange-rate regimes to be different. After all, flexible

exchange rates should provide the necessary monetary independence to avoid a transmission of this contractionary shock. Even though there is a “delayed” overshooting appreciation of the home currency as in Eichenbaum and Evans (1995), this exchange rate movement is not enough to offset the contractionary pressure of the increased world interest rate. Even countries with flexible exchange rates raise their interest rates in response to an increase in foreign interest rates, instead of letting their own currency depreciate to such an extent that they could profit from the positive expenditure switching effect. Models from the NOEM that include elements of pricing-to-market, different elasticities of substitution or home bias are able to provide an explanation for the persistent symmetric co-movement of home and foreign output observed in the empirical findings.

5.4 References

- Baxter, M., and A. C. Stockman (1989). Business Cycles and the exchange rate system. *Journal of Monetary Economics* 23: 377-400.
- Bernanke, B.S. (1986). Alternative Explanations of the Money-income Correlation. *Carnegie-Rochester Conference Series on Public Policy* 25: 49-99.
- Betts, C., and M.B. Devereux (2000a). The International Effects of Monetary and Fiscal Policy in a Two Country Model. In: G.A. Calvo, R. Dornbusch, and M. Obstfeld (eds.), *Money, Capital Mobility: Essays in Honor of Robert A. Mundell*. MIT Press, Cambridge, MA.
- Betts, C., and M.B. Devereux (2000b). Exchange Rate Dynamics in a Model of Pricing-to-market. *Journal of International Economics* 50 (1): 215-244.
- Borondo, C. (2000). International Transmission of Monetary Shocks with Interest Rate Rules. Working Paper at the University of Valladolid, DT 00-04.
<http://www2.eco.uva.es/~borondo/papers/Interest.pdf>
- Borondo, C. (2001). International Transmission of Monetary Shocks with Interest Rate Rules. Working Paper at the University of Valladolid, DT 00-05.
<http://www2.eco.uva.es/~borondo/papers/Chapter%20MF%20feb01.pdf>
- Clarida, R. and J. Gali (1995). Sources of Real Exchange-Rate Fluctuations: How Important Are Nominal Shocks? *Carnegie-Rochester Conference Series on Public Policy* 41: 1-56.
- Clausen, V. (2001). *Asymmetric Monetary Transmission in Europe*. Heidelberg: Springer.
- Clausen, V., and H.-W. Wohltmann (2001). Geldpolitik, Fiskalpolitik und ausländische Zinsschocks in einer asymmetrischen Währungsunion. *Kredit und Kapital* 34 (2): 149-177.
- Christiano, L., M. Eichenbaum and C. Evans (1999). Monetary Policy Shocks: What Have We Learned and to What End? In: J.B. Taylor and M. Woodford (eds.), *Handbook of Macroeconomics* (1a). Amsterdam: Elsevier Science.
- Dornbusch, R. (1976). Expectations and Exchange Rate Dynamics. *Journal of Political Economy* 8 (6).
- Eichenbaum, M., and C. Evans (1995). Some Empirical Evidence on the Effects of Shocks to Monetary Policy on Exchange Rates. *Quarterly Journal of Economics* 110 (4): 975-1010.
- Fleming, J.M. (1962). Domestic Financial Policies under Fixed and Floating Exchange Rates. *IMF Staff Papers* 9: 369-379.
- Flood, R.P., and A.K. Rose (1995). Fixing Exchange Rates – A Virtual Quest for Fundamentals *Journal of Monetary Economics* 36: 3-37.

- Hau, H. (2000). Exchange Rate Determination: The Role of Factor Price Rigidities and Nontradables. *Journal of International Economics* 50 (2): 421–448.
- Holstein, M. (1999). Zur Rolle der Geldpolitik im Konjunkturzyklus. *Jahrbücher für Nationalökonomie und Statistik* 218 (3+4): 346–360.
- International Financial Statistics (IFS). Database.
- Kim, S. (2001). International Transmission of the US Monetary Policy Shocks: Evidence from VAR's. *Journal of Monetary Economics* 48 (2): 339–372.
- Kollmann, R. (2001). The Exchange Rate in a Dynamic-optimizing Business Cycle Model With Nominal Rigidities: A Quantitative Investigation. *Journal of International Economics* 55 (2): 243–262.
- Lane, P. (2001). The New Open Economy Macroeconomics: A Survey. *Journal of International Economics* 54 (2): 235–266.
- Leeper, E.M., C.A. Sims, and T. Zha (1996). What does monetary policy do? *Brookings Papers on Economic Activity* (2): 1-63.
- Levy-Yeyati, E., and F. Sturzenegger (2001). Exchange Rate Regimes and Economic Performance. *IMF Staff Papers* 47: 62–89.
- Monacelli, T. (2001). New International Monetary Arrangements and the Exchange Rate. *International Journal of Finance and Economics* 6 (4): 389–400.
- Mundell, R. (1962). The Appropriate Use of Monetary and Fiscal Policy for Internal and External Stability. *IMF Staff Papers* 9: 70–79.
- Obstfeld, M., and K. Rogoff (1995). Exchange Rate Dynamics Redux. *Journal of Political Economy* 103 (3): 624–660.
- Pierdzioch, C. (2003). Noise Trading and the Effects of Monetary Policy Shocks on Nominal and Real Exchange Rates. Kiel Working Paper 1140. <http://www.uni-kiel.de/IfW/pub/kap/2003/kap1140.pdf>
- Rudebusch, G. (1998). Do Measures of Monetary Policy in a VAR Make Sense? *International Economic Review* 39 (4): 907–948.
- Sachverständigenrat (2001). *Für Stetigkeit – gegen Aktionismus. Jahresgutachten 2001/2002.* Wiesbaden.
http://www.sachverstaendigenrat-wirtschaft.de/gutacht/themen/z458_479j01.pdf
- Sims, C.A. (1986). Are forecasting models usable for policy analysis? *Federal Reserve Bank of Minneapolis Quarterly Review* 10 (1): 2-16.
- Sims, C.A., and T. Zha (1999). Error Bands for Impulse Responses. *Econometrica* 67 (5): 1113–1155.
- Sims, C.A., J.H. Stock, and M.W. Watson (1990) Inference in Linear Time Series Models with some Unit Roots. *Econometrica* 58 (1): 113-144.

Tille, C. (2001). The Role of Consumption Substitutability in the International Transmission of Shocks. *Journal of International Economics* 53 (2): 421–444.

5.5 Appendix

Figure 2: Impulse Responses United States/Japan

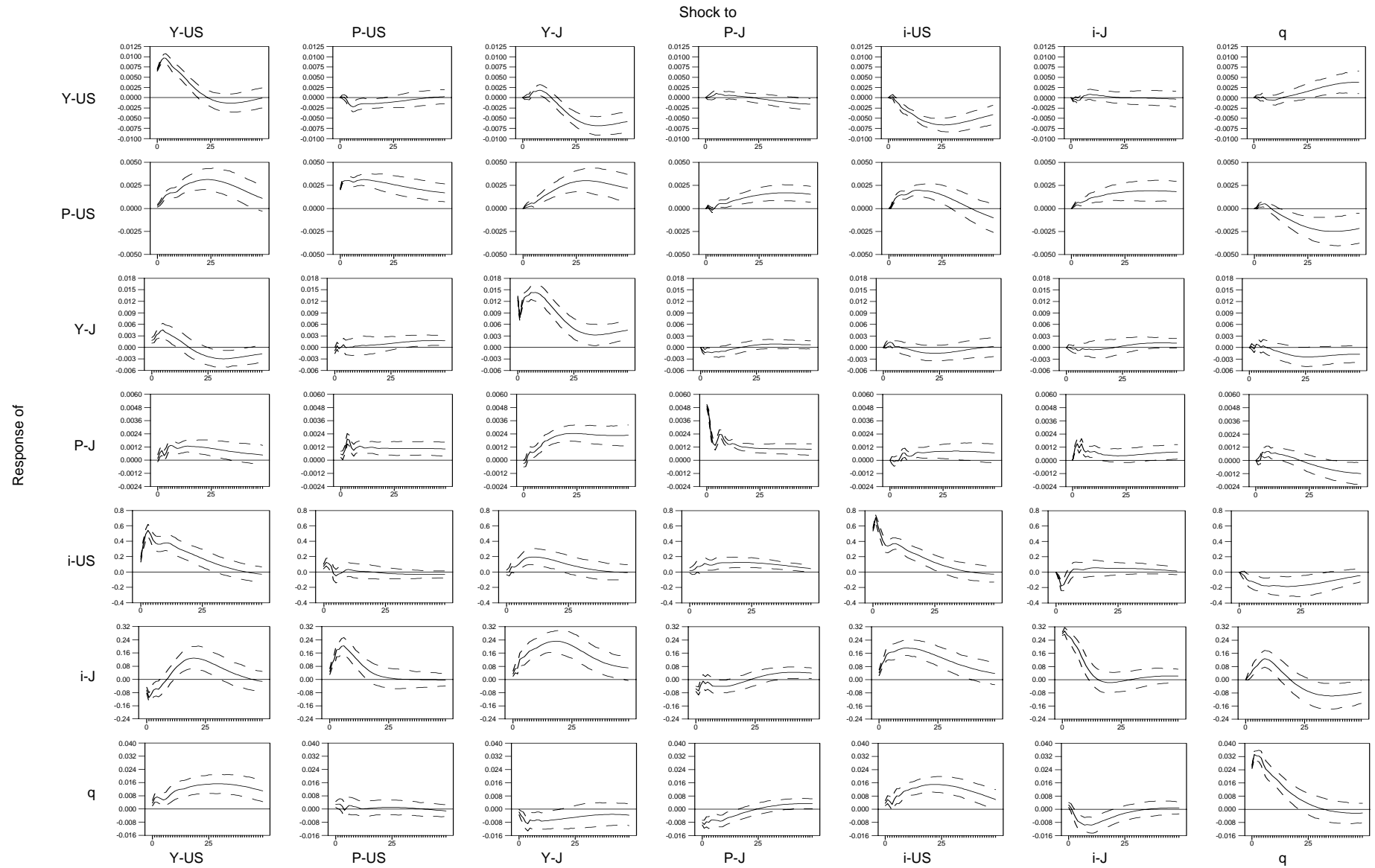


Figure 3: Impulse Responses Germany/Netherlands

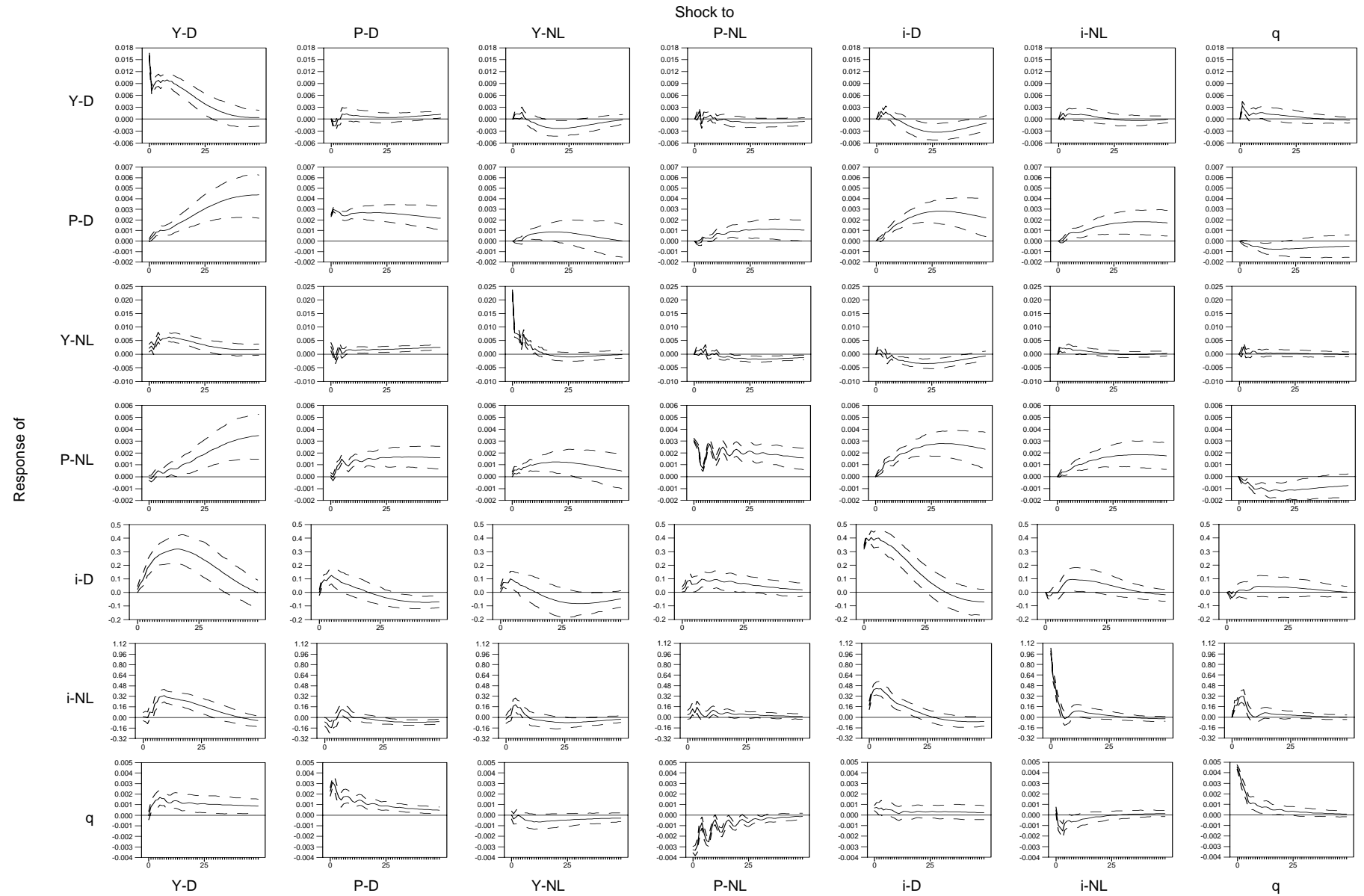


Figure 4: Impulse Responses Germany/Austria

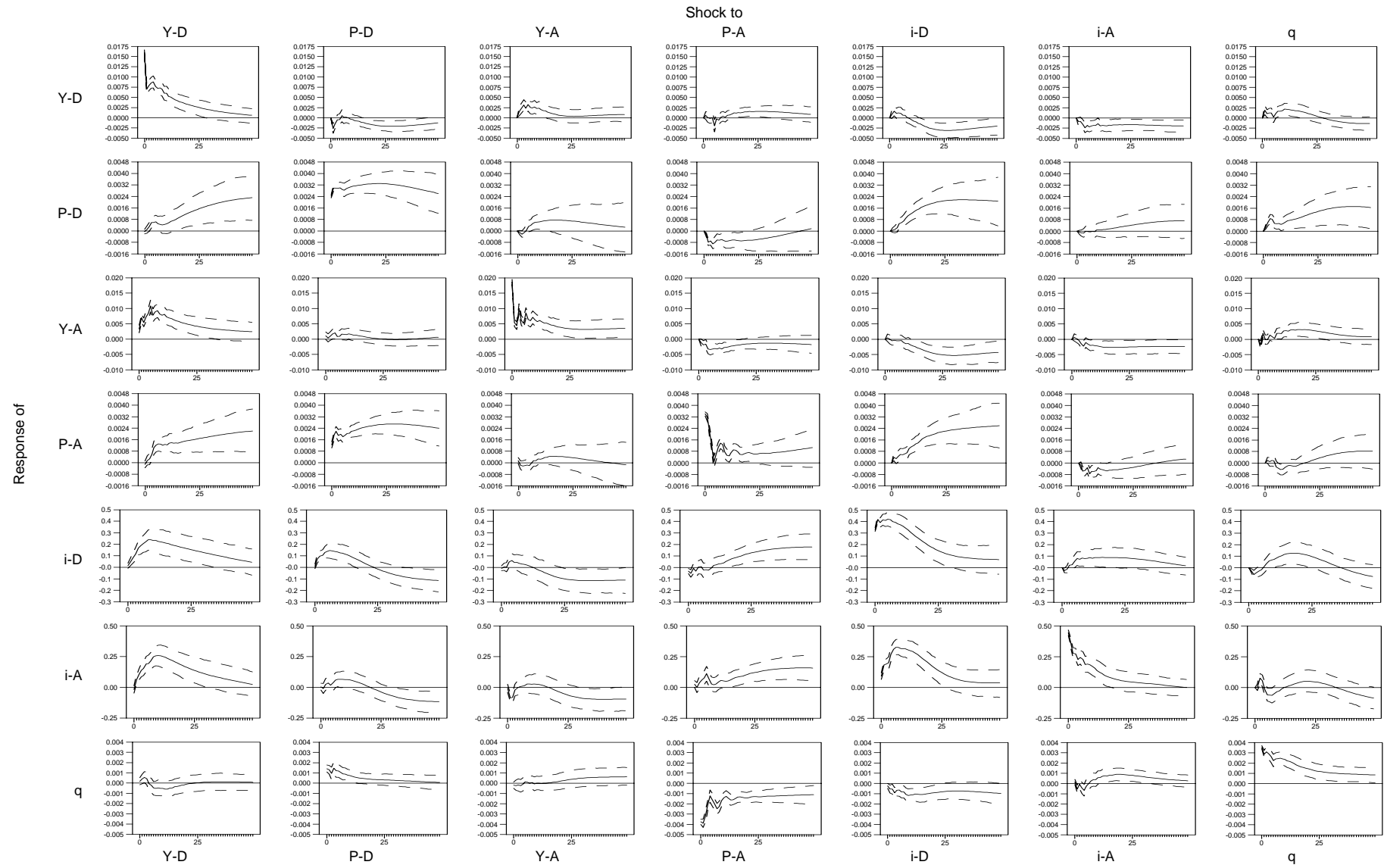


Table 5.1: Forecast-Error-Variance Decomposition for German and Japanese Output

Country	After month	Standard Error	Y-US	P-US	y*	p*	i-US	i*	q
Germany	12	0.03	11.3	0.6	82.8	1.1	2.7	1.1	0.5
	48	0.04	7.7	0.4	41.9	6.0	28.3	13.3	2.5
Japan	12	0.04	6.0	0.08	92.8	0.6	0.3	0.1	0.1
	48	0.06	8.2	1.4	84.5	0.7	1.1	0.6	3.6
Japan '90	12	0.03	37.9	0.1	58.1	0.1	2.7	0.2	0.8
	48	0.04	25.0	0.4	30.8	0.3	34.9	2.5	6.2

Notes: In this table Y-US stands for the industrial production of the United States, P-US for the consumer price index of the US, i-US for the federal funds rate and q for the real exchange rate. y* and p* are German and Japanese industrial production and consumer price index respectively. i* stands for the short run interest rates in these countries. Japan '90 presents the forecast-error-variance decomposition of the estimation for Japan up to 1990, which was included due to a structural break in Japanese data.

Table 5.2: Forecast-Error-Variance Decomposition for Dutch and Austrian Output

Country	After month	Standard Error	Y-D	P-D	y*	p*	i-D	i*	q
Netherlands	12	0.03	24.8	2.6	65.9	1.0	2.0	2.9	0.9
	48	0.04	31.3	8.0	38.7	5.2	14.3	1.9	0.6
Austria	12	0.04	42.1	1.4	48.1	4.7	0.5	1.6	1.6
	48	0.06	32.2	0.8	33.1	4.1	18.5	5.7	5.5

Notes: In this table Y-D stands for German industrial production, P-D for the consumer price index of Germany, i-D for German short run interest rates and q for the real exchange rate. y* and p* are Dutch and Austrian industrial production and consumer price index respectively. i* stands for the short run interest rates in these countries.

Curriculum Vitae

Personal data

Surname: Kamps, née Kuhn
First name: Annette Johanna
Date of birth: 18 May 1977
Place of birth: Heidelberg
Nationality: German

Education

01/2002 – 01/2007 Ph.D. student in quantitative economics at the Christian-Albrechts-Universität, Kiel
08/2001 Doctorandus (Master) in International Economics, University of Maastricht (NL)
08/2000 – 06/2001 Scholarship to the University of California at Berkeley
08/1998 – 08/2001 Studies in International Economics at the University of Maastricht (NL), Specialisation in “Money, Credit and Banking“
10/1996 – 07/1998 Studies in Economics at the Ruprecht-Karls-Universität Heidelberg
08/1987 – 06/1996 St. Raphael Gymnasium, Heidelberg, Abitur 06/1996

Professional Experience

Since 09/2007 Graduate Programme Participant, European Central Bank, Directorate General Economics, Frankfurt am Main
02/2007 – 08/2007 Economist, Deka Bank, Macro Research, Frankfurt am Main
01/2002 – 01/2007 Research Associate, Kiel Institute for the World Economy, Business Cycles Department
08/2006 – 12/2006 Consultant, European Central Bank, DG International and European Relations, Division EU Neighbouring Regions, Frankfurt am Main
08/2005 – 10/2005 Consultant, European Central Bank, DG International and European Relations, Division EU Neighbouring Regions, Frankfurt am Main
11/2004 – 02/2005 Internship, European Central Bank, DG International and European Relations, Division EU Neighbouring Regions, Frankfurt am Main

Frankfurt am Main, 30 October 2007

Eidesstattliche Versicherung

Ich versichere hiermit an Eides Statt, dass ich die Dissertation "Essays in International Macroeconomics" selbständig angefertigt habe, alle von anderen Autoren wörtlich übernommenen Stellen und sich an die Gedankengänge anderer Autoren eng anlehenden Ausführungen besonders gekennzeichnet und keine anderen als die in der Dissertationsschrift angegebenen Hilfsmittel benutzt habe.

Frankfurt am Main, 30. Oktober 2007