Three Essays on Challenges in International Trade and Finance

Inauguraldissertation
zur Erlangung des akademischen Grades eines Doktors der Wirtschaftswissenschaften des Fachbereichs Wirtschaftswissenschaften der Universität Osnabrück

vorgelegt von
Nannette Lindenberg

Dekan: Professor Dr. Frank Teuteberg
Referenten: Professor Frank Westermann, Ph.D. und Professor Dr. Bernd Meyer
Tag der Disputation: 11. November 2011

Abstract

This dissertation is a collection of essays on challenges in international trade and international finance, which apply econometric methods to diverse data sets and relate them to economic policy questions.

In times of crises, the question, whether individual countries have the ability to pursue idiosyncratic monetary policy, is important. The degree of integration and comovement between financial markets, for instance, is critical to better assess the real threat facing a country in a crisis. Also, from a macroeconomic modeling perspective, there has recently been a renewed interest in the cyclical and long-run comovement of interest rates. Hence, in a first essay, we reinvestigate the long- and short-run comovements in the G7-countries by conducting tests for cointegration, common serial correlation and codependence with nominal and real interest rates. Overall, we only find little evidence of comovements: common trends are occasionally observed, but the majority of interest rates are not cointegrated. Although some evidence for codependence of higher order can be found in the pre-Euro area sample, common cycles appear to exist only in rare cases. We argue that some earlier, more positive findings in the literature are difficult to reconcile due to differing assumptions about the underlying stochastic properties of interest rates. Hence, we conclude that they cannot be generalized for all interest rates, time periods, and reasonable alternative estimation procedures. This finding indicates that scope for individual countries to pursue stabilization policy does still exist in a globalized world.

Emerging economies, in general, are much more exposed and vulnerable to crises than industrialized countries. Accordingly, stabilization policy is especially important in these countries and the selection of the best monetary regime is essential. This is why, in a second essay, we contrast two different views in the debate on official dollarization: the Mundell (1961) framework of optimum currency areas and a model on boom-bust cycles by Schneider and Tornell (2004), who take account of credit market imperfections prevalent in middle income countries. We highlight the strikingly different role of the exchange rate in the two models. While in the Mundell framework the exchange rate is expected to smooth the business cycle, the second model predicts the exchange rate to play an amplifying role. We empirically evaluate both models for eight highly dollarized Central American economies. We document the existence of credit market imperfections and find that shocks from the exchange rate indeed amplify business cycles in these countries. Using a new method proposed by Cubadda (1999, 2007), we furthermore test for cyclical comovement and reject the hypothesis that the selected countries form an optimum currency area with the United States according to the Mundell definition.

In the context of the recent global crisis, globalization and vertical integration in particular were often blamed for being the cause for the severe trade crisis. For that reason, in the essay that contributes to the trade literature, we analyze the role of international supply chains in explaining the long-run trade elasticity and its short-term volatility in the context of the recent trade collapse. We adopt an empirical strategy based on two steps: first, stylized facts on long- and short-term trade elasticity are derived from exploratory analysis and formal modeling on a large and diversified sample of countries. Then, we derive observations of interrelated input-output matrices for a demonstrative sub-set of countries. We find evidence for two supply chain related factors to explain the overshooting of trade elasticity during the 2008-2009 trade collapse: the composition and the bullwhip effect. However, evidence for a magnification effect could not be found. Overall, we do not accept the hypothesis that international supply chains explain all by themselves the changes in trade-income elasticity.

Keywords: boom-bust cycles, bullwhip effect, business cycle comovement, codependence, cointegration, composition effect, credit market imperfections, dollarization, error-correction-model, input-output analysis, interest rates, international supply chain, magnification effect, real exchange rate, serial correlation common feature, trade collapse, trade elasticity

JEL: C22, C67, E32, E43, E52, F15, F19, F30, F36, G12, O54

Acknowledgement

Throughout the last years, I have benefited from the support and encouragement of many people. First and foremost I would like to thank my supervisor, Frank Westermann, for the outstanding guidance, the fruitful discussions, and the continuous feedback on my research during my time at the Chair of International Economic Policy at the University of Osnabrück. In addition, I am thankful to Bernd Meyer for his willingness to co-supervise my PhD thesis.

I have benefited a lot from my research stay at the Economic Research and Statistics Division of WTO and would like to express my gratitude to Andreas Maurer and his ITS team. Many thanks to Hubert Escaith for all that I learned at WTO, and to both him and Sébastien Miroudot from OECD for the productive research cooperation in the aftermath of the WTO Public Forum 2009.

I want to thank the current and former members as well as the guests of the Institute of Empirical Economic Research at the University of Osnabrück for the stimulating discussions of my papers in the lunchtime and paper seminars (and outside of them). Special thanks are due to Katja Drechsel, Jan Kuckuck, and Florian Hartmann for their critical suggestions and continuous encouragement. Also, comments from the participants at several workshops and conferences are gratefully acknowledged.

Last but not least, I wish to thank my family for all their support, encouragement, and confirmation during this time. In particular, I would like to thank my husband José for his love and understanding as well as his willingness to forgo exciting job opportunities for the benefit of my research position in Osnabrück and this dissertation.

Osnabrück, April 2011 *Nannette Lindenberg*

Contents

List of Figures

List of Tables

List of Abbreviations

ADF	Augmented Dickey Fuller
AIC	Akaike Information Criterion
AR	Autoregressive
ARCH-LM	Autoregressive Conditional Heteroscedasticity — Lagrange Multiplier
CEEC	Central and Eastern European Countries
CIP	Covered Interest Parity
CPI	Consumer Price Index
DR-CAFTA	Dominican Republic-Central America Free Trade Agreement
ECM	Error Correction Model
Eds.	Editors
EMS	European Monetary System
EMU	Economic and Monetary Union
ESCB	European System of Central Banks
EU	European Union
FDI	Foreign Direct Investments
FIML	Full Information Maximum Likelihood
G7	Group of Seven
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
IDB	Inter-American Development Bank
IDE-JETRO	Institute of Developing Economies — Japan External Trade Organization
IFS	International Financial Statistics
IMF	International Monetary Fund
IO	Input-Output
IRF	Impulse Response Function
ISIC	International Standard Industrial Classification
ITS	International Trade Statistics
LR	Likelihood Ratio

NAFTA	North American Free Trade Agreement
N-sector	Nontradable Sector
OCA	Optimum Currency Area
OECD	Organisation for Economic Co-operation and Development
ROW	Rest of the World
SCCF	Serial Correlation Common Feature
SIC	Schwarz Information Criterion
SITC	Standard International Trade Classification
T-sector	Tradable Sector
TSLS	Two-Step-Least-Square
UIP	Uncovered Interest Parity
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
VA	Value Added
VAR	Vector Autoregressive
VS	Vertical Specialization Share
WDI	World Development Indicators
WEO	World Economic Outlook
WTO	World Trade Organization

Summary

The three empirical essays that make up the dissertation at hand discuss different aspects of challenges in international trade and finance; yet, all three are linked to the topic of globalization. Consequently, they are of special relevance in times of (global) financial and economic crises.

The first essay deals with the integration of financial markets of the G7-countries — an important topic when assessing the threat of contagion during financial crises. Using the example of official dollarization, the second essay addresses policies that aim for stabilization via the choice of a monetary regime. This option is especially relevant for emerging economies, which are more exposed and vulnerable to global crises than industrial countries. The third essay focuses on the occurrence of trade crises. As in a globalized world, vertical specialization, via outsourcing and offshoring, is one potential channel for the transmission and intensification of global crises, the essay studies whether global supply chains are the driving force for the recent trade collapse.

In terms of methodology, the three essays have in common that they all apply advanced time series econometrics, analyzing, for instance, short- and long-run comovements.

The three essays (and their extensive appendices) are strongly based on joint research with my co-authors Hubert Escaith, Sébastien Miroudot, and Frank Westermann:

- Essay I of the dissertation, **"Common Trends and Common Cycles among Interest Rates of the G7-Countries"**, is an extension of
  - Lindenberg and Westermann (2009a), "Common Trends and Common Cycles among Interest Rates of the G7-Countries", *CESifo Working Paper* #2532.[1]
- Essay II, **"How Strong is the Case for Dollarization in Central American Countries?"**, is based on
  - Lindenberg and Westermann (2011), "How Strong is the Case for Dollarization in Central America? An Empirical Analysis of Business Cycles, Credit Market Imperfections and the Exchange Rate", forthcoming in *International Journal of Finance and Economics*,[2] and
  - Lindenberg and Westermann (2009b), "How Strong is the Case for Dollarization in Costa Rica? A Note on the Business Cycle Comovements with the United States", *CESifo Working Paper* #2785.[3]
- Essay III of the dissertation, **"International Supply Chains and Trade Elasticity in Times of Global Crisis"**, goes back to
  - Escaith, Lindenberg and Miroudot (2011), "Global supply chains, the great trade collapse and beyond: More elasticity or more volatility?", In: Mandel, and di Mauro (Eds.) "Recovery And Beyond – Lessons For Trade Adjustment And Competitiveness", European Central Bank, Frankfurt am Main;
  - Escaith, Lindenberg and Miroudot (2010a), "Global Value Chains And The Crisis: Reshaping International Trade Elasticity?", In: Cattaneo,

[1] Also published as *Institute of Empirical Economic Research Working Paper* #77 and currently under review at the Journal of Macroeconomics.
[2] Also published as *Institute of Empirical Economic Research Working Paper* #83.
[3] Also published as *Institute of Empirical Economic Research Working Paper* #79.

Gereffi, and Staritz (Eds.), "Global Value Chains in a Post-Crisis World: A Development Perspective", World Bank, Washington; and

- Escaith, Lindenberg and Miroudot (2010b), "International supply chains and trade elasticity in times of global crisis", *World Trade Organization (Economic Research and Statistics Division) Staff Working Paper* ERSD-2010-08.[4]

In the following, I will give a more detailed summary of the three parts of this thesis.

The first essay analyzes common trends and common cycles among different nominal and real interest rates of the G7-countries. As already mentioned, knowledge about the degree of integration of the world's main capital markets is important both from a policy point of view and for economic theory — even more in times of global crises. However, the literature so far does not provide a clear picture of this topic as the presented results are rather mixed. One problem with the different methods to test for comovements, for instance with the test for cointegration and the tests for serial correlation common features, is that they should not be applied to all types of time series. The usability of these tests depends on the type of stochastic process of the time series, i.e. the unit-root property and the lag structure. In other words, the cointegration test that studies whether a long-run comovement, i.e. a common trend, exists, can only be applied to non-stationary time series. In contrast, the tests for serial correlation common feature and codependence that analyze short-run common cyclical behavior, can be used only with stationary time series that have the same lag structure.

Thus, the contribution of this essay is to provide a structured framework to test the possible comovements. Hereby, we do not only take into consideration

[4] Currently under review (status revise and resubmit) at the Review of World Economics.

the conscientious analysis of the time series characteristics, but also apply the tests to different types of interest rates and different appropriate time windows. Accordingly, we first of all test the unit-root properties and the lag structures of the interest rates before applying either the test for cointegration (Johansen, 1988, 1991) or the test for serial correlation common feature and codependence (Engle and Kozicki, 1993; Vahid and Engle, 1997; Cubadda, 1999, 2007) to the series. We use money market rates, government bond yields, and Euro-Market rates of Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States and conduct the analysis in six different samples. Consequently, we cover a wide range of variation: different issuers, different maturities, in- and exclusion of country risks, and different political and economic time windows.

Overall, evidence for short- and long-run comovements remains quite poor over all different testing specifications in the G7-countries. Our main result is, therefore, that more positive evidence for comovements of interest rates reported in the literature can not be generalized for all interest rates and time periods. Consequently, even in globally well-integrated capital markets, as those of the G7-countries, central banks still have sufficient scope for idiosyncratic monetary policy to react to a common exogenous shock.

The second essay analyzes the case for dollarization in the Central American countries. As mentioned above, monetary policy is one important stabilization tool, especially in times of crises. Since emerging markets are often very vulnerable to global shocks, the selection of the adequate monetary regime can be vital. The debate on common currencies and dollarization has mostly been discussed in the literature within the optimum currency area framework of Mundell (1961). However, in the presence of capital market imperfections, the boom-bust-cycle model of Schneider and Tornell (2004) might be better suitable to evaluate the question of dollarization in emerging markets.

The contribution of this essay is twofold: on the one hand, we propose an alternative methodology to analyze dollarization within the Mundell (1961) framework. We argue that besides the pure contemporaneous correlations of shocks also the absorption of the common shocks is important to evaluate the effectiveness of a common monetary policy. We consequently analyze the business cycles of Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, and Panama and the United States with the common features methodology already applied in the first essay. An important difference, however, is that in this essay we test the same time series for common trends with the Johansen (1988, 1991) test for cointegration (in levels) and, additionally, we test for common cycles with the serial correlation common feature and codependence tests proposed by Engle and Kozicki (1993); Vahid and Engle (1997), and Cubadda (1999, 2007) (in growth rates).[5] The existence of a common business cycle, i.e. a common reaction to a standard shock, would be an ideal precondition for official dollarization in the Mundell (1961) framework.

On the other hand, we document within the Schneider and Tornell (2004) framework that credit market imperfections as well as other factors exist that make the occurrence of boom-bust-cycles in the Central American countries quite probable. The two models imply totally opposed reactions of GDP to a change in the real exchange rate: In the Mundell (1961) framework, we would expect the exchange rate to smooth business cycle fluctuations, while in the Schneider and Tornell (2004) framework the free floating exchange rate should amplify the business cycle. For that reason, we finally estimate an impulse response function of GDP to a shock in the exchange rate to determine which of the two models is better suitable to analyze dollarization in Central America.

[5] In the cases where a common trend exists, i.e. the series are cointegrated, we include an error correction term in the estimation equations for serial correlation common features and codependence.

As our main findings, we conclude that the Central American countries do not share a common business cycle with the United States and that credit market imperfections do exist in these countries. Furthermore, according to our evaluation, the contribution of Schneider and Tornell (2004) seems to provide the more adequate framework for the dollarization debate in this region. Nevertheless, we do not recommend official dollarization for the Central American countries, as the first best solution would always be to strengthen the legal systems and to eliminate the credit market imperfections. Meanwhile, a freely fluctuating exchange rate is not an adequate stabilization tool, either, as long as these imperfections exist.

The third essay analyzes the role of international supply chains for trade elasticity in times of global crises. Since the globalization wave in the 1990s, international production has been vertically specialized via outsourcing and offshoring. In the recent global crisis, these global supply chains have been blamed to play an important role in the transmission and amplification of the trade crisis. There are, for instance, three possible channels to be considered: the magnification effect, the composition effect, and the disruption effect. In this essay, we analyze the former two effects in more detail. The magnification effect refers to the fact that in global production networks intermediate inputs can cross the border several times before the final product is delivered to the consumer, i.e. trade volumes may overstate the effective amount of final consumption products exchanged with foreign countries. The composition effect alludes to the fact that trade flows are mainly composed by durable goods, while GDP consists to a large extent of services.

The contribution of this essay is to investigate the hypothesis of global supply chains being the cause for the increase in trade elasticities during the last decades. We, therefore, derive short- and long-run trade elasticities for the world's 49 most important exporters using exploratory analysis. For instance, we estimate the trade elasticities for different clusters of countries in rolling time windows to generate some stylized facts about the evolution of trade elasticities over time. In addition, we formalize the analysis and estimate an error-correction model for a wide range of countries, including, among others, a vertical specialization variable. Furthermore, we extend this macro-economic perspective by examining interrelated input-output matrices of a demonstrative sub-set of countries.

According to our findings, two supply chain related factors may explain the overshooting of trade elasticities during the recent trade collapse: a composition effect and a bullwhip effect, i.e. an inventory adjustment. However, evidence for a magnification effect could not be found. Thus, our main conclusion is that global supply chains all by themselves have not driven the recent trade collapse.

The remainder of this dissertation is divided into three parts, each containing one of the three essays plus an extensive appendix with additional background information and robustness checks.

Essay I

Common Trends and Common Cycles among Interest Rates of the G7-Countries[6]

[6] This essay is based on Lindenberg and Westermann (2009a).

1 Introduction

A recent empirical literature has analyzed whether interest rates comove in the short-run and in the long-run, using different time periods and different types of interest rates.[7] A good knowledge about the nature of the comovements is important for both, economic policy and from a theoretical macroeconomic modeling perspective.[8] The methods to test for comovement range from simple correlations to tests for *cointegration* as well as *common serial correlation*.[9] Results from these studies, however, are often difficult to reconcile, as the different types of tests are relevant for different types of stochastic processes. In particular, they depend on the unit-root properties of interest rates and the lag structure in case of stationarity.

We contribute to the existing literature by implementing a structured framework to analyze possible comovements in interest rates. We start by identifying the AR(p)-structure and testing for stationarity, taking into account the small sample properties of the data set.[10] Then, in the set of non-stationary interest

[7] Such as Poghosyan and de Haan (2007); Zhou (2003); Bremnes, Gjerde and Soettem (2001); Kugler and Neusser (1993).

[8] See Romero-Ávila (2007); Henriksen, Kydland and Sustek (2009).

[9] Another possible method is to directly test for uncovered or covered interest rate parity (UIP or CIP). See for example Chinn and Meredith (2004) who test UIP for the G7-countries using short and long horizon data and find evidence for UIP in the latter case.

[10] We find that interest rates are in most cases I(1) (as in Romero-Ávila, 2007; Rapach and Weber, 2004; Bremnes et al., 2001; Thornton and García-Herrero, 1997; King, Plosser, Stock et al., 1991; Rose, 1988). Although some series are also I(0) (as in Choi and Chul Ahn, 1999; Wu and Zhang, 1996; Kugler and Neusser, 1993). This finding is consistent with studies that conclude that there is no unambiguous evidence for either stationarity or non-stationarity for all interest rates (as in Cheung, Tam and Yiu, 2008; Koustas and Lamarche, 2010; Karanasos, Sekioua and Zeng, 2006).

rates, we test for common trends, using the Johansen (1988, 1991) cointegration procedure.[11] Finally, among the set of stationary interest rates, we test for common cycles, using the serial correlation common feature and the codependence tests that were initially suggested by Engle and Kozicki (1993) and Vahid and Engle (1997) and later extended by Cubadda (1999, 2007).

We apply our analysis to money market rates, government bond yields and Euro-Market rates, both nominal and real, using a long sample of quarterly data from 1975 to 2010. The idea behind choosing these series is to include interest rates of different issuers (public, private), different maturities, and rates with and without country risk.

Our main conclusion is that, independent of the interest rate measure that is chosen, there is only very limited evidence on either long-run or short-run comovement in the G7-countries.[12] In the set of non-stationary interest rates we find some evidence of cointegration, but the majority of interest rates are not cointegrated. Among stationary interest rates, we find even less evidence of comovement. As a first pass, we observe that the lag structure of the AR-representations varies substantially across countries, which indicates that it is unlikely to find a common cyclical pattern among interest rates. More formally, we reject the strict form of a serial correlation common feature for all interest rates, and find evidence of codependence — a common cyclical pattern after an initial time interval — only in rare cases. Taking various efforts to find more positive evidence of short-run comovements, such as changing the sample period, lag structures, and estimation procedures, does not change this main conclusion. Some evidence of higher order codependence is found, however, in the pre-Euro area sample that ends in 1998:4.

[11] Again, we control for finite sample properties, using the scaling factors of Cheung and Lai (1993).

[12] Among the set of G7-countries, the European countries do not seem to display a higher degree of comovement than the remaining countries.

With regard to the long-run comovements among interest rates that were previously reported in the literature, we confirm the finding that cointegration exists only in the minority of the cases (Bremnes et al., 2001) and in special circumstances (Poghosyan and de Haan, 2007). Also, Zhou (2003), who studies long-run relationships between interest rates within the European Monetary System (EMS) and with the US in the time from 1979 to 1998, shows that the detection of cointegration relationships depends among other things on the adequate splitting of the sample.[13] Our results, however, stand out against the findings of Romero-Ávila (2007) who reports strong evidence for non-stationarity in nominal interest rates of 13 OECD countries and argues that a stochastic common factor is the source of this unit-root property. Concerning comovements in the short-run, our results suggest that more positive evidence reported in Kugler and Neusser (1993) cannot be generalized for all interest rates, time periods, and reasonable alternative estimation procedures.[14]

While most papers interpret these comovements as evidence of financial market integration in general, Romero-Ávila (2007) also points out policy implications: if all interest rates are I(1), and cointegrated with a unity coefficient, uncovered interest rate parity would hold in its strong form, leaving little scope for individual monetary policy. The same argument would be even stronger, when series are I(0) and the responses to shocks are perfectly collinear. In this case, central

[13] Zhou (2003) applies Johansen cointegration tests with alternative trend specifications to different sub-periods that capture the changing trend behavior of her data. While for the whole sample evidence in favor of cointegration is rather scarce in her study, the analysis of three sub-samples, corresponding to different degrees of EMS monetary integration, lends convincing support to the hypothesis that interest rates are comoving within the European Monetary Union (EMU). Including the US, 18 out of 27 pairs of interest rates are cointegrated at least at the 10% level of significance.

[14] Kugler and Neusser (1993) use a codependence test that is based on a MA-representation of real Euro-currency rates from 1980 to 1991. Confining our analysis to the same sample period and interest rate, we indeed also find some more evidence of stationarity and common lag structures. Interest rates are mostly AR(1) processes in this time period. Although the null of a common feature cannot be rejected in 5 out of 6 cases, the coefficient in the cofeature relationship is insignificant in all but one case (real Euro-Market rates of France and Italy). For all other interest rates, as well as for longer sample periods, we cannot confirm this partial evidence for common features.

banks would have only limited scope for an idiosyncratic monetary policy as a reaction to a common exogenous shock. Collinearity in short term reactions might be generated by coordinated monetary policy or by unilateral pressure to follow global markets. The main policy conclusion from our analysis is that there is no empirical evidence of such concerns, even in globally well integrated capital markets as in the G7-countries.

Knowledge about the cyclical comovements of interest rates is also important from a theoretical macroeconomic modeling perspective. Henriksen et al. (2009), for instance, report that cyclical comovements among nominal interest rates are higher than the comovements of real output. They provide empirical evidence based on cross-country correlations for the period 1960 – 2006. According to this stylized fact they develop an international business cycle model, where spillovers of technology shocks and expected future responses of national central banks to output fluctuations can generate such cyclical comovements in interest rates even if output is much less synchronized. As we show in this essay, another way of testing the synchronization of interest rate movements is based on the serial correlation common feature approach. In contrast to the high cross-country correlations documented by Henriksen et al. (2009), this type of cyclical comovement among interest rates is much less pronounced.

The essay is organized as follows: The next chapter presents the data description and preliminary analysis, namely unit root tests and the definition of the autoregressive process of the interest rates. Chapter three discusses comovements in interest rates. After a brief presentation of the applied methodology, we then present results of the cointegration, serial correlation common feature and codependence tests for nominal and real interest rates. In order to augment the possibility of finding at least common if not synchronized cycles we use two different methodologies for the latter common feature. Chapter 4 contains some concluding remarks and an extensive appendix provides further robustness checks.

2 Data and Descriptive Statistics

2.1 Description of the Data

Our analysis is conducted with nominal and ex post real interest rates for the G7-countries: Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. We use money market rates and 10-year government bond yields. In addition, we run the same investigation with Euro-Market rates of the seven countries. Our sample period covers quarterly data of the post Bretton-Woods-era, i.e. from 1975:1 to 2010:1.[15]

For the analysis of real interest rates, ex post rates are constructed with the logged first differences of the respective consumer price index.

Data on money market rates, government bond yields and consumer prices are extracted from the International Financial Statistics Database of the International Monetary Fund (IMF, 2010). In order to complement unavailable data on French interest rates, missing data are taken from the statistics of the Banque de France (2009). The Euro-Market rates are provided by Thomson Reuters (2010) (see Table 2.1 for a detailed data description).

[15] The main results of our essay are robust to changes in the sample period. Results for various different time periods are available in the appendix, namely the samples 1957:1 – 2007:1 (excluding the years of the recent 2008-2009 crisis, see section 5.B); 1975:1 – 1998:4 (the period until the introduction of the Euro and the System of European Central Banks, see section 5.C); 1980:1 – 1991:4 (the sample used in Kugler and Neusser, 1993, see section 5.D); 1985:1 – 2007:1 (period excluding the volatile years after the oil crises of the seventies and the recent 2008-2009 crisis, see section 5.E); 1999:1 – 2010:1 (period after the introduction of the Euro and the ESCB, see section 5.F).

Table 2.1: Data sources

Country	Start	End	Source	Code
Money Market Rates				
Canada	1975q1	2010q1	IFS	15660B..ZF
France	1952q1	2010q3	Banque de France	mt.m.e00250.b.m.t.b.x
Germany	1957q1	2010q1	IFS	13460B..ZF
Italy	1971q1	2010q1	IFS	13660B..ZF
Japan	1957q1	2010q1	IFS	15860B..ZF
UK	1972q1	2010q1	IFS	11260B..ZF
USA	1957q1	2010q1	IFS	11160B..ZF
Government Bond Yields				
Canada	1957q1	2010q1	IFS	15661...ZF
France	1957q1	2010q1	IFS	13261...ZF
Germany	1957q1	2010q1	IFS	13461...ZF
Italy	1957q1	2010q1	IFS	13661...ZF
Japan	1966q4	2010q1	IFS	15861...ZF
UK	1957q1	2010q1	IFS	11261...ZF
USA	1957q1	2010q1	IFS	11161...ZF
Consumer Price Indexes				
Canada	1975q1	2010q1	IFS	15664...ZF
France	1957q1	2010q1	IFS	13264...ZF
Germany	1957q1	2010q1	IFS	13464.D.ZF + 13464...ZF
Italy	1957q1	2010q1	IFS	13664...ZF
Japan	1957q1	2010q1	IFS	15864...ZF
UK	1957q1	2010q1	IFS	11264...ZF
USA	1957q1	2010q1	IFS	11164...ZF
Euro-Market Rates				
Canada	1975q1	2010q3	Datastream	ECCAD3M
France	1975q1	2010q3	Datastream	ECFFR3M
Germany	1975q1	2010q3	Datastream	ECWGM3M
Italy	1978q3	2010q3	Datastream	ECITL3M
Japan	1978q3	2010q3	Datastream	ECJAP3M
UK	1975q1	2010q3	Datastream	ECUKP3M
USA	1975q1	2010q3	Datastream	ECUSD3M

Note: From 1992:1 the real interest rates were calculated with the inflation of reunified Germany.

Graphs of the nominal and real interest rates are displayed in Figure 2.1. Note that the test for common serial correlation only assesses the common response to shocks. It does not test, whether the contemporaneous correlations of the shocks are high or low. Our results in the following sections suggest that the visible comovements in the graphs are the result from a high correlation of the shocks, rather than from a common response pattern. Common shocks could for instance be oil shocks or world business cycle conditions.

Figure 2.1: Nominal and real interest rates

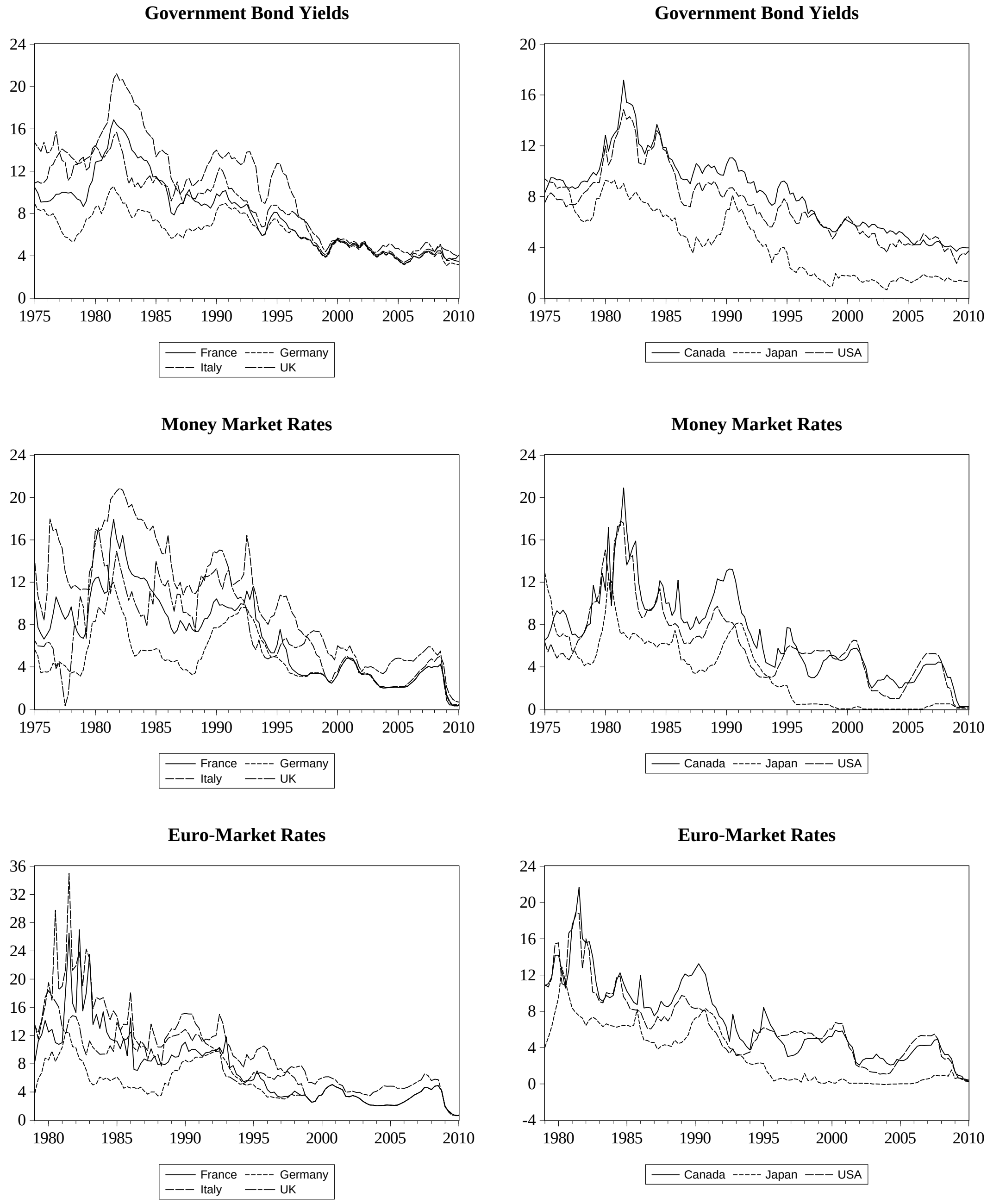
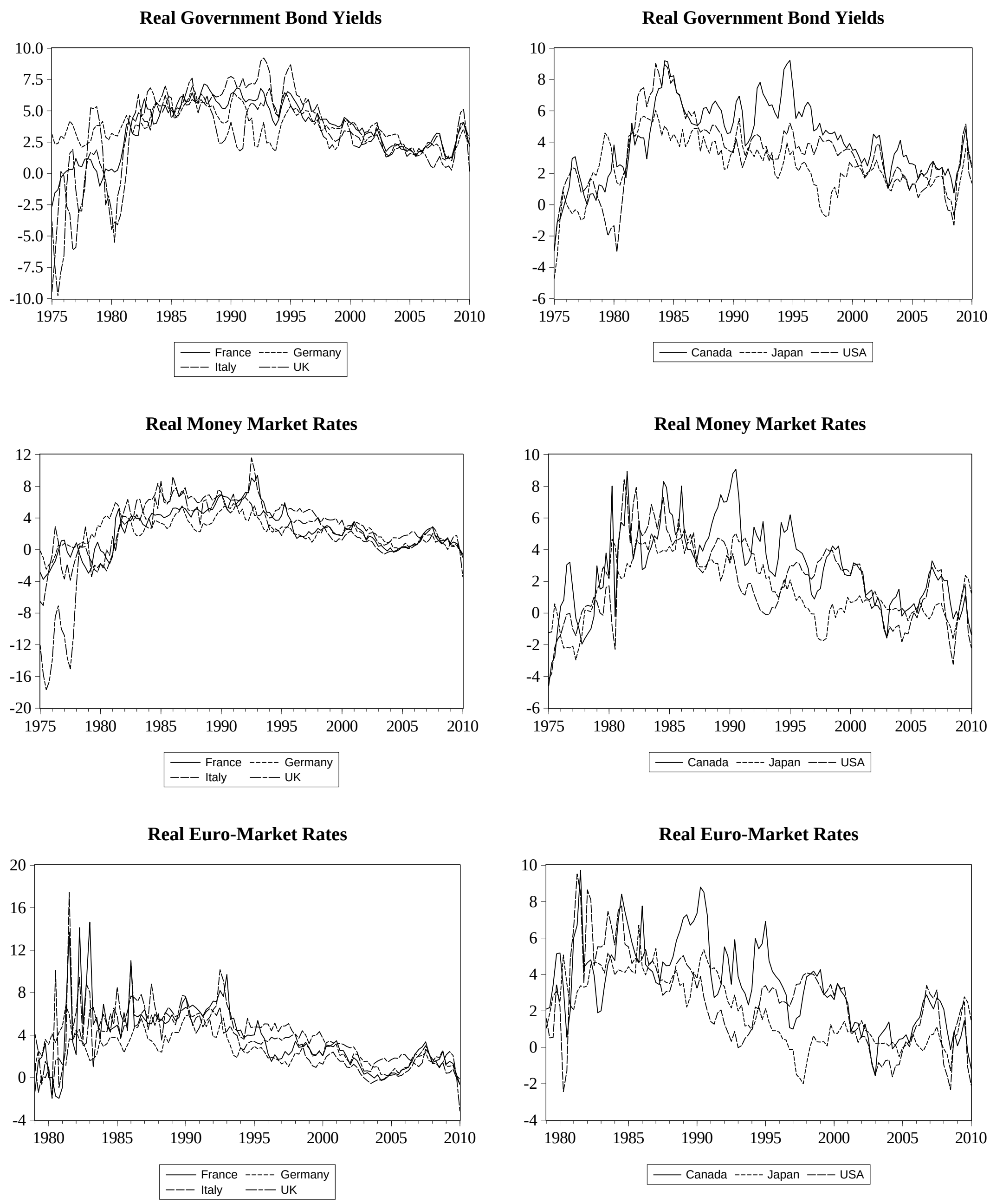


Figure 2.1: continued



Note: Nominal and real interest rates are displayed.
Source: Authors' representation, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

2.2 Preliminary Analysis

We start our empirical analysis by defining the lag structure of each time series and by performing unit root tests.

Process

We first estimate different AR representations of the process of each variable using the following regression equation:

$$x_t = \mu + \sum_{i=1}^{p} \beta_i x_{t-i} + \epsilon_t,$$

with x_t = the interest rate at time t, p = lag parameter and ϵ_t = an error term. We then select a parsimonious lag structure[16] by identifying the minimum lag length that is needed to remove all autocorrelation from the residuals, i.e. all Q-statistics are insignificant.

In addition, we perform the same analysis with the first differences of the interest rates Δx_t. The lag structures of the nominal and real interest rates and their first differences are shown in Table 2.2.

The lag structures of the nominal interest rates typically vary from AR(1) to AR(6).[17] Similarly, the real interest rates have lag structures from AR(1) to AR(8).

The diversity of lag structures across countries and interest rates is interesting in the context of the main aim of the essay that is to identify common trends and common cycles among interest rates. While chapter three will formally investigate whether the autoregressive components of interest rate time series ("cycles") are common across countries, the diversity of lag structures in interest rates already

[16] In order to generate the best condition for finding serial correlation common features or codependence we choose the most parsimonious model. However, using the AIC or SIC criterion to choose the lag length does not change the results qualitatively.

[17] There is an exceptionally high lag length of 10 for the money market rate in Japan.

Table 2.2: AR(p) representations of the process of nominal and real interest rates

1975:1 - 2010:1
(1979:1 - 2010:1 for Euro-Market Rates)

	Nominal		Real	
	AR(...)		AR(...)	
Country	Level	1st diff	Level	1st diff
Money Market Rates				
Canada	6	7	8	8
France	2	1	3	5
Germany	3	1	1	1
Italy	2	1	3	3
Japan	10	4	1	3
UK	1	4	5	7
USA	6	5	6	5
Government Bond Yields				
Canada	4	3	5	4
France	2	1	5	4
Germany	4	4	2	2
Italy	2	1	5	4
Japan	2	1	5	4
UK	1	2	8	4
USA	4	3	5	4
Euro-Market Rates				
Canada	1	1	1	1
France	3	2	3	4
Germany	3	4	1	1
Italy	3	2	3	3
Japan	2	1	1	1
UK	6	5	1	1
USA	6	5	5	4

Note: AR representations of the process of the nominal and real interest rates (money market rates, government bond yields and Euro-Market rates) for the sample 1975:1 to 2010:1 (respectively from 1979:1 onwards for the Euro-Market rates) are reported. The specification with the smallest number of AR terms is selected, under the constraint that the residual is free of autocorrelation (i.e. the Q-statistics are insignificant).
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

Table 2.3: Results of ADF-test for nominal and real interest rates

PANEL A

1975:1 - 2010:1
(respectively 1979:1 - 2010:1 for Euro-Market Rates)

Nominal

Country	Level (AIC) Lags	Statistic	Crit. Val.	Level (SIC) Lags	Statistic	Crit. Val.	1st differences (AIC) Lags	Statistic	Crit. Val.	1st differences (SIC) Lags	Statistic	Crit. Val.
Money Market Rates												
Canada	8	-0.890	-2.841	1	-1.128	-2.878	7	-5.450 **	-2.846	0	-15.480 **	-2.883
France	5	-0.989	-2.857	1	-1.723	-2.877	4	-6.828 **	-2.862	0	-8.657 **	-2.883
Germany	6	-2.393	-2.852	1	-2.352	-2.877	5	-4.913 **	-2.857	5	-4.913 **	-2.857
Italy	5	-0.369	-2.857	1	-1.475	-2.877	4	-8.083 **	-2.862	0	-8.941 **	-2.883
Japan	1	-2.722	-2.877	1	-2.722	-2.877	8	-5.430 **	-2.842	0	-6.921 **	-2.883
UK	0	-1.569	-2.883	0	-1.569	-2.883	9	-4.836 **	-2.837	0	-11.720 **	-2.883
USA	7	-1.545	-2.847	1	-1.789	-2.877	6	-5.056 **	-2.852	1	-8.861 **	-2.877
Government Bond Yields												
Canada	7	-0.585	-2.847	0	-0.624	-2.883	6	-4.984 **	-2.852	0	-10.400 **	-2.883
France	4	-0.772	-2.862	1	-1.124	-2.877	3	-6.184 **	-2.867	0	-7.423 **	-2.883
Germany	3	-2.181	-2.867	1	-2.092	-2.877	2	-5.451 **	-2.872	0	-7.989 **	-2.883
Italy	1	-1.027	-2.877	1	-1.027	-2.877	0	-6.983 **	-2.883	0	-6.983 **	-2.883
Japan	3	-1.688	-2.867	0	-1.470	-2.883	2	-5.318 **	-2.872	0	-10.430 **	-2.883
UK	5	-1.118	-2.857	0	-1.750	-2.883	1	-10.250 **	-2.877	0	-11.350 **	-2.883
USA	5	-0.919	-2.857	1	-1.243	-2.877	6	-5.728 **	-2.852	0	-9.277 **	-2.883
Euro-Market Rates												
Canada	0	-1.345	-2.886	0	-1.345	-2.886	0	-10.660 **	-2.886	0	-10.660 **	-2.886
France	3	-1.049	-2.869	2	-0.866	-2.874	1	-14.600 **	-2.880	1	-14.600 **	-2.880
Germany	2	-2.287	-2.874	2	-2.287	-2.874	1	-5.335 **	-2.880	1	-5.335 **	-2.880
Italy	6	-1.045	-2.852	4	-0.703	-2.863	10	-4.174 **	-2.828	3	-6.536 **	-2.869
Japan	0	-1.045	-2.886	0	-1.045	-2.886	0	-8.511 **	-2.886	0	-8.511 **	-2.886
UK	11	-0.715	-2.825	0	-1.200	-2.886	11	-4.582 **	-2.825	0	-10.600 **	-2.886
USA	7	-1.393	-2.846	5	-1.923	-2.857	6	-4.933 **	-2.852	4	-4.367 **	-2.863

tells us that an important precondition for finding common cycles (or common serial correlation patterns) is not met in many countries. Not being able to establish a common lag structure in many cases, makes it very unlikely to find strong evidence in favor of a serial correlation common feature in the following exercises.

Stationarity

As a second preliminary exercise, we test for possible unit roots, using the Augmented-Dickey-Fuller (ADF) test:

$$\Delta x_t = \mu + \gamma x_{t-1} + \sum_{j=1}^{p-1} \phi_j \Delta x_{t-j} + \epsilon_t,$$

Table 2.3: continued

PANEL B

Real

Country	Level (AIC) Lags	Statistic		Crit. Val.	Level (SIC) Lags	Statistic		Crit. Val.	1st differences (AIC) Lags	Statistic		Crit. Val.	1st differences (SIC) Lags	Statistic		Crit. Val.
Money Market Rates																
Canada	1	-3.084	**	-2.878	1	-3.084	**	-2.878	7	-6.551	**	-2.846	0	-15.500	**	-2.883
France	8	-1.594		-2.842	2	-2.061		-2.872	7	-5.230	**	-2.847	0	-9.375	**	-2.883
Germany	1	-2.291		-2.877	0	-1.888		-2.883	7	-5.938	**	-2.847	0	-10.320	**	-2.883
Italy	5	-2.037		-2.857	1	-2.860		-2.877	4	-8.075	**	-2.862	4	-8.075	**	-2.862
Japan	4	-4.380	**	-2.862	0	-4.841	**	-2.883	3	-8.329	**	-2.867	3	-8.329	**	-2.867
UK	7	-2.472		-2.847	4	-2.210		-2.862	6	-4.053	**	-2.852	3	-8.509	**	-2.867
USA	9	-2.171		-2.837	2	-2.480		-2.872	6	-6.703	**	-2.852	1	-10.120	**	-2.877
Government Bond Yields																
Canada	4	-2.621		-2.862	4	-2.621		-2.862	3	-9.071	**	-2.867	3	-9.071	**	-2.867
France	9	-2.536		-2.837	4	-2.528		-2.862	8	-5.225	**	-2.842	3	-8.966	**	-2.867
Germany	1	-2.914	**	-2.877	0	-2.499		-2.883	11	-5.188	**	-2.828	0	-10.460	**	-2.883
Italy	4	-3.709	**	-2.862	4	-3.709	**	-2.862	3	-11.260	**	-2.867	3	-11.260	**	-2.867
Japan	4	-6.591	**	-2.862	4	-6.591	**	-2.862	7	-7.332	**	-2.847	3	-8.691	**	-2.867
UK	8	-2.150		-2.842	1	-4.066	**	-2.877	7	-5.363	**	-2.847	3	-8.429	**	-2.867
USA	5	-3.092	**	-2.857	1	-3.387	**	-2.877	3	-7.429	**	-2.867	3	-7.429	**	-2.867
Euro-Market Rates																
Canada	0	-2.835		-2.886	0	-2.835		-2.886	7	-5.784	**	-2.846	0	-11.350	**	-2.886
France	2	-2.300		-2.874	2	-2.300		-2.874	10	-4.972	**	-2.830	1	-14.300	**	-2.880
Germany	0	-2.435		-2.886	0	-2.435		-2.886	0	-12.070	**	-2.886	0	-12.070	**	-2.886
Italy	10	-1.039		-2.829	4	-1.781		-2.863	9	-4.942	**	-2.834	3	-7.866	**	-2.869
Japan	1	-2.602		-2.880	0	-2.766		-2.886	3	-7.441	**	-2.869	0	-12.310	**	-2.886
UK	13	-0.570		-2.815	0	-2.437		-2.886	5	-8.784	**	-2.857	0	-12.970	**	-2.886
USA	7	-1.384		-2.846	4	-1.630		-2.863	6	-6.049	**	-2.852	3	-8.328	**	-2.869

Note: The ADF-test statistics, calculated for the levels and first differences of nominal (panel A) and real (panel B) interest rates (money market rates, government bond yields and Euro-Market rates) for the sample 1975:1 to 2010:1 (respectively from 1979:1 onwards for the Euro-Market rates), are reported. The tests are conducted with intercept only (no trend). The lag length was selected by the AIC and SIC criterion and is given in the corresponding column. Critical values of Cheung and Lai (1995) were applied and are reported. ** indicate rejection of the existence of both, stochastic and deterministic trends with a significance of 5%.
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

where Δ is the first difference operator.[18]

[18] The lag parameter p is determined by the Akaike information criterion (AIC). Using the Schwarz criterion (SIC) gives in some cases different results. However, the qualitative interpretation of the analysis is robust to the selected lag length. The subsequent tests for comovements will be applied to all interest rates that are I(0) (respectively I(1)) indicated by either one of the two criteria. As our main finding is "no comovement", we bias the test setups in a way, by using different lag structures, that the common features tests are given the best chance for finding comovements. Therefore, we use the AIC and SIC criterion in the ADF-test, and apply the subsequent common feature tests to all interest rates that are suitable for testing by either one criterion; and for the common features tests we apply the AR representation outcome produced in Table 2.2.

The t-statistic of the ADF-test is compared with the finite sample critical values from Cheung and Lai (1995).[19]

We apply the ADF-test to the levels and to their first differences. Results of the ADF-test are shown in Table 2.3. For all nominal interest rates the null hypothesis of a unit root cannot be rejected in levels, but in first differences it can. Thus, the nominal interest rates are I(1) series.

For the real interest rates the picture is quite different. The money market rates of Canada and Japan and the government bond yields of Germany, Italy, Japan, UK, and the United States are stationary. For the remaining real interest rates we cannot reject the null of non-stationarity.

Again, the mixed pattern found on stationarity suggests that strong evidence on either common trends or common cycles is unlikely to be found in this data set.

[19] The main conclusions remain the same whether we use the critical values of MacKinnon (1996) or the finite sample critical values of Cheung and Lai (1995).

3 Comovements in Interest Rates

In recent years a number of new tests to detect comovements in time series have been developed (see Urga, 2007, for a discussion). The concept of common feature has been first suggested by Engle and Kozicki (1993) and encompasses common stochastic trends (the I(1)-feature), common serial correlation (common AR(p)-feature), as well as other times series characteristics, including seasonality and ARCH and GARCH effects.

A necessary element in the analysis is that the "feature" (I(1), AR(p), and so on) needs to exist in *both* time series under investigation. The large diversity of AR(p) processes and I(1)/I(0) processes in interest rate data documented above yields only a limited number of country pairs where the common features of interest — common trends and common cycles — can be tested.

We divide the following analysis into two parts: with the interest rates that are found to have a unit root we conduct cointegration tests and with the stationary interest rates we pursue serial correlation common feature and, if applicable, codependence tests.

3.1 Common Stochastic Trends

To test for cointegration we adopt the Johansen (1988, 1991) maximum likelihood approach, allowing for an intercept in the cointegrating equations. We assume that the time series that we analyze for cointegration follow a vector autoregressive process of order p:

$$X_t = \mu + \sum_{i=1}^{p-1} \Gamma_i X_{t-i} + \epsilon_t$$

where X_t is a $n \times 1$ vector of different interest rates (with $n =$ number of interest rates included in the VAR), μ is an intercept vector and ϵ_t is a vector of error terms.

In order to generate the test statistic of the Johansen test, namely the trace or the maximum eigenvalue statistic,[20] we require the canonical correlations between the least squares residuals of the two subsequent regressions:

$$\Delta X_t = \mu_1 + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \epsilon_{1t}$$
$$\text{and} \quad X_{t-p} = \mu_2 + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \epsilon_{2t},$$

i.e. between the matrices ϵ_{1t} and ϵ_{2t}. For the lag parameter p we choose the largest lag structure of the process of the first differenced terms of the relevant interest rates (see Table 2.2).

The maximum eigenvalue statistic tests the null hypothesis of r cointegrating vectors against the alternative hypothesis that there are $r+1$ cointegrating vectors:

$$\text{Maximum Eigenvalue Statistic} = -T\, ln(1 - \lambda_{r+1}).$$

[20] In the subsequent discussion of the results of the cointegration tests only the maximum eigenvalue statistic will be used. The trace statistic tests the null hypothesis that there are r or fewer cointegrating vectors:

$$\text{Trace Statistic} = -T \sum_{k=r+1}^{n} ln(1 - \lambda_k),$$

where λ_k are the squared canonical correlations calculated in the former step of the analysis. The trace statistic gives slightly different interpretations in some cases. However, a pattern that one of the two statistics is more favorable to cointegration cannot be detected.

The number of cointegration relations r is restricted to $0 \leq r \leq n$ with n being the number of variables. $n-r$ assigns the number of independent stochastic trends pushing the long-run dynamics.

The test statistic is compared with the critical values of Osterwald-Lenum (1992) for the 5% and 1% levels that are corrected with the scaling factor of Cheung and Lai (1993) to control for a possible finite-sample bias.

We perform tests with all available pairs of interest rates. This yields up to $\binom{7}{2} = 21$ possible cointegration relations (as we have seven different countries) among each type of interest rates.

Nominal interest rates

We start our analysis with the nominal money market rates, nominal government bond yields and nominal Euro-Market rates.

Among the nominal interest rates we do not find any stationary time series, so that we can conduct the cointegration analysis with all of the nominal interest rates. The results of theses tests are shown in Table 3.1.

The evidence shows that about a third of the pairs of nominal interest rates are cointegrated: The null hypothesis of no cointegration is rejected at the 1% level for the money market rate of Canada and France; of Italy with the Canadian, the French, the Japanese, and the US money market rates, as well as for the British-French, the British-German and the British-Japanese pairs. Furthermore, the money market rates of Canada and Japan; Canada and the UK; and France and the United States reject the null hypothesis of no cointegration at the 5% level of significance.

Much less cointegration relation is revealed between the government bond yields of the different countries. Only for the Canadian-German, the Franco-American and the Italian-German pairs of bonds the null of no cointegration can be rejected.

Table 3.1: Results of Johansen test for nominal interest rates

1975:1 - 2010:1
(respectively 1979:1 - 2010:1 for Euro-Market Rates)

Johansen Test (Maximum Eigenvalue Statistic) of Money Market Rates

			Canada	France	Germany	Italy	Japan	UK
France	r=0	Statistic	25.664 ***	--				
		Crit.Val.	17.514	--				
		Vector	-0.953	--				
	r=1	Statistic	1.331	--				
		Crit.Val.	10.327	--				
Germany	r=0	Statistic	11.625	7.423	--			
		Crit.Val.	17.514	15.895	--			
		Vector	-2.035	-3.364	--			
	r=1	Statistic	2.581	3.108	--			
		Crit.Val.	10.327	9.373	--			
Italy	r=0	Statistic	26.507 ***	24.410 ***	8.307	--		
		Crit.Val.	17.514	15.895	15.895	--		
		Vector	-0.637	-0.674	-0.242	--		
	r=1	Statistic	1.667	3.023	2.810	--		
		Crit.Val.	10.327	9.373	9.373	--		
Japan	r=0	Statistic	18.958 **	16.400	12.859	21.801 ***	--	
		Crit.Val.	17.514	16.613	16.613	16.613	--	
		Vector	-1.238	-1.379	-0.279	-1.992	--	
	r=1	Statistic	2.442	5.289	8.450	3.206	--	
		Crit.Val.	10.327	9.796	9.796	9.796	--	
UK	r=0	Statistic	17.554 **	23.608 ***	25.787 ***	15.766	21.910 ***	--
		Crit.Val.	17.514	16.613	16.613	16.613	16.613	--
		Vector	-1.191	-1.226	-0.611	-1.959	-0.778	--
	r=1	Statistic	2.295	1.410	3.765	1.210	2.304	--
		Crit.Val.	10.327	9.796	9.796	9.796	9.796	--
USA	r=0	Statistic	8.683	21.312 **	10.930	28.226 ***	13.596	13.952
		Crit.Val.	17.514	16.866	16.866	16.866	16.866	16.866
		Vector	-1.208	-1.366	-0.524	-2.034	-1.074	-1.397
	r=1	Statistic	2.045	1.9447	5.216	1.443	5.307	5.032
		Crit.Val.	10.327	9.945	9.945	9.945	9.945	9.945

Running the Johansen test with the nominal Euro-Market rates yields eight cointegrated pairs of interest rates: The Euro-Market rates of France and Italy; Canada and UK; UK and Germany; France and the United States; as well as Italy and the United States reject the null of no cointegration at the 1% level of significance. The Euro-Market rates of Canada and Italy; of Italy and the UK; and of France and UK reject the null hypothesis of no cointegration at the 5% level of significance.

Table 3.1: continued

Johansen Test (Maximum Eigenvalue Statistic) of Government Bond Yields

			Canada	France	Germany	Italy	Japan	UK
France	r=0	Statistic	9.297	--				
		Crit.Val.	17.397	--				
		Vector	-0.953	--				
	r=1	Statistic	1.655	--				
		Crit.Val.	10.259	--				
Germany	r=0	Statistic	22.517 ***	13.074	--			
		Crit.Val.	17.397	15.895	--			
		Vector	-1.808	-2.253	--			
	r=1	Statistic	0.783	1.407	--			
		Crit.Val.	10.259	9.373	--			
Italy	r=0	Statistic	8.153	11.933	23.130 ***	--		
		Crit.Val.	17.397	15.895	15.895	--		
		Vector	-0.676	-0.693	-0.341	--		
	r=1	Statistic	1.404	1.667	1.419	--		
		Crit.Val.	10.259	9.373	9.373	--		
Japan	r=0	Statistic	10.744	10.562	9.280	14.488	--	
		Crit.Val.	17.397	16.613	16.613	16.613	--	
		Vector	-1.455	-1.381	-0.471	-1.983	--	
	r=1	Statistic	2.313	2.410	3.225	2.465	--	
		Crit.Val.	10.259	9.796	9.796	9.796	--	
UK	r=0	Statistic	14.108	9.596	12.298	14.289	13.261	--
		Crit.Val.	17.397	16.613	16.613	16.613	16.613	--
		Vector	-1.192	-1.163	-0.376	-1.575	-0.780	--
	r=1	Statistic	4.569	4.652	2.649	4.904	5.645	--
		Crit.Val.	10.259	9.796	9.796	9.796	9.796	--
USA	r=0	Statistic	7.591	19.229 **	15.354	10.936	11.256	13.148
		Crit.Val.	17.397	16.866	16.866	16.866	16.866	16.866
		Vector	-1.118	-1.283	-0.592	-1.778	-0.890	-1.011
	r=1	Statistic	0.860	1.544	1.204	1.109	2.584	5.626
		Crit.Val.	10.259	9.945	9.945	9.945	9.945	9.945

Real interest rates

One possible distortion to comovements among interest rates are differing inflation rates. Therefore, we conduct the same analysis also for real interest rates (results are displayed in Table 3.2).[21] However, we find that the results are overall very similar.

We reject the null of no cointegration at the 1% level of significance and find cointegration between the real money market rates of Germany and Italy. Fur-

[21] Note that the decision for or against non-stationarity sometimes varies depending on the selected lag length. Therefore, for the cointegration test of the real interest rates, we exclude only those interest rates that are found to be unambiguously stationary, i.e. both results of the ADF-tests, conducted with AIC and SIC, reject the hypothesis of non-stationarity.

Table 3.1: continued

Johansen Test (Maximum Eigenvalue Statistic) of Euro-Market Rates

			Canada	France	Germany	Italy	Japan	UK
France	r=0	Statistic	13.935	--				
		Crit.Val.	17.970	--				
		Vector	-0.818	--				
	r=1	Statistic	1.906	--				
		Crit.Val.	10.596	--				
Germany	r=0	Statistic	14.975	10.601	--			
		Crit.Val.	17.970	15.925	--			
		Vector	-2.042	-1.875	--			
	r=1	Statistic	2.628	2.596	--			
		Crit.Val.	10.596	9.390	--			
Italy	r=0	Statistic	20.418 **	24.144 ***	10.656	--		
		Crit.Val.	18.128	15.925	15.925	--		
		Vector	-0.666	-0.745	-0.383	--		
	r=1	Statistic	3.347	2.336	1.983	--		
		Crit.Val.	10.689	9.390	9.390	--		
Japan	r=0	Statistic	18.101	13.957	10.235	15.802	--	
		Crit.Val.	18.128	18.128	18.128	18.128	--	
		Vector	-1.385	-1.575	-0.282	-1.115	--	
	r=1	Statistic	3.059	7.170	2.441	6.098	--	
		Crit.Val.	10.689	10.689	10.689	10.689	--	
UK	r=0	Statistic	24.685 ***	18.235 **	24.074 ***	16.209 **	9.585	--
		Crit.Val.	17.970	15.925	15.925	15.925	18.128	--
		Vector	-1.135	-1.228	-0.700	-1.661	-0.887	--
	r=1	Statistic	2.958	2.884	6.008	3.136	5.942	--
		Crit.Val.	10.596	9.390	9.390	9.390	10.689	--
USA	r=0	Statistic	5.996	30.749 ***	10.560	24.488 ***	9.524	8.969
		Crit.Val.	17.970	17.033	17.033	17.082	18.128	17.033
		Vector	-1.219	-1.424	-0.597	-1.983	-0.663	-1.259
	r=1	Statistic	2.083	3.255	3.450	3.586	3.135	4.086
		Crit.Val.	10.596	10.043	10.043	10.072	10.689	10.043

Note: Results of testing for bivariate cointegration among the nominal interest rates (money market rates, government bond yields, and Euro-Market rates) for the sample 1975:1 to 2010:1 (respectively 1979:1 – 2010:1) are shown. The deterministic trend assumptions of the Johansen tests are the following: intercept (no trend) in the cointegration equation, and no intercept in the VAR. The Table contains the maximum eigenvalue statistics for r=0 and r=1 with the corresponding critical values for each pair of variables. The critical values of Osterwald-Lenum (1992) were scaled with the scaling factor of Cheung and Lai (1993) to adjust for finite samples. The normalized cointegrating coefficient is reported in the rows named "vector". ** and *** indicate the rejection of the null hypothesis with a significance of 5% and 1%.
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

Table 3.2: Results of Johansen test for real interest rates

1975:1 - 2010:1
(1979:1 - 2010:1 for Euro-Market Rates)

Johansen Test (Maximum Eigenvalue Statistic) of Money Market Rates

			Canada	France	Germany	Italy	Japan	UK	USA
France	r=0	Statistic		--					
		Crit.Val.		--					
		Vector		--					
	r=1	Statistic		--					
		Crit.Val.		--					
Germany	r=0	Statistic		19.687 **	--				
		Crit.Val.		16.866	--				
		Vector		-2.088	--				
	r=1	Statistic		3.155	--				
		Crit.Val.		9.945	--				
Italy	r=0	Statistic		14.412	27.151 ***	--			
		Crit.Val.		16.866	16.366	--			
		Vector		-0.809	-0.448	--			
	r=1	Statistic		2.936	4.589	--			
		Crit.Val.		9.945	9.651	--			
Japan	r=0	Statistic							
		Crit.Val.							
		Vector							
	r=1	Statistic							
		Crit.Val.							
UK	r=0	Statistic		9.060	11.121	9.525		--	
		Crit.Val.		17.397	17.397	17.397		--	
		Vector		-1.529	-0.416	-1.009		--	
	r=1	Statistic		4.089	5.050	4.679		--	
		Crit.Val.		10.259	10.259	10.259		--	
USA	r=0	Statistic		10.078	11.226	13.281		10.119	--
		Crit.Val.		16.866	16.866	16.866		17.397	--
		Vector		-1.975	-0.674	-1.764		-1.362	--
	r=1	Statistic		3.332	3.917	5.293		3.329	--
		Crit.Val.		9.945	9.945	9.945		10.259	--

thermore, the Franco-German pair of real money market rates reject the null hypothesis of no cointegration at the 5% level.

Among the real government bond yields we detect five more pairs that are cointegrated: the Canadian-UK; and the French-UK pairs (both rejection at the 1% level of significance); and the Canadian-French; the Franco-German; and the German-UK couples (the latter all reject the null hypothesis of no cointegration at the 5% level).

Conducting the Johansen test with the real Euro-Market rates gives eleven cointegrated pairs of interest rates: The Euro-Market rate pairs of Italy with Canada, France, and Germany, as well as of the UK with Canada, France, and Germany

Table 3.2: continued

Johansen Test (Maximum Eigenvalue Statistic) of Government Bond Yields

			Canada	France	Germany	Italy	Japan	UK	USA
France	r=0	Statistic	20.327 **	--					
		Crit.Val.	17.676	--					
		Vector	-1.031	--					
	r=1	Statistic	7.608	--					
		Crit.Val.	10.423	--					
Germany	r=0	Statistic	13.160	19.135 **	--				
		Crit.Val.	17.676	16.866	--				
		Vector	-1.350	-1.635	--				
	r=1	Statistic	2.107	2.918	--				
		Crit.Val.	10.423	9.945	--				
Italy	r=0	Statistic							
		Crit.Val.							
		Vector							
	r=1	Statistic							
		Crit.Val.							
Japan	r=0	Statistic							
		Crit.Val.							
		Vector							
	r=1	Statistic							
		Crit.Val.							
UK	r=0	Statistic	48.332 ***	23.732 ***	20.769 **			--	
		Crit.Val.	17.676	17.397	17.397			--	
		Vector	-0.906	-0.904	-0.540			--	
	r=1	Statistic	5.050	7.587	1.871			--	
		Crit.Val.	10.423	10.259	10.259			--	
USA	r=0	Statistic							
		Crit.Val.							
		Vector							
	r=1	Statistic							
		Crit.Val.							

reject the null hypothesis at the 1% level of significance; and the Euro-Market rates of France with Canada, Germany, and Japan; of Canada and Germany; and of Italy and the UK reject the null of no cointegration at the 5% level.

Summing up, the change from nominal to real interest rates does not enhance the evidence for cointegration among the studied interest rates in a significant way.

Table 3.2: continued

Johansen Test (Maximum Eigenvalue Statistic) of Euro-Market Rates

			Canada	France	Germany	Italy	Japan	UK	USA
France	r=0	Statistic	19.415 **	--					
		Crit.Val.	16.188	--					
		Vector	-0.726	--					
	r=1	Statistic	4.946	--					
		Crit.Val.	9.545	--					
Germany	r=0	Statistic	19.624 **	18.060 **	--				
		Crit.Val.	16.188	16.188	--				
		Vector	-1.355	-1.943	--				
	r=1	Statistic	5.028	4.198	--				
		Crit.Val.	9.545	9.545	--				
Italy	r=0	Statistic	22.876 ***	40.536 ***	22.029 ***	--			
		Crit.Val.	16.192	16.192	16.192	--			
		Vector	-0.761	-0.996	-0.512	--			
	r=1	Statistic	3.587	3.671	3.022	--			
		Crit.Val.	9.548	9.548	9.548	--			
Japan	r=0	Statistic	13.928	16.633 **	15.300	15.234	--		
		Crit.Val.	16.474	16.474	16.474	16.474	--		
		Vector	-0.980	-1.199	-0.689	-1.387	--		
	r=1	Statistic	2.937	3.041	2.722	1.914	--		
		Crit.Val.	9.714	9.714	9.714	9.714	--		
UK	r=0	Statistic	29.136 ***	27.993 ***	21.202 ***	19.072 **	10.701	--	
		Crit.Val.	16.188	16.188	15.925	16.192	16.474	--	
		Vector	-0.939	-1.253	-0.689	-1.230	-0.827	--	
	r=1	Statistic	1.926	1.723	1.462	2.107	2.015	--	
		Crit.Val.	9.545	9.545	9.390	9.548	9.714	--	
USA	r=0	Statistic	9.576	8.415	9.889	4.708	9.647	10.878	--
		Crit.Val.	16.741	16.741	16.741	16.770	16.770	16.741	--
		Vector	-0.845	-1.055	-0.444	-2.250	-0.934	-1.392	--
	r=1	Statistic	3.123	3.474	3.252	3.793	1.859	4.457	--
		Crit.Val.	9.872	9.872	9.872	9.888	9.888	9.872	--

Note: Results of testing for bivariate cointegration among the real interest rates (real money market rates, real government bond yields and real Euro-Market rates) for the sample 1975:1 to 2010:1 (respectively from 1979:1 onwards for the Euro-Market rates) are shown. The deterministic trend assumptions of the Johansen tests are the following: intercept (no trend) in the cointegration equation, and no intercept in the VAR. The Table contains the maximum eigenvalue statistics for r=0 and r=1 with the corresponding critical values for each pair of variables. The critical values of Osterwald-Lenum (1992) were scaled with the scaling factor of Cheung and Lai (1993) to adjust for finite samples. The normalized cointegrating coefficient is reported in the rows named "vector". ** and *** indicate the rejection of the null hypothesis with a significance of 5% and 1%.
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

3.2 Common Cycles

Serial correlation common feature

As a generalization of the cointegration test, Engle and Kozicki (1993) have developed the test for common features. If a feature (such as the I(1)-property, AR(p)-structure, seasonality, etc.) is common to two times series, there should exist a linear combination that does not have this feature.

In this section, we focus on the serial correlation common feature (SCCF). While the previous section focused on long-run comovement, the analysis of a common autoregressive structure of time series is often interpreted as cyclical comovement (Cheung and Westermann, 2003). It is important to point out that not *both* tests can be meaningfully applied to the same time series, as one requires stationarity, and the other non-stationarity. In this section we therefore only continue with interest rates that were identified as I(0)-series in Table 2.3.[22]

Furthermore, a "common feature" among time series can only exist, when the feature (i.e. the AR(p)-structure) is identical in both time series. As reported in Table 2.2, this is rarely the case, however, and, as pointed out in section 2.2, this substantially limits the degree of common cycles that we anticipate to find in the data.

For those pairs of interest rates that are stationary and follow the same stochastic process we estimate the equation

$$x_t = c + \beta y_t + \epsilon_t \tag{3.1}$$

[22] It is also possible to conduct the serial correlation common feature test in the 1^{st} differences of the non-stationary interest rates. However, as it is difficult to attribute an economic interpretation to the change in interest rates, we focus on the levels of interest rates in this essay only.

with two-stage-least-squares, including as instruments all lagged variables of x and y, i.e. x_{t-k} and y_{t-k} for $k = 1, ..., p$. $(1, \beta)$ is the normalized common feature vector.

In a second step, we test whether the estimated residual $\hat{\epsilon}_t$ of the former estimation is still driven by the same stochastic process as x_t and y_t. Therefore, we estimate the following equation by OLS:

$$\hat{\epsilon}_t = c + \sum_{k=1}^{p} \delta_k x_{t-k} + \sum_{k=1}^{p} \gamma_k y_{t-k} + u_t. \tag{3.2}$$

Next, we test the null hypothesis that all lagged variables of x_t and y_t do not explain jointly the endogenous variable $\hat{\epsilon}_t$, i.e. $\delta_k = \gamma_k = 0$ for $k = 1, ..., p$. If the lagged variables do not explain the movement of the estimated residual, the common AR(p)-pattern of the interest rates x_t and y_t is removed. The null hypothesis is tested with the F-statistic:

$$F_{k-1,T-k} = \frac{R^2}{1 - R^2} \frac{T - k}{k - 1},$$

where T denotes the number of observations and k refers to the number of restrictions, i.e. the number of exogenous variables including the constant. R^2 is the R-squared of regression 3.2. The null hypothesis of a common feature will be rejected, if the value of the calculated F-statistic is larger than the tabulated critical value of the F-distribution.[23]

For the nominal interest rates we cannot perform the analysis of testing for serial correlation common features as we do not have a single pair of stationary interest rates.[24] Thus, none of the potentially 63 pairs of nominal interest rates shares a serial correlation common feature.

[23] Thus, in contrast to the cointegration test, where a rejection of H_0 stands for the existence of a common trend, in the case of the serial correlation common feature test we must not reject the null hypothesis in order to detect a common feature.

[24] See Table 2.3.

Among the real interest rates there exist several pairs of interest rates that meet the requirements of being stationary and following the same AR process.[25] The results of the serial correlation common feature test are displayed in Table 3.3 (panel A).

In our sample, 7 of the 21 real interest rates fulfill the condition of being stationary. Among these 7 time series we identify 3 pairs of interest rates of the same type that follow the same autoregressive process: the real government bond yields of Italy, Japan, and the United States (all AR(5)). For all pairs of real interest rates we reject the null hypothesis of a common feature at the 1% significance level. Thus, none of the 63 pairs of real interest rates shares a serial correlation common feature.

As a robustness test, we also conduct the analysis in a shorter sample, ending in 1998:4. The aim is to control for possible influences of the change in the institutional environment that resulted from the introduction of the Euro and the European System of Central Banks (ESCB).[26]

Now, we find 8 pairs to test for serial correlation common feature: real government bond yields of France, Italy, Japan and the UK (all AR(5)-processes) form the first 6 couples and the real Euro-Market rates from Canada and France (AR(1)), and from Italy and the UK (AR(2)) are the remaining two couples (see panel B of Table 3.3). In 7 of the 8 cases the F-statistics are significant, indicating that a common serial correlation does not exist. In the case of the real Euro-Market rates of Italy and the UK, the F-statistic is insignificant. However, the cofeature vector is insignificant. Thus, a serial correlation common feature does not exist in the shortened sample either.

[25] See Table 2.2, and Table 2.3.

[26] Results of the preliminary analysis for the shortened sample are reported in section 5.C in the appendix.

Table 3.3: Results of serial correlation common feature and codependence tests for real interest rates

PANEL A

1975:1 - 2010:1

Country	AR(...)	Coefficient	CF = 0	Codependence of order 1	2	3	4
Real Government Bond Yields							
Italy	5	1.822 **	153.300 ***	5.244 ***	5.306 ***	7.848 ***	11.190 ***
Japan	5						
Italy	5	1.242 **	87.820 ***	3.389 ***	3.387 ***	4.769 ***	8.623 ***
USA	5						
Japan	5	0.604 **	56.970 ***	2.353 **	2.622 **	2.816 **	0.530
USA	5						

PANEL B

1975:1 - 1998:4
(respectively 1979:1 - 1998:4 for Euro-Market Rates)

Country	AR(...)	Coefficient	CF = 0	Codependence of order 1	2	3	4
Real Euro-Market Rates							
Canada	1	0.5611 **	8.409 ***				
France	1						
Italy	2	0.3097	0.921	1.713			
UK	2						
Real Government Bond Yields							
France	5	0.6192 **	22.53 ***	2.787 ***	1.619	2.204	3.167 **
Italy	5						
France	5	0.7989 **	63.82 ***	2.542 **	3.010 **	3.781 ***	6.713 ***
Japan	5						
France	5	0.5511 **	35.65 ***	5.217 ***	2.781 **	2.134	4.261 **
UK	5						
Italy	5	1.1838 **	59.04 ***	4.517 ***	4.146 ***	6.155 ***	11.53 ***
Japan	5						
Italy	5	0.8429 **	24.83 ***	7.443 ***	3.372 ***	3.099 **	6.132 ***
UK	5						
Japan	5	0.3762 **	26.02 ***	4.234 ***	3.677 ***	4.277 ***	7.673 ***
UK	5						

Note: Results of the common feature and codependence test of real government bond yields for the sample 1975:1 – 2010:1 (panel A) are reported. In the lower part of the Table we report the results of the common feature and codependence test of real government bond yields for the sample 1975:1 – 1998:4 (panel B) and of real Euro-Market rates for the sample 1979:1 – 1998:4 (panel B). Only few pairs of real interest rates are stationary and have the same autoregressive representation (indicated in the second column). The third column contains the coefficient of the common feature vector. The following columns report the F-statistics for the common feature test (= codependence of order 0) and the codependence tests. ** and *** indicate the rejection of the null hypothesis with a significance of 5% and 1%.
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

Codependence: TSLS estimation

In Table 3.3 we also report the results on codependence among interest rates of higher order. This weaker form of cyclical, but non-synchronized comovement was first described by Gourieroux and Peaucelle (1989) and Vahid and Engle (1997): Some time series may have a different initial response to a shock, but a common response after some lags.[27]

We test for codependence estimating the same equations as for the SCCF: 1. TSLS (equation 3.1) and 2. OLS of the residual (equation 3.2).

Then, we compute a Wald-Test, testing whether all but the first lagged terms of both interest rates do not explain jointly the estimated residual $\hat{\epsilon}_t$. The null hypotheses are: H_0 for codependence of order 1: $\delta_k = \gamma_k = 0$ for $k = 2, ..., p$; H_0 for codependence of order 2: $\delta_k = \gamma_k = 0$ for $k = 3, ..., p$ and so forth. Again, H_0 will be rejected, if the value of the calculated F-statistic is larger than the tabulated critical value.

We test for codependence up to order four for the real government bond yields of Italy, Japan, and the United States (see Table 3.3 (panel A) for the results). Up to order three all test statistics are highly significant, thus a codependence relationship does not exist. Only for the interest rates of Japan and the United States we find codependence of order four.

As before, we pursue the codependence tests for the shortened sample (see Table 3.3 (panel B)). In this specification, very weak evidence is found in favor of codependence. The result lends support to the view that the real government bond yields of France and Italy are codependent of order two and that the real government bond yields of France and the UK show third order codependence. However, codependence of order four is not found in both cases, which suggests that there is little correlation left after the third lag in either time series. For the remaining pairs the tests statistics are highly significant, again.

[27] Thus, codependence of order 0 is actually a serial correlation common feature.

To sum up, reliable evidence for a comovement in the transitory components of the interest rates cannot be found. As the evidence for serial correlation common feature is really poor among all types of interest rates, we finally ignore for a moment the condition that the time series have to follow the same process of autocorrelation and conduct the test for serial correlation common feature with all interest rates of the same type that are I(0). The results are displayed in Table 3.4. This relaxation leaves us with one pair of real money market rates and 10 pairs of real government bond yields to test for comovements in the short-run. For each test the respectively longer lag length is selected. All test statistics are highly significant (at the 1% level), meaning that no serial common feature exists among them. This result indicates that the poor evidence for serial correlation common feature is not due to a wrong lag length selection.

Codependence: GMM estimation

We finally consider a general method of moments (GMM) estimation of the codependence relationship. Vahid and Engle (1997) and Cubadda (1999, 2007) both report that due to its relative efficiency, an optimal general method of moments estimation is more appropriate for a codependence test than a TSLS estimation.[28] Thus, in a last attempt to detect evidence for cyclical comovement, we conduct the optimal GMM test proposed by Cubadda (1999, 2007). Results of the GMM estimation of codependence relations are shown in Table 3.5.

As in the previous section, we first test the three pairs of real government bond yields of Italy and Japan, Italy and the United States, and Japan and the United States, where common lag structures are given in the full sample (Table 3.5 (panel

[28] Schleicher (2007) proposes another alternative to the TSLS procedure claiming that likelihood ratio (LR) tests based on full information maximum likelihood (FIML) estimates have even higher power than the optimal GMM estimates when testing for codependence of order one. However, this applies above all if error correction terms are included, which is not given in our investigation.

Table 3.4: Serial correlation common feature with all pairs of stationary real interest rates

		1975:1 - 2010:1					
Common Feature Test of Real Money Market Rates							
		Canada	France	Germany	Italy	Japan	UK
Japan	lags	8	--	--	--	--	--
	Coef.	1.553	--	--	--	--	--
	F-Stat.	8.480 ***	--	--	--	--	--
Common Feature Test of Real Government Bond Yields							
		Canada	France	Germany	Italy	Japan	UK
Italy	lags	--	--	3	--		
	Coef.	--	--	3.085	--		
	F-Stat.	--	--	80.710 ***	--		
Japan	lags	--	--	1	3	--	
	Coef.	--	--	2.589	-0.061	--	
	F-Stat.	--	--	186.500 ***	110.100 ***	--	
UK	lags	--	--	6	6	6	--
	Coef.	--	--	3.047	0.537	1.222	--
	F-Stat.	--	--	45.330 ***	35.050 ***	30.990 ***	--
USA	lags	--	--	5	5	5	6
	Coef.	--	--	2.594	0.005	0.773	-0.163
	F-Stat.	--	--	47.590 ***	87.600 ***	46.230 ***	36.140 ***

Note: Table 3.4 reports common feature tests for each pair of stationary real interest rates for the sample 1975:1 to 2010:1. For each pair, the longer lag length of the two series is chosen for the common feature test (see Table 2.2). The first row for each pair contains the lag length, the second row reports the coefficient of the common feature vector and the third row reports the F-statistic of the common feature test. *** indicate rejection of the null hypothesis with a significance of 1%.
Source: Authors' calculations, based on IMF (2010); and Banque de France (2009).

A)). In all cases the χ^2-statistics are highly significant, thus we do not find evidence for codependence.

In the shorter sample the evidence for some codependence of higher order strengthens a bit: For the real government bond yields of France and the UK, as well as of Italy and the UK, we find third order codependence; and for the country pairs of France and Japan; and Italy and Japan codependence of order four (the null hypothesis of codependence cannot be rejected at conventional levels) (see Table 3.5 (panel B)). For the remaining two pairs of real government bond yields we can still detect weak evidence for codependence of order three for Japan

Table 3.5: Results of optimal GMM estimation of codependence relations for real interest rates

PANEL A

1975:1 - 2010:1

Country	AR(...)		Codependence of order 0	1	2	3	4
Real Government Bond Yields							
Italy	5	Vector	-1.425 ***	-1.460 ***	-1.512 ***	-1.617 ***	-1.630 ***
Japan	5	χ^2-test	130.943 ***	66.717 ***	40.776 ***	25.690 ***	18.619 ***
Italy	5	Vector	-0.975 ***	-0.975 ***	-0.969 ***	-0.995 ***	-1.007 ***
USA	5	χ^2-test	130.900 ***	68.187 ***	41.071 ***	25.043 ***	15.554 ***
Japan	5	Vector	-0.400 ***	-0.386 ***	-0.360 ***	-0.333 ***	-0.311 ***
USA	5	χ^2-test	129.907 ***	64.676 ***	37.655 ***	19.797 ***	9.848 **

PANEL B

1975:1 - 1998:4
(respectively 1979:1 - 1998:4 for Euro-Market Rates)

Country	AR(...)		Codependence of order 0	1	2	3	4
Real Euro-Market Rates							
Canada	1	Vector	- 0.1888 **				
France	1	χ^2-test	66.0714 ***				
Italy	2	Vector	- 0.2746 **	- 0.2875			
UK	2	χ^2-test	41.3502 ***	21.0472 ***			
Real Government Bond Yields							
France	5	Vector	- 0.5598 ***	- 0.5731 ***	- 0.5971 ***	- 0.6594 ***	- 0.7212 ***
Italy	5	χ^2-test	85.1935 ***	40.2984 ***	21.1621 ***	11.4594 ***	7.4646 *
France	5	Vector	- 0.7127 ***	- 0.7398 ***	- 0.7877 ***	- 0.9032 ***	- 1.0668 ***
Japan	5	χ^2-test	85.5049 ***	41.1686 ***	22.0305 ***	11.2271 **	5.6531
France	5	Vector	- 0.4206 ***	- 0.4641 ***	- 0.5692 ***	- 0.7779 ***	- 0.9242 ***
UK	5	χ^2-test	86.3631 ***	41.3578 ***	19.0679 ***	5.6549	1.5596
Italy	5	Vector	- 0.9824 ***	- 1.0216 ***	- 1.0416 ***	- 1.0173 ***	- 0.9617 ***
Japan	5	χ^2-test	83.3915 ***	39.3762 ***	19.5484 ***	8.5181 **	4.6488
Italy	5	Vector	- 0.7591 ***	- 0.8348 ***	- 0.9261 ***	- 0.9634 ***	- 0.8064 ***
UK	5	χ^2-test	79.9158 ***	30.3733 ***	8.2637 **	0.4974	1.7558
Japan	5	Vector	- 0.4967 ***	- 0.5216 ***	- 0.6022 ***	- 0.7531 ***	- 0.8462 ***
UK	5	χ^2-test	85.1985 ***	39.8417 ***	20.1449 ***	7.7318 *	3.1982

Note: Results of the optimal GMM estimation of codependence relations of real government bond yields for the sample 1975:1 – 2010:1 (panel A) and 1975:1 – 1998:4 (panel B) as well as of real Euro-Market rates for the sample 1979:1 – 1998:4 (panel B) are reported. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level.
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

and the UK; and codependence of order four for France and Italy (rejection at the 10%-level of significance). Concerning the real Euro-Market rates we continue not finding any evidence for codependence.

Overall, strong evidence for cyclical comovement cannot be found. Some codependence of higher order can be detected for pairs of real government bond yields in a shortened sample (ending in 1998:4) using the optimal GMM estimation. The strongest evidence of codependence exists among some EU countries: Italy, France and the UK.

4 Conclusions

The contribution of this essay is to analyze comovements in interest rates in a structured framework. We point out that previous findings on cointegration and codependence can not be generalized for all interest rates, as they make different assumptions about the unit root properties in the data.

Already the preliminary analysis of defining the lag structure and the stationarity of the interest rates gives rise to the suspicion that little evidence of comovement can be detected in our data set. We generally find only weak evidence for cointegration. Neither the abstraction of the country risk by looking at Euro-Market rates, nor the distinction between nominal and real rates is vital for finding comovements in the long run. The same conclusion also applies to cyclical comovement: using two different methodologies, the TSLS estimation proposed by Engle and Kozicki (1993) and a GMM estimation suggested by Cubadda (1999, 2007), we were not able to establish convincing evidence of either common synchronized cycles (SCCF) or common non-synchronized cycles (codependence). Very limited evidence of higher order codependence only exists among some real government bond yields in the pre-Euro area sample (ending in 1998:4).

Therefore, the lesson to be drawn from our analysis is that we cannot expect that there exist common stochastic trends and cycles in interest rates, although some of each have been reported in the earlier literature. We also cannot generalize the limited evidence of comovements that is found in this essay, for all interest rates. With regard to the conduct of monetary policy, for the purpose of stabilizing the economy, this implies that central banks appear to be less constrained by external factors than is often argued. The design of an optimal monetary policy in a small open economy continues to be an interesting topic for further research.

Further research could also analyze whether the currency risk could explain the weak evidence for comovements among interest rates.[29] We tried to approach this aspect by performing the analysis for the three Eurozone-countries: France, Germany and Italy, for the time after the introduction of the Euro as common currency.[30] We did not find common cycles in this attempt either, but certainly more work could be done in this direction.

Another promising field for future research could be to extend the tests in the literature on the causality among interest rates. A deeper knowledge of the common trend and cycle comovements would be useful for this purpose. Finally, it would be interesting to contrast the findings of the G7-countries to either emerging market rates, or the interest rates of large economies, with small neighboring countries that pursue similar central bank policies.

[29] The interaction between interest rates and the exchange rate was the topic of many research papers in the last years. However, evidence is quite mixed. For a discussion about the relationship between interest rates and exchange rates see Hnatkovska, Lahiri and Vegh (2008).

[30] We use the same interest rates as before, namely money market rates and government bond yields in a reduced sample from 1999:1 – 2010:1. Results are available in section 5.F in the appendix.

5 Appendix

In the following sections additional results and robustness checks will be provided. The appendix is structured as follows: in section 5.A additional Tables for the main sample under study, the post Bretton-Wood period from 1975:1 to 2010:1, respectively from 1979:1 to 2010:1 in the case of the Euro-Market rates, are presented, namely correlations between the real interest rates and the results of the ARCH-LM-Test of both, nominal and real interest rates.

In the following five sections we present results of the analysis for several control samples, i.e. the same Tables as in the main part of the essay, namely AR(p)-representations, ADF-test, Johansen-test, serial correlation common feature and codependence tests, both with TSLS and GMM (the latter two Tables only for those samples, where it is possible to test for SCCF and codependence).

The first control sample goes as far back in the past as possible (compare the data availability in Table 2.1) and ends before the recent economic and financial crisis: 1957:1 to 2007:1 (section 5.B).

The second control sample starts in 1975:1 (respectively in 1979:1) and ends in 1998:4 before the introduction of the Euro and the European System of Central Banks (section 5.C).

The third control sample comprises the time studied in Kugler and Neusser (1993) and goes from 1980:1 to 1991:4 (section 5.D).

The fourth control sample starts in 1985:1 and ends in 2007:1, thus, excluding the time of and after the oil crises of the seventies and the recent 2008-2009 crisis (section 5.E).

The last control sample comprises the time from 1999:1 to 2010:1, i.e. the time after the introduction of the Euro (section 5.F).

Finally, in the last section 5.G of this appendix, we analyze whether interest rates of the same country show more evidence of comovements than interest rates of different countries. Therefore, we analyze the money market rates and the government bond yields of each country for the sample 1975:1 to 2007:1, and the Euro-Market rates together with the before mentioned rates for the sample 1979:1 to 2007:1.

5.A Additional Results for the Main Sample 1975:1 – 2010:1

Contemporaneous correlation

As already pointed out in the main part of the essay, the visible comovements of the graphs of the interest rates (see Figure 2.1) does not necessary mean that we should find evidence for serial correlation common features. The test for common serial correlation only assesses the common response to shocks and not the contemporaneous correlations of the interest rates. These are indeed for many interest rate pairs relatively high as can be seen in Table 5.1. However, the results of this essay suggest that the visible comovements in the graphs and the high contemporaneous correlations of the interest rates are the result from a high correlation of the shocks, rather than of a common response pattern.

Table 5.1: Correlation of real interest rates

1975:1 - 2010:1
(respectively 1979:1 - 2010:1 for Euro-Market Rates)

Real Money Market Rates

	Canada	France	Germany	Italy	Japan	UK	USA
Canada	1.00						
France	0.72	1.00					
Germany	0.77	0.77	1.00				
Italy	0.71	0.87	0.66	1.00			
Japan	0.66	0.60	0.72	0.59	1.00		
UK	0.60	0.70	0.66	0.77	0.59	1.00	
USA	0.72	0.52	0.60	0.61	0.57	0.58	1.00

Real Government Bond Yields

	Canada	France	Germany	Italy	Japan	UK	USA
Canada	1.00						
France	0.84	1.00					
Germany	0.62	0.65	1.00				
Italy	0.77	0.89	0.48	1.00			
Japan	0.62	0.62	0.58	0.63	1.00		
UK	0.73	0.75	0.51	0.76	0.64	1.00	
USA	0.78	0.75	0.63	0.66	0.66	0.73	1.00

Real Euro-Market Rates

	Canada	France	Germany	Italy	Japan	UK	USA
Canada	1.00						
France	0.62	1.00					
Germany	0.73	0.59	1.00				
Italy	0.62	0.80	0.59	1.00			
Japan	0.61	0.59	0.66	0.52	1.00		
UK	0.59	0.66	0.55	0.67	0.54	1.00	
USA	0.69	0.52	0.48	0.50	0.49	0.53	1.00

Note: Correlation coefficients of the real interest rates (real money market rates, real government bond yields and real Euro-Market rates) for the sample 1975:1 – 2010:1 (respectively from 1979:1 onward for the Euro-Market rates) are reported. As some of the real interest rates are non-stationary, the correlation coefficients often are not interpretable correctly.
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

Table 5.2: Results of ARCH(1)-LM-test

1975:1 - 2010:1
(1979:1 - 2010:1 for Euro-Market Rates)

	Nominal			Real		
Country	F-stat.	Prob(F)	Prob(χ^2)	F-stat.	Prob(F)	Prob(χ^2)
Money Market Rates						
Canada	43.290	0.000	0.000	41.645	0.000	0.000
France	4.590	0.034	0.034	0.324	0.570	0.567
Germany	6.705	0.011	0.011	2.705	0.102	0.101
Italy	16.514	0.000	0.000	5.595	0.019	0.020
Japan	38.620	0.000	0.000	0.324	0.570	0.567
UK	3.090	0.081	0.080	12.143	0.001	0.001
USA	1.199	0.276	0.272	5.260	0.023	0.023
Government Bond Yields						
Canada	38.790	0.000	0.000	4.812	0.030	0.030
France	0.030	0.864	0.863	0.135	0.714	0.711
Germany	0.682	0.410	0.407	0.007	0.933	0.933
Italy	0.029	0.865	0.864	3.913	0.050	0.049
Japan	0.645	0.423	0.420	0.680	0.411	0.407
UK	5.295	0.023	0.023	13.212	0.000	0.001
USA	6.812	0.010	0.010	0.295	0.588	0.585
Euro-Market Rates						
Canada	9.835	0.002	0.002	7.025	0.009	0.009
France	20.477	0.000	0.000	15.532	0.000	0.000
Germany	0.357	0.551	0.547	0.122	0.727	0.724
Italy	4.883	0.029	0.029	0.039	0.843	0.842
Japan	27.915	0.000	0.000	1.846	0.177	0.174
UK	0.790	0.376	0.372	5.102	0.026	0.026
USA	1.167	0.282	0.279	3.193	0.077	0.075

Note: Results of testing for volatility clustering among nominal and real interest rates (money market rates, government bond yields and Euro-Market rates) for the sample 1975:1 to 2010:1 (respectively from 1979:1 onwards for the Euro-Market rates) are shown. The ARCH-LM-test was conducted with the optimal number of lags for the AR(p)-structure of the interest rates (as determined in Table 2.2) and one lag for the volatility. The Table reports the F-statistic, and the p-values for the F- and the χ^2-statistic.
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

Heteroscedasticity

As the interest rates seem to suffer from heteroscedasticity, we investigate the nature of this heteroscedasticity with the Lagrange multiplier test for autoregressive conditional heteroscedasticity in the residuals (ARCH-LM test). The ARCH-LM test verifies the null hypothesis that there is no ARCH up to order p in the residuals.

Table 5.2 reports the results from our tests for volatility clustering. We find that regressing the original time series on lagged values (according to optimal lag length), leaves the residuals free of volatility clustering in many of the cases. However, a substantial number of series (nearly half of the series) indeed display a significant ARCH-LM test.

With regard to our testing framework, this would imply that standard errors would possibly have to be corrected upwards, to be robust against this volatility pattern. However as our central result is already that there is hardly any evidence of cyclical comovement, it would only reinforce this statement, possibly eliminating the last remaining cases of comovement.

5.B Control Sample I — Largest Possible Sample: 1957:1 – 2007:1

One of the main concerns when conducting the analysis of common trends and cycles is whether the power of the different tests may be improved by a longer sample. Therefore, in the following section we will analyze whether the largest possible sample — excluding the years of the recent global crisis — yields more evidence for comovements.

In the IFS database time series for the money market rates and the government bond yields are available since 1957 (see Table 2.1 in the main part of the essay).[31] We conduct the analysis for this longest possible time period, namely from 1957 to 2007[32] including 201 observations.

Table 5.3 reports the optimal AR(p)-specifications of the nominal and real interest rates; Table 5.4 gives results of the ADF-test, both with AIC and SIC criterion; Table 5.5 displays the results of the Johansen-test; and Tables 5.6 and 5.7 report the results of the serial correlation common feature and codependence tests.

However, the main results are robust to this change of the sample. Thus, low power of the tests does not seem to be driving the result of lack of comovement across interest rates. We chose the shorter sample in the main part of the essay as other studies often (but not always) focus on the post-Bretton Woods period.

[31] Euro-Market rates are only available since the end of the 1970s.
[32] We exclude the recent years of the global financial and economic crisis.

Table 5.3: AR(p)-representations of the process of nominal and real interest rates

	1957:1 - 2007:1			
	Nominal		Real	
	AR(...)		AR(...)	
Country	Level	1^{st} diff	Level	1^{st} diff
Money Market Rates				
Canada	6	6	8	8
France	2	1	2	1
Germany	10	9	5	6
Italy	2	2	4	4
Japan	11	10	5	4
UK	5	5	6	4
USA	6	7	6	6
Government Bond Yields				
Canada	5	5	5	4
France	2	1	9	8
Germany	4	3	4	4
Italy	2	1	5	4
Japan	4	3	5	5
UK	10	10	8	8
USA	4	3	3	3

Note: AR representations of the process of the nominal and real interest rates (money market rates and government bond yields) for the sample 1957:1 to 2007:1 are reported. The specification with the smallest number of AR terms is selected, under the constraint that the residual is free of autocorrelation (i.e. the Q-statistics are insignificant).
Source: Authors' calculations, based on IMF (2010); and Banque de France (2009).

Table 5.4: Results of ADF-test for nominal and real interest rates

	1957:1 - 2007:1																	
	Nominal								Real									
	Level (AIC)			Level (SIC)			1st differences (AIC)		Level (AIC)			Level (SIC)			1st differences (AIC)			
Country	Statistic	Lags	Crit. Val.	Statistic	Lags	Crit. Val.	Statistic	Crit. Val.	Statistic	Lags	Crit. Val.	Statistic	Lags	Crit. Val.	Statistic	Crit. Val.		
Money Market Rates																		
Canada	-1.155	8	-2.840	-1.503	1	-2.880	-5.186 **	-2.846	-3.330 **	1	-2.880	-3.330 **	1	-2.880	-6.351 **	-2.846		
France	-1.690	5	-2.856	-2.372	1	-2.871	-7.655 **	-2.860	-4.129 **	2	-2.868	-4.398 **	1	-2.871	-6.010 **	-2.841		
Germany	-2.797	12	-2.830	-3.833 **	2	-2.867	-6.836 **	-2.845	-2.312	9	-2.841	-4.107 **	1	-2.871	-7.436 **	-2.845		
Italy	-1.021	5	-2.857	-1.897	1	-2.877	-6.933 **	-2.862	-1.267	5	-2.857	-2.254	1	-2.877	-7.841 **	-2.862		
Japan	-1.369	9	-2.842	-2.343	1	-2.871	-5.856 **	-2.845	-2.997 **	4	-2.860	-2.997 **	4	-2.860	-10.00 **	-2.864		
UK	-2.131	0	-2.883	-2.131	0	-2.883	-4.717 **	-2.836	-2.052	7	-2.847	-1.398	5	-2.857	-4.043 **	-2.852		
USA	-2.318	7	-2.849	-2.657	3	-2.864	-6.302 **	-2.853	-2.280	7	-2.849	-3.031 **	2	-2.868	-7.116 **	-2.853		
Government Bond Yields																		
Canada	-1.364	8	-2.845	-1.317	0	-2.875	-4.726 **	-2.849	-1.929	4	-2.860	-3.002 **	1	-2.871	-9.463 **	-2.864		
France	-1.270	4	-2.860	-1.517	1	-2.871	-6.670 **	-2.864	-1.665	8	-2.845	-6.272 **	1	-2.871	-6.254 **	-2.834		
Germany	-2.453	3	-2.864	-2.339	1	-2.871	-9.525 **	-2.875	-2.791	5	-2.856	-3.499 **	0	-2.875	-5.830 **	-2.834		
Italy	-1.505	1	-2.871	-1.505	1	-2.871	-8.723 **	-2.875	-2.354	5	-2.856	-2.117	4	-2.860	-10.36 **	-2.864		
Japan	-1.231	3	-2.866	-0.841	1	-2.875	-5.282 **	-2.870	-2.043	8	-2.843	-2.721	4	-2.861	-6.179 **	-2.848		
UK	-1.368	1	-2.871	-1.368	1	-2.871	-11.61 **	-2.875	-2.643	8	-2.845	-4.633 **	1	-2.871	-6.587 **	-2.849		
USA	-1.713	5	-2.856	-1.829	1	-2.871	-7.018 **	-2.860	-2.941 **	5	-2.856	-3.046 **	1	-2.871	-6.129 **	-2.853		

Note: The ADF-test statistics, calculated for the levels and first differences of nominal and real interest rates (money market rates, and government bond yields) for the sample 1957:1 to 2007:1 are reported. The lag length was selected by the AIC and SIC criterion and is given in the corresponding column. Critical values of Cheung and Lai (1995) were applied and are reported. ** indicate rejection of the existence of both, stochastic and deterministic trends with a significance of 5%.

Source: Authors' calculations, based on IMF (2010); and Banque de France (2009).

Table 5.5: Results of Johansen test for nominal interest rates

1957:1 - 2007:1

Johansen Test (Maximum Eigenvalue Statistic) of Money Market Rates

			Canada	France	Germany	Italy	Japan	UK	USA
France	r=0	Statistic	19.832 **	--					
		Crit.Val.	17.379	--					
		Vector	-0.894	--					
	r=1	Statistic	1.405	--					
		Crit.Val.	10.248	--					
Germany	r=0	Statistic	10.840	12.417	--				
		Crit.Val.	18.463	17.300	--				
		Vector	-2.672	-2.141	--				
	r=1	Statistic	1.657	2.773	--				
		Crit.Val.	10.887	10.201	--				
Italy	r=0	Statistic	25.463 ***	16.831 **	38.736 ***	--			
		Crit.Val.	17.379	16.124	18.081	--			
		Vector	-0.619	-0.658	-0.302	--			
	r=1	Statistic	1.414	3.421	0.867	--			
		Crit.Val.	10.248	9.508	10.662	--			
Japan	r=0	Statistic	15.816	5.667	7.267	13.492	--		
		Crit.Val.	18.868	17.514	17.514	18.419	--		
		Vector	-1.184	-2.305	-0.317	-1.969	--		
	r=1	Statistic	1.627	2.638	2.404	1.760	--		
		Crit.Val.	11.126	10.327	10.327	10.861	--		
UK	r=0	Statistic	10.109	11.684	8.186	7.884	24.581 ***	--	
		Crit.Val.	17.379	16.924	18.166	16.924	18.519	--	
		Vector	-1.184	-1.266	-0.705	-2.050	-0.862	--	
	r=1	Statistic	4.670	1.475	5.171	0.854	2.098	--	
		Crit.Val.	10.248	9.979	10.712	9.979	10.920	--	
USA	r=0	Statistic	7.545	22.250 ***	8.844	11.686	4.779	11.628	--
		Crit.Val.	17.720	16.896	17.300	17.454	17.514	17.514	--
		Vector	-1.245	-1.246	-0.667	-1.958	-1.554	-0.739	--
	r=1	Statistic	2.689	4.179	3.719	1.182	2.539	5.572	--
		Crit.Val.	10.449	9.963	10.201	10.292	10.327	10.327	--

Table 5.5: continued

Johansen Test (Maximum Eigenvalue Statistic) of Government Bond Yields

			Canada	France	Germany	Italy	Japan	UK	USA
France	r=0	Statistic	13.435	--					
		Crit.Val.	16.703	--					
		Vector	-0.890	--					
	r=1	Statistic	2.327	--					
		Crit.Val.	9.849	--					
Germany	r=0	Statistic	8.349	7.619	--				
		Crit.Val.	17.300	17.300	--				
		Vector	-3.230	-3.156	--				
	r=1	Statistic	1.849	2.199	--				
		Crit.Val.	10.201	10.201	--				
Italy	r=0	Statistic	14.244	11.271	7.386	--			
		Crit.Val.	16.703	15.993	17.300	--			
		Vector	-0.644	-0.699	-0.215	--			
	r=1	Statistic	1.959	1.761	3.356	--			
		Crit.Val.	9.849	9.431	10.201	--			
Japan	r=0	Statistic	5.904	5.282	14.595	6.772	--		
		Crit.Val.	18.062	18.062	18.062	18.062	--		
		Vector	-1.396	-1.112	-0.534	-1.534	--		
	r=1	Statistic	4.215	4.527	2.471	3.465	--		
		Crit.Val.	10.651	10.651	10.651	10.651	--		
UK	r=0	Statistic	9.865	9.407	12.322	16.700 **	8.624	--	
		Crit.Val.	16.703	16.517	17.300	16.517	18.062	--	
		Vector	-0.821	-0.920	-0.395	-1.293	-0.800	--	
	r=1	Statistic	3.872	1.836	2.064	2.197	1.883	--	
		Crit.Val.	9.849	9.739	10.201	9.739	10.651	--	
USA	r=0	Statistic	7.893	10.959	6.311	11.636	6.365	10.447	--
		Crit.Val.	16.896	16.896	17.300	16.896	18.062	16.896	--
		Vector	-1.088	-1.205	-0.303	-1.616	-1.130	-1.229	--
	r=1	Statistic	1.567	2.468	2.500	2.483	3.358	2.661	--
		Crit.Val.	9.963	9.963	10.201	9.963	10.651	9.963	--

Note: Results of testing for bivariate cointegration among the nominal interest rates (money market rates, and government bond yields) for the sample 1957:1 to 2007:1 are shown. The Table contains the maximum eigenvalue statistics for r=0 and r=1 with the corresponding critical values for each pair of variables. The critical values of Osterwald-Lenum (1992) were scaled with the scaling factor of Cheung and Lai (1993) to adjust for finite samples. The normalized cointegrating coefficient is reported in the rows named "vector". ** and *** indicate the rejection of the null hypothesis with a significance of 5% and 1%.

Source: Authors' calculations, based on IMF (2010); and Banque de France (2009).

Table 5.6: Results of serial correlation common feature and codependence tests for real interest rates

		1957:1 - 2007:1		Codependence of order			
Country	AR(...)	Coefficient	CF = 0	1	2	3	4
Real Money Market Rates							
Germany	5	0.692	20.840 ***	5.902 ***	6.387 ***	6.324 ***	1.615
Japan	5						

Note: Results of the common feature and codependence test of real money market rates for the sample 1957:1 – 2007:1 are reported. Only one pair of real interest rates is stationary and has the same autoregressive representation (indicated in the second column). The third column contains the coefficient of the common feature vector. The following columns report the F-statistics for the common feature test (= codependence of order 0) and the codependence tests. *** indicate the rejection of the null hypothesis with a significance of 1%.
Source: Authors' calculations, based on IMF (2010); and Banque de France (2009).

Table 5.7: Results of optimal GMM estimation of codependence relations for real interest rates

			1957:1 - 2007:1		Codependence of order		
Country	AR(...)		0	1	2	3	4
Real Money Market Rates							
Germany	5	Vector	-0.285 ***	-0.304 ***	-0.336 ***	-0.400 ***	-0.458 ***
Japan	5	χ^2-test	182.230 ***	92.280 ***	52.660 ***	26.571 ***	13.018 ***

Note: Results of the optimal GMM estimation of codependence relations of real money market rates for the sample 1957:1 – 2007:1 are reported. *** indicate statistical significance at the 1% level.
Source: Authors' calculations, based on IMF (2010); and Banque de France (2009).

5.C Control Sample II — Before ESCB and Euro: 1975:1 – 1998:4

The introduction of the European System of Central Banks (ESCB) and the Euro in 1999 is an important structural break for the monetary policies in the countries of the Eurozone. We, therefore, conduct a second robustness study with the sample that ends before the introduction of the Euro and the ESCB. As in our benchmark regressions, the sample starts after the end of the Bretton Woods system, i.e. in 1975 for the money market rates and government bond yields, and in 1979 for the Euro-Market rates due to the reduced data availability. The sample under study, thus, comprises the years from 1975:1 to 1998:4.

Table 5.8 reports the optimal AR(p)-specifications of the nominal and real interest rates; Table 5.9 gives results of the ADF-test, both with AIC and SIC criterion; and Table 5.10 displays the results of the Johansen-test. Results for the serial correlation common feature and codependence tests are reported in Tables 3.3 and 3.5 in the main part of the essay.

The exclusion of the Euro-time, however, cannot increase the evidence for comovements between the interest rates either. As from a policy point of view we would rather expect that the degree of comovement has increased in Euro-times, this result, however, is not surprising. In section 5.F we intend to generate some evidence for this case even if the number of observations is quite reduced for this period.

Table 5.8: AR(p)-representations of the process of nominal and real interest rates

1975:1 - 1998:4
(1979:1 - 1998:4 for Euro-Market Rates)

	Nominal		Real	
	AR(...)		AR(...)	
Country	Level	1st diff	Level	1st diff
Money Market Rates				
Canada	2	1	2	1
France	2	1	3	3
Germany	3	1	1	1
Italy	2	1	2	1
Japan	2	1	1	3
UK	1	1	4	3
USA	4	5	3	2
Government Bond Yields				
Canada	1	1	2	1
France	2	1	5	3
Germany	4	3	1	1
Italy	2	1	5	4
Japan	1	1	5	1
UK	1	1	5	4
USA	2	1	4	1
Euro-Market Rates				
Canada	1	1	1	1
France	2	1	1	2
Germany	2	1	1	1
Italy	2	4	2	4
Japan	3	3	1	1
UK	1	2	2	1
USA	3	2	3	2

Note: AR representations of the process of the nominal and real interest rates (money market rates, government bond yields and Euro-Market rates) for the sample 1975:1 to 1998:4 (respectively from 1979:1 onwards for the Euro-Market rates) are reported. The specification with the smallest number of AR terms is selected, under the constraint that the residual is free of autocorrelation (i.e. the Q-statistics are insignificant).
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

Table 5.9: Results of ADF-test for nominal and real interest rates

1975:1 - 1998:4 (1979:1 - 1998:4 for Euro-Market Rates)

	Nominal								Real							
	Level (AIC)			Level (SIC)			1st differences (AIC)		Level (AIC)			Level (SIC)			1st differences (AIC)	
Country	Statistic	Lags	Crit. Val.	Statistic	Lags	Crit. Val.	Statistic	Crit. Val.	Statistic	Lags	Crit. Val.	Statistic	Lags	Crit. Val.	Statistic	Crit. Val.
Money Market Rates																
Canada	-1.606	1	-2.888	-1.606	1	-2.888	-13.10 **	-2.896	-3.359 **	1	-2.888	-3.359 **	1	-2.888	-13.14 **	-2.896
France	-1.934	1	-2.888	-1.934	1	-2.888	-5.735 **	-2.866	-1.572	8	-2.838	-2.399	1	-2.888	-4.544 **	-2.844
Germany	-2.753	6	-2.851	-2.321	1	-2.888	-4.152 **	-2.851	-2.309	1	-2.888	-1.921	0	-2.895	-8.256 **	-2.895
Italy	-0.163	5	-2.858	-1.763	1	-2.888	-6.840 **	-2.866	-2.100	5	-2.858	-2.748	1	-2.888	-6.914 **	-2.866
Japan	-2.574	1	-2.888	-2.574	1	-2.888	-5.726 **	-2.895	-4.098 **	4	-2.866	-4.516 **	0	-2.895	-6.683 **	-2.873
UK	-2.086	0	-2.895	-2.086	0	-2.895	-9.908 **	-2.895	-2.07	7	-2.844	-1.854	4	-2.866	-3.581 **	-2.851
USA	-2.486	5	-2.858	-1.662	0	-2.895	-4.065 **	-2.851	-1.726	7	-2.844	-2.216	2	-2.880	-5.673 **	-2.851
Government Bond Yields																
Canada	-1.019	1	-2.888	-0.707	0	-2.895	-8.533 **	-2.895	-2.630	4	-2.866	-2.790	0	-2.895	-6.861 **	-2.873
France	-0.629	4	-2.866	-1.003	1	-2.888	-4.869 **	-2.873	-2.481	8	-2.838	-2.926 **	1	-2.888	-5.351 **	-2.844
Germany	-2.203	1	-2.888	-2.203	1	-2.888	-6.701 **	-2.895	-3.096 **	1	-2.888	-2.648	0	-2.895	-4.546 **	-2.819
Italy	-0.863	1	-2.888	-0.863	1	-2.888	-6.187 **	-2.895	-3.438 **	4	-2.866	-3.438 **	4	-2.866	-8.510 **	-2.873
Japan	-1.192	3	-2.873	-0.553	0	-2.895	-4.233 **	-2.880	-5.934 **	4	-2.866	-5.934 **	4	-2.866	-6.137 **	-2.844
UK	-1.315	0	-2.895	-1.315	0	-2.895	-8.373 **	-2.888	-1.946	8	-2.838	-3.331 **	1	-2.888	-4.284 **	-2.844
USA	-1.293	1	-2.888	-1.293	1	-2.888	-7.427 **	-2.895	-2.971 **	1	-2.888	-2.971 **	1	-2.888	-7.653 **	-2.895
Euro-Market Rates																
Canada	-1.631	0	-2.904	-1.631	0	-2.904	-9.078 **	-2.905	-3.934 **	3	-2.878	-4.029 **	0	-2.904	-4.839 **	-2.807
France	-1.568	2	-2.886	-2.105	1	-2.895	-3.410 **	-2.836	-4.047 **	1	-2.895	-6.024 **	0	-2.904	-3.597 **	-2.813
Germany	-1.938	1	-2.895	-1.938	1	-2.895	-2.858 **	-2.820	-2.678	0	-2.904	-2.678	0	-2.904	-8.239 **	-2.904
Italy	-1.267	8	-2.836	-1.267	8	-2.836	-2.777	-2.844	-5.787 **	8	-2.836	-3.400 **	5	-2.861	-4.066 **	-2.844
Japan	-0.976	3	-2.878	-1.512	1	-2.896	-7.120 **	-2.888	-1.885	1	-2.896	-2.219	0	-2.904	-7.450 **	-2.879
UK	-1.328	0	-2.904	-1.328	0	-2.904	-7.958 **	-2.904	-3.066 **	0	-2.904	-3.066 **	0	-2.904	-5.387 **	-2.877
USA	-1.445	9	-2.828	-1.400	3	-2.877	-3.188 **	-2.852	-2.162	11	-2.814	-1.857	10	-2.821	-2.580	-2.828

Note: The ADF-test statistics, calculated for the levels and first differences of nominal and real interest rates (money market rates, government bond yields and Euro-Market rates) for the sample 1975:1 to 1998:4 (respectively from 1979:1 onwards for the Euro-Market rates), are reported. The lag length was selected by the AIC and SIC criterion and is given in the corresponding column. Critical values of Cheung and Lai (1995) were applied and are reported. ** indicate rejection of the existence of both, stochastic and deterministic trends with a significance of 5%.

Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

Table 5.10: Results of Johansen test for nominal interest rates

1975:1 - 1998:4
(1979:1 - 1998:4 for Euro-Market Rates)

Johansen Test (Maximum Eigenvalue Statistic) of Money Market Rates

			Canada	France	Germany	Italy	Japan	UK	USA
France	r=0	Statistic	16.724 **	--					
		Crit.Val.	16.011	--					
		Vector	-1.047	--					
	r=1	Statistic	4.843	--					
		Crit.Val.	9.441	--					
Germany	r=0	Statistic	5.582	7.439	--				
		Crit.Val.	16.011	16.003	--				
		Vector	-2.247	2.400	--				
	r=1	Statistic	3.572	2.613	--				
		Crit.Val.	9.441	9.437	--				
Italy	r=0	Statistic	14.641	21.634 ***	6.845	--			
		Crit.Val.	16.011	16.003	16.003	--			
		Vector	-0.845	-0.814	0.189	--			
	r=1	Statistic	4.573	3.678	3.176	--			
		Crit.Val.	9.441	9.437	9.437	--			
Japan	r=0	Statistic	19.956 **	13.579	7.431	11.322	--		
		Crit.Val.	16.011	16.003	16.003	16.003	--		
		Vector	-1.357	-1.268	-1.897	-1.865	--		
	r=1	Statistic	1.591	4.426	6.129	5.073	--		
		Crit.Val.	9.441	9.437	9.437	9.437	--		
UK	r=0	Statistic	11.041	11.581	15.128	8.721	16.518 **	--	
		Crit.Val.	16.011	16.003	16.003	16.003	16.003	--	
		Vector	-1.131	-1.084	-0.718	-1.840	-0.990	--	
	r=1	Statistic	2.316	4.117	7.006	4.551	5.265	--	
		Crit.Val.	9.441	9.437	9.437	9.437	9.437	--	
USA	r=0	Statistic	8.555	14.338	11.259	19.858 **	9.331	9.783	--
		Crit.Val.	17.629	17.492	17.492	17.492	17.492	17.492	--
		Vector	-1.257	-1.486	-0.174	-1.771	-1.751	-2.344	--
	r=1	Statistic	3.614	1.654	4.888	0.968	4.877	7.367	--
		Crit.Val.	10.395	10.314	10.314	10.314	10.314	10.314	--

Johansen Test (Maximum Eigenvalue Statistic) of Government Bond Yields

			Canada	France	Germany	Italy	Japan	UK	USA
France	r=0	Statistic	15.589	--					
		Crit.Val.	16.003	--					
		Vector	-0.786	--					
	r=1	Statistic	1.412	--					
		Crit.Val.	9.437	--					
Germany	r=0	Statistic	15.499	10.920	--				
		Crit.Val.	16.003	16.003	--				
		Vector	-2.053	-2.726	--				
	r=1	Statistic	1.497	1.130	--				
		Crit.Val.	9.437	9.437	--				
Italy	r=0	Statistic	7.688	7.412	17.391 **	--			
		Crit.Val.	16.003	16.003	16.003	--			
		Vector	-0.547	-0.720	-0.254	--			
	r=1	Statistic	1.141	1.504	1.335	--			
		Crit.Val.	9.437	9.437	9.437	--			
Japan	r=0	Statistic	8.047	6.001	10.001	10.326	--		
		Crit.Val.	16.003	16.003	16.003	16.003	--		
		Vector	-1.089	-1.268	-0.418	-1.867	--		
	r=1	Statistic	2.694	2.644	2.652	3.478	--		
		Crit.Val.	9.437	9.437	9.437	9.437	--		
UK	r=0	Statistic	12.274	9.613	6.719	13.958	13.015	--	
		Crit.Val.	16.003	16.003	16.003	16.003	16.003	--	
		Vector	-1.337	-1.821	-0.210	-2.156	-1.031	--	
	r=1	Statistic	2.420	3.275	3.197	3.435	3.890	--	
		Crit.Val.	9.437	9.437	9.437	9.437	9.437	--	
USA	r=0	Statistic	7.054	13.941	11.416	9.133	8.063	9.432	--
		Crit.Val.	17.492	17.492	17.492	17.492	17.492	17.492	--
		Vector	-1.015	-1.247	-0.453	-1.473	-0.914	-0.762	--
	r=1	Statistic	0.993	1.256	1.291	1.279	1.814	4.634	--
		Crit.Val.	10.314	10.314	10.314	10.314	10.314	10.314	--

Table 5.10: continued

Johansen Test (Maximum Eigenvalue Statistic) of Euro-Market Rates

			Canada	France	Germany	Italy	Japan	UK	USA
France	r=0	Statistic	27.268 ***	--					
		Crit.Val.	16.082	--					
		Vector	-0.827	--					
	r=1	Statistic	4.195	--					
		Crit.Val.	9.483	--					
Germany	r=0	Statistic	3.802	11.493	--				
		Crit.Val.	16.082	16.072	--				
		Vector	-0.126	-1.821	--				
	r=1	Statistic	2.899	4.253	--				
		Crit.Val.	9.483	9.477	--				
Italy	r=0	Statistic	11.647	26.298 ***	7.079	--			
		Crit.Val.	17.541	17.541	17.541	--			
		Vector	-0.522	-0.848	0.002	--			
	r=1	Statistic	2.895	1.734	1.841	--			
		Crit.Val.	10.343	10.343	10.343	--			
Japan	r=0	Statistic	15.695	30.636 ***	17.166 **	18.906 **	--		
		Crit.Val.	17.013	17.013	17.013	17.541	--		
		Vector	-1.170	-1.668	-0.711	-3.003	--		
	r=1	Statistic	2.269	2.023	2.681	13.993 **	--		
		Crit.Val.	10.032	10.032	10.032	10.343	--		
UK	r=0	Statistic	15.094	10.672	16.399	10.996	10.378	--	
		Crit.Val.	16.529	16.495	16.495	17.541	17.013	--	
		Vector	-1.157	-1.519	-0.596	-3.102	-1.078	--	
	r=1	Statistic	2.121	3.586	12.104 **	3.280	2.868	--	
		Crit.Val.	9.746	9.726	9.726	10.343	10.032	--	
USA	r=0	Statistic	9.986	20.391 **	5.395	11.581	5.960	7.727	--
		Crit.Val.	16.529	16.495	16.495	17.541	17.013	16.495	--
		Vector	-0.857	-1.151	-0.006	-5.382	-1.249	-0.827	--
	r=1	Statistic	3.693	2.954	2.708	5.677	3.135	1.512	--
		Crit.Val.	9.746	9.726	9.726	10.343	10.032	9.726	--

Note: Results of testing for bivariate cointegration among the nominal interest rates (money market rates, government bond yields, and Euro-Market rates) for the sample 1975:1 to 1998:4 (respectively 1979:1 – 1998:4) are shown. The Table contains the maximum eigenvalue statistics for r=0 and r=1 with the corresponding critical values for each pair of variables. The critical values of Osterwald-Lenum (1992) were scaled with the scaling factor of Cheung and Lai (1993) to adjust for finite samples. The normalized cointegrating coefficient is reported in the rows named "vector". ** and *** indicate the rejection of the null hypothesis with a significance of 5% and 1%.

Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

5.D Control Sample III — As in Kugler/Neusser (1993): 1980:1 – 1991:4

One of the main papers of reference for our study is the contribution by Kugler and Neusser (1993). The authors use a codependence test that is based on a MA-representation of real Euro-currency rates from 1980 to 1991 to analyze short-run comovements between interest rates. Their results, however, suggest much more positive evidence for common cycles than our investigation. We, therefore, conduct our analysis as a further robustness check with the sample studied in Kugler and Neusser (1993): 1980:1 – 1991:4.

Table 5.11 reports the optimal AR(p)-specifications of the nominal and real interest rates; Table 5.12 gives results of the ADF-test, both with AIC and SIC criterion; Table 5.13 displays the results of the Johansen-test; and Tables 5.14 and 5.15 report the results of the serial correlation common feature tests. As the pairs of stationary interest rates have all AR(1)-processes, it is not possible to test for codependence of higher order.

Confining our analysis to the Kugler and Neusser (1993) sample, we indeed find also more evidence of stationarity and common lag structures. Interest rates are mostly AR(1) processes in this time period. Although the null of a common feature cannot be rejected in 5 out of 6 cases, the coefficient in the cofeature relationship is insignificant in all but one case (real Euro-Market rates of France and Italy).

However, for all other interest rates, time periods, and reasonable alternative estimation procedures, our results suggest that this positive evidence cannot be confirmed.

Table 5.11: AR(p)-representations of the process of nominal and real interest rates

1980:1 - 1991:4				
	Nominal		Real	
	AR(...)		AR(...)	
Country	Level	1^{st} diff	Level	1^{st} diff
Money Market Rates				
Canada	1	1	1	1
France	3	2	3	2
Germany	2	1	1	1
Italy	1	1	3	2
Japan	2	1	1	1
UK	1	1	2	1
USA	4	1	1	2
Government Bond Yields				
Canada	1	2	1	1
France	2	1	4	3
Germany	1	1	1	1
Italy	2	1	1	1
Japan	1	1	1	1
UK	1	1	2	1
USA	1	1	1	1
Euro-Market Rates				
Canada	1	1	1	1
France	1	1	1	1
Germany	2	1	1	1
Italy	2	2	1	2
Japan	1	2	1	1
UK	1	1	1	1
USA	3	3	2	2

Note: AR representations of the process of the nominal and real interest rates (money market rates, government bond yields and Euro-Market rates) for the sample 1980:1 to 1991:4 are reported. The specification with the smallest number of AR terms is selected, under the constraint that the residual is free of autocorrelation (i.e. the Q-statistics are insignificant).
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

Table 5.12: Results of ADF-test for nominal and real interest rates

1980:1 - 1991:4																
	Nominal								Real							
	Level (AIC)			Level (SIC)			1st differences (AIC)		Level (AIC)			Level (SIC)			1st differences (AIC)	
Country	Statistic	Lags	Crit. Val.	Statistic	Lags	Crit. Val.	Statistic	Crit. Val.	Statistic	Lags	Crit. Val.	Statistic	Lags	Crit. Val.	Statistic	Crit. Val.
Money Market Rates																
Canada	-1.596	1	-2.925	-1.596	1	-2.925	-10.11 **	-2.939	-3.006 **	1	-2.925	-4.366 **	0	-2.939	-10.85 **	-2.939
France	-1.226	2	-2.911	-1.226	2	-2.911	-6.142 **	-2.925	-2.114	6	-2.860	-1.804	2	-2.911	-3.331 **	-2.872
Germany	-1.553	1	-2.925	-1.553	1	-2.925	-4.916 **	-2.939	-2.297	1	-2.925	-1.862	0	-2.939	-5.913 **	-2.939
Italy	-1.123	1	-2.925	-0.916	0	-2.939	-5.982 **	-2.939	-2.807	0	-2.939	-2.807	0	-2.939	-6.113 **	-2.925
Japan	-2.623	1	-2.925	-2.623	1	-2.925	-4.202 **	-2.939	-3.639 **	0	-2.939	-3.639 **	0	-2.939	-7.309 **	-2.925
UK	-2.361	0	-2.939	-2.361	0	-2.939	-7.559 **	-2.939	-2.605	1	-2.925	-2.605	1	-2.925	-10.29 **	-2.939
USA	-1.471	0	-2.939	-1.471	0	-2.939	-6.245 **	-2.925	-2.135	2	-2.911	-2.529	0	-2.939	-6.516 **	-2.925
Government Bond Yields																
Canada	-1.248	0	-2.939	-1.248	0	-2.939	-6.122 **	-2.939	-2.342	0	-2.939	-2.342	0	-2.939	-6.371 **	-2.939
France	-1.167	1	-2.925	-1.167	1	-2.925	-4.138 **	-2.939	-2.764	8	-2.841	-2.935 **	3	-2.897	-2.590	-2.850
Germany	-1.603	1	-2.925	-1.603	1	-2.925	-5.268 **	-2.939	-3.021 **	1	-2.925	-2.694	0	-2.939	-4.769 **	-2.860
Italy	-1.143	1	-2.925	-1.143	1	-2.925	-4.592 **	-2.939	-2.522	1	-2.925	-2.522	1	-2.925	-4.398 **	-2.872
Japan	-1.924	3	-2.897	-1.364	0	-2.939	-3.130 **	-2.911	-2.339	0	-2.939	-2.339	0	-2.939	-4.624 **	-2.897
UK	-1.920	1	-2.925	-1.603	0	-2.939	-5.349 **	-2.925	-2.760	2	-2.911	-2.172	0	-2.939	-3.605 **	-2.841
USA	-1.295	1	-2.925	-1.295	1	-2.925	-5.448 **	-2.939	-3.321 **	5	-2.872	-2.428	0	-2.939	-5.787 **	-2.939
Euro-Market Rates																
Canada	-1.991	3	-2.897	-1.764	1	-2.925	-7.086 **	-2.939	-4.989 **	6	-2.863	-3.049 **	1	-2.925	-7.829 **	-2.939
France	-2.271	1	-2.925	-2.271	1	-2.925	-7.651 **	-2.925	-8.121 **	13	-2.852	-8.121 **	13	-2.852	-3.019 **	-2.835
Germany	-1.515	1	-2.925	-1.515	1	-2.925	-5.359 **	-2.939	-2.524	1	-2.925	-2.524	1	-2.925	-5.681 **	-2.939
Italy	-1.622	8	-2.846	-1.421	5	-2.874	-1.833	-2.855	-3.009 **	10	-2.841	-2.773	5	-2.874	-2.952 **	-2.855
Japan	-1.950	3	-2.897	-1.950	3	-2.897	-5.971 **	-2.939	-4.156 **	0	-2.939	-4.156 **	0	-2.939	-5.101 **	-2.925
UK	-2.311	0	-2.939	-2.311	0	-2.939	-6.680 **	-2.939	-2.665	0	-2.939	-2.665	0	-2.939	-4.498 **	-2.897
USA	-0.960	9	-2.835	-2.508	0	-2.939	-4.553 **	-2.911	-0.915	8	-2.842	-1.815	2	-2.911	-3.312 **	-2.851

Note: The ADF-test statistics, calculated for the levels and first differences of nominal and real interest rates (money market rates, government bond yields and Euro-Market rates) for the sample 1980:1 to 1991:4 are reported. The lag length was selected by the AIC and SIC criterion and is given in the corresponding column. Critical values of Cheung and Lai (1995) were applied and are reported. ** indicate rejection of the existence of both, stochastic and deterministic trends with a significance of 5%.
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

Table 5.13: Results of Johansen test for nominal interest rates

1980:1 - 1991:4

Johansen Test (Maximum Eigenvalue Statistic) of Money Market Rates

			Canada	France	Germany	Italy	Japan	UK	USA
France	r=0	Statistic	8.015	--					
		Crit.Val.	17.095	--					
		Vector	-0.754	--					
	r=1	Statistic	2.237	--					
		Crit.Val.	10.080	--					
Germany	r=0	Statistic	5.505	6.399	--				
		Crit.Val.	16.351	17.095	--				
		Vector	-0.594	5.497	--				
	r=1	Statistic	0.646	3.539	--				
		Crit.Val.	9.642	10.080	--				
Italy	r=0	Statistic	9.692	7.885	6.378	--			
		Crit.Val.	16.351	17.095	16.351	--			
		Vector	-0.508	-0.733	0.866	--			
	r=1	Statistic	2.315	1.284	2.276	--			
		Crit.Val.	9.642	10.080	9.642	--			
Japan	r=0	Statistic	13.781	15.815	18.006 **	11.970	--		
		Crit.Val.	16.351	17.095	16.351	16.351	--		
		Vector	-1.980	-1.872	-1.451	-4.943	--		
	r=1	Statistic	2.440	2.021	2.652	1.803	--		
		Crit.Val.	9.642	10.080	9.642	9.642	--		
UK	r=0	Statistic	8.057	10.086	9.266	9.942	10.704	--	
		Crit.Val.	16.351	17.095	16.351	16.351	16.351	--	
		Vector	-1.769	-28.381	-1.714	11.574	-0.681	--	
	r=1	Statistic	2.618	2.151	4.185	1.680	7.531	--	
		Crit.Val.	9.642	10.080	9.642	9.642	9.642	--	
USA	r=0	Statistic	8.139	9.953	4.284	19.992 **	14.209	6.593	--
		Crit.Val.	16.351	17.095	16.351	16.351	16.351	16.351	--
		Vector	-0.969	-0.896	13.379	-1.329	-0.489	-0.484	--
	r=1	Statistic	2.753	4.307	0.839	2.259	2.619	2.911	--
		Crit.Val.	9.642	10.080	9.642	9.642	9.642	9.642	--

Johansen Test (Maximum Eigenvalue Statistic) of Government Bond Yields

			Canada	France	Germany	Italy	Japan	UK	USA
France	r=0	Statistic	12.981	--					
		Crit.Val.	17.095	--					
		Vector	-0.638	--					
	r=1	Statistic	1.572	--					
		Crit.Val.	10.080	--					
Germany	r=0	Statistic	6.550	3.097	--				
		Crit.Val.	16.351	17.095	--				
		Vector	-0.180	1.107	--				
	r=1	Statistic	1.509	1.005	--				
		Crit.Val.	9.642	10.080	--				
Italy	r=0	Statistic	9.978	10.810	6.399	--			
		Crit.Val.	16.351	17.095	16.351	--			
		Vector	-0.424	-0.656	-0.204	--			
	r=1	Statistic	1.545	1.567	2.120	--			
		Crit.Val.	9.642	10.080	9.642	--			
Japan	r=0	Statistic	6.601	9.698	8.250	8.603	--		
		Crit.Val.	16.351	17.095	16.351	16.351	--		
		Vector	-1.135	-1.577	-0.798	-2.651	--		
	r=1	Statistic	3.237	3.330	2.169	2.557	--		
		Crit.Val.	9.642	10.080	9.642	9.642	--		
UK	r=0	Statistic	14.183	16.000	6.371	17.344 **	7.493	--	
		Crit.Val.	16.351	17.095	16.351	16.351	16.351	--	
		Vector	-1.341	-1.933	-1.326	-2.725	-1.088	--	
	r=1	Statistic	4.950	3.694	2.813	3.808	3.592	--	
		Crit.Val.	9.642	10.080	9.642	9.642	9.642	--	
USA	r=0	Statistic	9.048	8.970	6.395	6.300	5.605	8.625	--
		Crit.Val.	16.351	17.095	16.351	16.351	16.351	16.351	--
		Vector	-0.837	-1.322	2.337	-1.999	-0.784	-0.520	--
	r=1	Statistic	2.133	1.732	2.072	1.523	2.983	3.423	--
		Crit.Val.	9.642	10.080	9.642	9.642	9.642	9.642	--

Table 5.13: continued

Johansen Test (Maximum Eigenvalue Statistic) of Euro-Market Rates

			Canada	France	Germany	Italy	Japan	UK	USA
France	r=0	Statistic	22.834 ***	--					
		Crit.Val.	16.351	--					
		Vector	-0.709	--					
	r=1	Statistic	4.876	--					
		Crit.Val.	9.642	--					
Germany	r=0	Statistic	9.194	17.885 **	--				
		Crit.Val.	16.351	16.351	--				
		Vector	-0.631	-1.080	--				
	r=1	Statistic	0.784	3.201	--				
		Crit.Val.	9.642	9.642	--				
Italy	r=0	Statistic	10.729	11.219	2.346	--			
		Crit.Val.	17.095	17.095	17.095	--			
		Vector	-0.509	-0.790	-2.530	--			
	r=1	Statistic	2.123	2.500	1.351	--			
		Crit.Val.	10.080	10.080	10.080	--			
Japan	r=0	Statistic	20.652 **	13.347	24.265 ***	10.961	--		
		Crit.Val.	17.095	17.095	17.095	17.095	--		
		Vector	-2.099	-4.345	-1.631	-7.014	--		
	r=1	Statistic	2.309	2.955	3.072	2.020	--		
		Crit.Val.	10.080	10.080	10.080	10.080	--		
UK	r=0	Statistic	12.004	8.371	11.347	9.714	15.728	--	
		Crit.Val.	16.351	16.351	16.351	17.095	17.095	--	
		Vector	-1.582	-12.064	-1.454	19.838	-0.509	--	
	r=1	Statistic	3.579	5.419	3.926	3.444	7.542	--	
		Crit.Val.	9.642	9.642	9.642	10.080	10.080	--	
USA	r=0	Statistic	9.086	9.722	5.827	8.701	6.790	10.080	--
		Crit.Val.	17.909	17.909	17.909	17.909	17.909	17.909	--
		Vector	-0.719	-0.999	-0.255	-1.677	-0.363	-0.142	--
	r=1	Statistic	2.821	2.418	2.297	2.711	3.021	1.977	--
		Crit.Val.	10.560	10.560	10.560	10.560	10.560	10.560	--

Note: Results of testing for bivariate cointegration among the nominal interest rates (money market rates, government bond yields, and Euro-Market rates) for the sample 1980:1 to 1991:4 are shown. The Table contains the maximum eigenvalue statistics for r=0 and r=1 with the corresponding critical values for each pair of variables. The critical values of Osterwald-Lenum (1992) were scaled with the scaling factor of Cheung and Lai (1993) to adjust for finite samples. The normalized cointegrating coefficient is reported in the rows named "vector". ** and *** indicate the rejection of the null hypothesis with a significance of 5% and 1%.
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

Table 5.14: Results of serial correlation common feature and codependence tests for real interest rates

1980:1 - 1991:4							
				Codependence of order			
Country	AR(...)	Coefficient	CF = 0	1	2	3	4
Real Money Market Rates							
Canada	1	0.897	55.650 ***				
Japan	1						
Real Government Bond Yields							
Germany	1	0.313	184.900 ***				
USA	1						
Real Euro-Market Rates							
Canada	1	0.720 i	2.681				
France	1						
Canada	1	1.555 i	0.004				
Italy	1						
Canada	1	-0.824 i	12.75 ***				
Japan	1						
France	1	0.954	0.044				
Italy	1						
France	1	-2.067 i	0.755				
Japan	1						
Italy	1	0.513 i	0.043				
Japan	1						

Note: Results of the common feature and codependence test of real interest rates for the sample 1980:1 to 1991:4 are reported. Several pairs of real interest rates are stationary and have the same autoregressive representation (indicated in the second column). The third column contains the coefficient of the common feature vector. The following column reports the F-statistics for the common feature test (= codependence of order 0). *** indicate the rejection of the null hypothesis with a significance of 1%.
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

Table 5.15: Results of optimal GMM estimation of codependence relations for real interest rates

			1980:1 - 1991:4				
			Codependence of order				
Country	AR(...)		0	1	2	3	4
Real Money Market Rates							
Canada	1	Vector	0.456 i				
Japan	1	χ^2-test	34.911 ***				
Real Government Bond Yields							
Germany	1	Vector	-0.113 i				
USA	1	χ^2-test	39.455 ***				
Real Euro-Market Rates							
Canada	1	Vector	-0.074 i				
France	1	χ^2-test	38.486 ***				
Canada	1	Vector	-0.124 i				
Italy	1	χ^2-test	38.534 ***				
Canada	1	Vector	1.064 i				
Japan	1	χ^2-test	35.445 ***				
France	1	Vector	-0.844 ***				
Italy	1	χ^2-test	29.011 ***				
France	1	Vector	1.005 i				
Japan	1	χ^2-test	21.871 ***				
Italy	1	Vector	0.988 i				
Japan	1	χ^2-test	23.757 ***				

Note: Results of the optimal GMM estimation of codependence relations of real interest rates for the sample 1980:1 to 1991:4 are reported. *** indicate statistical significance at the 1% level. *Source:* Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

5.E Control Sample IV — After Oil-Crises: 1985:1 – 2007:1

In this section we report the results of a further robustness check: the chosen sample excludes the turbulent years of and after the oil crises in the 1970s and of the recent global crisis of 2008-2009. Accordingly, our sample starts only in 1985:1 and ends in 2007:1.

Table 5.16 reports the optimal AR(p)-specifications of the nominal and real interest rates; Table 5.17 gives results of the ADF-test, both with AIC and SIC criterion; and Table 5.18 displays the results of the Johansen-test. In this sample it is not possible to test SCCF and codependence, as there does not exist a single pair of stationary interest rates that has the same AR(p)-structure.

However, also in this sample specification the evidence for comovements between interest rates cannot be increased either. If at all, our results suggest that the little evidence found in the benchmark regressions has to be taken with caution as the exclusion of the turbulent oil-crises years reduces evidence for short-run and long-run comovements even further.

Table 5.16: AR(p)-representations of the process of nominal and real interest rates

	1985:1 - 2007:1			
	Nominal		Real	
	AR(...)		AR(...)	
Country	Level	1^{st} diff	Level	1^{st} diff
Money Market Rates				
Canada	1	3	4	3
France	4	3	2	2
Germany	2	1	1	1
Italy	1	1	3	2
Japan	2	1	2	1
UK	8	2	2	1
USA	2	1	3	2
Government Bond Yields				
Canada	1	1	5	4
France	5	4	6	4
Germany	4	3	6	5
Italy	5	4	5	4
Japan	1	1	2	4
UK	3	2	5	4
USA	5	4	5	4
Euro-Market Rates				
Canada	6	3	1	4
France	1	2	1	2
Germany	4	2	1	1
Italy	3	1	1	1
Japan	4	3	2	1
UK	2	2	1	4
USA	2	1	6	4

Note: AR representations of the process of the nominal and real interest rates (money market rates, government bond yields and Euro-Market rates) for the sample 1985:1 to 2007:1 are reported. The specification with the smallest number of AR terms is selected, under the constraint that the residual is free of autocorrelation (i.e. the Q-statistics are insignificant).
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

Table 5.17: Results of ADF-test for nominal and real interest rates

	1985:1 - 2007:1															
	Nominal								Real							
	Level (AIC)			Level (SIC)			1st differences (AIC)		Level (AIC)			Level (SIC)			1st differences (AIC)	
Country	Statistic	Lags	Crit. Val.	Statistic	Lags	Crit. Val.	Statistic	Crit. Val.	Statistic	Lags	Crit. Val.	Statistic	Lags	Crit. Val.	Statistic	Crit. Val.
Money Market Rates																
Canada	-1.757	7	-2.844	-1.855	0	-2.899	-5.004 **	-2.874	-1.836	4	-2.867	-2.520	0	-2.899	-7.098 **	-2.874
France	-1.689	3	-2.874	-1.821	2	-2.882	-4.884 **	-2.882	-1.737	2	-2.882	-1.324	0	-2.899	-5.263 **	-2.874
Germany	-1.976	2	-2.882	-1.710	1	-2.890	-4.621 **	-2.899	-1.78	0	-2.899	-1.780	0	-2.899	-5.840 **	-2.874
Italy	-1.868	1	-2.890	-1.826	0	-2.899	-6.944 **	-2.890	-1.457	2	-2.882	-1.708	0	-2.899	-8.253 **	-2.890
Japan	-1.751	3	-2.874	-1.554	1	-2.890	-3.444 **	-2.882	-1.292	4	-2.867	-1.773	0	-2.899	-5.963 **	-2.874
UK	-1.298	0	-2.899	-1.298	0	-2.899	-5.834 **	-2.890	-1.36	1	-2.890	-1.360	1	-2.890	-12.33 **	-2.899
USA	-1.941	1	-2.890	-1.941	1	-2.890	-3.843 **	-2.811	-2.096	5	-2.859	-2.000	1	-2.890	-8.029 **	-2.899
Government Bond Yields																
Canada	-1.250	0	-2.899	-1.250	0	-2.899	-6.961 **	-2.890	-1.163	4	-2.867	-1.163	4	-2.867	-9.128 **	-2.874
France	-1.707	4	-2.867	-1.707	4	-2.867	-5.900 **	-2.874	-0.171	9	-2.830	-1.176	0	-2.899	-3.453 **	-2.837
Germany	-1.208	4	-2.867	-1.377	1	-2.890	-4.774 **	-2.874	-1.028	8	-2.837	-1.923	0	-2.899	-4.951 **	-2.844
Italy	-1.495	4	-2.867	-1.580	1	-2.890	-5.535 **	-2.874	-0.794	4	-2.867	-0.794	4	-2.867	-7.468 **	-2.874
Japan	-1.516	0	-2.899	-1.516	0	-2.899	-8.887 **	-2.899	-1.856	4	-2.867	-2.567	0	-2.899	-6.596 **	-2.874
UK	-0.918	3	-2.874	-0.822	0	-2.899	-4.810 **	-2.882	-0.848	9	-2.830	-1.367	5	-2.859	-4.082 **	-2.837
USA	-2.373	4	-2.867	-2.499	1	-2.890	-5.395 **	-2.874	-2.665	4	-2.867	-2.665	4	-2.867	-7.231 **	-2.874
Euro-Market Rates																
Canada	-1.361	13	-2.805	-1.658	0	-2.899	-3.283 **	-2.805	-0.792	13	-2.805	-2.472	0	-2.899	-4.757 **	-2.811
France	-1.535	2	-2.882	-2.050	0	-2.899	-9.544 **	-2.890	-1.547	2	-2.882	-2.358	0	-2.899	-9.293 **	-2.890
Germany	-2.136	3	-2.874	-1.483	1	-2.890	-3.132 **	-2.882	-1.838	0	-2.899	-1.838	0	-2.899	-9.374 **	-2.899
Italy	-1.518	0	-2.899	-1.518	0	-2.899	-3.428 **	-2.811	-1.983	0	-2.899	-1.983	0	-2.899	-8.206 **	-2.890
Japan	-1.741	3	-2.874	-1.741	3	-2.874	-3.304 **	-2.882	-1.255	4	-2.867	-1.780	0	-2.899	-5.940 **	-2.874
UK	-1.255	1	-2.890	-1.095	0	-2.899	-2.171	-2.805	-0.692	4	-2.867	-1.579	0	-2.899	-7.007 **	-2.874
USA	-1.322	9	-2.830	-1.889	2	-2.882	-4.466 **	-2.805	-1.760	5	-2.859	-1.614	4	-2.867	-1.856	-2.805

Note: The ADF-test statistics, calculated for the levels and first differences of nominal and real interest rates (money market rates, government bond yields and Euro-Market rates) for the sample 1985:1 to 2007:1 are reported. The lag length was selected by the AIC and SIC criterion and is given in the corresponding column. Critical values of Cheung and Lai (1995) were applied and are reported. ** indicate rejection of the existence of both, stochastic and deterministic trends with a significance of 5%.

Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

Table 5.18: Results of Johansen test for nominal interest rates

1985:1 - 2007:1

Johansen Test (Maximum Eigenvalue Statistic) of Money Market Rates

			Canada	France	Germany	Italy	Japan	UK	USA
France	r=0	Statistic	15.795	--					
		Crit.Val.	16.803	--					
		Vector	-0.975	--					
	r=1	Statistic	5.008	--					
		Crit.Val.	9.908	--					
Germany	r=0	Statistic	7.891	9.260	--				
		Crit.Val.	16.803	16.803	--				
		Vector	-1.075	-1.061	--				
	r=1	Statistic	7.189	6.114	--				
		Crit.Val.	9.908	9.908	--				
Italy	r=0	Statistic	14.677	7.717	7.805	--			
		Crit.Val.	16.803	16.803	16.030	--			
		Vector	-0.669	-0.736	-0.672	--			
	r=1	Statistic	5.571	4.020	3.398	--			
		Crit.Val.	9.908	9.908	9.452	--			
Japan	r=0	Statistic	21.864 ***	26.975 ***	7.414	10.540	--		
		Crit.Val.	16.803	16.803	16.030	16.030	--		
		Vector	-1.133	-1.122	-0.703	-1.460	--		
	r=1	Statistic	4.823	3.348	4.003	4.271	--		
		Crit.Val.	9.908	9.908	9.452	9.452	--		
UK	r=0	Statistic	23.802 ***	14.749	9.419	10.692	24.793 ***	--	
		Crit.Val.	16.803	16.803	16.407	16.407	16.407	--	
		Vector	-0.874	-0.899	-0.401	-1.210	-0.804	--	
	r=1	Statistic	4.250	2.565	4.344	3.695	2.770	--	
		Crit.Val.	9.908	9.908	9.675	9.675	9.675	--	
USA	r=0	Statistic	5.444	7.147	8.022	5.640	10.807	13.274	--
		Crit.Val.	16.803	16.803	16.030	16.030	16.030	16.407	--
		Vector	-1.784	-1.585	-1.643	-2.501	-1.462	-1.836	--
	r=1	Statistic	3.051	2.667	4.248	2.645	3.188	5.013	--
		Crit.Val.	9.908	9.908	9.452	9.452	9.452	9.675	--

Johansen Test (Maximum Eigenvalue Statistic) of Government Bond Yields

			Canada	France	Germany	Italy	Japan	UK	USA
France	r=0	Statistic	20.755 **	--					
		Crit.Val.	16.803	--					
		Vector	-1.019	--					
	r=1	Statistic	3.401	--					
		Crit.Val.	9.908	--					
Germany	r=0	Statistic	8.396	9.461	--				
		Crit.Val.	16.803	16.803	--				
		Vector	-1.296	-0.951	--				
	r=1	Statistic	5.729	4.837	--				
		Crit.Val.	9.908	9.908	--				
Italy	r=0	Statistic	10.180	7.314	12.934	--			
		Crit.Val.	16.803	16.803	16.030	--			
		Vector	-0.722	-0.493	-0.461	--			
	r=1	Statistic	5.018	2.935	2.462	--			
		Crit.Val.	9.908	9.908	9.452	--			
Japan	r=0	Statistic	6.290	8.806	5.918	10.267	--		
		Crit.Val.	16.803	16.803	16.030	16.030	--		
		Vector	-1.345	-1.093	-0.902	-1.467	--		
	r=1	Statistic	4.252	3.576	4.443	3.449	--		
		Crit.Val.	9.908	9.908	9.452	9.452	--		
UK	r=0	Statistic	17.152 **	16.706	5.434	12.422	6.509	--	
		Crit.Val.	16.803	16.803	16.407	16.407	16.407	--	
		Vector	-0.933	-0.894	-0.612	-1.328	-0.713	--	
	r=1	Statistic	4.367	3.220	3.168	2.997	3.391	--	
		Crit.Val.	9.908	9.908	9.675	9.675	9.675	--	
USA	r=0	Statistic	16.114	16.872 **	14.006	9.677	10.074	19.510 **	--
		Crit.Val.	16.803	16.803	16.030	16.030	16.030	16.407	--
		Vector	-1.488	-1.444	-1.664	-3.835	-1.707	-1.553	--
	r=1	Statistic	3.451	3.644	2.780	3.294	3.312	4.245	--
		Crit.Val.	9.908	9.908	9.452	9.452	9.452	9.675	--

Table 5.18: continued

Johansen Test (Maximum Eigenvalue Statistic) of Euro-Market Rates

			Canada	France	Germany	Italy	Japan	UK	USA
France	r=0	Statistic	15.131	--					
		Crit.Val.	16.803	--					
		Vector	-0.861	--					
	r=1	Statistic	3.837	--					
		Crit.Val.	9.908	--					
Germany	r=0	Statistic	6.591	6.868	--				
		Crit.Val.	16.803	16.407	--				
		Vector	1.759	-1.448	--				
	r=1	Statistic	5.493	3.156	--				
		Crit.Val.	9.908	9.675	--				
Italy	r=0	Statistic	12.497	4.891	5.641	--			
		Crit.Val.	16.803	16.407	16.407	--			
		Vector	-0.682	-0.809	-0.491	--			
	r=1	Statistic	3.301	2.941	2.780	--			
		Crit.Val.	9.908	9.675	9.675	--			
Japan	r=0	Statistic	16.225	23.947 ***	8.510	19.186 **	--		
		Crit.Val.	16.803	16.803	16.803	16.803	--		
		Vector	-1.057	-1.215	-0.530	-1.560	--		
	r=1	Statistic	3.794	3.493	4.688	3.462	--		
		Crit.Val.	9.908	9.908	9.908	9.908	--		
UK	r=0	Statistic	22.931 ***	15.455	12.986	9.091	15.452	--	
		Crit.Val.	16.803	16.407	16.407	16.407	16.803	--	
		Vector	-0.847	-0.963	-0.547	-1.251	-0.805	--	
	r=1	Statistic	4.224	2.181	4.069	2.754	3.757	--	
		Crit.Val.	9.908	9.675	9.675	9.675	9.908	--	
USA	r=0	Statistic	6.446	8.518	7.771	5.764	8.982	17.076 **	--
		Crit.Val.	16.803	16.407	16.407	16.030	16.803	16.407	--
		Vector	-1.788	-1.791	-1.367	-1.995	-1.311	-1.713	--
	r=1	Statistic	2.651	2.124	3.472	2.658	2.417	4.308	--
		Crit.Val.	9.908	9.675	9.675	9.452	9.908	9.675	--

Note: Results of testing for bivariate cointegration among the nominal interest rates (money market rates, government bond yields, and Euro-Market rates) for the sample 1985:1 to 2007:1 are shown. The Table contains the maximum eigenvalue statistics for r=0 and r=1 with the corresponding critical values for each pair of variables. The critical values of Osterwald-Lenum (1992) were scaled with the scaling factor of Cheung and Lai (1993) to adjust for finite samples. The normalized cointegrating coefficient is reported in the rows named "vector". ** and *** indicate the rejection of the null hypothesis with a significance of 5% and 1%.
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

5.F Control Sample V — After ESCB and Euro Introduction: 1999:1 – 2010:1

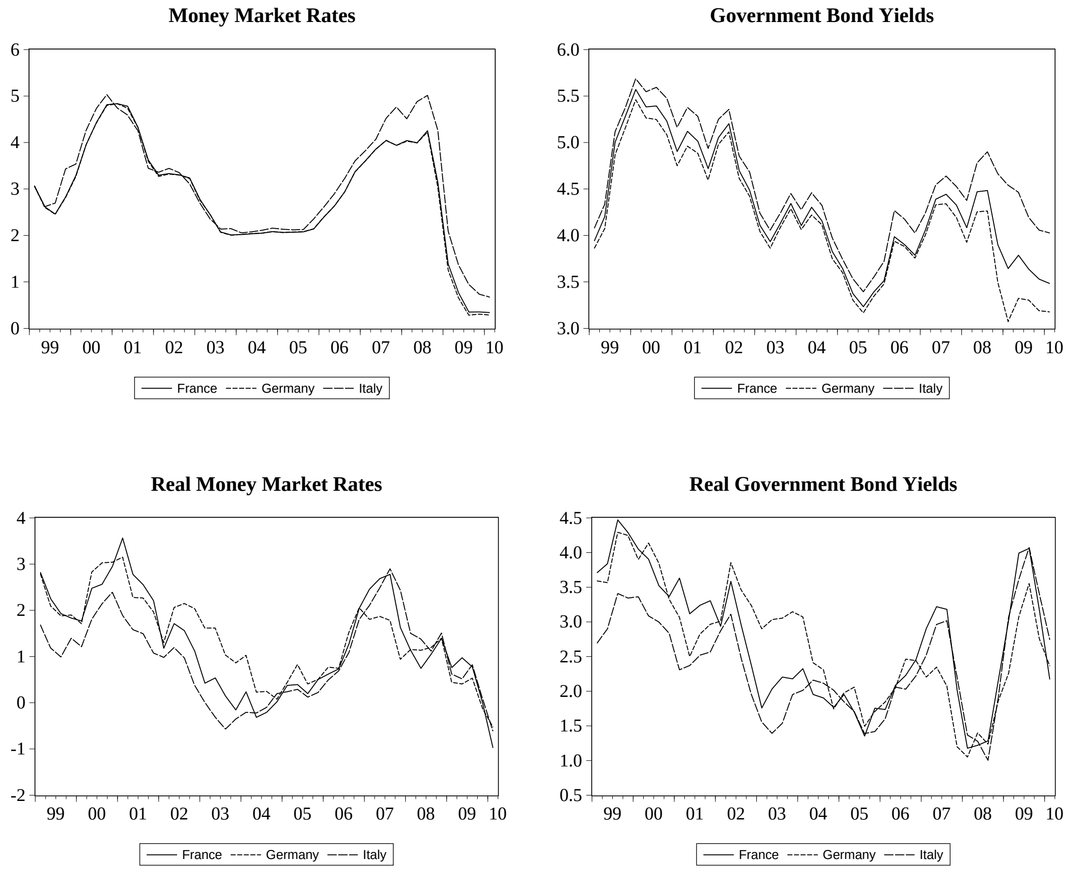
This section reports the results of the last control sample, the time after the introduction of the Euro and the ESCB, namely 1999:1 to 2010:1. We would expect to find much more evidence for comovements among the Eurozone-countries, France, Germany, and Italy, as in this period they have had a common monetary policy.

Figure 5.1 shows the studied interest rates in the Euro-time sample; Table 5.19 reports the optimal AR(p)-specifications of the nominal and real interest rates; Table 5.20 gives results of the ADF-test, both with AIC and SIC criterion; and Table 5.21 displays the results of the Johansen-test. In this sample it is not possible to test SCCF and codependence, as there does not exist a single pair of stationary interest rates that has the same AR(p)-structure.[33]

Surprisingly, we do not find evidence for common long-run trends among the three Eurozone-countries in this sample. Thus, evidence for comovements remains very weak in this recent time period as well.

[33] It would be possible to test whether the real government bond yields of Italy and Japan share a serial correlation common feature, however, as in this section we are only interested in the comovements between the three Eurozone-countries France, Germany, and Italy, we do not conduct this test.

Figure 5.1: Interest rates in the sample 1999:1 – 2010:1



Note: Nominal and real interest rates are displayed.
Source: Authors' representation, based on IMF (2010); and Banque de France (2009).

Table 5.19: AR(p)-representations of the process of nominal and real interest rates

	1999:1 - 2010:1			
	Nominal		Real	
	AR(...)		AR(...)	
Country	Level	1st diff	Level	1st diff
Money Market Rates				
Canada	2	1	5	4
France	2	1	2	1
Germany	2	1	5	3
Italy	2	1	2	1
Japan	2	1	2	4
UK	2	1	2	1
USA	2	1	6	4
Government Bond Yields				
Canada	1	1	6	4
France	1	1	2	1
Germany	1	1	5	4
Italy	1	1	2	4
Japan	1	2	2	4
UK	1	1	3	3
USA	1	2	5	4

Note: AR representations of the process of the nominal and real interest rates (money market rates, and government bond yields) for the sample 1999:1 to 2010:1 are reported. The specification with the smallest number of AR terms is selected, under the constraint that the residual is free of autocorrelation (i.e. the Q-statistics are insignificant).
Source: Authors' calculations, based on IMF (2010); and Banque de France (2009).

Table 5.20: Results of ADF-test for nominal and real interest rates

	1999:1 - 2010:1																
	Nominal								Real								
	Level (AIC)			Level (SIC)			1st differences (AIC)		Level (AIC)			Level (SIC)			1st differences (AIC)		
Country	Statistic	Lags	Crit. Val.	Statistic	Lags	Crit. Val.	Statistic	Crit. Val.	Statistic	Lags	Crit. Val.	Statistic	Lags	Crit. Val.	Statistic	Crit. Val.	
Money Market Rates																	
Canada	-1.893	1	-2.930	-1.893	1	-2.930	-3.365 **	-2.945	-2.080	0	-2.945	-2.080	0	-2.945	-3.193 **	-2.852	
France	-2.673	1	-2.930	-2.673	1	-2.930	-3.549 **	-2.930	-1.549	1	-2.930	-1.184	0	-2.945	-5.129 **	-2.945	
Germany	-2.658	1	-2.930	-2.658	1	-2.930	-3.614 **	-2.930	-1.335	0	-2.945	-1.335	0	-2.945	-4.468 **	-2.901	
Italy	-2.434	1	-2.930	-2.434	1	-2.930	-3.650 **	-2.945	-1.767	1	-2.930	-1.767	1	-2.930	-4.598 **	-2.945	
Japan	-2.203	1	-2.930	-2.203	1	-2.930	-4.461 **	-2.945	-3.323 **	4	-2.887	-3.323 **	4	-2.887	-5.803 **	-2.901	
UK	-1.406	1	-2.930	-1.406	1	-2.930	-4.827 **	-2.945	-0.008	3	-2.901	-0.008	3	-2.901	-3.971 **	-2.915	
USA	-2.252	2	-2.915	-1.861	1	-2.930	-2.953 **	-2.945	-1.681	5	-2.875	-1.681	5	-2.875	-1.653	-2.835	
Government Bond Yields																	
Canada	-0.474	0	-2.945	-0.474	0	-2.945	-5.741 **	-2.930	-2.160	8	-2.844	-2.097	4	-2.887	-5.196 **	-2.852	
France	-1.760	1	-2.930	-1.760	1	-2.930	-5.192 **	-2.930	-1.558	9	-2.836	-2.805	1	-2.930	-2.052	-2.844	
Germany	-1.698	1	-2.930	-1.698	1	-2.930	-5.393 **	-2.930	-1.737	0	-2.945	-1.737	0	-2.945	-3.722 **	-2.836	
Italy	-2.018	1	-2.930	-2.018	1	-2.930	-5.197 **	-2.945	-1.829	4	-2.887	-4.113 **	1	-2.930	-6.729 **	-2.901	
Japan	-3.372 **	0	-2.945	-3.372 **	0	-2.945	-7.459 **	-2.945	-4.373 **	7	-2.852	-3.846 **	4	-2.887	-5.101 **	-2.901	
UK	-1.757	2	-2.915	-2.670	1	-2.930	-6.510 **	-2.930	-1.405	4	-2.887	-4.850 **	1	-2.930	-6.382 **	-2.901	
USA	-0.899	4	-2.887	-1.247	0	-2.945	-2.926 **	-2.852	-1.482	8	-2.844	-1.783	4	-2.887	-4.781 **	-2.852	

Note: The ADF-test statistics, calculated for the levels and first differences of nominal and real interest rates (money market rates, and government bond yields) for the sample 1999:1 to 2010:1 are reported. The lag length was selected by the AIC and SIC criterion and is given in the corresponding column. Critical values of Cheung and Lai (1995) were applied and are reported. ** indicate rejection of the existence of both, stochastic and deterministic trends with a significance of 5%.

Source: Authors' calculations, based on IMF (2010); and Banque de France (2009).

Table 5.21: Results of Johansen test for nominal interest rates

1999:1 - 2010:1

Johansen Test (Maximum Eigenvalue Statistic) of Money Market Rates

			Canada	France	Germany	Italy	Japan	UK	USA
France	r=0	Statistic	14.149	--					
		Crit.Val.	16.399	--					
		Vector	-1.931	--					
	r=1	Statistic	8.230	--					
		Crit.Val.	9.670	--					
Germany	r=0	Statistic	14.810	11.117	--				
		Crit.Val.	16.399	16.399	--				
		Vector	-1.814	-1.003	--				
	r=1	Statistic	8.110	4.282	--				
		Crit.Val.	9.670	9.670	--				
Italy	r=0	Statistic	16.136	10.834	10.324	--			
		Crit.Val.	16.399	16.399	16.399	--			
		Vector	-2.014	-1.334	-1.439	--			
	r=1	Statistic	8.906	4.724	4.272	--			
		Crit.Val.	9.670	9.670	9.670	--			
Japan	r=0	Statistic	9.518	9.250	9.367	7.270	--		
		Crit.Val.	16.399	16.399	16.399	16.399	--		
		Vector	17.416	6.516	6.694	5.918	--		
	r=1	Statistic	2.301	0.908	0.870	0.913	--		
		Crit.Val.	9.670	9.670	9.670	9.670	--		
UK	r=0	Statistic	8.210	10.503	10.492	12.424	9.365	--	
		Crit.Val.	16.399	16.399	16.399	16.399	16.399	--	
		Vector	-0.904	180.291	15.646	0.148	0.028	--	
	r=1	Statistic	4.120	5.411	5.388	5.067	1.596	--	
		Crit.Val.	9.670	9.670	9.670	9.670	9.670	--	
USA	r=0	Statistic	6.192	12.635	12.330	16.722 **	6.326	9.344	--
		Crit.Val.	16.399	16.399	16.399	16.399	16.399	16.399	--
		Vector	-0.729	-0.373	-0.387	-0.346	0.028	-0.826	--
	r=1	Statistic	2.025	4.194	3.883	5.634	3.203	2.395	--
		Crit.Val.	9.670	9.670	9.670	9.670	9.670	9.670	--

Table 5.21: continued

Johansen Test (Maximum Eigenvalue Statistic) of Government Bond Yields

			Canada	France	Germany	Italy	Japan	UK	USA
France	r=0	Statistic	6.541	--					
		Crit.Val.	16.399	--					
		Vector	-1.784	--					
	r=1	Statistic	1.596	--					
		Crit.Val.	9.670	--					
Germany	r=0	Statistic	7.251	4.595	--				
		Crit.Val.	16.399	16.399	--				
		Vector	-1.546	-0.902	--				
	r=1	Statistic	1.545	3.485	--				
		Crit.Val.	9.670	9.670	--				
Italy	r=0	Statistic	6.545	6.491	6.021	--			
		Crit.Val.	16.399	16.399	16.399	--			
		Vector	-2.742	-1.259	-1.413	--			
	r=1	Statistic	1.412	2.613	3.040	--			
		Crit.Val.	9.670	9.670	9.670	--			
Japan	r=0	Statistic							
		Crit.Val.							
		Vector							
	r=1	Statistic							
		Crit.Val.							
UK	r=0	Statistic	12.077	12.022	12.488	9.968		--	
		Crit.Val.	16.399	16.399	16.399	16.399		--	
		Vector	-2.473	-2.062	-1.910	-2.251		--	
	r=1	Statistic	1.139	3.178	2.519	4.554		--	
		Crit.Val.	9.670	9.670	9.670	9.670		--	
USA	r=0	Statistic	5.260	8.934	9.952	8.143		12.961	--
		Crit.Val.	16.399	16.399	16.399	16.399		16.399	--
		Vector	-1.589	-0.413	-0.370	-0.380		-0.408	--
	r=1	Statistic	1.075	5.984	6.336	4.426		2.134	--
		Crit.Val.	9.670	9.670	9.670	9.670		9.670	--

Note: Results of testing for bivariate cointegration among the nominal interest rates (money market rates, and government bond yields) for the sample 1999:1 to 2010:1 are shown. The Table contains the maximum eigenvalue statistics for r=0 and r=1 with the corresponding critical values for each pair of variables. The critical values of Osterwald-Lenum (1992) were scaled with the scaling factor of Cheung and Lai (1993) to adjust for finite samples. The normalized cointegrating coefficient is reported in the rows named "vector". ** indicate the rejection of the null hypothesis with a significance of 5%.
Source: Authors' calculations, based on IMF (2010); and Banque de France (2009).

5.G Within-Country Analysis

As the comovements between the G7-countries — and even between the Eurozone countries — is rather low, we would at least expect the comovements of interest rates of the same country to be stronger than the comovements between other country pairs. We, therefore, conduct the analysis with interest rates of the same country in this section.

We analyze the money market rates and the government bond yields of each country for the sample 1975:1 to 2007:1, and the Euro-Market rates together with the before mentioned rates in the sample 1979:1 to 2007:1. Tables 5.22 and 5.23 show the optimal lag structure of the interest rates and the results of the ADF-test for the sample 1975:1 – 2007:1. Table 5.24 reports the results of the Johansen-test for interest rates of the same country for this sample. Tables 5.25 and 5.26 show the optimal lag structure of the interest rates and the results of the ADF-test for the sample 1979:1 – 2007:1. Table 5.27 reports the results of the Johansen-test in the latter sample.

Evidence for cointegration increases, but serial correlation common features cannot even be tested, as no common lag structures exist.

Table 5.22: AR(p)-representations of the process of nominal and real interest rates

	1975:1 - 2007:1			
	Nominal		Real	
	AR(...)		AR(...)	
Country	Level	1st diff	Level	1st diff
Money Market Rates				
Canada	6	6	8	8
France	2	1	3	2
Germany	12	2	1	1
Italy	2	1	3	3
Japan	4	2	1	4
UK	1	4	5	8
USA	6	5	7	2
Government Bond Yields				
Canada	4	3	2	4
France	2	1	5	4
Germany	4	3	1	1
Italy	2	1	5	4
Japan	2	1	5	3
UK	1	3	8	5
USA	4	3	2	1

Note: AR representations of the process of the nominal and real interest rates (money market rates and government bond yields) for the sample 1975:1 to 2007:1 are reported. The specification with the smallest number of AR terms is selected, under the constraint that the residual is free of autocorrelation (i.e. the Q-statistics are insignificant).
Source: Authors' calculations, based on IMF (2010); and Banque de France (2009).

Table 5.23: Results of ADF-test for nominal and real interest rates

	1975:1 - 2007:1																
	Nominal								Real								
	Level (AIC)			Level (SIC)			1st differences (AIC)		Level (AIC)			Level (SIC)			1st differences (AIC)		
Country	statistic	lags	Crit. Val.	statistic	lags	Crit. Val.	statistic	Crit. Val.	statistic	lags	Crit. Val.	statistic	lags	Crit. Val.	statistic	Crit. Val.	
Money Market Rates																	
Canada	-1.155	8	-2.840	-1.503	1	-2.880	-5.186 **	-2.846	-3.330 **	1	-2.880	-3.330 **	1	-2.880	-6.351 **	-2.846	
France	-1.197	5	-2.857	-1.944	1	-2.879	-6.611 **	-2.863	-2.185	2	-2.874	-2.599	1	-2.879	-6.718 **	-2.863	
Germany	-2.647	6	-2.852	-2.535	1	-2.879	-4.799 **	-2.852	-2.540	1	-2.879	-2.540	1	-2.879	-5.742 **	-2.846	
Italy	-0.494	5	-2.857	-1.638	1	-2.879	-7.871 **	-2.863	-2.089	5	-2.857	-2.889 **	1	-2.879	-7.832 **	-2.863	
Japan	-2.665	1	-2.879	-2.665	1	-2.879	-5.188 **	-2.841	-4.370 **	4	-2.863	-4.778 **	0	-2.885	-7.759 **	-2.868	
UK	-1.985	0	-2.885	-1.985	0	-2.885	-4.695 **	-2.836	-2.487	7	-2.846	-2.177	5	-2.857	-4.118 **	-2.852	
USA	-1.839	7	-2.846	-2.103	1	-2.879	-4.765 **	-2.852	-3.063 **	13	-2.816	-2.377	2	-2.874	-5.925 **	-2.852	
Government Bond Yields																	
Canada	-0.587	7	-2.846	-0.605	0	-2.885	-4.736 **	-2.852	-2.602	4	-2.863	-3.237 **	1	-2.879	-8.382 **	-2.868	
France	-0.792	4	-2.863	-1.209	1	-2.879	-5.863 **	-2.868	-2.528	8	-2.841	-3.102 **	1	-2.879	-5.808 **	-2.846	
Germany	-2.287	1	-2.879	-2.287	1	-2.879	-7.848 **	-2.885	-2.942 **	1	-2.879	-2.518	0	-2.885	-5.257 **	-2.826	
Italy	-1.019	1	-2.879	-1.019	1	-2.879	-7.248 **	-2.885	-3.808 **	4	-2.863	-3.808 **	4	-2.863	-9.845 **	-2.868	
Japan	-1.634	3	-2.868	-1.392	0	-2.885	-5.058 **	-2.874	-6.649 **	4	-2.863	-6.649 **	4	-2.863	-7.098 **	-2.846	
UK	-1.082	5	-2.857	-1.739	0	-2.885	-9.736 **	-2.879	-2.176	8	-2.841	-3.835 **	1	-2.879	-5.060 **	-2.846	
USA	-1.350	1	-2.879	-1.350	1	-2.879	-5.742 **	-2.863	-3.221 **	1	-2.879	-3.221 **	1	-2.879	-8.770 **	-2.885	

Note: The ADF-test statistics, calculated for the levels and first differences of nominal and real interest rates (money market rates and government bond yields) for the sample 1975:1 to 2007:1 are reported. The lag length was selected by the AIC and SIC criterion and is given in the corresponding column. Critical values of Cheung and Lai (1995) were applied and are reported. ** indicate rejection of the existence of both, stochastic and deterministic trends with a significance of 5%.

Source: Authors' calculations, based on IMF (2010); and Banque de France (2009).

Table 5.24: Results of Johansen test for interest rates of the same country

1975:1 - 2007:1

Johansen Test of Nominal Money Market Rates and Government Bond Yields

	Canada	France	Germany	Italy	Japan	UK	USA
r=0	21.988 **	23.961 ***	24.816 ***	30.089 ***	33.806 ***	13.547	27.971 ***
	17.379	15.917	16.434	15.917	16.171	16.706	16.987
r=1	1.171	1.802	6.486	1.505	3.294	3.622	1.365
	10.248	9.386	9.691	9.386	9.536	9.851	10.016

Johansen Test of Real Money Market Rates and Government Bond Yields

	Canada	France	Germany	Italy	Japan	UK	USA
r=0		24.804 ***	10.999			16.012	
		16.706	15.917			17.889	
r=1		4.207	6.276			7.341	
		9.851	9.386			10.548	

Note: Results of testing for bivariate cointegration among money market rates, and government bond yields of the same country for the sample 1975:1 to 2007:1 are shown. The Table contains the maximum eigenvalue statistics for r=0 and r=1 for each pair of variables. The critical values of Osterwald-Lenum (1992) were scaled with the scaling factor of Cheung and Lai (1993) to adjust for finite samples. ** and *** indicate the rejection of the null hypothesis with a significance of 5% and 1%.

Source: Authors' calculations, based on IMF (2010); and Banque de France (2009).

Table 5.25: AR(p)-representations of the process of nominal and real interest rates

	1979:1 - 2007:1			
	Nominal		Real	
	AR(...)		AR(...)	
Country	level	1^{st} diff	level	1^{st} diff
Money Market Rates				
Canada	2	1	2	1
France	2	1	3	1
Germany	2	1	1	1
Italy	2	1	2	2
Japan	5	3	4	3
UK	1	1	2	1
USA	4	5	3	2
Government Bond Yields				
Canada	1	1	2	4
France	2	1	4	4
Germany	4	3	1	1
Italy	2	1	3	4
Japan	1	1	4	4
UK	2	1	2	7
USA	2	1	2	1
Euro-Market Rates				
Canada	1	3	1	3
France	2	2	2	4
Germany	2	1	1	1
Italy	5	4	5	4
Japan	4	3	2	1
UK	6	4	5	2
USA	4	2	3	2

Note: AR representations of the process of the nominal and real interest rates (money market rates, government bond yields, and Euro-Market rates) for the sample 1979:1 to 2007:1 are reported. The specification with the smallest number of AR terms is selected, under the constraint that the residual is free of autocorrelation (i.e. the Q-statistics are insignificant).
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

Table 5.26: Results of ADF-test for nominal and real interest rates

	1979:1 - 2007:1																	
	Nominal									Real								
	Level (AIC)			Level (SIC)			1st differences (AIC)			Level (AIC)			Level (SIC)			1st differences (AIC)		
Country	statistic	lags	Crit. Val.	statistic	lags	Crit. Val.	statistic	Crit. Val.		statistic	lags	Crit. Val.	statistic	lags	Crit. Val.	statistic	Crit. Val.	
Money Market Rates																		
Canada	-1.146	8	-2.840	-1.375	1	-2.883	-4.940 **	-2.845		-3.033 **	1	-2.883	-3.033 **	1	-2.883	-5.565 **	-2.845	
France	-1.334	1	-2.883	-1.334	1	-2.883	-8.394 **	-2.889		-2.364	7	-2.845	-2.520	0	-2.889	-3.868 **	-2.851	
Germany	-2.643	2	-2.876	-2.267	1	-2.883	-5.700 **	-2.889		-2.422	0	-2.889	-2.422	0	-2.889	-9.727 **	-2.889	
Italy	-0.804	1	-2.883	-0.804	1	-2.883	-8.361 **	-2.889		-1.709	4	-2.864	-1.685	0	-2.889	-5.769 **	-2.870	
Japan	-1.374	2	-2.876	-1.666	1	-2.883	-6.127 **	-2.883		-1.658	5	-2.858	-1.939	0	-2.889	-4.528 **	-2.864	
UK	-1.288	11	-2.823	-1.767	0	-2.889	-4.708 **	-2.828		-1.808	5	-2.858	-1.852	1	-2.883	-6.652 **	-2.851	
USA	-1.661	7	-2.845	-1.567	0	-2.889	-4.473 **	-2.851		-3.044 **	13	-2.812	-2.463	0	-2.889	-4.965 **	-2.851	
Government Bond Yields																		
Canada	-0.736	6	-2.851	-0.562	0	-2.889	-5.447 **	-2.864		-1.929	4	-2.864	-2.447	0	-2.889	-8.071 **	-2.870	
France	-0.753	4	-2.864	-1.051	1	-2.883	-5.220 **	-2.870		-2.101	9	-2.834	-2.585	1	-2.883	-3.458 **	-2.840	
Germany	-1.496	1	-2.883	-1.496	1	-2.883	-7.595 **	-2.889		-2.539	1	-2.883	-2.259	0	-2.889	-9.751 **	-2.889	
Italy	-1.040	1	-2.883	-1.040	1	-2.883	-6.671 **	-2.889		-1.960	4	-2.864	-2.579	1	-2.883	-6.556 **	-2.870	
Japan	-1.098	3	-2.870	-0.761	0	-2.889	-4.745 **	-2.876		-1.994	4	-2.864	-2.434	0	-2.889	-6.899 **	-2.870	
UK	-1.037	2	-2.876	-1.237	1	-2.883	-6.252 **	-2.870		-1.647	8	-2.840	-3.050 **	1	-2.883	-5.550 **	-2.845	
USA	-1.267	1	-2.883	-1.267	1	-2.883	-8.309 **	-2.889		-2.238	1	-2.883	-2.238	1	-2.883	-8.689 **	-2.889	
Euro-Market Rates																		
Canada	-2.014	8	-2.839	-1.686	0	-2.890	-10.66 **	-2.890		-3.367 **	0	-2.890	-3.367 **	0	-2.890	-5.205 **	-2.814	
France	-1.396	4	-2.864	-1.655	2	-2.876	-4.159 **	-2.839		-2.710	4	-2.864	-3.897 **	1	-2.883	-4.363 **	-2.821	
Germany	-2.146	11	-2.821	-2.080	1	-2.883	-3.500 **	-2.827		-2.760	1	-2.883	-2.495	0	-2.889	-9.691 **	-2.889	
Italy	-1.594	8	-2.839	-1.594	8	-2.839	-3.432 **	-2.845		-2.025	8	-2.839	-2.025	8	-2.839	-4.942 **	-2.845	
Japan	-1.315	3	-2.871	-1.560	1	-2.883	-8.531 **	-2.877		-1.657	4	-2.864	-2.480	0	-2.890	-8.797 **	-2.871	
UK	-1.374	0	-2.889	-1.374	0	-2.889	-3.599 **	-2.809		-1.510	8	-2.839	-2.899 **	0	-2.889	-6.525 **	-2.870	
USA	-2.255	12	-2.815	-1.734	9	-2.833	-3.765 **	-2.827		-2.350	10	-2.827	-2.350	10	-2.827	-2.734	-2.833	

Note: The ADF-test statistics, calculated for the levels and first differences of nominal and real interest rates (money market rates, government bond yields, and Euro-Market rates) for the sample 1979:1 to 2007:1 are reported. The lag length was selected by the AIC and SIC criterion and is given in the corresponding column. Critical values of Cheung and Lai (1995) were applied and are reported. ** indicate rejection of the existence of both, stochastic and deterministic trends with a significance of 5%.

Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

Table 5.27: Results of Johansen test for nominal and real interest rates of the same country

1979:1 - 2007:1

Johansen Test (Maximum Eigenvalue Statistic) of Nominal Interest Rates

		Canada	France	Germany	Italy	Japan	UK	USA
mmr-gby	r=0	13.767	15.388	18.776 **	15.627	24.102 ***	10.007	17.750 **
		15.952	15.952	16.549	15.952	16.549	15.952	17.191
	r=1	1.9409	1.4271	2.9704	1.3036	1.8522	2.797	1.6476
		9.406	9.406	9.758	9.406	9.758	9.406	10.137
mmr-er	r=0	31.889 ***	19.387 **	88.321 ***	9.505	26.191 ***	17.980 **	65.219 ***
		16.583	16.245	15.952	16.924	16.583	16.875	17.221
	r=1	3.761	1.709	5.064	3.243	6.146	5.417	5.3619
		9.778	9.579	9.406	9.979	9.778	9.951	10.155
gby-er	r=0	13.526	18.954 **	17.049 **	14.628	18.023 **	16.303	9.2829
		16.583	16.245	16.549	16.924	16.583	16.875	16.245
	r=1	1.998	1.340	3.822	2.196	4.471	2.675	4.046
		9.778	9.579	9.758	9.979	9.778	9.951	9.579

Johansen Test (Maximum Eigenvalue Statistic) of Real Interest Rates

		Canada	France	Germany	Italy	Japan	UK	USA
mmr-gby	r=0		15.53	11.586	10.703	18.548 **	15.908	13.245
			16.864	15.952	16.864	16.864	17.886	16.245
	r=1		4.4919	5.5954	3.4286	2.1465	3.8839	5.2855
			9.944	9.406	9.944	9.944	10.547	9.579
mmr-er	r=0		18.903 **	33.365 ***	9.3778	19.063 **	15.044	24.049 ***
			16.875	15.952	16.924	16.583	16.245	16.245
	r=1		5.037	7.537	5.063	2.143	6.538	3.3795
			9.951	9.406	9.979	9.778	9.579	9.579
gby-er	r=0		24.880 ***	8.6795	13.374	29.813 ***	9.6918	8.3253
			16.875	15.952	16.924	16.924	17.979	16.245
	r=1		5.939	6.506	9.201	2.369	4.036	4.459
			9.951	9.406	9.979	9.979	10.602	9.579

Note: Results of testing for bivariate cointegration among the nominal and real interest rates (money market rates (mmr), government bond yields (gby), and Euro-Market rates (er)) of the same country for the sample 1979:1 to 2007:1 are shown. The Table contains the maximum eigenvalue statistics for r=0 and r=1 with the corresponding critical values for each pair of variables. The critical values of Osterwald-Lenum (1992) were scaled with the scaling factor of Cheung and Lai (1993) to adjust for finite samples. ** and *** indicate the rejection of the null hypothesis with a significance of 5% and 1%.
Source: Authors' calculations, based on IMF (2010), Banque de France (2009); and Thomson Reuters (2010).

Essay II

How Strong is the Case for Dollarization in Central American Countries?[34]

[34] This essay is based on Lindenberg and Westermann (2011) and Lindenberg and Westermann (2009b).

6 Introduction

Unofficial dollarization has increased substantially over the past decade in Central America and in several countries the 50% mark has been crossed in recent years. There is a high degree of de facto dollarization[35] and the issue of *official dollarization* has therefore become an important part of the discussion on stabilization policy. Recently, for instance, one of the presidential candidates of the Costa Rican elections of February 2010, Otto Guevara, proposed to dollarize the economy officially, a proposal that is also supported by the ex president of the Costa Rican Central Bank, Eduardo Lizano, and further politicians and academics.[36] The issue of official dollarization is also an important part of the policy debate in many of the other Central American countries, of which Panama and El Salvador already have the US Dollar as an official currency since 1904 and 2001, respectively.[37]

Despite the increasing political discussion, there is so far only little empirical evidence on the economic cost and benefit of a dollarization policy in Central American countries.[38] Partly, this may be due to the lack of an easy to use comprehensive empirical framework to address the issue of dollarization and its implications for stabilization policy. So far, most of the literature has used the

[35] See Figure 8.1.

[36] A short discussion of the pros and cons of official dollarization is provided in section 11.A in the appendix. Given the high relevance of the dollarization debate in Costa Rica, section 11.B in the appendix gives a closer inspection to the economy.

[37] For example Berg, Borensztein and Mauro (2002); Temprano-Arroyo (2003); Salvatore (2001); Alesina, Barro and Tenreyro (2002) propose dollarization of the economies.

[38] Levy Yeyati and Sturzenegger (2002) give a review of the issue of dollarization; and Mishkin and Savastano (2001) provide an overview of monetary policy options for Latin America, including currency boards and dollarization.

Mundell (1961) model of optimum currency areas.[39] In a seminal paper Bayoumi and Eichengreen (1993) have proposed a method to empirically measure the degree of business cycle comovements, in order to assess optimum currency areas, that can also be used to address the issue of fixed exchange rate regimes or full dollarization. Applying a procedure to decompose temporary and permanent shocks in a time series, the authors identify demand shocks as the transitory component of GDP. They find that the correlation among the demand shocks is not very high in the European Union and conclude that Europe might not be an optimum currency area (OCA), according to the OCA model of Mundell (1961). Related trend/cycle decompositions have been used for Central America by Fiess (2007), who also primarily focuses on the contemporaneous correlation of shocks, when evaluating the scope for macroeconomic policy coordination in Central America.

In our view, this approach provides only incomplete information to policy makers for several reasons. On the one hand, there may be permanent demand shocks or temporary supply shocks. It is therefore useful to also investigate the *full* time series in growth rates, rather than focusing on the transitory elements only. More importantly, on the other hand, the contemporaneous correlation of the transitory component (or the full time series) may not be sufficient, as a basis for monetary policy coordination or a common currency. Even when the correlation of shocks between two countries is high, the response of each country to a shock — often interpreted as a business cycle — can be very different. When one country reacts to and absorbs the shock more quickly than the other, it remains difficult to implement a common stabilization policy.

In order to address this issue, we investigate in the first part of this essay whether there exist common cyclical reactions to a standard shock in the Central American

[39] An introduction to the concept of optimum currency area is provided in section 11.A in the appendix. An overview of the Mundell model is provided in De Grauwe (1994). A formal analysis of exchange rate regime choice, based on the correlation of shocks, is also given in Berger, Jensen and Schjelderup (2001).

countries and the United States, using the test for common serial correlation that was first developed by Engle and Kozicki (1993) and Vahid and Engle (1993) and later extended by Cubadda (1999, 2007).[40] The authors show that it is possible to test for common serial correlation (i.e. a common business cycle) by constructing a linear combination of the two time series (that each follow an AR(p)-process) that is free of autocorrelation. If it is feasible to construct such a linear combination, it implies that there exists a common AR(p)-structure, as well as a perfectly collinear response of two time series to a standard shock.

The existence of such a common reaction to shocks would be an ideal precondition for official dollarization in the Mundell (1961) framework.[41] We will show, however, that this precondition is not convincingly met in any of the countries we studied. Despite the relatively high contemporaneous correlation of shocks, the different *persistence* of shocks would be a strong argument against official dollarization, rather than for it.

In the second part of this essay, we argue that the optimum currency area framework of Mundell (1961) also neglects some important characteristics of most middle income countries that may change the dollarization debate substantially: The Mundell framework — in its original version — is build on the assumption that a freely floating exchange rate would help to smooth asymmetric shocks. In the case of idiosyncratic business cycles, the exchange rate could then contribute to stabilize the economy. Schneider and Tornell (2004), however, argue that in the presence of credit market imperfections, a free floating exchange rate would *amplify* the business cycle fluctuations, rather than smooth them. There is also a second vintage of the Mundell framework (see Mundell, 1973) that argues that exchange rate changes can be destabilizing. This model is different, however,

[40] See Urga (2007) for an overview of recent developments in the literature of common features in time series.

[41] This approach has been also used in the context of the policy debate on a common currency in North-East Asia by Cheung and Yuen (2005) (see chapter on further literature).

from the Schneider and Tornell (2004) argument. It is based on the view that in a flexible exchange rate environment, insurance against asymmetric shocks is difficult, while in a monetary union it exists automatically.

The Schneider and Tornell (2004) argument is that in the presence of enforceability problems, agents will find it optimal to undertake risk to overcome their credit constraints. Tornell and Westermann (2002) document that many middle income countries have undertaken such risk by denominating their debt in US Dollars, thereby taking advantage of the lower interest rates in foreign currency. The consequence for the whole economy, when liabilities are denominated in foreign currency, is that a real appreciation will reduce the value of the debt and allow the agents to take on even more debt during the boom period. In the case of a depreciation, the value of the debt will increase and reduce the scope to finance further investment. Contrary to the Mundell assumption, the exchange rate does therefore not smooth the business cycle, but amplifies it and generates the boom-bust cycle pattern that is also characteristic for many Central American economies. In a currency crisis, a very large depreciation, a large number of firms and banks can become bankrupt, in a partially dollarized economy — a possibility that has first been pointed out in the context of the dollarization debate by Calvo (2001).

We document in the second part of this essay that several characteristics of countries with boom-bust cycle patterns are present in Central America. A high dollarization of liabilities, relatively weak judicial institutions and credit constraints, particularly for small firms, are present in all countries. More subtle, but also informative — and an implication of the model on boom-bust cycles — is the fact that in recent years, a real appreciation has coincided with a high credit growth rate and an expansion of non-tradable sector's output relative to the tradable sector. Furthermore, most countries have already experienced systemic banking and currency crises over the past 20–30 years.[42]

Finally, we attempt to uncover the impact of exchange rate movements on domestic output directly. Using a bivariate VAR, we find that in Central American countries there is indeed a positive reaction of GDP to an appreciation of the exchange rate and vice versa. We follow the identification approach of Tornell and Westermann (2005) to derive the impulse response functions and pool the reactions across countries in order to overcome the small sample problem. The evidence is confirmed also, when considering Mexico, for which a longer time series exists.

Our main policy conclusion is that official dollarization is not likely to counteract the countries' efforts to achieve business cycle stabilization, although business cycles are not similar to the US. We find that full impulse response patterns are quite different from the US, even for countries where the contemporaneous correlations are high. However, we argue that due to the mismatch between foreign currency liabilities and domestic revenues, in particular for small, non-tradable goods producing firms, the exchange rate cannot perform its typical role as a shock absorber. On the contrary, pronounced cyclical movements and financial crises could follow from exchange rate movements. The recent European experience has shown that a common currency, by itself, does not safeguard against financial crises either. The first best solution would be to strengthen the legal systems and eliminate the credit market imperfections that are ultimately the source of pronounced cycles. In the context of the dollarization debate, it is important, however, to point out that a freely fluctuating exchange rate is not an adequate stabilization instrument in their presence.

[42] See Table 7.1, and also Kaminsky and Reinhart (1998) who study financial crises in Latin America. In a later paper the authors analyze the links between banking and currency crises, the so called twin crises phenomenon (Kaminsky and Reinhart, 1999).

The next chapter contains the analysis of the dollarization question in the Mundell (I) framework. In chapter 8, the empirical analysis is guided by the boom-bust cycle framework of Schneider and Tornell (2004). Chapter 9 gives a review of the related literature, chapter 10 concludes, and an extensive appendix provides further analysis and information.

7 Mundell-Framework

As a first approach, we will analyze the dollarization question in the context of the optimum currency area (OCA) framework (see Mundell, 1961; McKinnon, 1963; Kenen, 1969). In this framework, the main loss associated with dollarization is the loss of individual monetary policy that helps to smooth asymmetric shocks. The more symmetric shocks are across countries, the smaller is this potential welfare loss. Tests for comovements of business cycles (Bayoumi and Eichengreen, 1993; Fiess, 2007, among others) are therefore a main empirical tool to assess the costs of policy coordination that a monetary union or an official policy of dollarization implies. In the following sections we analyze various forms of comovement and argue that the methods that have been used so far only provide an incomplete picture for a reliable policy contribution.

7.1 Data and Descriptive Statistics

The time series for the Central American countries, Belize, Costa Rica, Dominican Republic,[43] El Salvador, Mexico, Nicaragua, and Panama, GDP real indices (seasonally adjusted) are obtained from the *Latin American and Caribbean Macro Watch* of the *Inter-American Development Bank* (IDB, 2010). Equivalent data for the United States were retrieved from the *International Financial Statistics*

[43] The Dominican Republic is not a Central American, but a Caribbean country. However, as it pertains to the *Dominican Republic-Central America Free Trade Agreement* (DR-CAFTA), we include it when referring to the Central American economies. A second glance at the Caribbean region is given in section 11.C in the appendix.

Database of the *International Monetary Fund* (IMF, 2010). For Guatemala we use the monthly index of economic activity from *Banco de Guatemala* (Banco de Guatemala, 2010)[44] and for Honduras the monthly index of industrial production (real and seasonally adjusted) from the *Inter-American Development Bank* (IDB, 2010).[45] All series are re-based to 2001:1. In the following analysis, logarithmized growth rates of GDP will be studied in the longest common available sample, from 1997:1 to 2008:1.

Figure 7.1 displays the GDP series in levels and growth rates. The growth rates of Belize, Honduras, and Nicaragua stand out highly volatile. In many countries there have been slightly negative growth rates in 2000/2001, e.g. in Costa Rica, Dominican Republic, Guatemala, Mexico and Panama. In the US growth has been nearly stagnating at this time. The common slowdown of the countries in the post 2001-period provides a first visual impression that some sort of comovement across business cycles exists vis-à-vis the United States, and across Central American countries.

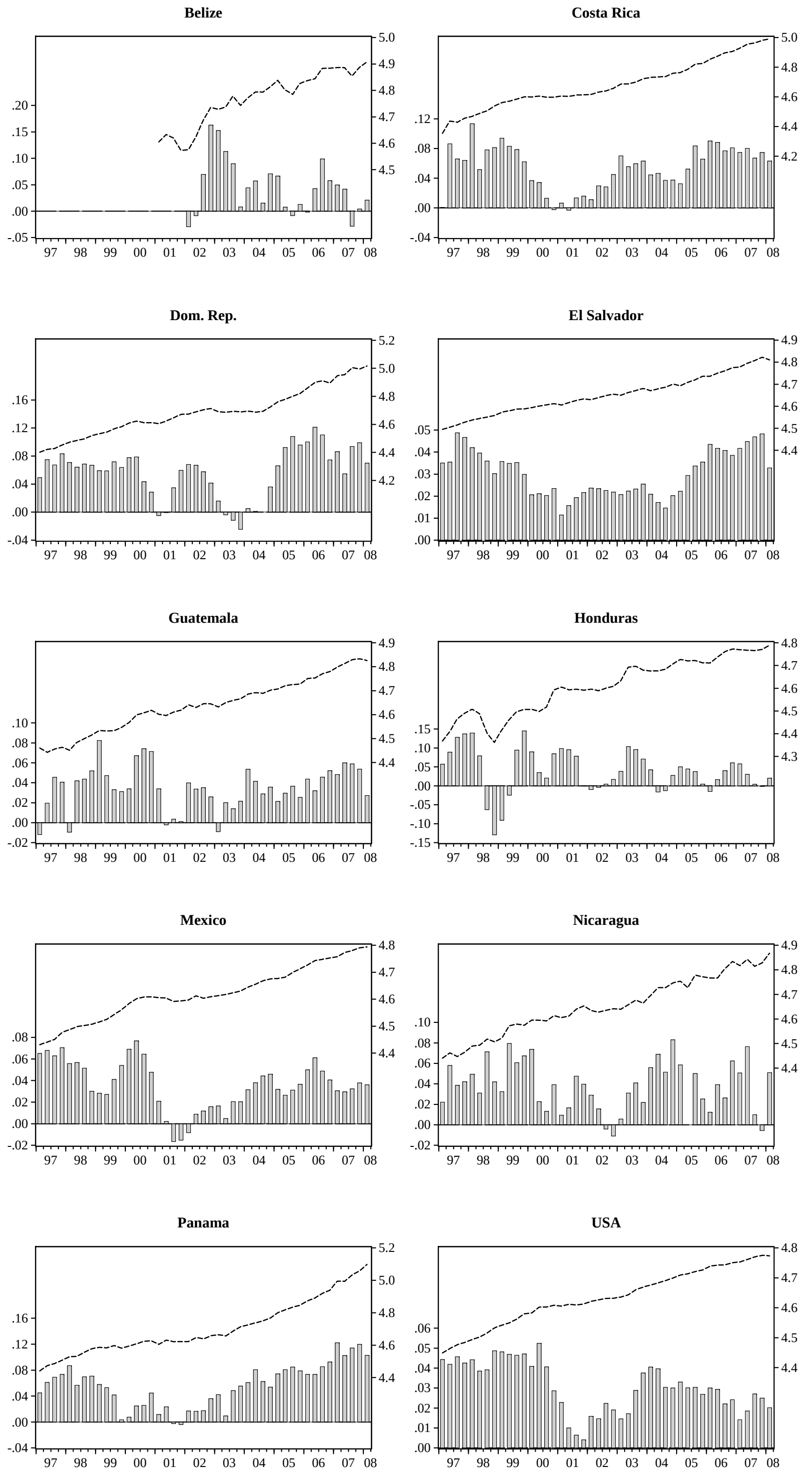
Other periods with negative rates that are more idiosyncratic can be explained with the occurrence of occasional banking and/or currency crises, as in the Dominican Republic in 2003 (twin crisis), in Honduras in 1999 (banking crisis), and in Nicaragua in 2002 (banking crisis) (see Table 7.1, which gives an overview of the systemic banking and currency crises in Central America in the last decades). On average, however, the growth rates of the Central American countries have been relatively high (compare Table 7.2) with mean growth rates between 3% and 6% annual growth. Many of the countries even have experienced boom-periods, prior to busts, with a maximum growth rate of more than 10%, e.g. Belize, Costa Rica, Dominican Republic, Honduras, and Panama.

---

44 Data have been seasonally adjusted with the Census X12 method.

45 For both countries quarterly GDP is not available. However, we use these indices as proxies for GDP and we will refer to both as "GDP" in the following.

Figure 7.1: GDP levels and growth rates



Note: GDP levels and growth rates of the Central American countries are displayed in quarterly data from 1997:1 to 2008:1. The growth rates are displayed on the left axis (bar charts), the levels on the right axis (dashed lines).
Source: Authors' representation, based on IDB (2010), Banco de Guatemala (2010); and IMF (2010).

Table 7.1: Systemic banking and currency crises in Central America

	Systemic Banking Crises		Currency Crises	
	Year	Source	Year	Source
Belize	--	--	--	--
Costa Rica	1987	B01, CK03, LV08	1981	LV08
	1994-1997	B01, CK03, J08, LV08	1991	LV08
Dom. Rep.	1996	J08	1985	LV08
	2003	J08, LV08	1990	LV08
			2003	LV08
El Salvador	1989	CK03, LV08	1986	LV08
	1998	J08		
Guatemala	1991	CK03	1986	LV08
	2001	J08		
	2006	J08		
Honduras	1999	J08	1990	LV08
	2001	J08		
	2002	J08		
Mexico	1981-1982	B01, LV08	1982	LV08
	1982-1991	KR99, CK03	1995	LV08
	1992	KR99		
	1994-1997	B01, CK03, J08, LV08		
Nicaragua	1987-1996	CK03	1985	LV08
	1990	LV08	1990	LV08
	2000-2002	J08, LV08		
Panama	1988-1989	CK03, LV08	--	--

Note and Source: The Table reports the systemic banking crises and currency crises of Central America since the 1980s that have been reported by various authors. *B01* refers to Bordo, Eichengreen, Klingebiel et al. (2001), *CK03* to Caprio and Klingebiel (2003), *J08* to Jácome (2008), *KR99* to Kaminsky and Reinhart (1999), and *LV08* to Laeven and Valencia (2008).

In order to get a first quantitative impression of the similarity of the business cycles in the Central American countries and the United States, we look at the contemporaneous correlations of the GDP growth rates that are displayed in Table 7.3.

Table 7.2: Descriptive statistics of the GDP growth rates

	Belize	Costa Rica	Dom. Rep.	El Salvador	Guatemala	Honduras	Mexico	Nicaragua	Panama	USA
Mean	0.044	0.054	0.056	0.030	0.035	0.039	0.036	0.038	0.056	0.031
Maximum	0.163	0.113	0.121	0.049	0.082	0.145	0.077	0.083	0.122	0.052
Minimum	-0.029	-0.003	-0.024	0.011	-0.012	-0.129	-0.017	-0.011	-0.004	0.004
Std. Dev.	0.051	0.029	0.036	0.010	0.022	0.058	0.023	0.024	0.033	0.013
Obs.	25	45	45	45	45	45	45	45	45	45

Note: Descriptive statistics of the GDP growth rates of the Central American countries are displayed in quarterly data from 1997:1 to 2008:1 (the sample for Belize is shorter due to data availability).
Source: Authors' calculations, based on IDB (2010), Banco de Guatemala (2010); and IMF (2010).

Table 7.3: Contemporaneous correlations between the GDP growth rates of Central American countries and the USA

1997:1 - 2008:1 (pairwise samples)									
	Belize	Costa Rica	Dom. Rep.	El Salvador	Guatemala	Honduras	Mexico	Nicaragua	Panama
Belize	1								
Costa Rica	0.004	1							
Dom. Rep.	-0.375	0.446	1						
El Salvador	-0.350	0.696	0.691	1					
Guatemala	-0.474	0.155	0.257	0.247	1				
Honduras	0.430	-0.130	-0.171	0.019	-0.370	1			
Mexico	-0.097	0.297	0.367	0.416	0.307	0.202	1		
Nicaragua	-0.035	0.241	-0.014	0.054	0.069	0.084	0.238	1	
Panama	-0.311	0.623	0.417	0.686	0.284	-0.191	0.320	0.108	1
USA	-0.229	0.326	0.119	0.234	0.328	0.006	0.731	0.301	0.119

Note: Contemporaneous correlations between the (logarithmized) GDP growth rates of Central American countries and the United States are displayed. All samples with Belize are 2002:1 – 2008:1; the remaining samples start in 1997:1.
Source: Authors' calculations, based on IDB (2010), Banco de Guatemala (2010); and IMF (2010).

All GDP growth rates, excepting the Belizean one — which has a negative correlation with the US, and the growth rate of Honduras, where the correlation is nearly zero —, are positively correlated with the GDP growth rate of the United States. The contemporaneous correlation between Mexico and the US is with 0.73 especially high, which reflects the close economic relationship between the two

NAFTA-countries.[46] Among the remaining Central American countries, Costa Rica, Guatemala, and Nicaragua have the highest correlations with 0.33 (0.33, 0.30), which are still significantly higher than the correlations between the US GDP growth rate and the German or Japanese ones (0.26 and -0.01). The two dollarized economies Panama and El Salvador, however, have a weaker correlation with the US, with a value of 0.12 and 0.23, respectively.[47]

This relatively high correlation of business cycles is often interpreted as a precondition being fulfilled to introduce a policy of official dollarization at a relatively low cost in terms of stabilization policy. Our first main point is, however, that not only the correlation of shocks, but also the reactions to the shocks over time are important. As a first pass, we illustrate this point, by displaying the autocorrelation functions of the GDP growth rates in Figure 7.2. Although in some cases the reaction in the first quarters is quite similar, we find that after some time the functions differ substantially, both with respect to the magnitude and to the length of the reaction that each country has to a standard shock. Clearly this asymmetric adjustment will pose further difficulties for monetary policy under a common currency. In the following section, we will test more formally, whether the first visual impression is confirmed and cyclical reactions to shocks are indeed significantly different between the countries.

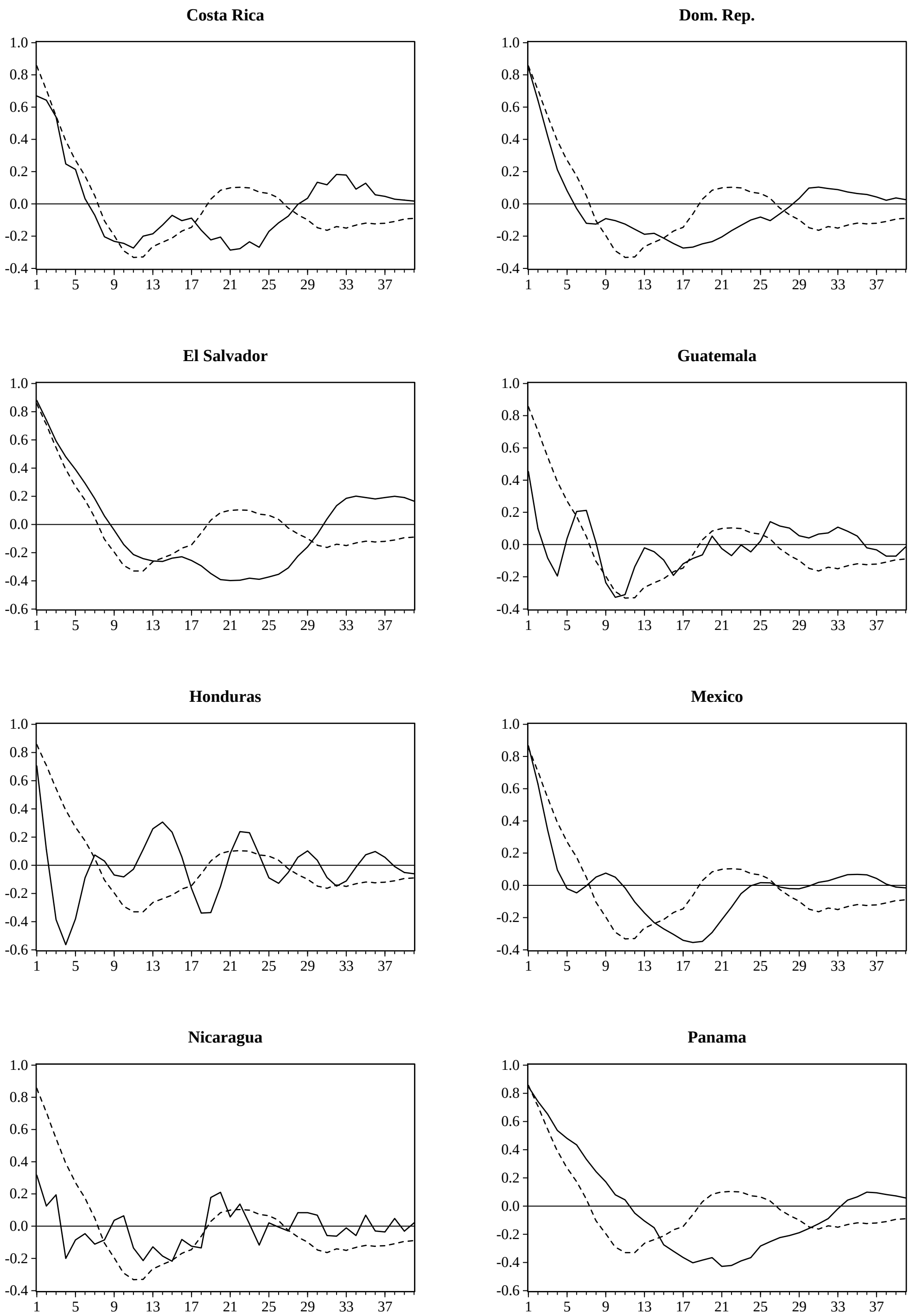
7.2 Common Cycles and Codependence

In this section we implement a formal test for various types of comovement between the Central American economies and the United States. We start with the unusual

[46] The correlation between Canada and the US is quite similar with 0.77. Correlations among the Eurozone countries are slightly smaller, e.g. among Germany and France 0.58 and among Germany and Italy 0.72.

[47] Goldfajn, Olivares, Frankel et al. (2001) analyze the disadvantages and advantages of dollarization on the example of Panama, one of the largest dollarized economies in the world, comparing the country especially with Costa Rica and Argentina to control for idiosyncratic effects.

Figure 7.2: Autocorrelation functions of GDP growth rates



Note: The autocorrelation functions of the logarithmized growth rates of the GDP of the Central American countries (solid line) and the United States (dashed line) are displayed in the sample 1997:1 – 2008:1.

Source: Authors' calculations, based on IDB (2010), Banco de Guatemala (2010); and IMF (2010).

preliminary exercises on the stationarity properties of the time series in levels and first differences and on cointegration. We then conduct a test for common cycles between Central American countries and the United States, using the test for common serial correlation, developed by Engle and Kozicki (1993).

The intuition for this test is the following: If both the first differences of country i and country j are stationary AR(p) time series, a linear combination should exist that has a reduced AR(0) structure, if the reaction to shocks is *the same* across countries. Even if the contemporaneous correlation of growth rates is quite high, as it was shown to be the case in several countries in the previous section, the two countries do not need to respond similarly to shocks. We therefore argue that the application of the test for *common features* — with regard to both trend and cycles in GDP — provides a more complete picture to understand the comovements of business cycles across countries, and to evaluate the potential costs of the loss of an autonomous monetary policy.

Stationarity

As a first preliminary analysis, we test for the stationarity of the time series, using the Augmented-Dickey-Fuller (ADF) test:

$$\Delta y_t = \mu + \gamma y_{t-1} + \sum_{j=1}^{p} \phi_j \Delta y_{t-j} + \epsilon_t,$$

where y_t = GDP at time t[48], p = the lag parameter, ϵ_t = an innovation term, and Δ is the first difference operator. The lag parameter p is determined by the Schwarz information criterion (SIC) and the finite sample critical values from Cheung and Lai (1995) are used. The results of the ADF test are displayed in Table 7.4.

[48] We conduct the test both in logarithmized levels and in logarithmized growth rates.

Table 7.4: Results of ADF-test for GDP

	1997:1 - 2008:1					
	Level			1st differences		
	lags	statistic	crit. value	lags	statistic	crit. value
Costa Rica a)	4	-2.75	-3.46	0	-10.51 **	-2.95
Dominican Rep. a)	0	-1.10	-3.54	0	-6.17 **	-2.95
El Salvador b)	4	-0.51	-2.89	1	-4.96 **	-2.93
Guatemala	0	-0.75	-2.95	0	-7.71 **	-2.95
Honduras	4	-1.47	-2.89	3	-5.77 **	-2.90
Mexico	1	-1.09	-2.93	0	-4.27 **	-2.95
Nicaragua	2	-0.90	-2.92	1	-7.59 **	-2.93
Panama a)	1	1.43	-3.52	1	-3.05 **	-2.93
USA	0	-2.66	-2.95	1	-2.96 **	-2.93

Note: ADF-test statistics are reported for the sample 1997:1 – 2008:1 (quarterly data). The ADF-test was conducted in levels and in first differences. The lag length was selected by the SIC criterion. Critical values of Cheung and Lai (1995) were applied. ** indicate rejection of the existence of both, stochastic and deterministic trends with a significance of 5%. a) A trend has been included in the estimation equation. b) For El Salvador the ADF-test in first differences has been conducted with only one lag (selected manually; SIC would require 3 lags).
Source: Authors' calculations, based on IDB (2010), Banco de Guatemala (2010); and IMF (2010).

For all countries, the null of non-stationarity cannot be rejected in levels and can be rejected in first differences, hence all series are I(1).[49]

Cointegration

As a second step, we examine whether there exist common long run trends by implementing the test for cointegration using the Johansen (1988, 1991) maximum likelihood approach, and allowing for an intercept in the cointegrating equations:

$$Y_t = \mu + \sum_{i=1}^{p-1} \Gamma_i Y_{t-i} + \epsilon_t$$

[49] For El Salvador the lag length of the ADF-test in first differences has been manually selected.

where Y_t is a 2×1 vector of the GDP series, μ is an intercept vector, and ϵ_t is a vector of innovation terms.

The canonical correlations between the least squares residuals of the two subsequent regressions are calculated in order to deduce the maximum eigenvalue test statistic:

$$\Delta Y_t = \mu_1 + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \epsilon_{1t}$$
$$\text{and} \quad Y_{t-p} = \mu_2 + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \epsilon_{2t}.$$

The null hypothesis of the maximum eigenvalue statistic claims that there are r, and the alternative hypothesis that there are $r+1$ cointegrating vectors:

$$\text{Maximum Eigenvalue Statistic} = -T\, ln(1 - \lambda_{r+1}).$$

The critical values of Osterwald-Lenum (1992), corrected with the scaling factor of Cheung and Lai (1993) to control for a possible finite-sample bias, are then compared with the calculated test statistics.

The results are shown in Table 7.5. We find that the GDP series of the Dominican Republic, El Salvador, Guatemala, and Honduras are cointegrated with the US GDP. For these countries, we include an error correction term in the computation of the following test statistics for common cycles.

Common serial correlation

Finally, we conduct the test for common serial correlation. We start with the two-stage least squares (TSLS) approach of Engle and Kozicki (1993). The first regression

$$y_{i,t} = c + \beta y_{j,t} + \epsilon_t \tag{7.1}$$

Table 7.5: Results of Johansen cointegration test

1997:1 - 2008:1

Johansen Test (Maximum Eigenvalue Statistic)

			Costa Rica	Dom. Rep.	El Salvador	Guatemala	Honduras a)	Mexico	Nicaragua	Panama
USA	r=0	Statistic	11.15	22.10 ***	22.54 ***	24.06 ***	26.76 **	15.67	31.00 ***	8.99
		Crit.Val.	17.20	16.40	16.40	16.40	26.12	18.08	16.40	19.15
		Vector	-2.13	-0.09	-1.29	-0.94	-2.44	-0.75	-0.42	0.45
	r=1	Statistic	4.54	2.87	2.96	5.70	9.91	3.99	19.16 ***	3.54
		Crit.Val.	10.14	9.67	9.67	9.67	15.40	10.66	9.67	11.29

Note: Results of testing for cointegration between the GDPs of the Central American countries and the United States are shown for the sample 1997:1 − 2008:1. The Table contains the maximum eigenvalue statistics for r=0 and r=1. The critical values of Osterwald-Lenum (1992) were scaled with the scaling factor of Cheung and Lai (1993) to adjust for finite samples. ***, ** indicates the rejection of the null hypothesis with a significance of 1%, 5%. a) To test for cointegration with Honduras, industrial production instead of GDP has been used for the United States.
Source: Authors' calculations, based on IDB (2010), Banco de Guatemala (2010); and IMF (2010).

is estimated with TSLS, including as instruments all lagged variables of y_i and y_j[50], i.e. $y_{i,t-k}$ and $y_{j,t-k}$ for $k = 1, ..., p$ as well as the lagged error correction terms, ec_{t-k}, where it is needed. $(1, \beta)$ is the normalized common feature vector.[51]

Then, we analyze whether the estimated residual $\hat{\epsilon}_t$ still contains autocorrelation that affects the present values through the same channels as $y_{i,t}$ and $y_{j,t}$ by estimating the following equation:

$$\hat{\epsilon}_t = c + \sum_{k=1}^{p} \delta_k y_{i,t-k} + \sum_{k=1}^{p} \gamma_k y_{j,t-k} + \sum_{k=1}^{p} \phi_k ec_{t-k} + u_t. \qquad (7.2)$$

The null hypothesis is defined as all parameters being not statistically different from zero. If all lagged variables do not explain the estimated residual, the com-

50 y_i and y_j refer to the logarithmized growth rates of GDP.

51 In order to generate the best condition for finding cyclical comovement, we choose the most parsimonious lag structure that is sufficient to remove all autocorrelation from the residuals. However, using the AIC or SIC criterion to choose the lag length does not change the results qualitatively.

mon AR(p)-pattern has been removed in the first regression. H_0 is tested with the F-statistic:

$$F_{k-1,T-k} = \frac{R^2}{1-R^2}\frac{T-k}{k-1},$$

where T denotes the number of observations and k refers to the number of restrictions, i.e. the number of exogenous variables including the constant. R^2 is the R-squared of regression 7.2. Thus, if the null hypothesis cannot be rejected, evidence in favor of a common cycle is established.

Results of the serial correlation common feature test (with TSLS estimation) are displayed in panel A of Table 7.6. In column *CF*, we see that a serial correlation common feature is found only for Mexico, where the null of a common feature cannot be rejected at the 1% or 5% level and the serial correlation common feature vector is statistically significant. Also, for Costa Rica and Nicaragua the null cannot be rejected, however, the vectors are insignificant as well.

As a robustness check, we also conduct the test with an optimal general method of moments (GMM) estimation as proposed by Cubadda (1999, 2007), who argues that GMM is more appropriate for testing for common cycles, due to its relative efficiency. Panel B in Table 7.6, Column CF, shows that with this alternative estimation method, none of the countries shares a common serial correlation feature with the United States.

Codependence

Some time series may have a different initial response to a shock, but a common response after some lags. This weaker form of cyclical, but non-synchronized comovement, called codependence, was first described by Gourieroux and Peaucelle (1989) and Vahid and Engle (1997). We test for codependence estimating the same equations as for the SCCF: 1. TSLS (equation 7.1) and 2. OLS of the residual (equation 7.2). Then, we compute a Wald-Test, testing whether all but

Table 7.6: Results of serial correlation common feature and codependence tests

PANEL A: TSLS

1997:1 - 2008:1

	p		CF	Codependence of order 1	2	3
Costa Rica	2	test-statistic	1.13	1.97		
		vector	-0.10	-0.10		
Dominican Rep.	1	test-statistic	69.70 ***			
		vector	0.05			
El Salvador	1	test-statistic	66.75 ***			
		vector	0.31			
Guatemala	1	test-statistic	13.16 ***			
		vector	0.63 ***			
Honduras [a)]	9	test-statistic	18.89 ***	6.11 ***	4.71 ***	3.70 **
		vector	0.02	0.02	0.02	0.02
Mexico	3	test-statistic	1.24	1.17	0.77	
		vector	0.27 ***	0.27 ***	0.27 ***	
Nicaragua	1	test-statistic	0.00			
		vector	-0.44			
Panama	4	test-statistic	2.53 **	2.73 **	3.11 **	2.69 *
		vector	-0.07	-0.07	-0.07	-0.07

PANEL B: GMM

1997:1 - 2008:1

	p		CF	Codependence of order 1	2	3
Costa Rica	2	test-statistic	27.64 ***	15.10 ***		
		vector	-0.23 ***	-0.15 **		
Dominican Rep.	1	test-statistic	29.59 ***			
		vector	-0.09			
El Salvador	1	test-statistic	28.63 ***			
		vector	-0.40 **			
Guatemala	1	test-statistic	27.23 ***			
		vector	-1.01			
Honduras [a)]	9	test-statistic	33.62 ***	12.49 ***	6.30 *	2.66
		vector	-0.28	-0.43	-0.77	-2.22
Mexico	3	test-statistic	16.76 ***	6.62	2.19	
		vector	-0.40 ***	-0.37 ***	-0.37 ***	
Nicaragua	1	test-statistic	21.36 ***			
		vector	-0.33 ***			
Panama	4	test-statistic	27.79 ***	11.31 **	8.23	2.29
		vector	-0.22 ***	-0.26 ***	-0.18	-0.36 ***

Note: Results of the TSLS estimation (panel A) and GMM estimation (panel B) of serial correlation common features and codependence between the GDP growth rates of the Central American countries and the United States are reported for the sample 1997:1 – 2008:1. In the rows *test statistic* F-statistics are reported in panel A and χ^2-statistics are reported for the GMM approach (panel B). The rows titled *vector* report the coefficient β of the common feature vector. ***, **, and * indicate the rejection of the null hypothesis with a significance of 1%, 5%, and 10%. a) To test for a common feature with Honduras, industrial production instead of GDP has been used for the United States.

Source: Authors' calculations, based on IDB (2010), Banco de Guatemala (2010); and IMF (2010).

the first lagged terms of both interest rates do not explain jointly the estimated residual $\hat{\epsilon}_t$.

For the remaining countries (excepting Mexico), codependence of higher order, i.e. a synchronized reaction to a common shock after some periods, can not be found either. Using the optimal GMM test proposed by Cubadda (1999, 2007), we can only confirm the codependence of order one between Mexico and the US, and we find codependence of order three for Panama (see panel B in Table 7.6).

Interestingly, there is no obvious difference between countries that intend to dollarize, and those who already have officially dollarized their economies, like Panama and El Salvador. This suggests that there is not much endogeneity between the exchange rate regime and the degree of business cycle comovement.

Finally, as a last robustness check, we disregard the requirement of common lag structures and conduct the TSLS serial correlation common feature test with four lags in the estimation equations. When running the test with four lags in each estimation equation, results remain qualitatively unchanged (see Table 7.7). The only country for which we find a robust evidence in favor of codependence — that holds in all specifications of the test — is Mexico.

Table 7.7: Results of serial correlation common feature and codependence tests with 4 lags

	1997:1 - 2008:1				
			Codependence of order		
	vector	CF	1	2	3
Costa Rica	0.02	2.16 *	2.13 *	2.07	2.06
Dominican Rep.	0.03	3.29 ***	1.70	1.58	1.56
El Salvador	0.18	5.14 ***	1.16	1.13	0.86
Guatemala	0.61 ***	2.11 *	0.47	0.59	0.80
Honduras [a)]	0.06	9.84 ***	5.04 ***	4.81 ***	4.02 **
Mexico	0.29 ***	1.30	1.07	0.94	1.14
Nicaragua	0.14	2.11 *	2.59 **	1.86	1.25
Panama	-0.07	2.53 **	2.73 **	3.11 **	2.69 *

Note: Results of the TSLS estimation of serial correlation common features and codependence between the GDP growth rates of Central American countries and the United States are reported for the sample 1997:1 – 2008:1. Independently of the true lag structure, all equations have been estimated with 4 lags. Error-correction terms have been included for Dominican Republic, El Salvador, Guatemala, and Honduras. The column *CF* gives the F-statistic for the serial correlation common feature test, and the columns titled *codependence of order 1, 2, 3* report the F-statistic for the codependence test. The column *vector* contains the coefficient β of the common feature vector. ***, **, and * indicate the rejection of the null hypothesis with a significance of 1%, 5%, and 10%. Please note that in some cases the non-rejection of the null hypothesis is trivial (e.g. as in the case of the codependence tests for Guatemala, where both countries, Guatemala and the US, have a lag structure of 1). a) To test for a common feature with Honduras, industrial production instead of GDP has been used for the United States.
Source: Authors' calculations, based on IDB (2010), Banco de Guatemala (2010); and IMF (2010).

8 Schneider/Tornell-Framework

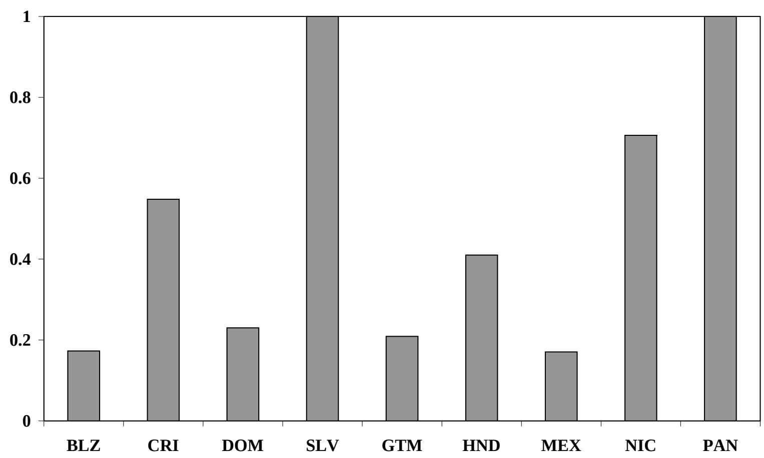
In the previous chapter we have shown that the Central American economies do not seem to form an optimum currency area — according to the Mundell (I) definition. By dollarizing officially they would appear to lose an important stabilization instrument, as asymmetric shocks, as well as common shocks with asymmetric persistence, cannot easily be offset by domestic stabilization policy. The countries would lose the option of a depreciation against the US Dollar to stimulate their exports. In this section we will show that it is not clear, whether this indeed constitutes an important loss in the presence of credit market imperfections. Schneider and Tornell (2004) have proposed a conceptual framework, where dollarization and currency mismatch arise as a consequence of contract enforceability problems and bailout expectations. In this model, the exchange rate plays just the opposite role. Rather than stabilizing the business cycle, it amplifies cyclical fluctuations. In their model firms denominate their debt in foreign currency in order to overcome credit constraints. The revenues of the non-tradable goods producing sector, however, are still in domestic currency. In this setting, a real appreciation reduces the debt burden of the firms and allows them to take on even more debt, as their net worth has increased. A real depreciation, on the other hand, leads to an increase of the debt burden and a reduction in net worth. A very large depreciation — such as in a currency crisis — will therefore lead to widespread bankruptcies. Overall, their model explains the patterns of boom-bust cycles that many middle income countries have experienced over the past decades.

We will document in the following sections that several of the characteristics of middle income countries that give rise to boom-bust cycle patterns are clearly present in the Central American economies.

Currency mismatch

Figure 8.1 displays the percentages of foreign-currency denominated liabilities. Besides El Salvador and Panama that use the US$ as official currency since 2001 (1904), especially Costa Rica and Nicaragua display a high degree of unofficial dollarization with percentage shares of 54.8% and 70.6%. In Honduras the de facto dollarization is still high with 41%. The smallest degree of unofficial dollarization can be observed in Mexico with only 17.1%.

Figure 8.1: Foreign-currency denominated liabilities



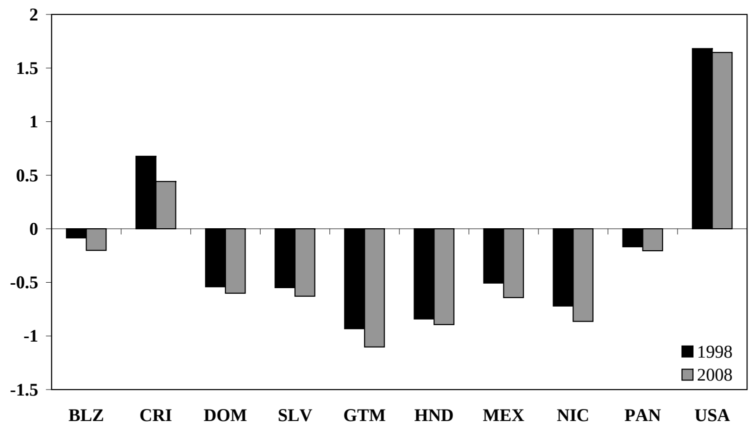
Note: Percentages of foreign-currency denominated liabilities in 2007 are reported. El Salvador has been dollarized in 2001, Panama uses the US$ as currency since 1904.
Source: Authors' representation, based on Caprio, Levine and Barth (2008).

In the model of Schneider and Tornell (2004), foreign currency financing is the consequence of institutional problems and credit constraints. Firms opt for a foreign currency loan that they can obtain at a lower interest rate despite the associated risk, because they expect a bailout in case of a systemic crisis.

Contract enforceability problems

In Figure 8.2 the index rule of law, which measures the extent to which agents have confidence in and abide by the rules of society, in particular the quality of contract enforcement, the police, and the courts, as well as the likelihood of crime and violence, is displayed for the Central American countries and the US. The index varies from -2.5 to 2.5, with higher values corresponding to better government outcomes. As can be seen easily, a high discrepancy between the situation in the US and the Central American countries exists. In 2008 the index has the value 1.65 in the United States, followed by Costa Rica with a value of only 0.44. The poorest outcome (-1.1) can be assigned to Guatemala. This difference means, for example, that enforcing contracts in 2008 took in the US about 300 days, in Costa Rica about 877 days, and in Guatemala 1459 days[52].

Figure 8.2: Rule of law



Note: The indicator "rule of law" measures the extent to which agents have confidence in and abide by the rules of society, in particular the quality of contract enforcement, the police, and the courts, as well as the likelihood of crime and violence. Indicators for 1998 and 2008 are reported. The range of the indicator is from -2.5 to 2.5, with higher values corresponding to better governance outcomes.
Source: Authors' representation, based Kaufmann, Kraay and Mastruzzi (2010).

52 Source: World Bank, AGI Data Portal, Doing Business (2010).

Credit constraints

Table 8.1: Access to financing

PANEL A: Share of financial constrained firms

	total	small	medium	large	exporter	non-exporter	T-sector	N-sector
Costa Rica	60.06	62.90	60.92	36.84	59.42	60.22	60.75	50.00
Dom. Rep.	51.56	46.15	56.90	53.13	50.00	51.63	na	na
El Salvador	24.24	30.88	24.80	11.04	21.60	25.05	27.41	17.70
Guatemala	18.97	26.22	14.74	11.21	12.82	20.74	22.56	12.89
Honduras	25.00	34.74	19.55	10.00	9.38	27.69	26.62	22.54
Mexico	18.51	20.24	16.96	16.55	18.92	18.47	20.07	12.85
Nicaragua	22.38	24.73	20.26	15.22	23.53	22.25	23.84	17.70
Panama	9.27	11.01	7.22	6.76	5.15	10.06	8.23	9.97

PANEL B: Total number of firms

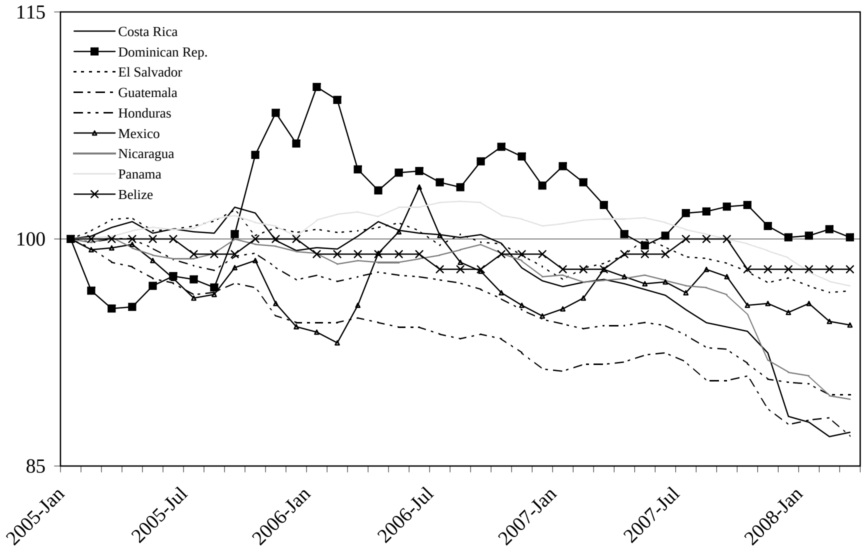
	total	small	medium	large	exporter	non-exporter	T-sector	N-sector
Costa Rica	343	124	87	38	69	274	321	22
Dom. Rep.	225	65	58	32	10	215	na	na
El Salvador	693	285	254	154	162	531	467	226
Guatemala	522	225	190	107	117	405	328	194
Honduras	436	213	133	90	64	372	263	173
Mexico	1480	736	448	296	148	1332	1161	319
Nicaragua	478	279	153	46	51	427	365	113
Panama	604	336	194	74	97	507	243	361

Note: The company-level data for El Salvador, Guatemala, Honduras, Mexico, Nicaragua, and Panama are from 2006 and are based on the same standardized questionnaire. Data for Costa Rica and Dominican Republic are from 2005. However, the questionnaires differ. Company-level data for Belize (and also for the US) do not exist.
In panel A the percentage of financial constrained firms and in panel B the absolute number of firms (i.e. the sum of all firms in this category whether constrained or not) are displayed. A firm is defined as financially constrained if *access to financing, which includes availability and cost,* is a *major* or a *very severe obstacle*. A firm is defined as small if the number of employees lies between 5 and 19; as medium if the number is between 20 and 99; and as large if there are more than 100 employees. A firm is defined as exporter if less than 85% of the establishment's revenues are from national sales. A firm is defined as T-sector-firm if the screener sector is manufacturing (i.e. foods, garments, textiles, machinery and equipment, chemicals, electronics, non-metallic minerals, other manufacturing); and as N-sector-firm if the sector is services (i.e. retail sale, IT, other services) or others (i.e. construction and transport) (for Costa Rica the definition differs: a firm is defined as T-sector-firm if the percentage of revenues from the manufacturing sector is bigger than the percentage of revenues from the sum of *comercio*, *servicios* and *otros*).
Source: Authors' calculations, based on World Bank (2010a).

The importance of credit constraints can be illustrated in a descriptive analysis of enterprise surveys conducted by the World Bank among Central American firms. Table 8.1 shows in panel A the percentage of subgroups of financial constrained firms and in panel B the total number of firms (both constrained and not constrained). As the number of firms is rather low, the interpretations have to be handled quite carefully. However, some general features can be concluded from the data: Small firms are typically more credit constrained than medium and large firms, whereby a small firm is defined as having between 5 and 19 employees. In most countries, non-exporting firms are more constrained than exporting firms, whereby a firm is defined as exporter if less than 85 percent of its revenues are from national sales.

A real appreciation

Figure 8.3: Real exchange rate vis-à-vis the US$



Note: Real exchange rates vis-à-vis the US$ are displayed for the period 2005 – 2008. Data for Belize is quarterly; for all other countries monthly data is used.
Source: Authors' representation, based on IDB (2010).

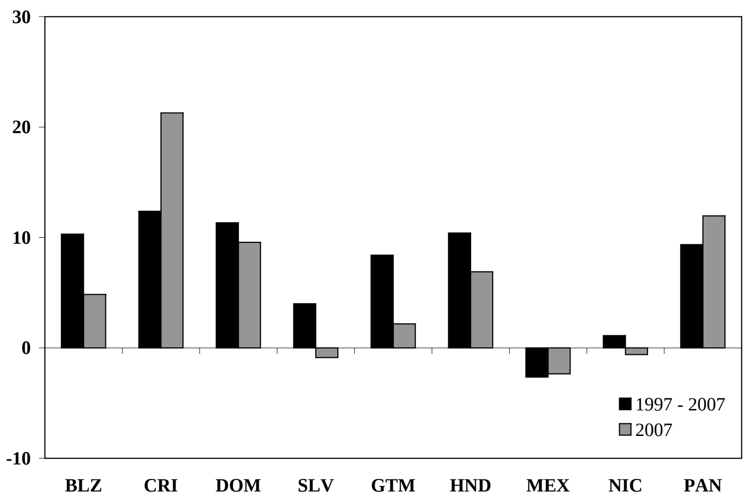
Another factor that strengthens the risk for a boom-bust-cycle is a real appreciation, as it raises the risk of a depreciation that would at the same time augment the credit burden in the Central American country. As can be observed in Figure

8.3 that displays the real exchange rates vis-à-vis the US$, a real appreciation has taken place in almost all countries (with the exception of Belize), especially since mid-2006. Thus, the fear of a reversal with a following real depreciation is justifiable.

Credit growth

The observed real appreciation is especially alarming, if the credit volume has increased significantly during the last years, as more agents would be exposed to a suddenly increasing credit burden. Figure 8.4 shows the average annual growth rates of real domestic credit between 1997 and 2007 as well as the growth rate of 2007.

Figure 8.4: (Average) annual credit growth



Note: (Average) annual growth rates of real domestic credit (in local currency) are displayed. Growth rates are expressed in percentages. For comparison: the average annual growth rate in the US between 1997 and 2007 has been 5.64%.
Source: Authors' calculations, based on World Bank (2010b).

Considering that the average annual growth rate of domestic credit has been about 5.6% in the US in the same sample, credit has grown at a considerable rate in many of the Central American countries. Particularly, in Costa Rica credit has grown enormously with an average rate of 12.4% per year. Also in Belize, the Dominican Republic and Honduras credit growth has been remarkable with an average of over 10% per year. However, there have been lending booms in all Central American countries (excepting Mexico and Nicaragua) during the sample period.[53] Especially Costa Rica, the Dominican Republic and Honduras have gone through sustained boom phases: Costa Rica had a lending boom from 2000 to 2003, and 2005 to 2007, the Dominican Republic from 1997 to 1999, in 2001, and from 2005 to 2006, and Honduras from 1999 to 2000, in 2002, and from 2004 to 2006.

Sectoral growth

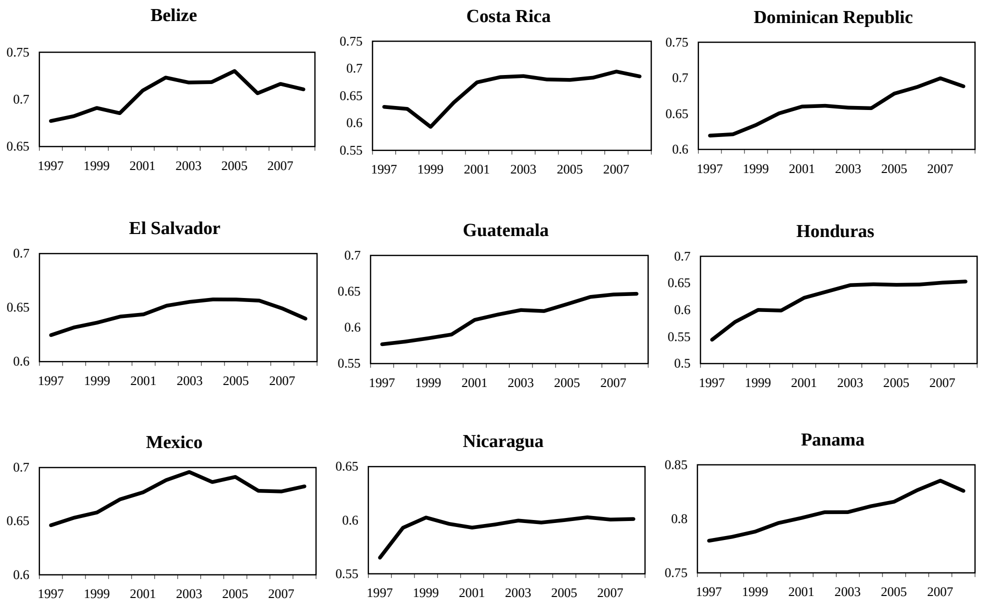
Middle income economies, experiencing boom-bust cycles, often display a very unequal development of the tradable and the non-tradable sector. Typically, the non-tradable sector grows at a higher level than the tradable sector. As can be observed in Figure 8.5 that displays the share of the non-tradable sector in total gross value added, this is especially true for Guatemala and Honduras. But also in Costa Rica and the Dominican Republic the share of the non-tradable sector has increased in the last years.

The role of the real exchange rate

We conclude this section by directly estimating the impact of real exchange rate movements on the business cycle. We implement a vector autoregressive (VAR) framework, to which Tornell and Westermann (2005) have given a structural interpretation in the context of a two-sector economy with contract enforceability

[53] A lending boom is defined for year t if the average annual growth rate of domestic credit of the years t and $t+1$ is more than 10%.

Figure 8.5: Shares of N-sector in total gross value added



Note: The displayed line represents the share of the non-tradable sector in total gross value added. Tradable and non-tradable sector sum up to 1. The tradable sector is defined by "Agriculture, hunting, forestry, fishing (ISIC A-B)" and "Mining, Manufacturing, Utilities (ISIC C-E)". The non-tradable sector comprises "Construction (ISIC F)", "Wholesale, retail trade, restaurants and hotels (ISIC G-H)", "Transport, storage and communication (ISIC I)" and "Other Activities (ISIC J-P)".
Source: Authors' calculations, based on UN (2010).

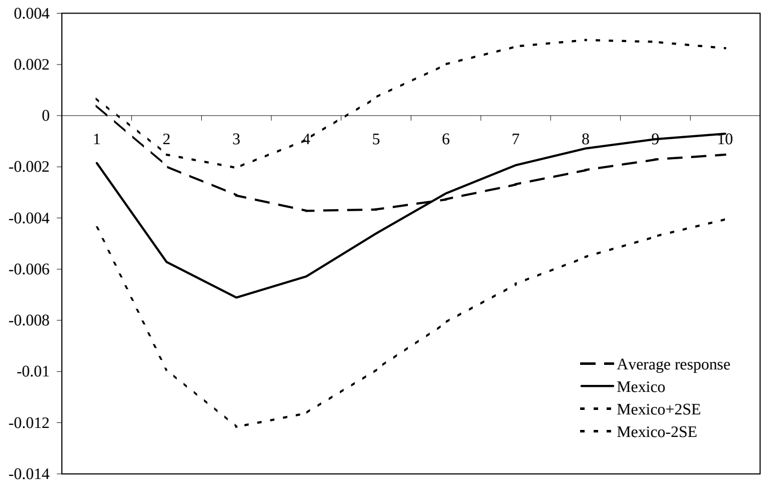
problems and bailout expectations. The bivariate VAR includes GDP and the real exchange rate. The estimation model is

$$\Delta Y_t = c + \sum_{i=1}^{p} A \Delta Y_{t-i} + \epsilon_t,$$

where the vector $Y_t = \begin{pmatrix} GDP_t \\ RER_t \end{pmatrix}$. Impulse response functions are computed by inverting this autoregressive model to the moving average representation.

Identification is achieved by the assumption that output in period t depends on the real exchange rate in period $t-1$. This assumption is plausible in a theoretical model, where investment — in period $t-1$ — is financed in foreign currency. It is

Figure 8.6: The role of the real exchange rate



Note: The bivariate VAR includes GDP and the real exchange rate. The reaction of GDP to a shock in the real exchange rate is displayed for Mexico (solid line). Moreover, the average response from the countries that have entered the previous common features analysis is reported (dashed line).
Source: Authors' calculations, based on IDB (2010).

therefore assumed that the real exchange rate does not have a contemporaneous effect on GDP, but GDP can effect the real exchange rate in the same period. Given this recursive system the standard Cholesky decomposition can be applied.

The impulse response functions from this VAR are displayed in Figure 8.6. The graph shows the reaction of Mexico, for which a much longer time series exists, as well as the average response from the countries that have entered the previous common features analysis.[54] We find that in both cases the reaction to a shock in the real exchange rate is clearly negative. About one to four quarters after an appreciation of the exchange rate, GDP will go up, and vice versa, a depreciation will trigger a decrease in GDP. This pattern is clearly at odd with conventional assumptions of the stabilizing role of the exchange rate in the Mundell model,

[54] Except Guatemala and Honduras, for which we did not have GDP data and used production indices in the common feature part.

but it can be rationalized in the alternative model that includes credit market imperfections typically present in middle income countries.

9 Related Literature

Over the last ten years, several researchers as well as policy makers have given a recommendation for official dollarization in Central America.[55] Berg et al. (2002); Temprano-Arroyo (2003); and Salvatore (2001) discuss the issue of dollarization in Latin America and conclude that the Central American countries might be good candidates for a fixed exchange rate with the United States. Alesina et al. (2002), who test in a large set of countries whether they should belong to a dollar-, a euro-, or a yen-area, assign the Central American countries clearly to the dollar-area.[56]

A recent study about the costs of macroeconomic coordination with the US for Central America was conducted in Fiess (2007). Using different filters to identify the cyclical component of GDP, he analyzes business cycle synchronization of Central America and the United States — measured by the contemporaneous correlations between the cycles — and calculates the degree of trade integration in the countries pertaining to the Dominican Republic-Central America Free Trade Agreement (DR-CAFTA) with annual GDP data from 1965 – 2005 and monthly

[55] However, there are also some voices demanding the opposite. Fernández-Arias, Yeyati and Morón (2006) for example, recommend de-dollarization for the Central American countries (a short overview of the topic of de-dollarization is given in section 11.D in the appendix). Edwards and Magendzo (2003) find that dollarized economies grow slower than non-dollarized ones and suspect that this may be caused by difficulties in accommodating external shocks. Also Schmitt-Grohe and Uribe (2001) are skeptical of a policy of dollarization. Focusing on Mexico and using a calibrated general equilibrium model, they conclude that dollarization is the least preferable option among different monetary policy regimes, from a welfare point of view.

[56] A general discussion of alternative long-run strategies for monetary policy for Latin America, including currency boards and dollarization, is proposed by Mishkin and Savastano (2001), whereas Levy Yeyati and Sturzenegger (2002) provide a broad analysis of the issue of dollarization, both from the empirical and theoretical side.

data on economic activity from 1995 – 2005. He finds that Costa Rica has the highest business cycle synchronization with the United States of the Central American countries, and that all of them have become more sensitive to developments of the American economy in recent years.[57]

The common cycle approach of Vahid and Engle (1993) that we propose as an alternative measure of comovement, has also been applied to (annual) output data in Central America in Roache (2008), although not in the context of dollarization. The author analyzes annual real GDP from 1950 to 2006 in a multivariate framework including both Central American countries and the United States. For the purpose of addressing the policy issue of dollarization, the bivariate framework, and the extension of Cubadda (2007), allows us to clearly attribute the common cycle (or the lack of it) to specific individual countries, such as Costa Rica and the US. The multivariate framework is, however, useful for addressing the issue of a potential monetary union among several countries. This has been done for instance by Cheung and Yuen (2005) in the context of a policy debate of a potential currency union in Northeast Asia. Using the approach of Vahid and Engle (1993), the authors find evidence that the three Asian economies have synchronous output movements at both long-run and short-term horizons, and thus, provide arguments in favor of a currency union.

The second part of this essay challenges the view that the OCA-Model of Mundell is the right framework to think about the issue of macroeconomic policy coordination in middle income countries. This line of argument is related to an earlier paper of Calvo (2001), who also argues — within a broader discussion of pros and cons — that the optimum currency area theory omits some important features of emerging economies, namely recent financial crises, combined with the existence of partial dollarization, imperfect credibility, weak financial systems

[57] Ahmed (2003) points out that external shocks only play a limited role for business cycle fluctuations. He concludes that fixed exchange rates in Latin America may not be as costly as theory predicts.

and contagion. Our analysis in the second part supports his argument that the consideration of these factors can make dollarization become more attractive.[58]

Our analysis also complements and extends the findings of Gourinchas, Valdes and Landerretche (2001), who study lending boom episodes and show that in Latin America particularly, they make the economy considerably more vulnerable to financial crises. A case study on the asymmetries of the tradable and non-tradable sectors in Mexico between 1995 and 1998, i.e. the time of the recovery from the Mexican crisis, was first given in Krueger and Tornell (1999). Gelos and Werner (2002) analyze a firm-level data set on Mexican manufacturing establishments and show that especially the smallest firms are financially constrained. A model that takes account of these credit market imperfections in the context of exchange rate regime choice has been developed by Lahiri, Singh and Végh (2007).[59]

In our essay, we focus on stabilization policy. This focus seems appropriate in light of the increasing evidence on the welfare cost of macroeconomic volatility in developing countries (see for instance Loayza, Rancière, Servén et al., 2007). But certainly, there are also several other pros and cons.[60] An overview of the broader debate is given for example in Salvatore, Dean and Willet (2003), especially in the chapters by Feige, Faulend, Šonje et al. (2003); Berg and Borensztein (2003); Corbo (2003); Edwards (2003); Eichengreen (2003); Schuler (2003); and Cohen (2003). Among the pro-arguments is that a reduction of volatility in real exchange rates helps both foreign trade and foreign investment to increase.[61] On the other side, the loss of monetary policy — that we discussed in the context of stabilization

58 Also, Edwards (2009) considers the degree of partial dollarization as one of the sources of macroeconomic vulnerability and financial crises.

59 For a theoretical model of a small open economy and the costs of dollarization see Schmitt-Grohe and Uribe (2001).

60 Section 11.A in the appendix provides a short discussion of the pros and cons of dollarization.

61 Freund and Spatafora (2008) show that reductions in transaction costs (e.g. by reducing the exchange rate volatility) increase remittance flows. Thus, one hypothesis to test would be that dollarization leads to an increase in remittances and thus to a stabilization of the domestic economy.

policy — also implies that seigniorage and the scope for acting as lender-of-last-resort are no longer possible. The second contra-argument is that in the presence of nominal rigidities, it is hard to carry out a real depreciation, i.e. in the absence of devaluation possibilities, external shocks result in greater costs than in non-dollarized countries.

Berg and Borensztein (2003) argue that the more unofficially dollarized the economy already is, the smaller are the costs of official dollarization. Eichengreen (2003) points out that the benefits depend on whether dollarization helps to speed the pace of financial, labor, and fiscal reforms. Moreover, also the number of countries that participate in the dollar area is crucial (Mundell, 2003), i.e. dollarization would be much more favorable for every single Central American country if all countries in the region decided to adopt the dollar as legal tender. A discussion of key aspects of the implementation of official dollarization is given in Jácome and Lönnberg (2010).

10 Conclusions

In this essay, we have focused on two model frameworks — Mundell (1961) and Schneider and Tornell (2004) — that can be used to address the issue of dollarization, and their opposing views about the role of the real exchange rate. The two models guide our empirical analysis of eight Central American economies.

The first contribution of this essay is a methodological point on the assessment of optimum currency areas in the Mundell framework. We emphasize that in addition to the correlation of shocks the reaction of each country to a shock is of high relevance for a common monetary policy. Even if the growth rates of GDP are highly correlated, the reaction to a shock — that can be interpreted as the business cycle — may differ significantly across countries. We apply the test for common serial correlation to a data set from Central America, where the topic of dollarization is an important part of the discussion on stabilization policy. We can not confirm the existence of a common business cycle between the GDP growth rates of Central America and the United States. Thus, in the optimum currency area framework of Mundell (1961) dollarization would be associated with the loss of an important stabilization instrument — the flexible exchange rate.

Our second point is that this framework may not be adequate for the emerging middle income countries in Central America as it does not take account of the existence of credit market imperfections. Analyzing the dollarization question in the boom-bust cycle framework of Schneider and Tornell (2004), where enforceability problems and bailout expectations play a major role, we challenge one of the standard arguments against official dollarization: Even a freely floating exchange rate cannot protect the economies from pronounced cyclical fluctuations (in either direction) that will arise from a mismatch between foreign currency denominated debt and domestic currency revenues.

Which one of the two models is appropriate for a particular country depends critically on the role of the real exchange rate. The impulse response functions, generated from a vector-autoregressive (VAR) model, indicate that an unexpected change in real exchange rate leads to a pro-cyclical response of output, i.e. an appreciation leads to an increase and a depreciation to a decrease in gross domestic product. This unconventional relationship — that is typical for many middle income countries — suggests that a model with contract enforceability problems and bailout expectations, rather than the typical OCA model, provides an appropriate conceptual framework for the countries studied in this essay.

11 Appendix

In the following sections additional background information and robustness checks are provided. The appendix is structured as follows: section 11.A introduces the concept of optimum currency area (OCA) and discusses the pros and cons of dollarization; section 11.B provides a more detailed analysis of business cycles in Costa Rica, the country where the debate on official dollarization is the most topical, and the United States; section 11.C extends the investigation of the main part of this essay to the Caribbean region using the case of Jamaica as an example. Finally, section 11.D gives a short overview of the topic of de-dollarization which is relevant especially for the South American countries and cannot be omitted completely in a debate on official dollarization.

11.A Pros and Cons of Dollarization

This essay has discussed some important aspects of the debate on official dollarization. In order to facilitate the subsumption of the analysis in the broader context, the following section presents shortly the origin of the OCA literature and lists further pros and cons of official dollarization.

Optimum currency area

In the literature the dollarization question is mostly analyzed in the optimum currency area (OCA) framework that is referred to as going back to Mundell

(1961). However, the roots of the OCA framework are much more diverse. Besides Mundell (1961), also McKinnon (1963) and Kenen (1969) have been major contributors to this theory, and there have been many others.[62] The known OCA criteria of the basic theory thus have various authors: Mundell (1961) introduced the labor mobility respectively the wage and price flexibility argument, as well as the discussion about the symmetry of shocks. The openness and trade integration criteria, and the argument of the size of an economy are based on the work of McKinnon (1963). Kenen (1969), finally, is responsible for the following three aspects: similarity of the economic structures, degree of product diversification, and level of fiscal integration.

According to the optimum currency area framework, the introduction of a common currency — or in this case official dollarization — is favorable, if the above mentioned criteria are fulfilled. If they are not met, the costs of the loss of a sovereign monetary policy outweigh the advantages.

In this essay we have, however, not analyzed the above mentioned criteria for an optimum currency area between individual Central American countries and the US. We have rather proposed a new criterion that we consider important, and a method to test it: the synchronization in the absorption of a shock, i.e. not the synchronization of the shock itself, but of the way the economies react to the same shock.

Further pros and cons of dollarization

As mentioned before, we have focused only on some special aspects of the dollarization debate. Evaluating the question of dollarization extensively is not easy as there are numerous pros and cons. A good overview is given in Salvatore et al. (2003), especially in the chapters by Feige et al. (2003); Berg and Borensztein

[62] For the development of the OCA literature, the controversy of the before mentioned contributions, and a discussion of recent contributions see Dellas and Tavlas (2009).

Table 11.1: Pros and cons of dollarization

Pro	Contra
Reduction of volatility in real exchange rate: → More stability → Assured stability of prices in dollar terms → Lower variability in relative prices of tradable goods (vis-à-vis the US) → Expansion of foreign trade → Expansion of foreign investment → More economic and financial integration with the US → Accelerates the convergence to income level of the US	Loss of monetary sovereignty: → Loss of seigniorage → Loss of autonomous monetary and exchange rate policy → Loss of monetary policy as stabilization tool → Reduced scope for lender-of-last-resort benefits → Loss of an "exit option"
Eliminates or at least reduces currency and default premiums on interest rates: → Reduction of country risk premiums → Lower interest rates → More investment and growth	In the presence of nominal rigidities, real depreciations are difficult to make: → External shocks result in greater costs than in non-dollarized countries
Eliminates currency transaction costs	Facilitates an overexpansion of foreign indebtedness
Provides a clear commitment: → No inflationary finance → Lower inflation → More transparency → Strengthened institutions → Credibility gain → More confidence by international investors	Political costs: → National identity and sovereignty (e.g. currency = national symbol)
Elimination of currency mismatch: → Prevents banking crises → Avoids currency and balance of payment crises	Very limited empirical knowledge about the costs and benefits of dollarization

Source: The arguments are based on the contributions in Salvatore et al. (2003).

(2003); Corbo (2003); Edwards (2003); Eichengreen (2003); Schuler (2003); Cohen (2003). Mainly, there can be contrasted five arguments in favor of dollarization and five in contra (see Table 11.1).

The first advantage of dollarization is that it leads to a reduction of volatility in real exchange rates, which results in more stability, especially in stable prices in dollar terms and relative prices of tradable goods. This again favors the expansion of international linkages, both in foreign trade and foreign investment, i.e. the dollarized economy will be economically and financially more integrated with the

US. And finally, deeper integration with one of the leading world economies favors the convergence process to a higher income level.

The second advantage of official dollarization is that currency and default premiums on interest rates are significantly reduced or even eliminated in the former case. Also, the country risk premium will most probably be reduced substantially, which in total signifies a lowering of interest rates, i.e. it favors the investment and growth climate in the country.

Third, currency transaction costs are eliminated — at least for all transactions in dollar terms.

Politically, and this is the fourth argument in favor, dollarization provides a clear commitment: Inflationary finance is no longer possible for the local government. This implies that the economy will have a lower inflation rate, more transparency, and strengthened institutions. Overall, the credibility gain should lead to more confidence from the side of international investors.

Finally, the fifth argument in favor is that dollarization eliminates the risk of currency mismatch and by this, helps to prevent banking as well as currency and balance of payment crises.[63]

On the other side, there are a number of arguments in contra: The first disadvantage of dollarization is that the dollarized economy loses its monetary sovereignty, which implies that seigniorage and the scope for acting as lender-of-last-resort are no longer possible. Besides, the country does not dispose any longer of an autonomous monetary and exchange rate policy, i.e. it loses an important stabilization tool. Last, but not least, the dollarized economy does not have an "exit option".

The second argument against dollarization is that in the presence of nominal rigidities it is hard to carry out a real depreciation, i.e. in the absence of deval-

[63] Câmara Neto and Vernengo (2006), however, point out that dollarization may also increase dependency from foreign capital flows and balance of payments problems, and thus increase the financial fragility.

uation possibilities, external shocks result in greater costs than in non-dollarized countries.

Third, dollarization may facilitate an overexpansion of foreign indebtedness, as it is easier to obtain credit from foreign creditors.

The fourth argument against dollarization, are its political costs: dollarizing an economy implies the loss of national identity and sovereignty as the own currency is an important national symbol.[64]

Finally, the fifth argument in contra is that so far only very limited empirical evidence exists on the costs and benefits of dollarization, as most of the countries are either very small, often city-states, or have dollarized only relatively recently, e.g. Ecuador or El Salvador. In addition, many of the above mentioned aspects are hard to quantify. Thus, a country that decides to dollarize its economy buys to some extend a pig in a poke.

Besides these clear statements in favor or against dollarization, there are some arguments that relativize the discussion. Corbo (2003) points out that dollarization is especially advantageous for countries with a poor record of financial stability and that are already relatively closely integrated with the US. Berg and Borensztein (2003) underline this argument by stating that the more unofficially dollarized the economy already is, the smaller are the costs of official dollarization.

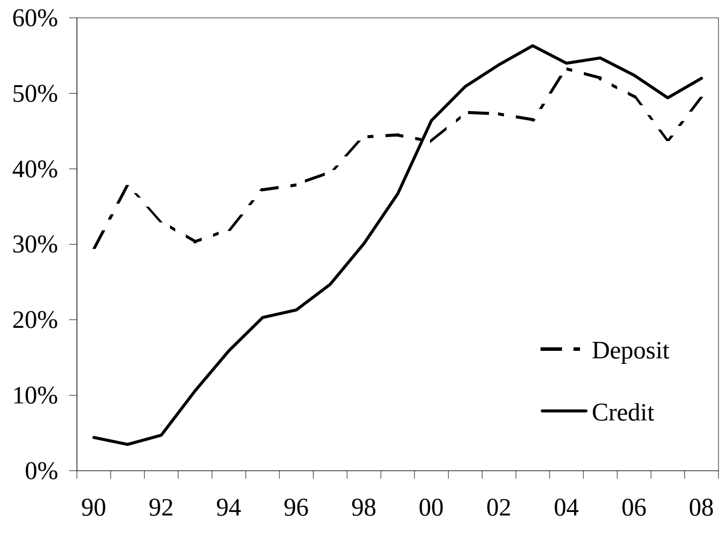
However, formation of a final opinion remains a difficult task, as the evaluation depends on whether dollarization helps to speed the pace of financial, labor, and fiscal reforms (Eichengreen, 2003), and also, on the number of countries that participate in the dollar area (Mundell, 2003), e.g. dollarization would be much more favorable for every single Central American country if all countries in the region decided to adopt the dollar as legal tender.

[64] Some dollarized economies use national coins in order to preserve at least partly this important national symbol, but also because the US coins are difficult to understand for non English speaking people (Jácome and Lönnberg, 2010).

11.B Dollarization in Costa Rica

The main part of this essay has analyzed the case of dollarization for eight highly dollarized Central American countries, among them the Costa Rican economy. As Costa Rica is the country in Central America where the discussion about an introduction of a common currency with the United States is the most topical, we will have a second look at this special case. As shown in Figure 11.1 both, deposit and credit dollarization have increased to shares of about 50% since the 2000s in Costa Rica, and, the topic of dollarization has been — and still is — an important part of the discussion on stabilization policy. Therefore, we will provide further robustness checks for the test for common cycles among Costa Rica and the United States.[65] Concretely, we will conduct the analysis with stronger assumptions: in

Figure 11.1: Unofficial dollarization in Costa Rica



Note: The degree of deposit and credit dollarization (in % end of period) in Costa Rica are displayed.
Source: Authors' calculations, based on IDB (2010).

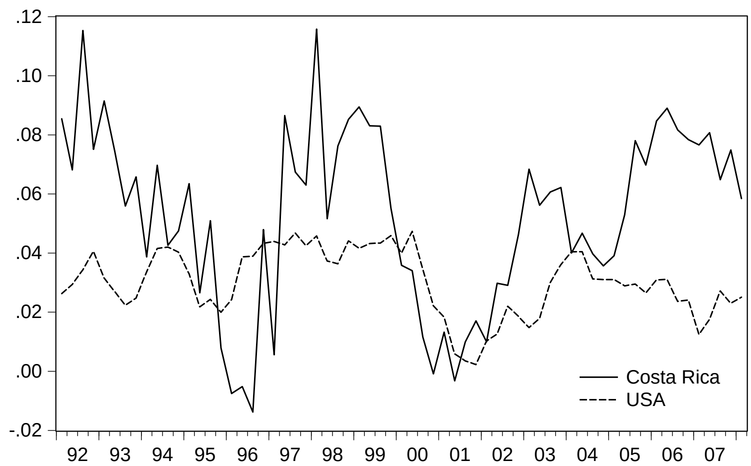
65 The methodology is basically the same as in the main part of the essay. Thus, in the following, we will only point out differences and present the results.

order to apply the test for serial correlation common features,[66] the growth rates of GDP of both economies have to follow the same AR(p)-process.[67]

Data

The time series for Costa Rica, quarterly GDP from 1991:1 to 2008:1 in constant prices, seasonally adjusted and in millions of domestic currency, was obtained from the *Latin American and Caribbean Macro Watch* of the *Inter-American Development Bank* (IDB, 2010). Equivalent data for the United States were retrieved from the *International Financial Statistics* Database of the *International Monetary Fund* (IMF, 2010). The growth rates of GDP are displayed in Figure 11.2.

Figure 11.2: GDP growth rates of Costa Rica and the USA



Note: GDP growth rates of Costa Rica and the United States are displayed.
Source: Authors' calculations, based on IDB (2010); and IMF (2010).

In Costa Rica two stagnation periods stand out: the first in the mid- to late 1990s, a period in which many countries in Latin America experienced financial crises[68], and the second the world wide slowdown in the beginning of the 21st

[66] The test for codependence will not be applied in this specification as the relevant series follow an AR(1)-process.
[67] This assumption has been relaxed in the main part of this essay as the assumption is so strong that the test can be applied only in rare cases in its strict form.
[68] Laeven and Valencia (2008) date a systemic banking crisis to 1994 in Costa Rica.

century. The latter period has also been a time of slow growth in the United States. Over the sample period, it appears that the volatility of output has declined in Costa Rica. The relatively high volatility at the beginning of the sample, however, is not due to remaining seasonal components of the data as the peaks occur very irregularly. Possibly the decline in volatility in the mid-1990s can be ascribed to the change in the Central Bank's policy: Until the end of 1995 inflation was only a secondary objective, though from 1996 onwards the main objectives for monetary policy have been price and exchange rate stability.

Business cycle synchronization

Table 11.2 shows the identified AR(p)-structures of the US and the Costa Rican GDP for 10 different sub-samples. Each sample starts at the indicated date and ends in 2008:1. The US GDP is always optimally specified as an AR(1)-process, in all samples. The Costa Rican GDP, however, is characterized by different AR(p)-processes depending on the chosen sub-sample. In the two largest sub-samples, starting in the early 1990s, the data is best described by an AR(4)-process; in the following two sub-samples, starting 1994 and 1995, as AR(3); then, in the sub-samples starting 1996 to 1998 as AR(2); and finally, from 1999 onwards, the data follow an AR(1)-process. This finding can be interpreted as a first indication that the Costa Rican cycle has become more similar to the US cycle in recent years.[69] In addition, this implicates that synchronized common serial correlation patterns (that we interpret as common business cycles) can — potentially — only be found in the last three sub-samples (1999 onwards). In the following, we will test this hypothesis more formally.

[69] Note that the convergence of the Costa Rican GDP data towards an AR(1)-representation is not trivially caused by the simple reduction of the number of observations as the sub-samples become smaller. Conducting the same analysis with rolling windows of each 33 observations, i.e. the first sub-sample is 1992:1 – 2000:1, the second 1993:1 – 2001:1, and so on, yields similar results: only the first two sub-samples are described by different AR(p)-processes (AR(3)); for the remaining sub-samples we get the same results.

Table 11.2: AR(p) representations for Costa Rica and the USA

	AR(p) - Process Q-Statistics (5 respectively 10 lags)									
	1992:1	1993:1	1994:1	1995:1	1996:1	1997:1	1998:1	1999:1	2000:1	2001:1
Costa Rica										
optimal lag length	4	4	3	3	2	2	2	1	1	1
Q(5)	1.072	1.086	5.266	3.932	8.395	8.871	5.666	3.317	3.123	2.201
Q(10)	4.986	5.755	10.920	8.580	13.171	13.996	9.260	11.101	8.527	7.192
USA										
optimal lag length	1	1	1	1	1	1	1	1	1	1
Q(5)	4.272	4.307	3.783	4.029	3.932	3.204	3.563	2.263	1.395	3.645
Q(10)	5.956	5.795	8.133	8.542	7.701	7.710	8.433	6.095	3.702	6.812

Note: AR representations of the process of the time series of national GDP data are reported for different sub-samples, which differ in their starting point. Each sample ends in 2008:1. Under the restriction that the residual is free of autocorrelation, the specification with the smallest number of AR terms is selected. Q-Statistics of 5 and 10 lags are reported beneath.
Source: Authors' calculations, based on IDB (2010); and IMF (2010).

Stationarity

The results of the ADF test are displayed in Table 11.3. In the first sub-sample, 1999:1 – 2008:1, both series are non-stationary in growth rates.[70] Thus, even if they follow both AR(1)-processes, it is not possible to formally test for common cycles, as the test for common serial correlation requires stationarity. However, in the other two sub-samples, starting 2000 and 2001, the US and the Costa Rican GDP are stationary in growth rates and it is possible to test for common cycles in theses two sub-samples.

Common stochastic trend

The results of the Johansen cointegration test are shown in Table 11.4. We find that, except for the 1998 sub-sample, the US and the Costa Rican GDP are

[70] Using the SIC criterion does not yield I(1) series either.

Table 11.3: Results of ADF-test for Costa Rica and the USA

ADF-Test - t-Statistic

	1999:1		2000:1		2001:1	
	level	1st diff.	level	1st diff.	level	1st diff.
Costa Rica	1.794	-2.789	2.649	-3.174 **	1.709	-2.947 **
USA	-0.769	-1.926	0.420	-3.244 **	0.551	-3.209 **

Note: ADF-test statistics are reported for three different sub-samples, all ending in 2008:1. For both, GDP data of Costa Rica and the United States, the ADF-test was conducted in level and in logarithmized growth rates. The lag length was selected by the AIC criterion. Critical values of Cheung and Lai (1995) were applied. ** indicate rejection of the existence of both, stochastic and deterministic trends with a significance of 5%.
Source: Authors' calculations, based on IDB (2010); and IMF (2010).

Table 11.4: Results of Johansen cointegration test for GDP of Costa Rica and the USA

Johansen Test (Maximum Eigenvalue Statistic) - Costa Rica and USA

	1992:1	1993:1	1994:1	1995:1	1996:1	1997:1	1998:1	1999:1	2000:1	2001:1
r=0	13.637	11.376	11.776	10.627	27.849 ***	25.604 ***	15.716	52.122 ***	49.100 ***	49.408 ***
r=1	3.429	3.673	6.020	5.212	8.917	5.257	4.307	7.195	5.973	2.346

Note: Results of testing for cointegration between the GDP of Costa Rica and the United States are shown for different sub-samples. All samples end in 2008:1. The Table contains the maximum eigenvalue statistics for r=0 and r=1. The critical values of Osterwald-Lenum (1992) were scaled with the scaling factor of Cheung and Lai (1993) to adjust for finite samples. *** indicates the rejection of the null hypothesis with a significance of 1%.
Source: Authors' calculations, based on IDB (2010); and IMF (2010).

cointegrated in all sub-samples from 1996 onwards. Again, this result supports the view that a process of convergence has taken place. In all recent sub-samples, GDP series of both countries share a common stochastic trend. Thus, in the subsequent analysis of common cycles, an error-correction term will be included in the test for common cycles in both sub-samples (starting 2000 and 2001).

Table 11.5: Results of serial correlation common feature tests for Costa Rica and the USA

Serial Correlation Common Feature Tests - Costa Rica and USA

	2000:1		2001:1	
	test statistic	vector	test statistic	vector
TSLS	32.697 ***	0.906 [i]	12.626 ***	1.522
GMM	19.772 ***	-0.785	5.451 **	-2.612 [i]

Note: Results of the TSLS and GMM estimation of serial correlation common features between the GDP growth rates of Costa Rica and the United States are reported for the sample 2000:1 – 2008:1 and 2001:1 – 2008:1. In the columns *test statistic* F-statistics are reported for the TSLS and χ^2-statistics for the GMM approach. The columns titled *vector* report the coefficient β of the common feature vector. ***, ** indicates the rejection of the null hypothesis with a significance of 1%, 5%; i indicates that the coefficient β of the common feature vector is insignificant.
Source: Authors' calculations, based on IDB (2010); and IMF (2010).

Common cycle

We can now analyze whether the US and the Costa Rican GDP share a common serial correlation pattern in the two sub-samples 2000 – 2008 and 2001 – 2008.

Results of the serial correlation common feature test (with TSLS estimation) are displayed in the first row of Table 11.5. Our results clearly indicate that the null hypothesis of a common cycle is rejected at all conventional levels.

Cubadda (1999, 2007) argues that an optimal general method of moments (GMM) estimation is more appropriate than a TSLS estimation for testing for common cycles, due to its relative efficiency. As Table 11.5 shows, our results remain unchanged, when using the optimal GMM test proposed by Cubadda (1999, 2007).

Additionally, as a robustness check, we disregard the question of stationarity and the requirement of common lag structures and conduct the same serial correlation common feature test for all sub-samples including from one to four

Table 11.6: Comprehensive serial correlation common feature tests (TSLS) for Costa Rica and the USA

Serial Correlation Common Feature Tests (TSLS) - Costa Rica and USA

	1992:1		1993:1		1994:1		1995:1	
lags	F-statistic	vector	F-statistic	vector	F-statistic	vector	F-statistic	vector
1	14.850 ***	0.829	15.519 ***	0.711 [i]	14.620 ***	0.725 [i]	14.733 ***	0.766 [i]
2	13.558 ***	0.822	10.273 ***	0.713	9.912 ***	0.745	9.858 ***	0.829
3	8.165 ***	0.742	7.016 ***	0.716	7.020 ***	0.775	6.887 ***	0.758
4	13.025 ***	0.932	12.167 ***	0.913	11.894 ***	0.953	11.470 ***	0.850

	1996:1		1997:1		1998:1		1999:1	
lags	F-statistic	vector	F-statistic	vector	F-statistic	vector	F-statistic	vector
1	14.040 ***	0.685 [i]	9.267 ***	1.072	22.782 ***	0.998	33.647 ***	0.919
2	8.507 ***	0.768	9.422 ***	1.143	13.078 ***	1.133	15.962 ***	0.821 [i]
3	4.601 ***	0.884	5.675 ***	1.164	9.391 ***	1.039	12.215 ***	0.677 [i]
4	8.122 ***	1.033	8.153 ***	1.261	9.478 ***	1.044	12.593 ***	0.795 [i]

	2000:1		2001:1	
lags	F-statistic	vector	F-statistic	vector
1	32.697 ***	0.906 [i]	12.626 ***	1.522
2	12.208 ***	1.210	5.955 ***	1.198
3	6.347 ***	1.466	4.087 ***	0.835 [i]
4	4.789 ***	1.474	5.187 ***	0.409 [i]

Note: Results of the TSLS estimation of the serial correlation common features between the GDP cycles of Costa Rica and the United States are reported for all samples, including from 1 to 4 lags in the regression equations. In the first columns F-statistics are reported. The columns titled *vector* report the coefficient β of the common feature vector. *** indicates the rejection of the null hypothesis with a significance of 1%; i implies that the coefficient β of the common feature vector is insignificant.
Source: Authors' calculations, based on IDB (2010); and IMF (2010).

lags in the estimation equations. Results are reported in Table 11.6 and confirm our previous finding that the series under consideration do not share a common AR(p)-structure.

Summary

To summarize, using this strict form of the test, we find some evidence for a convergence process in the last years, with respect to a common autoregressive structure and a common stochastic trend, but we still can not confirm the existence of a common business cycle between the GDP growth rates of Costa Rica and the United States.

11.C Dollarization in the Caribbean

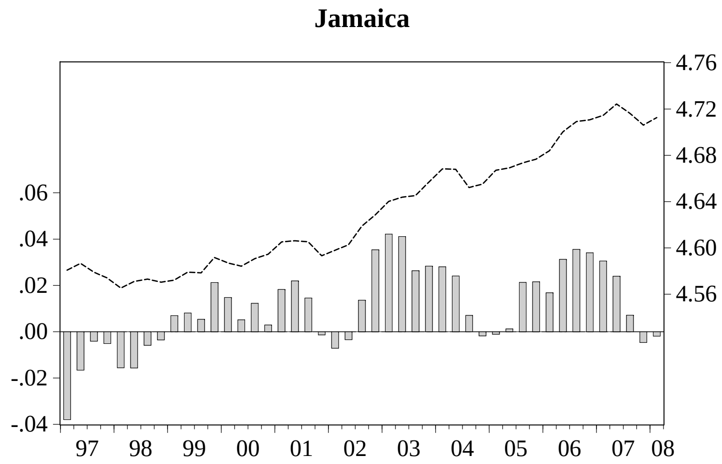
In the main part of the essay we have analyzed the Central American countries Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, and Panama. As member of the *Dominican Republic-Central America Free Trade Agreement* (DR-CAFTA) the Dominican Republic has also been included, although it is a Caribbean and not a Central American country. In this section, we will give a second glance at the Caribbean region as they pertain to the countries that are, in the literature, often referred to as being ideal candidates for dollarization.

Mundell-framework

Unfortunately, data availability for the Caribbean economies is rather bad, and we can only conduct the same detailed analysis as in the main part of the essay with one more Caribbean country, namely Jamaica. However, we assume that the results of the Dominican Republic (in the main part of the essay) and those of Jamaica should be quite representative for the remaining countries of the region.

For the analysis in the Mundell-framework, we use GDP real indices for Jamaica and the United States that were retrieved from the *International Financial Statistics* Database of the *International Monetary Fund* (IMF, 2010). The data for Jamaica have been seasonally adjusted with the Census X12 method, for the

Figure 11.3: GDP level and growth rate of Jamaica

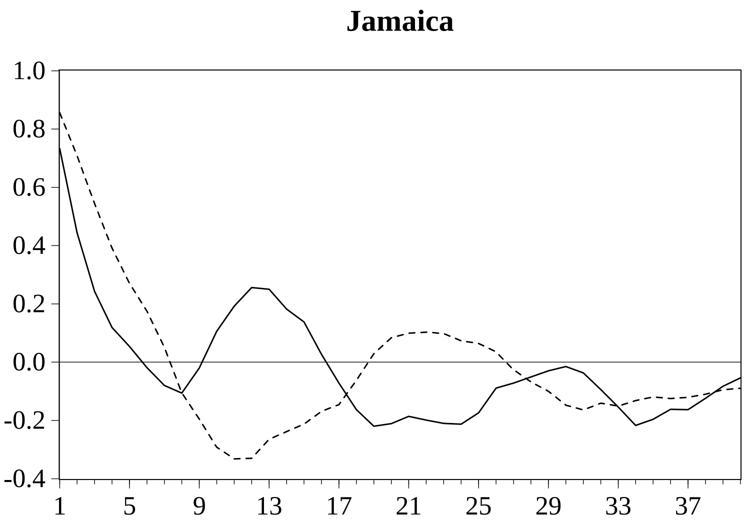


Note: GDP level and growth rate of Jamaica are displayed in quarterly data from 1997:1 to 2008:1. The growth rates are displayed on the left axis (bar charts), the levels on the right axis (dashed lines).
Source: Authors' representation, based on IMF (2010).

United States seasonally adjusted series are already included in the database. As in the main part of the essay, both series are re-based to 2001:1 and logarithmized growth rates are constructed. The sample includes quarterly data from 1997:1 to 2008:1 (excluding the volatile years of the recent economic and financial crisis). As can be seen in Figure 11.3, the GDP growth rates of Jamaica are very volatile. Caprio and Klingebiel (2003) date a systemic banking crisis to the years 1995 – 2000 and Laeven and Valencia (2008) to the year 1996. As in many other of the countries in the Central American and Caribbean region, Jamaica had slightly negative growth rates in 2001. But also in the years 2004/05 and 2007 growth rates were negative. The result of this volatility is a mean growth rate over the sample of only 0.011, with a maximum of 0.042 and a minimum of -0.038.

Interestingly, Jamaica has — opposed to most of the Central American countries — a negative contemporaneous correlation of -0.367 with the GDP growth rate of the United States. This negative correlation is illustrated in Figure 11.4 where the

Figure 11.4: Autocorrelation functions of GDP growth rates of Jamaica and the USA



Note: The autocorrelation functions of the logarithmized growth rates of the GDP of Jamaica (solid line) and the United States (dashed line) are displayed in the sample 1997:1 – 2008:1.
Source: Authors' calculations, based on IMF (2010).

autocorrelation functions of GDP growth rates of Jamaica and the United States are displayed.

Results of the ADF-test (conducted with a trend) indicate that the GDP data of Jamaica are stationary in first differences[71] and the Johansen cointegration test does not find a cointegration relationship between Jamaica and the United States.[72] Thus, the serial correlation common feature and codependence tests can be conducted without an error correction term.

Table 11.7 reports the results of the serial correlation common feature test and codependence test of the GDP growth rates of Jamaica and the United States.[73]

71 The ADF-test has been conducted in levels and in first differences. The lag length was selected by the SIC criterion, and critical values of Cheung and Lai (1995) were applied. In levels the test statistic is -2.74 and the critical value -3.52; in first differences the test statistics has a value of -5.43 and the critical value is -2.95.

72 For the cointegration test the maximum eigenvalue statistics for r=0 and r=1 have been used (the values are 13.79 and 7.41 respectively); the critical values of Osterwald-Lenum (1992) were scaled with the scaling factor of Cheung and Lai (1993) to adjust for finite samples (the calculated critical values are 17.20 and 10.14 respectively).

73 The methodology is explained in the main part of the essay.

Table 11.7: Results of serial correlation common feature and codependence tests of Jamaica and the USA

PANEL A: TSLS

			1997:1 - 2008:1			
				Codependence of order		
	p		CF	1	2	3
Jamaica	2	test-statistic	1.77	3.07 *		
		vector	-0.43 ***	-0.43 ***		

PANEL B: GMM

			1997:1 - 2008:1			
				Codependence of order		
	p		CF	1	2	3
Jamaica	2	test-statistic	30.28 ***	12.04 ***		
		vector	0.13	-0.01		

Note: Results of the TSLS estimation (panel A) and GMM estimation (panel B) of serial correlation common features and codependence between the GDP growth rates of Jamaica and the United States are reported for the sample 1997:1 – 2008:1. In the rows *test statistic* F-statistics are reported in panel A and χ^2-statistics are reported for the GMM approach (panel B). The rows titled *vector* report the coefficient β of the common feature vector. ***, * indicate the rejection of the null hypothesis with a significance of 1%, 10%.
Source: Authors' calculations, based on IMF (2010).

Surprisingly, the serial correlation common feature test does find a common feature for Jamaica and the United States. This result, however, cannot be confirmed in the test specification with the GMM estimator. Thus, we do not consider the serial correlation common feature as a robust result.

Schneider/Tornell-framework

The results of testing for a common business cycle in the Mundell-framework between Jamaica and the United States have been very similar to those for the remaining Central American countries. Also when applying the conceptual framework of Schneider and Tornell (2004) to Jamaica we will find that the situation in Jamaica is comparable to those in the remaining economies of this region.

Table 11.8: Access to financing of Jamaica

PANEL A: Share of financial constrained firms

	total	small	medium	large	exporter	non-exporter	T-sector	N-sector
Jamaica	69.15	65.63	76.32	69.23	73.33	68.35	na	na

PANEL B: Total number of firms

	total	small	medium	large	exporter	non-exporter	T-sector	N-sector
Jamaica	94	32	38	13	15	79	na	na

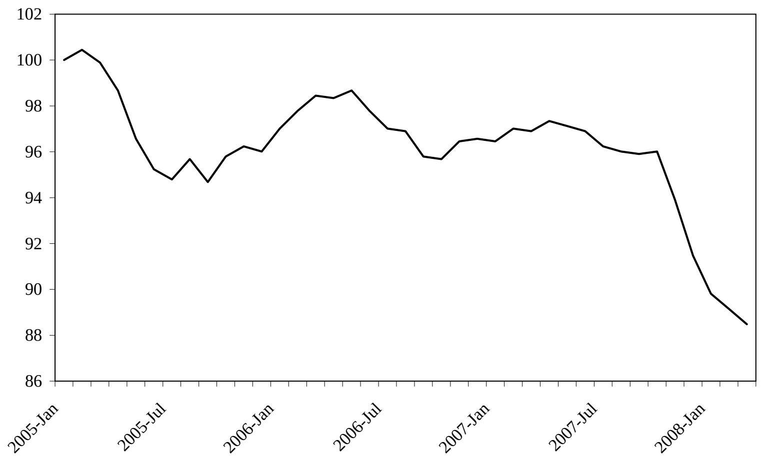
Note: The company-level data for Jamaica are from 2005. In panel A the percentage of financial constrained firms and in panel B the absolute number of firms (i.e. the sum of all firms in this category whether constrained or not) are displayed. A firm is defined as financially constrained if *access to financing, which includes availability and cost,* is a *major* or a *very severe obstacle.* A firm is defined as small if the number of employees lies between 5 and 19; as medium if the number is between 20 and 99; and as large if there are more than 100 employees. A firm is defined as exporter if less than 85% of the establishment's revenues are from national sales.
Source: Authors' calculations, based on World Bank (2010a).

In 2007, 42.9 percent of the Jamaican liabilities have been denominated in foreign currency,[74] thus the degree of currency mismatch has a similar dimension as in Honduras (see Figure 8.1). Also, the indicator "rule of law" that measures among other things the quality of contract enforcement and ranges between 2.5 (best) and -2.5 (worst), has similar values as in the other Central American countries (see Figure 8.2), namely -0.28, -0.46, and -0.49 in 1998, 2008, and 2009.[75]

Table 11.8 shows that the issue of credit constraints is a quite important problem in Jamaica as nearly 70% of the Jamaican firms categorize themselves as financially constrained. These obstacles are especially important for medium size firms and exporters.[76]

[74] Based on Caprio et al. (2008), Bank Regulation and Supervision Database, World Bank.
[75] Based on World Bank, Kaufmann, Kraay and Mastruzzi (2010).
[76] The information to classify the Jamaican firms according to the sector of activity is not available in the questionnaire.

Figure 11.5: Real exchange rate vis-à-vis the US$



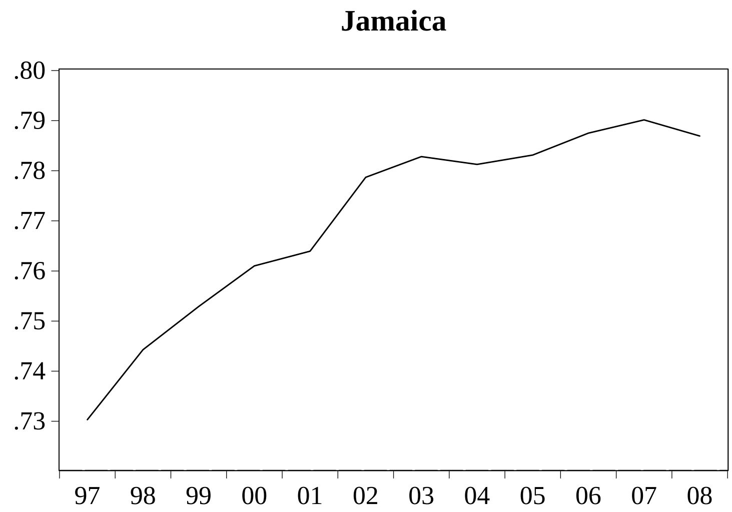
Note: Real exchange rate vis-à-vis the US$ for the period 2005 – 2008.
Source: Authors' representation, based on IDB (2010).

As can be observed in Figure 11.5, that displays the real exchange rate vis-à-vis the US$, also in Jamaica a real appreciation has taken place in recent years. Thus, the fear of a reversal with a following real depreciation is quite justifiable. In particular as the annual growth rate of real domestic credit has been with 12.12% very high in 2007 (the average annual growth rate for the period 1997 – 2007 has been only 4.43%). Also, the non-tradable sector has grown at a higher level than the tradable sector in Jamaica, as can be seen in Figure 11.6.

Summary

We can, thus, not find robust evidence for a common business cycle between Jamaica and the United States. Therefore, also for the Jamaican economy dollarization in the optimum currency area framework of Mundell (1961) would be associated with welfare losses. Moreover, we documented also for Jamaica that the boom-bust cycle framework of Schneider and Tornell (2004) would be more adequate to analyze the dollarization question: As in the other studied countries, currency mismatch and contract enforceability are serious problems in Jamaica.

Figure 11.6: Shares of N-sector in total gross value added



Note: The displayed line represents the share of the non-tradable sector in total gross value added. Tradable and non-tradable sector sum up to 1. The tradable sector is defined by “Agriculture, hunting, forestry, fishing (ISIC A-B)” and “Mining, Manufacturing, Utilities (ISIC C-E)”. The non-tradable sector comprises “Construction (ISIC F)”, “Wholesale, retail trade, restaurants and hotels (ISIC G-H)”, “Transport, storage and communication (ISIC I)” and “Other Activities (ISIC J-P)”.
Source: Authors’ calculations, based on UN (2010).

More than half of the Jamaican firms claim being financially constrained, and a significant real appreciation vis-à-vis the US$ has taken place in recent years. Domestic credit growth has been more than 10% and the sectors of the economy have witnessed a very unequal development.

Therefore, with two of the biggest Caribbean countries — the Dominican Republic and Jamaica — analyzed, we assume that the situation in the Caribbean region should be very similar to the one in Central America.

11.D De-dollarization

The issue of official dollarization cannot be discussed without mentioning the debate on de-dollarization which has been more and more important in the last years. Many of the Latin American countries, especially those in South America, have reduced the degree of dollarization significantly in the last decade.[77] Figure 11.7 shows the percentage of foreign-currency denominated liabilities of Central American (in panel (a)) and South American countries (panel (b)) in 2003 and 2007.[78]

While the degree of foreign-currency denominated liabilities in the Central American countries has remained stable or has even increased during this time, many of the South American countries have reduced the degree of foreign-currency denominated liabilities significantly. Among the countries with the most important reductions are Argentina (from 73% in 2003 to 17% in 2007) , Bolivia (91% to 82%), Brazil (21% to 11%), Chile (33% to 20%), Peru (72% to 66%), and Uruguay (90% to 80%).[79] In a recent "Finance and Development Report" Cartas (2010) assumes that the decline in dollarization in South America may be linked to sounder economic and financial policies, including the elimination of high inflation rates.

A formal analysis of the driving forces of financial de-dollarization in Bolivia, Paraguay, Peru and Uruguay is conducted in Garcia-Escribano and Sosa (2011). The authors find that strong fundamentals and macroeconomic stability are necessary prerequisites for de-dollarization. Furthermore, a sound regulation framework of the financial sector that aims to internalize the currency risks, and the development of local currency capital markets are needed to encourage the de-dollarization process. Moreover, they find that deposit de-dollarization gives rise to credit de-dollarization.

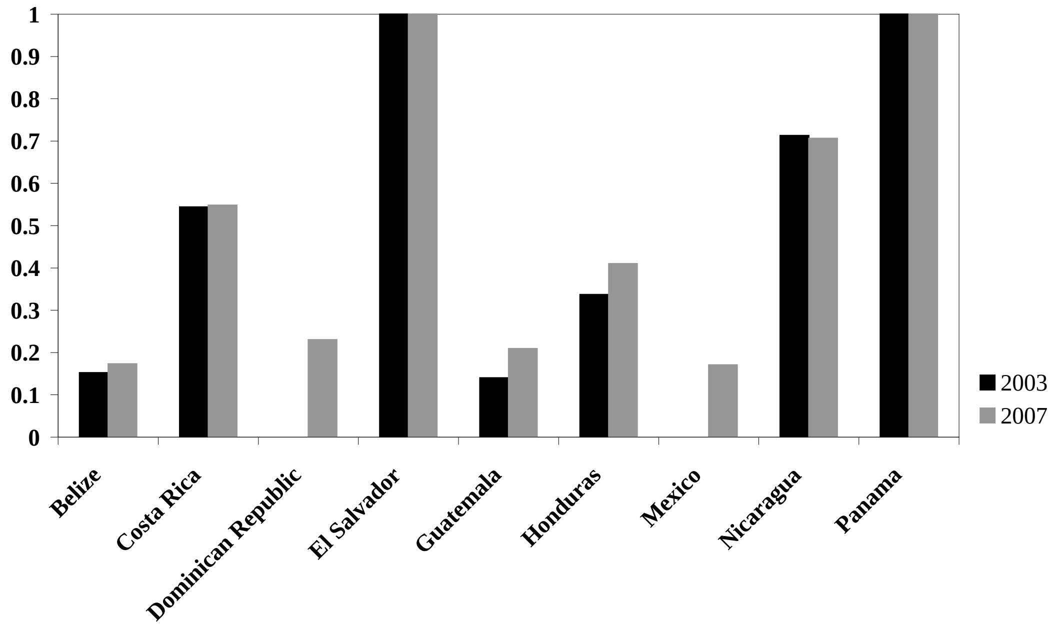
An even more comprehensive study on the key policies that favor de-dollarization is given in Kokenyne, Ley and Veyrune (2010). Besides a discussion of the dif-

[77] Latin America refers to all those countries on the North and South American continent and the nearby islands where the official language comes from the Latin, i.e. is either Spanish, Portuguese, or French. South America refers to those countries that are on the South American continent, i.e. the northern boarder of South America are Venezuela and Colombia. The most southern country of Central America is Panama.

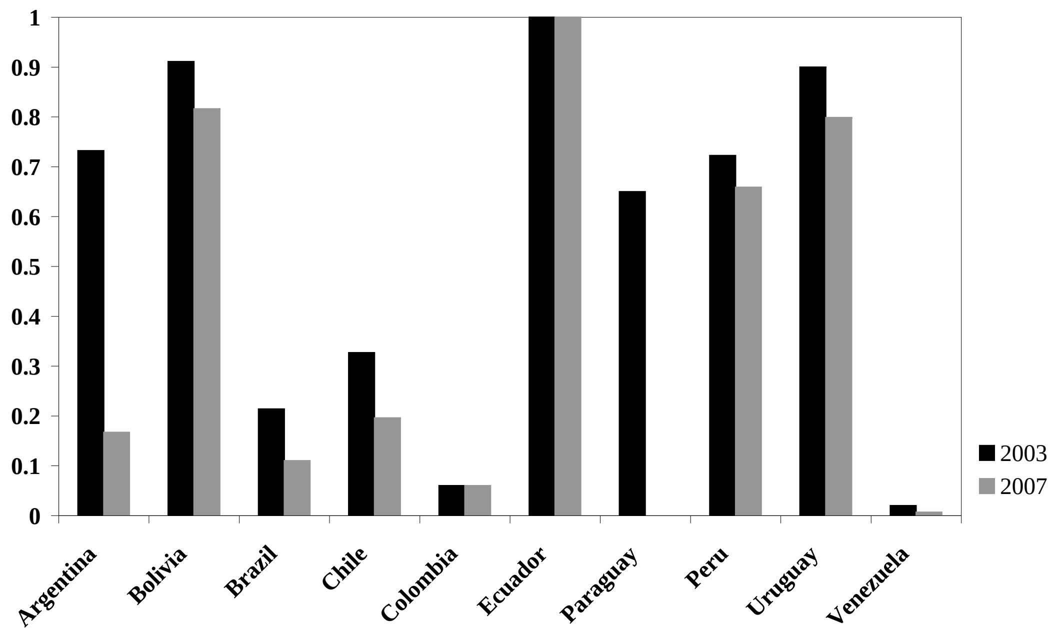
[78] We assume that these liabilities are mainly denominated in US$.

[79] Caprio (2003 and 2007), see Figure 11.7.

Figure 11.7: Foreign-currency denominated liabilities



(a) Central America



(b) South America

Note: What percent of the commercial banking system's liabilities is foreign-currency denominated? Data are from the Bank Regulation and Supervision Database for 2003 (for Chile, Peru and Venezuela data are from end of 2002) and 2007.
Source: Authors' representation, based on Caprio et al. (2008).

ferent macro- and microeconomic policies and measures, they also document the de-dollarization experiences in a broad range of countries.

In this essay we have, however, abstracted from these recent developments in the southern part of Latin America as the extensive discussion of this topic would have been out of the scope of this dissertation.

Essay III

International Supply Chains and Trade Elasticity in Times of Global Crisis[80]

[80] This essay is based on Escaith et al. (2011), Escaith et al. (2010a) and Escaith et al. (2010b)

12 Introduction

The crisis that, after several months of gestation in the US financial sphere, irrupted into the international scene in September 2008 has been dubbed the "Great Trade Collapse" (Baldwin, 2009) for its impact on international commerce. The shock, emanating from the largest world financial center, spread very quickly and almost simultaneously to most industrial and emerging economies. The collapse of world trade has been unprecedented, even in comparison with the Great Depression of the 1930s (Eichengreen and O'Rourke, 2009). During the first quarter of 2009, world exports in value terms were 31 percent lower than one year before and world imports 30 percent lower.

International trade, which dropped five times more rapidly than global GDP,[81] was both a casualty of the 2008-2009 crisis and one of its main channels of transmission. While a decrease in trade is expected when world output falls following a severe financial crisis, the magnitude of the collapse has surprised observers. Moreover, the trade collapse was not only sudden and severe, but also synchronized, which is another distinguishing feature of the 2008-2009 crisis.

The fast growing literature on this trade collapse discusses several potential driving forces for this phenomenon, among them an important drop in world demand, an inventory effect, freezing of investment, a drop in demand for durables, trade finance and credit, and, finally, the fragmentation of international production.[82]

[81] The reaction of trade and GDP during the recent crisis is described more in detail in chapter 17.C in the appendix.

[82] See chapter 13.

This essay contributes to the debate on the role of global supply chains in the recent trade crisis.[83] These production networks are a prominent and often discussed new element in world manufacturing: With the opening of new markets, the technical revolution in IT and communications, and the closer harmonization of economic models worldwide, new business models emerged in the 1990s based on new opportunities to develop comparative advantages (Krugman, 1995; Baldwin, 2006). Trade became much more than just a simple exchange of merchandise across borders. It developed into a constant flow of investment, of technologies and technicians, of goods for processing and business services. While providing renewed opportunities for increasing productivity and promoting industrialization in developing countries, the greater industrial interconnection of the global economy has created newer and faster channels for the propagation of adverse external shocks. Referring to the breakdown of 2008-2009, some authors (e.g. Tanaka, 2009; Yi, 2009; Cheung and Guichard, 2009) have pointed out that these channels may explain the abrupt decrease in world trade or its synchronization across countries.

There are three different channels to be considered when discussing the role of international supply chains in the recent trade collapse: The first one is the magnification effect of global production networks: intermediate inputs may cross the border several times before the final product is shipped to the final customer, i.e. trade is measured in gross terms, whereas GDP is accounted in value added terms.

The second channel is the so called composition effect. Trade flows are composed mainly of durable goods (about two thirds or more), while GDP consists mainly of services. Trade in goods was strongly impacted by the crisis while services showed some resilience to the crisis (Borchert and Mattoo, 2009). Moreover, if the drop

[83] Chapter 17.A in the appendix defines the concepts of offshoring and outsourcing and explains how vertical integration can be measured.

in demand falls in priority on highly fragmented productive sectors, international supply chains become important when explaining the crisis.

The third channel refers to the disruption effect. In international supply chains, all the different production stages of the global supply chain rely on each other — as suppliers and as customers. Thus, when a shock occurs in one of the participating sectors or countries, it is transmitted quickly to the other stages of the supply chain through both backward and forward linkages. These transmission channels apply both to financial shocks, e.g. a credit crunch in one country[84], and to trade policy shocks, e.g. rising tariffs and non-tariff barriers, or implementing "buying local" campaigns.

The objective of this essay is to analyze the role of global supply chains in the impressive collapse in world trade, in particular to assess whether a magnification and a composition effect have taken place during the 2008-2009 crisis.[85] After reviewing the literature, the study adopts an empirical strategy based on two complementary steps. Stylized facts on the long-term and short-term trade elasticity are first derived from exploratory analysis, then from formal modeling on a large and diversified sample of countries. This macroeconomic perspective is complemented with the analysis of interrelated input-output matrices for a demonstrative sub-set of countries (Asia and the United States). A conclusion summarizes the main results and an extensive appendix provides further background information.

[84] See e.g. Bricongne, Fontagné, Gaulier et al. (2010).
[85] The disruption effect will not be addressed explicitly in this essay.

13 Related Literature on the Trade Collapse

This essay analyzes the role of the magnification and the composition effect in explaining the 2008-2009 trade collapse, i.e. whether global supply chains have caused the overshooting of trade. Before undertaking a quantitative analysis of trade elasticity, we start with a brief literature review on the role of supply chains as driving forces of the recent trade collapse.[86]

The trade collapse and international supply chains

A conclusive overview about the importance of global supply chains is proposed by Koopman, Powers, Wang et al. (2010) who provide a conceptual framework for the estimation of value added and the correct allocation to the source country. Escaith and Gonguet (2009) study the role of international supply chains as transmission channels of financial shocks and propose an indicator of supply-driven shocks. Such shocks to international supply chains are one important characteristic of the recent trade collapse when compared to the Great Depression as pointed out by Grossman and Meissner (2010) who do not only show the similarities of the two crisis, but also concentrate on differences. Whereas in the Great Depression trade collapsed due to income losses and the rise of trade barriers, trade wars have been avoided in the recent crisis. This time, the trade collapse is mainly due to

[86] A broader review of the literature on offshoring is provided in chapter 17.B in the appendix.

shocks to international supply chains and to uncertainty. Concentrating on this last argument, Tanaka (2009) and Yi (2009), among others, explain the collapse of trade during the current world wide crisis as a systematic over-shooting due to the globalization of supply chains. Cheung and Guichard (2009) also attribute part of the reasons for the collapse to a possible breakdown of global supply chains.

However, Bénassy-Quéré, Decreux, Fontagné et al. (2009), using a multi-region/multi-sector CGE model, reject this hypothesis showing that a large part of the fall in trade is caused by a relative price effect and the use of an inadequate weighting scheme to calculate aggregated GDP. Thus, they do not find a multiplier effect and reject the hypothesis of a systematic over-shooting of trade. Also, Van Bergeijk (2010) challenges the view that international value chains may have caused the recent trade collapse and points out that the effect of international value chains is rather unclear, i.e. they may also have had a dampening effect on the trade collapse. Instead, he proposes that trade uncertainty may be the driver behind the collapse. The future of global supply chains after the great trade collapse are discussed by different authors, e.g. Escaith (2010) or Milberg and Winkler (2010). However, de-globalization does not seem to be a serious threat.

The trade collapse and further supply-side distortions

Another supply-side distortion may be credit constraints. Cheung and Guichard (2009) show that credit constraints have been one driving factor for the trade collapse. Also, Bénassy-Quéré et al. (2009) attribute some importance to the existence of credit shortages to explain the recent trade collapse. Wynne (2009) takes this point up and argues that reduced access to trade finance can explain an important part of the trade collapse. In contrast to these findings, Levchenko, Lewis and Tesar (2010) do not find support for the hypothesis that trade credit has been important for the collapse. In addition, Bricongne et al. (2010) show that the impact of credit constraints on the recent trade collapse has been rather limited for French firms.

Alessandria, Kaboski and Midrigan (2010b) propose yet another explanation for the strong trade reaction: studying production, trade, and expenditures in the US, they find that there has been an important inventory adjustment at work. These amplified adjustments in inventory levels are well known by supply chain managers, and result in what is known as "bullwhip effect" in production-distribution systems (Stadtler, 2008).

The trade collapse and demand-side distortions

Besides these supply-side effects, the role of the demand side in the recent trade collapse has been highly questioned in the literature. Various authors agree that the collapse may be (also or mainly) demand-side driven. Behrens, Corcos and Mion (2010) analyze the 2008-09 trade crisis in Belgium using microdata and find that, overall, the trade collapse was caused by a fall in economic activity. They therefore claim that Belgium did not face a trade crisis, but only a demand-side driven trade collapse. The effects of the recent trade crisis on the UK have been studied in Domit and Shakir (2010) who find that the collapse has mainly been caused by a combination of a shock to global demand and the strengthened globalization in the production of tradable sector goods. Bricongne et al. (2010), who analyze a unique dataset of French firms combining detailed firm-level data with firm-level credit constraints, find that, in the aggregate, the strong demand shock, and also product characteristics, have been the main driving forces of the recent trade collapse. Berthou and Emlinger (2010) claim that there has been especially a decrease of demand for the most expansive varieties and, thus, that countries specialized in high quality products are supposed to suffer more in times of global crises. Bems, Johnson and Yi (2010) calculate that changes in (final) demand alone can explain about 70 percent of the recent trade collapse. Eaton, Kortum, Neiman et al. (2010), who combine an input-output framework with a gravity trade model, calculate that the decrease in total manufacturing demand can explain more than 80 percent of the drop in trade/GDP. The argument of the demand side effect is also taken up by Cheung and Guichard (2009) who show that among other factors, world demand is one explanatory factor for the recent trade collapse.

The trade collapse and product characteristics

A third strand of literature focuses on the products themselves: For example, McKibbin and Stoeckel (2009) and also Wang (2010) point out that the distinction between durable and non durable goods is fundamental to explain the overreaction of trade to the contraction of GDP in the current crisis. Borchert and Mattoo (2009) emphasize that services trade is much less affected in the crisis than goods trade. They argue that this can probably be explained by lower demand cyclicality and less dependence on external finance. Haddad, Harrison and Hausman (2010) identify a bundle of stylized facts of the recent 2008-09 crisis and find that in general, quantities declined and prices decreased. However, there are important differences between products. While the fall in prices was primary driven by commodities, for manufacturing products they observed the opposite effect. Thus, supply side frictions may have occurred in the manufacturing sector.

Sector-specific studies include for example Gereffi and Frederick (2010) for the apparel industry, Sturgeon and Van Biesebroeck (2010) for the automotive industry, or Sturgeon and Kawakami (2010) for the electronics industry.[87]

[87] At a more aggregated level, regional studies have also been conducted, e.g. a series of studies in Inomata and Uchida (2009) look at the various dimensions (trade, employment, finance) of the global crisis in the Asian Pacific region.

14 Trade Elasticities in the Long-Run and the Short-Run

Evidence from Standard Regressions and Formal Modeling

In this section, we first present evidence on the long-run evolution of trade elasticities through standard regressions.[88] Using OLS regression, Freund (2009), who analyzes the effect of a global downturn on trade from a historical perspective, finds a rising elasticity of world trade to world income, from 1.77 in the 1960s to 3.69 in the 2000s. This raise is attributed to the fragmentation of production and/or lean retailing. In the following section, we will have a closer look at these elasticities and try to see whether this increase is robust to changes in the sample of countries. We then rely on a formal model of imports and GDP to distinguish between the long-run elasticity of trade to income and the short-term elasticity.

Authors that have suggested that vertical specialization can explain to some extent the severity and the synchronization of the 2008-2009 trade collapse assume that it is during the downturn that an amplification effect can be observed. As explained by Yi (2009), the decline in trade flows is a multiple of the decline in demand for final imported goods. Because trade flows are measured in gross values and not in value added terms, they incorporate the value of intermediate goods and services from abroad. For that reason, trade is expected to decrease at an accelerating rate when demand falls. This amplification effect refers however to

[88] Chapter 17.C in the appendix discusses the concept of trade elasticity.

the short-term elasticity of trade to income. In the phase of recovery, trade should also increase faster than demand (the amplification effect playing the other way round), thus leaving the long-term elasticity unaffected. This is why this chapter explores both the long-run and short-run trade elasticities.

14.1 Global Patterns in the Long-Run: OLS and Kalman Filter Regressions

We start by extracting stylized facts at world level using a set of standard regressions, then analyzing how the parameters of interest vary according to specific groupings of observations, or change in time. It should be noted that the results presented in this section are exploratory, and do not pretend to provide a strong statistical basis for confirmatory inferences or predictions. For this purpose, more formal dynamic specifications are presented in the next section.

The data supporting the exploration are obtained from the IMF's World Economic Outlook (IMF, 2009). World GDP weighted at market exchange rates[89] is constructed by combining World GDP at 2000 prices from the World Development Indicators database (World Bank, 2009) with GDP growth rates (market exchange rate) from the World Economic Outlook (WEO) (IMF, 2009). Our sample comprises annual data between 1980 and 2009.

The GDP elasticity of imports aggregated at world level is estimated in a first step by OLS:

$$m_t = \alpha + \beta y_t + \epsilon_t \tag{14.1}$$

with m_t = logarithmized imports, y_t =logarithmized GDP and ϵ_t = residuals. We obtain an elasticity of 2.28 for the full sample (R^2= 0.99 for 30 observations). As robustness check and to provide a benchmark for subsequent calculations, we

[89] World GDP is usually weighted with PPP, which, however, is inadequate when investigating demand on international markets (i.e. GDP-trade elasticity).

estimate a state space object containing GDP and imports, to which we apply a Kalman Filter, with maximum likelihood:

$$\text{Signal:}\, m_t = \alpha_t + \beta_t y_t + \epsilon_t \tag{14.2}$$

$$\text{State:}\, \beta_t = \beta_{t-1} + v_t \tag{14.3}$$

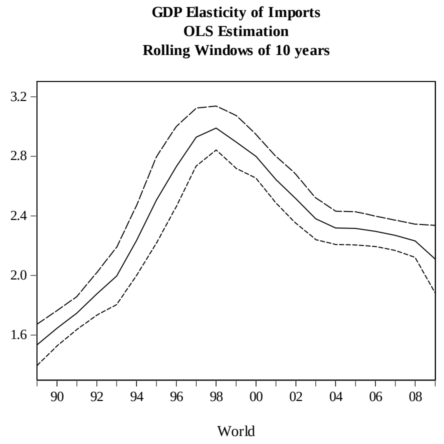
The estimated elasticity is also 2.28. This result is slightly higher than the estimation of Freund (2009) who finds an elasticity of 1.77 for a sample starting 20 years earlier. Using input-output tables for 2004, Bems et al. (2010) calculate an elasticity of world trade to world GDP of 2.8. Thus, our estimation is within the range of previous calculations in the literature.

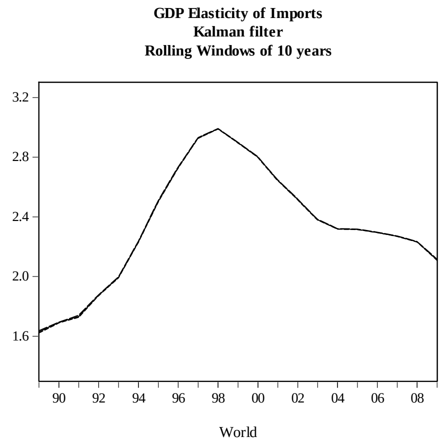
To explore and validate the likelihood of the hypothesis of global supply chains having led to an increase in the long-term GDP elasticity of imports — transition from a world economy without global supply chains to another one with global supply chains — we should observe changing elasticities patterns over time and across the sample.[90]

To visualize the changing characteristics over time, we redo the estimations both with OLS and Kalman Filter for rolling time windows of each 10 years, i.e. the estimation sample subsequently changes by one year, the first sample comprising 1980 – 1989, the second 1981 – 1990 and so forth. Results are displayed graphically in Figure 14.1. Both graphs show clearly that the GDP elasticity of imports is not at all constant and changes over the years. From 1989 to 1998, we can observe a steady increase in the elasticity from about 1.6 to 3.0. The first years in the Figures seem to confirm that global value chains have indeed increased trade elasticities in the long-run. However, after 1998 we observe a significant decrease and the elasticity stabilizes between 2004 and 2008 at a level of about 2.3, before a new decrease in the crisis year 2009. Thus, the observed data patterns seem to

90 This is what Freund (2009) finds in her data: an increasing elasticity over time.

Figure 14.1: GDP elasticity of imports — world





Note: Results of the estimations of rolling time windows of each 10 years for the GDP elasticity of imports (constant prices) are displayed. Each data point of the graph reflects the estimated coefficient for the previous 10 years, e.g. the displayed value in the year 2000 reflects the GDP elasticity of imports computed for the 10-year window between 1991 and 2000.
Source: Authors' calculations, based on IMF (2009); and World Bank (2009).

indicate that if trade elasticities have increased in the years of rising globalization in the 1990s, this is an overshooting phenomenon or a temporary rise during the transition to a new state reached around 2004, where trade elasticities seem to have stabilized at a new level, slightly higher than their former levels observed at the beginning of the 1990s. Vertical specialization would have provoked a temporary rise of the long term elasticity of trade to GDP and not a continuing rise as assumed by Freund (2009). A possible explanation for the different results is that we are using world GDP weighted at market exchange rates whereas Freund (2009) uses the WDI data directly.[91]

But even if these results seem to support the hypothesis of a structural change in world trade that temporarily increased the long-term trade elasticity, it should be pointed out that the analysis does not give any information on the causes of

[91] The difference refers especially to the 2000s as our results are quite comparable until the end of the 1990s.

the observed change. For example, it may be caused by an aggregation effect, as emerging countries, with high trade to GDP ratio, began acquiring an increasing weight in the world economy in the 1990s. The result would lead to an increase in the world trade to GDP ratio and the apparent world trade elasticity, without any change at individual country level. Therefore, we continue the explorative data analysis by looking at sub-groups of countries. If global supply chains were the cause for the observed change in elasticities, the results should be similar for countries participating heavily in global supply chains and a different trend should be observed in the remaining countries.

14.2 Long-Term Trade Elasticity: Exploring Country Patterns

In this section, we analyze the group of the 50 most important exporters as listed in International Trade Statistics (WTO, 2008a, p.12 Table I.8)[92], using data from the IMF's World Economic Outlook (IMF, 2009)[93], namely imports of goods (volume) and gross domestic product (in constant prices) in a sample from 1980 to 2009. In order to address the trade-off between number of observations and disaggregation,

[92] Chinese Taipei is excluded due to data availability. Thus, we analyze the remaining 49 countries of the group of the 50 leading exporters in world merchandise trade in 2007, namely Algeria, Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Czech Republic, Denmark, Finland, France, Germany, Hong Kong, China, Hungary, India, Indonesia, Iran, Ireland, Israel, Italy, Japan, Korea, Kuwait, Malaysia, Mexico, Netherlands, Nigeria, Norway, Philippines, Poland, Portugal, Russian Federation, Saudi Arabia, Singapore, Slovak Republic, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, Ukraine, United Arab Emirates, United Kingdom, United States, Venezuela, and Viet Nam.

[93] From 1980 – 1991 data for GDP and imports for Russia and the Ukraine are missing in WEO 2009. These missing values are replaced with the corresponding values from WEO 2008. As all GDP values of Russia in WEO 2009 were multiplied with 1.1362 (in comparison to the WEO 2008) the added values were also multiplied with the same factor.

we take advantage of the panel dimension of our data and cluster the countries in an appropriate way.[94]

First, we cluster the countries according to their observed data patterns. For this purpose, we estimate the elasticity of imports to GDP using a state space object for each individual country, and apply a Kalman Filter for three different samples: 1980 – 1990, 1990 – 2000, and 2000 – 2008. The results provide a first idea of how the elasticity of imports is evolving for each country in the sample. Then, we construct up to 9 different clusters (3 x 3) with the following logic:

1. Does the elasticity from sample one to sample three increase, remain stable or decrease? (3 options)
2. If so, does the elasticity of the second sample lay above, in between or beneath the two other elasticities? (another 3 possible cases)

We arrive at the following country groups:[95]

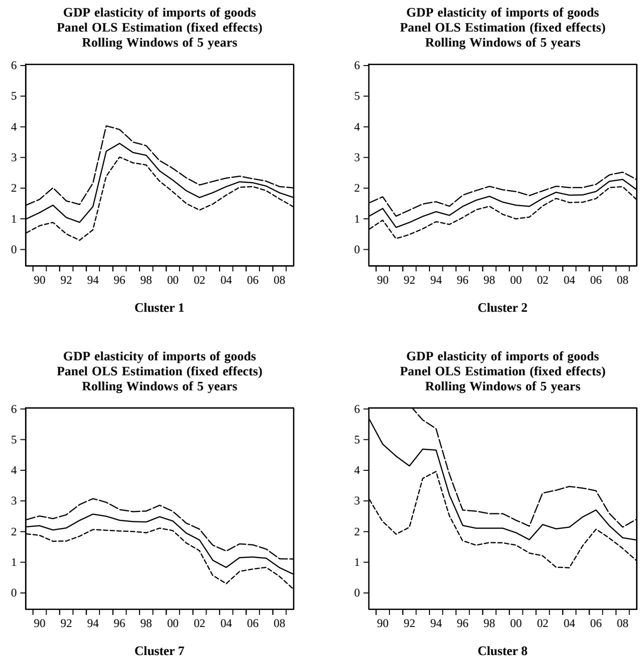
- Cluster 1: countries with an increasing elasticity over the full sample, which overshoots in the middle of the sample;
- cluster 2: countries with an increasing elasticity over the full sample;
- cluster 3: countries with an increasing elasticity over the full sample, but with a drop in the middle of the sample;
- cluster 7: countries with a decreasing elasticity over the full sample, but with an increase in the middle of the sample;
- and cluster 8: countries with a decreasing elasticity over the full sample.

The results of the panel OLS estimation with fixed cross-section effects and rolling windows of 5 years are displayed in Figure 14.2.

94 It is important to point out that contrary to the world aggregate, where countries are weighted by their GDP, all countries have the same weight in the following clusters. Thus, comparison with the results of Figure 14.1 is somehow biased.

95 The actual number of cluster is smaller than 9 as no country pertains to clusters 4, 5 or 6, which have in common that the elasticity from sample one to sample three remains stable. Cluster 9 (decrease, with the second elasticity beneath the first and the third elasticity) is omitted, as only one country falls in this category. Tables with an overview over all clusters are available in chapter 17.C the appendix (Table 17.2 and Table 17.3).

Figure 14.2: GDP elasticity of imports — cluster based on elasticity patterns



Note: Constant prices. Country groupings are based on the combined changes in trade elasticity in the three samples 1980 – 1990, 1990 – 2000, 2000 – 2008 (see text for further explanation).
Source: Authors' calculations, based on IMF (2009).

As the data show, only the first cluster of countries features a trend compatible with our hypothesis of global supply chains having caused a temporary overshooting in elasticities before stabilizing at a new, slightly higher level than in the 1980s. If this cluster contained all the countries that participate in global supply chains, the hypothesis mentioned before would be enormously strengthened. Many of the participants of global supply chains are actually in the cluster (e.g. Austria, Czech Republic, Japan etc.) — however, many others which are known for their participation in global supply chains, like Germany, China or Mexico, are missing, which suggests that it might be just coincidence that some of the countries show the data structure that confirms the above mentioned hypothesis.

Thus, given these findings, we rather tend not to accept the hypothesis that global supply chains explain all by themselves the changes in the long-term trade-income elasticity. However, this does not imply that the emergence of global production networks since the late 1980s did not play a role, only that other factors may also be at work to explain the results observed when estimating equations 14.1 to 14.3.

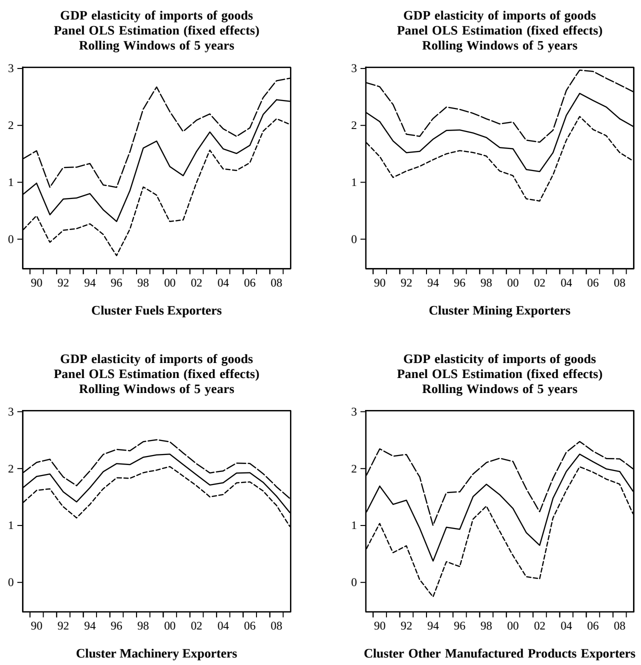
Robustness checks

In the following, we want to conduct some more robustness checks before discarding definitively the hypothesis of a magnification effect over the long-run: As the clustering by pure elasticity patterns cannot confirm the hypothesis of global supply chains being the driving force behind the change in the GDP elasticity of imports, we have tried to cluster the countries in two alternative ways. First, as several authors emphasize the importance of product characteristics for the trade collapse (e.g. Haddad et al., 2010), we group countries according to their export specialization. Main export activities are given by UNCTAD in its Table "Country trade structure by product group" (UNCTAD, 2008, Table 3.1). We obtain the following five clusters: fuel exporters; ores, metals, precious stones and non-monetary gold exporters; manufactured goods exporters; machinery and transport equipment exporters; and other manufactured goods exporters.[96] Results of panel OLS estimations with fixed cross-section effects and rolling windows of 5 years are displayed graphically in Figure 14.3.

Again, the patterns of the calculated elasticities change significantly among the different clusters of countries. The elasticity of the group of fuel exporters increases steadily, which however is certainly a terms-of-trade effect and has nothing to do with the globalization of supply chains. For the manufacturing sector, both for the aggregate (manufacturing exporters) and for the two subgroups (machinery exporters, and other manufactured goods exporters) there have been three peaks

[96] The following three product groups were not considered in the analysis, as they comprise less than three countries: all food items; agricultural raw materials; chemical products.

Figure 14.3: GDP elasticity of imports — cluster based on export specialization



Note: Constant prices. See text for methodology.
Source: Authors' calculations, based on IMF (2009).

in trade elasticity, the first one in 1990, the second in 1998, and the third in 2005. Each time, elasticity has decreased in between. This however, does not support the hypothesis of an impact of supply chains on the elasticity either. Thus, we still do not find supporting evidence for the implication of the globalized supply chains in the changes of trade elasticities.[97]

Lastly, to complete the exploration of trade elasticity patterns, we cluster the countries by (geographical) regions. Within one regional cluster the countries often dispose of a similar endowment and may, accordingly, have assumed a similar role in the world economy. For example, the literature often refers to Central and Eastern European Countries (CEEC) or Emerging Asia as one entity when

[97] Yet another way of clustering the countries by export specialization, using the main export products of each country, does not change the result qualitatively either: the hypothesis of an impact of the global supply chains on the changes in GDP elasticity of imports can still not be confirmed by our explorative data analysis. The results of this robustness check are available in chapter 17.C in the appendix (Figure 17.3).

discussing offshoring. Therefore, we construct the following set of clusters: Latin America, Emerging Asia, New EU-Member States, Middle East, G7-Countries, and Western European Countries.[98] Elasticities vary substantially between the different regions, but overall there is no evidence for the supply chain hypothesis. The evolution of the elasticity of the New EU-Member countries could be an illustration of a transition that has taken place, but for these ex-communist countries, changes are of a larger institutional nature than simply attributable to their insertion into European supply chains.

In short

To sum up, even ignoring the known limitations of the model, we cannot find strong evidence for the role of global supply chains as "*the*" driving force behind the changes in the long-run GDP elasticity of imports. Although on the aggregated world level trade elasticity is changing in a way that one could interpret as a transition (increased trade elasticity in the years of rising globalization in the 1990s, then fall back to lower level in the mid-2000s), the disaggregated analysis does not support this hypothesis. Some countries that are part of global supply chains do not show significant differences in the evolution of their elasticities, while countries less integrated in global production networks tend to do so. Besides possible aggregation effects, there are probably additional causal factors at work. We mentioned the changes in relative prices which inflated the value of primary commodities. Other factors could include the lowering of trade barriers after the conclusion of the Uruguay Round in 1995, or the increasing taste of consumers for diversity as their income increased.

[98] Results of the panel OLS estimation with fixed cross-section effects for rolling windows of five years of the GDP elasticity of imports are available in chapter 17.C in the appendix (Figure 17.4).

14.3 Long-Run vs. Short-Run Trade Elasticity: An Estimation with the Error Correction Model

The previous section was exploratory and no formal assumption was made on the kind of relationship existing between imports and GDP. We now assume that there is a long-run equilibrium relationship between the growth of trade and the growth of GDP, i.e. the elasticity is stable in the long-run. The elasticity that we measure through trade and GDP data is a short-run parameter that reflects both the long-run equilibrium and the stochastic fluctuations leading to volatility. We use an error correction model (ECM) to account for this and to estimate both the long-run and short-run elasticity.

We use quarterly data from the OECD National Accounts database (OECD, 2010) over the period 1970 – 2010[99] in order to have a consistent dataset with time-series for the OECD area (based on 30 OECD economies). The data, in constant prices, allows controlling for changes in relative prices.

We start with a very simple proportional relationship between trade and GDP: $M_t = QY_t$, where M_t are imports (in volume), Y_t is real GDP and Q the share of imports in GDP. In log form, the equation can be written: $m_t = q + y_t$ with m, q and y the natural logs of the previous variables. Adding the lagged values of both trade (m_{t-1}) and GDP (y_{t-1}), as well as stochastic fluctuations (u_t), the model can be written:

$$m_t = \alpha_0 + \alpha_1 m_{t-1} + \beta_1 y_t + \beta_2 y_{t-1} + u_t \tag{14.4}$$

[99] Year-on-year change, volumes in USD (fixed PPPs, OECD reference year), seasonally adjusted.

Assuming that there is a long-run equilibrium relationship between M and Y, and that m^* and y^* are the equilibrium values of m and y, we have:

$$m^* = \alpha_0 + \alpha_1 m^* + \beta_1 y^* + \beta_2 y^* \tag{14.5}$$

At the equilibrium, we set u_t equal to zero and the above equation implies that:

$$m^* = \frac{\alpha_0}{1-\alpha_1} + \frac{\beta_1+\beta_2}{1-\alpha_1} y^* \tag{14.6}$$

This equation is consistent with $m_t = q + y_t$ if we have $q = \frac{\alpha_0}{1-\alpha_1}$ and $\frac{\beta_1+\beta_2}{1-\alpha_1} = 1$. This is the long-run equilibrium relationship between trade and GDP. We can interpret $\gamma = \frac{\beta_1+\beta_2}{1-\alpha_1}$ as the long-run equilibrium trade elasticity.

We can then model a divergence from equilibrium in the presence of stochastic shocks. Taking the first difference of m_t adding and subtracting both $\beta_1 y_{t-1}$ and $(\alpha_1 - 1)y_{t-1}$ from the right hand side, the model can be rewritten as:

$$\Delta m_t = \alpha_0 + (\alpha_1 - 1)(m_{t-1} - y_{t-1}) + \beta_1 \Delta y_t + (\beta_1 + \beta_2 + \alpha_1 - 1)y_{t-1} + u_t \tag{14.7}$$

The coefficients β_1 and β_2 indicate the short-run impact of a change in GDP on imports. $(\alpha_1 - 1)$ is the speed at which trade adjusts to the discrepancy between trade and GDP in the previous period. This is the error correction rate.

The above equation is the traditional ECM specification. Before proceeding to its estimation, we check for the degree of integration. Running Phillips-Perron unit root tests, we can see that m and y have unit roots, but we reject the assumption that Δm and Δy contain unit roots. A Johansen cointegration test further shows that the rank of cointegration of m and y is one. This justifies the use of the above specification.[100]

[100] Results of both tests are available in chapter 17.D in the appendix.

Table 14.1: Estimation of the error correction model and long-run trade elasticity

	Time period				
	1970-2010	**1970s**	**1980s**	**1990s**	**2000s**
Dependent variable: Δm_t					
m_{t-1}	-0.024***	-0.214***	-0.115***	-0.100***	-0.119***
	(0.005)	(0.031)	(0.027)	(0.019)	(0.019)
Δy_t	1.455***	1.290***	1.404***	1.683***	1.799***
	(0.107)	(0.213)	(0.172)	(0.194)	(0.138)
y_{t-1}	0.045***	0.291***	0.198***	0.227***	0.214***
	(0.009)	(0.049)	(0.042)	(0.044)	(0.039)
Number of observations	3974	974	1000	1000	1000
R-squared	0.208	0.241	0.193	0.351	0.386
Long-run trade elasticity (δ_3/δ_1)	1.84	1.36	1.72	2.27	1.80

Note: OLS estimation with robust standard errors (24 OECD countries). *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' calculation, based on OECD (2010).

We can estimate the model in the following way:

$$\Delta m_t = \alpha_0 + \delta_1 m_{t-1} + \delta_2 \Delta y_t + \delta_3 y_{t-1} + \epsilon_t \tag{14.8}$$

The latter equation is similar to the former one with $\delta_1 = \alpha_1 - 1$, $\delta_2 = \beta_1$ and $\delta_3 = \beta_1 + \beta_2$. The advantage of the specification is that we can derive directly the long-run equilibrium trade elasticity from the estimated coefficients: $\gamma = \frac{\beta_1+\beta_2}{\alpha_1-1} = \frac{\delta_3}{\delta_1}$. Furthermore, δ_1 is the speed at which imports adjust to trade and δ_2 is the short-term impact of GDP on trade (short-term elasticity).

First, the regression is run on aggregate data for OECD economies (1970 – 2010). Results are presented in Table 14.1.

We find a strong coefficient (both in terms of statistical and economic significance) for the short-term adjustment of trade to GDP changes (Δy_t) in all periods.[101] Of special relevance to our present concern, the last row of Table 14.1 reports the implied long-run trade elasticity (γ). Its overall value of 1.84 over the 1970 – 2010 period is smaller than the elasticity measured in the previous sec-

[101] Figure 17.5 in chapter 17.D in the appendix shows the impulse response function of imports to a shock on GDP.

tion (2.28). As hypothesized, trade elasticity has increased up to the 1990s and appears to have decreased afterwards.

It is nonetheless very interesting to see that the long-term elasticity, according to this model, is almost the same in the 1980s and 2000s. This result would confirm that vertical specialization, as suggested by theory, has no reason to increase the equilibrium elasticity of trade to GDP and that the 1990s, with their higher trade elasticity, can be interpreted as a transition period to a new "equilibrium".[102]

To examine discrepancies across countries and relate those possible differences to vertical integration, Table 14.2 reports the results of similar regressions at the country level.

Generally, the model works quite well in explaining the variations across the growth rate of trade and GDP. There are however some countries for which coefficients are not significant and the trade elasticity cannot be precisely calculated. All countries demonstrate an increase in their trade elasticity until 1990. Afterwards, countries differ in the evolution of the elasticity between the 1990s and 2000s. In Australia, Denmark, Finland, Korea, Norway and Portugal, the trade elasticity continues to increase after 2000. In the case of Mexico, the Netherlands, New Zealand, Spain and Turkey, there is a decrease in the elasticity as seen with the aggregate data in Table 14.1. For other countries, the results are not significant and we cannot assess a trend.

In order to check more precisely for the influence of international supply chains in the change in trade elasticity, we modify the model and introduce a vertical specialization variable.[103]

[102] We use "equilibrium" in the very limited sense of "long-term outcome"; the trade patterns that emerged in the 2000s witnessed the accumulation of large macroeconomic imbalances.

[103] Cheung and Guichard (2009) suggest that the way vertical specialization affects trade is by raising its elasticity with respect to income.

Table 14.2: Estimation of the error correction model at the country level

		Estimation — Dependent variable: Δm_t			Long-run trade elasticity		
Country	Period	m_{t-1}	Δy_t	y_{t-1}	All years	1990s	2000s
Australia	1961q2-2009q2	-0.049*	0.757**	0.087*	1.77	2.15	2.85
Austria	1961q2-2009q3	-0.139***	1.888***	0.266***	1.91		
Belgium	1961q2-2009q3	-0.066**	1.597***	0.120**	1.82	2.40	1.84
Canada	1961q2-2009q3	-0.046**	1.809***	0.081**	1.75		2.12
Czech Republic	1995q2-2009q3	-0.038	1.190**	0.067			2.06
Denmark	1961q2-2009q2	-0.025	1.273***	0.045		2.23	3.82
Finland	1961q2-2009q3	-0.164***	1.990***	0.271***	1.65	1.73	2.06
France	1961q2-2009q3	-0.038**	2.124***	0.081**	2.13	2.98	
Germany	1961q2-2009q3	-0.029	0.802***	0.06			
Greece	1961q2-2009q3	-0.050**	3.136***	0.110**	2.22	3.25	
Hungary	1995q2-2009q2	-0.094*	2.868***	0.252			
Ireland	1961q2-2009q2	-0.019	0.485**	0.028			0.89
Italy	1961q2-2009q2	-0.052**	1.406***	0.092**	1.78	3.17	2.67
Japan	1961q2-2009q3	-0.037**	1.165***	0.055**	1.50		2.47
Korea	1970q2-2009q3	-0.132**	2.029***	0.205**	1.56	1.83	2.06
Luxembourg	1961q2-2009q2	-0.079***	0.208	0.108***	1.37		1.64
Mexico	1961q2-2009q2	-0.021	2.653***	0.060**		3.65	2.34
Netherlands	1961q2-2009q3	-0.033	0.383***	0.054		2.42	2.16
New Zealand	1961q2-2009q2	-0.116***	0.753***	0.200***	1.73	1.97	1.91
Norway	1961q2-2009q3	-0.076***	0.435	0.071**	0.93	1.33	2.62
Poland	1995q2-2009q3	-0.256**	3.474***	0.510**	1.99		1.75
Portugal	1961q2-2009q3	-0.02	0.960***	0.038		2.62	3.66
Slovak Rep.	1993q2-2009q3	-0.061	0.793*	0.076			
Spain	1961q2-2009q3	0.004	-0.273	-0.036		3.73	2.21
Sweden	1961q2-2009q3	-0.148***	0.868***	0.266***	1.79		1.86
Switzerland	1961q2-2009q3	-0.02	1.081***	0.045			1.84
Turkey	1961q2-2009q2	-0.054*	2.199***	0.109*	2.03	2.68	1.74
United Kingdom	1961q2-2009q3	-0.188***	1.343***	0.385***	2.05	2.56	
United States	1961q2-2009q3	-0.077***	1.695***	0.154***	1.99	2.72	

Note: OLS estimation with robust standard errors. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. The multiplier is not reported when the coefficients used to calculate it are not significant.
Source: Authors' calculation, based on OECD (2010).

The estimated equation becomes:

$$\Delta m_t = \alpha_0 + \delta_1 m_{t-1} + \delta_2 \Delta y_t + \delta_3 y_{t-1} + \delta_4 VS y_{t-1} + \delta_5 VS + \epsilon_t \tag{14.9}$$

where VS is the country vertical specialization share, calculated as in Hummels, Ishii and Yi (2001).[104]

[104] Data come from Miroudot and Ragoussis (2009). Time series have been created over the period 1995 – 2009 with three data points (1995, 2000 and 2005 for most countries). Because the country vertical specialization share (VS) data are imputed within these base years, there is no guarantee that the variable accurately reflects the variation over time of the vertical specialization share. The assumption is that this share is relatively stable over years and that the trend suggested by the three data points is enough to account for its evolution.

The vertical specialization variables slightly increase the goodness-of-fit of the model for most countries but are not always significant. To see to what extent vertical specialization can help to explain the trade collapse during the crisis, we conduct a forecasting exercise. For each quarter, we predict the value of imports based on the estimated model. We then compare the results between the first model (without vertical specialization) and the second model (with vertical specialization). As it can be seen in Table 14.3, the discrepancy between the predicted change in trade and the observed trade collapse is only marginally reduced when using the specification with vertical specialization. The difference in percentage points tends to be lower for most countries but not in a way that has significantly increased the ability of the model to predict the trade collapse, even if vertical specialization has shaped the dynamics of transmission.

We can conclude this section by pointing out that there is no convincing evidence that trade elasticities have increased as a consequence of vertical integration and the fragmentation of production in global supply chains. Analyzing the long-run elasticity of imports to GDP, the ECM analysis confirms the increase at the end of the 1990s that we could attribute to the transitional reorganization of world production, as elasticities revert to their pre-1990s values in the second half of the 2000s. But the aggregated result is not always present at country level and more evidence would be needed to fully attribute this change in elasticities to international supply chains. In the next chapter, we use a different methodological approach to further assess, from a sectoral and microeconomic perspective, the relationship between trade and income during a global downturn.

Table 14.3: Predicted change in imports and observed values (estimates from the error correction model)

Country	Observed change in imports			Model 1 — No VS variable						Model 2 — With VS variable					
				Predicted change			Difference in % points			Predicted change			Difference in % points		
	2008Q4	2009Q1	2009Q2	2008Q4	2009Q1	2009Q2	2008Q4	2009Q1	2009Q2	2008Q4	2009Q1	2009Q2	2008Q4	2009Q1	2009Q2
Australia	-8.2%	-7.9%	2.1%	-2.1%	0.5%	2.0%	-6.1	-8.5	0.1	-2.3%	-0.5%	0.4%	-5.9	-7.5	1.7
Austria	-4.2%	-5.8%	-2.4%	-2.7%	-5.4%	-1.6%	-1.5	-0.4	-0.8	-3.0%	-5.6%	-2.2%	-1.3	-0.2	-0.2
Belgium	-8.6%	-5.8%	-1.2%	-6.1%	-3.9%	1.0%	-2.6	-1.9	-2.2	-6.2%	-3.9%	0.9%	-2.4	-1.9	-2.0
Canada	-6.7%	-12.5%	-1.8%	-5.0%	-6.1%	-1.4%	-1.6	-6.3	-0.4	-4.7%	-5.6%	-0.1%	-2.0	-6.8	-1.7
Czech Republic	-6.0%	-8.3%	-1.4%	-0.2%	-4.6%	1.0%	-5.8	-3.7	-2.3	-0.4%	-4.0%	4.3%	-5.6	-4.3	-5.7
Denmark	-3.2%	-8.2%	-4.0%	-3.9%	-3.6%	-4.7%	0.6	-4.7	0.7	-4.0%	-3.7%	-3.7%	0.8	-4.5	-0.3
Finland	-7.4%	-18.7%	-4.6%	-11.3%	-13.8%	1.0%	4.0	-4.9	-5.6	-10.5%	-14.8%	-2.2%	3.1	-3.9	-2.4
France	-3.3%	-6.2%	-2.7%	-4.7%	-4.4%	0.7%	1.4	-1.8	-3.4	-4.9%	-5.1%	-0.2%	1.5	-1.1	-2.4
Germany	-4.3%	-5.8%	-5.6%	-2.9%	-5.1%	-0.3%	-1.4	-0.7	-5.2	-3.1%	-5.0%	-0.2%	-1.1	-0.8	-5.4
Greece	2.3%	-14.4%	-2.9%	-2.8%	-2.6%	-1.3%	5.1	-11.8	-1.6	-3.9%	-5.4%	-2.3%	6.3	-9.0	-0.6
Hungary	-9.1%	-9.5%	-2.2%	-6.2%	-7.9%	-5.9%	-2.9	-1.6	3.6	-6.2%	-8.4%	-6.3%	-2.9	-1.1	4.1
Ireland	-4.5%	-3.1%	1.0%	-1.6%	-0.4%	0.6%	-2.9	-2.7	0.4	-3.0%	-3.4%	-3.1%	-1.5	0.3	4.1
Italy	-5.9%	-9.4%	-3.1%	-5.4%	-7.2%	-0.7%	-0.5	-2.2	-2.3	-5.9%	-7.9%	-2.1%	0.0	-1.6	-1.0
Japan	-1.6%	-16.2%	-3.5%	-5.7%	-8.6%	1.5%	4.1	-7.6	-4.9	-6.1%	-9.6%	-0.2%	4.5	-6.7	-3.3
Korea	-15.3%	-8.7%	8.4%	-16.7%	-0.8%	7.8%	1.4	-7.9	0.7	-	-	-	-	-	-
Luxembourg	-8.9%	-9.0%	-0.8%	-2.6%	-0.5%	2.5%	-6.3	-8.5	-3.3	-3.3%	-0.7%	2.7%	-5.6	-8.2	-3.5
Mexico	-12.7%	-13.2%	-6.2%	-6.2%	-15.7%	-0.5%	-6.5	2.5	-5.7	-	-	-	-	-	-
Netherlands	-3.8%	-5.6%	-2.3%	-1.9%	-4.2%	-1.1%	-1.9	-1.4	-1.1	-2.0%	-4.3%	-1.2%	-1.9	-1.3	-1.0
New Zealand	-7.0%	-8.6%	-3.8%	-2.0%	-0.3%	3.0%	-5.0	-8.4	-6.9	-5.4%	-4.3%	-1.8%	-1.6	-4.3	-2.0
Norway	-6.0%	-8.1%	1.5%	-1.1%	-0.6%	0.4%	-4.9	-7.5	1.0	-1.0%	-0.3%	0.8%	-5.0	-7.8	0.6
Poland	-7.9%	-7.0%	-6.1%	-3.2%	-0.4%	2.7%	-4.7	-6.6	-8.9	-3.6%	-0.7%	2.5%	-4.3	-6.3	-8.6
Portugal	-6.7%	-8.1%	-2.2%	-4.8%	-4.9%	1.1%	-1.8	-3.2	-3.3	-4.7%	-4.6%	1.1%	-2.0	-3.5	-3.3
Slovak Republic	-4.6%	-15.5%	-1.1%	0.1%	-8.0%	0.7%	-4.7	-7.5	-1.8	-0.2%	-7.8%	1.9%	-4.3	-7.7	-3.1
Spain	-6.5%	-11.8%	-2.4%	-7.3%	-9.3%	-3.0%	0.8	-2.5	0.6	-7.5%	-9.2%	-2.3%	1.0	-2.5	-0.1
Sweden	-3.1%	-12.8%	-0.9%	-5.8%	-2.3%	0.9%	2.7	-10.5	-1.9	-5.8%	-2.3%	1.0%	2.7	-10.5	-1.9
Switzerland	-4.6%	-1.6%	-4.2%	-1.8%	-2.0%	-0.2%	-2.8	0.4	-3.9	-	-	-	-	-	-
Turkey	-18.7%	-7.6%	3.1%	-11.8%	-7.4%	8.5%	-6.8	-0.1	-5.4	-11.7%	-7.3%	8.6%	-6.9	-0.3	-5.6
United Kingdom	-5.6%	-7.3%	-2.2%	-5.3%	-7.2%	-0.7%	-0.3	-0.1	-1.5	-5.1%	-7.0%	-1.7%	-0.6	-0.2	-0.5
United States	-4.6%	-11.3%	-4.0%	-4.2%	-4.8%	-0.7%	-0.4	-6.6	-3.3	-4.5%	-6.0%	-1.9%	-0.1	-5.3	-2.1

Source: Authors' calculation, based on OECD (2010).

15 Trade Multipliers from an Input-Output Perspective

The speed and simultaneity of the 2008-2009 crisis is unprecedented and indicates that there might have been a mutation in the way economic pandemic spread across the world. In previous instances of global turmoil, the transmission of shocks was mainly of macroeconomic nature: A recession in a foreign economy reduced demand for exports, which in turn depressed the activity in the home country. This traditional vision is compatible with trade theories where countries exchange finished products (consumer or investment goods) and are therefore vulnerable to fluctuations in the level of their trading partners' final demand.

Global supply chains introduce new microeconomic dimensions that run parallel to the traditional macroeconomic mechanism of shock transmission. In the context of fragmented production and offshoring, adverse external shocks affect firms not only through their sales of finished goods (the final demand of national accounts), but also through fluctuations in the supply and demand of intermediate inputs. In this section, we further characterize the role of global supply chains in the trade collapse by first looking at evidence on the magnification and composition effects in input-output tables[105] and then examining the inventory and the bullwhip effect of global supply chains.

[105] A short formalization of the input-output analysis can be found in chapter 17.E in the appendix.

15.1 Growth of Trade in Intermediate Inputs and Vertical Specialization

We focus on the United States and Asia, a subset that epitomizes the vertical integration phenomenon from both a micro and macro perspective. The investigation, based on observed data, relies on national accounts and statistics on inter-sectoral trade in inputs produced by the Institute of Developing Economies Japan External Trade Organization (IDE-JETRO, 2009) for various benchmark years.[106] The information is presented as a set of interlinked input-output tables to form an estimate of the composition of intermediate and final flows of goods and services between home and foreign countries. The calculation of a "Leontief inverse matrix" derived from these input-output (IO) matrices is used to estimate the resulting effect of the series of direct and indirect effects on all domestic sectors of activity. This procedure allows to estimate the imported content of exports and to measure the vertical integration of productive sectors.[107]

As seen in Table 15.1, the observations on the United States and Asia, one of the most dynamic trade compact in the recent history of international trade, tend to support the "magnifying hypothesis" over the long-run. While exports of final products (consumer and investment goods) increased 7% in annual average over the 1990-2008 period, exports of inputs (intermediate consumption, in the national account terminology) raised by more than 10% per year. In the same time, imports of such intermediate goods increased by 9%.[108]

[106] We used the 7 sectors aggregation for 1990, 1995, 2000 and 2008 matrices. The data for 2008 are estimates; other years are derived from national accounts and countries' official statistics. For a presentation and evaluation, see IDE-JETRO (2006); Oosterhaven, Stelder and Inomata (2007); Inomata and Uchida (2009).

[107] The increase in the imported content of exports has been documented in various studies, starting with OECD (1992) and Fontagné, Freudenberg and Uenal-Kesenci (1996). See Miroudot and Ragoussis (2009); Koopman et al. (2010) for more recent estimates.

[108] Differences between imports and exports are due to the rest of the world (ROW). Within an international IO, trade is symmetric (bilateral exports should equal bilateral imports).

Table 15.1: Asia and the USA: annual growth of intermediate inputs and exports, 1990 – 2008

	Total imported intermediates	Exports		
		Intermediate inputs	Final goods and services	Total
Agriculture	9.5	3.5	13.0	5.9
Mining quarrying	15.6	7.6	...	7.9
Manufacturing	9.0	10.7	6.6	9.1
Total sectors	9.1	10.2	7.1	9.1

Note: Sum of China, Indonesia, Japan, Korea, Malaysia, Taipei, Philippines, Singapore, Thailand, and the United States in nominal values in US dollar; Total sectors include services and other sectors; 2008 estimates. Imports and exports include exchanges with the rest of the world.
Source: Authors' calculation, based on IDE-JETRO (2009).

Because intermediate goods include commodities, in particular fuels, and are valuated at nominal prices, imports of intermediate goods show the highest growth rate for mining and quarrying. But manufacturing is the sector where exports of intermediate products increased most since 1990, despite low, or even negative, changes in unit value. This comforts the hypothesis that vertical integration and trade in intermediate goods drove international trade in the recent past, and explained the trade collapse after September 2008.

Retrospectively, there is a clear signal that export-led growth among developing economies has been associated with higher reliance on manufacturing and imported inputs.[109] To mention a recent study on production sharing and the value added content of trade (Johnson and Noguera, 2010), countries systematically shift towards manufacturing exports, which have lower value added content on average, as they grow richer and this depresses the aggregate value added to export ratio per unit value.[110] These authors show that the largest exporters among developed countries (Germany and United States) see their value added content

[109] The relationship between export orientation and reliance on imported inputs is further analyzed in Figure 17.6 in chapter 17.E in the appendix.

[110] Obviously, this strategy of diversifying into manufacture allows the developing countries to increase labor productivity and generate more income per capita. Thus richer countries are not defined by the intensity of the creation of value added, but by its extension.

Table 15.2: Asia and USA: changes in exports and imported inputs elasticity, 1990 – 2008

		1. Exports	**2. d[Export/Output]**	**3. Elast.(imported inputs/exports)**	**1. Exports**	**2. d[Export/Output]**	**3. Elast.(imported inputs/exports)**	**1. Exports**	**2. d[Export/Output]**	**3. Elast.(imported inputs/exports)**	**1. Exports**	**2. d[Export/Output]**	**3. Elast.(imported inputs/exports)**
	Variation (%):	*YoY*	*PoP*	*YoY*	*YoY*	*PoP*	*YoY*	*YoY*	*PoP*	*YoY*	*YoY*	*PoP*	*YoY*
Country:	**Sector\Period:**	**1990 – 2008p**			**1990 – 1995**			**1995 – 2000**			**2000 – 2008p**		
China	**Agriculture**	7.5	0.6	1.4	3.6	-0.4	3.5	9.1	0.2	...	8.9	-0.4	2.3
	Mining quarrying	6.0	-6.8	4.1	2.2	-4.4	14.9	0.9	-1.8	36.8	11.9	-0.6	1.2
	Manufacturing	20.7	6.5	0.9	26.1	1.8	0.9	15.8	1.7	0.7	20.5	2.9	0.9
	Total sectors	20.1	3.7	0.9	27.3	1.5	0.9	14.3	0.7	0.9	19.5	1.6	0.9
Indonesia	**Agriculture**	15.3	3.3	1.0	15.8	0.4	0.3	9.1	2.3	2.9	19.1	0.6	0.8
	Mining quarrying	7.4	-17.6	3.1	1.4	-8.7	4.5	4.5	1.6	4.9	13.3	-10.5	2.7
	Manufacturing	9.7	-2.3	0.9	18.2	-0.7	0.9	6.4	7.9	...	6.7	-9.4	1.6
	Total sectors	8.8	-1.9	1.1	10.5	-2.4	1.4	5.3	5.7	0.2	10.1	-5.1	1.2
Japan	**Agriculture**	7.2	0.4	0.8	5.9	0.0	0.7	2.3	0.1	1.2	11.3	0.4	0.8

	Mining quarrying	5.7	1.6	1.0	6.8	0.1	...	-1.5	0.3	...	9.7	1.2	2.2
	Manufacturing	5.1	6.1	0.9	10.9	1.0	0.5	0.5	1.5	3.8	4.5	3.6	1.4
	Total sectors	5.4	2.0	1.0	11.6	0.1	0.5	0.8	0.5	1.5	4.6	1.4	1.7
Malaysia	**Agriculture**	0.1	-16.3	...	-12.0	-13.9	...	-1.3	-1.9	3.6	9.4	-0.6	1.5
	Mining quarrying	9.3	-5.7	1.7	-2.6	-5.0	0.9	6.3	-11.7	5.9	19.6	11.1	0.9
	Manufacturing	13.6	13.5	0.9	29.1	9.3	1.0	7.0	7.5	1.1	8.9	-3.4	0.7
	Total sectors	11.7	5.4	1.1	20.1	2.8	1.4	7.4	5.1	1.1	9.5	-2.5	0.6
Thailand	**Agriculture**	16.0	15.8	0.6	1.2	-1.4	11.3	-4.2	-0.1	1.7	42.4	17.2	0.5
	Mining quarrying	8.0	2.7	1.2	-15.5	-14.1	...	8.0	1.4	...	25.9	15.5	1.4
	Manufacturing	11.8	10.8	0.7	22.7	4.5	0.7	5.1	7.4	0.3	9.7	-1.0	0.8
	Total sectors	12.1	8.7	0.7	20.9	2.0	0.8	5.3	4.7	...	11.2	1.9	0.8
USA	**Agriculture**	4.6	1.7	2.1	5.0	0.7	2.0	-6.1	-1.5	...	11.8	2.6	1.2
	Mining quarrying	2.1	-0.4	7.2	-3.1	-0.2	...	-4.5	-0.4	...	10.0	0.3	1.7
	Manufacturing	5.1	0.2	1.5	12.0	0.9	0.7	1.0	-0.5	9.3	3.6	-0.3	1.8
	Total sectors	5.0	-0.1	1.7	10.8	0.2	0.9	0.6	-0.3	...	4.3	0.0	1.7

Note: Nominal values in national currencies, converted in US dollars using average IMF exchange rate. YoY: Average annual changes; PoP accumulated variation from initial to final year, in percentage points. Exports include final goods and intermediate consumption; intermediate inputs include oil and other commodities. "Total sectors" includes other industries and services. 2008p: preliminary estimates. Results should be interpreted with caution, as variations in exchange rates can greatly affect the comparison between benchmark years.
Source: Authors' calculations, based on IDE-JETRO (2009).

scaled down due to a more integrated production structure with their respective regional partners (NAFTA for the US, and EU for Germany).

The data compiled from national accounts data on Asian economies and the United States since 1990 confirm the positive relationship between export orientation (share of export over total output) and reliance on imported inputs. Table 15.2 indicates also that all the Asian economies increased their exposure to exports during the 1990 – 2008 period while the United States registered a slight reduction, especially before 2000.

The ratio of imported inputs in relation to total exports (all sectors together) is stable for most economies (aggregated results for column 3 — growth rate of imported inputs / growth rate of exports — are close to 1). The exceptions are the United States and Japan where elasticity is about 1.7 percentage points (i.e. an increase in 1 percentage point of exports necessitates a 1.7% increase in imported inputs). Considering the size of these economies, this would indicate that the increase in the weight of intermediate goods in world trade is the result of the change in business models in developed economies, rather than due to the emergence of developing countries. Moreover, the latter may both result and explain the former, as the recent industrialization phase of developing countries is closely linked to the outsourcing strategy of transnational corporations (Sturgeon and Gereffi, 2009).

15.2 Vertical Integration and Trade Elasticity

The previous results relate to the imported content of exports, a level variable, and do not have direct implication on the debate on the stability of the Trade/GDP elasticity. Table 15.3 goes further and looks into the weight of imported inputs in sectoral value added (and in GDP). Contrary to some pre-conceived ideas about export led growth, emerging countries are not only reprocessing goods for ex-

Table 15.3: Share of value added and imported inputs, 1990 – 2008

		VA/Total product. costs		Imported inputs/VA	
Country:	**Sector\Period:**	**1990**	**2008**	**1990**	**2008**
China	**Agriculture**	64.3	77.6	2.9	2.3
	Mining quarrying	46.2	77.1	1.6	4.6
	Manufacturing	28.2	32.2	24.9	37.3
	Total sectors	40.1	46.4	11.2	18.1
Indonesia	**Agriculture**	80.8	64.7	1.4	4.6
	Mining quarrying	80.3	67.0	1.3	11.4
	Manufacturing	33.2	30.5	44.3	32.3
	Total sectors	55.1	44.6	13.9	16.0
Japan	**Agriculture**	57.0	60.0	2.6	6.6
	Mining quarrying	48.6	45.0	3.3	10.5
	Manufacturing	34.0	35.5	18.5	32.8
	Total sectors	50.2	55.2	7.5	12.1
Malaysia	**Agriculture**	69.3	66.8	10.9	15.4
	Mining quarrying	80.8	50.8	5.2	22.4
	Manufacturing	30.2	24.7	78.7	131.2
	Total sectors	47.3	41.4	31.6	51.4
Thailand	**Agriculture**	66.2	53.3	8.4	18.4
	Mining quarrying	72.3	82.5	4.0	5.0
	Manufacturing	32.1	27.9	81.4	98.3
	Total sectors	47.5	45.0	32.0	39.6
USA	**Agriculture**	34.4	34.2	4.7	16.0
	Mining quarrying	75.1	55.3	3.5	28.2
	Manufacturing	39.9	36.2	17.1	30.9
	Total sectors	54.3	54.0	5.6	9.2

Note: In percentage. Total sectors also includes other sectors, in particular services. Total production costs include factorial inputs (labor and capital) and taxes, as measured by total value added (VA).
Source: Authors' calculations, based on IDE-JETRO (2009).

ports, but do also incorporate a sizable domestic content in their exports. While the share of domestic value added in total inputs (including factorial costs) for manufacturing is still lower for developing economies, compared with developed economies, the gap is closing for China.

More importantly for the purpose of the present study on trade and GDP elasticity, the weight of imported inputs in sectoral value added (and in GDP) has been increasing from 1990 to 2008 in all countries. The rate of increase is above 60%, except in Indonesia and Thailand (16% and 24%, respectively). The change

Table 15.4: Asia and USA: imported inputs coefficients, 2008

Sector/Country	China	Indonesia	Japan	Malaysia	Thailand	USA
Agriculture	0.08	0.07	0.06	0.25	0.16	0.09
Mining quarrying	0.11	0.04	0.06	0.17	0.09	0.10
Manufacturing	0.24	0.25	0.14	0.71	0.50	0.17
Services	0.12	0.09	0.03	0.25	0.15	0.04
Total sectors	0.22	0.17	0.12	0.60	0.42	0.12

Note: Normalized imported inputs requirements ($\Delta m^{IC}/\Delta d$). Total sectors includes other sectors.
Source: Authors' calculations, based on IDE-JETRO (2009).

is particularly significant when considering the manufacturing sector of the two developed economies, Japan and the United States, where the participation of imported inputs in total production costs has raised by an average of 80% between 1990 and 2008. With imported inputs contributing to more than 30% of their production costs in manufactures, these two industrialized countries are not far from the two largest developing countries of the Table: China (37%) or Indonesia (32%).

Finally, the intensity of the inter-industry linkages varies greatly from sector to sector, confirming the role of the composition effect. The reliance on imported inputs is consistently larger in manufacture than in other productive sectors, and also larger in smaller countries. At the extreme, the value of imported inputs may be more than industry's value added, as is the case of manufacture in Malaysia. As the sectoral import requirements differ from sector to sector, then the apparent import elasticity for the national economy will change according to the sectoral distribution of the shock.[111]

111 The more complex the production process, the more potential gains in outsourcing part of it; thus it is natural to expect much more vertical integration in the manufacturing sector. Miroudot and Ragoussis (2009) show that manufacturing sectors in OECD countries generally use more imported inputs than other industrial and services sectors. It is specially the case for final consumer goods like "motor vehicles" and "radio, TV and communication equipments", or computers. Services are, as expected, less vertically integrated into the world economy. But even these activities show an upward trend in the use of imported services inputs (e.g. business services).

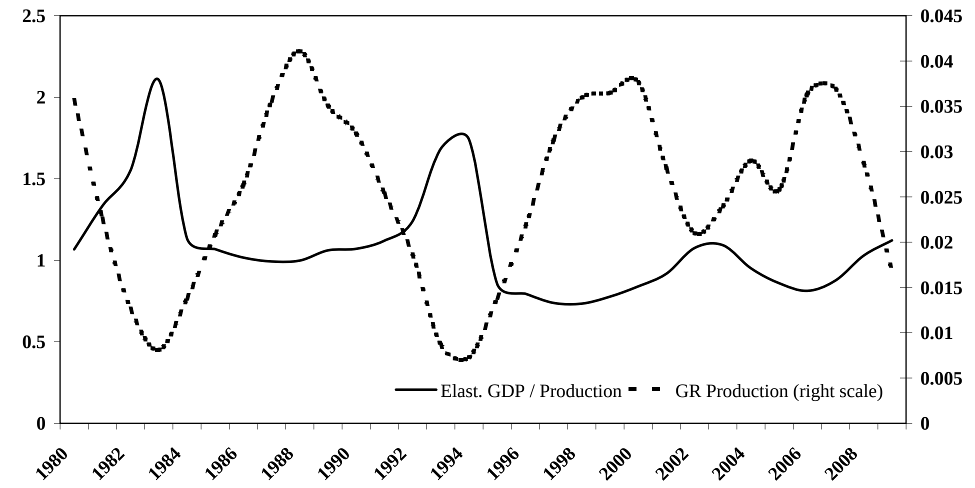
It was in particular the case after the financial crisis of September 2008, as demand for consumer durable and investment goods (consumer electronics, automobile and transport equipment, office equipment and computers, etc.) was particularly affected by the sudden stop in bank credits. Because these sectors are also vertically integrated, the impact on international trade in intermediate and final goods was high. Table 15.4 shows that the coefficients of imported inputs are much larger than in other sectors, for example agriculture or services.

Services sectors, which are the main contributors to GDP in developed countries and also the less dependent on imported inputs, were more resilient to the financial crisis than manufacture. But services and other non-tradable goods sectors will eventually be affected by the external shock (Figure 15.1).

Because the initial shock was concentrated on manufacture and other tradable goods, the most vertically integrated sectors, the apparent trade-GDP elasticity soared to approximately 5. In a second phase, the initial shock reverberates through the rest of the economy, transforming the global financial crisis into a great recession. GDP continues to slow down but the decrease in trade tends to decelerate as the import content of services sectors (its sectoral imported input-VA ratio, as shown before in Table 15.3) is much lower than for manufacturing sectors.

The four building blocs that were identified above are central for explaining the specificities of the 2008-2009 great trade collapse. First, we have evidence on the composition effect with trade in some industries falling by more than 30% in two consecutive quarters (see Table 17.1). This is only when demand falls in priority on sectors highly fragmented that global supply chains can play a role in the trade collapse. In addition, a disruption effect may be considered. When industrial production is spread across various countries, and all segments of the chain are critical to the other ones (supplied constrained networks), a shock affecting one segment of the chain will reverberate through the whole network. At

Figure 15.1: World production and GDP response, 1980 – 2009



Note: Five year rolling periods, constant prices, percentage growth and elasticity. Production includes agriculture, mining and manufactures.
Source: Authors' representation, based on WTO (2010).

the difference of the traditional macroeconomic transmission of shocks, impacts are moving forward, from supplier to clients, and not backward as in the traditional demand-driven Leontief model (from client to suppliers). The intensity of the supply shock will vary according to the affected industry; if the origin of the shock is a systemic credit crunch, it will affect disproportionably the international segments of the global supply chains, through increased risk aversion and shrinking trade finance (Escaith and Gonguet, 2009).

15.3 Inventory Effects

Besides these structural effects, recent changes in the apparent trade elasticity are also probably linked to inventories as mentioned by various analysts (Baldwin, 2009; Bénassy-Quéré et al., 2009, among others), as retailers run-down their stocks in reaction to a large drop in final demand. Here again, this traditional macroeconomic effect on inventories is amplified on the microeconomic side by the new business model that surged in the late 1980s and opened the way to international vertical integration. Even under the "just-in-time" management (production-to-order) favored by global supply chain managers, geographically fragmented networks need to maintain a minimum level of inventories (buffer stocks) in order to face the usual risks attached to international transportation. While large players try to keep their inventories at the lowest possible level considering their sales plans and the acceptable level of risk, they tend in the same time to force their suppliers to maintain large stocks (production-to-stock) in order to be able to supply them quickly upon request. In addition, some up-stream suppliers, engaged in highly capitalistic processes such as foundries, need to process large batches in order to benefit from economies of scale and lower their unit costs.

As a result, there is always a significant level of inventories in a global supply chain, translating into a higher demand for banking loans (Escaith and Gonguet, 2009). When a drop in final demand reduces the activity of down-stream firms, or/and when they face a credit crunch, their first reaction is to run down their inventories. Thus, a slow-down in activity transforms itself into a complete stand-still for the supplying firms that are located up-stream.

These amplified fluctuations in ordering and inventory levels result in what is known as "bullwhip effect" in the management of production-distribution systems (Stadtler, 2008). This effect is more sensitive in an international setting. Alessandria, Kaboski and Midrigan (2010a) provide direct evidence that participants in international trade face more severe inventory management problems. Importing firms have inventory ratios that are roughly twice those of firms that only purchase materials domestically, and the typical international order tends to be about 50 percent larger and half as frequent as the typical domestic one. The related international trade flows, at the microeconomic level, are therefore lumpy and infrequent. As long as the down-stream inventories of imported goods have not been reduced to their new optimum level, foreign suppliers are facing a sudden stop in their activity and must reduce their labor force or keep them idle.

The timing and intensity of the international transmission of supply shocks may differ from traditional demand shocks applying on final goods. For example, the supply-side transmission index proposed by Escaith and Gonguet (2009) implicitly assumes that all secondary effects captured by the IO matrix occur simultaneously, while these effects may actually propagate more or less quickly depending on the length of the production chain. Also, there might be contractual pre-commitments for the order of parts and material that manufacturers have to place well in advance in order to secure just-in-time delivery in accordance to their production plans (Uchida and Inomata, 2009).

Nevertheless, in closely integrated networks, these mitigating effects are probably reduced, especially when the initial shock is large. A sudden stop in final demand is expected to reverberate quickly through the supply chain, as firms rundown their inventories in order to adjust to persistent changes in their market. This inventory effect magnifies demand shocks and is principally to blame for the initial collapse of trade in manufacture that characterized the world economy from September 2008 to June 2009. A study on the electronic equipment sector during the crisis (Dvorak, 2009) indicates that a fall in consumer purchase of 8% reverberated into a 10% drop in shipments of the final good and a 20% reduction in shipments of the related intermediate inputs (e.g. computer chips and other parts). The velocity of the cuts was much faster than in previous slumps, as reordering is now done on a weekly basis, instead of the monthly or quarterly schedules that prevailed up to the early 2000s.

16 Conclusions

The essay investigates the role of global supply chains in explaining the long-term trade elasticity and its short-term volatility in the context of the 2008-2009 trade collapse. A question that is of importance for its economic and financial implications, but also for its social impact as the reorganization of global supply chains implies the destruction and creation of jobs at different locations.

The results obtained from the exploratory analysis highlight that import elasticities have been in general very volatile and suggest the specification of a statistical ECM model to measure the respective short-term and long-term dynamics of trade elasticity. Aggregated results obtained using both exploratory and ECM models tend to support the hypothesis that long-term trade elasticity has raised during the 1990s, before lowering in the late 2000s. The concept of equilibrium implies, however, that vertical integration should only affect the level of trade relative to GDP but not the elasticity. While we expect the trade elasticity to be stable in the long-run, we also recognize that the pattern observed from the data is compatible with a structural change from one equilibrium (an economy where countries trade final goods) to another one (a "trade in tasks" economy, where countries trade also intermediate goods in a global supply chain). Accordingly, from the late 1980s onwards, the internationalization of production has caused a shift from a low-fragmented economy to a highly-fragmented economy with trade elasticities rising only during the transition phase, coming back then to their long-run level, at a new equilibrium where trade represents a higher share of GDP.

On the other hand, while the aggregate results did provide ground for the shifting-equilibrium hypothesis, disaggregated analysis could not confirm the generality of the hypothesis at individual country level. Indeed, a more detailed analysis showed significant differences among trade elasticities for different countries and sectors. Moreover, when a more formal specification is used, and vertical specialization is explicitly included as an explanatory variable, the results still remain inconclusive.

In the short run, the essay shows that a shock affecting differently distinctive sectors of the economy could also have a transitory impact on the trade elasticity of the whole economy, explaining some of the volatility observed in the data. Two supply chain related factors are at work to explain the overshooting of trade elasticity that occurred during the 2008-2009 trade collapse. The first one is the composition effect, as the initial demand shocks linked to the credit crunch concentrated disproportionably on consumer durables and investment goods, the most vertically integrated industrial sectors; the second one is the bullwhip effect where inventory adjustments are amplified as one moves upstream in the supply chain. But the disturbance is expected to dissipate and the elasticity to return to its long-run value. Evidence for a magnification effect, however, could not be found.

Overall, given these findings, we rather tend not to fully accept the hypothesis that global supply chains explain all by themselves the changes in trade-income elasticity. However, our results clearly indicate that they did have a role in the short-term world trade volatility observed during the crisis through the composition and bullwhip effects. More importantly, global supply chains should not lead to higher trade elasticities in the long-run.

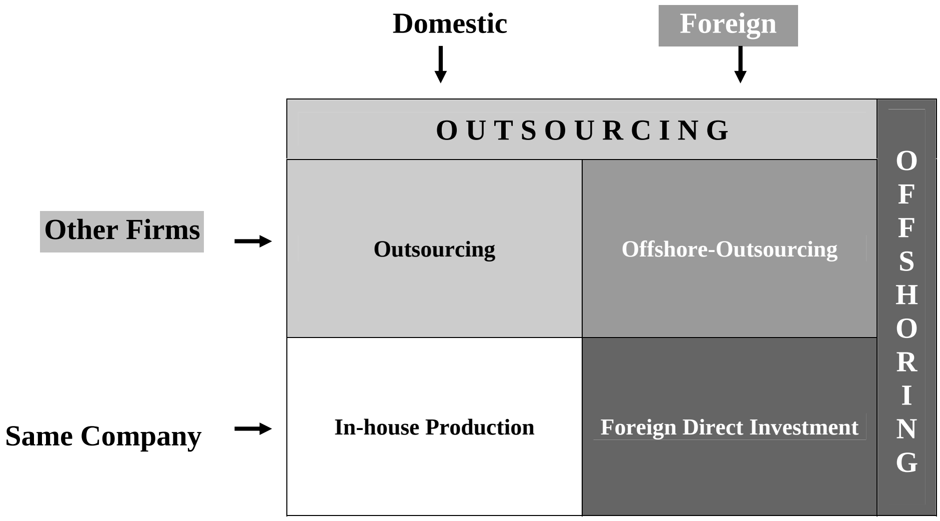
17 Appendix

In the following sections additional background information and robustness checks will be provided. The appendix is structured as follows: section 17.A discusses the definition of offshoring, outsourcing and the measure of vertical integration; section 17.B provides a broader literature review on supply chains and offshoring; section 17.C gives the definition of trade elasticities, outlines the situation in the recent global crisis, and provides trade elasticities by export specialization and by regions before giving an overview of the exact composition of the different clusters used in this analysis. Section 17.D contains some background information for the estimation with the error correction model, i.e. unit-root and cointegration tests as well as a computed impulse response function of the reaction of a decrease in GDP on trade. Finally, section 17.E comprises a formalization of the input-output-analysis and provides information on the relationship between export orientation and reliance on imported inputs.

17.A Offshoring, Outsourcing and the Measure of Vertical Integration

In this part of the dissertation the role of supply chains in global crises has been discussed. In order to provide some background information to the conducted

Figure 17.1: Differentiation between outsourcing and offshoring



Source: Authors' representation.

analysis, we start by defining the concepts of offshoring and outsourcing. Furthermore, we explain how vertical integration can be measured.

Definition of offshoring and outsourcing

The current crisis has important implications as the consequences are not only of an economic and financial nature. There is also a social impact as the reorganization of global supply chains implies the destruction and creation of jobs at different locations. During the 1990s, firms offshored and outsourced part of their production and built global supply chains, two phenomena that define globalization and are often mixed up. The relevant process when discussing global supply chains is offshoring, which comprises both offshore-outsourcing and foreign direct investments (FDI). Outsourcing to another domestic firm is not considered. Figure 17.1 gives an overview of the distinction between outsourcing and offshoring.

Measure of vertical integration

The fragmentation of the supply chain can be measured using three different methods. Some authors use firm surveys to account for the fragmentation of the value chain, others use foreign trade statistics and look, for example, at the share of parts and components in trade flows as an indicator for increased international production-sharing. A third possibility is offered by international input-output tables that relate the output of one industry to the inputs of other industries, accounting for different countries, giving information on how each industry depends on other industries, both as customer and as supplier of intermediate inputs. For example, Hummels et al. (2001) calculate the extent of vertical specialization, i.e. the share of imported inputs in total exports used for industrial production. One short-coming, however, of international input-output tables is that the data quality could often be improved and that they are not available on a yearly basis. They are nonetheless a powerful tool for measuring the size of production linkages and tracking the international transmission of demand and supply shocks.

17.B Review of the Literature on Offshoring

So far, we have only given a literature review on the recent trade collapse. This section will go one step further and present relevant contributions to the literature on offshoring in general.

Trade in tasks and the fragmentation of production along global supply chains have challenged the validity of traditional trade models, based on the exchange of final goods, each country specializing in a certain type of products. By introducing imperfect competition, consumer preference for variety, economies of scale and the heterogeneity of producers, recent trade models can explain that countries that are similar in factor endowment and technology have developed a significant part of their trade in the same products, and trade intermediate goods between their industries. These models also explain why firms offshore and outsource part of their production and build global supply chains (see Helpman, 2006; WTO, 2008b, for a review).

The tendency to locate production stages in other countries is favored by several factors. First of all, overall trade costs have decreased in the last decades, i.e. not only tariffs have fallen, but also transport and communications costs as well as the time cost of transport (Jacks, Meissner and Novy, 2008). A second important factor has been that through better infrastructure and logistic services, the reliability and timeliness of delivery has improved significantly (Hummels et al., 2001; Nordås, Pinali and Grosso, 2006). Finally, technological improvements, i.e. advances in IT, made it possible to separate geographically an increasing number of services tasks (Jones and Kierzkowski, 1990).

An illustrative example of a globalized supply chain can be found in Linden, Kraemer and Dedrick (2007), who study the case of Apple's iPod. Nordås (2005) gives a review of vertical specialization and presents six country case studies analyzing production sharing in the automotive and the electronics industry. Sturgeon and Gereffi (2009) contribute to the understanding of the phenomenon from a business perspective, providing an overview of the microeconomic evidence and the role of outsourcing in industrial upgrading and competitiveness, while pointing-out some crucial data issues.

On the conceptual side, a straightforward introduction to the economics of offshoring, the underlying motivations and effects is given in Smith (2006). Grossman and Rossi-Hansberg (2008) present a model of offshoring where the production process is represented as a continuum of tasks. The authors, thus, focus on tradable tasks rather than on trade of finished goods, i.e. during the production process, different countries participate in global supply chains by adding value. Yet another model of offshoring is proposed by Harms, Lorz and Urban (2009) who allow for variations of the cost saving potential along the production chain and consider transportation costs for unfinished goods. Within this framework they can explain large changes in offshoring activities with small variations of the parameters of their model. The link between the offshoring literature and the research on firm heterogeneity is established in Mitra and Ranjan (2008). They construct an offshoring model with firm heterogeneity and externalities and study the effects of temporary shocks on offshoring activities.

Grossman and Helpman (2005) develop a model to study outsourcing decisions focusing on equilibria where some firms outsource in the home country and others abroad. In an earlier paper (Grossman and Helpman, 2002) the authors propose a general equilibrium model of the "make-or-buy-decision", i.e. the decision between insourcing and outsourcing. A model that allows firms to choose between vertical integration and outsourcing, as well as between locating the production at home or in the low-wage South is proposed by Antràs and Helpman (2004). They point out that the more productive firms source inputs in low-cost countries whereas less productive firms in the high-cost countries of the North. Besides, if both types of firms acquire inputs in the same country, the former insource and the latter outsource.

An explanation for the steady increase in outsourcing activities is offered by Şener and Zhao (2009), who analyze the globalization process by setting up a dynamic model of trade with endogenous innovation, where a local-sourcing-targeted and an outsourcing-targeted R&D race take place at the same time. The latter represents the so called "iPod cycle" where firms combine innovation activity with simultaneous outsourcing, a form of R&D strategy which becomes more and more important. Ornelas and Turner (2008) propose another model that explains the current trend towards foreign outsourcing and intra-firm trade. That the motivation for outsourcing can also be strategic rather than cost-motivated is shown by Chen, Ishikawa and Yu (2004). They model strategic outsourcing as a response to trade liberalization in the intermediate-product market.

Of particular relevance for the present analysis, various papers help to understand the volatility linked to globalized activities. Du, Lu and Tao (2009) elaborate a model on bi-sourcing, i.e. simultaneous outsourcing and insourcing for the same set of inputs, a strategy that is more and more often adopted by multinational enterprises. The use of this strategy, with the inherent options of preferring either the external or the internal source of intermediate inputs, may explain part of the reduction of trade flows in times of economic crisis.

A model of in-house competition, i.e. between the different facilities of a multi-plant firm, is introduced by Kerschbamer and Tournas (2003). Their model shows that in downturns firms may decide to produce in the establishment that has higher costs even when it would also be possible to locate production to the lower cost facility. The stability of supply chain networks is studied in Ostrovsky (2008), who proposes a model of matching in supply chains. The author deduces the sufficient conditions for the existence of stable networks which, however, rely on the assumptions of the model of same-side substitutability and cross-side complementarity. Bergin, Feenstra and Hanson (2009) analyze empirically the volatility of the Mexican export-processing industry compared to their US counterparts with a difference-in-difference approach; they find that, on average, the fluctuations in value added in the Mexican outsourcing industries are twice as high as in the US. In addition, the authors propose a theoretical model of outsourcing that can explain this stylized fact.

17.C Trade Elasticities

After providing definitions and additional information on outsourcing and offshoring, we focus in the following section on trade elasticities. After discussing the concept of trade elasticity and describing the reaction of trade and GDP in the recent crisis, we provide some robustness checks on the evolution of trade elasticities in the last decades. We finish this section with an overview of the different clusters used in this part of the dissertation.

Definition of trade elasticity

Elasticities measure the responsiveness of demand or supply to changes in income, prices, or other variables. Two prominent representatives of elasticities are the income elasticity and the price elasticity of demand. While the former measures the percentage change in the quantity demanded resulting from a one-percent increase in income, the latter measures the percentage change in the quantity demanded resulting from a change of one percent in its price.

$$E_P = \frac{\Delta Q/Q}{\Delta P/P} = \frac{P}{Q}\frac{\Delta Q}{\Delta P} \qquad \text{and} \qquad E_I = \frac{\Delta Q/Q}{\Delta I/I} = \frac{I}{Q}\frac{\Delta Q}{\Delta I} \quad ,$$

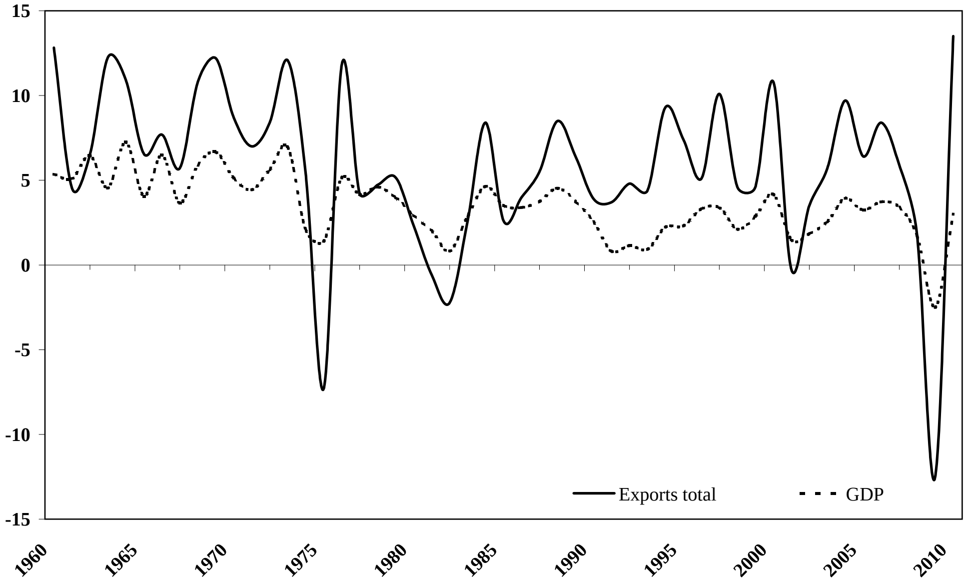
with E = elasticity, Q = quantity demanded, P = price, and I = income.

In consumer theory, price elasticity is complemented by elasticity of substitution between competing goods and services, leading to the concept of indifference curves. In this contribution we are, however, focusing on the macroeconomic income elasticities of trade, in short, trade elasticities.

It is important to remember that in most of the literature reviewed in this part of the dissertation, neither price effects nor substitutions effects are explicitly taken into consideration in this context. Thus, the trade elasticities are reflecting the pure effect of a change in domestic income (measured by GDP) to the quantity of imports. It is also the convention that we have adopted in the rest of the dissertation.

The variation in the relative price of exports and imports is, nonetheless, implicitly taken into consideration in the calculation of the domestic product. Because GDP, on the demand side, is equal to the sum of consumption, investment and the net balance between exports minus imports (X-M), any changes in the terms of

Figure 17.2: World merchandise exports and GDP, 1960 – 2010



Note: Real annual percentage change.
Source: Authors' representation, based on WTO (2010).

trade that affect (X-M) will be reflected, ceteris paribus, into the domestic product. The terms of trade effect is immediate when GDP is computed at current prices; it is formally imputed by national accounts when elaborated at constant prices.

Situation in the recent global crisis

Trade reacted very strongly to the first signals of recession in 2008 (see Figure 17.2), with a decrease of much higher magnitude than the fall in GDP. Similarly, trade rebounded strongly in 2010, much faster than the underlying world economy. Contrary to the fears of deglobalization which accompanied the large drop of 2008-2009, this robust recovery tends to entail the existence of a higher trade elasticity.

The sectors most affected were fuels and minerals, due to a strong price effect, and machinery and transport equipment because of a strong demand effect (see Table 17.1). Indeed, consumer durable and capital goods were on the front line,

Table 17.1: Quarterly growth of world manufactures exports by product

Sectors/Quarter	08:1	08:2	08:3	08:4	09:1	09:2	09:3
Manufactures	-1	9	-2	-15	-21	8	9
Office and telecom equipment	-13	5	5	-10	-27	13	14
Automotive products	1	6	-14	-18	-33	15	12
Iron and steel	10	23	7	-34	-32	-7	10
Ores and other minerals	10	21	4	-33	-35	12	25

Note: Percentage change over previous quarter, current dollar values, 2008 Q1 – 2009 Q3.
Source: Authors' calculation, based on WTO (2010).

as demand for these products relies on credit, which dried-up as banks closed their loan windows and flocked to liquidity. In turn, the lower industrial activity reversed brutally the trend in the prices of key primary commodities, which had been rising substantively since 2003.

The speed and simultaneity of the 2008-2009 crisis is unprecedented, and indicates that there might have been a mutation in the way economic pandemic spread across the world. In previous instances of global turmoil, the transmission of shocks was mainly of macroeconomic nature: A recession in a foreign economy reduced demand for exports, which in turn depressed the activity in the home country. This traditional view is compatible with the Ricardian approach of international economy, when countries exchange finished products (consumer or investment goods) and are therefore vulnerable to fluctuations in the level of their trading partners' final demand.

Global supply chains introduce new microeconomic dimensions that run parallel to the traditional macroeconomic mechanism of shock transmission, explaining in large part the magnifying effect of the crisis on international trade. Some of the mechanisms are purely of accounting nature: while GDP is computed on a net basis, exports and imports are registered on their gross value. In addition, because supply chains cover various countries, a lot of double counting takes place while goods for processing cross the borders at each step of the production process.

But the core of the explanation is to be found in the economic implications of the structural changes that affected world production since the late 1980s. In the contemporaneous context, adverse external shocks affect firms not only through their sales of finished goods (the final demand of national accounts), but also through fluctuations in the supply and demand of intermediate inputs. It has therefore been tempting to attribute the large trade-GDP elasticity to the leverage effect induced by this geographical fragmentation of production.

Trade elasticity by export specialization

In order to give the best chance to find evidence for the hypothesis of a magnification effect, i.e. of global supply chains being the driving force behind the changes in trade elasticity, we build some more clusters of countries by export specialization. For instance, we construct country clusters with the help of the "export structure by product" as compiled by UNCTAD (2008, Table 3.2D (year 2005-2006)). For each of our 49 countries all export products with a share among the country's exports of 5% or higher have been extracted (if no product exceeds 5%, the product with the highest share is taken). These export groups are classified on a Standard International Trade Classification (SITC) Rev.3 3-digit basis. Then, we constructed clusters of countries with the same export products on a 2-digit basis (in order to have clusters with a significant number of countries); and undertook the analysis with those clusters that comprise at least three countries. The analysis was conducted with the following export-product-country groups: Metalliferous ores and metal scrap exporters; coal, coke and briquettes exporters; petroleum, petroleum products and related materials exporters; gas, natural and manufactured, exporters; medicinal and pharmaceutical products exporters; office machines and automatic data-processing machines exporters; telecommunications and sound-recording and reproducing apparatus and equipment exporters; electrical machinery, apparatus and appliances, and electrical parts thereof exporters;

Figure 17.3: GDP elasticity of imports — export specialization (main product)

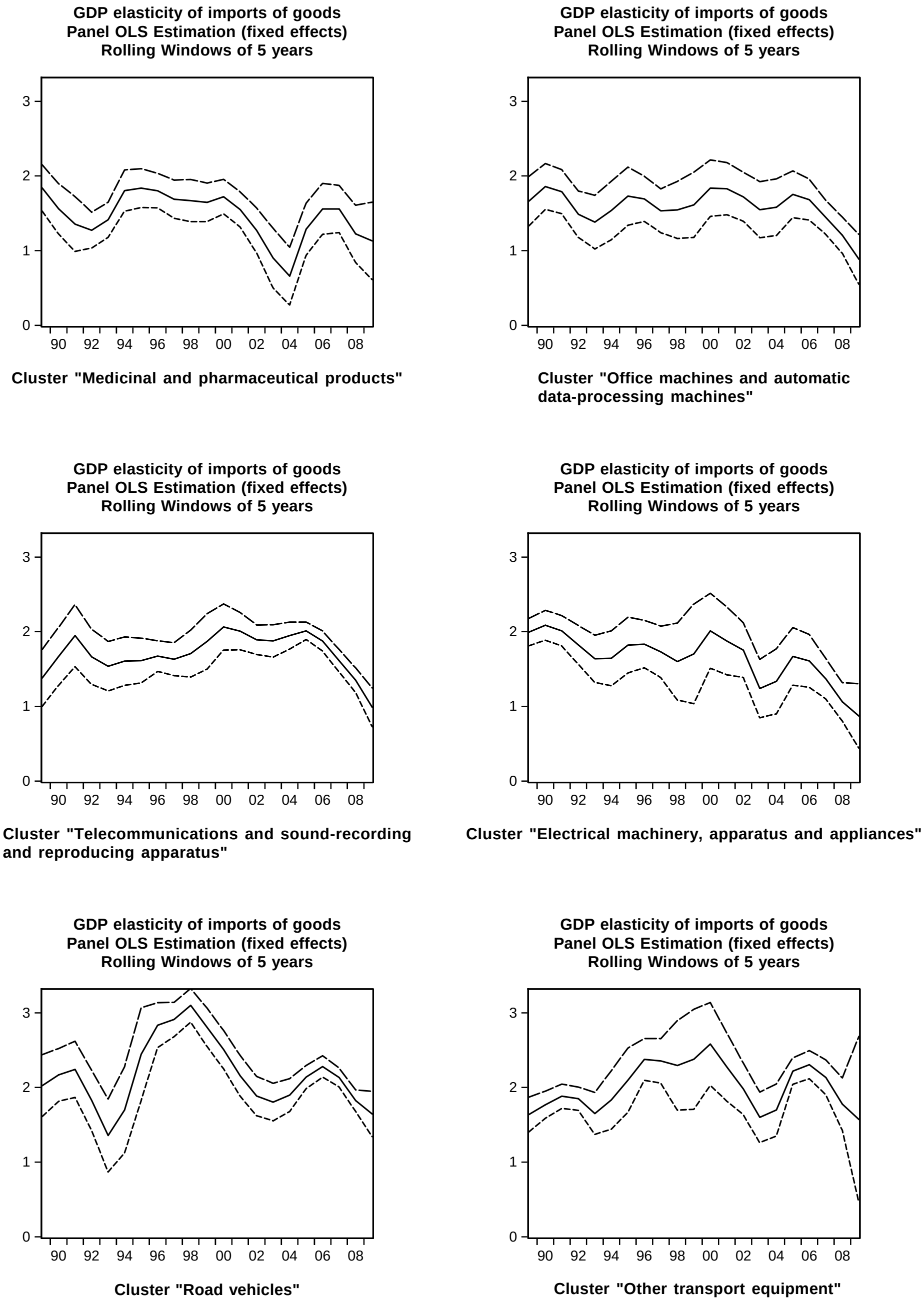
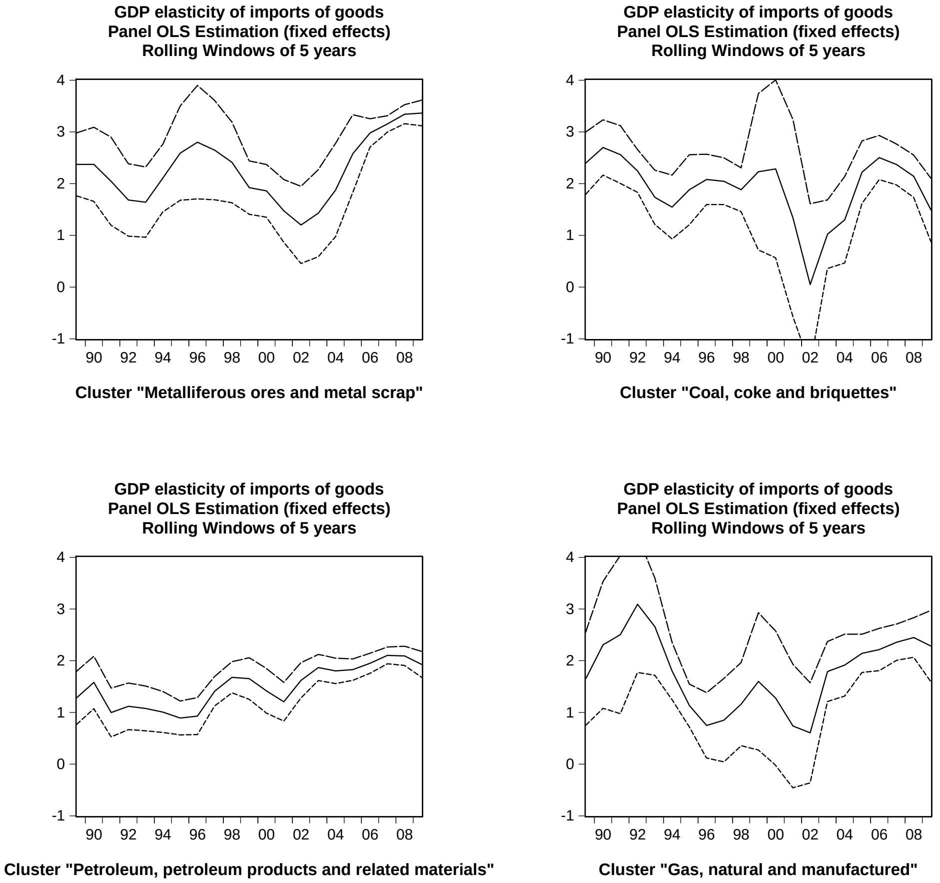


Figure 17.3: continued



Note: Description of clusters see text.
Source: Authors' calculations, based on IMF (2009).

road vehicles (including air-cushion vehicles) exporters; and other transport equipment exporters.

However, using the main export products of each country does not change the result qualitatively either: the hypothesis of an impact of the global supply chains on the changes in GDP elasticity of imports can still not be confirmed by our explorative data analysis. The results of this robustness check can be found in Figure 17.3.

Trade elasticity in the world

Another robustness check for long-term trade elasticities among individual countries consists in analyzing regional clusters. In the literature countries of the same region are often expected to show the same economic reactions. The motivation for this assumption are probably geological and political similarities among the countries.

We construct the following regional clusters: Latin America, Emerging Asia, New EU-Member States, Middle East, G7-Countries, and Western European countries. Results of the panel OLS estimation with rolling windows of 5 years are displayed in Figure 17.4.

Trade elasticities have quite different patterns in the different regions. However, the hypothesis of the supply chains having induced a transition from one equilibrium to another cannot be confirmed in this specification either.

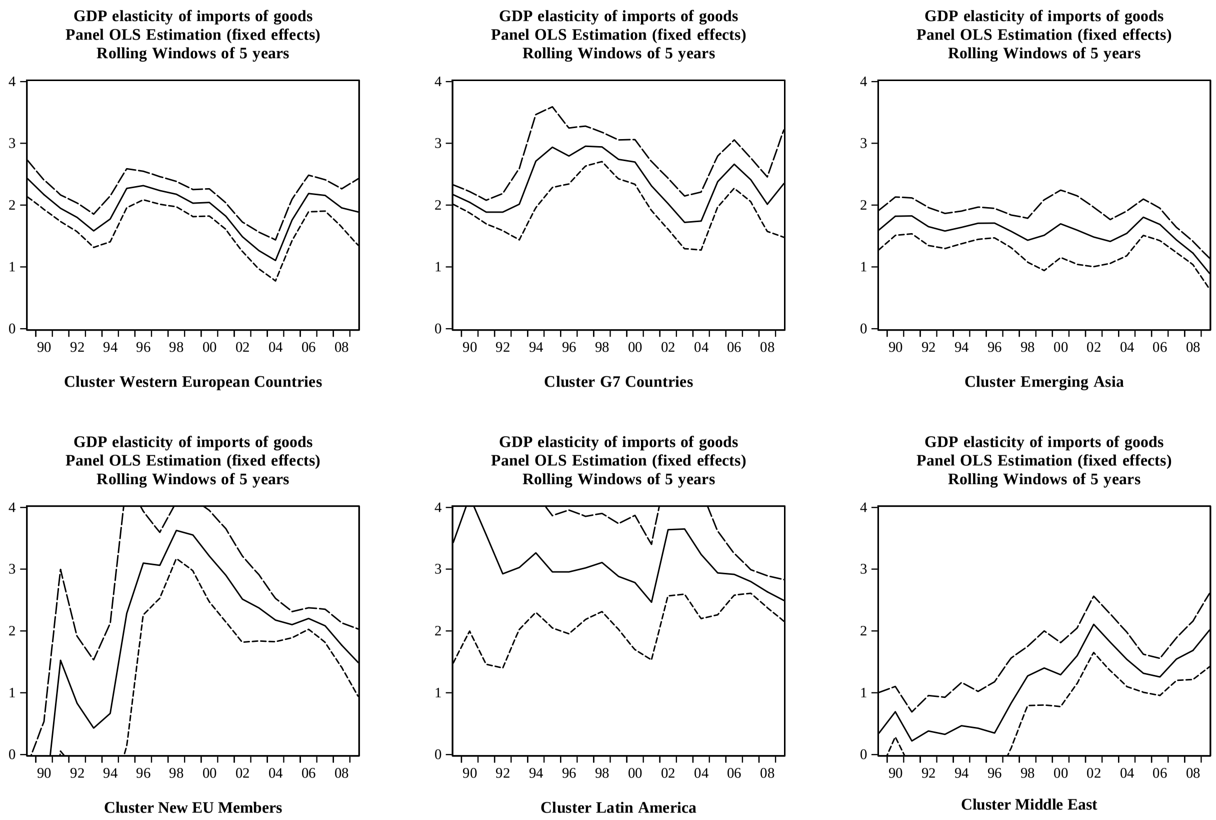
Definition of clusters

The following Tables sum up the different ways of clustering the countries used in this study and help to get an overview. Table 17.2 displays an overview of the clusters ordered by country.

The clusters can be described as:

- For the clusters 1,2,3,7 and 8 the countries were grouped together according to the consecutive patterns observed for the estimated elasticities of total imports to GDP through three subperiods: 1980 – 1990, 1990 – 2000, and 2000 – 2008:
  - cluster 1: countries with an increasing elasticity over the full sample, which overshoots in the middle of the sample;
  - cluster 2: countries with an increasing elasticity over the full sample;

Figure 17.4: GDP elasticity of imports — regions



Note: Constant prices. See text for methodology and groupings.
Source: Authors' calculations, based on IMF (2009).

Table 17.2: Overview of clusters ordered by countries

	1	2	3	7	8	LA	EA	New EU	ME	G7	Europe	fuels	mining	manufac-turing	machines and transport equip.	other manu-factures	metals	coal	petrole um	gas	medic ine	pc	commu-nications	electro-nics	vehicles	Other trans-port equip-ment
Algeria			x									x							x	x						
Argentina					x	x													x							
Australia		x											x				x	x								
Austria	x													x	x										x	
Belgium				x										x							x				x	
Brazil	x					x								x	x		x									
Canada				x						x				x	x				x	x					x	
Chile		x				x							x				x									
China		x					x							x	x							x	x			
Czech Republic	x							x						x	x						x	x			x	
Denmark		x									x			x	x				x		x					
Finland	x										x			x	x								x			
France	x									x	x			x	x										x	x
Germany		x								x	x			x	x										x	
Great Britain				x						x	x			x	x				x		x		x		x	
Hong Kong				x			x							x	x							x	x	x		
Hungary	x							x						x	x							x	x			
India	x						x							x		x			x							
Indonesia							x					x		x		x		x	x	x						
Iran			x						x			x							x							
Ireland					x						x			x							x	x				
Israel				x					x				x	x	x						x		x			
Italy				x						x	x			x		x									x	
Japan	x									x				x	x									x	x	
Korea		x					x							x	x				x				x	x	x	x
Kuwait		x							x			x							x							

Table 17.2: continued

	1	2	3	7	8	LA	EA	New EU	ME	G7	Europe	fuels	mining	manufac-turing	machines and transport equip.	other manu-factures	metals	coal	petrole um	gas	medic ine	pc	commu-nications	electro-nics	vehicles	Other trans-port equip-ment
Malaysia		x					x							x	x				x			x	x	x		
Mexico					x	x								x	x				x				x		x	
Netherlands		x									x			x	x				x			x				
Nigeria		x										x							x							
Norway		x									x	x							x	x						
Philippines				x			x							x	x							x		x		
Poland	x							x						x	x										x	
Portugal		x									x			x		x									x	
Russia		x										x							x	x						
Saudi Arabia		x							x			x							x							
Singapore			x				x							x	x				x			x	x	x		
Slovak Republic	x							x						x	x				x				x		x	
South Africa	x												x	x	x			x							x	
Spain					x						x			x	x										x	
Sweden	x										x			x	x						x		x		x	
Switzerland				x										x		x										
Thailand			x				x							x	x							x		x		
Turkey	x													x		x										
Ukraine			x											x		x			x							
United Arab Emirates		x							x			x							x							
United States				x						x				x	x									x		x
Venezuela		x				x						x							x							
Viet Nam		x												x		x			x							

Note: The Table provides information on the clustering of countries according to a series of characteristics, e.g. linked to their export specialization or the specific behavior of their trade elasticity.
Source: Authors' representation.

  - cluster 3: countries with an increasing elasticity over the full sample, but with a drop in the middle of the sample;
  - cluster 7: countries with a decreasing elasticity over the full sample, but with an increase in the middle of the sample;
  - cluster 8: countries with a decreasing elasticity over the full sample;

  (albeit the total number of possible clusters is 9, some of them were empty)

- LA = Latin America; EA = Emerging Asia; New EU = New Member Countries of the EU; ME = Middle East; G7 = G7-Countries; Europe = European Countries;

- fuels = fuels; mining = ores, metals, precious stones and non-monetary gold; manufacturing = manufactured goods; machines and transport equip. = machinery and transport equipment; other manufactures = other manufactured goods;

- metals = metalliferous ores and metal scrap; coal = coal, coke and briquettes; petroleum = petroleum, petroleum products and related materials; gas = gas, natural and manufactured; medicine = medicinal and pharmaceutical products; pc = office machines and automatic data-processing machines; communications = telecommunications and sound-recording and reproducing apparatus and equipment; electronics = electrical machinery, apparatus and appliances, and electrical parts thereof; vehicles = road vehicles (including air-cushion vehicles); other transport equipment = other transport equipment.

Table 17.3 lists the countries included in each cluster.

Table 17.3: Overview of countries in each cluster

Clusters by observed elasticity patterns	
Cluster 1	Austria, Brazil, Czech Republic, Finland, France, Hungary, India, Japan, Poland, Slovak Republic, South Africa, Sweden, Turkey
Cluster 2	Australia, Chile, China, Denmark, Germany, Korea, Kuwait, Malaysia, Netherlands, Nigeria, Norway, Portugal, Russia, Saudi Arabia, United Arab Emirates, Venezuela, Viet Nam
Cluster 3	Algeria, Iran, Singapore, Thailand, Ukraine
Custer 7	Belgium, Canada, Great Britain, Hong Kong, Israel, Italy, Philippines, Switzerland, USA
Cluster 8	Argentina, Ireland, Mexico, Spain
Clusters by export specialization	
Fuel exporters	Algeria, Indonesia, Iran, Kuwait, Nigeria, Norway, Russia, Saudi Arabia, United Arab Emirates, Venezuela
Ores, metals, precious stones and non-monetary gold exporters	Australia, Chile, Israel, South Africa
Manufactured goods exporters	Austria, Belgium, Brazil, Canada, China, Czech Republic, Denmark, Finland, France, Germany, Great Britain, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, Philippines, Poland, Portugal, Singapore, Slovak Republic, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, Ukraine, USA, Viet Nam
Machinery and transport equipment exporters	Austria, Brazil, Canada, China, Czech Republic, Denmark, Finland, France, Germany, Great Britain, Hong Kong, Hungary, Israel, Japan, Korea, Malaysia, Mexico, Netherlands, Philippines, Poland, Singapore, Slovak Republic, South Africa, Spain, Sweden, Thailand, USA
Other manufactured goods exporters	India, Indonesia, Italy, Portugal, Switzerland, Turkey, Ukraine, Viet Nam

Clusters by export specialization (export product)	
Metalliferous ores and metal scrap exporters	Australia, Brazil, Chile
Coal, coke and briquettes exporters	Australia, Indonesia, South Africa
Petroleum, petroleum products and related materials exporters	Algeria, Argentina, Canada, Denmark, Great Britain, India, Indonesia, Iran, Korea, Kuwait, Malaysia, Mexico, Netherlands, Nigeria, Norway, Russia, Saudi Arabia, Singapore, Slovak Republic, Ukraine, United Arab Emirates, Venezuela, Viet Nam
Gas, natural and manufactured, exporters	Algeria, Canada, Indonesia, Norway, Russia
Medicinal and pharmaceutical products exporters	Belgium, Czech Republic, Denmark, Great Britain, Ireland, Israel, Sweden
Office machines and automatic data-processing machines exporters	China, Czech Republic, Hong Kong, Hungary, Ireland, Malaysia, Netherlands, Philippines, Singapore, Thailand
Telecommunications and sound-recording and reproducing apparatus and equipment exporters	China, Finland, Great Britain, Hong Kong, Hungary, Israel, Korea, Malaysia, Mexico, Singapore, Slovak Republic, Sweden
Electrical machinery, apparatus and appliances, and electrical parts thereof exporters	Hong Kong, Japan, Korea, Malaysia, Philippines, Singapore, Thailand, USA
Road vehicles (including air-cushion vehicles) exporters	Austria, Belgium, Canada, Czech Republic, France, Germany, Great Britain, Italy, Japan, Korea, Mexico, Poland, Portugal, Slovak Republic, South Africa, Spain, Sweden
Other transport equipment exporters	France, Korea, USA

Clusters by region	
Latin America	Argentina, Brazil, Chile, Mexico, Venezuela

Emerging Asia	China, Hong-Kong, India, Indonesia, Korea, Malaysia, Philippines, Singapore, Thailand
New EU-Member States	Czech Republic, Hungary, Poland, Slovak Republic
Middle East	Iran, Israel, Kuwait, Saudi Arabia, United Arab Emirates
G7-Countries	Canada, France, Germany, Great Britain, Italy, Japan, USA
Western European Countries	Denmark, Finland, France, Germany, Great Britain, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden

Note: The Table provides information on the countries included in each cluster.
Source: Classification based on authors' calculations and UNCTAD (2008).

17.D Estimation with the Error Correction Model

In the following section we provide some background econometrics for the estimation with the error correction model in the main part of this essay. In order to check whether an ECM is the correct specification, we report results on unit-root and cointegration testing. Furthermore, we compute an impulse response function that shows the impact of an exogenous decrease in GDP on trade.

Unit-root and cointegration test

Before proceeding to the estimation of the error correction model (ECM), we check for the degree of integration. Running Phillips-Perron unit root tests, we can see that m and y have unit roots but we reject the assumption that Δm and Δy contain unit roots (see Table 17.4). A Johansen test further shows that the rank of cointegration of m and y is one (see Table 17.5). This justifies the use of the ECM specification applied in the main part of this essay.

Table 17.4: Phillips-Perron unit root test

Variable	**Test statistic Z(t)**	**Interpolated Dickey-Fuller**			**MacKinnon approximate p-value for Z(t)**	**Result of the test (null hypothesis: the variable contains a unit root)**
		1% critical value	**5% critical value**	**10% critical value**		
Imports	-1.385	-4.022	-3.443	-3.143	0.8651	Accepted (unit root)
GDP	-0.841	-4.022	-3.443	-3.443	0.9620	Accepted (unit root)
First difference of imports	-6.071	-3.492	-2.886	-2.576	0.0000	Rejected (no unit root)
First difference of GDP	-6.134	-3.492	-2.886	-2.576	0.0000	Rejected (no unit root)

Note: Phillips-Perron unit root test for the OECD variable used in the error correction model.
Source: Authors' calculation, based on OECD (2010).

Table 17.5: Johansen test for cointegration

Maximum rank	**Eigenvalue**	**Trace statistic**	**5% critical value**
0		19.2781	15.41
1	0.10148	3.0135	3.76
2	0.01963		

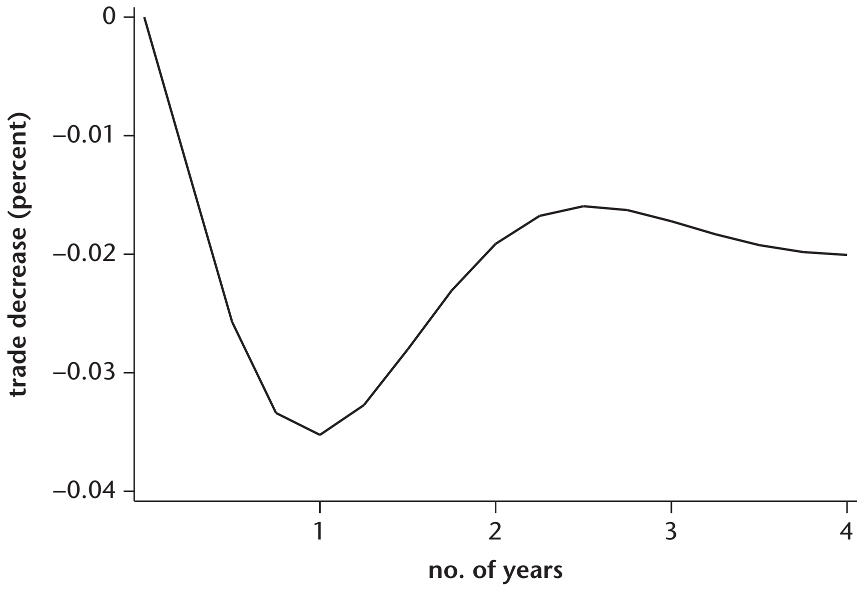
Source: Authors' calculation, based on OECD (2010).

Trade response to external shocks

Figure 17.5 represents the impulse response function (IRF) of imports when there is an exogenous shock on GDP.[112] When there is a 1% decrease in GDP, we can see that during the first year following the shock trade decreases more than proportionally and "over-reacts" (there is a 3% decrease in imports). Then, there is a convergence towards a new equilibrium value. Trade recovers during the second and third year; 4 years after the shock the decrease in trade is about 2%, in line with the multiplier calculated in the main part of the essay.

[112] Calculated on the basis of the estimation of the OECD time-series for 1999 – 2009.

Figure 17.5: Impulse response function: impact of an exogenous decrease in GDP on trade



Note: Orthogonalized IRF based on the estimation of the OECD model for the period 1999 – 2009 (24 OECD countries).
Source: Authors' calculations, based on OECD (2010).

17.E Input-Output Analysis

In this last section of the appendix we will shortly formalize the approach of the input-output analysis. In addition, we document that for the Asian countries a positive relationship between export orientation and reliance on imported inputs exists.

Formalization of the input-output analysis

The following equations formalize the empirical observations from a demand-oriented input-output perspective.[113] In absence of structural changes affecting production function (i.e. when technical coefficients, as described by an input-

[113] Analyzing the supply-shocks from the quantity space would pose a series of methodological issues (Escaith and Gonguet, 2009). Notation uses macroeconomic practices and differs from usual IO conventions.

output matrix, are constant), the relationship linking demand for intermediate inputs with an external shock can be described by the following linear relationship:

$$\Delta m^{IC} = u' M^{\circ} (I - A)^{-1} \Delta D \tag{17.1}$$

Where, in the case of a single country with s sectors:[114] Δm^{IC}: variation in total imported inputs (scalar); u': summation vector $(1 \times s)$; M°: diagonal matrix of intermediate import coefficients $(s \times s)$; $(I - A)^{-1}$: Leontief inverse, where A is the matrix of fixed technical coefficients $(s \times s)$; ΔD: initial shock on final demand $(s \times 1)$.[115]

Similarly, changes in total production caused by the demand shock (including the intermediate inputs required to produce the final goods) is obtained from:

$$\Delta Q = A \Delta Q + \Delta D \tag{17.2}$$

Solving for ΔQ yields the traditional result:

$$\Delta Q = (I - A)^{-1} \Delta D \tag{17.3}$$

Aggregating impacts across all sectors "s", the total additional output derived from this demand shock is equal to:

$$\Delta q = u' \Delta Q \tag{17.4}$$

[114] The model can be extended easily to the case of n countries by modifying accordingly the matrix A, extending the IO relationship to include inter-sectoral international transactions of intermediate goods, and adapting the summation vector u.

[115] In this traditional IO framework considering one country and the rest of the world, exports of intermediate goods are considered as being part of the final demand. The situation differs when extending the IO relationship to include international transactions of intermediate consumptions, as in equation 17.1.

The comparison between equations 17.1 and 17.4 is illustrative. Since $M°(I - A)^{-1}$ is a linear combination of fixed coefficients, the ratio $(\Delta m^{IC}/\Delta q)$ is a constant, and the trade elasticity is 1. This result is consistent with the critiques advanced by Bénassy-Quéré et al. (2009) against the hypothesis of the large trade multiplier observed during the crisis being attributed to supply chains and vertical integration.[116]

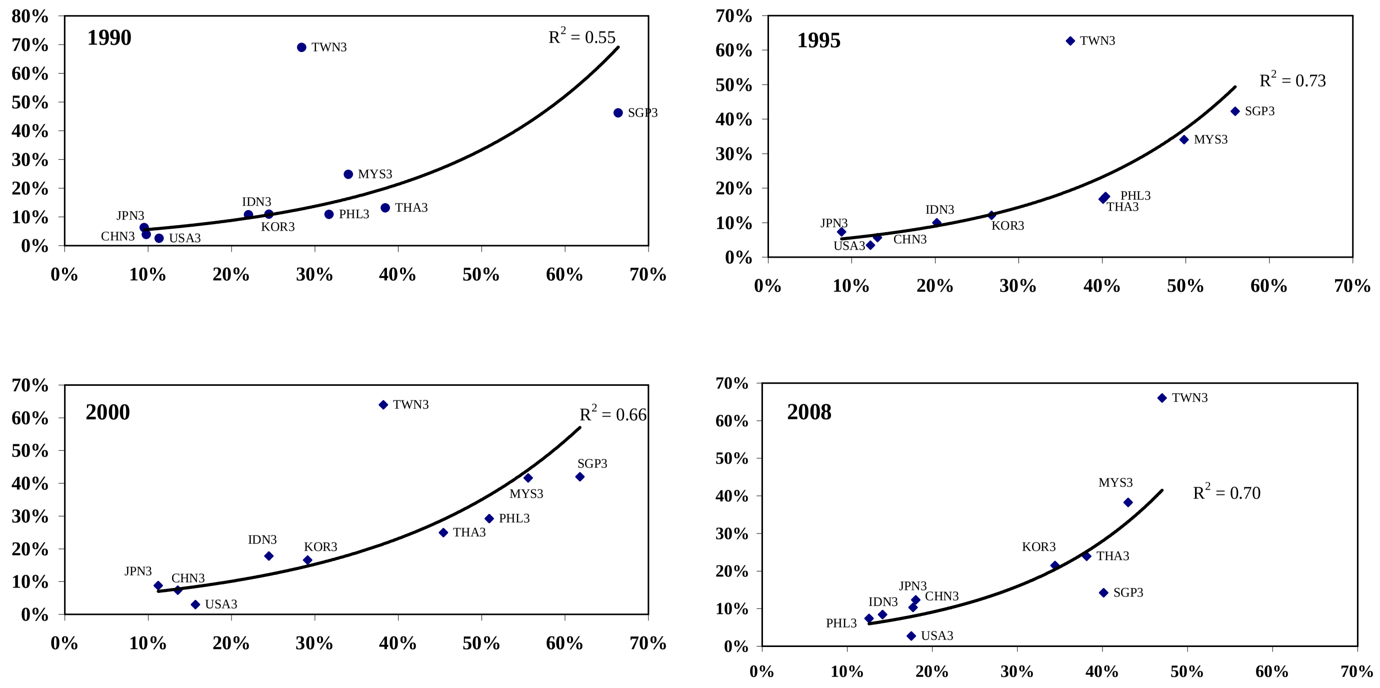
Relationship between export orientation and reliance on imported inputs

In Figure 17.6 the ratio of exported output to total production (vertical axis) is plotted against the ratio of imported inputs to intermediate inputs (horizontal axis) for the manufacture sectors of the Asian countries and the United States. It exists a positive relationship between export orientation (share of export over total output) and reliance on imported inputs. Furthermore, Figure 17.6 shows that the relationship is rather stable over time (between 1990 and 2000).[117]

[116] Using a slightly different approach, the authors conclude that "the growth rate of imports of domestic goods is the same as that of domestic GDP. [...] When the trend of globalization is correctly accounted for, the income elasticity of imports is generally close to unity." (page 15). Exploring the potential impact of the 2008-2009 downturn using a CGE model, using appropriate benchmarks for trade and GDP, the authors do not find any multiplier effect on trade.

[117] The data for 2008 tend to indicate a reduction in the reliance on imported inputs. Yet, because the 2008 data are based on estimates rather than official national account statistics, this result should be taken with care.

Figure 17.6: Manufacture sector: ratio exported output / total production to imported inputs / intermediate inputs



Note: For the manufacture sector the ratio of [exported output / total production] (vertical axis) and [imported inputs / intermediate inputs] (horizontal axis) in percent is displayed. Based on national input-output tables, converted to USD using commercial exchange rates: 2008, preliminary estimates.
Source: Authors' calculations, based on IDE-JETRO (2009).

References

Ahmed, S. (2003). "Sources of economic fluctuations in Latin America and implications for choice of exchange rate regimes". *Journal of Development Economics*, *72*(1), 181 – 202.

Alesina, A., Barro, R. J. and Tenreyro, S. (2002). "Optimal currency areas". In "NBER Macroeconomics Annual 2002, Volume 17", The University of Chicago Press.

Alessandria, G., Kaboski, J. and Midrigan, V. (2010a). "Inventories, lumpy trade, and large devaluations". *American Economic Review*, *100*(5), 2304 – 2339.

Alessandria, G., Kaboski, J. P. and Midrigan, V. (2010b). "The great trade collapse of 2008-09: An inventory adjustment?" *IMF Economic Review*, *58*(2), 254 – 294.

Antràs, P. and Helpman, E. (2004). "Global sourcing". *Journal of Political Economy*, *112*(3), 552 – 580.

Baldwin, R. (2006). "Globalisation: The great unbundling(s)". In Secretariat of the Economic Council (editor), "Globalisation challenges for Europe", chap. 1. Finnish Prime Minister's Office, Helsinki.

Baldwin, R. (2009). "The great trade collapse: Causes, consequences and prospects". VoxEU.org.

Banco de Guatemala (2010). "Estadísticas Económicas". http://www.banguat.gob.gt/inc/main.asp?id=30&aud=1&lang=1.

Banque de France (2009). "Statistiques". http://www.banque-france.fr/fr/statistiques/accueil.htm.

Bayoumi, T. and Eichengreen, B. (1993). "Shocking aspects of European Monetary Unification". In F. Torres and F. Giavazzi (editors), "Adjustment and growth in the European Monetary Union", chap. 7, 193 – 241. Cambridge University Press.

Behrens, K., Corcos, G. and Mion, G. (2010). "Trade crisis? What trade crisis?" Research series 201009-23, National Bank of Belgium.

Bems, R., Johnson, R. C. and Yi, K.-M. (2010). "Demand spillovers and the collapse of trade in the global recession". *IMF Economic Review*, *58*(2), 295 – 326.

Bénassy-Quéré, A., Decreux, Y., Fontagné, L. et al. (2009). "Economic crisis and global supply chains". Working Papers 2009-15, CEPII Research Center.

Berg, A., Borensztein, E. and Mauro, P. (2002). "An evaluation of monetary regime options for Latin America". *The North American Journal of Economics and Finance*, *13*(3), 213 – 235.

Berg, A. and Borensztein, E. R. (2003). "The pros and cons of full dollarization". In D. Salvatore, J.W. Dean and T.D. Willet (editors), "The dollarization debate", chap. 3, 72 – 102. Oxford University Press.

Berger, H., Jensen, H. and Schjelderup, G. (2001). "To peg or not to peg? A simple model of exchange rate regime choice in small economies". *Economics Letters*, *73*(2), 161 – 167.

Bergin, P. R., Feenstra, R. C. and Hanson, G. H. (2009). "Offshoring and volatility: Evidence from Mexico's maquiladora industry". *American Economic Review*, *99*(4), 1664 – 1671.

Berthou, A. and Emlinger, C. (2010). "Crises and the collapse of world trade: The shift to lower quality". Working Papers 2010-07, CEPII Research Center.

Borchert, I. and Mattoo, A. (2009). "The crisis-resilience of services trade". Policy Research Working Paper Series 4917, The World Bank.

Bordo, M., Eichengreen, B., Klingebiel, D. et al. (2001). "Is the crisis problem growing more severe?" *Economic Policy*, *16*(32), 51 – 82.

Bremnes, H., Gjerde, O. and Soettem, F. (2001). "Linkages among interest rates in the United States, Germany and Norway". *The Scandinavian Journal of Economics*, *103*(1), 127 – 145.

Bricongne, J.-C., Fontagné, L., Gaulier, G. et al. (2010). “Firms and the global crisis: French exports in the turmoil”. Working Paper Series 1245, European Central Bank.

Calvo, G. A. (2001). “Capital markets and the exchange rate, with special reference to the dollarization debate in Latin America”. *Journal of Money, Credit and Banking*, *33*(2), 312 – 334.

Câmara Neto, A. F. and Vernengo, M. (2006). “Monetary integration and dollarization: What are the lessons?” In M. Vernengo (editor), “Monetary integration and dollarization”, chap. 15, 287 – 294. Edward Elgar.

Caprio, G. and Klingebiel, D. (2003). “Episodes of systemic and borderline financial crisis”. Tech. rep., The World Bank, Research Datasets.

Caprio, G., Levine, R. E. and Barth, J. R. (2008). “World Bank, Bank Regulation and Supervision Database”. http://go.worldbank.org/SNUSW978P0.

Cartas, J. M. (2010). “Dollarization declines in Latin America”. *Finance & Development (IMF)*, *47*(1), 57 – 60.

Chen, Y., Ishikawa, J. and Yu, Z. (2004). “Trade liberalization and strategic outsourcing”. *Journal of International Economics*, *63*(2), 419 – 436.

Cheung, C. and Guichard, S. (2009). “Understanding the world trade collapse”. OECD Economics Department Working Papers 729, OECD, Economics Department.

Cheung, Y.-W. and Lai, K. S. (1993). “Finite-sample sizes of Johansen’s likelihood ration tests for cointegration”. *Oxford Bulletin of Economics and Statistics*, *55*(3), 313 – 328.

Cheung, Y.-W. and Lai, K. S. (1995). “Lag order and critical values of the Augmented Dickey-Fuller test”. *Journal of Business & Economic Statistics*, *13*(3), 277 – 280.

Cheung, Y.-W., Tam, D. C. and Yiu, M. S. (2008). “Does the Chinese interest rate follow the US interest rate?” *International Journal of Finance & Economics*, *13*(1), 53 – 67.

Cheung, Y.-W. and Westermann, F. (2003). “Sectoral trends and cycles in Germany”. *Empirical Economics*, *28*(1), 141 – 156.

Cheung, Y.-W. and Yuen, J. (2005). “An output perspective on a Northeast Asia currency union”. In P.D. Grauwe and J. Mélitz (editors), “Prospects for monetary unions after the Euro”, 289 – 317. MIT Press, Cambridge and London.

Chinn, M. D. and Meredith, G. (2004). “Monetary policy and long-horizon uncovered interest parity”. *IMF Staff Papers*, *51* (3), 409 – 430.

Choi, I. and Chul Ahn, B. (1999). “Testing the null of stationarity for multiple time series”. *Journal of Econometrics*, *88* (1), 41 – 77.

Cohen, B. J. (2003). “Monetary union: The political dimension”. In D. Salvatore, J.W. Dean and T.D. Willet (editors), “The dollarization debate”, chap. 13, 221 – 237. Oxford University Press.

Corbo, V. (2003). “Is it time for a common currency for the Americas?” In D. Salvatore, J.W. Dean and T.D. Willet (editors), “The dollarization debate”, chap. 4, 102 – 110. Oxford University Press.

Cubadda, G. (1999). “Common cycles in seasonal non-stationary time series”. *Journal of Applied Econometrics*, *14* (3), 273 – 291.

Cubadda, G. (2007). “A unifying framework for analysing common cyclical features in cointegrated time series”. *Computational Statistics & Data Analysis*, *52* (2), 896 – 906.

De Grauwe, P. (1994). *The economics of monetary integration*. Oxford University Press, New York.

Dellas, H. and Tavlas, G. S. (2009). “An optimum-currency-area odyssey”. *Journal of International Money and Finance*, *28* (7), 1117 – 1137.

Domit, S. and Shakir, T. (2010). “Interpreting the world trade collapse”. *Bank of England Quarterly Bulletin*, *50* (3), 183 – 189.

Du, J., Lu, Y. and Tao, Z. (2009). “Bi-sourcing in the global economy”. *Journal of International Economics*, *77* (2), 215 – 222.

Dvorak, P. (2009). “Clarity is missing link in supply chain”. *The Wall Street Journal*.

Eaton, J., Kortum, S., Neiman, B. et al. (2010). “Trade and the global recession”. Research series 201010-196, National Bank of Belgium.

Edwards, S. (2003). “Dollarization: Myths and realities”. In D. Salvatore, J.W. Dean and T.D. Willet (editors), “The dollarization debate”, chap. 5, 111 – 128. Oxford University Press.

Edwards, S. (2009). “Sequencing of reforms, financial globalization, and macroeconomic vulnerability”. *Journal of the Japanese and International Economies*, *23*(2), 131 – 148.

Edwards, S. and Magendzo, I. I. (2003). “Dollarization and economic performance: What do we really know?” *International Journal of Finance & Economics*, *8*(4), 351 – 363.

Eichengreen, B. (2003). “What problems can dollarization solve?” In D. Salvatore, J.W. Dean and T.D. Willet (editors), “The dollarization debate”, chap. 6, 129 – 139. Oxford University Press.

Eichengreen, B. and O’Rourke, K. H. (2009). “A tale of two depressions”. VoxEU.org.

Engle, R. F. and Kozicki, S. (1993). “Testing for common features”. *Journal of Business & Economic Statistics*, *11*(4), 369 – 380.

Escaith, H. (2010). “Global supply chains and the great trade collapse: Guilty or casualty?” *Theoretical and Practical Research in Economic Fields*, *I*(1), 27 – 41.

Escaith, H. and Gonguet, F. (2009). “International trade and real transmission channels of financial shocks in globalized production networks”. WTO Working Papers ERSD-2009-06, World Trade Organization.

Escaith, H., Lindenberg, N. and Miroudot, S. (2010a). “Global value chains and the crisis: Reshaping international trade elasticity?” In O. Cattaneo, G. Gereffi and C. Staritz (editors), “Global Value Chains in a Post-Crisis World: A Development Perspective”, chap. 3, 73 – 124. World Bank.

Escaith, H., Lindenberg, N. and Miroudot, S. (2010b). “International supply chains and trade elasticity in times of global crisis”. WTO Working Papers ERSD-2010-08, World Trade Organization.

Escaith, H., Lindenberg, N. and Miroudot, S. (2011). “Global supply chains, the great trade collapse and beyond: More elasticity or more volatility?” In B.R.

Mandel and F. di Mauro (editors), "Recovery and beyond: Lessons for trade adjustment and competitiveness", chap. 14, 138 – 150. European Central Bank.

Feige, E. L., Faulend, M., Šonje, V. et al. (2003). "Unofficial dollarization in Latin America: Currency substitution, network externalities, and irreversibility". In D. Salvatore, J.W. Dean and T.D. Willet (editors), "The dollarization debate", chap. 2, 46 – 71. Oxford University Press.

Fernández-Arias, E., Yeyati, E. L. and Morón, E. (2006). "Financial dollarization and dedollarization [with comments]". *Economía*, *6*(2), 37 – 100.

Fiess, N. (2007). "Business cycle synchronization and regional integration: A case study for Central America". *World Bank Economic Review*, *21*(1), 49 – 72.

Fontagné, L., Freudenberg, M. and Uenal-Kesenci, D. (1996). *Statistical analysis of EC trade in intermediate products*. Eurostat, Serie 6D, Luxembourg.

Freund, C. (2009). "The trade response to global downturns: Historical evidence". Policy Research Working Paper Series 5015, The World Bank.

Freund, C. and Spatafora, N. (2008). "Remittances, transaction costs, and informality". *Journal of Development Economics*, *86*(2), 356 – 366.

Garcia-Escribano, M. and Sosa, S. (2011). "What is driving financial dedollarization in Latin America?" IMF Working Papers 11/10, International Monetary Fund.

Gelos, R. G. and Werner, A. M. (2002). "Financial liberalization, credit constraints, and collateral: Investment in the Mexican manufacturing sector". *Journal of Development Economics*, *67*(1), 1 – 27.

Gereffi, G. and Frederick, S. (2010). "The global apparel value chain, trade and the crisis: Challenges and opportunities for developing countries". Policy Research Working Paper Series 5281, The World Bank.

Goldfajn, I., Olivares, G., Frankel, J. et al. (2001). "Full dollarization: The case of Panama [with comments]". *Economía*, *1*(2), 101 – 155.

Gourieroux, C. and Peaucelle, I. (1989). "Detecting a long run relationship (with an application to the p.p.p. hypothesis)". CEPREMAP Working Papers (Couverture Orange) 8902, CEPREMAP.

Gourinchas, P.-O., Valdes, R. and Landerretche, O. (2001). "Lending booms: Latin America and the World". *Economía*, *1* (2), 47 – 97.

Grossman, G. M. and Helpman, E. (2002). "Integration versus outsourcing in industry equilibrium". *The Quarterly Journal of Economics*, *117* (1), 85 – 120.

Grossman, G. M. and Helpman, E. (2005). "Outsourcing in a global economy". *Review of Economic Studies*, *72* (1), 135 – 159.

Grossman, G. M. and Rossi-Hansberg, E. (2008). "Trading tasks: A simple theory of offshoring". *American Economic Review*, *98* (5), 1978 – 1997.

Grossman, R. S. and Meissner, C. M. (2010). "International aspects of the great depression and the crisis of 2007: Similarities, differences, and lessons". *Oxford Review of Economic Policy*, *26* (3), 318 – 338.

Haddad, M., Harrison, A. and Hausman, C. (2010). "Decomposing the great trade collapse: Products, prices, and quantities in the 2008-2009 crisis". NBER Working Papers 16253, National Bureau of Economic Research, Inc.

Harms, P., Lorz, O. and Urban, D. M. (2009). "Offshoring along the production chain". CESifo Working Paper Series 2564, CESifo GmbH.

Helpman, E. (2006). "Trade, FDI, and the organization of firms". *Journal of Economic Literature*, *44* (3), 589 – 630.

Henriksen, E., Kydland, F. E. and Sustek, R. (2009). "The high cross-country correlations of prices and interest rates". NBER Working Papers 15123, National Bureau of Economic Research, Inc.

Hnatkovska, V., Lahiri, A. and Vegh, C. A. (2008). "Interest rates and the exchange rate: A non-monotonic tale". NBER Working Papers 13925, National Bureau of Economic Research, Inc.

Hummels, D., Ishii, J. and Yi, K.-M. (2001). "The nature and growth of vertical specialization in world trade". *Journal of International Economics*, *54* (1), 75 – 96.

IDB (2010). "Latin American and Caribbean Macro Watch Database". http://www.iadb.org/Research/LatinMacroWatch/index.cfm.

IDE-JETRO (2006). "How to make Asian input-output tables". Tech. rep., Institute of Developing Economies, Japan External Trade Organization (IDE-JETRO).

IDE-JETRO (2009). "IDE-JETRO Asian Input-Output Matrices".

IMF (2009). "World Economic Outlook Database". http://www.imf.org/external/pubs/ft/weo/2009/01/weodata/index.aspx.

IMF (2010). "International Financial Statistics".

Inomata, S. and Uchida, Y. (2009). "Asia beyond the crisis -Visions from international input-output analyses". IDE Spot Survey 31, Institute of Developing Economies, Japan External Trade Organization (IDE-JETRO).

Jacks, D. S., Meissner, C. M. and Novy, D. (2008). "Trade costs, 1870-2000". *American Economic Review*, *98*(2), 529 – 534.

Jácome, L. I. (2008). "Central bank involvement in banking crises in Latin America". IMF Working Papers 08/135, International Monetary Fund.

Jácome, L. I. and Lönnberg, Å. (2010). "Implementing official dollarization". IMF Working Papers 10/106, International Monetary Fund.

Johansen, S. (1988). "Statistical analysis of cointegration vectors". *Journal of Economic Dynamics and Control*, *12*(2-3), 231 – 254.

Johansen, S. (1991). "Estimation and hypothesis testing of cointegration vectors in gaussian vector autoregressive models". *Econometrica*, *59*(6), 1551 – 1580.

Johnson, R. C. and Noguera, G. (2010). "Accounting for intermediates: Production sharing and trade in value added". Working paper, mimeo.

Jones, R. W. and Kierzkowski, H. (1990). *The role of services in production and international trade: A theoretical framework*, 31–48. Oxford and Cambridge, Mass.

Kaminsky, G. L. and Reinhart, C. M. (1998). "Financial crises in Asia and Latin America: Then and now". *American Economic Review*, *88*(2), 444 – 448.

Kaminsky, G. L. and Reinhart, C. M. (1999). "The twin crises: The causes of banking and balance-of-payments problems". *American Economic Review*, *89*(3), 473 – 500.

Karanasos, M., Sekioua, S. and Zeng, N. (2006). "On the order of integration of monthly US ex-ante and ex-post real interest rates: New evidence from over a century of data". *Economics Letters*, *90*(2), 163 – 169.

Kaufmann, D., Kraay, A. and Mastruzzi, M. (2010). "World Bank, Worldwide Governance Indicators". http://info.worldbank.org/governance/wgi/index.asp.

Kenen, P. (1969). "The theory of optimum currency areas: An eclectic view". In R. Mundell and A. Swoboda (editors), "Monetary problems of the international economy", 41 – 60. University of Chicago Press.

Kerschbamer, R. and Tournas, Y. (2003). "In-house competition, organizational slack, and the business cycle". *European Economic Review*, *47*(3), 505 – 520.

King, R. G., Plosser, C. I., Stock, J. H. et al. (1991). "Stochastic trends and economic fluctuations". *American Economic Review*, *81*(4), 819 – 840.

Kokenyne, A., Ley, J. and Veyrune, R. (2010). "Dedollarization". IMF Working Papers 10/188, International Monetary Fund.

Koopman, R., Powers, W., Wang, Z. et al. (2010). "Give credit where credit is due: Tracing value added in global production chains". NBER Working Papers 16426, National Bureau of Economic Research, Inc.

Koustas, Z. and Lamarche, J.-F. (2010). "Evidence of nonlinear mean reversion in the real interest rate". *Applied Economics*, *42*(1), 237 – 248.

Krueger, A. and Tornell, A. (1999). "The role of bank restructuring in recovering from crises: Mexico 1995-98". NBER Working Papers 7042, National Bureau of Economic Research, Inc.

Krugman, P. (1995). "Growing world trade: Causes and consequences". *Brookings Papers on Economic Activity*, *26*(1), 327 – 377.

Kugler, P. and Neusser, K. (1993). "International real interest rate equalization: A multivariate time-series approach". *Journal of Applied Econometrics*, *8*(2), 163 – 174.

Laeven, L. and Valencia, F. (2008). "Systemic banking crises: A new database". IMF Working Papers 08/224, International Monetary Fund.

Lahiri, A., Singh, R. and Végh, C. (2007). "Segmented asset markets and optimal exchange rate regimes". *Journal of International Economics*, *72*(1), 1 – 21.

Levchenko, A. A., Lewis, L. T. and Tesar, L. L. (2010). "The collapse of international trade during the 2008-2009 crisis: In search of the smoking gun". *IMF Economic Review*, *58*(2), 214 – 253.

Levy Yeyati, E. and Sturzenegger, F. e. (2002). *Dollarization: Debates and policy alternatives*. MIT Press, Cambridge and London.

Linden, G., Kraemer, K. L. and Dedrick, J. (2007). "Who captures value in a global innovation system? The case of Apple's iPod". *Communications of the ACM*, *52*(3), 140 – 144.

Lindenberg, N. and Westermann, F. (2009a). "Common trends and common cycles among interest rates of the G7-countries". CESifo Working Paper Series 2532, CESifo GmbH.

Lindenberg, N. and Westermann, F. (2009b). "How strong is the case for dollarization in Costa Rica? A note on the business cycle comovements with the United States". CESifo Working Paper Series 2785, CESifo GmbH.

Lindenberg, N. and Westermann, F. (2011). "How strong is the case for dollarization in Central America? An empirical analysis of business cycles, credit market imperfections and the exchange rate". *International Journal of Finance & Economics*, *(forthcoming)*.

Loayza, N. V., Rancière, R., Servén, L. et al. (2007). "Macroeconomic volatility and welfare in developing countries: An introduction". *World Bank Economic Review*, *21*(3), 343 – 357.

MacKinnon, J. G. (1996). "Numerical distribution functions for unit root and cointegration tests". *Journal of Applied Econometrics*, *11*(6), 601 – 618.

McKibbin, W. J. and Stoeckel, A. (2009). "The potential impact of the global financial crisis on world trade". Policy Research Working Paper Series 5134, The World Bank.

McKinnon, R. I. (1963). "Optimum currency areas". *American Economic Review*, *53*(4), 717 – 725.

Milberg, W. and Winkler, D. (2010). "Trade crisis and recovery: Restructuring of global value chains". Policy Research Working Paper Series 5294, The World Bank.

Miroudot, S. and Ragoussis, A. (2009). "Vertical trade, trade costs and FDI". OECD Trade Policy Working Papers 89, OECD, Trade Directorate.

Mishkin, F. S. and Savastano, M. A. (2001). "Monetary policy strategies for Latin America". *Journal of Development Economics*, *66*(2), 415 – 444.

Mitra, D. and Ranjan, P. (2008). "Temporary shocks and offshoring: The role of external economies and firm heterogeneity". *Journal of Development Economics*, *87*(1), 76 – 84.

Mundell, R. A. (1961). "A theory of optimum currency areas". *American Economic Review*, *51*(4), 657 – 665.

Mundell, R. A. (1973). "Uncommon arguments for common currencies". In H. Johnson and A. Swoboda (editors), "The economics of common currencies", 114–132. George Allen & Unvin Ltd.

Mundell, R. A. (2003). "Currency areas, exchange rate systems, and international monetary reform". In D. Salvatore, J.W. Dean and T.D. Willet (editors), "The dollarization debate", chap. 1, 17 – 46. Oxford University Press.

Nordås, H. K. (2005). "International production sharing: A case for a coherent policy framework". WTO Discussion Papers 11, World Trade Organization.

Nordås, H. K., Pinali, E. and Grosso, M. G. (2006). "Logistics and time as a trade barrier". OECD Trade Policy Working Papers 35, OECD, Trade Directorate.

OECD (1992). "The international sourcing of intermediate inputs by Canada, France, Germany, Japan, the United Kingdom, and the United States". *DSTI/STII/IND*, *92*(1).

OECD (2010). "OECD National Accounts Statistics Online Database". http://www.oecd.org/document/47/0,3746,en_21571361_33915056_39129327_1_1_1_1,00.html.

Oosterhaven, J., Stelder, D. and Inomata, S. (2007). "Evaluation of non-survey international IO construction methods with the Asian-Pacific input-output table". IDE Discussion Papers 114, Institute of Developing Economies, Japan External Trade Organization (IDE-JETRO).

Ornelas, E. and Turner, J. L. (2008). "Trade liberalization, outsourcing, and the hold-up problem". *Journal of International Economics*, *74*(1), 225 – 241.

Osterwald-Lenum, M. (1992). "A note with quantiles of the asymptotic distribution of the maximum likelihood cointegration rank test statistics". *Oxford Bulletin of Economics and Statistics*, *54*(3), 461 – 472.

Ostrovsky, M. (2008). "Stability in supply chain networks". *American Economic Review*, *98*(3), 897 – 923.

Poghosyan, T. and de Haan, J. (2007). "Interest rate linkages in EMU countries: A rolling threshold vector error-correction approach". CESifo Working Paper Series 2060, CESifo GmbH.

Rapach, D. E. and Weber, C. E. (2004). "Are real interest rates really non-stationary? New evidence from tests with good size and power". *Journal of Macroeconomics*, *26*(3), 409 – 430.

Roache, S. K. (2008). "Central America's regional trends and U.S. cycles". IMF Working Papers 08/50, International Monetary Fund.

Romero-Ávila, D. (2007). "Unit roots and persistence in the nominal interest rate: A confirmatory analysis applied to the OECD". *Canadian Journal of Economics*, *40*(3), 980 – 1007.

Rose, A. K. (1988). "Is the real interest rate stable?" *Journal of Finance*, *43*(5), 1095 – 1112.

Salvatore, D. (2001). "Which countries in the Americas should dollarize?" *Journal of Policy Modeling*, *23*(3), 347 – 355.

Salvatore, D., Dean, J. W. and Willet, T. D. (2003). *The dollarization debate*. Oxford University Press, New York.

Schleicher, C. (2007). "Codependence in cointegrated autoregressive models". *Journal of Applied Econometrics*, *22*(1), 137 – 159.

Schmitt-Grohe, S. and Uribe, M. (2001). "Stabilization policy and the costs of dollarization". *Journal of Money, Credit and Banking*, *33*(2), 482 – 509.

Schneider, M. and Tornell, A. (2004). "Balance sheet effects, bailout guarantees and financial crises". *Review of Economic Studies*, *71*(3), 883 – 913.

Schuler, K. (2003). "What use is monetary sovereignty?" In D. Salvatore, J.W. Dean and T.D. Willet (editors), "The dollarization debate", chap. 7, 140 – 153. Oxford University Press.

Şener, F. and Zhao, L. (2009). "Globalization, R&D and the iPod cycle." *Journal of International Economics*, *77*(1), 101 – 108.

Smith, D. (2006). "Offshoring: Political myths and economic reality". *World Economy*, *29*(3), 249 – 256.

Stadtler, H. (2008). "Supply chain management - An overview". In H. Stadtler and C. Kigler (editors), "Supply Chain Management and Advanced Planning: Concepts, Models, Software and Case Studies", Springer, 4th ed.

Sturgeon, T. J. and Gereffi, G. (2009). "Measuring success in the global economy: International trade, industrial upgrading, and business function outsourcing in global value chains". *Transnational Corporations*, *18*(2), 1 – 36.

Sturgeon, T. J. and Kawakami, M. (2010). "Global value chains in the electronics industry: Was the crisis a window of opportunity for developing countries?" Policy Research Working Paper Series 5417, The World Bank.

Sturgeon, T. J. and Van Biesebroeck, J. (2010). "Effects of the crisis on the automotive industry in developing countries: A global value chain perspective". Policy Research Working Paper Series 5330, The World Bank.

Tanaka, K. (2009). "Trade collapse and international supply chains: Evidence from Japan".

Temprano-Arroyo, H. (2003). "Prospects for regional monetary integration in Latin America: A view from the EU". *Comparative Economic Studies*, *45*(3), 384 – 420.

Thomson Reuters (2010). "Datastream".

Thornton, J. and García-Herrero, A. (1997). “Additional evidence on monetary base and interest rate linkages in the EMS”. *Review of World Economics (Weltwirtschaftliches Archiv)*, *133*(2), 359 – 368.

Tornell, A. and Westermann, F. (2002). “Boom-bust cycles in middle income countries: Facts and explanation”. *IMF Staff Papers*, *49*(Special Issue), 111 – 155.

Tornell, A. and Westermann, F. (2005). *Boom-bust cycles and financial liberalization*. MIT Press Books, The MIT Press.

Uchida, Y. and Inomata, S. (2009). “Vertical specialization in the time of the economic crisis”. In Institute of Developing Economies, Japan External Trade Organization (IDE-JETRO) (editor), “Asia Beyond the Crisis -Visions from International Input-Output Analyses”, .

UN (2010). “UNdata”. http://data.un.org/.

UNCTAD (2008). “UNCTAD handbook of statistics 2008”. http://www.unctad.org/Templates/Webflyer.asp?intItemID=1397&docID=10193.

Urga, G. (2007). “Common features in economics and finance: An overview of recent developments”. *Journal of Business & Economic Statistics*, *25*(1), 2 – 11.

Vahid, F. and Engle, R. F. (1993). “Common trends and common cycles”. *Journal of Applied Econometrics*, *8*(4), 341 – 360.

Vahid, F. and Engle, R. F. (1997). “Codependent cycles”. *Journal of Econometrics*, *80*(2), 199 – 221.

Van Bergeijk, P. A. (2010). “Let’s assume the WTO is wrong: 6 plus 1 hypotheses for the world trade collapse”. Working papers, CERES, Research School for Resource Studies for Development.

Wang, J. (2010). “Durable goods and the collapse of global trade”. *Economic Letter*, *5*(2).

World Bank (2009). “World Development Indicators”. http://data.worldbank.org/data-catalog.

World Bank (2010a). “Enterprise Surveys”. http://www.enterprisesurveys.org/.

World Bank (2010b). "World Development Indicators". http://data.worldbank.org/data-catalog.

WTO (2008a). "International trade statistics 2008". http://www.wto.org/english/res_e/statis_e/its2008_e/its08_toc_e.htm.

WTO (2008b). "World trade report 2008". http://www.wto.org/english/res_e/reser_e/wtr08_e.htm.

WTO (2010). "International trade statistics 2010". http://www.wto.org/english/res_e/statis_e/its2010_e/its10_toc_e.htm.

Wu, Y. and Zhang, H. (1996). "Mean reversion in interest rates: New evidence from a panel of OECD countries". *Journal of Money, Credit, and Banking*, *28*(4), 604 – 621.

Wynne, M. (2009). "The financial crisis, trade finance and the collapse of world trade". *Globalization and Monetary Policy Institute*, *Annual Report*.

Yi, K.-M. (2009). "The collapse of global trade: The role of vertical specialisation". In R. Baldwin and S. Evenett (editors), "The collapse of global trade, murky protectionism, and the crisis: Recommendations for the G20", VoxEU.org.

Zhou, S. (2003). "Interest rate linkages within the European Monetary System: New evidence incorporating long-run trends". *Journal of International Money and Finance*, *22*(4), 571 – 590.