Title

Risk Sharing, Financial integration, and "Mundell II" in the Enlarged European Union

Author
Boewer (Böwer), Uwe

Publication Date
2006-08-01

Risk sharing, financial integration, and "Mundell II" in the enlarged European Union

Uwe Böwer*
University of Munich
Munich Graduate School of Economics
Kaulbachstr. 45, 80539 Munich, Germany
uwe.boewer@lrz.uni-muenchen.de

Current version: August 1, 2006

Abstract

While empirical research in the tradition of the classical optimum currency area theory, inspired by Mundell (1961), has stressed the *costs* of a common currency ("Mundell I"), the later and less well-known contribution of Mundell (1973) highlights the *benefits* that arise from the risk-sharing opportunities in a financially-integrated currency union. This paper assesses the degrees of risk sharing and financial integration in the enlarged EU in the context of Mundell II. We find limited but increasing comovement of consumption, output and real interest rates between the new member states (NMS) and the euro area. In comparison, we find substantially higher figures for the "old" EU countries which give rise to the hope that the NMS will develop in a similar fashion. Also, we observe that output comovement increases faster than consumption comovement which may lend support to Imbs (2006) who argues that the consumption correlation puzzle may not be rooted in a lack of risk sharing but rather in the even stronger effect that financial integration excerts on output comovement in comparison to consumption comovement. In essence, the benefits for the NMS to join the euro area rather earlier than later may have been underestimated.

JEL Classification: E32, C32.

Key words: Risk sharing, financial integration, euro area enlargement, Mundell II.

*I would like to thank Christoph Bärenreuther, Barry Eichengreen, Jean Imbs, Maurice Obstfeld, Ronald Wendner and Frank Westermann for helpful comments and advice. I am grateful for the hospitality of the Institute of European Studies, University of California, Berkeley, where large parts of this research were conducted.

1 Introduction

Since the enlargement of the European Union by ten new member states in 2004, the next major phase of economic integration will be the inclusion of these countries in the euro area. Slovenia will be the first country to adopt the single European currency in January 2007 and others may follow in due course. Joining Economic and Monetary Union (EMU) is, however, not a costless enterprise. According to the framework of optimum currency areas (OCA), inspired by Mundell (1961), only those countries should renounce the tools of exchange rate policy and individual monetary policy that exhibit a sufficient degree of similarity, often summed up in the criterion of synchronised business cycles. Less attention has, however, been payed to the benefits that arise from joing a currency union in terms of risk sharing and income insurance. McKinnon (2002) pointed out that it was also Robert Mundell (Mundell 1973) who formulated this idea and reconsidered a number of his earlier ideas. Hence, the earlier Mundell has been known as "Mundell I" whereas the later Mundell is often called "Mundell II".

Numerous papers have analysed empirical aspects of Mundell I. For the new member states (NMS) of the EU, Fidrmuc and Korhonen (2004) provide a good review of the relevant literature. These papers typically assess the degree of business cycle synchronsiation or the correlation of shocks between the NMS vis-à-vis the euro area and conclude that, the more similar the countries, the lower the costs of adopting the euro. Mundell II, however, argues that especially countries with asymmetric cycles may benefit from joining a monetary union due to the risk-sharing property of a financially integrated currency area. Hence, the NMS may consider joining EMU early, rather than waiting until their business cycles are perfectly synchronised with the euro area.

This paper analyses the NMS and the euro area in the context of Mundell II. We measure the degrees of risk sharing and financial integration of the eight formerly communist NMS with the euro area and assess the "old" EU members for comparison. Methodologically, we proxy risk sharing by the degree of consumption comovement in comparison to output comovement. Financial integration is approximated by measures of real interest rate comovement, dispersion and variability. We first measure comovement by means of simple correlations before we apply the more advanced time-series technique of codependence by Engle and Kozicki (1993).

We find that, firstly, the degree of risk sharing between the NMS and the euro area has been limited over the past decade. This may stem from the also low degree of financial integration. Secondly, the EU-15 countries exhibit substantially higher degrees of risk sharing and financial integration. Given their common history of economic integration, we may expect a similar development for the NMS as they further integrate with the EU-15. Exploring risk sharing and financial integration with rolling windows we find, thirdly, that in both the NMS and the EU-15 countries the degrees of consumption and output comovement have increased over time. Also, financial integration seems to have gone up in most countries. It is interesting to observe that, with rising financial integration, we see output comovement boosting more quickly than comovement of consumption. Although a formal causality analysis is beyond the scope of this paper, we may see this as a confirmation of the hypothesis of Imbs (2006) who argues that the consumption correlation puzzle may not stem from low degrees of risk sharing in the first place but is rather rooted in the fact that financial integration does not only raise consumption comovement but also, and at an even faster rate, boost output comovement, or business cylce synchronisation.

In the light of these results, the case for the NMS of joining the euro area rather sooner than later appears in a different light. We acknowledge that more research is needed for substantiation but it seems that the potential risk sharing benefits of a currency union deserve closer attention than previously assumed.

The remainder of this paper is structured as follows. Section 2 provides a literature review of the Mundell I and Mundell II frameworks of OCA theory. Sections 3 and 4 deal with risk sharing and financial integration in the enlarged EU, respectively, and section 5 concludes.

2 Mundell I and Mundell II in perspective

This section presents the conceptual backgrounds of OCA theory as it evolved over time. We successively review the theory and empirics of Mundell I and Mundell II.

2.1 The initial OCA framework of Mundell I

The theory of optimum currency areas has been at the heart of currency union research. Although it is no fully-fledged theory, the initial OCA framework provides helpful guidelines for the investigation whether or not certain countries would be good candidates for a currency union. We first describe the basic OCA ideas before we outline various attempts to model OCA theory more formally. This early OCA approach has been known as Mundell I, distinguishing it from Mundell's later work to which we come below.

In his seminal contribution, Mundell (1961) highlights that regions with similar economic characteristics may benefit from a common currency even if they do not belong to the same national federation, i.e. if "the national currency area does not coincide with the optimum currency area" (Mundell 1961: 657). The efficiency benefits of a common currency need, however, to be weighted against the costs of renouncing independent monetary policy and exchange rate adjustments.

Over the subsequent years, a number of criteria have evolved which typically characterise an OCA. First, the flexibility and mobility of production factors is regarded as a key prerequisite (Mundell 1961). If wages can adjust freely and capital or labour can re-allocate without restrictions, the need for exchange rate adjustments in response to economic disturbances is reduced. Second, the more open a country is to international trade, the more is the domestic economy influenced by international price changes (McKinnon 1963). Hence, the scope of national monetary policy and exchange rate adjustments is naturally low. Third, a more diversified economy is favourable because it is less threatened by idiosyncratic shocks and hence not so much in need of domestic monetary or exchange rate response (Kenen 1969). Furthermore, interregional compensation schemes and the political will for integration have been cited as additional aspects of OCAs (Krugman 1993; Mongelli 2002).

It has proved difficult to test the OCA criteria empirically in a systematic and consistent manner. For instance, labour market flexibility is notoriously difficult to quantify. Also, similarity indices of diversification or capital mobility tend to involve a significant degree of subjectivity. Instead, it has become customary to analyse the symmetry in the stochastic experience of countries' economic performance, i.e. the symmetry of shocks or the synchronisation of business cycles. This approach has been known as the "meta property" of OCA theory because most of the individual criteria translate into the probability of asymmetric shocks and the economy's ability to respond to these shocks (Mongelli 2002; Masson and Taylor 1993). For example, the more diversified the economic structure, the less likely is the occurance of idiosyncratic shocks in the first place. Moreover, if the countries are very trade-integrated, the probability of being hit by symmetric shocks tends to be larger. In case of mobile production factors and fiscal federalism, adjustments in these areas can cushion the adverse impacts of asymmetric shocks. Thus, the more symmetric the shocks, or the more synchronised the business cycle behaviour of two countries, the more likely it is that the major OCA criteria are satisfied.

Two alternative ways of measuring the stochastic experience stand out. One part of the literature attempts to measure the similarity of shocks directly. Based on the structural vector autoregressive (SVAR) approach of Blanchard and Quah (1989) these scholars distinguish demand and supply shocks by imposing the assumption that only supply shocks exert a permanent effect on output, while the long-term impact of demand shocks is restricted to zero. Bayoumi and Eichengreen (1993) apply this methodology to Western Europe. They argue that the more similar the incidence of shocks across countries, the better are the OCA criteria fulfilled and the more likely a country would benefit from currency union. Comparing European countries to US regions, they establish a core-periphery distinction and assert that only a few core EU countries would be suited for EMU.

Another branch of the literature adopts a more general approach and explores the observed comovement of short-run stochastic output behaviour, i.e. the synchronisation of business cycles. Mostly, real output data have been de-trended using the Hodrick-Prescott filter or the Baxter-King band-pass filter. The correlation coefficients of the resulting cyclical output components are then interpreted as synchronisation indicators across countries. Also, Markov-switching VARs have been employed to identify a common European cycle, see Artis et al. (2004). Furthermore, Engle and Kozicki (1993) develop the common features approach which investigates business cycle synchronisation by identifying common serial correlation features on the basis of cointegration. Rubin and Thygesen (1996) apply an early version of this technique and find some evidence of common cycles among Western European countries in the run-up to EMU.

A number of studies with a focus on various Central and Eastern European Countries (CEECs) and the euro area have been conducted recently. Fidrmuc and Korhonen (2004) provide a literature overview and perform a meta-analysis of business cycle correlation.

They conclude that the cycles of several CEECs are highly correlated with the euro area cycle, in particular those of Estonia, Hungary, Poland, and Slovenia. However, little attention has so far been paid to the combined analysis of long-run trends and short-run cycles, as incorporated in the codependence technique. While most of the reviewed studies adopt the SVAR technique, only Buch and Döpke (2000) apply the common features framework. They find little evidence of common cycles, which may, however, be due to the limited data period at the time the study was conducted.

2.2 Mundell II and contributions on risk sharing and financial integration

It was McKinnon (2002) who drew attention to the seminal Mundell II paper, Mundell (1973). The classical framework of Mundell I concentrates on the potential *costs* of currency union incurred by the loss of independent monetary policy and nominal exchange rate adjustments and asserts the importance of economic similarity, notably in terms of business cycles, trade openness, diversification and labour mobility. Mundell II, in contrast, revises this cost argument and turns the attention more towards the *benefits* of a common currency.

Regarding the cost of currency union, Mundell II argues that national monetary policies may not be as effective an adjustment tool to asymmetric shocks as the Keynesian beliefs of the 1960s would have suggested. This period was shaped by the static Mundell-Fleming framework of the open economy with its assumption of stationary expectations regarding prices, interest rates and exchange rates. Also, the Brettow Woods system of fixed exchange rates was functioning reasonably well and most countries had captial controls in place. These circumstances of what has been called the "fine-tuning fallacy[1]" led Mundell I to emphasise the costs associated with the loss of renouncing inidividual monetary policy - over-emphasise, in the eyes of Mundell II.

Moreover, Mundell II no longer considers exchange rates to be an adjustment mechanism only but, to a substantial degree, a source of shocks in itself. In a world with little capital controls, McKinnon (2002) argues, exchange rate movements "are likely to be erratic at best" so that the notion of smooth adjustment under flexible exchange rates, one of Mundell I's key assumptions, turns out to be an illusion. Both aspects, the reduced effectiveness of national monetary policy and the ambiguous role of exchange rate, downsize the role of the costs of currency union as they were pointed out by Mundell I.

The third and probably most interesting point of Mundell II, however, refers to the benefits of currency union due to enhanced risk sharing. In a currency union, financial market integration may develop into a powerful risk-sharing mechanism by providing income insurance across the union. Due to enhanced reserve pooling and portfolio diversification, adverse shocks to one country are shared across the union. Trade and financial integration act as income insurance since individuals across countries hols claims on each other's output and one country can draw on the resources of the other country by running down its holdings of the international currency. As a result, consumption streams

[1] See Buiter (1999: 49).

become smoother and more highly correlated across countries, even and particularly in the presence of idiosycratic shocks to production. Alternatively, imagine a positive productivity shock in one country. Under separate currencies, GDP and consumption rise by the same amount and falling prices lead to increased real balances. With a common currency, however, the union-wide price level goes down less than proportionally to the productivity shock in the respective country. To increase real balance holdings, that country could run a balance of payments surplus, for instance through trade in nominal bonds. The increase in consumption is less than the rise in GDP so that the other countries of the union participate in the positive shock by enjoying higher consumption as well.

While financially integrated countries make good candidates for currency union against this background, Mundell II suggests that a common currency can be expected to deliver risk sharing benefits even for countries with hitherto little financial integration. Exchange rate uncertainty and interest rate risk premia inhibit international portfolio diversification and constitute a major reason behind the home bias puzzle in international finance. A common currency, it is argued, would convince financial intermediaries to diversify their portfolios so that the currency union in itself may develop into a boost for financial market integration.

Against this background, Mundell II challenges a central argument of Mundel I. While the initial OCA framework warns countries with asynchronous business cycles about joining a currency union due to the resulting loss of national monetary policy and exchange rate adjustments, Mundell II suggests that it is exactly those countries with asymmetric shocks which may benefit most from adopting a common currency and the resulting risk-sharing and income insurance mechanism. In other words, a country that considers joining a currency union, such as the new EU member states, may not want to wait until business cycles are perfectly synchronised but rather benefit from the insurance mechanism of a financially-integrated currency union as long as cycles are asynchronous.

The proponents of Mundell II apply a similar logic to the ex post experience in a currency union. While Krugman (1993) predicts problems for EMU due to increased specialisation in a currency union, McKinnon (2002) holds that the case for a common currency grows even stronger as the union members become more specialised and concludes that "the productivity gain from greater regional specialisation is one of the major benefits of having and economic cum monetary union in the first place." (McKinnon 2002: 217)

A number of empirical studies have been conducted on the areas of financial integration and risk sharing although rarely linked explicitly to the Mundell II argument. Genereally, financial integration and risk sharing are notoriously difficult to measure. Baele et al. (2004) provide a survey on price-based and quantity-based indicators of financial integration. Price-based indicators rely on the idea of purchasing power parity (PPP) and imply converging interest rates across countries. Quantity-based measures include cross-country capital flows although data on bilateral flows are hardly available. In a series of papers, Lane and Milesi-Feretti (2001, 2005) analyse the dynamics of international financial integration on the basis of foreign assets and liabilities. Their findings suggest an increasing degree of financial integration among a selection of industrialised countries. Another quantity-based indicator is captured by the consumption-correlation puzzle which is one of the "Six Major Puzzles in International Macroeconomics" as pointed out by Obstfeld and Rogoff (2000). A large degree of financial integration should be reflected, it is argued, by the correlation of private consumption across countries because consumers can smooth their consumption flows by benefiting from the risk-sharing effect of international portfolio diversification. Notably, consumption correlation would, from a theoretical viewpoint, be exptected to exceed output correlation. However, poor empirical evidence on consumption correlation has been puzzling. For instance, Darvas and Szapáry (2005) find that consumption correlation among the European Union countries remains below GDP correlation.

In a next step, we would be interested in the interaction of financial integration, risk sharing and business cycle synchronisation in the context of currency union. Although many studies do not make explicit reference to currency union, they do touch on related topics. Kalemli-Ozcan et al. (2003) argue that financially integrated regions can "afford" to exploit increasing returns to scale by specialisation because capital markets make up for the insurance function otherwise exerted by geographical diversification. In an empirical excercise, they find evidence for their hypothesis that regions with well-integrated financial markets, such as U.S. states, tend to be more specialised than European countries. This is interpreted as supporting the Krugman (1993) argument which predicts increasingly asynchronous business cycles due to integration-induced specialisation. Imbs (2004, 2006), on the other hand, finds a positive impact of financial integration on cycle synchronisation. He employs various financial integration indicators in a simultaneous equations model and argues that a direct spill-over channel from financial integration to cycle sychronisation prevails over potential indirect effects via specialisation. But none of these studies considers the beneficial impact of risk-sharing via consumption insurance which may, according to Mundell II, compensate the adverse effects of asynchronous cycles.

As for other potential endogenous effects of currency union, more time is needed to make reliable statements about the impact of the euro on financial integration. First indications are, however, encouraging. Cappiello et al. (2005) find evidence on a positive effect of the euro on capital markets. On the micro levels, conditional correlations between euro area equity returns tend to move up at around 1999 and the volatility of bond markets has been reduced. Concerning macro aspects, the variability of yield premia has decreased with EMU, related to a reduction in macroeconomic volatility. Hence, the unfolding impact of currency union on financial integration seems to lend support to parts of Mundell II.

3 Risk sharing in the enlarged EU

This section portrays the conceptual framework of the risk-sharing analysis and presents the empirical results of consumption and output comovement in the enlarged EU. We investigate the degree of risk sharing between the NMS and the euro area during the last decade and compare their experience to that of the "old" EU countries. The theoretical foundation of analysing consumption correlations in the context of risk sharing is based on models of markets for contingent claims. In a world of complete markets, consumers can diversify risk by investing in Arrow-Debreu securities. These financial assets constitute contingent claims and deliver a state-contingent pay-off. By purchasing and selling Arrow-Debreu securities, households can consume the same amount of resources in varying states of the world. In other words, they can effectively insure against domestic risks and decouple their consumption patterns from domestic income flows. In equilibrium, cross-country consumption should be highly correlated because national consumption is internationally diversified and thus invariant to domestic output shocks. On these grounds, Backus, Kehoe and Kydland (1992) construct a calibrated international real business cycle model which predicts consumption to be more highly correlated than output across countries.

Empirical analysis, however, has not substantiated this prediction. In fact, cross-country consumption tends to be less highly correlated than output. The resulting consumption correlation puzzle is one of the "six major puzzles in international macroeconomics" as pointed out by Obstfeld and Rogoff (2000). Various reasons may be responsible for this puzzle. Low degrees of financial integration may prevent consumers from diversifying their portfolios internationally to the Arrow-Debreu degree. Also, trade costs and other barriers to international trade may inhibit risk sharing across countries. Moreover, a large degree of non-traded goods may contribute to the puzzle since risk sharing is possible only for risk to tradable output. Hence, measuring cross-country correlation in consumption of tradables only may alleviate the puzzle. Another measurement issue pertains to the output side. Given that only output remaining after investment and government consumption can be shared by private consumers, consumption correlations should rather be compared to correlations in GDP net of investment and government consumption, see Obstfeld and Rogoff (2000). In practice, however, limited data availability often restricts this type of analysis. Finally, Imbs (2006) investigates potential interactions between financial integration, output and consumption correlation. He finds that increased financial integration does not only raise consumption correlations across countries but that it boosts output correlation to an even larger degree. As a result, he argues, "the bulk of the quantity puzzle originates in the tendency for GDP correlations to increase with financial links, not in low risk sharing" (Imbs 2006: 315).

The following empirical investigation of risk sharing in the EU proceeds in two steps. We explore consumption and GDP comovement first by looking at cross-country correlations and then move on to the codependence analysis.

3.1 Consumption correlation

In a first step, we compare cross-country correlations of consumption and GDP. We use quarterly data of real private consumption and real GDP for the euro area and the eight NMS over the time period 1995Q1-2005Q4.[2] For comparison, we also investigate 14 "old" EU countries.[3] Data mostly stem from Eurostat, supplemented by national sources. Given that we are interested in the new member countries' prospective adoption of the euro, we correlate each country with the aggregate euro area.

Table 1 presents consumption correlation coefficients of growth rates and various cycle specifications. We derive the latter by detrending real GDP applying the Hodrick-Prescott (HP) filter and the Baxter-King (BK) band-pass filter.[4]

Table 1: *Consumption correlation*

Country	Growth rates	HP cycles	BK cycles *(k = 4)*	BK cycles *(k = 8)*
Czech Rep.	-0.06	-0.51	-0.20	-0.21
Estonia	-0.06	-0.62	-0.24	-0.52
Hungary	-0.16	0.23	0.07	0.06
Latvia	-0.31	-0.44	-0.32	-0.33
Lithuania	-0.28	-0.34	-0.04	0.03
Poland	0.20	-0.28	-0.23	-0.26
Slovakia	-0.02	-0.39	-0.26	-0.37
Slovenia	0.15	0.12	0.05	0.22
Austria	0.34	0.76	0.50	0.60
Belgium	0.17	0.72	0.54	0.65
Denmark	0.26	-0.26	0.00	-0.30
Finland	0.38	-0.12	0.07	0.03
France	0.63	0.82	0.59	0.79
Germany	0.76	0.83	0.60	0.79
Greece	-0.25	-0.20	-0.04	-0.03
Ireland	0.49	0.83	0.42	0.75
Italy	0.41	0.64	0.48	0.61
Netherlands	0.33	0.73	0.49	0.79
Portugal	0.38	0.70	0.33	0.67
Spain	0.31	0.79	0.61	0.80
Sweden	0.45	0.78	0.52	0.68
UK	0.39	0.57	0.21	0.45

Note: Correlation coefficients of real private consumption vis-à-vis the aggregate euro area in growth rates and cycles, applying the Hodrick-Prescott (HP) filter and the Baxter-King (BK) filter, the latter with alternative lead/lag parameters k = 4 and k = 8.

[2] Private consumption includes consumption of households and non-profit institutions serving households (NPISH). All data are in euro, scaled to 1995 prices and exchange rates, indexed and taken in logs. At this stage, we use seasonally-adjusted data. In the following section, we apply the codependence framework which incorporates seasonal adjustment within the statistical model and hence employs non-adjusted data.

[3] These include the EU-15 without Luxembourg, due to data constraints.

[4] See Hodrick and Prescott (1997) and Baxter and King (1999).

Both filters have been used extensively in business cycle analysis. The BK filter identifies the cyclical component by removing very high and very low frequency fluctuations from the data but the choice of the lead/lag parameter k involves a trade-off particularly in small samples like ours. The larger k, the more periods need to be cut off at the beginning and at the end of the sample. A smaller k, however, reduces the reliability of the results. The HP filter involves minimising the variance of the cyclical component but has been critised for the arbitrariness of the smoothing parameter employed. Although the HP filter does not reduce the sample size like the BP filter, the HP marginal values tend to be biased due to the required estimation of values for differencing.

According to table 1, the correlation of consumption with the euro area is very low for all NMS. In fact, the majority of coefficients is even negative, regardless of the specification of the indicator. Estonia, Latvia and Slovakia exhibit the lowest correlation whereas only Slovenia's consumption is positively correlated with euro area consumption throughout specifications, with coefficients ranging from 0.05 to 0.22. Not surprisingly, consumption correlation is much higher for EU-14 countries. France and Germany are characterised by top values between 0.59 and 0.83 while this is, of course, partly due to their large weight in euro area aggregate consumption. Depending on the specification, large correlation coefficients also pertain to Ireland, Spain and Sweden. We note that the correlation coefficients of the non-euro area members Sweden and the UK are not considerably lower than than those of euro area countries. Low and partly negative coefficients can be observed, however, in the cases of Denmark, Finland and Greece.

Table 2 presents the same growth rate and cycle specifications for GDP correlations. For the NMS, most coefficients take positive values although the sizes vary across specifications. Hungary stands out with the largest correlation coefficients of up to 0.88. Also, Slovenia and, in part, Poland show a relatively large degree of output correlation with the euro area. Lithuania, Slovakia and, partly, the Czech Republic have rather low, if not negative coefficients. For the EU-14 countries, France and Germany again exhibit the largest correlation values, between 0.72 and 0.97. Other countries with large coefficients include Belgium, Italy, the Netherlands and the UK. Greece has again by far the lowest correlation coefficients.

Regarding the consumption correlation puzzle, we turn to the differences between consumption and GDP correlations across countries. Figure 1 illustrates this gap at the example of the HP-filtered series.[5] It is very obvious that the consumption-GDP gap is negative and with down to -0.56 very large for most NMS, i.e. the consumption correlations are considerably lower than the GDP correlations. This is a first indication that the consumption correlation puzzle applies for the NMS. The only two positive gaps in the cases of Slovakia and Lithuania stem from the fact that both consumption and GDP correlations are very negative, with GDP even exceeding consumption correlation in absolute value. For the EU-14 countries, we identify large negative gaps for Denmark (-0.79) and Finland (-0.69) whereas the remaining countries are characterised by much

[5] We acknowledge that both the HP and the BP filters deliver imperfect results in the presence of small samples. To avoid further reduction of our sample, we employ the HP filter for the following exercise.

smaller or even positive gaps. Except for Greece and Italy, all remaining countries have values above -0.20. Austria, Portugal and Ireland have positive gaps, i.e. for these countries, consumption correlation exceeds output correlation - an indication of functioning risk sharing with the euro area. Taken together, the consumption-GDP correlations seem to indicate that those countries which have shared years of economic integration already (EU-14) tend to have much smaller consumption-GDP gaps than those still in economic transition. Hence, the consumption correlation puzzle may decline as integration proceeds.

Table 2: *GDP correlation*

Country	Growth rates	HP cycles	BK cycles ($k = 4$)	BK cycles ($k = 8$)
Czech Rep.	-0.13	0.05	0.04	0.54
Estonia	0.20	-0.06	0.59	0.33
Hungary	0.43	0.78	0.76	0.88
Latvia	0.06	0.03	0.40	0.27
Lithuania	-0.18	-0.51	-0.04	-0.19
Poland	0.32	0.18	0.68	0.62
Slovakia	0.05	-0.42	0.18	-0.06
Slovenia	0.08	0.41	0.35	0.58
Austria	0.43	0.72	0.69	0.80
Belgium	0.63	0.83	0.83	0.85
Denmark	0.34	0.53	0.39	0.77
Finland	0.17	0.51	0.36	0.61
France	0.72	0.93	0.93	0.94
Germany	0.78	0.92	0.93	0.97
Greece	0.05	0.06	-0.13	0.00
Ireland	0.45	0.67	0.65	0.82
Italy	0.65	0.87	0.89	0.94
Netherlands	0.68	0.79	0.84	0.82
Portugal	0.30	0.64	0.21	0.41
Spain	0.46	0.83	0.61	0.75
Sweden	0.53	0.80	0.70	0.75
UK	0.37	0.71	0.71	0.85

Note: Correlation coefficients of real GDP vis-à-vis the aggregate euro area in growth rates and cycles, applying the Hodrick-Prescott (HP) filter and the Baxter-King (BK) filter, the latter with alternative lead/lag parameters $k = 4$ and $k = 8$.

To find out more about the dynamics of risk sharing, we investigate rolling correlation windows. Figures 2-4 depict 5-year rolling windows ranging from 1995Q1-1999Q4 to 2001Q1-2005Q4. Due to the large number of countries, we form country groups composed of weighted averages of correlation coefficients.[6]

[6] We use relative GDP as weighting factor for averaging the respective correlation coefficients. Ap-

Figure 2 includes the eight NMS and shows that the average degree of GDP correlation with the euro area has increased markedly from -0.01 up to 0.58 during the 1999Q4-2004Q3 window before it declined to 0.27 in the most recent period. The very last windows may, however, be subject to some endpoint instability of the detrending filters and hence not be overestimated. The average consumption correlation of the NMS-8 with the euro area is clearly below GDP correlation. It has, however, risen from a starting value of -0.27 to a maximum of 0.00 in 1998Q4-2003Q3 and then moved down to -0.21. The distance between consumption and GDP correlation is illustrated by the bottom line in the graph. On the whole, the gap has widened over time.

Figure 3 averages nine euro area countries (EA-9) which seem to behave roughly similar. The euro area countries Finland and Greece, in contrast, appear idiosyncratic and hence grahped together with the non-euro area countries in figure 4 (EU-5). Although GDP correlation exceeds consumption correlation for the EA-9 countries, both lines are at far higher levels and have a more narrow gap than the NMS-8. GDP correlation of the EA-9 increased from 0.77 to 0.93 in 2000Q2-2005Q1 before it fell slightly to 0.90. Consumption correlation also rose on average from 0.70 to 0.85 in the same peak window as GDP, then decreasing somewhat to 0.79. As in the case of the NMS-8, we observe increasing rates of both GDP and consumption correlations, though at a lower rate for consumption. This finding is summarised by the negative and decreasing gap line. However, the EA-9 gap never touches the -0.20 shreshold.

The experience of the remaining EU-5 countries is less uniform. Figure 4 graphs only the consumption-GDP gaps but for each country individually. While the gap lines of Sweden and the UK declined moderately, we observe a massive decline in the case of Finland and a very volatile behaviour for Denmark and Greece.

On the whole, our correlation results confirm the consumption correlation puzzle for the NMS and the EU-14 countries as GDP correlations frequently exceed consumption correlations. However, the correlation levels of the EA-9 countries are much higher than for the NMS. Also, the gaps are more narrow. This may lead us to the conclusion that, as integration between the NMS and the euro area makes progress, the consumption-GDP gap may go down. Another interesting overall observation is that both GDP and consumption correlations increased on average over time. This may, without having performed any causal analysis, be interpreted as supportive evidence of the hypothesis by Imbs (2006). He suggests that the consumption-GDP gap widens not because of lacking risk sharing. Instead, he argues, it is financial integration with promotes both GDP and consumption correlation. According to his estimates, the effect of financial integration on GDP, or business cycle correlation is much stronger than that on consumption correlation. As a result, a widening consumption-GDP gap may be a more ambiguous phenomenon than previously assumed.

---

plying unweighted averages instead does not have a major impact on the results. The presented figures are based on HP-filtered data.

3.2 Consumption codependence

In addition to the correlation analysis above, we explore the data using the codependence framework of Engle and Kozicki (1993). This method is a more sophisticated time-series technique which takes both long-run and short-run comovement into account. Also, the codependence analysis explicitly incorporates the seasonal adjustment into the statistical model. For a more detailed review of the codependence technique, see Böwer (2006). We use non-adjusted data in this section. For more detailed information on the methodology of codependence, we refer to chapter 2. In this section, we consider quarterly real household consumption and real GDP the eight new EU member states (NMS-8) and 13 "old" EU countries, again covering 1995Q1-2005Q4.[7] Since we are mostly interested in short-term comovement of consumption and output, we omit the cointegration results at this stage and turn directly to the short-term analysis of common cycles.[8]

Since the codependence operates with difference-stationary data, we conduct unit root tests for all data in levels and seasonal differences, employing the Dickey-Fuller General Least Squares (DF-GLS) unit root test by Elliot et al (1996). This test is a modified version of the Augmented Dickey-Fuller (ADF) test and involves transforming the time series via a generalised least squares regression. It has been shown that the DF-GLS test, as compared to the standard ADF test, tends to be substantially more powerful, i.e. it is more likely to reject the null hypothesis of a unit root when the alternative hypothesis of stationarity is true.[9]

The series of the NMS, presented in the upper panel of table 3, reveal a considerable amount of unstability in the data. For consumption, five out of eight countries cannot be considered difference-stationary. Among the EU countries, Irish and Dutch consumption show non-stationary behaviour in differences. In the case of GDP, we cannot reject the unit root hypothesis for three NMS and three EU-13 countries. These countries basically disqualify for the codependence analysis. However, given the uncertainties of unit root testing with a relatively short time sample, all countries are tested for codependence with borderline cases receiving special attention.

Starting with consumption codependence, the results show again that comovement of consumption is weaker than that of GDP. Also, the relative comovement levels of EU-13 countries tends to be higher than that of the NMS.

[7] Greece and Portugal are not included due to data unavailability. For Ireland, the data span begins in 1997Q1.

[8] For the series under investigation, hardly any cointegration relations can be detected. Only France shows some indication of common stochastic trends with the euro area at the standard frequency. We do, however, find seasonal cointegration for a number of countries which hints at seasonal unit roots in the data and supports the idea of using non-adjusted figures.

[9] See Obstfeld and Taylor (2002), Stock and Watson (2003).

Table 3: *Unit root test results, consumption and GDP*

Country	Consumption				GDP			
	Levels	Lag	Diff	Lag	Levels	Lag	Diff	Lag
Euro Area	-1.41	4	-1.72*	1	-1.50	4	-1.94*	1
Czech Rep.	-1.83	4	-1.12	1	-3.27**	4	-2.62***	4
Estonia	-2.93*	4	-2.54**	1	-2.77	4	-3.43***	2
Hungary	-1.68	4	-0.95	1	-3.17**	4	-1.55	1
Latvia	-1.08	4	-1.51	1	-1.20	4	-1.49	1
Lithuania	-2.24	4	-1.85(*)	1	-1.51	4	-2.02**	1
Poland	-0.35	4	-0.31	1	-0.96	4	-1.65**	1
Slovakia	-1.92	4	-2.06*	1	-1.44	4	-1.23	2
Slovenia	-1.76	4	-0.73	4	-0.75	4	-2.36***	1
Austria	-1.65	4	-2.65***	1	-1.24	4	-2.32**	1
Belgium	-1.35	4	-2.60***	1	-2.13	4	-2.90***	2
Denmark	-1.39	4	-1.88*	1	-1.44	4	-2.27**	1
Finland	-1.43	4	-1.96**	1	-1.35	4	-1.87*	1
France	-2.21	4	-3.51***	1	-1.63	4	-1.91*	1
Germany	-0.76	4	-1.76*	1	-1.04	4	-2.05**	1
Ireland	-1.30	4	-0.72	2	-0.53	4	-0.16	4
Italy	-1.95	4	-1.88*	1	-1.36	4	-2.68***	1
Luxembourg	-1.14	4	-2.18**	1	-1.58	4	-1.99***	3
Netherlands	-1.71	4	-0.67	2	-1.83	4	-1.34	1
Spain	-2.08	4	-3.39***	1	-1.61	4	-1.15	4
Sweden	-2.14	4	-1.95*	1	-1.71	4	-2.51***	1
UK	-0.01	4	-1.95*	1	-0.39	4	-2.59***	1

*Note: Results of the DF-GLS unit root test by Elliot et al (1996), in the case of levels including a deterministic trend. The significance levels are indicated as follows: *** = 1%, ** = 5%, *=10%.*

Table 4 reports the consumption codependence results of the NMS. We find no clear-cut case of common features or, in other words, codependence of zero order. Hence, no NMS seems to have synchronised common consumption cycles with the euro area. Considering borderline cases, we note that for Lithuania the hypothesis of one common feature vector is rejected with a p-value of 0.02. Applying the 5 percent significance criterion, Lithuania does not qualify for a common feature - applying 1 percent, however, it does. Another borderline case is Slovakia which exibits codependence of first order, $CD(1)$, with a p-value of 0.049. However, Slovakia's unit root test concluded an optimal autocorrelation lag length of 1 which would exclude any codependence of order higher than zero. Since the choice of the unit root lag length tends to be ambiguous, we consider Slovakia a candidate for $CD(1)$, i.e. common but non-synchronised consumption cycles with the euro area.

Table 4: *Consumption codependenc results, NMS-8*

Country	rank	Common features	Codependence Order 1	Order 2	Order 3
Czech Rep.	$m = 1$	34.17***	13.71***	17.90***	1.34
	$m = 2$	108.68***	24.44***	24.33***	5.91
Estonia	$m = 1$	21.77***	1.57	4.09	2.85
	$m = 2$	67.15***	11.81*	9.03	4.83
Hungary	$m = 1$	34.07***	10.70***	4.18	1.90
	$m = 2$	91.42***	21.75***	12.92**	4.77
Latvia	$m = 1$	24.90***	9.04	16.24***	6.34
	$m = 2$	110.43***	21.85**	23.92**	11.22
Lithuania	$m = 1$	11.95**	1.77	8.64	2.35
	$m = 2$	64.52***	12.89	16.69	4.86
Poland	$m = 1$	40.32***	9.60**	12.13**	5.20
	$m = 2$	105.60***	23.97***	21.28**	11.79
Slovakia	$m = 1$	22.63***	3.87**	0.57	0.00
	$m = 2$	60.11***	13.51***	5.34	2.37
Slovenia	$m = 1$	24.16***	1.88	15.27***	2.48
	$m = 2$	68.47***	12.28	23.01**	11.28

*Note: Codependence results of real private consumption of each country vis-à-vis the euro area. Rejection of the null hypothesis of common feature/codependence vectors at the 1 percent level is indicated by "***", the 5 percent level is marked with "**", the 10 percent level with "*". If we find the combination of accepting one vector* $(m = 1)$ *and rejecting a second vector* $(m = 2)$*, we conlude the existence of* $n - m = 2 - 1 = 1$ *common cycle.*

In other words, the Slovak consumption cycles may not be perfectly synchronised with the one of the euro area but it may adjust after one lag period. On the whole, however, consumption codependence results for the NMS with the euro area are largely negative and the only indications of comovement are burdened with uncertainty.

Turning to consumption codependence of the EU-13 countries, the evidence is only slightly more favourable. Austria, Belgium and Denmark are the only clear cases of synchronised common consumption cycles with the euro area as table 5 makes clear. In all of these cases, the notion of one common feature vector cannot be rejected with p-values above the 0.10 threshold whereas second vectors are rejected at the 1 percent levels throughout. For Austria and Belgium, this is in line with the correlation results that indicated a large degree of consumption comovement for these countries with the euro area. Interestingly, Denmark shows signs of zero-order codependence whereas the consumption correlation results were rather poor. Other countries which were ascribed a high consumption correlation coefficient in the analysis above do not qualify for consumption codependence.

Table 5: *Consumption codependenc results, EU-13*

Country	h	rank	Common features	Codependence Order 1	Codependence Order 2	Codependence Order 3
Austria	2	$m = 1$	5.65	1.40	9.74**	1.86
		$m = 2$	56.02***	14.42*	18.42**	9.77
Belgium	2	$m = 1$	3.38	0.96	10.11**	2.29
		$m = 2$	61.04***	14.45**	18.22**	8.74
Denmark	1	$m = 1$	3.21	0.91	2.55	0.03
		$m = 2$	64.55***	11.25*	9.20	4.09
Finland	1	$m = 1$	19.69***	4.31	4.67*	1.62
		$m = 2$	68.51***	13.91**	10.48	6.78
France	1	$m = 1$	18.17***	3.47*	0.46	0.02
		$m = 2$	60.06***	13.56***	5.01	2.68
Germany	2	$m = 1$	23.60***	8.22**	6.41*	2.31
		$m = 2$	81.14***	21.78***	14.79*	16.18**
Ireland	1	$m = 1$	18.92***	3.53	0.60	0.58
		$m = 2$	91.40***	16.79**	7.84	6.41
Italy	1	$m = 1$	20.04***	4.23**	0.85	0.07
		$m = 2$	64.11***	13.99***	6.08	3.76
Luxembourg	1	$m = 1$	19.68***	5.84*	1.13	0.88
		$m = 2$	71.13***	15.18**	5.57	2.87
Netherlands	1	$m = 1$	6.91***	3.93**	4.51**	0.01
		$m = 2$	59.05***	16.77***	11.04**	3.79
Spain	1	$m = 1$	5.51**	0.43	0.00	0.46
		$m = 2$	43.35***	9.92**	4.78	1.94
Sweden	1	$m = 1$	32.48***	9.31	5.68	8.56
		$m = 2$	108.22***	24.78	17.99	19.73
UK	3	$m = 1$	20.33***	9.80	4.43	3.24
		$m = 2$	80.16***	24.61**	19.79	14.84

*Note: Codependence results of real private consumption of each country vis-à-vis the euro area. Rejection of the null hypothesis of common feature/codependence vectors at the 1 percent level is indicated by "***", the 5 percent level is marked with "**", the 10 percent level with "*". If we find the combination of accepting one vector* ($m = 1$) *and rejecting a second vector* ($m = 2$), *we conlude the existence of* $n - m = 2 - 1 = 1$ *common cycle.*

Neither France nor Germany exhibit synchronised common correlation cycles with the euro area. In the cases of France and Luxembourg, we find find evidence of non-synchronised common cycles, i.e. $CD(1)$. These results, however, depend on the true autoregressive order which may be 1 or 2. The Netherlands, on the other hand, would qualify for $CD(1)$ if they did not fail to be difference-stationary. Spain is another borderline case which hinges on the level of significance applied. In the standard case of the 5 percent level, it fails but it qualifies if we use the 1 percent criterion - the corresponding p-value for the rejectance of one common feature vector is 0.02. In sum, the consumption codependence results for both the NMS and the EU-13 countries with the euro area turn out to be weak, with the EU-13 slightly more positive than the NMS.

Table 6: *GDP codependenc results, NMS-8 plus Turkey*

Country	h	rank	Common features	Codependence Order 1	Codependence Order 2	Codependence Order 3
Czech Rep.	2	$m = 1$	27.01***	7.03	3.85	1.18
		$m = 2$	149.03***	22.30**	11.91	7.68
Estonia	2	$m = 1$	31.93***	11.78**	9.73**	2.99
		$m = 2$	96.98***	24.03***	16.09*	11.28
Hungary	3	$m = 1$	9.54*	0.96	5.96	4.23
		$m = 2$	44.78***	9.71	12.77	10.04
Latvia	1	$m = 1$	19.77***	1.66	0.05	1.65
		$m = 2$	75.83***	13.37***	5.54	5.90
Lithuania	2	$m = 1$	4.32	2.07	8.90**	1.69
		$m = 2$	58.35***	12.49	13.02	9.19
Poland	1	$m = 1$	11.61***	3.33*	1.73	0.47
		$m = 2$	48.14***	11.21**	12.42**	7.40
Slovakia	2	$m = 1$	13.70***	4.27	7.99**	3.76
		$m = 2$	58.40***	14.40*	13.34	8.16
Slovenia	1	$m = 1$	3.65*	7.31***	2.84*	0.49
		$m = 2$	41.74***	17.01***	9.29**	9.07*
Turkey	2	$m = 1$	22.37***	9.09**	3.88	06.69
		$m = 2$	60.28***	17.40**	15.61**	10.59

*Note: Codependence results of real GDP of each country vis-à-vis the euro area. Rejection of the null hypothesis of common feature/codependence vectors at the 1 percent level is indicated by "***", the 5 percent level is marked with "**", the 10 percent level with "*". If we find the combination of accepting one vector* ($m = 1$) *and rejecting a second vector* ($m = 2$)*, we conlude the existence of* $n - m = 2 - 1 = 1$ *common cycle.*

Not unexpectedly, the common GDP cycles are more pronounced. Table 6 provides the results for the NMS. Lithuania and Slovenia exhibit one common feature vector which indicates synchronised common cycles with the euro area. Hungary also qualifies according to the codependence test but the non-stationarity result for Hungary's GDP growth rates calls that result in question. The Czech Republic, Estonia, Latvia and Poland show signs of first-order codependence, i.e. common but non-synchronised common cycles. Slovakia, on the contrary, clearly fails both in terms of difference-stationarity and codependence. In addition to the above countries, we consider the EU candidate country Turkey but find no evidence of any codependence. In brief, the results on common GDP cycles of the NMS with the euro area are clearly better than in the case of consumption which tends to lend support to the consumption correlation puzzle.

Next we turn to GDP codependence of the EU-13 countries vis-à-vis the euro area, see table 7 Again, we generally find a larger degree of GDP than consumption comovement. Austria, Germany and the UK qualify for synchronised common GDP cycles with the euro area. Borderline cases for $CD(0)$ are Belgium, France and Luxembourg for which the p-value of rejecting one common feature vector is below 0.05 but above 0.01.

Table 7: *GDP codependenc results, EU-13*

Country	rank	Common features	Codependence Order 1	Or-13der 2	Order 3
Austria	$m = 1$	7.49*	0.58	3.73	3.92
	$m = 2$	45.75***	8.30	7.67	12.83
Belgium	$m = 1$	5.51**	1.89	0.01	0.28
	$m = 2$	45.92***	10.78**	8.22*	11.04**
Denmark	$m = 1$	35.01***	8.29**	3.32	7.99**
	$m = 2$	77.65***	15.78**	15.90**	11.87
Finland	$m = 1$	22.76***	6.21	2.71	1.93
	$m = 2$	55.44***	14.25*	7.85	7.67
France	$m = 1$	4.11**	1.17	1.74	0.03
	$m = 2$	35.16***	7.87*	7.83*	2.09
Germany	$m = 1$	0.07	0.00	1.99	0.09
	$m = 2$	37.37***	7.60	4.01	6.28
Ireland	$m = 1$	0.20	1.90	0.12	1.26
	$m = 2$	32.77***	8.76*	2.24	4.80
Italy	$m = 1$	11.55***	1.52	0.01	0.00
	$m = 2$	44.41***	10.21**	6.54	9.93**
Luxembourg	$m = 1$	7.29**	0.97	21.91***	1.47
	$m = 2$	59.10***	12.63**	32.40***	15.03**
Netherlands	$m = 1$	15.78***	3.26**	0.94	0.06
	$m = 2$	72.20***	15.31***	8.44	6.30
Spain	$m = 1$	2.21	0.37	0.00	0.58
	$m = 2$	38.12***	7.01	4.09	4.56
Sweden	$m = 1$	12.35***	2.57	0.58	0.03
	$m = 2$	46.91***	9.67**	3.29	0.59
UK	$m = 1$	0.01	0.04	0.47	0.05
	$m = 2$	32.48***	7.42	4.62	9.19*

*Note: Codependence results of real GDP of each country vis-à-vis the euro area. Rejection of the null hypothesis of common feature/codependence vectors at the 1 percent level is indicated by "***", the 5 percent level is marked with "**", the 10 percent level with "*". If we find the combination of accepting one vector* ($m = 1$) *and rejecting a second vector* ($m = 2$), *we conlude the existence of* $n - m = 2 - 1 = 1$ *common cycle.*

Ireland and Spain seem to qualify for common features but both suffer from non-stationarity results in the unit root test. Italy and Sweden seem to have common but non-synchronised cycles with the euro area, i.e. they exhibit one codependence vector of order one. This $CD(1)$ result holds also true for Belgium and Luxembourg who were considered borderline for $CD(0)$. These results largely correspond with the correlation evidence concerning Austria, Belgium, France, Germany and the UK. For other countries, the codependence results tend to be weaker than the correlation evidence. However, simple correlations do not provide a clear benchmark threshold and are a more simplistic concept per se.

Summing up, we make two general observations. First, the degree of consumption comovement tends to be weaker than that of GDP comovement which, at first glance, hints at a low degree of risk sharing. However, the rolling correlations seem to indicate that both consumption and GDP comovement vis-à-vis the euro area have been increasing over the recent years, for both the NMS and the "old" EU countries. Considering the argumentation of Imbs (2006) who sees increased financial integration behind the rise of both consumption and GDP comovement, we may not draw unequivocal conclusions from our evidence on the consumption correlation puzzle on the underlying degree of risk sharing. The second observation pertains the fact that the overall levels of consumption and GDP comovement to the euro area tend to be larger among the EU-13 countries than among the NMS. This is not surprising given the longer integration history among the "old" EU and the fact that most EU-15 are actually included in the euro area aggregate. It may indicate, however, that with ongoing economic integration, the obstacles to risk sharing may continue to shrink and hence the improve the future perspective of risk sharing among the member states of the enlarged EU. To shed more light on the degree and dynamics of financial integration, we now turn to the analysis of real interest rate comovement.

4 Financial integration in the enlarged EU

The argument of Mundell II stipulates that, in the presence of financial integration, countries with asymmetric business cycles may benefit most from joining a currency union because consumers can diversify their portfolios across the region and decouple their consumption patterns from potentially idiosyncratic output cycles at home. The previous section presented evidence that the degree of risk sharing, measured by consumption comovement, is to date limited in the NMS. The "old" EU members, however, enjoy a larger degree of risk sharing which is a likely result from their common integration history.

This section investigates financial integration for both the NMS and the EU-15 countries. It finds that the degree of financial integration as measured by real interest rate comovement is limited for the NMS. The EU-15 countries have, however, made considerable progress in financial integration from the 1980s to the 1990s. This development can be expected to have contributed to higher levels of risk sharing and may be anticipated for the NMS as they continue to integrate with the EU-15.

One way to measure financial integration is to compare cross-country interest rates. If financial markets are integrated, identical financial assets should have the same price whether they are traded at home or abroad. As a result, we would expect to see equalised real interest rates between countries that share a perfect financial market. Various concepts capture the different dimensions of interest parity. Uncovered interest parity states that differences in nominal returns across countries should equal expected exchange rate changes. Covered interest rate parity uses the forward rate instead of spot rates. According to real interest parity, the expected difference between domestic and foreign real interest rates is zero. We follow Kugler and Neusser (1993) who investigate long-run and short-run comovement of real interest rates across countries using the codependence technique. While they foucs on pairwise codependence among five G7 countries and Switzerland, we consider the 23 countries of the enlarged EU vis-à-vis the euro area aggregate. Before conducting the correlation and codependence analyses, we discuss the ambiguous issue of stationarity in the context of interest rates.

4.1 Interest rates and stationarity

It has been an issue of debate whether interest rates should be regarded as stationary or non-stationary. A stationary time series is characterised by constant expected mean and variance and is hence considered mean-reverting. For consumption and GDP, the case seems clear: Most countries exhibit long-run positive trends which turn the series non-stationary. Growth rates or cyclical components, however, tend to be stationary, i.e. they fluctuate around a constant mean and have a finite variance.

The case of interest rates is less clear. In theory, the life cycle model of consumption predicts consumption growth rates to have similar time-series properties as real interest rates.[10] Hence, interest rates would be expected to be stationary, similar to consumption growth rates. But empirical evidence on interest rate stationarity is mixed. Kugler and Neusser (1993) confirm the theoretical proposition for their 1980s sample of industrialised countries and find that the unit root hypothesis can be easily rejected. Rose (1988), in contrast, suggests that interest rates in the U.S. and elsewhere tend to be non-stationary. Also, Obstfeld et al. (2005) find that, at least during the post-Bretton Woods era, interest rates are overwhelmingly non-stationary. However, they admit that interest rates are unlikely to follow a literal unit root process - otherwise we would see interest rates rise unboundedly. This is hardly the case. Driffell and Snell (2003) propose that the unit root result my stem from the high persistency of interest rates and not from a truely non-stationary process. Moreover, they argue that what seems like a unit root process may often be a result of regime shifts in otherwise stationary data. Also, Garcia and Perron (1996) make this point and treat interest rates as stationary.

In our dataset of the enlarged EU, evidence on stationarity is mixed and thus reflects the ambiguity of the literature. The following sections present the unit root test results in the context of the correlation and codependence analyses.

[10] See Kugler and Neusser (1993).

4.2 Interest rate correlation

We consider quarterly short-term interest rates for the eight NMS and the EU-15 countries. We employ three-months money market rates from the IMF's International Financial Statistics, supplemented by Eurostat data. All data are deflated by CPI.[11] In the case of the NMS, our time frame is 1995Q1-2005Q4 and we pair each country with the euro area aggregate. For the EU-15 countries, we apply the pre-EMU time frame 1980Q1-1998Q4 which we divide into two subsamples at 1990Q1.[12] We use Germany as the reference country for the EU-15 countries because it served as benchmark and role model in the run-up to EMU.

Table 8: *Unit root test, interest rates, NMS*

Country	Levels	Lag	Differences	Lag
Euro Area	0.35	1	-2.47***	1
Czech Rep.	-1.65*	1	-2.85***	1
Estonia	-0.85	3	-2.07**	2
Hungary	-2.33***	2	-2.25***	1
Latvia	-1.13	1	-2.71***	1
Lithuania	-0.54	1	-1.54	1
Poland	-0.80	1	-1.75*	1
Slovakia	-1.65*	1	-2.48***	3
Slovenia	-3.13***	1	-2.13**	1

*Note: Results of the DF-GLS unit root test by Elliot et al (1996). The significance levels are indicated as follows: *** = 1%, ** = 5%, *=10%.*

Given the ambiguous stationarity situation for interest rates, we first conduct unit root tests for all real interest rate series. Tables 8 and 9 summarise the results for the NMS and the EU-15 for their respective time frames in levels and first differences.[13] The evidence is irregular. Some of the NMS seem stationary in levels whereas for others, the test cannot reject the hypothesis of a unit root. In differences, all countries but Lithuania seem stationary at least on the 10 percent level of significance. In case of the

[11] Although the Harmonised Index of Cosumer Inflation (HICP), compiled by Eurostat, would be preferable for the comparison of European countries, it is not available for all countries in all periods. Hence, we resort to the commonly used consumer price index (CPI), provided by IFS. Quarterly inflation rates are calculated on a year-on-year basis and then subtracted from the quarterly nominal interest rate. Following Obstfeld and Taylor (2002), we make the standard assumption that the observed *ex post* real interest rates are equal to the *ex ante* real rate plus a white-noise stationary forcast error.

[12] We analyse only pre-EMU data because with the start of the single monetary policy, nominal short-term interest rates are equalised across the euro area. Hence, real interest differentials would only be due to inflation differentials which are, in itself, not a prime measure of financial integration.

[13] We calculate the first differences from the interest rate levels, not logs. Hence, they cannot be considered growth rates. The reason is that logs cannot be computed for negative real interest rates which tend to prevail for quite a number of observations. Using instead the logs of the interest rate factors, log(1+R), as suggested by Obstfeld et al. (2005), would yield factor growth rates when differenced. Their correlation coefficients, however, are almost equal to those of the simple first differences of non-log levels since $d[\log(1+R)] \approx d[R]$ for small Rs.

EU-15 countries, only five countries show stationary behaviour in levels but in nearly all cases, the differences are stationary. For France and Ireland, we cannot reject a unit root either in levels or in differences. Given the ambiguity of interest rate stationarity, we present correlation results for both levels and differences in the following.

Table 9: *Unit root test, EU-15, 1980-1998*

Country	Levels	Lag	Differences	Lag
Austria	-2.12**	3	-1.42	2
Belgium	-1.54	1	-2.32***	1
Denmark	-2.09**	3	-4.77***	3
Finland	-1.03	2	-3.80***	1
France	-0.92	1	-0.67	3
Germany	-1.08	1	-2.83***	1
Greece	-0.53	2	-8.95***	1
Ireland	-0.72	2	-1.59	2
Italy	-0.91	2	-3.71***	1
Luxembourg	-1.48	1	-2.63***	1
Netherlands	-1.35	1	-2.05**	1
Portugal	-2.71***	1	-2.62***	2
Spain	-2.58***	1	-6.04***	1
Sweden	-2.90***	1	-5.59***	3
UK	-1.04	1	-5.44***	1
US	-1.622	2	-1.90*	1

*Note: Results of the DF-GLS unit root test by Elliot et al (1996). The significance levels are indicated as follows: *** = 1%, ** = 5%, *=10%.*

Table 10 presents the correlation coefficients of NMS real interest rates vis-à-vis those of the euro area aggregate. We calculate correlation coefficients of levels and differences for the entire 1995Q1-2005Q4 period as well as for two sub-periods, 1995Q1-1999Q4 and 2000Q1-2005Q4. In the levels case, we observe correlation coefficients of up to 0.55 for the Czech Republic and 0.50 for Slovakia. Three out of the eight countries show negative coefficients: Estonia, Hungary and Lithuania. Comparing the two sub-samples, it becomes clear that, except for Hungary and Slovenia, all countries exhibit increasing correlation which may hint at improved financial integration with the euro area. The correlation coefficients of the first differences are less dispersed. Generally, all coefficients remain below 0.50 but we find only two negative correlations. Now, Estonia and Hungary are among the countries with the highest correlation. Poland and Slovakia still exhibit a relatively large degree of interest rate correlation. Surprisingly, Slovenia's coefficient is now negative. Still, most coefficients tend to rise or remain relatively stable from the first to the second sub-period. They shrink in only two cass, the Czech Republic and Estonia.

Table 10: *Real interest rate correlation, NMS-8*

Country	Levels			First differences		
	95-05	95-99	00-05	95-05	95-99	00-05
Czech Rep.	0.55	-0.20	0.32	0.20	0.26	0.16
Estonia	-0.43	-0.53	0.42	0.33	0.45	0.31
Hungary	-0.44	-0.53	-0.61	0.29	0.15	0.40
Latvia	0.02	-0.38	0.75	0.21	0.13	0.39
Lithuania	-0.34	-0.80	0.53	-0.02	-0.15	0.20
Poland	0.18	-0.29	0.87	0.28	0.31	0.29
Slovakia	0.50	-0.08	0.07	0.26	0.27	0.33
Slovenia	0.10	-0.02	-0.77	-0.15	-0.36	0.25

Note: Correlation coefficients of real interest rates vis-à-vis the euro area.

To find out more about variations over time, we calculate moving correlation windows of five years length. Figures 5 and 6 present those in line graphs for both levels and differences. The levels tend to increase strongly over the considered period, ranging across almost the entire spectrum of -1 to 1. Only Hungary and Slovenia stand out with negatively sloped lines. The differences, graphed in figure 6, tend to move closer together and range between -0.5 and 0.6. Although most countries experience rising coefficients on the whole, the increase appears less dramatic.

Another way of analysing real interest rate comovement is looking at bilateral differentials. Figure 7 presents bilateral differentials of the eight NMS, each paired with the euro area. While most differentials experience enormous fluctuation over time, it seems that some countries achieved more stability since approximately 1999/2000. In particular, the currency boards of Estonia and Latvia seemed to have contributed to this development. To analyse the variability of real interest differentials further, we calculate the standard deviations for the whole period and for the two sub-periods, 1995-1999 and 2000-2005. The results are displayed in figure 8. All NMS are characterised by decreasing variation in their interest rate differentials with the euro area. While standard deviations vary considerably during the first sub-period, they seem to converge to a simliar low level during the second. We regard this as additional indication for increased financial integration.

For comparison, we investigate real interest rate correlation and variation of differentials for the EU-15 countries. Now we focus on the pre-EMU period where countries converged towards the benchmark country of those years, Germany. We again split our series into two sub-samples, now ranging from 1981Q1-1989Q4 and 1990Q1-1998Q4.

Table 11 provides the correlation coefficients for both levels and differences, each country paired with Germany. Austria, Belgium, Luxembourg and the Netherlands seem to form a core group and experience by far the largest correlation coefficients. This applies for both levels and differences, although the values for the differences tend to be lower on the whole. The smallest coefficients pertain to Greece and Portugal, followed by Ireland and Spain. Almost every country's correlation with Germany increases markedly from the first to the second sub-period, although again the effect is stronger in case of levels. Interestingly, the correlation coefficients for the UK tend to be increasing towards Germany while they go down vis-à-vis the United States.

Table 11: *Real interest rate correlation, EU-15*

Country	Levels			First differences		
	81-98	81-89	90-98	81-98	81-89	90-98
Austria	0.78	0.60	0.94	0.44	0.50	0.31
Belgium	0.85	0.79	0.92	0.47	0.48	0.46
Denmark	0.50	-0.20	0.83	0.12	0.11	0.13
Finland	0.42	-0.38	0.91	0.13	-0.15	0.53
France	0.49	-0.13	0.87	0.26	0.28	0.24
Greece	-0.34	-0.31	-0.38	0.02	-0.16	0.18
Ireland	0.17	-0.27	0.70	0.19	0.25	0.10
Italy	0.21	-0.24	0.63	0.28	0.11	0.54
Luxembourg	0.80	0.72	0.94	0.48	0.50	0.41
Netherlands	0.83	0.58	0.97	0.59	0.59	0.62
Portugal	0.00	-0.01	0.33	-0.12	-0.13	-0.11
Spain	0.20	-0.35	0.85	-0.13	-0.25	0.30
Sweden	0.16	0.03	0.24	0.29	0.08	0.50
UK	0.22	-0.28	0.74	0.15	0.12	0.22
UK-US	0.20	0.25	-0.30	0.14	0.19	-0.05

Note: Correlation coefficients of real interest rates vis-à-vis Germany.

Turning to rolling interest rate correlation windows, we split the country sample into three groups to facilitate graphical inspection. For many countries, correlation of interest rates with Germany seems to move in cycles. Figure 9 includes those countries with the largest overall correlation coefficients, the euro area core. These are relatively small countries which have maintained close ties to German monetary policy for many years. They tend to experience "correlation booms" during the late 1980s and the mid-1990s, interrupted by downturns around 1990 and in the most recent periods. The 1990 trough is likely to be due to German reunification which was associated with exceptionally high interest rates in Germany compared to the rest of Europe. On the whole, the core group fluctuates within a relatively narrow band of 0.40-0.90. Figure 10 shows the remaining euro area economies. These "periphery" countries show a larger degree of convergence as they all start at negative correlation values and increase drastically from there, some appraoching 0.95 in the mid-1990s. Again, we observe a certain cyclical behaviour and a downturn of correlation values towards the end of the sample. Figure 11 consists of the three non-euro area countries among EU-15, plus the UK-US relation for comparison. While Denmark and Sweden increased markedly in their interest rate correlations with Germany, the UK pattern against the US seems to mirror that vis-à-vis Germany. During the mid-1990s, UK-German interest rates tend to comove on a high level but turn negative in the most recent period whereas UK-US correlation remains negative during most of the 1990s and picks up towards the end of the sample. Apparently, the UK takes a changing position in terms of financial market integration with Germany and the US. We note, however, that neither for Germany, nor for the UK and the US we can formally reject the unit root hypothesis in levels.

The line graphs of the difference correlations, illustrated in figures 12-14, tend to follow a roughly similar pattern. Again, the core group fluctuates on a relatively high level against Germany while the periphery countries exhibit a clearer upward trend. Regarding the non-euro area countries, it stands out that the UK-German correlations remain above the UK-US relation at all times since the end of the 1990s. Taken together, the EU-15 countries seem to have followed German real interest rates to an increasing extent during the pre-EMU period which hints at improved financial market integration and policy coordiation in preparation for the euro.

To study the variability of bilateral interest rate differentials between the EU-15 countries and Germany, we first inspect the differentials graphically, see figure 15. Although all series seem to include considerable variation, some appear to narrow down in the second half of the sample. Austria, Belgium, Luxembourg and the Netherlands basically even out at a plus/minus one percentage level since around 1993. Other countries, such as France or the UK, tend to remain within a virtual plus/minus two percentage band towards the end of the sample. Figure 16 ranks countries according to the standard deviation of their bilateral interest rate differentials against Germany. The aforementioned euro area core group plus France and the UK lead the list of smallest variations over the whole sample. However, other countries which experienced a high level managed to reduce their variation considerably. As a result, except for Greece all EU-15 countries brought their variation level down to around two standard deviations - which is a similar level as for the NMS versus the euro area since 2000.

Finally, we study the degree of dispersion across EU-15 countries. For this purpose, we calculate the standard deviation across all EU-15 countries at one point in time and repeat this exercise for all periods. Analysing the cross-country dispersion over time has also been known as sigma convergence in the empirical growth literature. Figure 17 shows that despite some peaks, the overall dispersion level has clearly decreased between 1981 and 2005. One major spike stands out in 1994 which is due to idiosyncratic developments in Greece. Leaving out Greece delivers an even smoother path of decreasing dispersion, illustrated by figure 18.

In summary, our correlation, variability and dispersion evidence suggests that real interest rates have become more similar during the 1980s and 1990s in the EU-15. Although correlations for the NMS tend to be ambiguous, the reduced variability of bilateral interest rate differentials hints at more similar rates as well. We acknowledge that the stationarity analysis of interest rate is subject to limitations and has delivered mixed results. This is, however, in line with the conflicting propostions on stationarity of interest rates in the literature.

4.3 Interest rate codependence

In the following, we analyse real interest rates across countries employing the codependence technique. Again, as our focus is on the short run, we concentrate on the cyclical part of comovement. We employ the same time and country sample as in the correlation analysis of interest rates, i.e. eight NMS vis-à-vis the euro area during 1995Q1-2005Q4 as well as the EU-15 countries related to Germany during 1980Q1-1998Q4. For comparison, we again consider the relation of the UK to the US. Since the codependence framework incorporates a seasonal adjustment tool, we use annualised month-on-month CPI inflation to calculate "non-adjusted" real interest rates.

Table 12: *Unit root test results, NMS-8*

Country	Levels	Lag	Diff	Lag
Euro Area	-0.76	3	-3.68***	4
Czech Rep.	-3.03***	1	-3.39***	4
Estonia	-1.79*	1	-4.78***	1
Hungary	-0.17	4	-3.26***	1
Latvia	-0.80	4	-2.61***	1
Lithuania	-0.70	2	-2.03**	1
Poland	-0.58	3	-2.53***	1
Slovakia	-1.58	4	-2.08**	4
Slovenia	-1.22	4	-3.20***	1

*Note: Results of the DF-GLS unit root test by Elliot et al (1996). The significance levels are indicated as follows: *** = 1%, ** = 5%, *=10%.*

First, we look at unit root test results for the non-adjusted data, see tables 12 and 13, which are largeley similar to the adjusted data. We note that nearly all countries are stationary in differences while a few seem stationary in levels as well. For some countries, however, we cannot reject the unit root hypothesis either in the levels or in the difference cases.

On the whole, the unit-root results are again subject to debate, as discussed in the previous section, since interest rates are hard to imagine non-stationary in the classical sense. The codependence framework works with differences and almost all countries are stationary at least in differences.

Table 13: *Unit root test results, real interest rates, EU-15*

Country	1980-1989				1990-1998			
	Levels	Lag	Diff	Lag	Levels	Lag	Diff	Lag
Austria	-2.02**	4	-2.49***	1	-1.53	4	-2.41***	3
Belgium	-2.78***	1	-1.50	4	-0.81	2	-2.23**	1
Denmark	-4.77***	1	-2.19**	4	-0.59	3	-1.08	4
Finland	-1.40	4	-2.91***	1	-1.03	4	-1.75*	1
France	-1.76*	1	-2.80***	4	-1.09	2	-2.00**	4
Germany	-1.40	2	-2.35***	1	-1.39	4	-2.20**	1
Greece	-1.18	4	-3.79***	4	-2.32*	1	-2.77***	1
Ireland	-2.41***	3	-0.83	4	-2.25*	1	-2.98***	2
Italy	-1.80	1	-2.41***	4	-1.08	3	-3.19***	2
Luxembourg	-2.79***	1	-3.35***	1	-0.98	3	-0.84	4
Netherlands	-1.49	1	-1.99**	4	-0.78	4	-4.24***	4
Portugal	-1.81	4	-3.28***	4	-0.74	4	-2.32**	1
Spain	-3.08***	3	-1.73	4	-2.27*	2	-2.76***	4
Sweden	-3.11***	1	-1.71	1	-1.89	1	-2.23**	4
UK	-1.37	4	-3.23***	1	-1.33	4	-2.77***	1
US	-1.61	1	-2.23**	1	-1.25	2	-1.36	4

*Note: Results of the DF-GLS unit root test by Elliot et al (1996). The significance levels are indicated as follows: *** = 1%, ** = 5%, *=10%.*

Table 14 provides the codependence results for the NMS. Hungary, Poland and Slovakia seem to exhibit common features, or codependence of order zero, with the euro area. This would mean that their real interest rates have synchronised common cycles which hints at a high degree of financial integration. This evidence matches with the correlation of differences from the previous section where these three countries were among those with the largest correlation coefficients. Some uncertainty, however, remains concerning the autoregressive orders. Intuitively, two countries can only have a common feature if the individual features, i.e. serial correlations, are of equal length. Otherwise, the feature would not cancel out in the linear combination. For the euro area, we found an autoregressive order of $p = 4$ when testing for Q statistics of autocorrelation in the residuals of the autoregressive equations. For Hungary, this criterion yields $p = 1$ although according to the modified Akaike information criterion, lag length 4 would be the optimal choice. The fact that Hungary displays one codependence vector from order zero to three throughout supports the notion that Hungary acutally does qualify for $CD(0)$. For Poland and Slovakia, the cases are less clear. The unit root tests would also allow $p = 4$ but the fact that the codependence tests suggest two codependence vectors for $CD(1)$ renders the case of synchronised common cycles rather unlikely.

Table 14: *Interest rate codependenc results, NMS-8*

Country	rank	Common features	Codependence Order 1	Order 2	Order 3
Czech Rep.	$m = 1$	16.38***	2.17	4.10	5.73
	$m = 2$	48.36***	19.89**	28.13***	20.64***
Estonia	$m = 1$	23.61***	10.66*	16.68***	11.85**
	$m = 2$	89.00***	30.75***	57.15***	30.72***
Hungary	$m = 1$	1.05	2.57	1.64	2.97
	$m = 2$	36.22***	21.15***	27.23***	21.57***
Latvia	$m = 1$	17.30***	0.99	17.41***	2.00
	$m = 2$	56.89***	31.80***	47.45***	12.99
Lithuania	$m = 1$	14.38***	4.02	20.19***	7.38
	$m = 2$	72.44***	25.48***	53.44***	22.90**
Poland	$m = 1$	3.30*	1.22	0.08	1.37
	$m = 2$	20.17***	4.22	7.79*	16.05**
Slovakia	$m = 1$	5.05	4.03	4.92	5.50
	$m = 2$	30.93***	14.22	20.78**	18.91**
Slovenia	$m = 1$	28.52***	7.97	19.20	12.56*
	$m = 2$	67.49***	35.71***	50.48***	34.60***

*Note: Codependence results of real interest rates of each country vis-à-vis the euro area. Rejection of the null hypothesis of common feature/codependence vectors at the 1 percent level is indicated by "***", the 5 percent level is marked with "**", the 10 percent level with "*". If we find the combination of accepting one vector* ($m = 1$) *and rejecting a second vector* ($m = 2$), *we conlude the existence of* $n - m = 2 - 1 = 1$ *common cycle.*

The remaining countries have no common feature vectors but all have one $CD(1)$ vector. This indicates common but non-synchronised interest rate cycles which means that the countries would respond to euro area interest rates with a time lag of one quarter. However, the autoregressive orders for the unit root tests are again unclear. Hence, we conclude that the degree of financial integration between the NMS and the euro area is at best intermediate.

Codependence results for the EU-15 countries are provided by tables 15 and 16. We divide the sample into two the sub-groups 1980Q1-1989Q4 as well as 1990Q1-1998Q4 hoping to learn more about changes in financial integration among the EU-15 over time. During the 1980s, the real interest rates of Austria, France and the Netherlands seem to be synchronised with those of Germany. For France and the Netherlands, however, the autoregressive lag differs from that of the Germany. This does not exclude the possiblity of common features, given the ambiguity of the lag length choice, but it adds uncertainty to the results. The UK is a borderline case in which the hypothesis of one common feature vector is rejected with a p-value of 0.02. In addition, results indicate one common feature vector for Belgium.

Table 15: *Interest rate codependenc results, EU-15, 1980-1989*

Country	rank	Common features	Codependence Order 1	Order 2	Order 3
Austria	$m=1$	1.48	1.84	0.04	2.60
	$m=2$	17.23***	8.47	13.95**	12.30*
Belgium	$m=1$	1.47	2.18	4.10	3.65
	$m=4$	33.45***	6.32	30.22***	16.58
Denmark	$m=1$	18.63***	4.93	11.28**	0.93
	$m=2$	51.11***	15.38	32.60***	18.44**
Finland	$m=1$	15.06***	3.24	10.11**	4.34
	$m=2$	59.68***	19.14**	33.79***	16.49*
France	$m=1$	12.88*	9.61	10.25	11.09
	$m=2$	56.29***	37.37***	42.54***	40.21***
Greece	$m=1$	13.37***	0.38	8.36**	2.15
	$m=2$	34.52***	11.26	27.79***	14.60*
Ireland	$m=1$	12.40***	5.94	2.19	4.37
	$m=2$	71.74***	24.13***	18.14**	24.44***
Italy	$m=1$	19.26***	3.86	15.56***	5.56
	$m=2$	64.92***	16.41*	32.23***	32.52***
Luxembourg	$m=1$	13.08***	1.07	11.06**	3.57
	$m=2$	35.54***	6.77	26.94***	10.23
Netherlands	$m=1$	4.44	4.89	6.82	3.78
	$m=2$	19.35*	19.66*	23.27**	14.91
Portugal	$m=1$	16.43***	1.42	10.70**	5.60
	$m=2$	37.15***	7.38	28.15***	21.71***
Spain	$m=1$	15.91***	1.95	5.35	5.90
	$m=2$	51.67***	12.72	25.46	24.66***
Sweden	$m=1$	19.52***	2.62	8.10	2.86
	$m=2$	46.87***	12.04	27.53***	21.02*
UK	$m=1$	9.52**	2.57	1.02	6.38*
	$m=2$	40.21***	13.31	19.08**	21.35***
UK vs. US	$m=1$	37.28***	16.45***	27.91***	13.86**
	$m=2$	83.78***	38.07***	46.65***	25.92**

*Note: Codependence results of real interest rates of each country vis-à-vis Germany. Rejection of the null hypothesis of common feature/codependence vectors at the 1 percent level is indicated by "***", the 5 percent level is marked with "**", the 10 percent level with "*". If we find the combination of accepting one vector* ($m = 1$) *and rejecting a second vector* ($m = 2$)*, we conlude the existence of* $n - m = 2 - 1 = 1$ *common cycle.*

We can rule this out, however, since we were not able to detect stationarity for Belgium's interest rate differences. Codependence of first order is indicated for Finland and Ireland while the latter is disqualified by its unsatisfactory difference-stationarity result. All other countries reveal no signs of codependence vis-à-vis Germany. This holds also true for the UK-US relation.

Table 16: *Interest rate codependenc results, EU-15, 1990-1998*

Country	rank	Common features	Codependence Order 1	Order 2	Order 3
Austria	$m = 1$	1.87	8.42	14.03**	9.97*
	$m = 2$	21.38**	33.56***	37.59***	35.88***
Belgium	$m = 1$	20.43***	0.94	3.49	5.08
	$m = 4$	47.89***	10.16	23.39***	27.80***
Denmark	$m = 1$	17.40***	3.68	4.99	2.58
	$m = 2$	60.60***	22.76***	15.16*	11.03
Finland	$m = 1$	12.27***	2.08	3.82	4.57
	$m = 2$	32.76***	7.19	14.39*	15.42*
France	$m = 1$	13.48***	3.21	0.51	5.22
	$m = 2$	47.13***	14.83*	7.40	13.93
Greece	$m = 1$	0.56	3.26	11.26**	1.64
	$m = 2$	26.48***	9.144	29.36***	9.10
Ireland	$m = 1$	1.76	0.02	0.01	3.62*
	$m = 2$	29.72***	5.77	8.22*	7.23
Italy	$m = 1$	1.94	0.41	0.02	0.28
	$m = 2$	23.52***	4.72	1.24	4.45
Luxembourg	$m = 1$	4.52	3.02	18.61***	3.86
	$m = 2$	42.25***	17.95*	39.07***	21.02**
Netherlands	$m = 1$	7.76*	2.61	4.78	5.89
	$m = 2$	38.03***	11.94	18.39**	14.82*
Portugal	$m = 1$	0.13	0.01	2.53	2.99*
	$m = 2$	6.62	0.93	8.37*	8.32*
Spain	$m = 1$	1.27	4.32**	0.15	3.76*
	$m = 2$	7.38	15.05***	5.65	10.26**
Sweden	$m = 1$	25.17***	5.84	21.62***	5.64
	$m = 2$	53.33***	19.09*	45.27***	21.53**
UK	$m = 1$	4.73	9.14	14.23**	8.79
	$m = 2$	33.95***	26.91**	30.61***	17.64
UK vs. US	$m = 1$	26.60***	3.33	8.63**	7.88**
	$m = 2$	59.66***	16.22**	26.08***	16.23**

*Note: Codependence results of real interest rates of each country vis-à-vis Germany. Rejection of the null hypothesis of common feature/codependence vectors at the 1 percent level is indicated by "***", the 5 percent level is marked with "**", the 10 percent level with "*". If we find the combination of accepting one vector ($m = 1$) and rejecting a second vector ($m = 2$), we conlude the existence of $n - m = 2 - 1 = 1$ common cycle.*

Turing to the 1990s, we find more favourable results. Austria, Greece, Ireland, Italy, Luxembourg, the Netherlands and the UK have one common feature vector and thus synchronised common interest cycles with Germany. Out of these, only Luxembourg does not fulfill the difference-stationarity criterion. The UK-US relation has one codependence vector for $CD(1)$ and thus shares a common but non-synchronised cycle. Denmark seems to be $CD(1)$ but fails to be difference-stationary. All remaining countries do not exhibit clear results.

On the whole, the financial integration evidence for the EU-15 is not overwhelming but appears to be increasing over time. During the 1990s, more countries seem to share a common interest rate cycle with Germany than in the 1980s, for some even synchronised. This supports the correlation evidence of increasing comovement. However, several aspects remain unclear - for instance, France seems to deteriorate in its financial integration with Germany although these two countries are commonly seen as very integrated. The idiosyncratic impact of German unification in the early 1990s may come into play here but our analysis is not able to isolate such effects. It is remarkable to what a large degree the UK seems to be financially integrated with Germany. Based on this result, the UK may reap a large gain from joing the euro even in the presence of non-synchronised business cycles. For the NMS, it seems that financial market integration is still under development but prospects appear good that further economic integration would stimulate financial interactions, suggested by the more favourable results for the EU-15.

5 Summary and conclusion

This paper analysed the role of risk sharing and financial integration in the context of the OCA theory and the Mundell II framework. According to Mundell II, countries with less sychronised business cycles benefit most from the risk-sharing properties in a financially integrated currency union. Since a common currency removes exchange rate fluctuations and cross-country risk premia, portfolio diversification is expected to deepen across the currency union and serves as a consumption insurance mechanism because it decouples consumption from national production patterns. This benefit of common currencies has often been overlooked while the cost of currency union membership due to the loss of individual monetary policy has been highlighted alone.

In the present study, we investigated the degrees of risk sharing and financial integration in the enlarged EU to explore the case for Mundell II mechanisms for euro area enlargement. In particular, we analysed consumption and real interest rate comovement of the eight Central and Eastern European new member states, each in relation to the aggregate euro area which they are supposed to join in due course. For comparison, we investigated the member countries of the "old" EU-15 in relation to the euro area or, in the case of financial integration, relative to the pre-EMU benchmark Germany. Our main findings are as follows.

Regarding risk sharing, we compare cross-country comovement of consumption with that of GDP. Methodologically, we first look at simple correlation coefficients before we move on to the more sophisticated time-series technique of codependence. From a theoretical point of view, risk sharing would be manifested in internationally diversified consumption patterns so that consumption across countries should be relatively independent of income and hence more highly correlated than GDP. Our results indicate that consumption correlations with the euro area are lower than GDP correlations for most countries under investigation. While this result is, at first glance, in line with the consumption correlation puzzle, we find a number of insightful details. For the NMS, correlations are at far lower levels than for the EU-15 countries while Slovenia stands out with relatively high levels of consumption and GDP correlation. Also, Lithuania and Slovenia display synchronised common GDP cycles as identified by the codependence analysis. Furthermore, rolling correlation windows indicate increasing correlation coefficients for most countries over time. We note that GDP correlations exhibit steeper increases than consumption correlations.

Turning to financial integration, we investigate real interest rate comovement. In addition to the correlation measures, we analyse the variability of bilateral differentials and the dispersion of interest rates across countries over time. We also resort to the codependence framework. While we again look at the eight NMS vis-à-vis the euro area from 1995 through 2005, we consider the EU-15 countries against the pre-EMU benchmark Germany and consider the 1980-1998 period.

We acknowledge a somewhat unclear stationarity situation with interest rates. Theoretically, we would expect interest rates to be associated with consumption growth and hence stationary. However, the unit root hypothesis cannot be rejected in many cases although it is hard to imagine interest rates to be literally non-stationary. High persistence or structural breaks may account for the unit root results. Given this ambiguity, we analyse interest rates both in levels and in differences.

NMS evidence proves mixed. While the correlation analysis delivers partly conflicting results, the codependence exercise suggests common features for Hungary, Poland and Slovakia. In other words, real interest rates of these countries seem to exhibit synchronised common cycles with the euro area. When looking at rolling correlation windows, nearly all NMS seem to increase in their interest rate comovement with the euro area over time. Also, the variability of bilateral interest rate differentials decreases markedly from the mid-1990s until 2005.

For the EU-15 countries, we find more unambiguous evidence of financial integration. From the 1980s to the 1990s, interest rate correlations with Germany shot up to high levels. Austria, Belgium, Luxembourg and the Netherlands seem to form a core group whose interest rate correlation with Germany fluctuated on high levels whereas the correlation coefficients of most remaining countries started at low levels in the 1980s and experienced stark increases until the late 1990s. The core group of financially integrated countries is confirmed by the variability analysis of bilateral interest rate differentials. Furthermore, the dispersion measure, also known as sigma convergence, indicates a clear downward trend which is even more pronounced when excluding idiosyncratic Greece. Finally, we conducted separate codependence tests for the 1980s and 1990s and found increasing degrees of interest rate comovement between the EU-15 countries and Germany. While only a few countries qualified for synchronised common interest rate cylces during the 1980s, we find common feature evidence during the 1990s for Austria, Greece, Ireland, Italy, the Netherlands and the UK. A number of borderline cases add to this evidence. It is interesting to note that the UK displays high levels of financial integration throughout our analysed indicators.

Taken together, we draw a threefold conclusion from our results. First, we confirm the consumption correlation puzzle established by most empirical literature. Consumption correlations remain below output correlation for most considered countries which contradicts the theoretical proposition. One major reason behind this may be the relatively low degree of financial integration. We confirm this idea at least in the case of the NMS which, to date, seem to be characterised by both little risk sharing and limited financial integration with the euro area.

Second, even though GDP correlation still exceeds consumption correlation for the EU-15 countries, they are both on much higher levels and with a smaller differential than for the NMS. Also, financial integration has improved markedly for the EU-15 countries in the run-up to EMU. Given that these countries have shared a long history of economic integration, we may suspect a similar development for the NMS as integration with the euro area proceeds.

Third, we find that both consumption and GDP correlations increase over time, with the latter more strongly than the former. Also, interest rate correlations tend to rise for most countries over time. Although we did not conduct any causal analysis within the scope of this section, these observations may support the hypothesis of Imbs (2006). He analyses a large set of countries and finds that financial integration does not only improve risk-sharing opportunities in the form of cross-country consumption correlation but also boosts, to an even larger extent, business cycles synchronisation across countries. Hence, he argues, the consumption correlation puzzle may not stem from too little risk sharing. Accordingly, we see a widening gap between consumption and GDP correlation not because of low degrees of risk sharing but simply because GDP correlations increase even faster than those of consumption. From our results, we can at least confirm that GDP correlations do indeed increase faster than consumption correlations, and the rising levels of financial integration are not unlikely to play a central part in that.

These propositions hint at further need for research. To shed more light on the dynamics of risk sharing, financial integration and business cycle synchronisation, a more comprehensive framework would be desirable. Also, to respond to the prevailing policy question of euro area enlargement and its effects on the new member states and on the euro area, we would welcome more research on these countries. If, as Mundell II argues, those countries with relatively asynchronous business cycles benefit most from the risk-sharing opportunities in a financially integrated currency union, the NMS may have far more to gain from euro adoption than previously assumed. This logic applies even more if the euro delivers the enhanced degree of financial integration that some studies suggest.

References

[1] Artis, M., H.-M. Krolzig and J. Toro (2004). The European business cycle. *Oxford Economic Papers* 56(1): 1-44.

[2] Backus, D.K., P.J. Kehoe, and F.E. Kydland (1992) International real business cycles. *The Journal of Political Economy* 100(4): 745-775.

[3] Baele, Lieven, Annalisa Ferrando, Peter Hördahl, Elizaveta Krylova, and Cyril Monnet (2004) Measuring Financial Integration in the Euro Area. ECB Occasional Paper 14.

[4] Baxter, M. and G. King (1999). Measuring business cycles: Approximate band-pass filters for economic time series. *Review of Economics and Statistics* 81(4): 575-593.

[5] Bayoumi, T. and B. Eichengreen (1993). Shocking aspects of European Monetary Integration. In F. Torres and F. Giavazzi (eds.), *Adjustment and growth in the European Monetary Union.* Cambridge: Cambridge University Press.

[6] Blanchard, O. and D. Quah (1989). Dynamic effects of aggregate demand and supply shocks. *American Economic Review* 79(4): 655-673.

[7] Böwer, U. (2006) An empirical analysis of stochastic trends and cycles in Central and Eastern Europe and the euro area. University of Munich, MGSE, mimeo.

[8] Buch, C. and J. Döpke (2000). Real and financial integration in Europe: Evidence for the accession states and for the pre-ins. *Aussenwirtschaft* 55(3): 371-402.

[9] Burns, A. and W. Mitchell (1946). *Measuring business cycles.* New York: National Bureau of Economic Research.

[10] Cappielle, L., P. Hartmann, P. Hördahl, A. Kadareja, S. Manganelli (2005). Financial Integration in the Euro Area. European Central Bank, mimeo.

[11] Cheung, Y.-W. and K. Lai (1995a). Lag order and critical values of the Augmented Dickey-Fuller test. *Journal of Business & Economic Statistics* 13(3): 277-280.

[12] Darvas, Z. and G. Szapáry (2005). Business Cycle Synchronization in the Enlarged EU. CEPR Discussion Paper 5179.

[13] Driffell, J. and A. Snell (2003) What moves OECD real interest rates? *Journal of Money, Credit, and Banking* 35(3): 375-402.

[14] Elliot, G., T. Rothenberg and J.H. Stock (1996) Efficient tests for an autoregressive unit root. *Econometrica* 64: 813-836.

[15] Engle, R. and S. Kozicki (1993). Testing for common features. *Journal of Business & Economic Statistics* 11(4): 369-380.

[16] Fidrmuc, J. and I. Korhonen (2004). A meta-analysis of business cycle correlation between the euro area and CEECs. BOFIT Discussion Paper 20/2004, Bank of Finland, Helsinki.

[17] Garcia, R. and P. Perron (1996) An analysis of the real interest rate under regime shifts. *Review of Economics and Statistics* 78(1): 111-125.

[18] Hodrick, R.J. and E. Prescott (1997). Post-war U.S. business cycles: An empirical investigation. *Journal of Money, Credit, and Banking* 29(1): 1-16.

[19] Imbs, J. (2004) Trade, Finance, Specialisation, and Synchronisation. *Review of Economics and Statistics* 86(3): 723-734.

[20] Imbs, J. (2006) The Real Effects of Financial Integration. *Journal of International Economics* 68: 296-324.

[21] Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control* 12(2): 231-254.

[22] Juselius, K. (2004). *The Cointegrated VAR Model: Econometric Methodology and Macroeconomic Applications*, University of Copenhagen, mimeo.

[23] Kalemli-Ozcan, Sebnem, Bent Sorensen, and Oved Yosha (2003) Economic Integration, Industrial Specialisation, and the Asymmetry of Macroeconomic Fluctuations. *Journal of International Economics* 55, 107-137.

[24] Kenen, Peter (1969). The theory of optimum currency areas: An eclectiv view. In R. Mundell and A. Swoboda (eds.), *Monetary problems of the international economy.* Chicago: University of Chicago Press.

[25] Krugman, Paul (1993) Lessons of Massachusetts for EMU, in: Torres, Francisco and Francesco Giavazzi (eds.): *Adjustment and Growth in the European Monetary Union*, Cambridge: Cambridge University Press, 193-229.

[26] Kugler, P. and K. Neusser (1992) International real interest rate equalization. *Journal of Applied Econometrics* 8: 163-174.

[27] Lane, Philip R., and Gian Maria Milesi-Ferretti (2005). The External Wealth of Nations Mark II: Revised and Extended Estimations of Foreign Assets and Liabilities, 1970-2003, mimeo, Trinity College Dublin and International Monetary Fund.

[28] Lane, Philip R., and Gian Maria Milesi-Ferretti (2001). The External Wealth of Nations. Measures for Foreign Assets and Liabilities for Industrialised and Developing Countries. *Journal of International Economics* 5: 263-294.

[29] Masson, P. and M. Taylor (1993). *Policy issues in the operation of currency unions.* Cambridge: Cambridge University Press.

[30] McKinnon, R. (1963). Optimum currency areas. *American Economic Review* 53(4): 717-25.

[31] McKinnon, R. (2002). Optimum currency areas and the European experience. *Economics of Transition* 10(2): 343-364.

[32] Mongelli, F. (2002). 'New' views on the optimum currency area theory: What is EMU telling us? ECB Working Paper 138, European Central Bank, Frankfurt.

[33] Mundell, R. (1961). A theory of optimum currency areas. *American Economic Review* 51(4): 657-65.

[34] Mundell, R. (1973). Uncommon Arguments for Common Currencies, in: Johnson, H. and A. Swoboda (eds.): *The Economics of Common Currencies*, London: Allen and Unwin, 114-132.

[35] Obstfeld, M. and K. Rogoff (1996). *Foundations of International Macroeconomics.* Cambridge, MA: MIT Press.

[36] Obstfeld, M. and K. Rogoff (2000). The Six Major Puzzles in International Macroeconomics: Is there a Common Cause? NBER Working Paper 7777.

[37] Obstfeld, M. and A.M. Taylor (2002) Globalization and capital markets. NBER Working Paper 8846.

[38] Obstfeld, M., J.C. Shambaugh, and A.M. Taylor (2005) The trilemma in history: Tradeoffs among exchange rates, monetary policies, and capital mobility. *The Review of Economics and Statistics* 87(3): 423-438.

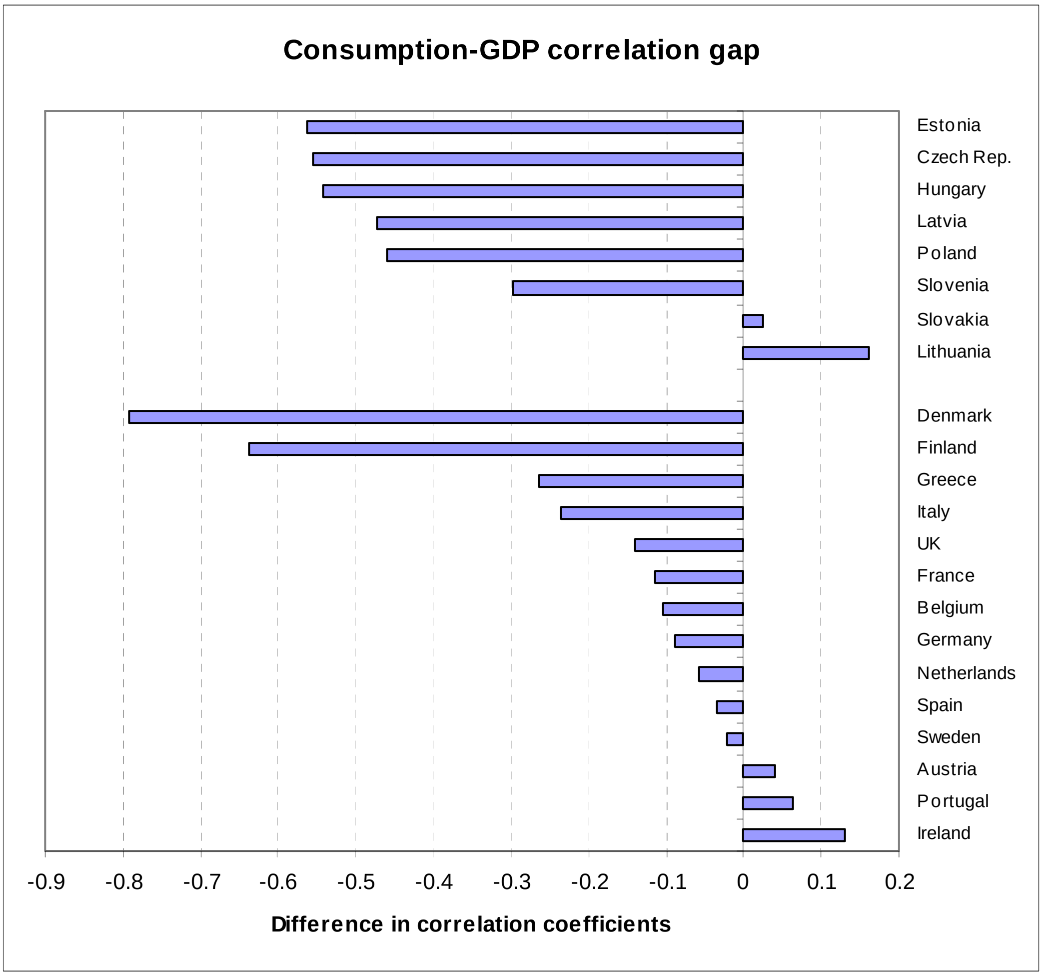
[39] Rose, A. (1988) Is the real interest rate stable? *Journal of Finance* 48: 1095-1112.

[40] Rubin, J. and N. Thygesen (1996). Monetary union and the outsiders: A cointegration - codependence analysis of business cycles in Europe. *Economie Appliquée* 49(3): 123-71.

[41] Stock, J.H. and M.W. Watson (2003) *Introduction to Econometrics.* Boston: Addison-Wesley.

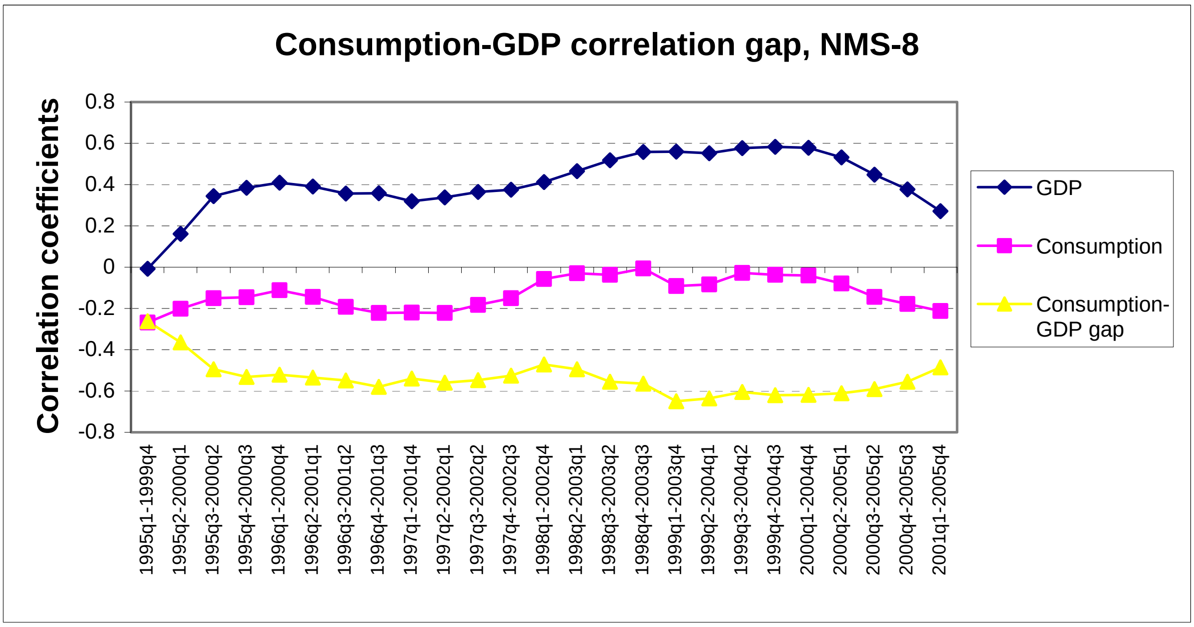
Appendix

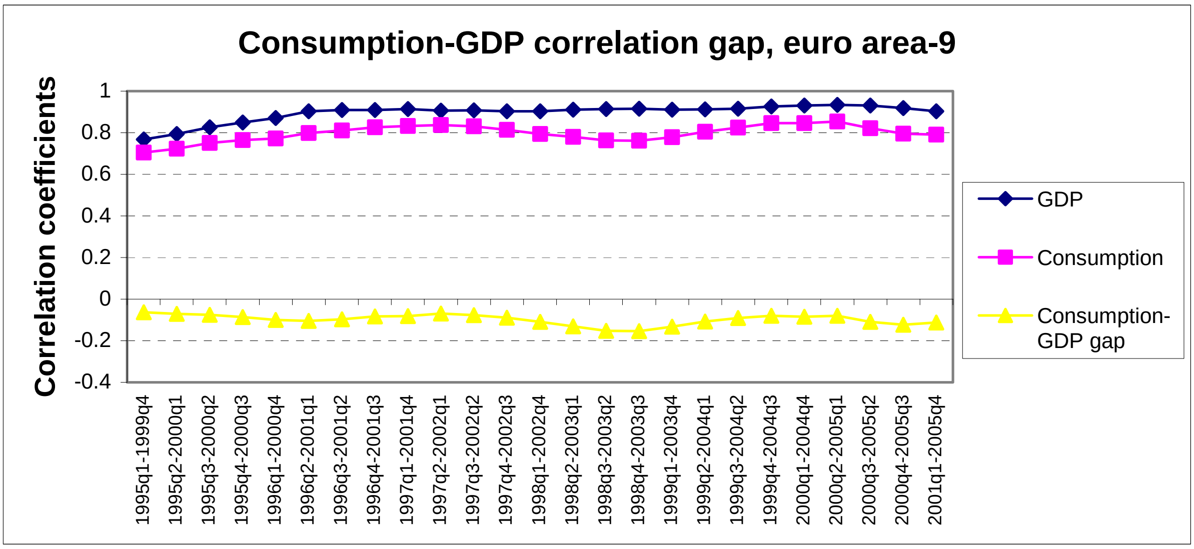
Figure 1

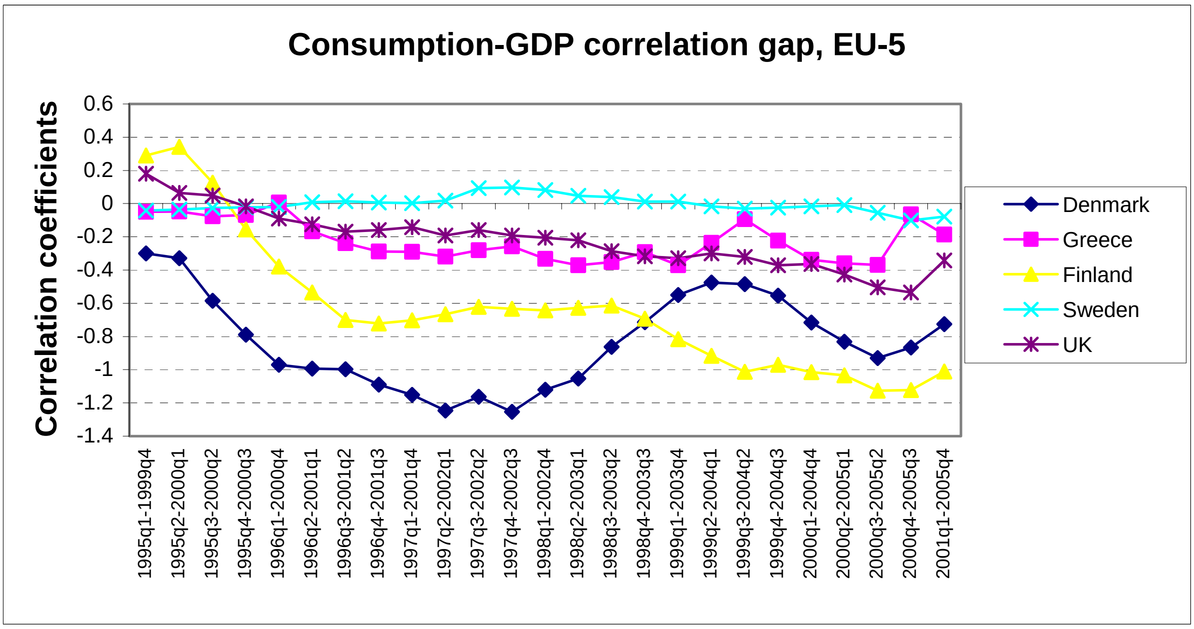


Note: Differences in the correlation coefficients of real consumption (households and NPISH) and real GDP vis-à-vis the euro area, 1995-2005 (HP-filtered series).

Figures 2-4







Note: 5-year rolling correlation windows of consumption, GDP and (consumption-GDP) vis-à-vis the euro area, based on quarterly HP-filtered data. See the text for exact country coverage.

Figure 5

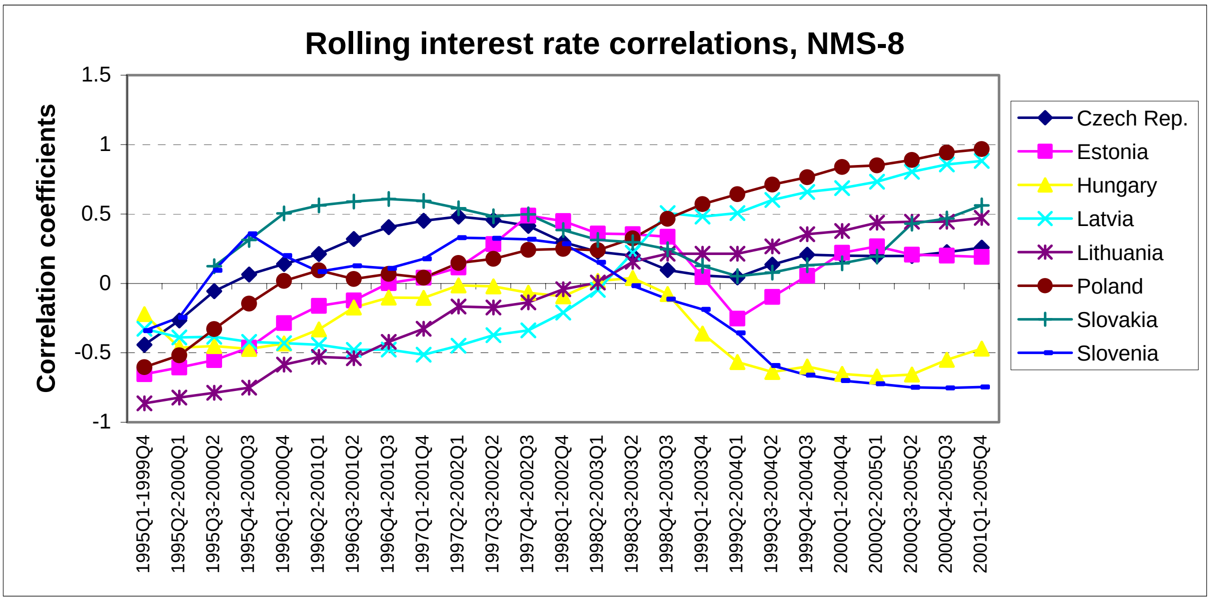
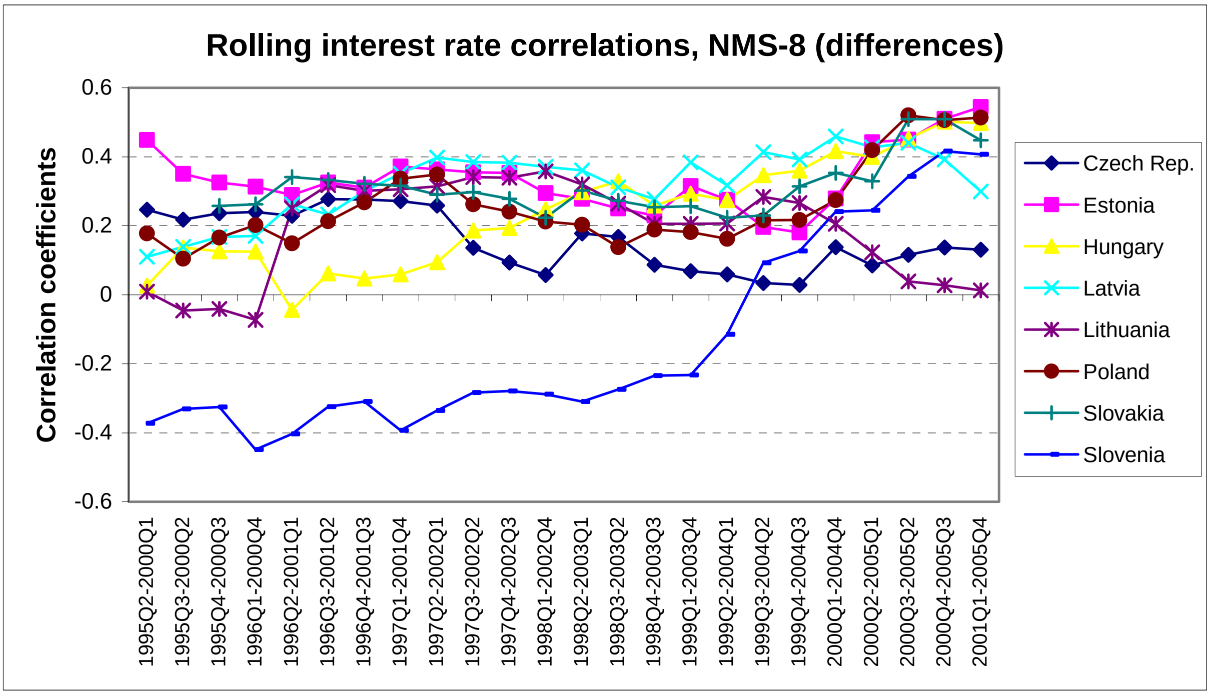
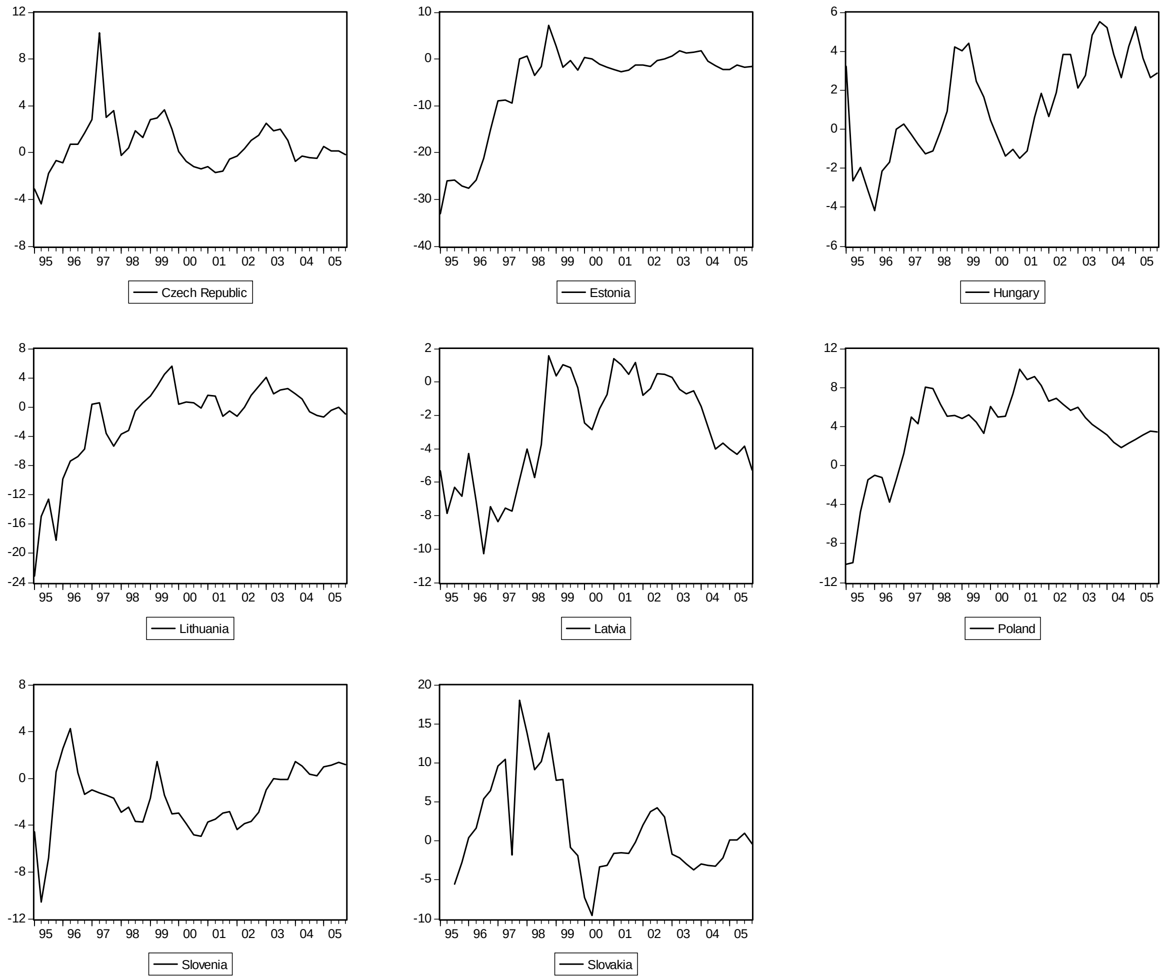


Figure 6



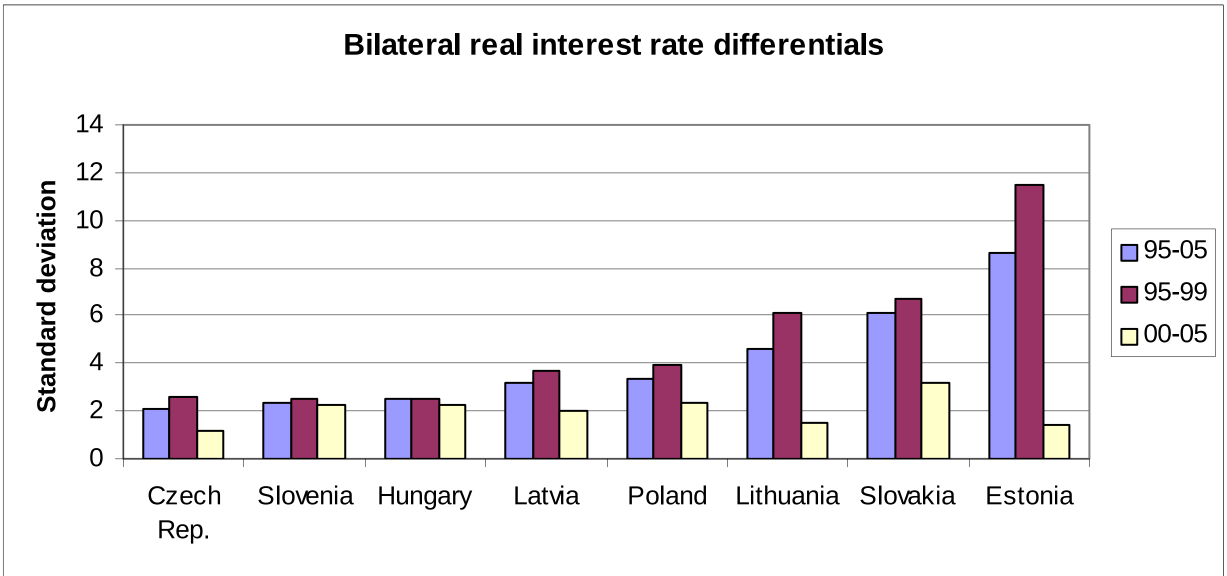
Note: 5-year rolling correlation windows of short-term real interest rates vis-à-vis the euro area, based on quarterly data in levels and first differences, respectively.

Figure 7
Interest rate differentials, NMS vis-à-vis the euro area



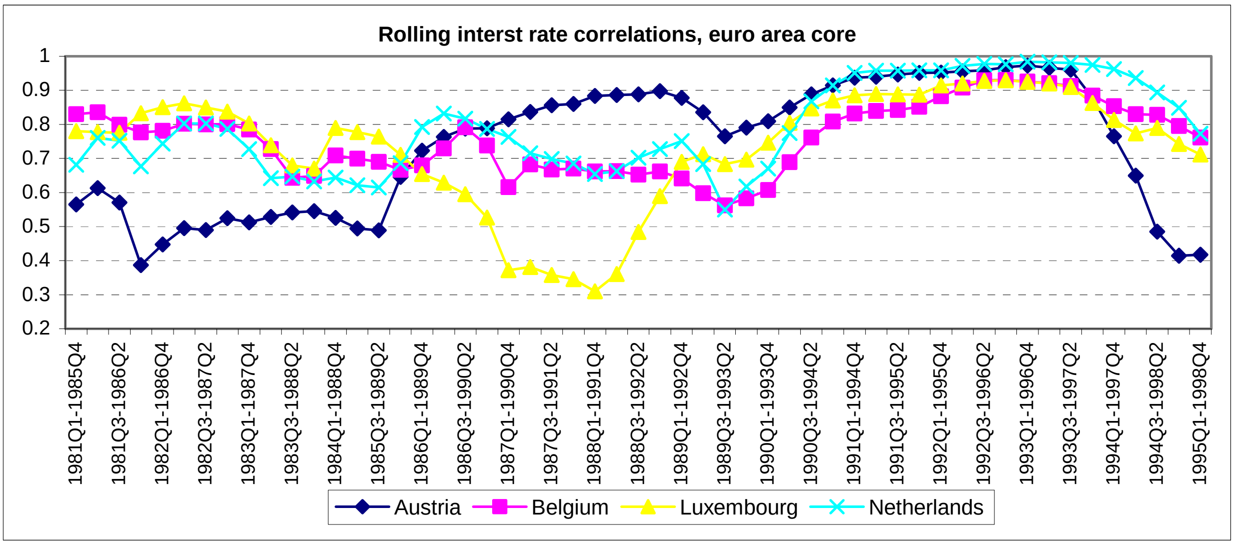
Note: Bilateral short-term real interest rate differentials, each country minus the euro area, 1995Q1-2005Q4.

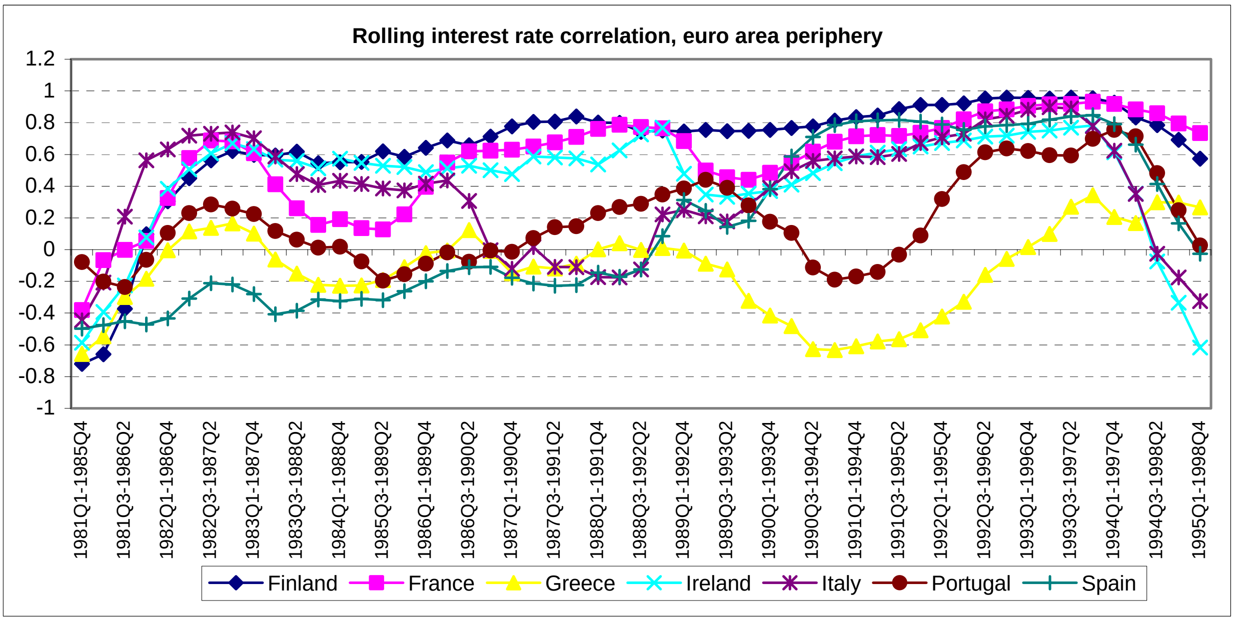
Figure 8

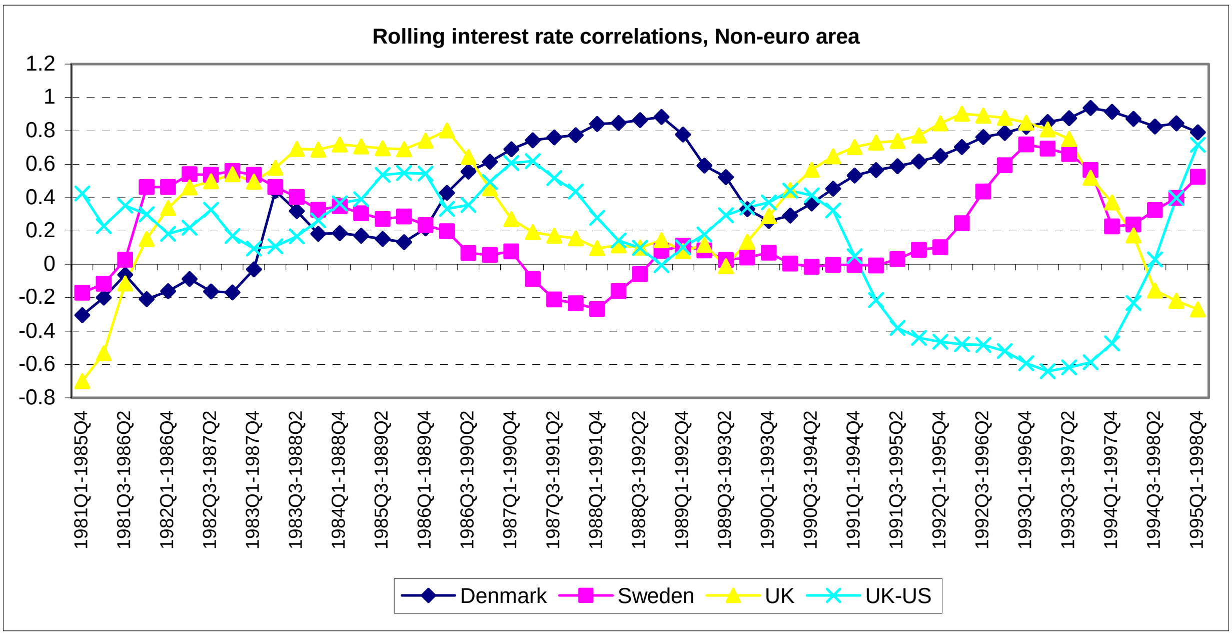


Note: Standard deviations of real interest rate differentials vis-à-vis the euro area.

Figures 9-11

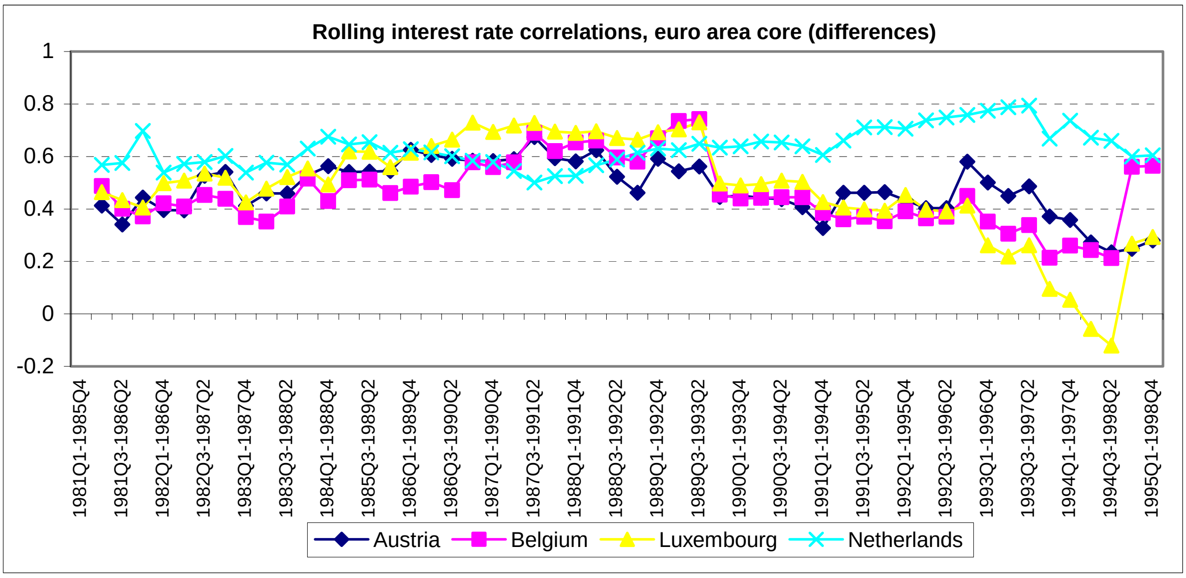


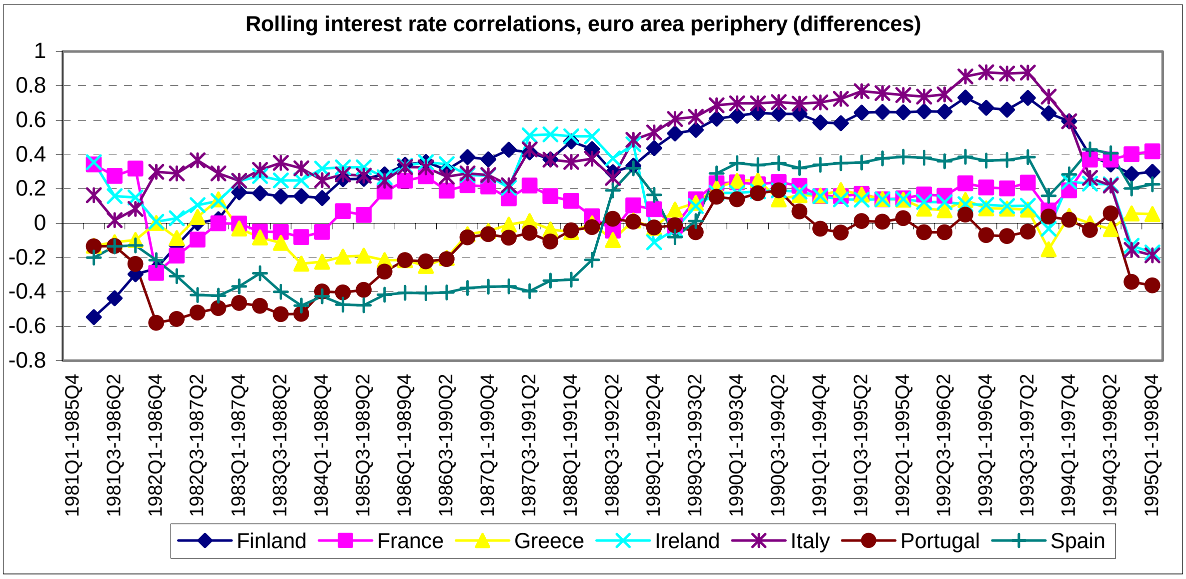


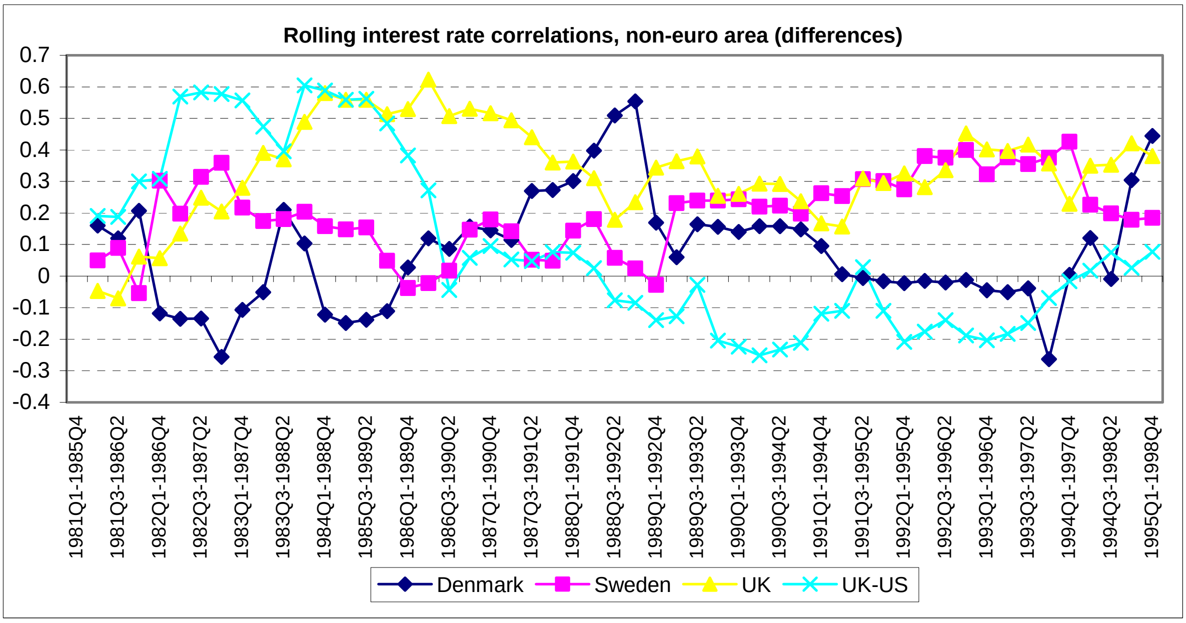


Note: 5-year rolling correlation windows of short-term real interest rates vis-à-vis Germany, based on quarterly data in levels.

Figure 12-14



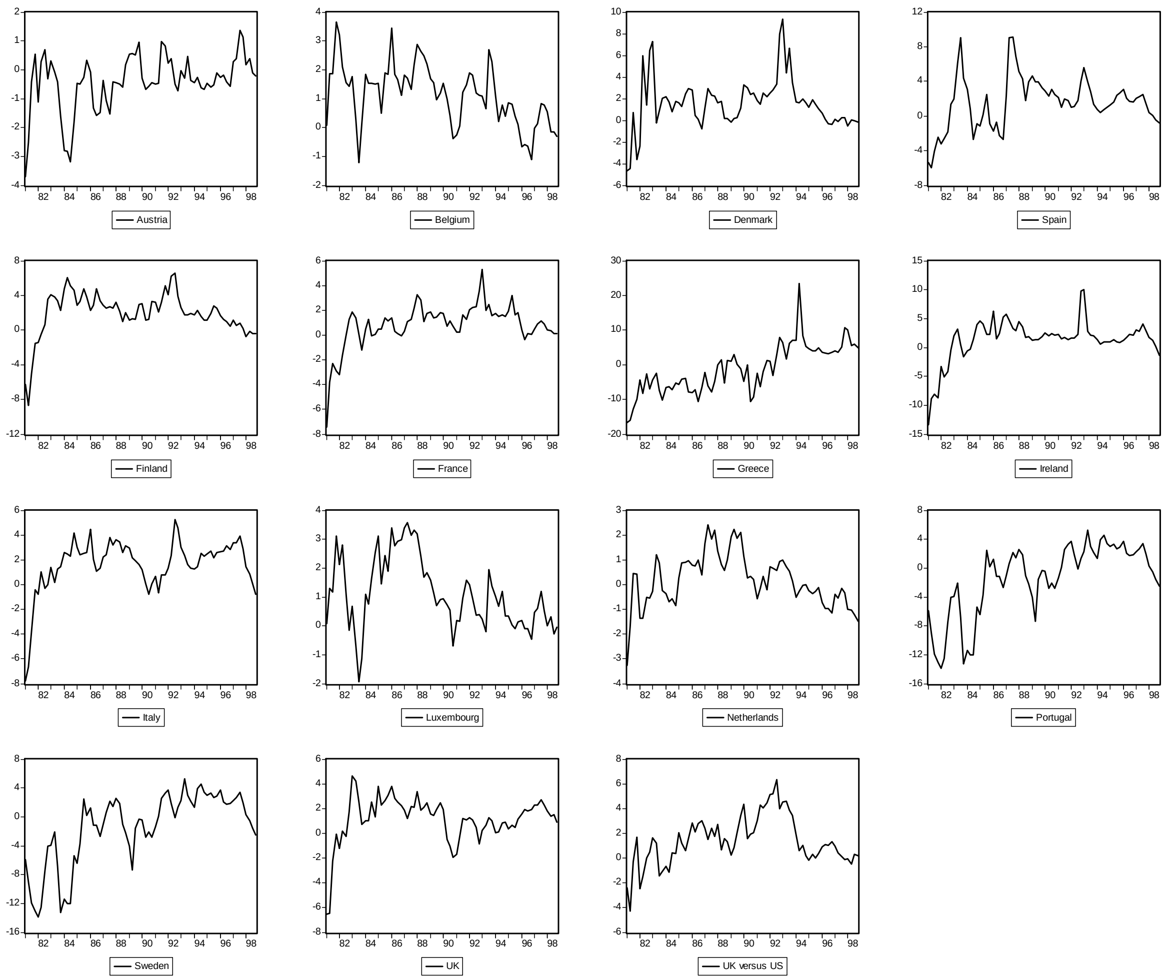




Note: 5-year rolling correlation windows of short-term real interest rates vis-à-vis Germany, based on quarterly data in first differences.

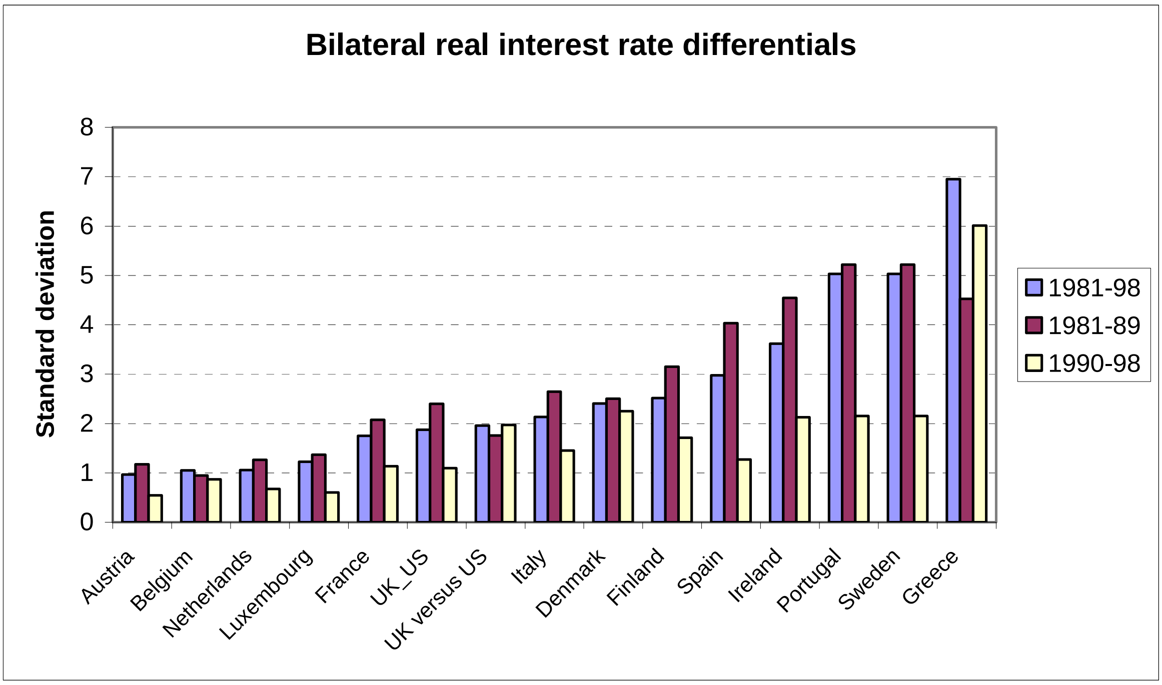
Figure 15

Interest rate differentials vis-à-vis Germany (plus UK vis-à-vis US)



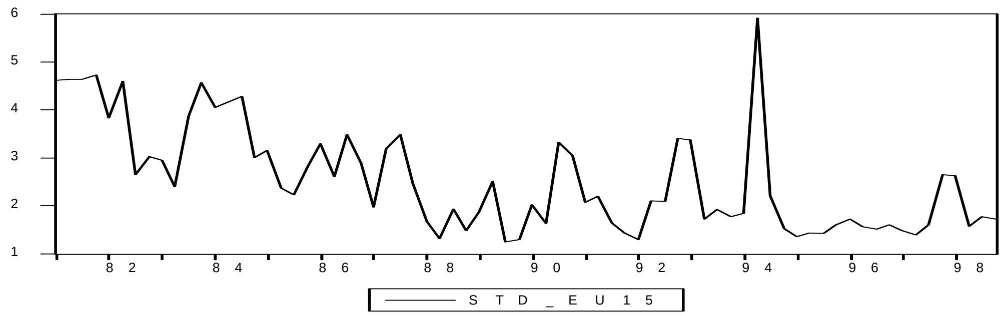
Note: Bilateral short-term real interest rate differentials, each country minus Germany, 1980Q1-1998Q4.

Figure 16



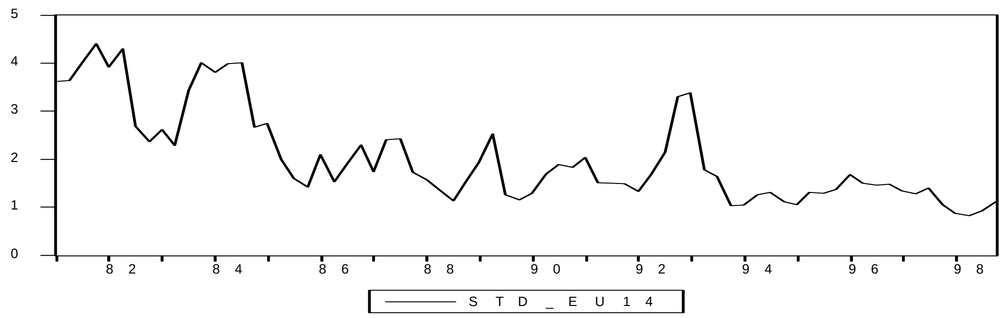
Note: Standard deviations of real interest rate differentials vis-à-vis Germany.

Figure 17
Interest rate dispersion (sigma convergence), 1980Q1-1998Q4



Note: Standard deviation of real interest rates across the EU-15 countries, at every point in time.

Figure 18
Interest rate dispersion (sigma convergence), 1980Q1-1998Q4, excluding Greece



Note: Standard deviation of real interest rates across the EU-14 countries, at every point in time.