The Price Approach to Financial Integration: Decomposing European Money Market Interest Rate Differentials

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I. Introduction

The present paper deals with a theoretical and empirical analysis of money market integration in the European Community (EC). We examine changes in the degree of money market integration between ten EC member states and Germany since the start of the European Monetary System (EMS) in March 1979. The key question is whether the step-by-step liberalisation of short-term capital movements in the EC, in preparing for the Economic and Monetary Union (EMU), has brought about a higher or perhaps perfect degree of money market integration in the EC.[1]

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[1] The road to the EMU is supposed to consist of three stages: The first stage, from 1 July 1990, should accomplish the liberalisation of financial markets, the enlargement of the membership in the Exchange Rate Mechanism (ERM) of the EMS, and a change in the mandate of the Committee of Central Bank Governors of the EC central banks to promote the co-ordination of monetary policies. The second stage, from 1 January 1994, establishes the European Monetary Institute (EMI), which would initially operate alongside the national monetary authorities. One of the main tasks of the EC's central banks will be the (preparation of the) harmonisation of their monetary instruments and targets. In addition, steps will be taken to ensure full central bank independence from other national authorities. The third stage, by 1997 at the earliest and 1 January 1999 at the latest, should accomplish the irrevocable fixing of exchange rates among national currencies eligible to join the third stage. Eligibility is based upon the Maastricht convergence criteria that EC countries have to meet. Convergence criteria have been formulated with respect to inflation differentials, exchange rate stability, long-term interest rate differentials, fiscal deficits and government debt. The European Central Bank (ECB) and the European System of Central Banks (ESCB) will be responsible for the monetary policy in the participating member states (see Committee of Governors of the Central Banks of the Member States of the European Economic Community, 1992).

The analysis is intended to shed some light on the changes in the degree of money market integration over time.[2] The empirical analysis relies on calculations of mean deviations from three-month covered, ex post uncovered and ex post real interest parity of ten EC member states relative to Germany over the period March 1979 until June 1993. The sample period March 1979 - June 1993 is split into four subperiods to take into account the various phases of development of the EMS. In addition, the paper uses forward exchange rate data to decompose mean deviations from three-month ex post real interest parity into a country premium, an ex post exchange risk premium and a deviation from ex post relative purchasing power parity.

The paper is organised as follows. Section II introduces the decomposition method of Frankel and MacArthur (1988) and specifies three alternative interest parity conditions to calculate the degree of perfect capital mobility in the short-run. Furthermore, section II defines the concept of money market integration. Section III, describes the data and sets out the empirical methodology to calculate mean deviations from interest parity conditions. Section IV offers the empirical evidence on money market integration and discusses the main results. Finally, section V concludes the paper.

II. Interest parity conditions

Quantifying the degree of money market integration implies measuring the degree in which short-term capital flows equalise expected returns on comparable money market assets denominated in different currencies. Essentially, the criteria for perfect capital mobility are nothing more than a re-interpretation of the familiar interest parity conditions. Following Frankel and MacArthur (1988), table 1 summarises an ascending order of three alternative interest parity conditions according to their cumulative assumptions. The criteria for perfect capital mobility rely on the dispersion of *prices* of identical European money market assets (i.e. short-term interest rates). Hence, they fit into the price approach to financial integration (see Feldman, 1986).[3] According to Frankel (1989)

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2 Discussion of policy implications of financial integration is beyond the scope of this study. See for example *Lamfalussy* (1990), *The Economist* (1992), *De Groof* and *Van Tuijl* (1993) and *Eijffinger* and *Gerards* (1993b).

3 Interest parity conditions are not the only valid tests for the degree of financial integration. For example, *Feldstein* and *Horioka* (1980) and *Lemmen* and *Eijffinger* (1993a) apply *saving-investment correlations* to assess the degree of financial integration. With perfect financial integration saving-investment correlations

and Lemmen and Eijffinger (1993b) the interest parity conditions in table 1 measure three different types of perfect capital mobility. Perfect capital mobility of a particular type is taken to be the joint hypothesis that bonds, identical in all respects apart from their currency denomination, are perfect substitutes and that arbitrage continually ensures the interest parity condition to hold (see MacDonald, 1988, pp. 33 - 34). The object of interest arbitrage is to allocate funds between financial markets in order to realize the highest possible expected return, subject to the least possible risk.

The first criterion – covered nominal interest parity (CIP) – examines perfect capital mobility of type I. CIP holds if the forward premium (discount) $[f_t^{t+k} - s_t]$ equals the difference between the domestic and foreign nominal interest rate at the appropriate maturity $[i_{t,t+k} - i^*_{t,t+k}]$. Investors cover themselves against the exchange rate risk of foreign investment in the forward foreign exchange market. A forward premium (discount) on foreign currency means that the forward price of foreign currency delivered and paid for some time in the future expressed in domestic currency is higher (lower) than the current spot price, i.e. $f_t^{t+k} - s_t$ is the forward premium when positive and the forward discount when negative. If the domestic nominal interest rate is higher (lower) than the foreign nominal interest, the lower (higher) foreign nominal interest rate is compensated by a forward premium (discount) on the foreign currency. Investors will buy (sell) foreign currency spot to sell (buy) it forward. A premium (discount) on the foreign currency corresponds with an expected future rise (fall) in the spot exchange rate. Perfect capital mobility of type I implies a zero covered nominal interest differential or in other words a zero country premium $[i_{t,t+k} - i^*_{t,t+k} - (f_t^{t+k} - s_t) = 0]$. With perfect capital mobility of type I, riskless arbitrage will ensure that CIP holds. Deviations from CIP reflect barriers to the integration of financial markets across national boundaries such as transaction costs, capital controls, information costs, tax laws that discriminate by country of residence, default risk and risk of future capital controls (Frankel, 1992, pp. 200 - 201).

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are expected to be small, since a domestic investor can tap the pool of foreign savings. Alternatively, *Obstfeld* (1986) proposes another test based upon the *Euler equation* for intertemporal consumption behaviour. The test attempts to detect whether residents of different political jurisdictions have access to the same risk-free asset. With perfect financial integration individuals in different countries have the possibility to smooth their consumption over time by borrowing and lending at the same risk-free interest rate prevailing in international financial markets. *Goldstein* and *Mussa* (1993) and *Obstfeld* (1994) provide an excellent survey of the existing literature.

Table 1

Interest Parity Conditions and their cumulative assumptions

I Covered nominal interest rate parity (CIP)	
Assumption:	
$i_{t,t+k} - i^*_{t,t+k} = f_t^{t+k} - s_t$	(CIP)
Yields:	
$i_{t,t+k} - i^*_{t,t+k} = f_t^{t+k} - s_t$	(CIP)
II Ex ante uncovered nominal interest rate parity (UIP)	
Assumptions:	
$i_{t,t+k} - i^*_{t,t+k} = f_t^{t+k} - s_t$	(CIP)
$E_t(s_{t+k}) = f_t^{t+k}$	(Forward exchange rate is an unbiased predictor of expected future spot exchange rate)
Yields:	
$i_{t,t+k} - i^*_{t,t+k} = E_t(s_{t+k} - s_t)$	(UIP)
III Ex ante real interest rate parity (RIP)	
Assumptions:	
$i_{t,t+k} - i^*_{t,t+k} = f_t^{t+k} - s_t$	(CIP)
$E_t(s_{t+k}) = f_t^{t+k}$	(Forward exchange rate is an unbiased predictor of expected future spot exchange rate)
$E_t(s_{t+k} - p_{t+k} + p^*_{t+k}) = s_t - p_t + p^*_t$	(Zero expected real exchange rate change)
Yields:	
$E_t(r_{t,t+k}) = E_t(r^*_{t,t+k})$	(RIP)

Symbols:

$i_{t,t+k}$	= domestic nominal interest rate at time t on a k-period bond held between time t and t+k
f_t^{t+k}	= forward exchange rate agreed at time t for the delivery of foreign currency at time t+k
s_t	= spot exchange rate at time t (i.e. domestic currency units per unit of foreign currency)
$f_t^{t+k} - s_t$	= forward premium (if positive) or discount (if negative) on foreign currency at time t
$E_t(s_{t+k})$	= expected spot exchange rate at time t+k
$E_t(s_{t+k} - s_t)$	= expected spot exchange rate change of the domestic currency vis-à-vis the foreign currency between time t and t+k
p_t	= domestic price level at time t
$E_t(r_{t,t+k})$	= expected domestic real interest rate at time t on a k-period bond held between time t and t+k
E_t	= conditional expectations operator based upon the information available at time t, i.e. $E(.\mid I_t)$
k	= holding period of the underlying debt instrument
*	= denotes a foreign variable

Note: All variables except the interest rates are expressed in natural logarithms. Lower-case letters represent natural logarithms.

Note: Table 1 is framed according to the terminology introduced by Frankel and MacArthur (1988) and Frankel (1989). In fact, e.g. the exact expression of CIP is: $F_t^{t+k}/S_t = (1+i_{t,t+k})/(1+i^*_{t,t+k})$. We obtain the logarithmic approximation, i.e. $i_{t,t+k} - i^*_{t,t+k} = f_t^{t+k} - s_t$, by taking natural logarithms of both sides and applying the approximation that $\ln(1+x) = x$ for small x where $s_t = \ln(S_t)$, $f_t^{t+k} = \ln(F_t^{t+k})$ and $i_{t,t+k}$ and $i^*_{t,t+k}$ are approximately equal to $\ln(1+i_{t,t+k})$ and $\ln(1+i^*_{t,t+k})$. We use the exact formulation in section IV: $\ln(1+i_{t,t+k}) - \ln(1+i^*_{t,t+k}) = f_t^{t+k} - s_t$.

Source: Frankel and MacArthur (1988) and Frankel (1989).

The second criterion – ex ante uncovered nominal interest parity (UIP) – examines perfect capital mobility of type II. UIP holds if the expected returns on comparable domestic and foreign bonds except for currency of denomination are equal. The expected nominal exchange rate change $[E_t(s_{t+k} - s_t)]$ equals the nominal interest differential at the appropriate maturity $[i_{t,t+k} - i^*_{t,t+k}]$. Replacement of the forward exchange rate by the expected spot exchange rate $[E_t(s_{t+k}) = f_t^{t+k}]$ yields UIP. This replacement is allowed if exchange rate expectations are held with certainty or if investors are risk-neutral.[4] Investors expect an exchange rate depreciation when the domestic nominal interest rate exceeds the foreign nominal interest rate. The second criterion can be framed in terms of the decomposition method of Frankel and MacArthur (1988). Frankel and MacArthur decompose the nominal uncovered interest rate differential in the following way: $i_{t,t+k} - i^*_{t,t+k} - E_t(s_{t+k} - s_t) = [i_{t,t+k} - i^*_{t,t+k} - (f_t^{t+k} - s_t)] + [(f_t^{t+k} - s_t) - E_t(s_{t+k} - s_t)]$. Ex ante UIP requires a zero country premium $[i_{t,t+k} - i^*_{t,t+k} - (f_t^{t+k} - s_t) = 0]$ and a zero exchange risk premium $[(f_t^{t+k} - s_t) - E_t(s_{t+k} - s_t) = 0]$. Because exchange rate expectations cannot be observed one generally formulates an assumption on how exchange rate expectations are formed. When exchange rate expectations are assumed to be rational ex ante UIP changes into ex post UIP. Rational expectations imply that the realized exchange rate change is used as a proxy for the expected exchange rate change. Thus, ex post UIP holds if expectations are rational, investors are risk-neutral and no capital controls exist. The underlying assumption of rationality means that the forecast errors of exchange rates $E(\eta_{t+k}|I_t) = E_t(s_{t+k}) - s_{t+k} = 0$ have mean zero and are uncorrelated. Hence, the ex ante spot exchange rate at time $t + k$ conditional on available information at time t equals the ex post spot exchange rate at time $t + k$, i.e. $E_t(s_{t+k}) = s_{t+k}$. Deviations from ex post UIP may therefore be caused by the lack of capital mobility of type II and or expectational errors.

CIP and ex ante UIP measure two important aspects of financial integration: international capital mobility and substitutability among assets denominated in different currencies. CIP is an *arbitrage* condition with covered positions and therefore a *riskless* operation with respect to exchange rate risk. The degree of substitutability between domestic and foreign bonds based on exchange rate risk and the degree of risk-aversion of the investors are therefore completely irrelevant (Dornbush,

[4] Or in other words, the forward exchange rate is an unbiased predictor of the expected future spot exchange rate (see *MacDonald* and *Taylor* 1992, p. 38).

1983). In contrast ex ante UIP is based on *speculation* and *open* positions. Theoretically, the UIP condition is to be preferred to assess the degree of money market integration because the UIP condition incorporates two important theoretical aspects of money market integration i.e. the *ability* and the *willingness* to move money market assets across national borders in response to expected differences in exchange-adjusted returns while the CIP only incorporates the *ability* to move money market assets across national borders (see Boothe et al. 1985, Caramazza et al. 1986, Akhtar and Weiller 1987, Reinhart and Weiller 1987). The country premium reflects the ability to move money market assets across national borders while the exchange risk premium reflects the willingness to move money market assets across national borders. The CIP condition is a more appropriate criterion for geographical money market segmentation across countries while the ex ante UIP condition is a more appropriate criterion for overall analysis of integration between short-term financial markets i.e. the money and the foreign exchange market (Haldane and Pradhan 1992b, p. 5). Boothe et al. (1985, p. 16) denote CIP with perfect capital mobility and ex ante UIP with perfect capital substitutability. We denote CIP with perfect capital mobility of type I and ex ante UIP with perfect capital mobility of type II. Since the absence of CIP suggests that there exist arbitrage opportunities, CIP indeed should hold in integrated markets. Frankel (1992, p. 197) argues that CIP is an unalloyed criterion for capital mobility in the sense of the degree of financial market integration across national boundaries. The absence of UIP, however, implies the existence of a risk premium in the exchange rate and as long as this is a fair reward for the risk that investors have to bear with respect to the currency, the absence of UIP does not necessarily imply a form of capital immobility.[5] Only, exchange risk that is not priced hampers capital mobility across national borders.

The third criterion – ex ante real interest parity (RIP) – examines perfect capital mobility of type III or in other words perfect financial and non-financial capital mobility (see Haldane and Pradhan, 1992b, p. 5). Non-financial capital mobility refers to the mobility of goods and services and the mobility of the production factors labour and physical capital (technology). Ex ante RIP means that the expected domestic and foreign real interest rate are equal $[E_t(r_{t,t+k}) = E_t(r^*_{t,t+k})]$. Substitution of ex ante relative PPP $[E_t(s_{t+k} - s_t) = E_t(p_{t+k} - p_t) - E_t(p^*_{t+k} - p^*_t)]$ into the UIP condition $[i_{t,t+k} - i^*_{t,t+k} = E_t(s_{t+k} - s_t)]$

[5] The argument assumes that CIP holds continuously.

leads to the RIP condition $E_t(r_{t+k}) = i_{t,t+k} - E_t(p_{t+k} - p_t) = E_t(r^*_{t+k}) = i^*_{t,t+k} - E_t(p^*_{t+k} - p^*_t)$.

The third criterion can also be framed in terms of the decomposition method of Frankel and MacArthur. The ex ante real interest differential can be decomposed as follows: $E_t(r_{t+k} - r^*_{t+k}) = (i_{t,t+k} - E_t(p_{t+k} - p_t)) - (i^*_{t,t+k} - E_t(p^*_{t+k} - p^*_t)) = (i_{t,t+k} - i^*_{t,t+k}) - E_t(p_{t+k} - p_t) + E_t(p^*_{t+k} - p^*_t)$. By adding and subtracting the forward premium (discount) and the expected depreciation (appreciation) of the domestic currency in terms of foreign currency, we obtain an expression of the ex ante real interest differential: $E_t(r_{t,t+k} - r^*_{t,t+k}) = [i_{t,t+k} - i^*_{t,t+k} - (f_t^{t+k} - s_t)] + [(f_t^{t+k} - s_t) - E_t(s_{t+k} - s_t)] + [E_t(s_{t+k} - s_t) - E_t(p_{t+k} - p_t) + E_t(p^*_{t+k} - p^*_t)]$ (see also Goldstein et al., 1991, p. 9).[6] The last two factors together constitute the currency premium, because they pertain to differences in assets according to the currency in which they are denominated, rather than the political jurisdiction in which they are issued. Thus, ex ante RIP requires not only a zero country premium and a zero exchange risk premium but also a zero expected real exchange rate change or in other words a zero deviation from ex ante relative purchasing power parity (PPP) $[E_t(s_{t+k} - s_t) - E_t(p_{t+k} - p_t) + E_t(p^*_{t+k} - p^*_t) = 0]$.

Again, the ex ante real interest rate is difficult to calculate since expected inflation and hence the ex ante real interest rate is not observable. The calculation of ex post real interest rate differentials implicitly assumes that expectations are rational. The ex post real interest rate is defined as the nominal interest rate minus the realized rate of inflation: $r_{t,t+k} = i_{t,t+k} - (p_{t+k} - p_t)$ for the domestic country and $r^*_{t,t+k} = i^*_{t,t+k} - (p^*_{t+k} - p^*_t)$ for the foreign country. The forecast errors of inflation equal the forecast errors of real interest rates: $\epsilon_{t+k} = E_t(r_{t,t+k}) - r_{t,t+k} = E_t(p_{t+k} - p_t) - (p_{t+k} - p_t)$ and $\epsilon^*_{t+k} = E_t(r^*_{t,t+k}) - r^*_{t,t+k} = E_t(p^*_{t+k} - p^*_t) - (p^*_{t+k} - p^*_t)$. The forecast errors of inflation and real interest rates $E(\epsilon_{t+k} \mid I_t) = 0$ and $E(\epsilon^*_{t+k} \mid I_t) = 0$ have mean zero and are uncorrelated. The equality of real interest rates across countries than implies (Mishkin, 1984, p. 1347): $E_t(r_{t,t+k}) = E_t(r^*_{t,t+k}) = r_{t,t+k} = r^*_{t,t+k}$.

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[6] If ex ante UIP holds ex ante real interest rate differentials between two countries reflect differences in inflationary expectations.

III. Data and Methodology

The main task of this paper is to compare mean deviations from ex post UIP with those deviations from CIP and ex post RIP of ten EC member states relative to Germany. The ten EC member states considered here are France, Belgium, the Netherlands, Italy, United Kingdom, Denmark, Ireland, Spain, Portugal and Greece.[7] The data used are monthly series of three-month domestic money market interest rates, spot exchange rates vis-à-vis the Deutsche Mark (DM), forward exchange rates vis-à-vis the DM with the same three-month maturity and consumer price indices (CPI) (see Appendix B).[8] Note that the spot and forward exchange rate are defined as the EC member state's external value vis-à-vis the DM. That is, the perspective of our calculations of interest parity conditions runs from the domestic country to the foreign country and corresponds with the continental definition of the exchange rate where Germany is the foreign country and the other EC countries are viewed as the domestic country.

One of the difficulties with respect to the measurement of money market integration results from the fact that financial assets are heterogeneous. Measuring money market integration with parity conditions boils down to finding similar assets in terms of the quality of debtor, size, depth and segmentation of money markets and of course term to maturity. Furthermore, for tests of interest parity conditions it is important that the timing of the interest rate data corresponds with the timing of the exchange rate data (see Appendix B).[9] We agree with Haldane and

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[7] Luxemburg is excluded from the analysis because Luxemburg and Belgium form a monetary union i.e. they share the same short-term interest rate and exchange rate.

[8] As is evident in the following analysis, it is difficult to obtain consistent interest rate, exchange rate and price level data. Since direct DM forward and spot exchange rates are not available for all EC countries considered and/or over a sufficiently long period, we calculated cross-rate exchange rates. Concerning these cross-rate calculations, we already *presume* in the investigation design perfect capital mobility of type I. However, this is only possible on the basis of the assumption of perfect arbitrage between markets of foreign exchange. Due to transactions costs in triangular arbitrage cross-rate calculations may not exactly correspond to direct quotations (*Frenkel* and *Levich,* 1981). All data used in this paper should be interpreted with caution.

[9] Concerning the data, the use of *average monthly* data may raise problems. However, since we are interested in the longer trends, average monthly data are in order. Furthermore, the use of overlapping data, in which the horizon of the interest rate and exchange rate changes is longer than the observation interval induces serial correlation in the mean deviations (*Hansen* and *Hodrick,* 1980).

Pradhan (1992b, p. 8) that *domestic* money market interest rates are to be preferred to pick up the effect of capital controls between EC countries in a way potentially overlooked if eurocurrency interest rates are used.[10]

Following Gaab et al. (1986, p. 693) we model deviations from CIP, ex post UIP and ex post RIP in percentages per year. Deviations from CIP are defined as $[\ln(1 + i_{t,t+3}) - \ln(1 + i^*_{t,t+3}) - (12/3)(f_t^{t+3} - s_t)] \cdot 100$ where $i_{t,t+3}$ and $i^*_{t,t+3}$ are the representative domestic and foreign money market interest rate over the three-month holding period expressed in percentages per year. The holding period k of the underlying debt instrument is equal to 3 months. s_t denotes the natural logarithm of the spot exchange rate vis-à-vis the DM and f_t^{t+3} denotes the natural logarithm of the forward exchange rate with the same three-month maturity vis-à-vis the DM. $[(12/3)(f_t^{t+3} - s_t)] \cdot 100$ is the three-month forward premium (discount) vis-à-vis the DM expressed in percentages per year. Similarly, deviations from ex post UIP are defined as $[\ln(1 + i_{t,t+3}) - \ln(1 + i^*_{t,t+3}) - (12/3)(s_{t+3} - s_t)] \cdot 100$ where $(12/3)(s_{t+3} - s_t) \cdot 100$ is the realised rate of depreciation (appreciation) vis-à-vis the DM over the three-month holding period expressed in percentages per year. Deviations from ex post RIP are defined as $\{[\ln(1 + i_{t,t+3}) - (12/3)(p_{t+3} - p_t)] \cdot 100\} - \{[\ln(1 + i^*_{t,t+3}) - (12/3)(p^*_{t+3} - p^*_t)]\} \cdot 100$ where $(12/3)(p_{t+3} - p_t) \cdot 100$ is the change in natural logarithms of domestic consumer price indices over the three month period in percentages per year. The ex post exchange risk premium is defined as the difference between the forward premium (discount) and the realised spot exchange rate change $[(12/3)(f_t^{t+3} - s_t) - (12/3)(s_{t+3} - s_t)] \cdot 100$ expressed in percentages per year. Deviations from ex post relative PPP are defined as $[(12/3)(s_{t+3} - s_t) - (12/3)(p_{t+3} - p_t) + (12/3)(p^*_{t+3} - p^*_t)] \cdot 100$. Finally, the ex post currency premium is defined as $\{[(12/3)(f_t^{t+3} - s_t)] - (12/3)(s_{t+3} - s_t)] + [(12/3)(s_{t+3} - s_t) - (12/3)(p_{t+3} - p_t) + (12/3)(p^*_{t+3} - p^*_t)]\} \cdot 100$. We calculate CPI based real interest rates for three reasons. First, its monthly availability (except for Ireland); second, the EMU-criterion for inflation is framed in terms of changes in the CPI (see Italianer, 1993, p. 24) and third, the basket of goods contains traded and non-traded goods and thus is a better measure of the purchasing power of the domestic country than when the basket only contained traded goods.

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10 Euromarkets are almost free of capital controls (see e.g. *Fukao* and *Hanazaki* 1987, p. 48).

Price expectations and exchange rate expectations have been proxied by their observed values on the basis of rational expectations. Of course, there are other methods to model inflationary and exchange rate expectations e.g. from an ARIMA model (see e.g. Barro and Sala-I-Martin, 1990, p. 17), survey data (see e.g. Haldane and Pradhan, 1992b) or regression analysis.[11] However, these other methods do not rule out systematic forecast errors. We agree with Tease et al. (1991, p. 119) who argue that: "The precise choice of the method to measure inflationary expectations is unlikely to alter the longer-term trends in the data although it may affect the timing and turning points."

We split the sample period March 1979 - June 1993 into four subperiods reflecting the various phases of development of the EMS following Ungerer (1990, p. 334). Ungerer characterises the first phase of the EMS (March 1979 - March 1983) as a *period of trial and orientation*. As is illustrated in table 2 during the first phase of the EMS relative frequent and large exchange rate realignments within the Exchange Rate Mechanism (ERM) of the EMS occurred. The exchange rate of high inflation EC countries was usually devalued immediately during periods of exchange rate tensions to maintain competitiveness. As a result the EMS behaved more or less as a "crawling peg" system.

In the second phase of the EMS (April 1983 - September 1987) the number of exchange rate realignments dropped sharply reflecting the monetary policy consensus within the EMS to fight inflation. This *period of consolidation* was characterised by a widespread consensus to follow stability-oriented policies, an increasing convergence in inflation rates, and by long periods without realignments. Monetary and official intervention policies of individual EC member states aimed at fixing nominal exchange rates to reduce inflation and inflationary expectations to German levels. According to De Grauwe (1992), during this phase the DM became the "anchor for price stability" in the EMS. The anti-inflationary monetary policy of the Bundesbank served as the reference point for the monetary policies of other EMS countries. Therefore, several EMS countries (e.g. the Netherlands and more recently France and Belgium) gave up parts of their monetary policy independence and aimed at stabilizing their exchange rate against the DM by (bilateral) intramarginal interven-

11 The use of survey data suffers from the methodological problem that brokers in foreign exchange markets do not have an interest in revealing their real interests. Survey data may not be an accurate measure of market participants true expectatations or people do no act on the expectations they express (*Boughton* 1988, p. 13).

Table 2

Dates and sizes of EMS realignments over the period March 1979 - June 1993[a]

	Percent changes									
Date	B/LFR	DKR	DM	ESC	FF	HFL	IRL	LIT[d]	PTA	UKL[d]
24/09/79	–	−3.00	+2.00	–	–	–	–	–	–	–
30/11/79	–	−5.00	–	–	–	–	–	–	–	–
23/03/81	–	–	–	–	–	–	–	−6.00	–	–
05/10/81	–	–	+5.50	–	−3.00	+5.50	–	−3.00	–	–
22/02/82	−8.50	−3.00	–	–	–	–	–	–	–	–
14/06/82	–	–	+4.25	–	−5.75	+4.25	–	−2.75	–	–
21/03/83	+1.50	+2.50	+5.50	–	−2.50	+3.50	−3.50	−2.50	–	–
18/05/83[b]	−1.90	−1.90	−1.90	–	−1.90	−1.90	−1.90	−1.90	–	–
17/09/84	–	–	–	–	–	–	–	–	–	–
22/07/85	+2.00	+2.00	+2.00	–	+2.00	+2.00	+2.00	−6.00	–	–
07/04/86	+1.00	+1.00	+3.00	–	−3.00	+3.00	–	–	–	–
04/08/86	–	–	–	–	–	–	−8.00	–	–	–
12/01/87	+2.00	–	+3.00	–	–	+3.00	–	–	–	–
08/01/90	–	–	–	–	–	–	–	−3.68	–	–
14/09/92[c e]	+3.50	+3.50	+3.50	+3.50	+3.50	+3.50	+3.50	−3.50	+3.50	+3.50
17/09/92[c e]	–	–	–	–	–	–	–	–	–	−5.00
23/11/92	–	–	–	−6.00	–	–	–	–	−6.00	–
01/02/93	–	–	–	–	–	–	−10.0	–	–	–
14/05/93	–	–	–	−6.50	–	–	–	–	−8.00	–

Symbols: + = revaluation − = devaluation

[a] Core-EMS countries which participate in the ERM of the EMS from March 13, 1979 onwards are: Belgium, Denmark, Germany, France, Ireland, Italy, the Netherlands and Luxemburg. Non-core-EMS countries are Spain which participate in the ERM as of June 16, 1989, the United Kingdom (as of October 8, 1990) and Portugal (as of April 6, 1992) and Greece which does not participate in the ERM at all. Belgium, Denmark, Germany, France, Ireland, the Netherlands and Luxemburg have a fluctuation margin of ± 2.25 %, Italy has a fluctuation margin of ± 6 % and as of January 8, 1990 ± 2.25 %, Spain, Portugal and the United Kingdom have a fluctuation margin of ± 6 %.

[b] Adjustment of the theoretical central rates of the pound sterling based on the market rates of May 13, 1983.

[c] The realignment dates of September 14 and 17, 1992 reflect the first EMS exchange crisis.

[d] The United Kingdom and Italy temporarily suspended ERM participation on September 17, 1992.

[e] The realignment date August, 1 1993 reflects the second EMS exchange crisis.

Source: Eurostat (1993, p. 99).

tion and by maintaining appropriate interest rate differentials vis-à-vis Germany. This is called the *German dominance hypothesis*.

During the third phase of the EMS (October 1987 - September 1992) no major realignment occurred for more than five and a half years until the ERM crisis of September 1992. The third period starts after the Basle-Nyborg Agreement of September 1987 which established a more flexible and concerted use of available instruments (official intervention, exchange rate movements within the band and interest rate changes) to promote exchange rate stability in the ERM (Committee of Governors of the central banks of the member states of the European Economic Community, 1992, p. 12). Improved coordination of interest rate policies to keep the exchange rates within the band and a more flexible use of

existing fluctuation margins helped to prevent speculative attacks on the ERM central rates. In addition, a number of EC countries entered the ERM of the EMS. Intra-European exchange rate stability increased substantially despite the elimination of remaining restrictions on short-term and long-term capital flows as from July 1, 1990. Notwithstanding these advantageous developments, the third phase was considered as a *period of re-examination,* in the light of growing concerns about the "asymmetry" in the EMS where Germany focused on price stability and other ERM-countries focused on maintaining their currency's exchange rates vis-à-vis the DM.

Finally, the fourth phase of the EMS (October 1992 - June 1993) marks the period after the turbulence in the exchange markets of September 1992 which was earmarked by the Committee of Governors of the central banks of the member states of the European Economic Community (1993, p. 2) as "[...] the most serious crisis of the EMS since its inception." We call this period the *period of destabilisation.* The period is characterised by uncertainty about EC exchange rate levels, relatively low inflation rates in EC countries and ergo a potential for lower nominal and real interest rates.

IV. Empirical results

The tests of the degree of short-term capital mobility of type I, II and III rely on calculations of mean deviations from CIP, ex post UIP and ex post RIP in percentages per year.[12] Table 3 summarises all three types of perfect capital mobility which were introduced in table 1 over the period March 1979 - June 1993 and the subperiods March 1979 - March 1983, April 1983 - September 1987, October 1987 - September 1992 and October 1992 - June 1993. In addition, table 3 decomposes the mean deviation from ex post UIP into a country premium and an ex post exchange risk premium, and the mean deviation from ex post RIP into a country premium, an ex post exchange risk premium and a deviation from ex post relative PPP. Each of these factors should be zero for a particular type of perfect capital mobility to hold.[13] Although the calculations in table 3 have been confined to the bilateral relationships between ten EC member states and Germany, table 3 indirectly also determines those deviations between any two EC countries. For example, if we know

12 Another possibility is to rely on regression analysis for tests of CIP, UIP and RIP.

13 Note that it is possible that (some of) these factors may add up to zero while in fact they differ from zero.

the mean deviation from ex post RIP between France and Germany and the mean deviation from ex post RIP between the United Kingdom and Germany we are able to calculate the mean deviation from ex post RIP between France and the United Kingdom in the following way: $r^{UK}_{t,t+3} - r^{FRA}_{t,t+3} = r^{UK}_{t,t+3} - r^{GER}_{t,t+3} - (r^{FRA}_{t,t+3} - r^{GER}_{t,t+3})$. The same holds of course for the building blocks of ex post RIP, that is, the country premium, the ex post exchange risk premium and the deviation from ex post relative PPP.

The use of mean deviations as a basis for the judgement of capital mobility may be sometimes misleading. Suppose all deviations are white noise. Under this condition the expected deviation is zero but in any individual period large deviations may occur. The chosen indicator signals perfect capital mobility despite the fact that capital is immobile internationally. The analysis may strongly suggest that CIP held *on average* over a period, when in fact it did not hold at *any instant* during the period. In so far, the figures in table 3 are to be interpreted with care.[14]

(1) Deviations from CIP

The CIP condition is the least stringent criterion for money market integration. Deviations from CIP i.e. country premia measure the ability to move money market assets across national borders. The country premium reflects the existence of transaction costs, capital controls (existing or expected), information costs, discriminatory tax laws, default risk and possibly imperfections in the data. A negative country premium is indicative of capital export restrictions, the domestic interest rate is artificially low to the German interest rate and capital export restrictions should exist. On the other hand, a positive country premium is indicative of capital import restrictions (Commission of the European Communities, 1990, p. 160).

According to table 3 the Netherlands, Belgium, Ireland and the United Kingdom have average country premia in percentage per year of not more than 50 basis points in absolute value over the period March 1979 - June 1993 reflecting probably only transaction costs. The United Kingdom is the only non-core-EMS country with a country premium of not more than 50 basis points in absolute value. These countries are followed at some distance by the other core-EMS countries Italy and

[14] However, since in Appendix A the underlying charts are provided this criticism is of limited importance for the present paper.

Table 3

The decomposition of European money market interest rate differentials relative to Germany: Averages of monthly observations (percentages per year)

March 1979-June 1993	CIP (1)	EXCHANGE RISK PREMIUM (2)	UIP (3)=(1)+(2)	PPP (4)	CURRENCY PREMIUM (5)=(2)+(4)	RIP (6)=(1)+(5)
France	-1.64	2.03	0.39	-0.06	1.98	0.34
Belgium	-0.55	1.47	0.92	0.77	2.24	1.69
Netherlands	-0.17	0.32	0.15	0.42	0.74	0.58
Italy	-1.40	2.85	1.45	-0.77	2.08	0.68
United Kingdom	-0.27	1.62	1.36	-0.67	0.95	0.69
Denmark	-0.64	2.31	1.68	-0.04	2.28	1.64
Ireland	-0.27	2.35	2.07	-0.93	1.42	1.15
Spain	-1.93	3.84	1.92	-0.50	3.35	1.42
Portugal	-4.46	3.73	-0.73	-1.00	2.74	-1.72
Greece[a]	–	–	-3.92	1.12	–	-2.80

March 1979-March 1983	CIP (1)	EXCHANGE RISK PREMIUM (2)	UIP (3)=(1)+(2)	PPP (4)	CURRENCY PREMIUM (5)=(2)+(4)	RIP (6)=(1)+(5)
France	-3.85	2.07	-1.78	-0.47	1.60	-2.25
Belgium	-1.53	0.17	-1.36	3.71	3.88	2.35
Netherlands	-0.47	0.43	-0.04	0.22	0.64	0.17
Italy	-4.76	5.68	0.92	-4.29	1.39	-3.37
United Kingdom	-0.73	5.16	4.43	-5.66	-0.49	-1.23
Denmark	-1.87	1.44	-0.43	1.17	2.61	0.74
Ireland	-1.00	4.63	3.62	-6.54	-1.92	-2.92
Spain	-4.34	1.95	-2.40	0.79	2.73	-1.61
Portugal	-7.31	3.32	-3.99	-1.34	1.98	-5.33
Greece[b]	–	–	-6.68	0.63	–	-6.05

April 1983-September 1987	CIP (1)	EXCHANGE RISK PREMIUM (2)	UIP (3)=(1)+(2)	PPP (4)	CURRENCY PREMIUM (5)=(2)+(4)	RIP (6)=(1)+(5)
France	-1.62	2.40	0.78	-0.12	2.28	0.66
Belgium	-0.44	3.07	2.62	-1.23	1.84	1.40
Netherlands	-0.18	0.38	0.20	0.42	0.80	0.62
Italy	-0.13	3.87	3.73	-1.00	2.87	2.74
United Kingdom	-0.41	0.24	-0.17	2.02	2.26	1.85
Denmark	-0.10	2.90	2.80	-1.37	1.54	1.44
Ireland	-0.52	2.46	1.94	0.67	3.13	2.61
Spain	-2.29	5.65	3.36	-1.21	4.44	2.15
Portugal	-7.91	4.10	-3.81	2.40	6.50	-1.40
Greece	-	-	-8.27	4.12	–	-4.14

[a] Calculation over the period May 1980-June 1993
[b] Calculation over the period May 1980-March 1983

Table 3: Continue

October 1987-September 1992	CIP (1)	EXCHANGE RISK PREMIUM (2)	UIP (3)=(1)+(2)	PPP (4)	CURRENCY PREMIUM (5)=(2)+(4)	RIP (6)=(1)+(5)
France	-0.09	1.60	1.51	0.12	1.72	1.63
Belgium	0.06	1.28	1.34	0.03	1.31	1.36
Netherlands	0.07	0.18	0.25	0.39	0.57	0.64
Italy	0.03	3.09	3.12	-1.48	1.61	1.64
United Kingdom	0.18	2.74	2.92	-1.88	0.85	1.03
Denmark	-0.10	2.12	2.02	-0.24	1.88	1.78
Ireland	0.34	1.83	2.17	-0.16	1.66	2.01
Spain	0.19	6.28	6.48	-3.75	2.53	2.73
Portugal	0.51	4.95	5.46	-5.53	-0.57	-0.06
Greece	-3.32	4.01	0.68	-1.19	2.82	-0.50

October 1992-June 1993	CIP (1)	EXCHANGE RISK PREMIUM (2)	UIP (3)=(1)+(2)	PPP (4)	CURRENCY PREMIUM (5)=(2)+(4)	RIP (6)=(1)+(5)
France	-0.09	2.54	2.45	1.38	3.92	3.83
Belgium	0.06	0.24	0.29	1.70	1.94	1.99
Netherlands	0.02	0.27	0.30	1.81	2.08	2.11
Italy	-0.23	-20.32	-20.56	24.55	4.23	3.99
United Kingdom	0.18	-16.74	-16.56	18.41	1.66	1.84
Denmark	-0.73	4.82	4.09	2.70	7.52	6.79
Ireland	1.06	-7.24	-6.18	14.93	7.69	8.75
Spain	-0.69	-12.94	-13.63	18.48	5.54	4.85
Portugal	-1.41	-4.35	-5.76	10.71	6.36	4.95
Greece	-3.22	5.42	2.19	0.39	5.81	2.59

France. Spain, Portugal and probably also Greece (on the basis of the periods October 1987 - September 1992 and October 1992 - June 1993) have high country premia and clearly maintained many capital controls over the period March 1979 - June 1993. The results confirm the findings of a previous study of mean deviations from CIP relative to Germany over the period September 1982 to April 1988 except for Ireland (see "One Market, One Money", Commission of the European Communities, 1990, pp. 160 - 161). The Commission of the European Communities basically transformed Frankel's (1989) calculations of money market interest rate differentials with respect to the United States in the following way: $r^{UK}_{t,t+3} - r^{GER}_{t,t+3} = r^{UK}_{t,t+3} - r^{US}_{t,t+3} - (r^{GER}_{t,t+3} - r^{US}_{t,t+3})$.[15]

[15] *Lemmen* and *Eijffinger* (1993b) reproduce the calculations of the Commission of the European Communities (1990).

The period before the ERM crisis can best seen as a yardstick of the present degree of money market integration because it will take some time for financial markets to calm down and a clear picture on the degree of money market integration will emerge. During the period of destabilisation (October 1992 - June 1993) policy deviations and diverging behaviour of fundamentals in the EC with an increasing degree of (destabilising) short-term capital flows caused high increases in nominal interest rates to defend exchange rates.

During the first phase of the EMS (March 1979 - March 1983) only the Netherlands has a country premium of not more than 50 basis points in absolute value. In the second phase of the EMS (April 1983 - September 1987) already six countries have country premia of not more than 50 basis points in absolute value: Denmark, the Netherlands, Ireland, the United Kingdom, Italy and Belgium. In the third phase of the EMS (October 1987 - September 1992) also France and Spain are included into the group of countries with low country premia with respect to Germany. Portugal and in particular Greece are the notable exceptions to the rule.[16] Investment in Portuguese Escudo gave an annual excess return of 0.51 per cent while investment in the Greek Drachma gave an annual loss of 3.32 per cent. An important explanation for above results was the directive of 24 June 1988, which is part of the Single Market Programme, when the European Commission stated that as from July 1, 1990 all short-term and long-term capital movements in the EC are to be free of restrictions. Greece, Ireland, Spain and Portugal do not have to fulfil this directive until 31 December 1992. Moreover, Portugal and Greece have the possibility to postpone implementation of this directive till December 31, 1995. In practice this meant that especially restrictions on short-term capital movements had to disappear (many restrictions on long-term capital movements were already lifted earlier).

(2) Ex post exchange risk premia

Table 3 also presents the ex post exchange risk premium. The ex post exchange risk premium is the difference between the forward premium (discount) and the realised spot exchange rate change. It is difficult to know the exact sign and magnitude of the exchange risk premium because the markets expectation of the exchange rate is not directly

[16] If capital controls exist, both arbitrageurs and speculators are prevented from eliminating profit opportunities.

observable so ex post devaluation in stead of ex ante devaluation has to be used. For example, a negative exchange risk premium may arise when the ex post devaluation exceeds the forward premium which is the case for Ireland, Italy, Spain, Portugal and the United Kingdom during the ERM crisis of September 1992. The exchange risk premia generally are rather persistent. The ex post exchange risk premium declines slowly in the core-EMS countries from September 1987 onwards despite relatively large intra-European exchange rate stability until the exchange crisis of September 1992 (compare the subperiods March 1979 - March 1983 and October 1987 - September 1992). In principle, as theory predicts the larger exchange rate fluctuations are allowed the higher the exchange risk premium. Non-core-EMS countries show higher exchange risk premia than core-EMS countries. Although some exchange rates of EMS countries are within a small band, the possibility of an exchange rate realignment in the EMS, always influences nominal exchange rate expectations which cause nominal short-term (and long-term) interest rate divergences. Table 3 unmistakably illustrates that exchange rate volatility is the principal source limiting money market integration in the EC. German investors only are *willing* to hold foreign assets if they obtain compensation in the form of an exchange risk premium. This argument assumes that CIP holds continuously and the ex post exchange risk premium is a good measure of the willingness to hold foreign assets. The willingness to hold foreign assets crucially depends on the devaluation risk i.e. the timing and size of devaluations. According to table 3, the Netherlands is the only country with average exchange risk premia in percentage per year of not more than 50 basis points in all subperiods.

(3) Deviations from ex post UIP

A stronger criterion for money market integration is the UIP condition. The UIP condition is the criterion we identify with money market integration and foreign exchange market integration. A positive deviation from ex post UIP means that the market requires a higher expected return from domestic investments than from German investments. According to table 3 the smallest mean deviation from ex post UIP relative to Germany over the period March 1979 - June 1993 is that of the Netherlands. This indicates high money market integration between the Netherlands and Germany. The Netherlands is followed by France, Portugal, Belgium, the United Kingdom, Italy, Denmark, Spain, Ireland and Greece respectively. Surprisingly, according to the UIP criterion the money market of the United Kingdom is not very well integrated with

the money market of Germany in contrast with the integration found according to the CIP criterion. German investors who invest in the United Kingdom apparently demand an exchange risk premium before they are willing to invest in the United Kingdom. German investors are risk-averse and demand compensation in the form of an (possibly time-varying) exchange risk premium to hold the more risky assets of other EC countries. In general, the relative strengths of risk-aversion in the two countries (as well as elsewhere) will play a key role in determining the realized exchange risk premium. Another factor will be the relative size of asset positions. More risk averse German investors will only hold those assets of EC countries with less frequent and sizeable realignments (i.e. devaluations) or will demand a higher exchange risk premium.

Notwithstanding above results, the interpretation of ex post UIP remains unclear because it entails a joint test of two underlying hypotheses. Deviations from ex post UIP may reflect a lack of short-term capital mobility of type II (country and/or exchange risk premia) and/or expectational errors. Consequently, inference of the degree of money market integration based upon ex post UIP differentials must be done with caution. Note also that inference of the degree of money market integration based upon one segment of the domestic and foreign money markets corresponding with two comparable money market assets is not always wise. Moreover, in the ERM of the EMS short-term nominal interest rates are used as policy instruments to keep exchange rates within the bands. Fukao and Hanazaki (1987, p. 75) argue: "Under an actual adjustable peg system such as the EMS, the nominal interest rates are not equalised in the short-run. This divergence of interest rates is due to the allowed margin of movements in the exchange rates and possible future changes in the parity rates." When financial markets expect an exchange rate devaluation, high nominal short-term nominal interest rate differentials relative to Germany are needed to maintain the exchange rate in the allowed fluctuation margins of the EMS. Short-term nominal interest rates fluctuate in response to *policy* forces and not to *market* forces. Therefore, it is hard to isolate the market induced effect of money market integration on short-term nominal interest rates from the policy induced effect of money market integration. Consequently, declining UIP (CIP and RIP) differentials may also be attributed to convergence in the implementation and performance of monetary policies of EC countries as measured by the development of four key variables: inflation rates, real exchange rates, real short-term interest rates (money market rates) and real long-term interest rates (capital market

rates) (Eijffinger, 1993a, p. 182).[17] In addition, EC money market interest rates are not only influenced by intra-EC capital mobility, but also by extra-EC capital mobility in accordance with international interest arbitrage relationships. Thus, capital mobility between the EC and the rest of the world may confuse the issue of measurement of capital mobility within the EC. Changing demand for short-term capital in the EC may change the supply of capital from abroad.

(4) Deviations from ex post relative PPP

The ex post relative PPP condition holds if the ex post real exchange rate between two countries remains constant. This means that the domestic currency depreciates at a rate equal to the ex post inflation differential. It also means that in the absence of relative price changes the nominal exchange rate change equals the real exchange rate change. Generally, the failure of ex post relative PPP in the short-run is evident from table 3 for most of the EC countries during the sample period except for the Netherlands. Because deviations from ex post relative PPP are generally smaller than ex post exchange risk premia, ex post exchange risk premia are the main source of deviations from ex post RIP. With inflation rates gradually coming down, increasing nominal exchange rate stability in the EMS also exerted a short-run stabilizing effect on intra-EMS real exchange rates.

Again, ex post relative PPP is hard to interpret. Calculations of ex post relative PPP not only require approximation of expected devaluation but also approximation of expected relative price changes by their observed values (Commission of the European Communities, 1990, p. 160). In addition, deviations from ex post PPP might be due to relative price changes of tradable and non-tradables in the consumption basket.

Table 2 shows that the size and frequency of realignments has decreased with time. Given divergent inflation rates, these realignments have been necessary to preserve real exchange-rate equilibrium within the EMS (Collins, 1988, p. 112). However, theoretical work on the credibility of monetary policy suggests that, if countries with higher inflation rates are to gain anti-inflation credibility through the EMS membership in order to reduce their inflation rate to German levels, they need a real appreciating exchange rate with Germany. This is because full adjust-

[17] Of course, the forward premium (discount) and the expected devaluation (revaluation) also incorporate market participant' expectations about the differences between domestic and German inflation rates.

ment of exchange rates would amount to accommodation of domestic inflationary pressures, whereas less than full adjustment of exchange rates would involve an element of punishment for excess domestic inflation by squeezing profits margins of producers of tradeable goods (Bleany, 1992, p. 66). Giavazzi and Pagano (1988, p. 1055) argue: "First, between successive realignments, excess inflation (combining with the fixity of the nominal exchange rate) results in one-for-one appreciation of the real exchange rate. Second, at realignment dates, excess inflation countries obtain devaluations which are generally insufficient to make-up for the real appreciation experienced since the previous realignment." The first factor introduces real exchange rate fluctuation between realignments while the second factor introduces a trend of real appreciation in the exchange rates of high inflation countries. Observe that movements in real exchange rates tend to be dominated by nominal exchange rate rather than by relative price level movements. EMS countries which have experienced relatively high inflation rates experienced real exchange rate appreciation (Giavazzi and Pagano, 1988, p. 1055). With respect to the first argument of Giavazzi and Pagano, as table 3 illustrates, during the period March 1979 - June 1993 nominal exchange rates didn't adjust fully to compensate for inflation differentials if negative PPP deviations occur except with respect to the Netherlands, Belgium and Greece. However, table 3 also complies with mean reversion in the real exchange as indicated by alternating positive and negative deviations from ex post relative PPP for many EC countries.

(5) Ex post currency premia

It is expected that financial markets translate monetary uncertainties – i.e. expected exchange rate and inflation variability – into higher currency premia, consisting of exchange risk premia and deviations from relative PPP (see (2) and (4) above). Notable declines in currency premia occurred for Spain, Portugal and the United Kingdom when they entered the ERM of the EMS (comparing the subperiod April 1983 - September 1987 with the subperiod October 1987 - September 1992). EMS discipline may have helped to limit previous nominal devaluation tendencies of these countries. Moreover, ERM membership of Spain, Portugal and the United Kingdom probably sharply increased the substitutability of bonds. However, the overall result is that currency premia remain rather persistent.[18]

[18] Note that unexpected high or low inflation rates (news about inflation rates) may be an important determinant of ex ante PPP deviations.

This means that even with the equalisation of covered interest rates, large differentials in real interest rates remain (Frankel, 1992, p. 201). Bonds are not perfect substitutes for equities or for physical capital.

(6) Deviations from ex post RIP

The RIP condition is the strongest criterion for money market integration. In fact, the RIP condition not only measures money market integration but non-financial integration as well (see section II). Deviations from ex post RIP are due to country and currency factors. Table 3 shows that currency factors dominate country factors in explaining real interest rate differentials with respect to Germany. Declining real interest rate differentials may point to increased cross-border trade in goods and services in Europe. Real interest convergence may be explained by the Single Market project to complete an internal market for persons, goods, services and capital in the EC by the end of 1992 (or later). The Netherlands and France are the EC countries showing the highest degree of short-term financial and non-financial integration with Germany (March 1979 - June 1993). In general, table 3 shows that ex post RIP has been violated because the building blocks of ex post RIP i.e. ex post UIP and ex post PPP have been violated. The low RIP values for Portugal and Greece over the period October 1987 - September 1992 are probably due to measurement errors.

The interpretation of the RIP condition is even more difficult than the interpretation of the UIP condition. Particularly, the interpretation of the RIP condition becomes more difficult in countries with relatively high and variable inflation rates. RIP deviations may be due to irrational expectations of inflation rates, the existence of non-traded goods in the basket of consumer goods and of course the lack of money market integration and/or short-term non-financial integration. The Economist (1992, p. 23) argues: "[...] the criterion of real interest parity is much more demanding than it seems to be. Exchange rate volatility undermines it in two ways: first by adding a risk premium to the cost of cover in the foreign exchange market [so UIP does not hold]; and, second by breaking the link between exchange rates and differences in inflation rates [so PPP does not hold]". *Short-term* ex post relative PPP may be an unrealistic assumption with respect to money market integration, because as was argued by Boughton (1988, p. 18) it has "[...] little or no bearing on short- or medium-term developments." That is, relative prices of domestic and foreign goods may be sticky in the short-

run.[19] Especially, in the short-run the real exchange rate may fluctuate around its equilibrium value while in the long-run we have mean reversion of the real exchange rate.

Note, that deviations from ex post UIP and ex post relative PPP determining RIP have opposite signs and often partly cancel out. The depreciation of the domestic currency is smaller than needed to maintain competitiveness which was lost due to high domestic inflation.[20] Therefore the real exchange rate appreciates (where the domestic inflation exceeds the German inflation and the nominal exchange rate depreciation is relatively small) while UIP remains positive. This implies that a country imports deflation given a high degree of openness. The relative small depreciation may be explained by the stabilisation of nominal exchange rates in the EMS. The worse record of inflation and concomitant devaluation tendencies required countries like Spain, Portugal, Greece, Italy and the United Kingdom to keep their money market interest rate above that in Germany.[21]

(7) Deviations from CIP, ex post UIP and ex post RIP compared

If we compare deviations from CIP, ex post UIP and ex post RIP over the period April 1983 - September 1987 in the present paper with those deviations over the approximately similar period September 1982 - April 1988 previously calculated by the European Commission (1990, Box 6.5, pp. 160 - 161) and reproduced in Lemmen and Eijffinger (1993b, p. 202), we safely may conclude that our calculations are of the same order of magnitude. However, note that our calculations for the period April 1983 - September 1987 are slightly lower in absolute value than those for the period September 1982 - April 1988 calculated by the European Commission due to the existence of capital controls in the early eighties. If we compare deviations from CIP over the period September 1982 - April 1988 with those deviations over the period October 1987 - September 1992 in the present paper, we conclude that capital mobility of type I between all EC member states and Germany has increased significantly

[19] Because non-financial integration is typically perceived to take place over a longer time horizon, it might be better to use yearly data rather than monthly data to assess the degree of non-financial integration.

[20] Of course, competitive real depreciations may have negative spill-over effects to other EC countries.

[21] The history of high inflation in those countries has made these countries more dependent on short-term financing than Germany, and thus more sensitive to shifts in short-term nominal interest rates.

after April 1988. Only Portugal and Greece have deviations from CIP above 50 basis points in absolute value over the period October 1987 - September 1992. The same holds for deviations from ex post RIP. Deviations from ex post UIP, however, show no clear tendency to decline for the greater part of EC countries.

Figure 1 (see Appendix A) plots movements in short-term deviations from CIP, ex post UIP and ex post RIP of ten EC countries relative to Germany. The solid line denotes CIP, the dotted line denotes ex post UIP and the dashed line denotes ex post RIP deviations. Figure 1 confirms the calculations in table 2. Figure 1 may be particular helpful to recognize the structural breaks closely connected with the various phases of development of the EMS. From an inspection of CIP, UIP and RIP deviations in figure 1, it appears that exchange risk premia and currency premia – and therefore deviations from ex post UIP and ex post RIP respectively – remain rather persistent. Contrary to CIP deviations which almost have disappeared (except with respect to Portugal and Greece). RIP and UIP deviations declined slowly until the ERM crisis of September 1992. Furthermore, evidence from both figure 1 as table 3 indicate that CIP deviations are much smaller than RIP deviations. This confirm that real integration lags (geographical) money market integration in the EC.

As is illustrated in figure 1, exchange rates were unstable causing considerable UIP variability. In general, fluctuations in UIP are larger than fluctuations in CIP corresponding with the earlier conclusion that exchange rate fluctuations in the EC nowadays hamper further money market integration. Furthermore, CIP, UIP and RIP deviations of core-EMS countries generally are more stable than those deviations of non-core-EMS countries. The exchange rate variability of the Netherlands, Belgium, France, Denmark, Ireland and Italy is lower than the exchange rate variability of Portugal, Spain, Greece and the United Kingdom.

Observe from figure 1 that with nearly perfect money market integration – e.g. between the Netherlands and Germany – RIP is more variable than UIP and CIP on average. In the case of the Netherlands and Germany with a fixed parity between the Guilder and the Deutsche Mark both nominal money market interest rates are approximately equalised. Therefore real money market interest rate differentials between both countries reflect differences in national inflation rates. With imperfect money market integration – e.g. between Spain and Germany – UIP is more variable than RIP and CIP. In the case of Spain and Germany both

nominal money market interest rates and exchange rates move to offset differences in national inflation rates.

The comparison of the realignment dates in table 2 with the movements of ex post UIP differentials reveals an important phenomenon in European money markets. The ex ante UIP condition implies that, if a realignment is expected, uncovered returns on currencies which are expected to devalue rise above those returns on currencies which are expected to revalue. However, this argument is only true if the exchange rate devaluation c.q. revaluation is anticipated (see e.g. Koedijk and Kool, 1993, pp. 162 - 163). If e.g. an exchange rate devaluation is anticipated, the nominal interest rate differential increases and a significant positive uncovered return arises before the devaluation takes place. If on the other hand the exchange rate devaluation is not anticipated, the nominal interest rate differential remains the same and no significant positive uncovered return arises before the devaluation takes place. De Boissieu (1988, p. 59) remarks about deviations from ex post UIP: "(...) the inability of operators to forecast accurately the date and the extent of realignments may explain differences in the *ex post* returns on financial assets with the same maturity denominated in different currencies." The ERM crisis of September 1992 was largely unanticipated. In the period October 1992 - June 1993 large negative uncovered interest differentials occurred in Ireland, Italy, Spain, Portugal and the United Kingdom. Unfortunately, the efforts following the ERM crisis to defend the exchange rates within the chosen bands through high nominal money market interest rates lacked credibility. Consequently, on August 1th 1993 ERM bands were widened to ±15% except for the band between the Netherlands and Germany which remained unchanged at ±2.25%.

V. Conclusions

This paper documents the available evidence on money market integration between ten EC countries and Germany. Defining the concept of money market integration was important because the three interest parity conditions measure different types of perfect capital mobility. We start our sample period in March 1979 when some EC members states tried to limit fluctuations in the nominal exchange rates linking their national currencies through the EMS.

The evidence presented in this paper provides strong support for an increasing degree of money market integration in the EC. In particular,

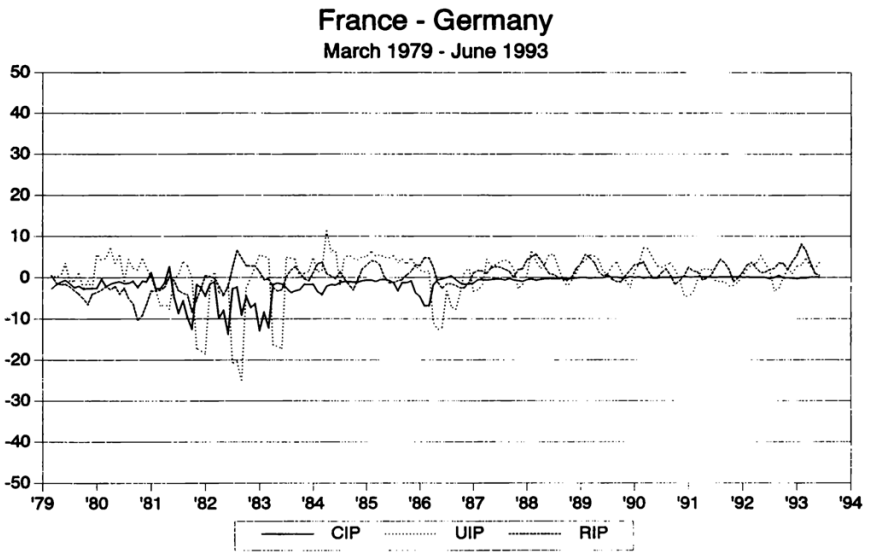
the ability to move short-term capital across national borders was greatly enlarged. Almost perfect capital mobility of type I can be said to exist between eight EC member states and Germany. Portugal and Greece are the exceptions to the rule and are not well integrated with Germany according to the CIP condition. However, the willingness to move short-term capital across national borders increased rather slowly. Presently, UIP only exists between the Netherlands and Germany. Investors still are risk-averse and demand a premium to cover themselves against the exchange risk arising from realised or expected devaluation. Devaluation risk as measured by the exchange risk premium is the main factor impairing UIP and thus money market integration. Notwithstanding increased nominal and real exchange rate stability in the EMS after the Basle-Nyborg Agreement of September 12, 1987, exchange rate and currency premia remain rather persistent.

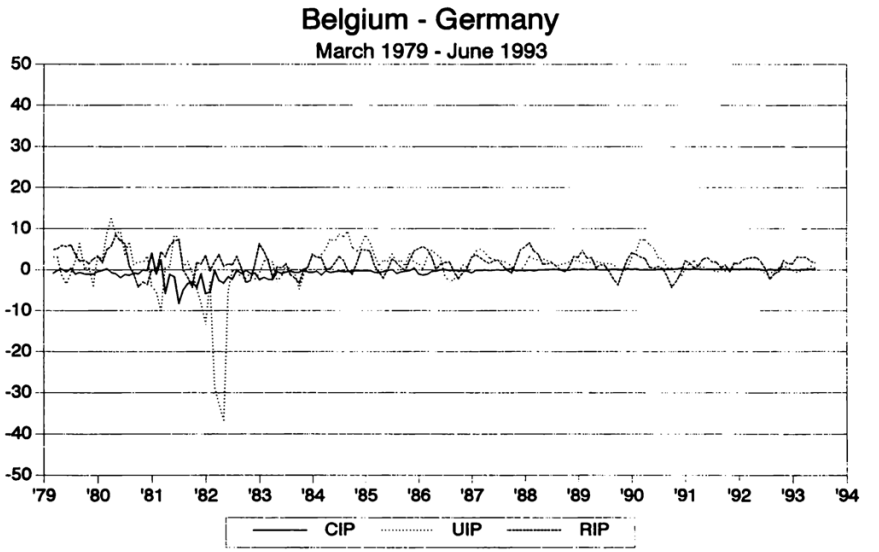
We also observed from table 3 and figure 1 that although CIP deviations were approximately zero for almost all EC countries, UIP and RIP deviations remained rather persistent. Consequently, money market integration eventually also needs real integration. Higher inflation rates are expected to translate into a worsening in competitiveness (real appreciation) under a fixed but adjustable exchange rate regime, which in turn dampens prices and hence promotes inflation convergence.

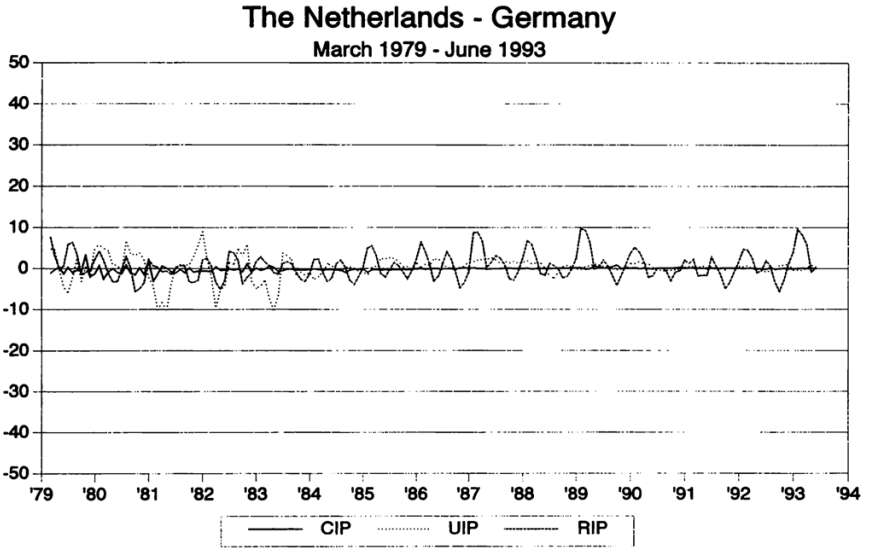
The higher degree of capital mobility of type I may also speed up the spread of financial and economic shocks in one EMS country to other EMS countries as the ERM crisis has proved. Morgan Guaranty Trust Company (1992, p. 10) argues: "Indeed, because the breadth and depth of the last many years' integration drive amplify synchronous tendencies across the region, deflationary forces in individual European countries are mutually reinforcing to a degree widely underestimated today." When financial markets calm down CIP differentials are expected to decline fast since capital controls simply do not exist or are not effective. However, exchange risk premia and consequently UIP differentials are expected to last for a longer time and to come down rather slowly.

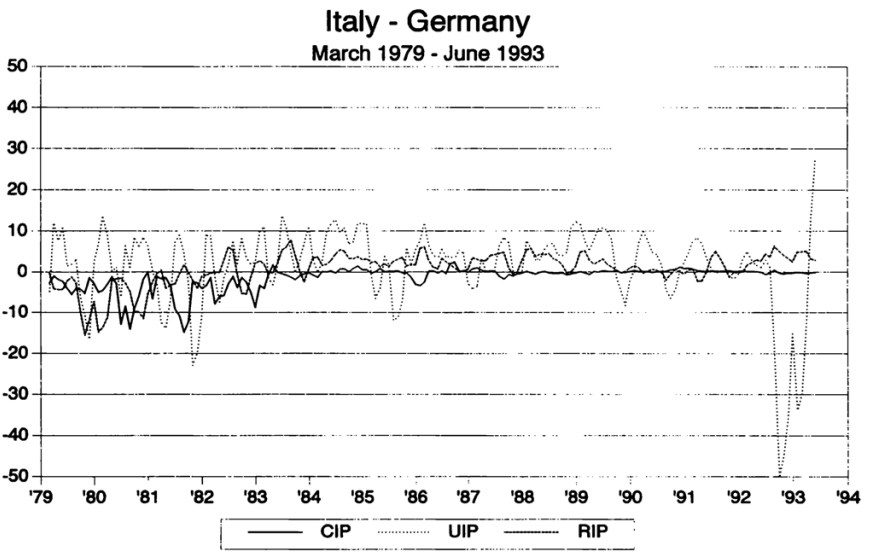
Appendix A

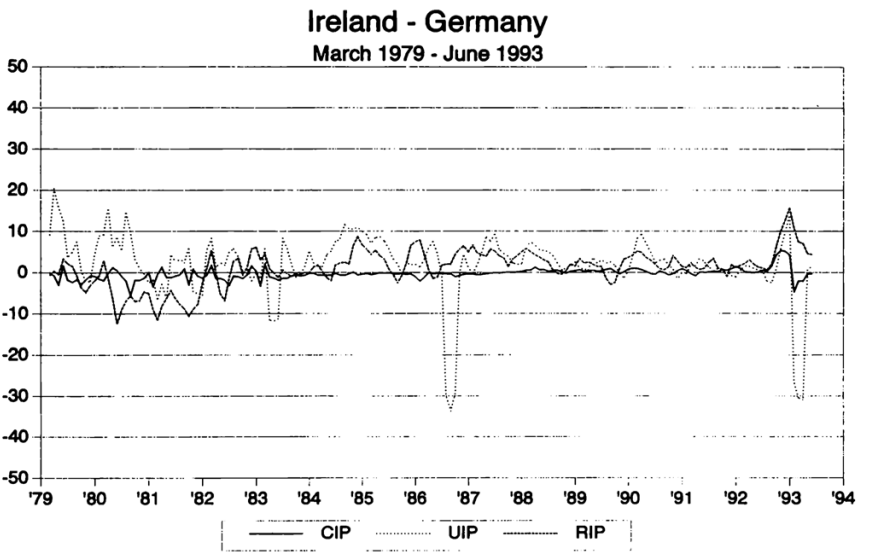
Figure 1: Deviations from CIP, ex post UIP and ex post RIP of ten EC member states relative to Germany (in percentages per year)

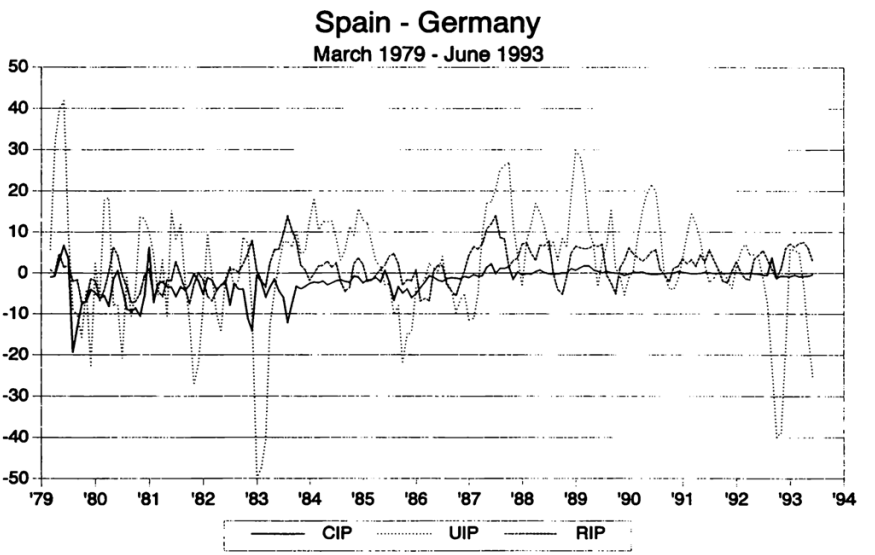


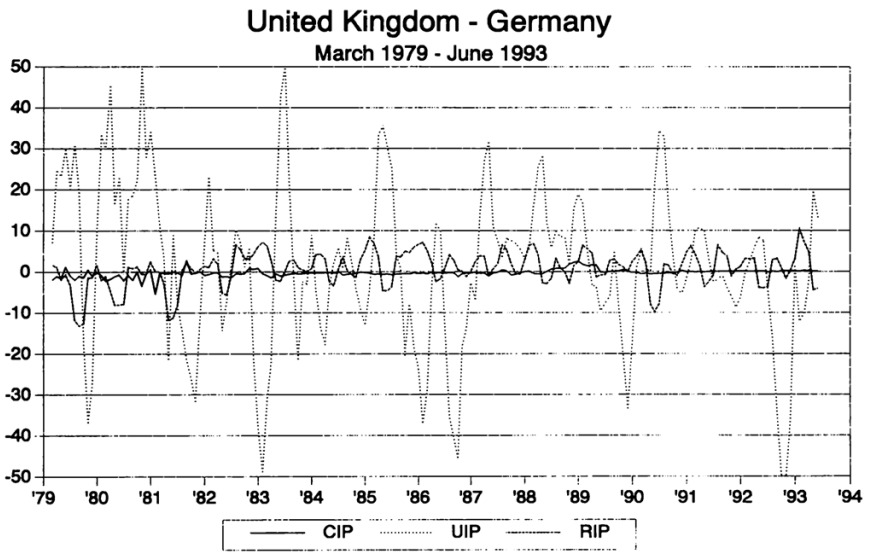


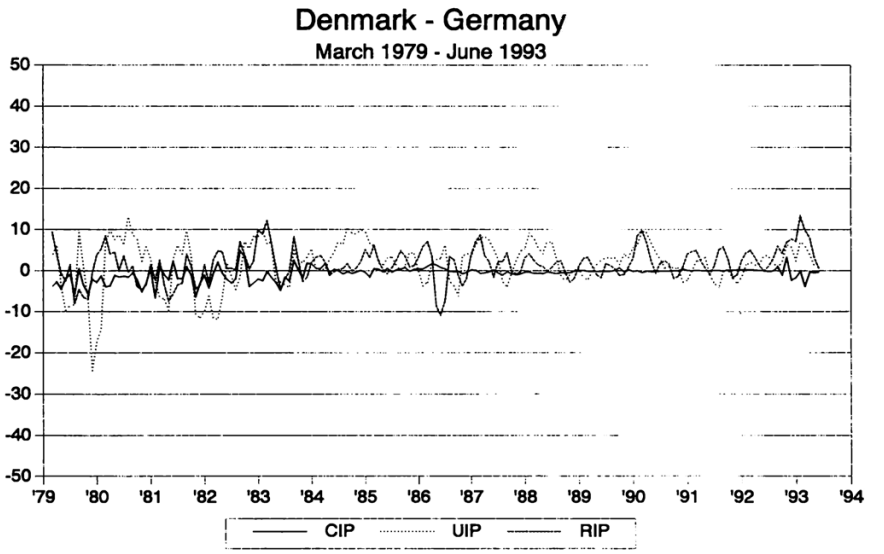


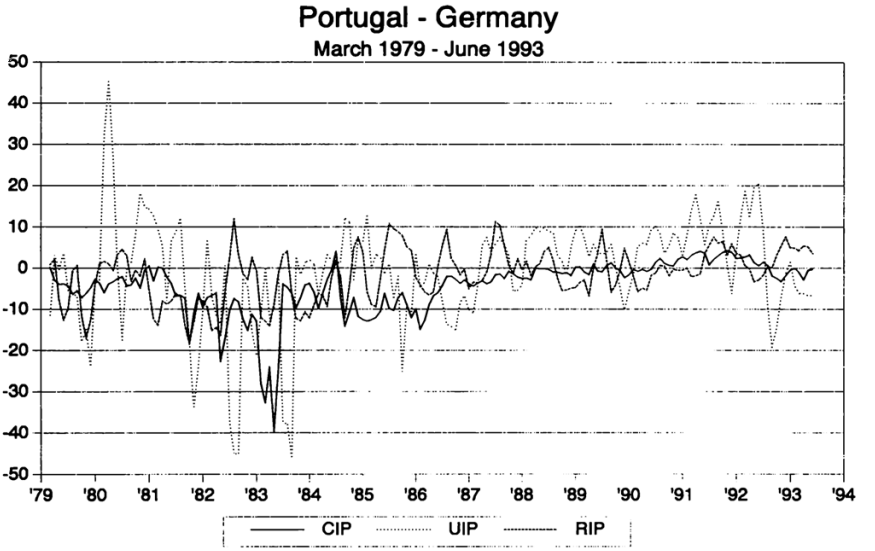


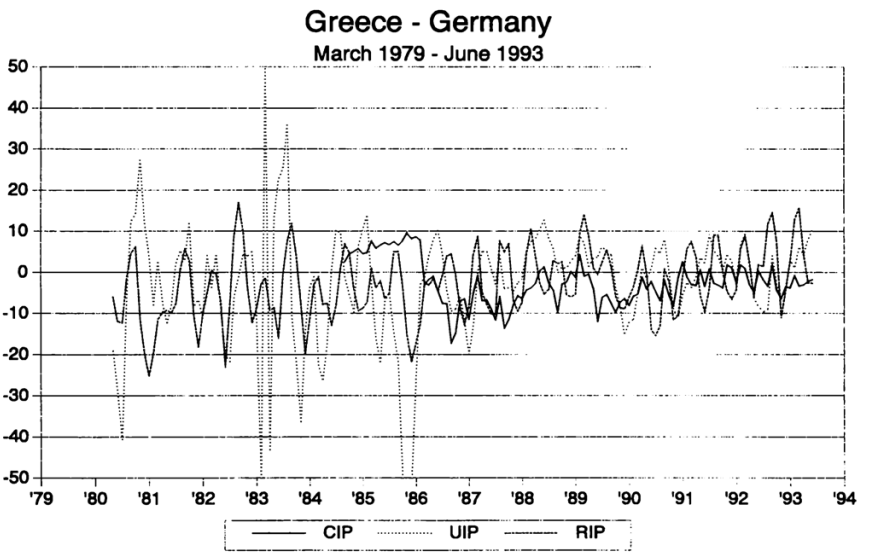












Appendix B

Money market interest rates

Countries	Period	Description	Source
Germany, France, Belgium, Netherlands, United Kingdom, Denmark, Spain, Portugal, Italy, Ireland	March 1979-June 1993	Taux d'interet marché monetaire 3 mois, monthly series at annual rate (monthly average)	Eurostat
Greece	May 1980-June 1993	Taux d'interet marché monetaire 3 mois, monthly series at annual rate (monthly average)	Eurostat

Consumer price indices

Countries	Period	Description	Source
Germany, France, Belgium, Netherlands, United Kingdom, Denmark, Spain, Portugal, Italy	March 1979-June 1993	Indices des prix à la consommation, monthly series, general index (1985 = 100)	Eurostat
Ireland	March 1979-June 1993	Consumer price index, quarterly series, general index (1985 = 100). Monthly Irish consumer price indices were arrived at by 3-month centered moving average of the quarterly series	Datastream, IMF
Greece	May 1980-June 1993	Indices des prix à la consommation, monthly series, general index (1985 = 100)	Eurostat

Spot exchange rates

Countries	Period	Description	Source
France, Belgium, Netherlands, United Kingdom, Denmark, Italy, Ireland	March 1979-June 1983	Own cross-rate calculations of spot exchange rates vis-à-vis the DM based upon spot exchange rates to £ 1 sterling (middle rate), monthly series	Datastream, Bank of England
Greece	May 1980-August 1984	Own cross-rate calculations of spot exchange rates vis-à-vis the DM based upon spot exchange rates to £ 1 sterling (middle rate), monthly series	Datastream, Bank of England
Spain, Portugal	March 1979-February 1986	Own cross-rate calculations of spot exchange rates vis-à-vis the DM based upon spot exchange rates to £ 1 sterling (middle rate), monthly series	Datastream, Bank of England
France, Belgium, Netherlands, United Kingdom, Denmark, Italy, Ireland	July 1983-June 1993	Own cross-rate calculations of spot exchange rates vis-à-vis the DM based upon "Taux de change dollar spot" (monthly average), monthly series	Eurostat
Greece	September 1984-June 1993	Own cross-rate calculations of spot exchange rates vis-à-vis the DM based upon "Taux de change dollar spot" (monthly average), monthly series	Eurostat
Spain, Portugal	March 1986-June 1993	Own cross-rate calculations of spot exchange rates vis-à-vis the DM based upon "Taux de change dollar spot" (monthly average), monthly series	Eurostat

Forward exchange rates

Countries	Period	Description	Source
Germany, France, Belgium, Netherlands, United Kingdom, Denmark, Italy, Ireland	March 1979-June 1983	Own cross-rate calculations of forward exchange rates vis-à-vis the DM based upon three-month forward exchange rates to £ 1 sterling (middle rate), monthly series	Datastream, Bank of England
Greece	May 1980-August 1984	Own cross-rate calculations of forward exchange rates vis-à-vis the DM based upon three-month forward exchange rates to £ 1 sterling (middle rate), monthly series	Datastream, Bank of England
Spain, Portugal	March 1979-February 1986	Own cross-rate calculations of forward exchange rates vis-à-vis the DM based upon three-month forward exchange rates to £ 1 sterling (middle rate), monthly series	Datastream, Bank of England
Germany, France, Belgium, Netherlands, United Kingdom, Denmark, Italy, Ireland	July 1983-June 1993	Own cross-rate calculations of forward exchange rates vis-à-vis the DM based upon "Taux de change dollar, terme 3 mois" (monthly average), monthly series	Eurostat, BIS
Greece	September 1984-June 1993	Own cross-rate calculations of forward exchange rates vis-à-vis the DM based upon "Taux de change dollar, terme 3 mois" (monthly average), monthly series	Eurostat, BIS
Spain, Portugal	March 1986-June 1993	Own cross-rate calculations of forward exchange rates vis-à-vis the DM based upon "Taux de change dollar, terme 3 mois" (monthly average), monthly series	Eurostat, BIS

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Summary

The Price Approach to Financial Integration: Decomposing European Money Market Interest Rate Differentials

The present paper deals with a theoretical and empirical analysis of money market integration in the European Community. The paper examines the degree money market integration between ten EC member states and Germany since the start of the European Monetary System in March 1979. Money market integration is defined as the *ability* and *willingness* to move money market assets across national borders. The empirical analysis relies on calculations of mean deviations from covered interest parity, ex post uncovered interest parity and ex post real

interest parity. The degree of money market integration crucially depends on the devaluation risk as measured by the ex post exchange risk premium. In the case of Portugal and Greece also capital controls matter.

Zusammenfassung

Finanzintegration über den Kurs als Vorgehensweise: Auflösung von Zinsgefällen am europäischen Geldmarkt

Dieser Beitrag befaßt sich mit einer theoretischen und empirischen Analyse der Geldmarktintegration in der Europäischen Gemeinschaft. Er untersucht den Grad an Geldmarktintegration zwischen zehn EG-Mitgliedstaaten und Deutschland seit Beginn des Europäischen Währungssystems im März 1979. Geldmarktintegration wird als die Fähigkeit und Bereitschaft zur grenzüberschreitenden Bewegung von Geldmarktpapieren definiert. Die empirische Analyse stützt sich auf Berechnungen der mittleren Abweichungen von der Nettozinsparität, der ex post ermittelten Bruttozinsparität und der ex post ermittelten Realzinsparität. Der Grad an Geldmarktintegration hängt entscheidend von den durch die Währungsrisikozuschläge zum Ausdruck kommenden Abwertungsrisiken ab. Im Falle Portugals und Griechenlands spielen auch Kapitalverkehrskontrollen eine Rolle.

Résumé

L'approche par les prix de l'intégration financière: la décomposition des différentiels de taux d'intérêt sur les marchés monétaires européens

Cet article traite d'une analyse théorique et empirique de l'intégration des marchés monétaires dans la Communauté Européenne. Il examine le degré d'intégration des marchés monétaires entre 10 pays membres de la Communauté Européenne et l'Allemagne depuis le début du Système Monétaire Européen en mars 1979. L'intégration des marchés monétaires est définie comme la capacité et la volonté de déplacer des actifs des marchés monétaires au-delà des frontières nationales. L'analyse empirique repose sur des calculs d'écarts principaux par rapport à la parité des intérêts couverts, à la parité ex-post des intérêts non couverts et à la parité des intérêts réels. Le degré d'intégration des marchés monétaires dépend de façon cruciale du risque de dévaluation, mesuré par la prime ex-post de risque de change. Dans le cas du Portugal et de la Grèce, les contrôles des capitaux comptent aussi.