EVALUATING CAPITAL MOBILITY IN THE EU: A NEW APPROACH USING SWAPS DATA

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Abstract:

The level of capital mobility prevailing in the 90s within a group of European Union countries - Belgium, France, Germany, Italy, the Netherlands and the United Kingdom - is evaluated by means of cointegration-based tests of the covered interest parity condition. Unlike other similar studies, this one concentrates on the long end of the maturity spectrum, investigating onshore and offshore assets with maturities of three, five, seven and ten years, and employing swaps data as a means of covering foreign exchange risk. Although such an assessment has not been previously developed, it has practical interest in the context of European economies. In fact, given member states' lack of autonomy over domestic monetary and fiscal policies, the sluggishness of salaries and prices, and the low mobility of European labour force, financial markets may become one major source of adjustment to asymmetric shocks. To this end, it is the mobility of long-term capital, rather than that of short-term one, that is of critical importance. This analysis suggests that long-term financial flows appear to be completely unrestrained only between domestic Dutch and German markets. Consequently, some countries may, in the future, face difficulties in attracting capital for purposes of long-run stabilisation, even in the absence of foreign exchange risk.

1 - Introduction:

The level of capital mobility that prevails within a group of six major European Union (EU) countries is evaluated by testing the covered interest parity (CIP) condition. Unlike other similar studies, we concentrate on the long end of the maturity spectrum and use swaps as instruments to cover foreign exchange risk. This is an important contribution to the literature since CIP-based assessments of capital mobility in the EU, of which Holmes and Pentecost (1999) are a good recent example, use data on short-term interest rates only.[1] The analysis proposed here has practical interest in the context of EU economies, given the fact that financial markets may become one important source of adjustment when asymmetric disturbances hit individual member states. Furthermore, it is the mobility of long-term capital, rather than that of short-term one, that is critical for this issue.

According to economic theory, there are two possible ways of solving the problems generated by asymmetric disturbances: factor adjustment and/or financing.[2] In the particular case of the EU, the adjustment of monetary variables such as exchange rates or interest rates is not an option, as the autonomy over national monetary policies is lost in favour of the European Central Bank. Moreover, the sluggishness of prices and wages, along with the low mobility of the European labour force, prevents their use for purposes of adjustment and stabilisation.[3] Countries will therefore have to rely mainly in public and private financing to promote the recovering of regions hit by specific disturbances. Taking into account that national fiscal policies are constrained, and that the EU central budget does not have a dimension compatible with the functioning of automatic fiscal stabilisers, similar to those existing in some monetary unions, the emphasis is mainly in private financing.

The role that may be played by flows of capital in the process of adjustment and stabilisation has been highlighted by many authors.[4] It relies on the assumption that when capital is free to move across national borders it seeks the highest rates of return and, therefore, will probably leave areas where it is relatively abundant in search for those where it is relatively scarce. Although it may be

[1] The usual financial classification is followed here. Accordingly, short-term and long-term assets are those with up to, and more than, one year to maturity, respectively.
[2] See, for instance, European Commission (1990).
[3] See, among others, Allsopp and Vines (1998).

argued that short-term flows of capital are not able to provide more than short-run stabilisation of consumption in the aftermath of crises, long-term capital, considered the most productive from a social point of view, may create the necessary conditions for economic recovery. However, a necessary condition for the functioning of this type of adjustment and stabilisation mechanism is that capital movements are not restrained.

Capital mobility is usually assessed by means of tests of the CIP condition. The use of this interest rate parity to this end is justified by the fact that, when hedging for foreign exchange risk is available, and capital is free to flow across national borders, arbitrage operations should equalise covered nominal returns on assets that are issued in different currencies but are similar in every other aspect. Differences in these returns should not exist (and consequently CIP should hold) between countries that have already abolished institutional obstacles to the free flow of capital across their borders. These barriers, however, are not the only source of financial segmentation. The risk of their future implementation, the existence of information asymmetries and high transactions costs may have similar effects. Therefore, in spite of the process of EU financial integration, analyses of capital mobility in such geographical area are not without interest, especially if the focus is on the least explored aspects, as it is the case here. We find out that the mobility of long-term capital is generally high but, contrary to what could be expected *a priori*, a number of cases were found where investors appear to be disregarding arbitrage opportunities.

The contribution of this analysis for the empirical literature is twofold. On the one hand, the paper is developed using mainly data on interest rates with maturities higher than one year. To the best of our knowledge this approach was adopted in no more than five published papers, briefly reviewed below, being the pioneer work developed by Popper (1993). Such studies, however, did not investigate the EU economies. On the other hand, although cointegration techniques have been used before to test CIP, as far as we are aware, they were not adopted in assessments involving long-term data.

The paper is organised as follows: section 2 briefly reviews the CIP theorem and provides a survey of relevant empirical literature; section 3 presents the data and the econometric methodology; section 4 describes the tests of CIP; section 5 concludes.

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[4] Examples may be found *inter alia* in Ingram (1969), and Allsopp and Vines (1998).

2 - Covered Interest Parity

The CIP theorem states that when capital mobility is unrestricted, and mechanisms to cover foreign exchange risk are available, arbitrage operations equalise covered nominal returns on assets that are similar in all respects but currency of denomination. Since the ways to hedge foreign exchange risk are different for assets of different maturities, the formalisation of CIP also differs for short-term and long-term assets. For the former, forward contracts are usually employed, and the CIP condition is represented by:

$$(2.1) \qquad (1+i) = (1+i^*)\,\frac{F}{S}$$

where i is the nominal interest rate, S is the spot exchange rate expressed in terms of units of domestic currency per unit of foreign currency, F is the forward exchange rate, and a the asterisk distinguishes foreign variables.

Applying a logarithmic transformation and the approximation $log(1+z) \approx z$, usual in the financial literature when z is relatively small, the CIP condition becomes:

$$(2.2) \qquad i - i^* = f - s$$

where f and s are the natural logarithms of the forward and spot exchange rates, respectively.

Expression (2.2) is a common way of representing CIP and shows that, when the parity holds, the interest rate differential is approximately equal to the forward premium (or discount).

As shown by Poitras (1992), (2.1) may be extended to comprise long-term assets. In this case the CIP becomes:

$$(2.3) \qquad (1+i_m)^m = (1+i_m^*)^m\,\frac{F_m}{S}$$

where i_m is the m year nominal interest rate, and F_m is the m year forward contract.

However, the use of forward contracts to cover foreign exchange risk of long-term assets is relatively complicated. On the one hand, this type of investments usually generate interest payments at least once a year and, therefore, it would be necessary to cover both the initial investment and interest payments. This could be done by combining a long forward with a stream of short-term contracts. However, the market for long-term forward contracts is relatively illiquid. Despite the fact that it was possible to establish contracts of this kind since the 1960s, up until the 1980s the volumes traded were small, and the bid-ask spreads very high, by comparison with short-term forwards.[5] According to Taylor and Fraser (1991) this may result from the fact that the main agents involved in arbitrage activities (i.e., banks) prefer to operate with assets that do not tie up their credit limits for long periods of time. Such a preference would restrain liquidity and increase prices for long-term hedging instruments, therefore limiting the possibilities for arbitrage operations at the long end of the maturity spectrum. This situation was substantially changed in the first half of the 1980s, with the development of the swaps market which offers a simpler method of hedging longer term investments.[6]

Currency and interest rate swaps were created to exploit one type of information inefficiency which lead to the existence of different credit risk premia in different markets. They are built to mimic bonds and permit the exploitation of arbitrage margins in longer maturities, thus allowing empirical evaluations of CIP in the longer end of the maturity spectrum. The definition of a long-term CIP, based on swaps, is due to Popper (1993):

$$i_{t,t+m} = i^{*}_{t,t+m} + i^{sw}_{t,t+m} - i^{sw*}_{t,t+m} \qquad (2.4)$$

where $i_{t,t+m}$ and $i^{*}_{t,t+m}$ are the nominal returns on comparable domestic and foreign assets with *m* years to maturity, $i^{sw}_{t,t+m}$ is a fixed domestic currency interest rate received in an interest rate swap, and $i^{sw*}_{t,t+m}$ is a fixed foreign currency interest rate, paid in a currency swap.

[5] See Poitras (1992).

[6] Swaps are agreements between two (or more) agents to exchange flows of interest payments which may (or may not) be denominated in different currencies. The swaps contract is based on a certain amount of money and duration, usually referred to as principal and maturity, respectively. The most important types of swaps are currency and interest rate swaps. The former involves always at least two different currencies, and also exchange of principal and interest payments. The latter does not include exchange of principal, and the flows of interest are denominated in a common currency. In both swaps, the interest rates exchanged may be fixed or variable. If one fixed rate is exchanged for a floating rate, the swap is denominated as *vanilla swap*. If both rates are variable the designation changes to *basis swap*.

As with the above formalisation, expression (2.4) indicates that the verification of CIP requires the equalisation of the known fixed returns on similar domestic and foreign currency denominated assets, bonds for instance. Instead of covering foreign exchange risk by means of a forward contract, investors use the swaps market to convert the stream of fixed rate interest payments earned with the foreign bond, into fixed payments denominated in the domestic currency.[7] Since swaps dealers do not usually price swaps that allow the performance of this operation in one step, the conversion is established in two stages: first, the foreign currency fixed rate is converted into a domestic currency floating rate, by means of a currency swap that costs $i_{t,t+m}^{sw*}$. Then, the domestic currency floating rate is converted into a fixed rate by means of an interest rate swap, in which the investor receives $i_{t,t+m}^{sw}$ and pays the floating rate. The floating rates cancel out and the net return on the foreign investment is $i_{t,t+m}^{*} + i_{t,t+m}^{sw} - i_{t,t+m}^{sw*}$ which, according to the CIP condition, should be equal to $i_{t,t+m}$.

Despite the fact that empirical evaluations of short-term CIP are not informative of the mobility of capital in the long end of the maturity spectrum, and that this information is important for many economic questions, the large majority of tests of the parity is performed using short-term assets only. Attempts to justify this preponderance of short-term analyses have referred mainly the lack of liquidity in long-term forward markets. However, since the development of swaps markets in the 1980s, it is possible to exploit covered margins at all maturities, and the absence of long-term studies may only be related with difficulties to obtain the necessary data. In fact, historical series of currency swaps rates are only collected by major swaps agents, which very rarely make them available for academic research. Furthermore, these data are not collected in the form which is appropriate for CIP tests, and their preparation is made more difficult by the fact that the idiosyncrasies of swaps markets are often unknown in the academic world.[8]

Two main forms of tests may be found in the literature on short-term CIP. One consists of checking if the series of covered differentials are significantly different from zero; the other is based on regression analyses performed to evaluate the validity, on average, of the CIP condition. Tests of CIP which are based on series of covered differentials are very popular in the literature. Generally, these empirical assessments produce evidence supportive of the parity, especially in Euromarkets,

[7] The initial capital is also covered in the same operation, because currency swaps involve exchange of principal at the beginning and at the end of the contract, at a pre-established exchange rate.

where covered margins are often found to be insignificantly different from zero, thus attesting the high level of capital mobility in these markets.[9] When analyses involve onshore assets instead, the conclusions are not so straightforward, but remain generally supportive of the parity.[10]

Regression-based analyses consist of estimating the parameters of expressions such as:

$$(2.5) \qquad f_t - s_t = \alpha + \beta\left(i - i^*\right)_t + u_t$$

and then testing the null hypotheses $\hat{\alpha} = 0$ and $\hat{\beta} = 1$. Employing Ordinary Least Squares (OLS) to estimate (2.5), Fratianni and Wakeman (1982) do not accept these restrictions in all analysed cases but conclude in favour of CIP in the Euromarkets of five major European countries, from 1967 to 1978.

The development of new econometric techniques has permitted the performance of new, and sometimes more reliable,[11] tests of CIP. In recent years, most empirical examinations of the parity rely on cointegration techniques. As Moosa and Bhatti (1997) point out, 'cointegration seems to have resolved the controversy over the two widely used tests of the CIP theory: (i) testing, using the actual formula underlying the relationship, whether the raw deviations from CIP differ significantly from zero; and (ii) testing, using regression analysis, whether net deviations from CIP converge, on average, to zero'.[12] In fact, since the existence of cointegration between non-stationary variables requires that at least one linear combination of them is stationary, unit root tests may be used to test whether the residuals of regressions such as (2.5) are I(0). If this is the case, interest rates and foreign exchange rates are involved in a long-run[13] equilibrium relationship and do not tend to drift apart in the future. Some authors identify the existence of stationary covered margins with evidence of a strict or strong form of CIP, whereas if the variables of interest are cointegrated, but the

[8] The transformations that raw swaps data underwent before being appropriate to be used in empirical analyses of CIP are described in the Appendix..
[9] See, among others, Giavazzi and Pagano (1988) and Frankel (1993).
[10] See *inter alia* Aliber (1973), and Taylor (1987, 1989).
[11] The early tests of CIP based on OLS estimations did not take into account the possible non-stationarity of the underlying variables and, therefore, may have produced spurious results.
[12] Moosa and Bhatti (1997), p. 241.
[13] Henceforth we use the terms 'short-term' and 'long-term' in connection with assets maturities, and 'short-run' and 'long-run', when referring to periods of time.

parameters of the cointegrating regression do not respect the conditions $\hat{a} = 0$ and $\hat{b} = 1$, CIP is considered to hold in a weak form.[14]

Holmes and Pentecost (1996), test CIP using three-month Treasury Bill rates for five EU countries against Germany, from 1979 to 1992. Having split the sample in 1983, to allow the analysis of two sub-periods, they find evidence of cointegration only in the second, but even in this case the parameter restrictions are accepted only for the parity involving Belgian rates (*vis-à-vis* German ones).

An analysis of the stationarity of covered differentials based on unit root panel data tests, developed by Holmes and Wu (1997), shows that CIP holds better, in the main EU countries, in a period where capital controls were still in place, but foreign exchange markets were relatively calm, i.e., from 1983 to 1990, than in more recent years (from 1990 to 1996), with no capital controls but with foreign exchange turbulence. This result was confirmed by Holmes and Pentecost (1999), who evaluate the parity by means of stationarity tests on the first largest component of covered margins.

As noted before, the large majority of empirical tests of CIP are developed using short-term assets. To the best of our knowledge, only six published studies examine the validity of the parity for assets with maturities higher than one year and, among them, only one uses data on forward exchange rates. This is the case of Poitras (1992), who analysed series of covered differentials between US and Canadian public bonds with three-, five-, seven- and ten-year maturities, from July to December of 1990. He found out that all mean covered deviations were significantly different from zero and negative and, therefore, not in compliance with the parity.

Interest rate and currency swaps are the more adequate instruments to explore arbitrage opportunities in the longer end of the maturity spectrum[15] and, therefore, tests of CIP should reflect this reality. The pioneer work in this area was developed by Popper (1993), who defined the appropriate formulae,[16] and coined the expression 'swaps covered interest parity'.

Popper tests CIP in onshore and offshore markets, from 1985 to 1988. Her study involves assets with maturities of five and seven years, denominated in Canadian dollars, Deutschemarks, Japanese

[14] See Throop (1994), and Fountas and Wu (1999).
[15] See Fletcher and Beidleman (1991).

yen and Swiss francs, *vis-à-vis* the US dollar. As a benchmark for the tests of long-term CIP, the parity is also assessed for three-month onshore assets. Deviations from the parity are analysed using several variability measures and mean absolute deviations. In some cases, the latter are found to be smaller in long-term domestic markets than in Euromarkets. Popper explains this result in terms of the difficulty of evaluating the credit risk of Eurobonds. It is also discovered that, for some currencies, covered deviations are larger for short-term assets than for long-term ones. However, since none of the differentials is found to be statistically different from zero, the study concludes that CIP holds on both short-term and long-term markets.

Takezawa (1995) repeats the analysis of CIP developed by Popper, but for a longer time period (from 1988 to 1994) and a smaller number of currencies: only the parities involving the Deutschemark, the Japanese yen and the Sterling pound, against the US dollar, are considered. The author finds evidence of covered deviations which are significantly different from zero, from 1988 to 1990, but not in the second part of the sample, and concludes that financial integration in long-term markets improved in recent years.

Fletcher and Beidleman (1991), and Fletcher and Taylor (1994, 1996) analyse CIP, from 1985 to 1989, using data on assets with five-, seven- and ten-year maturities, denominated in the same currencies considered in Popper's work. The first and third studies are based on the estimation of Tobit models, whereas the second contains a non-parametric analysis of the series of covered differentials. All three produce evidence of many deviations from CIP which are statistically different from zero and, in some cases, persistent in time. Part of the deviations is justified in terms of transactions costs, but unexploited profit opportunities, especially in the longer maturities, are also reported.

As far as we are aware, an empirical investigation of the level of long-term capital mobility within EU countries was never developed, nor was long-term CIP evaluated using cointegration-based techniques. It is therefore by developing such a study that we intend to make a contribution to this area of the literature.

[16] (2.4) $i_{t,t+m} = i^{*}_{t,t+m} + i^{sw}_{t,t+m} - i^{sw*}_{t,t+m}$

3 - Data and Methodology

Although the main objective of the analysis is to test long-term versions of CIP, one short-term maturity is also tested and used as a benchmark. The parity has received considerable support in tests developed with short-term Eurorates and, consequently, these may be used to control the quality of our testing procedure and also as a means of comparison for the results of tests on long-term rates. Following the procedure that is common in short-term analyses of CIP in the EU, Germany is considered to be the domestic economy. The foreign countries that are analysed are: Belgium, France, Italy, the Netherlands and the United Kingdom (UK).

Short-term CIP is assessed using six-month rates of Eurodeposits in London denominated in Deutschemarks, Belgian and French francs, Italian lire, Dutch guilders and Sterling pounds. These are combined with spot and six-month forward rates of the Deutschemark against the other five currencies. The 'swaps covered' or long-term version of the parity is tested using redemption yields on Eurobonds and on benchmark government bonds with maturities of three, five, seven and ten years, denominated in the above mentioned six currencies.[17] All these data have weekly frequency and were collected from Datastream. Quotations for interest rate and currency swaps are also used. The former were supplied by DART and the latter result form our own calculations based on DART's rates.[18]

The analysis covers the period from October 1992 to December 1997, a time span dictated by currency swaps data availability. These quotations are rather difficult to obtain as they are collected only by the main swaps dealers who, very often, do not have long reliable historic series or, when they do, rarely make them available for academic research. However, though the period of analysis is restricted by the availability of data, it is convenient in that it permits the analysis of the period that followed the last major ERM crisis.

A number of details have to be taken into account before the data is ready to use in applied tests. One important issue is the fact that the conventions followed in bonds and swaps markets, in what concerns the frequency of fixed and floating payments, and the day-count basis, are not

[17] In the case of Eurobonds only five currencies are analysed as, according to information provided by the Central Bank of Belgium, there are no Eurobonds denominated in Belgian francs.

[18] DART stands for Data Analysis Risk Technology. DART is a member of the Intercapital group. The procedure followed to obtain the currency swaps rates is explained in the Appendix.

homogeneous across the sample of countries that is considered here. The UK and Belgian markets adopted different procedures, so that rates quoted in pounds or Belgian francs have to be transformed to conform with the ones quoted in Deutschemarks.

In Germany, France, Italy and the Netherlands, fixed payments are made annually and floating payments twice a year, while the fixed day count basis is *30/360* and the floating day count basis is *Actual/360*. In the UK both types of payments are made twice a year and the day count basis is *Actual/365*. This counting basis was also adopted by Belgium, for both fixed and floating payments, even though this country follows the other EU members in what concerns the periodicity of payments.

To make UK and Belgian data compatible, UK fixed rates had to be converted from semi-annual into annual using the methodology suggested by DART:

$$\left(1+\frac{Annual\ Yield}{100}\right)=\left(1+\frac{Semi-Annual\ Yield}{200}\right)^2$$

and both UK and Belgian rates had to be converted to a 360-day year count basis through multiplication by 360/365.

In the empirical testing that follows, a simplified representation of CIP is adopted:

$$(3.1) \qquad i_t^{c*} = i_t$$

This is a simple way of specifying the parity for all maturities, and states that, under CIP, the return on a domestic asset, i_t , has to equal the covered return on an identical asset denominated in a foreign currency, i_t^{c*} . When dealing with the short-term rates, i_t^{c*} is equal to $i_t^* + f_t - s_t$. For long-term assets, i_t^{c*} takes the form of $i_{t,t+m}^* + i_{t,t+m}^{sw} - i_{t,t+m}^{sw*}$.

The parity is tested by means of tests of restrictions on the estimated parameters of the following regression:

$$(3.2) \qquad i_t^{c*} = b_0^c + b_1^c\, i_t + m_t$$

where m_t is a Gaussian error term.

In order to conclude in favour of CIP, $\hat{b}_0^c$ and $\hat{b}_1^c$ may not be statistically different from zero and one, respectively. When this is not the case, the failure to accept CIP may be interpreted in terms of the information provided by the statistic tests. For example, the effect of factors preventing the exploitation of covered margins, such as transactions costs and administrative obstacles to the flow of capital across borders, may be captured by the intercept term. Country or political risk, defined as the probability of future government intervention in financial markets,[19] may also be depicted by a non-zero intercept. In fact, if investors anticipate that some type of capital controls is likely to be put in place, they may demand an extra premium on foreign investments, or may not exploit all the available profit opportunities for fear of not being able to recover the totality of applied funds. On the other hand, different tax rates on interest income and foreign exchange gains, unequal fiscal treatment of domestic and foreign investors in the same market, reserve requirements or other forms of financial regulations that do not prevent, but restrain, the free flow of capital, alter the slope of the parity line and thus may lead to estimates of b_1^c which are statistically different from one.[20]

The univariate properties of the series of variables involved in expression (3.2) are of uttermost importance for the estimation and testing routines. In fact, if i_t^{c*} and i_t are stationary, (3.2) may be estimated using traditional regression techniques, such as OLS, and the appropriate parameter restrictions may be tested through standard procedures. However, if one or the two series are non-stationary, the use of OLS may produce inefficient estimates, irrespective of the existence of cointegration between the variables, and the common t and F tests may be invalid. In this case, and when i_t^{c*} and i_t are integrated of the same order, the tests of CIP may be developed by means of cointegration-based analyses. We use Augmented Dickey-Fuller (ADF) unit root tests to assess the stationarity of the series of nominal and covered interest rates. When the null of non-stationarity is not rejected the study proceeds with the Johansen methodology to test the existence of cointegration between i_t^{c*} and i_t and, if this is the case, to estimate the cointegrating relationships.

[19] See Aliber (1973).

[20] Data imperfections may also produce $\hat{b}_1^c \neq 1$.

4 - Tests of the CIP condition

ADF tests are used to investigate whether the series of German nominal and foreign covered interest rates contain unit roots. When performing these tests we first consider the most general model, which contains intercept and a time trend. In the large majority of cases, however, the time trend comes out as statistically insignificant and the results are never qualitatively changed when the more complete framework is considered. Therefore, the results shown are only those obtained with a model containing intercept, but no time trend.[21] In the interest of brevity, only the outcomes of ADF tests performed on the variables in levels are reported, given that when the series in first differences are analysed the null hypothesis of non-stationarity is always clearly rejected.

Table 4.1 - ADF Unit Root Tests on Nominal and Covered Interest Rates (levels): 10/92 - 12/97

Maturity	G	B	F	I	N	UK
	Eurorates					
6 months	-3.0934** (0)	-3.0986** (5)	-2.9610** (3)	-3.2578** (7)	-3.1753** (5)	-2.9095** (5)
3 years	-2.0807 (1)	-	-1.9148 (0)	-1.8715 (2)	-1.9117 (1)	-2.0470 (0)
5 years	-1.4878 (1)	-	-1.2536 (0)	-1.8005 (1)	-1.5578 (1)	-1.4069 (0)
7 years	-0.9252 (0)	-	-0.8499 (0)	-2.1155 (1)	-1.1491 (0)	-1.0297 (0)
10 years	-0.9139 (0)	-	-1.2455 (0)	-1.2295 (0)	-1.0741 (0)	-0.8699 (0)
	Domestic Rates					
3 years	-1.9673 (0)	-1.6902 (0)	-1.9049 (0)	-1.9668 (0)	-2.1857 (0)	-1.5594 (0)
5 years	-1.6384 (0)	-1.4980 (1)	-1.3668 (0)	-0.9177 (1)	-1.5085 (0)	-1.3860 (0)
7 years	-1.1852 (0)	-1.0430 (0)	-1.1437 (0)	-0.0845 (1)	-1.3664 (0)	-0.9750 (0)
10 years	-1.1326 (0)	-1.0194 (0)	-0.9303 (0)	-0.9599 (0)	-1.7199 (0)	-0.9555 (0)

Series of German rates are nominal interest rates; the other countries' are covered interest rates. (*k*) is the lag length. ** Indicates rejection of the null hypothesis of non-stationarity at the 5% level of significance. Critical value: -2.8722.

Stationarity of i_t^{c*} and i_t is a necessary condition for employing OLS in the estimation of (3.2) but, according to the information presented in this table, such requirement is verified only for the series of short-term interest rates. In the latter case the assessment of the parity is developed by means of OLS estimation. On the other hand, the analysis of the interest rates that appear to be I(1) is developed within the cointegration context. Specifically, we use the multivariate methodology of Johansen and Juselius (1990) who propose maximum likelihood procedures, namely the Maximum Eigenvalue and Trace tests, to assess the existence of cointegrating vectors between i_t and i_t^{c*}. The results of these tests are shown in tables 4.2 and 4.3.

Table 4.2 - Cointegration Likelihood Ratio Tests on Long-term Eurorates: 10/92 - 12/97

	H_0	H_a	F	I	N	UK
3 years	**λ_{MAX} test**					
	r = 0	**r = 1**	18.23**	15.91**	27.66**	26.59**
	r ≤ 1	**r = 2**	6.73	6.30	6.50	5.56
	Trace test					
	r = 0	**r ≥ 1**	24.95**	22.21**	34.16**	32.16**
			(2)	(2)	(2)	(2)
5 years	**λ_{MAX} test**					
	r = 0	**r = 1**	15.35	22.29**	15.95**	15.90**
	r ≤ 1	**r = 2**	5.58	4.06	5.09	4.24
	Trace test					
	r = 0	**r ≥ 1**	20.93**	26.35**	20.63**	20.24**
			(2)	(2)	(2)	(2)
7 years	**λ_{MAX} test**					
	r = 0	**r = 1**	9.73	21.78**	24.70**	16.36**
	r ≤ 1	**r = 2**	3.16	2.84	4.54	6.00
	Trace test					
	r = 0	**r ≥ 1**	12.90	24.62**	29.23**	20.36**
			(2)	(2)	(1)	(3)
10 years	**λ_{MAX} test**					
	r = 0	**r = 1**	13.80	15.60	21.14**	16.82**
	r ≤ 1	**r = 2**	2.73	2.90	2.56	3.66
	Trace test					
	r = 0	**r ≥ 1**	16.53	18.50	23.70**	20.48**
			(1)	(1)	(1)	(1)

** Indicates rejection of the null hypothesis at the 5% level. (k) is the lag length.
Critical values → λ_{MAX} test - r = 0: 15.87, r ≤ 1: 9.16; Trace test - r = 0: 20.18.

When conflicting results appear between the Trace and the Maximum Eigenvalue tests, as in the Euro French five-year and the domestic Italian three-year rates against German's, we take as more relevant the information supplied by the latter test. This procedure is in accordance with Johansen and Juselius (1990) who note that the Trace test has lower power and is comparatively less reliable.

[21] The order of augmentation of the DF tests (k) is determined as follows: first the maximum order is defined as $T^{1/3}$; then the appropriate value is chosen using the SBC.

Table 4.3 - Cointegration Likelihood Ratio Tests on Long-term Domestic Rates: 10/92 - 12/97

	H_0	H_a	B	F	I	N	UK
	l_{MAX} test						
	r = 0	**r = 1**	22.77**	21.32**	14.15	19.95**	26.11**
3 years	**r £ 1**	**r = 2**	3.87	5.15	7.45	7.04	6.43
	Trace test						
	r = 0	**r ³ 1**	26.65**	26.47**	22.33**	26.99**	32.54**
			(1)	(3)	(3)	(2)	(3)
	l_{MAX} test						
	r = 0	**r = 1**	17.77**	26.54**	10.02	17.49**	15.96**
5 years	**r £ 1**	**r = 2**	3.14	5.31	5.92	4.43	5.35
	Trace test						
	r = 0	**r ³ 1**	20.92**	31.84**	15.94	21.92**	20.71**
			(1)	(1)	(3)	(4)	(2)
	l_{MAX} test						
	r = 0	**r = 1**	27.65**	12.77	9.45	20.28**	22.60**
7 years	**r £ 1**	**r = 2**	1.66	3.75	3.84	3.89	3.33
	Trace test						
	r = 0	**r ³ 1**	29.31**	16.52	13.30	24.17**	25.93**
			(2)	(2)	(2)	(2)	(2)
	l_{MAX} test						
	r = 0	**r = 1**	6.25	14.16	13.73	35.56**	35.98**
10 years	**r £ 1**	**r = 2**	1.65	2.67	3.52	3.19	3.26
	Trace test						
	r = 0	**r ³ 1**	7.89	16.83	17.26	38.74**	39.25**
			(1)	(5)	(3)	(2)	(2)

** Indicates rejection of the null hypothesis at the 5% level. (*k*) is the lag length.
Critical values → l_{MAX} test - r = 0: 15.87, r ≤ 1: 9.16; Trace test - r = 0: 20.18.

The main conclusion of the cointegration analysis is that a cointegrating relationship appears to exist, for all long-term maturities, both in domestic and Euromarkets, only between German and Dutch, and German and UK rates. The three remaining pairs of interest rates reveal failures in rejecting non-cointegration and, in the case of domestic Italian rates, this failure is generalised to all the analysed maturities. According to the classification followed by Throop (1994), and Fountas and Wu (1999), all the pairs of variables found to be cointegrated verify the weak form of CIP.

In relative terms, and taking into account that the pairs of Euro German and Belgian rates are not analysed, there appears to exist more cointegrating relationships in Euromarkets. In domestic ones the absence of cointegration affects only long-term returns on assets denominated in the currencies of those countries where fiscal problems were felt during the period of analysis. In Italy, the high public deficits and debt, combined with political instability[22] must have contributed to the results observed

[22] There were various changes of government in Italy between 1992 and 1997.

for domestic long-term interest rates. In the case of Belgian and French rates, the acceptance of the hypothesis of no cointegration for the longer maturities is also possibly related with the high rate of indebtedness of the Belgian state and with the failure of fiscal stabilisation in France, where attempts to diminish public debt and to control deficits were not successful. CIP can only be considered as a good measure of capital mobility if the assets used in empirical evaluations are perfectly comparable. It is very unlikely, however, that German investors consider the bonds issued by less 'disciplined' governments as being of the same risk class as domestic ones. Therefore, even though they may acquire these foreign bonds, as part of a strategy of portfolio diversification, higher risk premia are certainly demanded. In these circumstances, domestic nominal and foreign covered returns may behave in a non-coordinated way, and this is reflected in the results of cointegration tests.

The existence of cointegration between German nominal and foreign covered rates is a necessary, but not sufficient, condition for the verification of the strong form of covered parity. It means that these rates are connected by a long-run relationship. However, for CIP to be accepted in its strict form, the cointegrating vector has to respect the necessary conditions of zero intercept and unitary slope. The next step in this analysis is then to estimate the coefficients of the cointegrating vectors, for all the cases where the null of no cointegration was rejected, and to submit them to hypotheses testing. This is done by means of Johansen's methodology. In what the short-term maturity is concerned, the fact that both nominal and covered interest rates are stationary indicates that the parity may be tested by means of OLS estimation.

When i_t^{c*} and i_t are cointegrated, the following bivariate cointegrating vector in error-correction form may be defined:

$$\Delta i_t = \sum_{j=1}^{k-1} \phi_{1j}\, \Delta i_{t-j} + \sum_{j=1}^{k-1} \theta_{1j}\, \Delta i_{t-j}^{c*} - \alpha_1 \left(i_{t-1}^{c*} - \beta_0^c - \beta_1^c\, i_{t-1} \right) + \varepsilon_{1t}$$

(4.1)

$$\Delta i_t^{c*} = \sum_{j=1}^{k-1} \phi_{2j}\, \Delta i_{t-j} + \sum_{j=1}^{k-1} \theta_{2j}\, \Delta i_{t-j}^{c*} - \alpha_2 \left(i_{t-1}^{c*} - \beta_0^c - \beta_1^c\, i_{t-1} \right) + \varepsilon_{2t}$$

where a_1 and a_2 are speed of adjustment coefficients, and the cointegrating relationship between i_t^{c*} and i_t is expressed in the cointegrating vector: $i_{t-1}^{c*} - b_0^c - b_1^c \, i_{t-1}$.

Table 4.4 presents OLS estimates of the parameters of regression (3.2) for six-month rates, maximum likelihood estimates of the restricted cointegrating vectors defined in model (4.1) for the longer term maturities, and tests of the adequate restrictions on all estimated parameters.

Table 4.4 - Estimates of CIP parameters and tests of the appropriate restrictions: $\hat{b}_0^c = 0$ and $\hat{b}_1^c = 1$.

	B		F		I		N		UK	
	$\hat{b}_o^c$	$\hat{b}_1^c$	$\hat{b}_o^c$	$\hat{b}_1^c$	$\hat{b}_o^c$	$\hat{b}_1^c$	$\hat{b}_o^c$	$\hat{b}_1^c$	$\hat{b}_o^c$	$\hat{b}_1^c$
	Eurorates									
6 mth	0.0008 (2.96*)	0.9825 (0.83)	-0.0001 (0.02)	1.0011 (0.01)	0.0001 (0.02)	1.0227 (0.86)	0.0002 (1.49)	0.9918 (1.13)	0.0011 (8.82**)	0.9703 (3.94**)
3 ys	-	-	-0.0024 (2.35)	1.0514 (2.89*)	-0.0211 (7.31**)	1.5250 (8.42**)	-0.0085 (18.7***)	1.1803 (19.1***)	-0.0002 (0.02)	1.0145 (0.28)
5 ys	-	-	-	-	-0.0170 (6.63**)	1.3868 (9.69**)	-0.0079 (6.24**)	1.1556 (7.29**)	0.0050 (1.96)	0.9034 (2.22)
7 ys	-	-	-	-	-0.0444 (10.9**)	1.8478 (13.0***)	0.0023 (0.51)	0.9837 (0.10)	0.0137 (7.96**)	0.7663 (7.96**)
10 ys	-	-	-	-	-	-	-0.0134 (6.24**)	1.2367 (7.86**)	-0.0075 (2.31)	1.1017 (1.98)
	Domestic Rates									
3 ys	0.0043 (1.72)	0.9092 (2.01)	0.0011 (0.47)	1.0098 (0.09)	-	-	-0.0006 (0.04)	1.0370 (0.53)	0.0045 (11.7**)	0.9402 (7.21*)
5 ys	0.0049 (0.39)	0.8984 (0.55)	0.0005 (0.47)	1.0202 (0.25)	-	-	-0.0015 (0.53)	1.0503 (1.66)	0.0003 (0.01)	1.0209 (0.15)
7 ys	0.0001 (0.01)	1.0042 (0.04)	-	-	-	-	-0.0011 (0.26)	1.0548 (2.12)	0.0026 (1.89)	0.9844 (0.28)
10 ys	-	-	-	-	-	-	-0.0007 (0.27)	1.0308 (2.21)	-0.0013 (0.44)	1.0394 (1.75)

The values in brackets are the χ^2 statistics for the tests of the restrictions: $\hat{b}_0^c = 0$ and $\hat{b}_1^c = 1$.
***, ** and * indicate rejection of the null hypotheses at the 1%, 5% and 10% levels.

Our analysis of short-term CIP is generally supportive of the parity, as expected. All parameter estimates are close to the values of zero and one (respectively for $\hat{b}_0^c$ and $\hat{b}_1^c$) and, with the exception of the parity involving Sterling pound rates, the hypotheses of zero intercept and unitary slope in the CIP regression, are not rejected at the 5% level. For long-term rates, the parameter estimates are also similar to the values indicated by theory, in both domestic and Euromarkets. However, the number of rejections of parameter restrictions is much higher in Euromarkets than in domestic ones. With the exception of Italian government bonds, for which no evidence of cointegration with German bonds could be found, all remaining results are more supportive of CIP in domestic markets than in Euromarkets, thus suggesting that the level of capital mobility is higher in the former. Popper (1993), who also found relatively better results in domestic markets, refers that these results may reflect the higher degree of difficulty in assessing credit risk in Euromarkets. Another possible explanation is related to the better quality of domestic data by comparison with Euromarkets data. In fact, although all redemption yields are collected from Datastream, domestic quotations are from individual benchmark government bonds, and Eurobond yields are derived from yield curves built by Datastream. It is therefore likely that the failure of the strong form of CIP in Euromarkets is due to the lack of comparability between the underlying assets. However, the fact that other empirical assessments have obtained qualitatively identical results make us believe that the former justification is more credible than that of data inadequacy.

Using the results of tests on short-term CIP as a benchmark, it may be concluded that long-term capital is perfectly mobile only between Dutch and German domestic markets. In the case of the UK, capital mobility appears to be higher for long-term domestic capital than for any of the remaining types analysed here. The other countries display failures of the weak form of long-term CIP, in both domestic and Euromarkets, and this may be interpreted as evidence of imperfect capital mobility. Where the weak form of the parity may not be rejected, domestic markets produce relatively more examples of compliance with the strong form of CIP than Euromarkets. In the latter case, the parameters' restrictions are practically always rejected.

5 - Conclusions

The CIP condition is empirically tested with the objective of evaluating the degree of capital mobility between Germany and five EU countries. The parity is analysed for one short-term maturity (six-month rates) and four long-term maturities (three-, five-, seven- and ten-year rates), from October 1992 to December 1997. This analysis, not previously developed within the EU, is of practical interest given the importance of integrated financial markets for the smooth functioning of both monetary and economic integration.

It is nowadays well established that short-term capital is relatively mobile, especially in Euromarkets. Our own tests are supportive of this fact. In what respects long-term rates, however, a number of failures of the parity, both in its weak and strong forms, are reported here. Specifically, CIP fails for some maturities of French and Italian rates, offshore, and for all Italian rates and the longer maturities of Belgian and French rates, onshore. In the remaining cases the strong form of the parity is generally accepted in domestic markets, but often rejected in Euromarkets.

The level of capital mobility prevailing within a group of countries indicates the ease with which funds may be transferred, for instance to take advantage of arbitrage opportunities. Our analysis indicates that, as of October 1992, no significant obstacles prevent the free flow of short-term capital between Germany and the major EU countries. In long-term markets, however, perceived differences in the quality of domestic and foreign debt appear to still be able to drive wedges between the German and the Belgian, French and Italian markets. This factor, which affects mainly the mobility of longer-term funds, may persist in a complete monetary union. This will probably occur if sovereign debtors fail to comply with what is established in the Stability and Growth Pact, or if information inefficiencies make the evaluation of the risk of foreign debt difficult for domestic investors. Consequently, despite the fact that no institutional barriers restrain the movements of capital within the EU, the less disciplined debtors may find it difficult to attract long-term funds, even in the absence of foreign exchange rate risk.

APPENDIX:

The data set supplied by DART contains series of rates on basis currency swaps involving the BF, DM, FF, ITL, NLG and £, against the US$ (different currencies floating rates, against flat US$ LIBOR), and rates on *vanilla* interest rate swaps denominated in the same currencies. Therefore, in order to obtain the series which are appropriate for our study, two main transformations are applied to DART's quotations. First, US$ currency basis swaps are converted into DM currency basis swaps. Then, these DM quotations are combined with interest rate swaps denominated in each of the foreign currencies, to obtain *vanilla* currency swaps quoted against DM floating rate.

The method used in the first of these two steps (converting US$ currency basis swaps into DM currency basis swaps) is described using, as an example, the following table of quotations:[23]

	CHF/	DM/	FF/	ECU/	JPY/
US$	1 / 1.75	2 / 2.5	1 / 2	-1.75 / -0.5	-9 / -7
CHF	-	0.25 / 1.5	-0.75 / 1	-3.5 / -1.5	-10.75 / -8
DM	-1.5 / -0.25	-	-1.5 / 0	-4.25 / -2.5	-11.5 / -9
FF	-1 / 0.75	0 / 1.5	-	-3.75 / -1.5	-11 / -8
ECU	1.5 / 3.5	2.5 / 4.25	1.5 / 3.75	-	-8.5 / -5.25
JPY	8 / 10.75	9 / 11.5	8 / 11	5.25 / 8.5	-

The table contains ask and bid rates for currency basis swaps. The first line shows quotations for swaps involving the Swiss franc (CHF), the DM, the FF, the ECU and the Japanese yen (JPY) against flat US$ LIBOR. For instance, the numbers 1 / 1.75, which appear in the first square, indicate that Tradition S.A. is willing to pay CHF LIBOR plus 1 basis point (ask rate) against receiving US$ flat, and to receive CHF LIBOR plus 1.75 basis points (bid rate) against paying US$ LIBOR flat.[24] The remaining quotations, which do not involve the US$, are obtained using the values in the first line.

Having the quotes for CHF/US$ and for DM/US$ basis swaps we may obtain CHF/DM rates. The ask rate for the CHF/DM swap (third square in the first column) is the difference between the ask rate on the CHF/US$ swap and the bid rate on the DM/US$ swap, whereas the bid rate for the CHF/DM swap is obtained by subtracting the bid rate on the CHF/US$ swap from the ask rate on the DM/US$ swap:

$$\text{CHF/US\$ swap} \rightarrow \text{ask rate} = 1; \text{bid rate} = 1.75$$

[23] This table was published in Tradition S.A.'s Internet homepage, on the 4th of November 1997.
[24] The convention in swap market is to quote basis swaps as the spread added to one currency LIBOR, in exchange for flat LIBOR in other currency (see Iben (1991)).

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DM/US$ swap → bid rate = 2.5; ask rate = 2

=

CHF/DM swap → ask rate = -1.5; bid rate = -0.25

In the sample of data supplied by DART we have bid and ask rates for currency basis swaps involving each of the currencies used in our study, against the US$ (DM/US$, BF/US$, FF/US$, ITL/US$, NLG/US$ and £/US$). Therefore, the bid and ask rates of the necessary currency swaps (BF/DM, FF/DM, ITL/DM, NLG/DM and £/DM) are obtained using the procedure described above. For the case of the FF, we have:

FF/DM basis currency swap (bid rate) = FF/US$ basis currency swap (bid rate) - DM/US$ basis currency swap (ask rate)

and

FF/DM basis currency swap (ask rate) = FF/US$ basis currency swap (ask rate) - DM/US$ basis currency swap (bid rate).

Having the quotes for currency basis swaps against the DM, we combine them with interest rate swaps denominated in each of the five foreign currencies, in order to obtain *vanilla* currency swaps (fix-to-floating). As referred before, *vanilla* currency swaps permit the conversion of foreign currency fixed interest rates into domestic currency floating rates.[25]

Continuing with the FF/DM example, we have:

[25] Therefore, the quotations on *vanilla* currency swaps involving DM floating rates against each of the other countries fixed rates provide the necessary data for the variable $i_{t,t+m}^{sw*}$. Data for $i_{t,t+m}^{sw}$, i.e., quotes on DM interest rate swaps are directly available.

FF/DM *vanilla* currency swap (bid rate) = FF interest rate swap (bid rate) + FF/DM basis currency swap (bid rate)

and

FF/DM *vanilla* currency swap (ask rate) = FF interest rate swap (ask rate) + FF/DM basis currency swap (ask rate).

If the quotations are, for instance, FF interest rate swap - bid rate: 5.51%, ask rate: 5.47%, and FF/DM basis currency swap - bid rate: 2.5 b.p., ask rate: -3 b.p., then for the FF/DM *vanilla* currency swap the bid rate would be 5.535% and the ask rate 5.44%.

With the above quotations, if the redemption yields on German and French government bonds of identical maturities are, respectively, 6% and 5%, for the CIP condition to hold, the ask rate of the appropriate DM *vanilla* interest rate swap would have to be equal to 6.44%. This rate ensures that, for a German investor, there is no difference between investing in a German bond and earning 6%, or investing in a French bond, converting the French fixed rate into a floating DM rate, via the currency swap, and finally converting the DM floating rate into a DM fixed rate, via an interest rate swap. In these swap transactions the investor first pays FF 5.44% and receives flat DM LIBOR (currency swap) and then pays flat DM LIBOR and receives DM 6.44%. Since the floating rates cancel out, the final return is 5% - 5.44% + 6.44%, i.e. 6%.

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