Financial Integration in Europe: Evidence from Euler Equation Tests

Jan J.G. Lemmen and Sylvester C.W. Eijffinger*

Department of Economics and CentER
Tilburg University
P.O. Box 90153
5000 LE Tilburg
The Netherlands

April, 1995

Abstract

This paper applies Obstfeld's Euler equation tests to assess the degree of financial integration in the European Union. In addition, we design a new Euler equation test which is intimately related to Obstfeld's Euler equation tests. Using data from the latest Penn World Table (Mark 6), we arrive at the following ranking of financial integration in the European Union: low integration (Greece and Portugal) intermediate (Austria, Denmark, Finland, France, Ireland, Italy, Spain and Sweden) and high (Belgium, Germany, the Netherlands and the United Kingdom). Furthermore, it appears that there is still significant room for risk diversification among European Union countries.

Keywords: Euler equation, consumption, financial integration, European Union.

Jel Classification: C12, D12, G15.

---

* The first author is at the Department of Economics and CentER for Economic Research of Tilburg University, P.O. Box 90153, 5000 LE Tilburg, The Netherlands, E-mail: J.J.G.Lemmen@kub.nl. The second author is at the Department of Economics, CentER for Economic Research of Tilburg University and the College of Europe. We thank Bas van Aarle, Harry Huizinga, Frans de Roon and Harald Uhlig for helpful comments. Furthermore, we thank Eric Canton and Henri de Groot for providing the Summers-Heston data (Penn World Table, Mark 6). Remaining errors are our own responsibility.

1 Introduction

This paper contributes to the ongoing debate on the theory and measurement of capital mobility and financial integration. Feldstein and Horioka (1980), Feldstein (1983) and Lemmen and Eijffinger (1995) apply savings-investment correlations to assess the degree of financial integration. Alternatively, Frankel and MacArthur (1988) and Eijffinger and Lemmen (1995) calculate differentials from covered, uncovered and real interest rate parity to assess the degree of financial integration.[1] Recently, Obstfeld (1986, 1989) proposes a third test to assess the degree of financial integration. Obstfeld's test is based upon the *Euler equation* that characterises optimal intertemporal consumption and investment of a representative consumer/investor. The test attempts to detect whether residents of different political jurisdictions have access to the same risk-free asset. Obstfeld's (1994a, 1994b) test of financial integration assumes both trade in risk-free and risky assets. Countries' consumption growth rates should be perfectly correlated across markets. Brennan and Solnik (1989, p. 360) argue: "In particular, capital account transactions may contribute to the international sharing of consumption risks, they permit individual countries to smooth consumption over time, by issuing claims to overcome transient shortfalls in domestic output or transient increases in domestic investment. This consumption smoothing aspect is strongly related to the holding of internationally diversified portfolios." Similarly, Bayoumi and McDonald (1994, p. 1) argue: "By allowing countries to borrow and lend money efficiently, open capital markets can provide the same services across countries that they provide within a single economy, allowing more efficient use of funds for investment and improving the allocation of consumption over time." Unlike arbitrage tests, Euler equation tests avoid the problems associated with the definition and measurement of interest rates and the endoqeneity of savings and investment.

The plan of the paper is as follows. In section 2, following Obstfeld (1986, 1989) and Obsfeld (1994a, 1994b), we review the simple representative consumer model to derive the Euler equation tests of financial integration. Subsequently, we design a new Euler equation test of financial integration, which is intimately related to Obstfeld's Euler equation tests. Furthermore, we present the associated econometric framework to assess the degree of financial integration in the European Union (EU). Section 3 presents the results. Using data from the latest Penn World Table (Mark 6), we arrive at the following ranking of financial integration in the European Union: low integration (Greece, Portugal and Spain), intermediate (Denmark, France, Ireland, Italy) and high (Belgium, Germany, the Netherlands and the United Kingdom). Section 4 evaluates the Euler equation test of financial integration. Finally, section 5 concludes the paper.

[1] Note that the concept of capital mobility analysed with saving-investment correlations may differ from the concept of capital mobility analysed with interest parity conditions. Covered and uncovered interest parity conditions analyse the integration of financial markets, while real interest parity and saving-investment correlations analyse the integration of financial, goods, services and factor markets (see Lemmen and Eijffinger, 1995). Obstfeld's Euler equation tests are intimitatedly related to the Feldstein-Horioka test of financial integration. Countries with a lower preference for the present could shift their consumption into the future through current account surplusses, while countries with higher preference for the present could shift their consumption patterns towards the present through debt accumulation.

2 Theory

This paper first applies Obstfeld's (1986, 1989) Euler equation test to assess the degree of financial integration in the EU.[2] The idea of this test is essentially as follows. Usual intertemporal utility maximization gives rise to the Lucas (1978) asset pricing equation or Euler equation[3],

$$1 = E_t [R_{t+1} m_{t+1}] \tag{1}$$

where R_{t+1} is the real return on some traded asset between time t and t+1, and m_{t+1} is the marginal rate of intertemporal substitution of future and current consumption of any consumer participating in this market, usually given by

$$m_{t+1} = \beta \frac{U_c(C_{t+1})}{U_c(C_t)} \tag{2}$$

for some instantaneous utility function U(C) and some discount factor $\beta < 1$.

Consider two countries, a home country (no star) and a foreign country (star). Further, consider a nominal bond, denominated in the home currency, paying a nominal interest rate of i_{t+1} known at date t. Let P_t, P^*_t denote price levels and S_t the exchange rate. Then,

$$R_{t+1} = (1 + i_{t+1}) \frac{P_t}{P_{t+1}} \tag{3}$$

or

$$R_{t+1} = (1 + i_{t+1}) \frac{P_t^*}{P^*_{t+1}} \frac{S_t}{S_{t+1}} \tag{4}$$

by definition of S_t. Define

$$\eta_{t+1} = \frac{P_t}{P_{t+1}} m_{t+1} - \frac{S_t}{S_{t+1}} \frac{P_t^*}{P^*_{t+1}} m^*_{t+1} \,. \tag{5}$$

Then the Euler equation implies that

---

[2] The paper implicitly assumes that there exists only one consumption good in the world although the analysis could equally well be performed with a vector of consumption goods.

[3] A key characteristic of the Lucas (1978) asset pricing model is that it assumes *complete frictionless markets*.

$$E_t[(1+i_{t+1})\eta_{t+1}] = 0 \tag{6}$$

and hence

$$E_t[\eta_{t+1}] = 0 \tag{7}$$

since i_{t+1} is known at date t. Assuming, a convenient utility function which takes the particular form[4]

$$U(C) = \frac{C^{1-\alpha} - 1}{1-\alpha} \qquad \alpha \geq 0 \tag{8}$$

where α is the relative risk-aversion coefficient. Taking C_t and C_t^* to be aggregate consumption in the home and foreign country (the representative agent assumption), one can write m_{t+1} as[5]

$$m_{t+1} = \beta\left(\frac{c_{t+1}}{c_t}\right)^{-\alpha} \tag{9}$$

and likewise for m_{t+1}^*. Thus, the restriction $E_t(\eta_{t+1})=0$ becomes testable. Assuming the asset to be the risk-free asset ($E_tR_{t+1}=R_{t+1}$) and rational expectations, the degree of financial integration can be tested as follows:

$$\eta_t = \gamma_0 + \sum_{i=1}^{N} \gamma_i \eta_{t-i} + v_t \tag{10}$$

Perfect financial integration with respect to the risk-free asset in the home country implies:

$$H_0: \ \gamma_0 = 0 \quad \wedge \quad \gamma_i = 0 \qquad i = 1, \ldots, N \tag{11}$$

Condition (11) states that η_t must be orthogonal to lagged information available represented by η_{t-i}, $E(\eta_t|\eta_{t-i})=0$. No variable contained in the information set available prior to time t should help to predict the time t value of η.

One can go a step further. Capital mobility allows countries to trade differential consumption risks. That

---

[4] If $\alpha=0$ utility is linear in consumption and the consumers are indifferent between receiving c for sure and having a pattern of consumption across states with expected value c. Consumers are said to be risk neutral. If $\alpha>0$ consumers always prefer the sure thing since it yields higher utility. Now, consumers are said to be risk-averse. The Arrow-Pratt measure of relative risk aversion is defined as:

$$-\frac{\partial^2 U(C)}{\partial U(C)} = \alpha \frac{C^{-\alpha-1}}{C^{-\alpha}} = \frac{\alpha}{C} > 0$$

The constant relative risk aversion (CARA) power utility function is the usual utility function used in consumption-based or utility based intertemporal asset pricing models. The virtue of the CARA power utility function is its simplicity, and therefore it is well suited for our benchmark test of financial integration. Section 4 addresses some caveats this utility function.

[5] Since for this utility function marginal utility is given by $C^{-\alpha}$.

is, internatioal financial markets provide mutual insurance against purely idiosyncratic national consumption fluctuations. The insurance function of financial markets is best analysed by assuming that countries trade a set of Arrow-Debreu securities.[6] To that end, assume that there are finitely many states of the world. Let the state at date t be denoted by x_t and assume further, that x_t follows a Markov process (i.e. the probability $\pi(x_t,x_{t+1})$ for a particular state x_{t+1} to occur at date t+1 depends solely on x_t) with $\pi(x_t,x_{t+1})>0$ for all x_t,x_{t+1}. Marginal rates of substitution become a function of the states x_t and x_{t+1}

$$m_{t+1} = m(x_t, x_{t+1}) \tag{12}$$

and the same holds true for returns. As a result, the Euler equation can be written as

$$1 = E[\boldsymbol{R}(x_t, x_{t+1})\, m(x_t, x_{t+1}) \mid x_t = x] \tag{13}$$

$$= \Sigma_{x_{t+1}} \pi(x, x_{t+1})\, \boldsymbol{R}(x, x_{t+1})\, m(x, x_{t+1}) \tag{14}$$

for all states x. Now assume (and that is a "big" assumption) that at date t, all state-contingent securities are actually traded.[7] Thus, for any state x', there is a security which pays one unit of the consumption good, should the state $x_{t+1}=x'$ be realized, and nothing in all other states, $x_{t+1}\neq x'$. This security will be exchanged for a certain amount $q_t(x')$ of the consumption good at date t and its return is given by

$$\boldsymbol{R}(s_{t+1}) = \begin{cases} \dfrac{1}{\boldsymbol{q}_t(x')} & \textit{if} \quad x = x_{t+1}, \\ 0 & \textit{else} \end{cases} \tag{15}$$

Substituting this into the Euler equation above yields that

$$1 = \frac{\pi(x, x')}{\boldsymbol{q}_t(x')}\, m(x, x') \tag{16}$$

Thus for two different consumers i and j, say, one gets that

$$m_i(x, x') = m_j(x, x') \tag{17}$$

for all states of the world x and x'. In other words, if insurance against any state of the world is traded on the financial market (perfect financial integration), then one gets the strong result that marginal rates

[6] Assets are characterized by non-negative payoffs they generate in different states. The payoff is in terms of a consumption good (here one consumption good). See for example Eichberger and Harper, Chapter 3, (1993), Aiyagari (1993) and Obstfeld (1994a, 1994b).

[7] Individuals do not face transaction costs, borrowing or short-sale constraints and all claims are always fulfilled, that is, there is no default and bankruptcy (Aiyagari, 1993, p. 19).

of substitution of different consumers must be perfectly correlated. In particular, if there is a representative agent in each country and instantaneous utility is given by equation (8), then one finds that under perfect financial integration in the sense of trading in all possible insurance contracts, consumption growth must be perfectly correlated across countries.

Obsfeld (1994a, p. 8) argues: "In general, the implication of an efficient allocation of consumption risks is that *countries' marginal utilities of consumption are perfectly correlated across states of nature*." This argument holds if there is free and costless international asset trade, and that the set of securities available is complete, so that all consumption risks are insurable."[8] Accordingly, Obstfeld's (1994a, 1994b) Euler equation test is a joint test of *perfect* financial integration and *complete* financial markets. Even under perfect capital mobility, there thus may be no close *ex post* co-movement of national consumption growth rates. Therefore, Obstfeld's (1994a, 1994b) test of financial integration is essentially a benchmark test of perfect financial integration. Highly correlated consumption growth rates should *indicate* increasing international financial integration.[9] Obstfeld's (1986, 1989) Euler equation test of financial integration is confined to a particular segment of the bond market, i.e. trade in *risk-free* assets, while Obstfeld's (1994a, 1994b) Euler equation test of financial integration applies to both trade in *risk-free* and *risky* assets. Obstfeld's (1986, 1989) test of financial integration focuses specifically on the ability of residents in different political jurisdictions to trade the same asset on the same terms.[10]

Also our Euler equation test follows from the intricate argument about perfect insurance and trading in state-contingent claims. This new test is intimately related to Obstfeld's (1994a, 1994b) Euler equation test. Consider two countries, a home country (no star) and a foreign country (star) each issuing their own country-specific nominal bond. The nominal bond, denominated in the home currency, pays a nominal interest rate of i_{t+1} known at date t, and the nominal bond denominated in the foreign currency pays a nominal interest rate of i^*_{t+1}. Again, let P_t and P^*_t denote price levels. Then,

$$R_{t+1} = (1 + i_{t+1}) \frac{P_t}{P_{t+1}} \tag{18}$$

and

$$R^*_{t+1} = (1 + i^*_{t+1}) \frac{P^*_t}{P^*_{t+1}} \tag{19}$$

Then, for simplicity omitting the variables denoting the different states of the world, one gets that

8 A set of Arrow-Debreu securities is said to be complete if there are exactly as many securities as there are states of nature.

9 Cochrane and Hansen (1992, p. 118) argue: "[...] a better understanding of the implications of asset market data viewed through the frictionless markets paradigm is valuable (and perhaps necessary) precursor to assessing the importance of financial market imperfections."

10 Generally, however, the real return of domestic and foreign assets will differ. Our new Euler equation test of financial integration will take this aspect into account.

$$E_t[m_{t+1} R_{t+1}] = E_t[m^*_{t+1} R^*_{t+1}] \tag{20}$$

Again assuming that domestic and foreign representative consumers apply the same constant relative risk aversion (CARA) utility function:

$$E_t[\beta(\frac{C_{t+1}}{C_t})^{-\alpha} R_{t+1}] = E_t[\beta^*(\frac{C^*_{t+1}}{C^*_t})^{-\alpha^*} R^*_{t+1}] \tag{21}$$

then, taking logarithms of both sides in equation (21) and writing out the covariances yields:

$$E_t[-\alpha(c_{t+1} - c_t) + \log\beta + r_{t+1}] + \frac{1}{2} VAR[-\alpha(c_{t+1} - c_t) + \log\beta + r_{t+1}] =$$

$$E_t[-\alpha^*(c^*_{t+1} - c^*_t) + \log\beta^* + r^*_{t+1}] + \frac{1}{2} VAR[-\alpha^*(c^*_{t+1} - c^*_t) + \log\beta^* + r^*_{t+1}] \tag{22}$$

where lower-case variables represent logarithms, thus $\log(C_{t+1})=c_{t+1}$, $\log(C^*_{t+1})=c^*_{t+1}$, $\log(R_{t+1})=r_{t+1}$ and $\log(R^*_{t+1})=r^*_{t+1}$. Hence

$$-\alpha E_t[\Delta c_{t+1}] + E_t[r_{t+1}] + \frac{1}{2} VAR[-\alpha(c_{t+1} - c_t) + \log\beta + r_{t+1}] + \log\beta =$$

$$-\alpha^* E_t[\Delta c^*_{t+1}] + E_t[r^*_{t+1}] + \frac{1}{2} VAR[-\alpha^*(c^*_{t+1} - c^*_t) + Log\beta^* + r^*_{t+1}] + Log\beta^* \tag{23}$$

leads to

$$E_t[r_{t+1} - r^*_{t+1}] = \frac{1}{2} VAR[-\alpha^*(c^*_{t+1} - c^*_t) + \log\beta^* + r^*_{t+1}] - \frac{1}{2} VAR[-\alpha(c_{t+1} - c_t) + \log\beta + r_{t+1}] +$$

$$\log\beta^* - \log\beta + \alpha E_t[\Delta c_{t+1}] - \alpha^* E_t[\Delta c^*_{t+1}] \tag{24}$$

where $E_t r_{t+1}$ and $E_t r^*_{t+1}$ are the logarithms of the expected real return on some traded asset in the home and the foreign country and $E_t(\Delta C_{t+1})$ and $E_t(\Delta C^*_{tt+1})$ are expected (per-capita) consumption growth rates in the home and foreign country.

Equation (24) should hold for any asset.[11] Clearly, the real return differential depends on the value of β=1/1+ρ (negatively) and β^*=1/1+ρ^* (positively) where ρ and ρ^* are the domestic and foreign utility discount factor, (per capita) consumption growth in the home country (positively), per capita consumption growth in the foreign country (negatively), the variance of home country-specific factors (negatively) and the variance of foreign country-specific factors (positively).

For example, the reason for the negative dependence on α is the following (see Aiyagari, 1993, p. 21). For a give growth rate of per-capita consumption, the lower α (the higher ρ, i.e. the more heavily individuals discount the future), the greater individuals' preferences for current consumption over future consumption. Therefore, the interest rate in the home country must be higher to make people accept the given growth rate and not borrow to have more current consumption. The reason for the positive dependence on the (per-capita) consumption growth rate in the domestic country is the following. For a given α, the higher the growth rate of consumption, the higher is future consumption relative to current consumption. Therefore, the higher the interest rate must be to prevent people from trying to borrow in order to convert future consumption into current consumption. The reason for the negative depends on the variance in home country-specific factors is the following. When there is uncertainty regarding the future, individuals typically attempt to save more. This increases lending and lowers the interest rate. The effect of the risk-aversion coefficient α is ambiguous. For small values of α, the positive effect of the per-capita consumption growth dominates the negative effect of the variance in home country-specific factors. Hence, lower values of α raise the expected return differential while higher values of α lower the expected return differential.

Since cross-border capital mobility will be limited if risk-averse consumers are not rewarded for the risk they take, it is important to analyse the determinants of the risk-premium of a risky asst. Following Aiyagari (1993), a risk averse consumer will demand a risk premium if an asset yields high returns when consumption is high and low returns when consumption is low. Such an asset tends to exacerbate consumption variability relative to the risk-free asset. Consequently, risk averse consumers will demand a positive risk-premium for holding such an asset, its expected return has to be higher than the risk-free rate. The risk premium defined as the expected return of the risky asset less the return of the risk-free asset depends on how the pattern of returns of the risky asset covaries with consumption. That is, by combining the expression for the risky asset from equation (1)

$$\beta^{-1} = E_t [R_{t+1} (C_{t+1} / C_t)^{-\alpha}] \tag{25}$$

and the expression for the risk-free asset from equation (1)

$$R_{t+1}^{risk-free} = \frac{\beta^{-1}}{E_t (C_{t+1} / C_t)^{-\alpha}} \tag{26}$$

[11] Since the interest rates paid on straight bonds are non-stochastic, contrary to the returns on bond and stock indices, they may be placed outside the conditional expectations operator.

and applying the utility function in equation (8) we arrive at the following expression of the risk-premium[12]

$$E(R_{t+1}) - R_{t+1}^{risk\text{-}free} = \frac{-cov(R_{t+1}, X)}{E(X)} \tag{27}$$

where $X=E(C_{t+1}/C_{t+1})^{-\alpha}$. In logarithms equation (27) is

$$E(r_{t+1}) - r_{t+1}^{risk\text{-}free} = -\alpha\,[cov(r_{t+1}, \log(C_{t+1}/C_t))] \tag{28}$$

Equation (28) shows that if an asset's return is positively correlated with consumption growth, so cov(r,X) is negative, then the risk-averse consumers will demand a positive risk premium.[13]

Financial integration may be tested as follows. Assuming rational expectations, thus replacing the expectation with realizations leads to the following regression model

$$r_{t+1} - r^{*}_{t+1} = constant + \alpha\,[\Delta C_{t+1}] - \alpha^{*}\,[\Delta C^{*}_{t+1}] + \epsilon_{t+1} \tag{29}$$

where the constant entails the difference between the variance terms and the β's. Financial markets are perfectly integrated when no information prior to time t+1, may help to explain the real interest c.q. real return differential.[14]

$$r_{t+1} - r^{*}_{t+1} = constant + \alpha\,[\Delta C_{t+1}] - \alpha^{*}[\Delta C_{t+1}] + \Sigma_{i=1}^{N}\gamma_i[\Delta C_{t+1-i}] - \Sigma_{j=1}^{N}\gamma_j^{*}[\Delta C^{*}_{t+1-j}] + \upsilon_{t+1} \tag{30}$$

Thus, perfect financial integration implies:[15]

$$H_0:\ \gamma_i = \gamma_j = 0 \qquad i = 1,\ldots,N \quad j = 1,\ldots,N \tag{31}$$

Assuming that consumption and prices are normally distributed, equations (29) and (30) may be readily estimated with Ordinary Least Squares (OLS).[16] In the next section we will apply the three Euler equation tests to quantify the degree of financial integration in the EU.

---

[12] To see that equation (27) follows from (25) and (26), note that (25) and (26) imply that $E(R_{t+1}X)=R_{t+1}^{risk\text{-}free}E(X)$. Then note that $E(R_{t+1}X)=cov(R_{t+1},X)+E(R_{t+1})E(X)$, where E and cov denote the unconditional expectation and the unconditional covariance respectively (see Mankiw and Shapiro, 1985, p. 453 and Aiyagari, 1993, p. 21).

[13] This analysis is strongly related to the analysis of the Consumption Capital Asset Pricing Model.

[14] Note however that even if real returns are identical in the absence of capital controls or other impediments, there could exist unexploited trading opportunities. Such case arises if countries have different aggregate time preferences.

[15] Note that since the constant includes variances terms, it does not have to be zero for perfect financial integration to hold.

[16] One might also wish to perform a Wald test of the restriction $\alpha=\alpha^{*}$ or $\alpha+\alpha^{*}=0$ for the real return differential to be (close to) zero. This test may be seen as an implicit test of financial integration since financial integration may also lead to convergence in national consumption growth rates.

3 Empirical results

Obsfeld's (1986, 1989) Euler equation test requires real (per-capita) consumption, national price level and exchange rate data. The Penn World Table (Mark 6) provides easy to use annual real per-capita private consumption data in 1985 international prices, the corresponding price level of private consumption and US dollar exchanges rates.[17] [18] The 14 EU countries considered are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.[19] We constructed the variable η_t as defined in equation (5) of section 2, for the EU countries (no star) vis-à-vis Germany (star).[20] Three alternatives were chosen for the parameter α which equals α^*: α=0.75, α=1 and α=2.[21] These values for α may be seen as reasonable benchmark values. As explained in section 2, the test procedure involves determining whether variables contained in the information set available prior to time t can help to predict η_t.

Table 1 summarizes t-statistics and F-statistics of bilateral tests of perfect financial integration between EU countries (home countries) and Germany (foreign country). The sample period is divided into two subperiods 1961-1978 and 1979-1992, reflecting the start of the European Monetary System (EMS).[22] The sample period begins in 1963, since three lags are lost in estimation. If the null hypothesis γ_0=0 is rejected and/or the null hypothesis γ_1=γ_2=0 is rejected, financial markets are said to be imperfectly integrated. Table 1 summarizes the results. The number of rejections of the null hypotheses over the period 1963-1978 are: Austria (0x), Belgium (0x), Denmark (0x), Greece (0x), Finland (1x), France (1x), Ireland (1x), Italy (1x), the Netherlands (1x), Spain (1x), United Kingdom (2x), Portugal (2x), Sweden (3x). The number of rejections of the null hypotheses over the period 1979-1992 are: Denmark (0x), Greece (0x), Ireland (0x), Belgium (1x), Finland (1x) Spain (1x), Sweden (1x), United Kingdom (1x), Italy (2x), Austria (3x), France (3x), the Netherlands (3x), Portugal (5x). As is clear, the interpretation of these results is complicated by few degrees of freedom. After 1979 it seems that the null hypotheses are rejected more often. Furthermore, if we compare the number of rejections with the year of full liberalisation of capital controls indicated in Table 1, we safely may conclude that Portugal is a country with a low degree of financial integration and the United Kingdom is a country with high financial integration. However, the result for Greece is strange.

---

[17] We use variable 3, RGDPL, Real GDP per capita, 1985 international prices; variable 4, C, Real consumption share of GDP, 1985 international prices; variable 14, PC, Price level of consumption; and variable XR, Exchange rate with US dollar (Penn World Table, Mark 6, see also Summers and Heston, 1988). All per capita private consumption data are in real terms and expressed in US dollars. If necessary, per-capita consumption was converted into the home currency. Per-capita consumption was used to reduce the effect of differences in population growth on consumption.

[18] Aggregate capital flows may also reflect public sector behaviour. This may be unrelated to the intertemporal consumption smoothing of the private sector. However, during the 1980s private capital flows are increasingly more important as opposed to public capital flows.

[19] That is, we exclude Luxembourg.

[20] Analogously, a variable η^* could also have been constructed.

[21] Since, we do not know the true value of α and α^*. Ideally, one would want to estimate α. However, this is not possible with Obstfeld's (1986, 1989) Euler equation test of financial integration, since the left-hand side of equation (29) collapses to zero ($R^{risk\text{-}free}_{t+1}$-$R^{risk\text{-}free}_{t+1}$=0). The estimation of α and α^* is taken up in our Euler equation test of financial integration. Obstfeld (1989) uses the following values for the parameter α to construct quarterly times series of η_t over the period 1962:II-1985:II using Japan and Germany as the foreign countries and the US as the domestic country: α=0.5, 0.75, 1, 1.5, 2, 3, 5, 7, 12, 25. Note that since α is assumed to be constant, α=0.75, α=2 and α=4 imply a constant risk premium.

[22] Due to data availability the total sample period of Greece and Portugal is 1961-1991 and 1961-1990 respectively.

Table 1 - Obstfeld's (1986, 1989) Euler equation test of financial integration: 1963-1978 and 1979-1992[a]

$$\eta_t = \gamma_0 + \sum_{i=1}^{2} \gamma_i \eta_{t-i} + \nu_t$$

Country	Year of full liberalization of capital controls[c]		1963-1978		1979-1992	
			$\gamma_0=0$	$\gamma_1=\gamma_2=0$	$\gamma_0=0$	$\gamma_1=\gamma_2=0$
			t	F(2,13)	t	F(2,11)
Austria-Germany	1991	α=0.5	0.01	0.62	-2.79*	4.39*
		α=1.0	-0.20	0.80	-2.56*	2.27
		α=2.0	-0.69	0.91	-1.76	0.08
Belgium-Germany	1990	α=0.5	0.73	0.71	1.01	1.42
		α=1.0	0.19	1.55	0.77	1.97
		α=2.0	-1.02	1.57	-2.06*	0.41
Denmark-Germany	1988	α=0.5	0.66	0.42	0.96	0.32
		α=1.0	0.25	0.30	0.40	0.33
		α=2.0	-0.86	0.01	-0.43	1.60
Finland-Germany	1991	α=0.5	1.35	0.27	0.09	2.45
		α=1.0	0.81	0.11	-0.15	3.82
		α=2.0	-2.06*	0.70	0.22	13.16*
France-Germany	1993	α=0.5	1.59	0.97	1.77	8.94*
		α=1.0	0.70	1.34	-0.46	5.39*
		α=2.0	-2.92*	2.38	-0.58	5.01*
Greece-Germany[a]	1994	α=0.5	1.16	1.44	1.78	0.15
		α=1.0	0.41	0.82	-0.01	0.17
		α=2.0	0.79	2.95	1.55	0.55
Ireland-Germany	1992	α=0.5	1.49	0.32	-0.03	3.89
		α=1.0	1.59	0.25	-1.12	2.51
		α=2.0	-1.80*	2.31	-1.34	0.42
Italy-Germany	1992	α=0.5	1.42	0.96	-0.94	2.44
		α=1.0	0.82	1.86	-2.69*	2.98
		α=2.0	-2.95*	1.96	-1.38	4.13*
Netherlands-Germany	1975	α=0.5	-0.97	0.14	2.65*	0.70
		α=1.0	-1.67	0.49	2.81*	0.51
		α=2.0	-3.19*	1.63	2.21*	0.20
Portugal-Germany[b]	1993	α=0.5	0.76	4.77*	2.23*	7.91*
		α=1.0	0.12	0.06	-1.27	8.14*
		α=2.0	-2.52*	0.75	-2.77*	5.37*
Spain-Germany	1994	α=0.5	0.75	0.69	-0.23	0.36
		α=1.0	-0.22	0.72	-1.54	0.33
		α=2.0	-2.12*	0.74	-2.35*	0.95
Sweden-Germany	1993	α=0.5	1.85*	5.00*	1.15	4.65*
		α=1.0	1.52	4.32*	0.09	3.19
		α=2.0	0.06	2.12	-0.53	1.57
United Kingdom-Germany	1979	α=0.5	2.19*	0.09	-0.30	1.76
		α=1.0	2.86*	1.14	-0.89	1.94
		α=2.0	-0.73	0.91	-1.51	4.11*

[a] Calculated over the period 1961-1978 and 1979-1991 due to data availability.
[b] Calculated over the period 1961-1978 and 1979-1990 due to data availability.
[c] Year of full liberalisation of capital controls with respect to the home country (Restrictions on payments for capital transactions + Separate exchange rate(s) for some or all capital transactions and/or some or all invisibles). Full liberalization of capital controls with respect to Germany in 1973. See Epstein and Schor (1992, p. 142) and IMF (various issues).
* Significantly different from zero for α=5%.

The critical values for the t-statistics at 95 % confidence interval are respectively 1.746 (1961-1978) and 1.761 (1979-1992).
The critical values for the F-statistics at 95 % confidence interval are respectively F(2,13)=3.81 (1961-1978) and F(2,11)=3.98 (1979-1992).

Source: Penn World Table (Mark 6).

The second test is Obstfeld's (1994a, 1994b) Euler equation test of financial integration. This test assumes both trade in risk-free and risky assets. Table 2 summarizes simple cross-correlation coefficients of per capita consumption growth rates on a country-by-country base. The sample period is split into three subperiods: 1961-1978, 1979-1992 and 1961-1992. To ensure comparability, growth rates are calculated from per-capita consumption denominated in US dollars. The bold figures on the diagonal are the mean of all correlations for each EU country over the three time episodes.

Table 2 - Obstfeld's (1994a, 1994b) Euler equation test of financial integration: 1961-1992, 1961-1978 and 1979-1992[a]

	Aus	Bel	Den	Fin	Fra	Ger	Gre	Ire	Ita	Net	Por	Spa	Swe	UK
Aus	**0.28** **0.07** **0.26**	0.40 0.22 0.28	0.09 -0.08 0.00	0.22 0.00 0.54	0.34 -0.08 0.28	0.34 -0.04 0.44	0.24[a] 0.30 -0.21[b]	0.01 -0.41 0.18	0.24 -0.04 0.28	0.40 -0.06 0.33	0.41[c] 0.51 0.35[d]	0.50 0.37 0.34	0.30 0.26 0.03	0.17 -0.04 0.54
Bel		**0.36** **0.18** **0.32**	0.04 -0.11 -0.11	0.26 0.23 0.21	0.50 0.21 0.42	0.48 0.19 0.53	0.15[a] -0.03 -0.12[b]	0.27 0.05 0.34	0.53 0.29 0.71	0.57 0.25 0.60	0.36[c] 0.47 0.26[d]	0.52 0.31 0.52	0.38 0.22 0.31	0.21 0.37 0.18
Den			**0.20** **0.15** **0.05**	0.47 0.60 0.15	0.51 0.57 0.19	0.46 0.44 0.28	0.12[a] 0.05 -0.08[b]	-0.01 -0.12 -0.08	0.14 0.16 -0.30	0.37 0.22 0.28	-0.34[c] -0.41 -0.24[d]	0.31 0.29 0.02	0.41 0.45 0.22	0.02 -0.13 0.27
Fin				**0.29** **0.26** **0.37**	0.52 0.67 0.54	0.36 0.36 0.33	0.24[a] 0.32 0.13[b]	0.01 -0.12 0.08	0.24 0.16 0.30	0.17 0.19 0.03	-0.07[c] -0.16 0.32[d]	0.36 0.39 0.24	0.53 0.47 0.64	0.45 0.27 0.78
Fra					**0.49** **0.33** **0.33**	0.56 0.34 0.22	0.52[a] 0.35 0.30[b]	0.28 0.23 -0.01	0.60 0.54 0.26	0.66 0.40 0.12	0.01[c] -0.12 0.42[d]	0.65 0.51 0.39	0.55 0.37 0.56	0.21 0.33 0.59
Ger						**0.39** **0.17** **0.40**	0.23[a] 0.37 -0.45[b]	0.43 0.18 0.55	0.36 0.03 0.46	0.74 0.46 0.80	0.07[c] -0.10 0.46[d]	0.42 -0.02 0.61	0.39 0.01 0.51	0.17 0.10 0.44
Gre							**0.22** **0.21** **-0.05**	0.10[a] -0.01 -0.04[b]	0.16[a] 0.16 -0.32[b]	0.41[a] 0.36 -0.05[b]	0.18[c] 0.19 0.23[d]	0.34[a] 0.18 0.13[b]	0.23[a] 0.22 -0.03[b]	-0.01[a] 0.29 -0.17[b]
Ire								**0.21** **0.00** **0.29**	0.26 -0.01 0.43	0.47 0.15 0.61	0.21[c] -0.03 0.58[d]	0.27 -0.26 0.68	0.13 -0.15 0.17	0.32 0.46 0.28
Ita									**0.33** **0.21** **0.25**	0.52 0.42 0.28	0.16[c] 0.20 0.11[d]	0.56 0.53 0.28	0.42 0.26 0.40	0.12 0.05 0.36
Net										**0.43** **0.25** **0.34**	0.18[c] 0.13 0.47[d]	0.64 0.31 0.69	0.48 0.53 0.16	-0.05 -0.10 0.10
Por											**0.16** **0.10** **0.35**	0.45[c] 0.36 0.87[d]	0.26[c] 0.27 0.31[d]	0.14[c] -0.02 0.40[d]
Spa												**0.44** **0.29** **0.42**	0.63 0.73 0.36	0.11 0.05 0.36
Swe													**0.38** **0.28** **0.33**	0.28 -0.02 0.63
UK														**0.16** **0.14** **0.37**

[a] Correlations over the period 1961-1991 due to data availability.
[b] Correlations over the period 1979-1991 due to data availability.
[c] Correlations over the period 1961-1990 due to data availability.
[d] Correlations over the period 1979-1990 due to data availability.

Source: Penn World Table (Mark 6).

Clearly, correlation coefficients increased over time except correlation coefficients with respect to Greece (compare the subperiods 1961-1978 and 1979-1992). This may point at increased risk sharing through the European financial markets.[23] However, all correlation coefficients are substantially below unity. Low correlation coefficients may indicate imperfect financial market integration and/or missing markets (market incompleteness). Although simple correlation coefficients are never conclusive - since a third factor may be important - Table 2 may give valuable insides about differences in the degree of capital mobility among EU countries.[24]

With the help of the bold figures on the diagonal, we may list the EU countries in ascending order of estimated degree of financial integration. Over the period 1961-1992 the ranking of EU countries is as follows: Portugal, United Kingdom, Denmark, Ireland, Greece, Austria, Finland, Italy, Belgium, Sweden, Germany, the Netherlands, Spain and France. Over the period 1961-1978 the ranking of EU countries is as follows: Ireland, Austria, Portugal, United Kingdom, Denmark, Germany, Belgium, Greece, Italy, the Netherlands, Finland, Sweden, Spain and France. Over the period 1979-1992 the ranking of EU countries is as follows: Greece, Denmark, Italy, Austria, Ireland, Belgium, France, Sweden, the Netherlands, Portugal, Finland, United Kingdom, Germany and Spain. The large degree of integration with respect to Portugal and Spain is odd (compared with year of full liberalization). An explanation might be the high speed of integration with respect to Portugal and Spain (see Eijffinger and Lemmen, 1995). It may not always be clear which country causes low (or high) cross-correlation coefficients, the home or the foreign country or both. The next section stresses some limitations inherent to this econometric work.

Table 3 estimated with OLS reports the results of our Euler equation tests of financial integration for the EU countries over the period 1961-1992. The first column concerns estimation of equation (29) and the second column concerns estimation of equation (30) for i=j=1. With the use of annual data the normality of consumption and prices is realistic. Moreover, the use of annual data avoids the problem of seasonality in consumption. Representative money market and capital market interest rates were obtained from the OECD Main Economic Indicators. Representative stock market indices to calculate returns were also obtained from the OECD Main Economic Indicators. Subsequently, annual real interest rates and real stock returns were calculated using the Penn World Table (Mark 6) implicit price deflator of private consumption (assuming rational expectations). Appendix A at the end of this paper depicts the time-series behaviour of these variables (see also for theoretical explanation in section 2) where S-T BOND is the real short-term interest rate, L-T BOND is the real long-term interest rate, STOCK is the real stock return and C is the per-capita consumption growth rate. Unfortunately, consistent long series of interest rates (Greece and Portugal) and stock market indices (Portugal) were not available.

---

[23] Note that international risk sharing may also have increased since financial integration is a global phenomenon. Representative agents are less liquidity constrained due to financial liberalisation (Jappelli and Pagano, 1989).

[24] Such third factors are:

- Economic integration c.q. real integration; countries are in the same phase of the business cycle.
- The large role played by non-traded goods in the sample.
- Preference shocks.
- Incomplete financial markets
- Errors in measuring real per capita private consumption.
- Cross listings of stocks of big companies in relative small markets.
- Differences in age structure and population growth rates.

Table 3 - The new Euler equation test of financial integration: 1961-1992

$$r_{t+1} - r^*_{t+1} = constant + \alpha[\Delta C_{t+1}] - \alpha^*[\Delta C^*_{t+1}] + \epsilon_{t+1}$$

$$r_{t+1} - r^*_{t+1} = constant + \alpha[\Delta C_{t+1}] - \alpha^*[\Delta C_{t+1}] + \gamma_1[\Delta C_t] - \gamma^*_1[\Delta C^*_t] + \nu_{t+1}$$

Austria	**Short-term bond market**		**Long-term bond market**[a]		**Stock market**[a]	
Constant	-0.003 (0.004)	-0.002 (0.004)	-0.007 (0.003)*	-0.006 (0.003)*	-0.02 (0.03)	-0.02 (0.04)
ΔC_{t+1}	0.24 (0.21)	0.06 (0.21)	0.16 (0.16)	0.15 (0.15)	2.31 (1.88)	2.32 (2.00)
ΔC^*_{t+1}	-0.24 (0.22)	-0.09 (0.21)	-0.18 (0.17)	-0.18 (0.16)	-2.60 (1.95)	-2.60 (2.07)
ΔC_t		-0.35 (0.20)*		-0.32 (0.15)*		0.58 (1.91)
ΔC^*_t		0.40 (0.20)*		-0.33 (0.15)*		-0.57 (1.98)
$\bar{R}^2$	-0.03	0.02	-0.03	0.11	0.01	-0.12
LM Serial Correlation $\chi^2(1)$	2.42	1.45	3.01	1.87	1.80	1.73
Belgium	**Short-term bond market**		**Long-term bond market**		**Stock market**	
Constant	0.006 (0.006)	0.005 (0.006)	0.003 (0.005)	0.002 (0.005)	-0.02 (0.03)	-0.02 (0.03)
ΔC_{t+1}	0.77 (0.14)*	0.77 (0.15)*	0.81 (0.12)*	0.80 (0.12)*	1.94 (0.65)*	2.25 (0.67)*
ΔC^*_{t+1}	-0.72 (0.15)*	-0.73 (0.16)*	-0.77 (0.13)*	-0.78 (0.13)*	-2.31 (0.71)*	-2.48 (0.71)*
ΔC_t		-0.002 (0.15)*		-0.04 (0.12)		-0.61 (0.66)
ΔC^*_t		0.03 (0.16)		0.09 (0.13)		0.17 (0.71)
$\bar{R}^2$	0.49	0.48	0.60	0.61	0.22	0.25
LM Serial Correlation $\chi^2(1)$	14.02	14.68	11.00	11.47	0.74	0.77
Denmark	**Short-term bond market**		**Long-term bond market**		**Stock market**	
Constant	0.02 (0.01)*	0.01 (0.01)*	0.02 (0.007)	0.02 (0.01)	0.03 (0.04)	0.04 (0.04)
ΔC_{t+1}	0.96 (0.23)*	0.92 (0.28)*	0.81 (0.19)*	0.92 (0.23)*	0.27 (1.05)*	1.16 (1.23)
ΔC^*_{t+1}	-0.94 (0.24)*	-0.91 (0.28)*	-0.83 (0.21)*	-0.93 (0.23)*	0.30 (1.11)*	-0.44 (1.24)
ΔC_t		0.29 (0.24)		0.10 (0.20)		-1.37 (1.07)
ΔC^*_t		-0.30 (0.25)		-0.19 (0.21)		1.01 (1.12)
$\bar{R}^2$	0.33	0.32	0.33	0.32	0.02	0.03
LM Serial Correlation $\chi^2(1)$	11.05	11.22	9.61	6.69	0.003	0.11
Finland	**Short-term bond market**		**Long-term bond market**[a]		**Stock market**	
Constant	-0.007 (0.01)	0.007 (0.01)	-0.006 (0.02)	0.01 (0.02)	0.004 (0.06)	-0.08 (0.06)
ΔC_{t+1}	0.76 (0.19)*	0.71 (0.20)*	0.85 (0.29)*	0.70 (0.30)*	0.98 (0.86)	1.16 (0.84)
ΔC^*_{t+1}	-0.84 (0.17)*	-0.86 (0.17)*	-0.91 (0.23)*	-0.88 (0.23)*	-1.43 (0.74)*	-1.26 (0.68)
ΔC_t		-0.30 (0.19)		-0.36 (0.26)		1.94 (0.80)*
ΔC^*_t		0.36 (0.17)*		0.44 (0.22)*		-2.10 (0.70)*
$\bar{R}^2$	0.43	0.48	0.42	0.48	0.06	0.25
LM Serial Correlation $\chi^2(1)$	9.84	6.48	9.74	5.23	1.98	1.82

Table 3 - Continued

France	**Short-term bond market**		**Long-term bond market**		**Stock market**	
Constant	0.03 (0.02)	0.02 (0.02)	0.04 (0.02)	0.03 (0.02)	0.007 (0.06)	0.001 (0.07)
ΔC_{t+1}	-0.37 (0.61)	-1.42 (0.85)	-0.45 (0.56)	-1.45 (0.78)*	0.78 (2.01)	0.77 (2.87)
ΔC^*_{t+1}	0.002 (0.10)	-0.04 (0.11)	-0.02 (0.09)	-0.06 (0.10)	-0.34 (0.33)	-0.25 (0.36)
ΔC_t		1.23 (0.83)		1.21 (0.77)		0.02 (2.82)
ΔC^*_t		0.17 (0.11)		0.16 (0.10)		-0.35 (0.38)
$\bar{R}^2$	-0.06	-0.003	-0.05	0.02	-0.03	-0.07
LM Serial Correlation $\chi^2(1)$	1.13	2.35	0.93	1.81	0.07	0.003
Greece	**Short-term bond market**		**Long-term bond market**		**Stock market**	
Constant					0.20 (0.09)*	0.14 (0.1)
ΔC_{t+1}					-1.41 (0.74)*	-1.05 (1.00)
ΔC^*_{t+1}					-0.51 (0.74)	-0.57 (0.90)
ΔC_t						0.08 (0.95)
ΔC^*_t						-0.75 (0.79)
$\bar{R}^2$					0.25	0.24
LM Serial Correlation $\chi^2(1)$					1.83	1.98
Ireland	**Short-term bond market**[a]		**Long-term bond market**[a]		**Stock market**	
Constant	0.02 (0.01)	0.03 (0.15)	0.01 (0.01)	0.01 (0.01)	0.03 (0.04)	0.07 (0.04)
ΔC_{t+1}	0.51 (0.17)*	0.60 (0.19)*	0.60 (0.13)*	0.63 (0.14)*	0.60 (0.61)	0.83 (0.60)
ΔC^*_{t+1}	-0.62 (0.17)*	-0.71 (0.19)*	-0.66 (0.12)*	-0.70 (0.14)*	-1.16 (0.61)*	-1.25 (0.62)*
ΔC_t		-0.15 (0.19)		-0.04 (0.14)		-1.19 (0.59)*
ΔC^*_t		0.22 (0.19)*		0.09 (0.14)		0.51 (0.61)
$\bar{R}^2$	0.38	0.37	0.60	0.56	0.07	0.19
LM Serial Correlation $\chi^2(1)$	2.75	1.73	2.18	1.28	1.32	1.20
Italy	**Short-term bond market**		**Long-term bond market**		**Stock market**	
Constant	-0.008 (0.010)	-0.01 (0.01)	-0.009 (0.008)	0.005 (0.009)	-0.10 (0.06)	-0.04 (0.07)
ΔC_{t+1}	0.66 (0.12)*	0.66 (0.12)*	0.58 (0.10)*	0.62 (0.10)*	1.20 (0.69)*	1.58 (0.69)*
ΔC^*_{t+1}	-0.64 (0.13)*	-0.65 (0.14)*	-0.55 (0.10)*	-0.60 (0.11)*	-1.49 (0.75)*	-1.80 (0.75)*
ΔC_t		0.04 (0.12)		-0.10 (0.10)		-1.49 (0.69)*
ΔC^*_t		0.01 (0.14)		0.18 (0.11)		1.21 (0.75)
$\bar{R}^2$	0.50	0.48	0.53	0.55	0.06	0.15
LM Serial Correlation $\chi^2(1)$	5.84	5.37	3.80	4.34	2.55	2.05

Table 3 - continued

Netherlands	**Short-term bond market**		**Long-term bond market**[a]		**Stock market**	
Constant	-0.007 (0.005	-0.004 (0.005)	0.006 (0.004)	0.007 (0.004)*	0.008 (0.02)	0.02 (0.02)
ΔC_{t+1}	0.15 (0.25)	0.18 (0.25)	0.11 (0.24)	0.12 (0.22)	-0.10 (0.98)	0.20 (0.91)
ΔC^*_{t+1}	-0.12 (0.25)	-0.15 (0.25)	-0.04 (0.25)	-0.07 (0.22)	0.36 (1.00)	0.11 (0.93)
ΔC_t		-0.43 (0.25)*		-0.53 (0.23)*		-2.22 (0.90)*
ΔC^*_t		0.41 (0.25)		0.54 (0.23)*		1.95 (0.93)*
$\bar{R}^2$	-0.03	0.003	0.11	0.26	-0.005	0.18
LM Serial Correlation $\chi^2(1)$	8.80	5.54	6.79	3.40	0.24	0.51
Spain	**Short-term bond market**[a]		**Long-term bond market**		**Stock market**	
Constant	-0.02 (0.02)	-0.02 (0.02)			0.02 (0.06)	0.01 (0.07)
ΔC_{t+1}	0.90 (0.21)*	0.83 (0.24)*			-0.06 (0.72)	0.20 (0.77)
ΔC^*_{t+1}	-0.78 (0.22)*	-0.75 (0.24)*			-0.15 (0.76)	-0.17 (0.78)
ΔC_t		0.10 (0.23)				-0.21 (0.74)
ΔC^*_t		0.03 (0.24)				-0.54 (0.78)
$\bar{R}^2$	0.45	0.41			-0.06	-0.06
LM Serial Correlation $\chi^2(1)$	3.81	2.96			5.83	7.46
Sweden	**Short-term bond market**		**Long-term bond market**		**Stock market**	
Constant	-0.007 (0.006)	-0.009 (0.006)	-0.004 (0.005)	-0.005 (0.005)	0.01 (0.03)	0.001 (0.03)
ΔC_{t+1}	0.91 (0.13)*	0.72 (0.13)*	0.86 (0.10)*	0.74 (0.11)*	1.67 (0.64)	2.22 (0.69)
ΔC^*_{t+1}	-0.92 (0.11)*	-0.83 (0.10)*	-0.91 (0.08)*	-0.85 (0.08)*	-1.24 (0.54)	-1.38 (0.53)
ΔC_t		0.21 (0.13)		0.14 (0.11)		-0.02 (0.67)
ΔC^*_t		0.03 (0.10)		0.01 (0.08)		-0.89 (0.51)*
$\bar{R}^2$	0.69	0.76	0.79	0.81	0.14	0.29
LM Serial Correlation $\chi^2(1)$	4.58	5.43	3.04	5.16	0.29	0.02
United Kingdom	**Short-term bond market**		**Long-term bond market**		**Stock market**	
Constant	-0.003 (0.006)	-0.005 (0.006)	-0.005 (0.005)	-0.007 (0.006)	0.03 (0.03)	0.06 (0.04)
ΔC_{t+1}	0.94 (0.08)	0.93 (0.09)	0.95 (0.07)	0.93 (0.08)	0.59 (0.48)	0.94 (0.51)
ΔC^*_{t+1}	-0.87 (0.07)	-0.88 (0.07)	-0.88 (0.07)	-0.88 (0.07)	-0.46 (0.42)	-0.78 (0.43)
ΔC_t		0.03 (0.08)		0.05 (0.08)		-1.10 (0.49)*
ΔC^*_t		0.02 (0.07)		0.01 (0.07)		0.58 (0.43)
$\bar{R}^2$	0.85	0.86	0.87	0.88	-0.01	0.09
LM Serial Correlation $\chi^2(1)$	2.08	1.29	1.51	0.70	0.45	0.34

[a] Estimated over the period 1973-1992 due to data availability.
* Significantly different from zero for α=5%.

Standard errors are indicated between parentheses.

The critical value for the $\chi_2(1)$ test of serial correlation is 3.84.

Source: Penn Word Table (Mark 6).

Evidently, the pricing performance of the Euler equations (29) and (30) with respect to the short-term bond, the long-term bond and the stock market is reasonably sound, as is clear from the many significant coefficients for ΔC_{t+1} and ΔC^*_{t+1} and the high level of $\bar{R}^2$. Differences in the degrees of national risk aversion are relatively small. The null hypothesis of no serial correlation in the data is often accepted. Only the estimation of α=-0.37 (short-term bond market), α=-0.45 (long-term bond market) with respect to France are peculiar, as they should be positive for risk-averse consumers (see also footnote 4). The same holds for the estimation of α=-1.41 (stock market) for Greece and α=-0.06 (stock market) for Spain.[25] As is hypothesised in section 2, market frictions may loosen the link between asset markets and measured intertemporal marginal rates of substitution based on estimation of equation (29) and (30). Market frictions in financial markets may be evidenced by remaining serial correlation. Significant coefficints for ΔC_t and ΔC^*_t imply less than perfect financial integration. One might think of restricted capital mobility due to risk which is not priced. Perfect financial integration over the period 1961-1992 is rejected for Austria (short-term bond market and long-term bond market), Belgium (short-term bond market), Finland (all markets), Ireland (short-term bond market and stock market), Italy (stock market), the Netherlands (all markets), Sweden (stock market) and the United Kingdom (stock market).

4 An evaluation of Euler equation tests of financial integration

Obstfeld’s Euler equation tests of financial integration may be seen as an alternative test of financial integration, since it uses non-financial data, particularly real per capita private consumption data. Unlike arbitrage tests based upon covered interest parity or uncovered interest parity, Euler equation tests, do not require comparisons between rates of return on what might be dissimilar assets. Tests of uncovered interest parity and real interest parity suffer from the need to adopt additional assumptions about unobservable expectations (resulting in tests of joint hypotheses). In addition, tests of real interest parity are rejected due to a failure of ex ante relative purchasing power parity although financial markets are perfectly integrated. Unlike arbitrage tests, Euler equation tests avoid methodological problems related to the definition and measurement of interest rates. Furthermore, unlike Feldstein-Horioka tests it is less vulnerable to indirect sources of saving-investment correlations.[26] Bayoumi and Taylor (1994, p. 6) argue: "Focusing on consumption has several attractive features. The underlying theory is stronger than that for saving-investment correlations. In addition, since consumption is the ultimate goal of economic activity, it is a more fundamental test of the effects of financial integration on economic welfare than either the saving-investment correlations or interest rate comparisons. Finally, [...], it also incorporates a test of real interest parity which does not require the assumption that ex ante purchasing parity is expected to hold."

Of course, there are some caveats to be placed with our analysis. The disadvantage of the Euler equation test, of course, is that restrictive assumptions on consumer behaviour across countries are required to

[25] Spain does also not perform well in the second test.

[26] Bayoumi and Taylor (1994, p. 6) argue: "[...] it appears unlikely that macroeconomic policy is directed at private nondurable consumption patterns in the way it may be at the current account."

implement it (see Aiyagari 1993, Muellbauer 1994, Bayoumi and MacDonald 1994).[27] Secondly, we do not address the role of different population growth rates in the two countries. This would probably lead to spurious correlations, which would complicate the inference on the degree of financial integration.

Completeness of asset markets and complete frictionless markets

The Euler equation test embodies multiple hypotheses, rejections may be difficult to interpret. For example, rejection of perfect financial integration may be due to asset market incompleteness, rather than restrictions on cross-border capital flows.

Representative consumer

It may not be realistic to replace individual consumption by aggregate consumption on the basis of the single representative consumer assumption. For instance, individual consumption typically is much more variable than aggregate consumption.

CARA power utility function

The virtue of the CARA power utility function is its simplicity, and therefore it is well suited for our benchmark test of financial integration. However, Cochrane and Hansen (1992) argue that the CARA power utility function may not always perform well for asset pricing equations. Furthermore, the underlying representative consumer model must be correct for both countries and cross-country differences in utility functions must be negligible.

The coincidence of consumers' decision making with the frequency of the consumption

In our test of financial integration the consumer's choice of consumption is made every year while the horizon with respect to the asset is three months in case of representative short-term bonds and three to five years in case of representative long-term bonds. Consequently, the result need to be interpreted with care.

Type of capital mobility

Euler equation tests address a different concept of capital mobility than interest parity conditions. We agree with Bayoumi and Taylor (1994, p. 23) who argue that the test implemented in the paper probably capture a different type of capital mobility than that contained in a comparison of the nominal interest rates set in financial centres. Therefore, the tests in this paper probably also measure economic integration of real activity.

Significance tests

Statistically significant rejections may not be economically important if the coefficient estimate is small on average. That is, the magnitude of the regression coefficient matters, not its significance. In addition, more sophisticated estimation methods (such as Generalised Methods of Moments estimation) might be appropriate.

---

[27] Of course, apart from possible poor data quality. Preferable, one might want to use data of non-durable consumption and its corresponding price deflator.

5 Conclusions

This paper reviews the Euler equation test of financial integration with respect to the EU. Since there is no single widely-accepted empirical measure for the degree of financial integration, Euler equation tests may shed some light on the integration between European financial markets. Particularly, in combination with other criteria for financial integration such as arbitrage conditions and savings-investment correlations, Euler equation tests may be valuable. One of the benefits expected to result from cross-border capital mobility is an improvement in international risk sharing, specifically, improvements in consumption smoothing and risk diversification. The simple correlations coefficients in Table 2 indicate that there is still significant room for risk diversification among EU countries. The results may point at some home diversification bias of investors (see French and Proterba (1991) and Tesar and Werner (1992). Per-capita private consumption growth correlations across European countries are far from unity and differ considerably. Particularly, the influence of taxes and all varieties of capital market restrictions can be expected to form significant barriers to European financial integration. Summarizing, Obstfeld's Euler equation tests result in the following ranking of EU countries: low integration (Greece and Portugal) intermediate (Austria, Denmark, Finland, France, Ireland, Italy, Spain and Sweden) and high (Belgium, Germany, the Netherlands and the United Kingdom).

Finally, note that the representative consumer theory as an exponent of the neoclassical theories assumes that financial markets price financial assets efficiently. The critics of the theory argued that financial markets may function substantially different than the representative agent model implies because its underlying assumptions are not valid in the real world. Economists and policymakers cannot abstract from the important relationships between financial institutions (banks, pension funds and insurance companies), households, firms and financial markets. Unfortunately, non-neoclassical theories lack a solid analytical framework. No doubt a fruitful area of future research will be on the implications of financial integration within the (financial) market structure of the EU.

References

Adler, M. and B. Dumas (1975), "Optimal International Acquisitions", *Journal of Finance*, 30, pp. 1-19.

Afford (1993), "Assessing Capital Market Segmentation: A Review of the Literature", In: S.R. Stansell (ed.), *International Financial Market Integration*, Blackwell Publishers, Cambridge.

Alessie, R. (1994), "Some Empirical Studies on Consumer Behaviour", Unpublished Ph.D Thesis, Tilburg, The Netherlands.

Aiyagari, S.R. (1993), "Explaining Financial Markets Facts: The Importance of Incomplete Markets and Transaction Costs", *Federal Reserve Bank of Minneapolis Quarterly Review*, Winter, pp. 17-31.

Bayoumi, T.A. and R. McDonald (1994), "Consumption, Income, and International Capital Market Integration", *CEPR Discussion Paper*, No. 1028, October.

Blanchard, O.J. and S. Fisher (1989), *Lectures on Macroeconomics*, The MIT Press, Cambridge.

Bisignano, J. (1994), "The Internationalisation of Financial Markets: Measurement, Benefits and Unexpected Interdependence", In: Banque de France, Mouvements de Capitaux et Marchés des Changes, *Cahiers Économiques et Monétaires*, No. 43, pp. 971,

Breeden, D.T. (1979), "An Intertemporal Asset Pricing Model with Stochastic consumption and Investment Opportunities", *Journal of Financial Economics*, Vol. 7, pp. 265-296.

Breeden, D.T., M.R. Gibbons and R.H. Litzenberger (1989), "Empirical Tests of the Consumption-oriented CAPM", *Journal of Finance*, Vol. 44, pp. 231-262.

Brennan, M.J. and B. Solnik (1989), "International Risk Sharing and Capital Mobility", *Journal of International Money and Finance*, Vol. 8, pp. 359-573.

Campbell, J.Y. and N.G. Mankiw, (1989), "Consumption, Income, and Interest Rates: Reinterpreting the Time Series Evidence", In. O.J. Blanchard and S. Fisher (eds.), *NBER Macroeconomics Annual 1989*, pp. 185-216.

Cochrane, J.H. and L.P. Hansen (1992), "Asset Pricing Explorations for Macroeconomics", In: O.J. Blanchard and S. Fischer (eds.), *NBER Macroeconomics Annual 1992*, pp. 115-163.

Eichberger, J. and I. Harper (1993), *Financial Economics*, Chapter 3, manuscript.

Eijffinger, S.C.W. and J.J.G. Lemmen (1995), "Money Market Integration in Europe", *Swiss Journal of Economics and Statistics*, Vol. 131, No. 1, January, pp. 3-37.

Epstein, G.A. and J.B. Schor (1992), "Structural Determinants and Economic Effects of Capital Controls in OECD Countries", In: T. Banuri and J.B. Schor (eds.), *Financial Openness and National Autonomy, Opportunities and Constraints*, Clarendon Press, Oxford.

Feldstein, M. and C. Horioka (1980), "Domestic Savings and International Capital Flows." The Economic Journal, Vol. 90, pp. 314-329.

Feldstein, M. (1983), "Domestic Saving and International Capital Movements in the Long Run and the Short Run." European Economic Review, Vol. 21, pp. 129-151.

Frankel, J.A. and A.T. MacArthur (1988), "Political vs. Currency Premia in International Real Interest Differentials: A Study of Forward Rates for 24 Countries", *European Economic Review*, Vol. 32, pp. 1083-1121.

French, K.R. and J.M. Proterba (1991), "Investor Diversification and International Equity Returns",*American Economic Review*, Vol. 81, No. 2, pp. 222-226.

Hall, R.E. (1988), "Intertemporal Substitution in Consumption", *Journal of Political Economy*, Vol. 86, No. 6, pp. 971-987.

International Monetary Fund, *Exchange Arrangements and Exchange Restrictions*, Several Years, Annual Report, Washington.

Jappelli, T. and M. Pagano, (1989), "Consumption and Capital Market Imperfections: An International Comparison", *American Economic Review*, Vol 79, No. 5, pp. 1088-1105.

Kollmann, R. (1992), "Consumptions, Real Exchange Rates and The Structure of International Asset Markets", University de Montréal, Cahier 9232, October 1992.

Lemmen, J.J.G. and S.C.W. Eijffinger (1995), "The Quantity Approach to Financial Integration: The Feldstein-Horioka Criterion Revisited", Tilburg University, *Open Economies Review*, Vol. 6, pp. 145-165.

Mankiw. N.G and M.D. Shapiro (1986), "Risk and Return: Consumption Beta Versus Market Beta, *The Review of Economics and Statistics*, pp. 452-459.

Lucas, R.E. (1978), "Asset Prices in an Exchange Economy", *Econometrica*, Vol. 46, No. 6, pp. 1429-1445.

Muellbauer, J. (1994), "The Assessment: Consumer Expenditure", *Oxford Review of Economic Policy*, Vol. 10, No. 2. pp. 1-41.

Obstfeld, M. (1986), "Capital Mobility in the World Economy, Theory and Measurement,", In: K. Brunner and A. Meltzer (eds.), *The National Bureau Method, International Capital mobility and Other Essays*, Carnegie-Rochester Conference Series on Public Policy, Vol. 24, pp. 55-104.

Obstfeld, M. (1989), "How Integrated are World Capital Markets?, Some New Tests", In: G. Calvo, R. Findlay, P. Kouri and J. Braga de Macedo. (eds.), *Debt, Stabilization and Development*, World Institute of for Development Economics Research and the United Nations University, Basil Blackwell, Oxford, pp. 134-159.

Obstfeld, M. (1994a), "International Capital Mobility in the 1990s", *Centre for Economic Policy Research Discussion Paper*, No. 902, February.

Obstfeld, M. (1994b), "Are Industrial-Country Consumption Risks Globally Diversified?", In: L. Leiderman and A. Razin (eds.), *Capital Mobility, The Impact on Consumption, Investment and Growth*, Cambridge University Press, Cambridge.

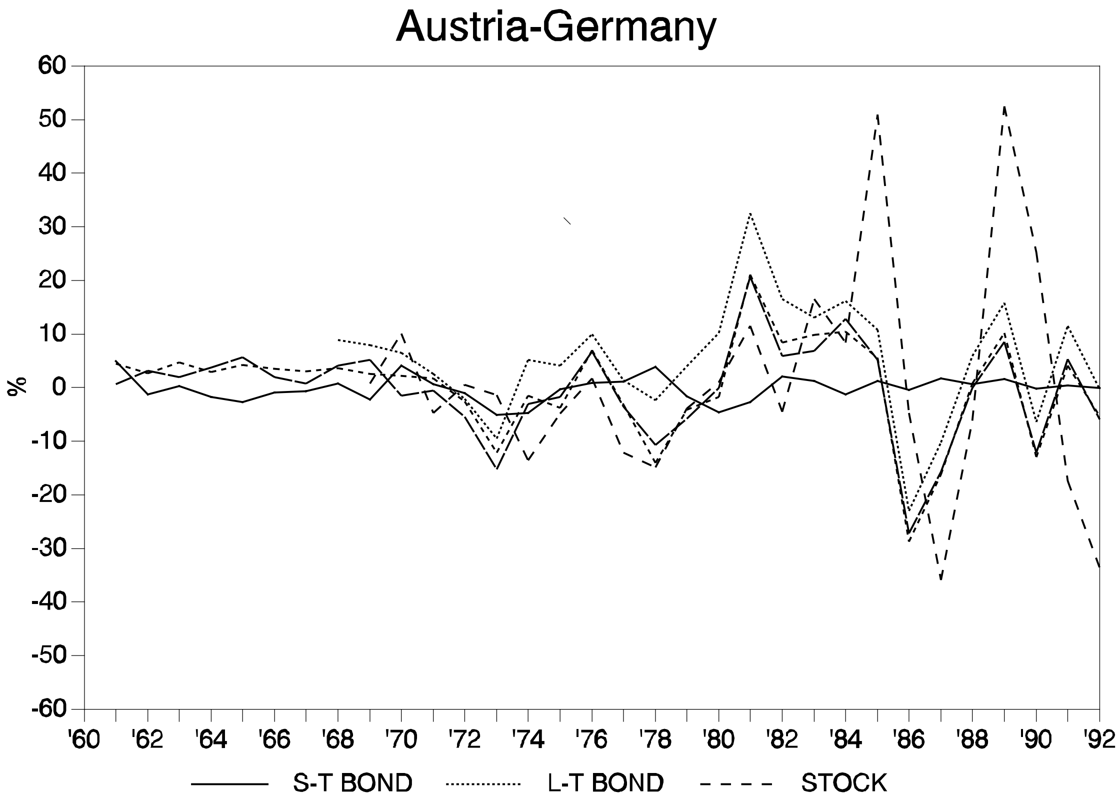
Stokey, N.L. and R.E. Lucas, with E.C. Prescott (1989), *Recursive Methods*, Harvard University Press, Cambridge.

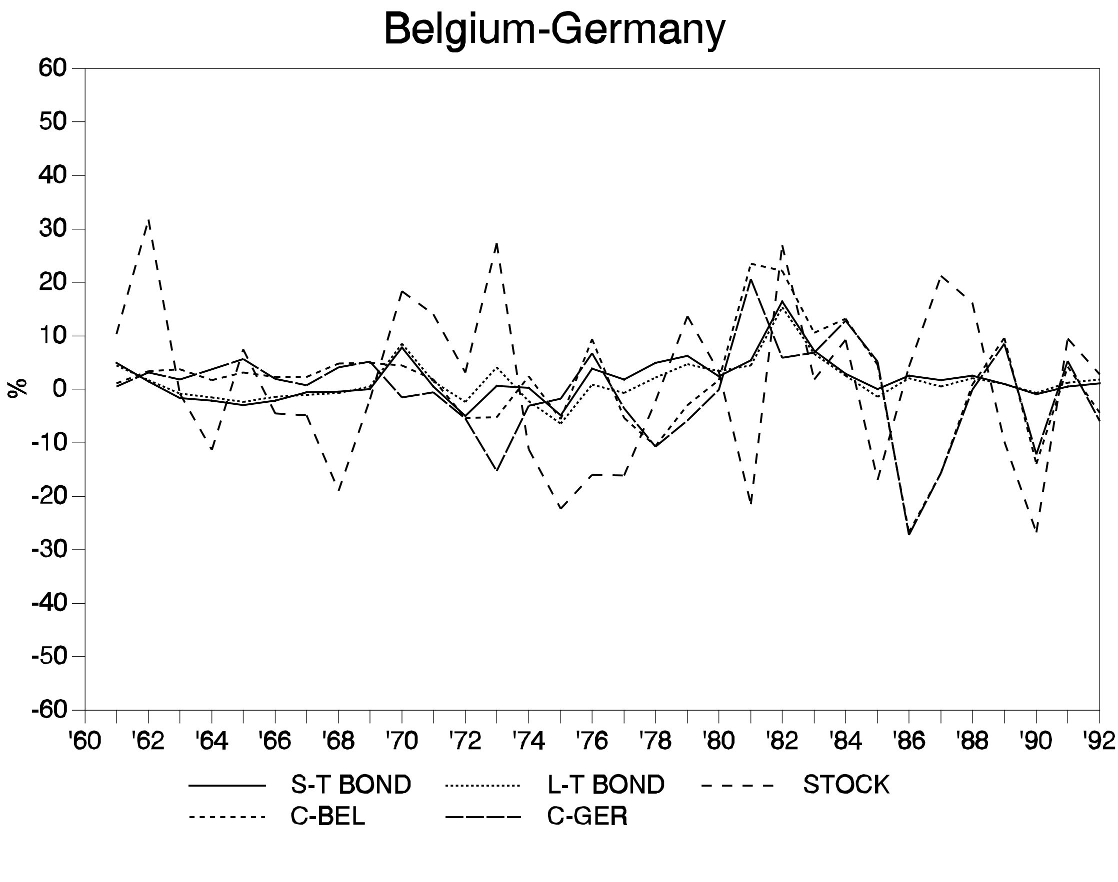
Summers, R. and A. Heston (1991), "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988", *Quarterly Journal of Economics*, Vol. 106, May, pp. 327-368.

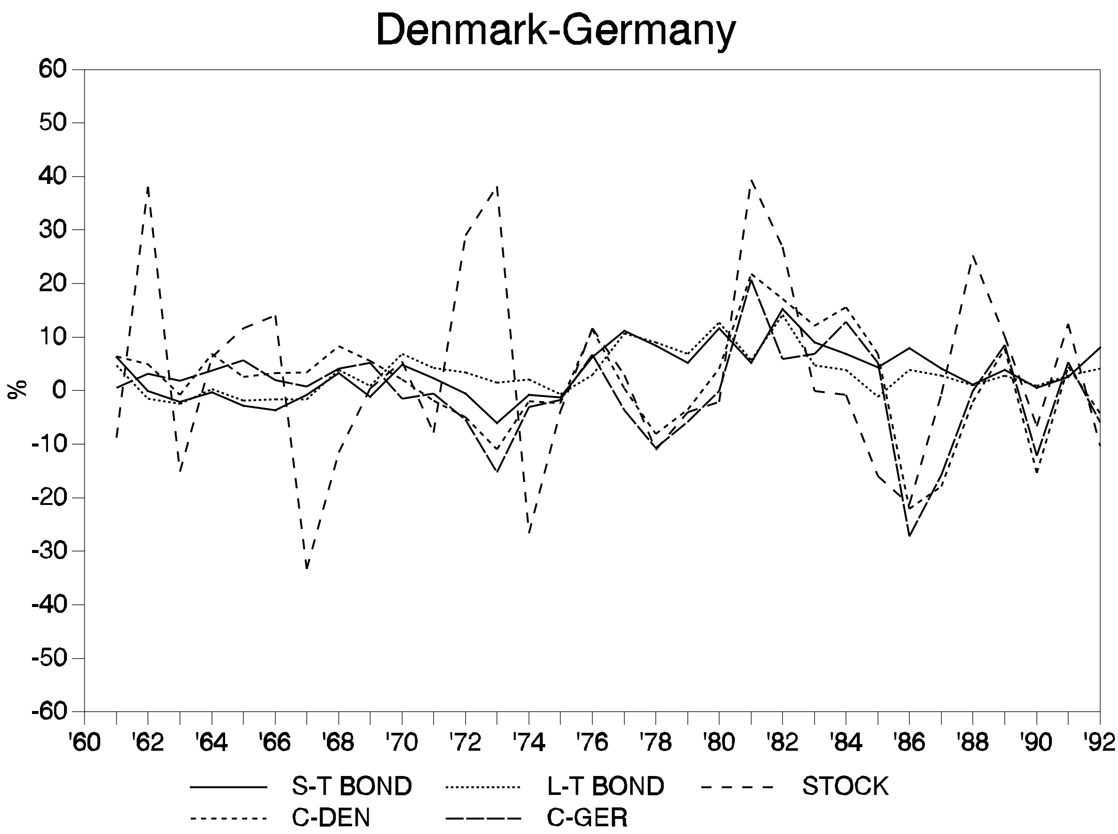
Tesar, L.L. and I.M. Werner (1992), "Home Bias and the Globalisation of Security Markets",*NBER Working Paper*, No. 4218, London.

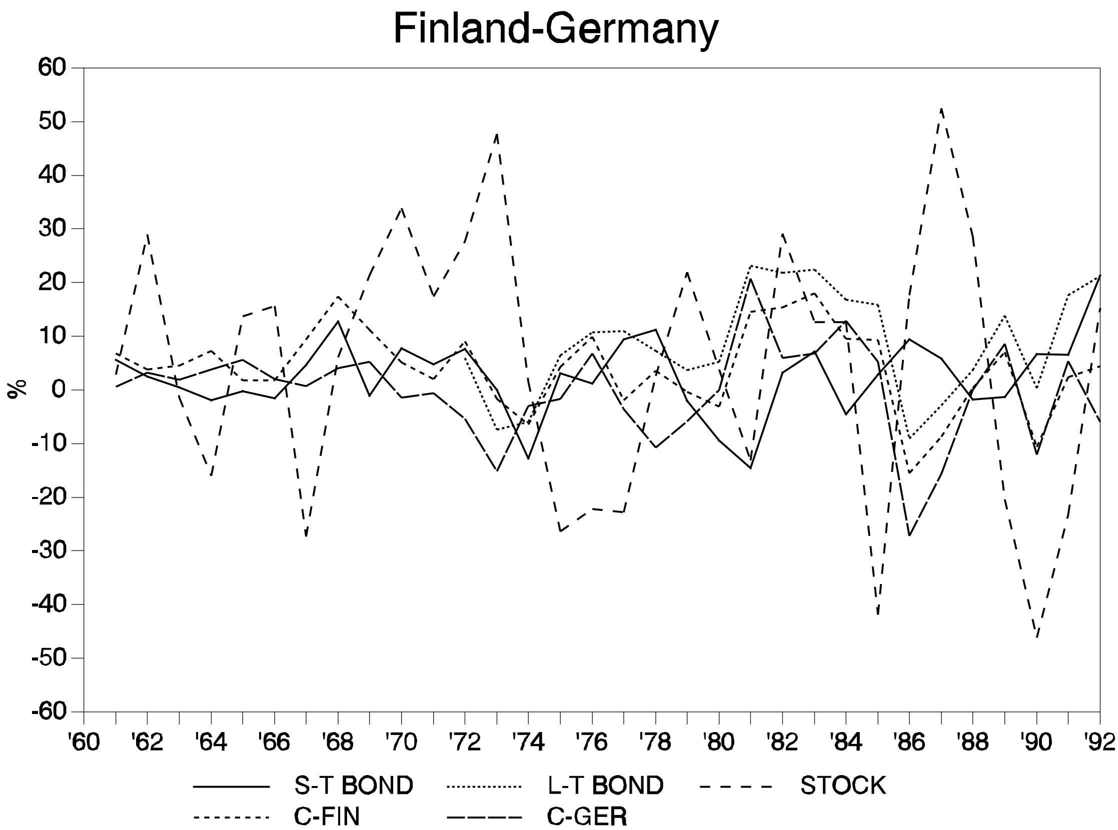
Appendix

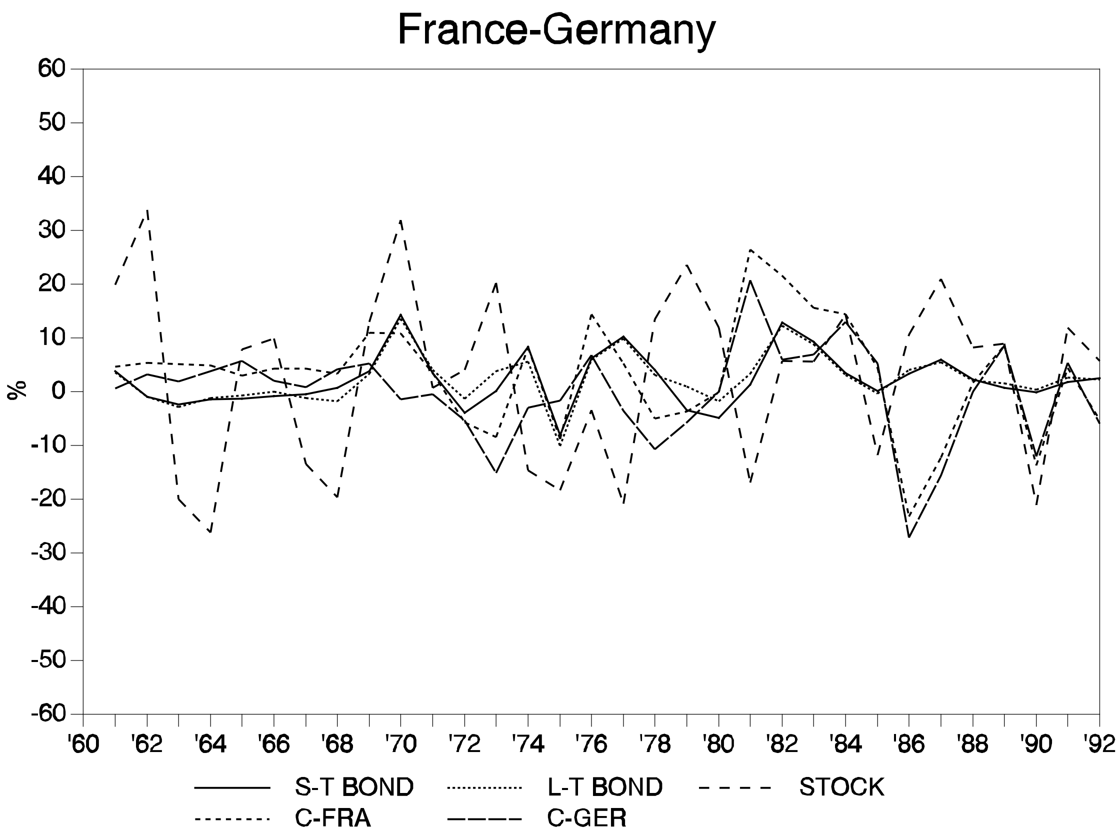
Real interest rate differentials, stock return differentials and consumption growth rates

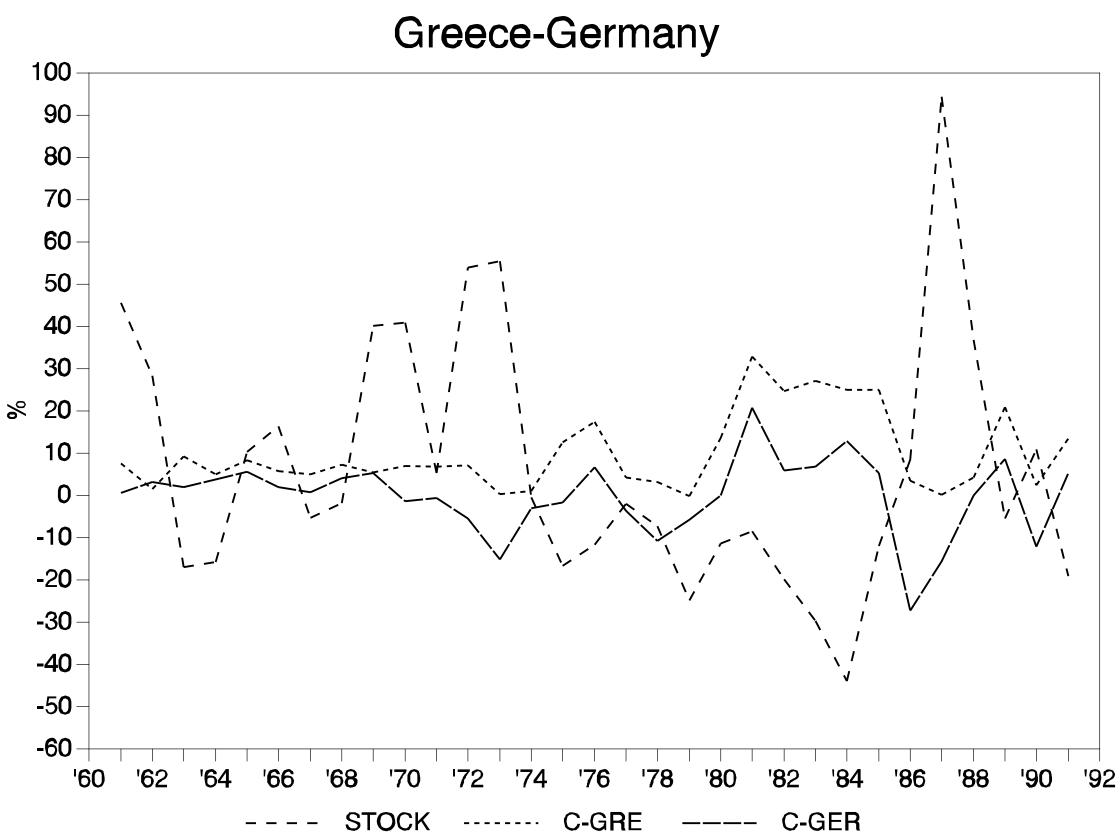


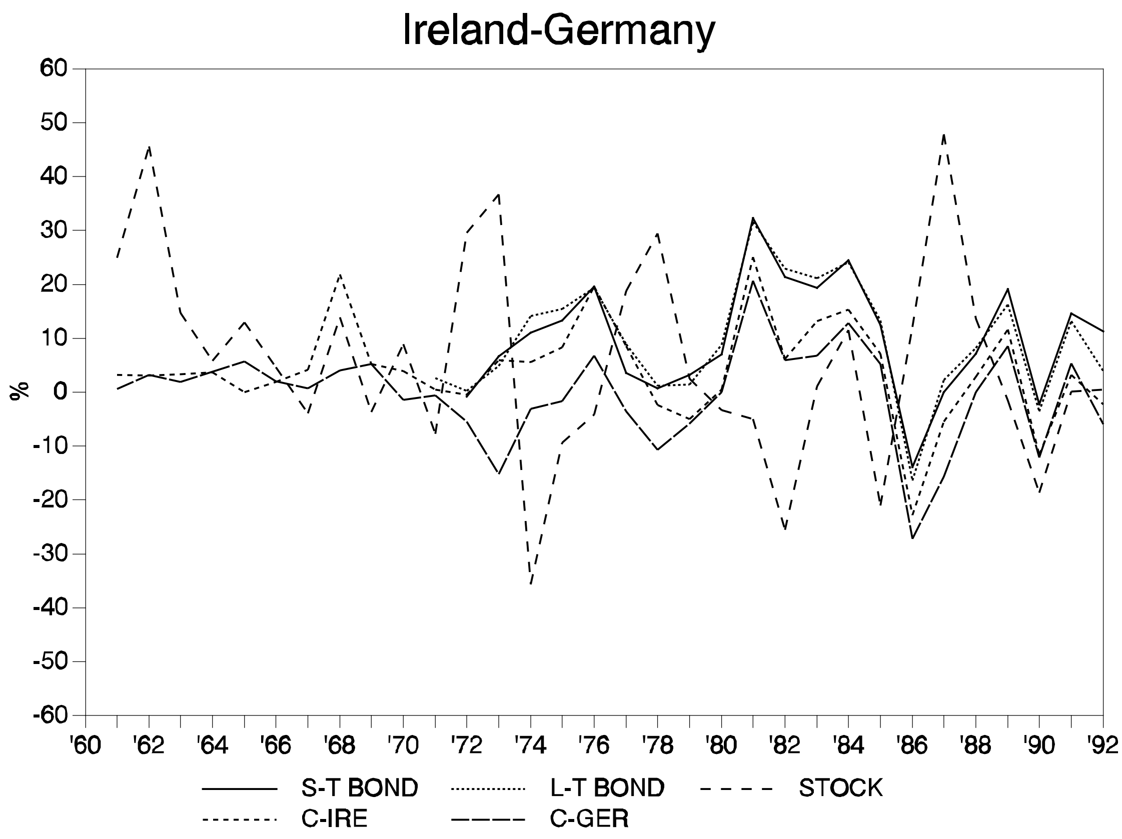



Denmark-Germany
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
%
'60
'62
'64
'66
'68
'70
'72
'74
'76
'78
'80
'82
'84
'86
'88
'90
'92
S-T BOND
L-T BOND
STOCK
C-DEN
C-GER

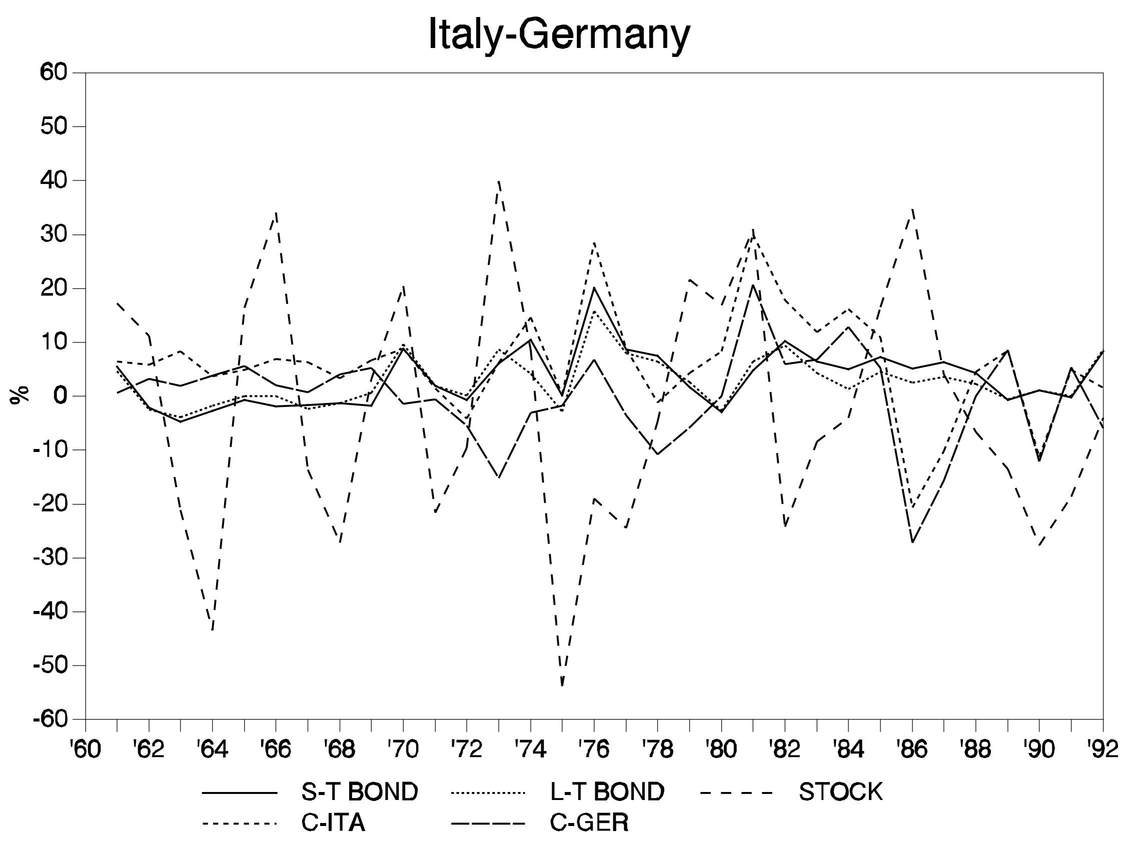

Finland-Germany
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
%
'60
'62
'64
'66
'68
'70
'72
'74
'76
'78
'80
'82
'84
'86
'88
'90
'92
S-T BOND
L-T BOND
STOCK
C-FIN
C-GER


France-Germany
%
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
'60
'62
'64
'66
'68
'70
'72
'74
'76
'78
'80
'82
'84
'86
'88
'90
'92
S-T BOND
L-T BOND
STOCK
C-FRA
C-GER

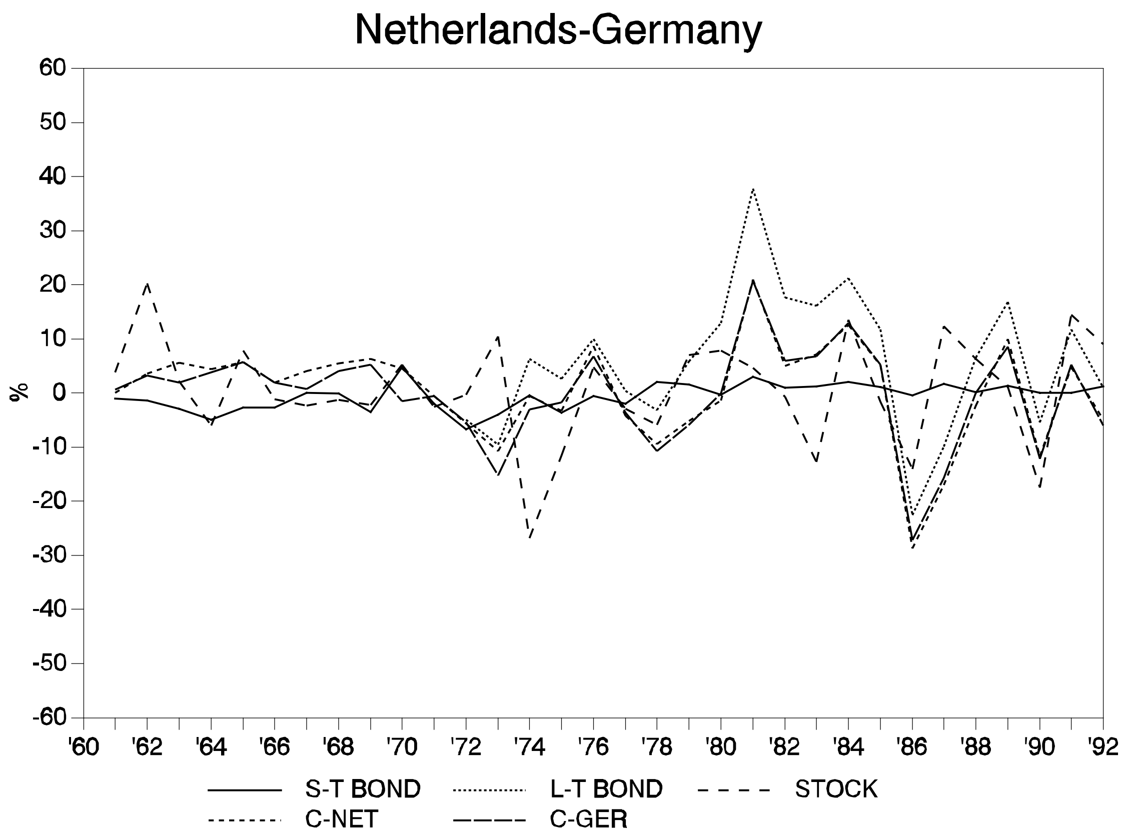

Greece-Germany
%
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
'60
'62
'64
'66
'68
'70
'72
'74
'76
'78
'80
'82
'84
'86
'88
'90
'92
STOCK
C-GRE
C-GER

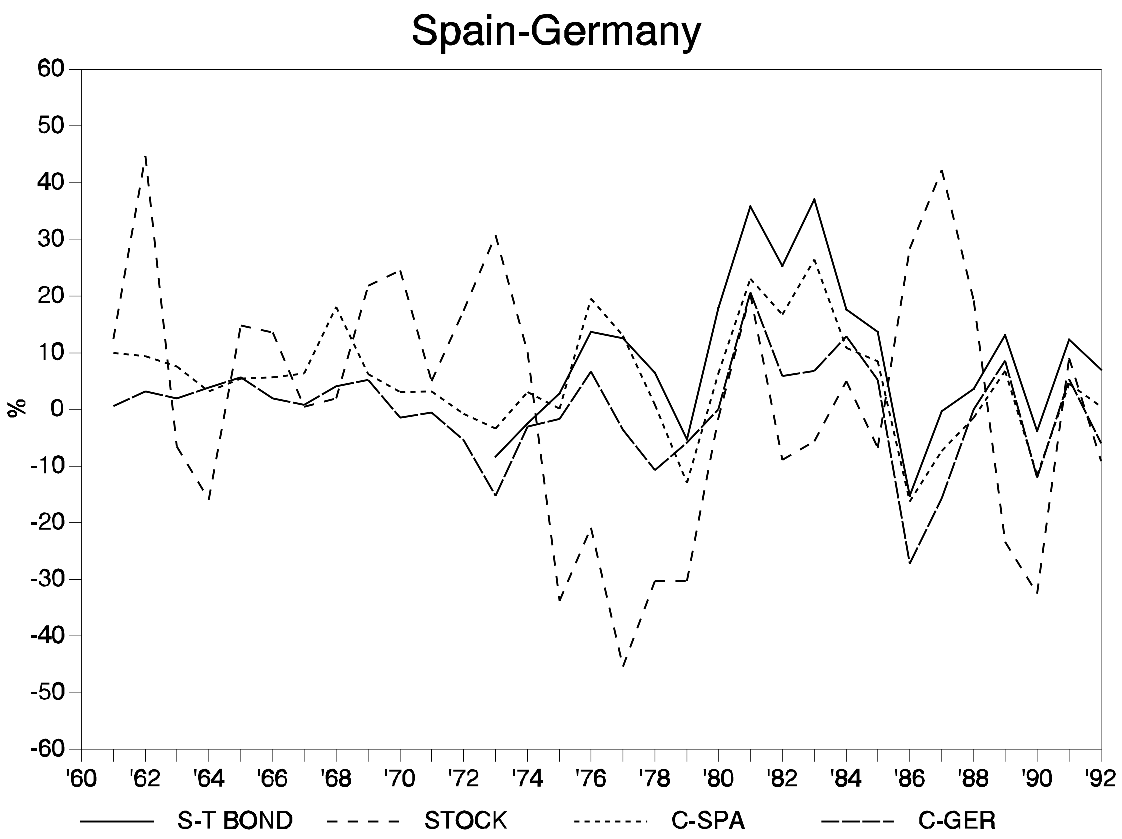


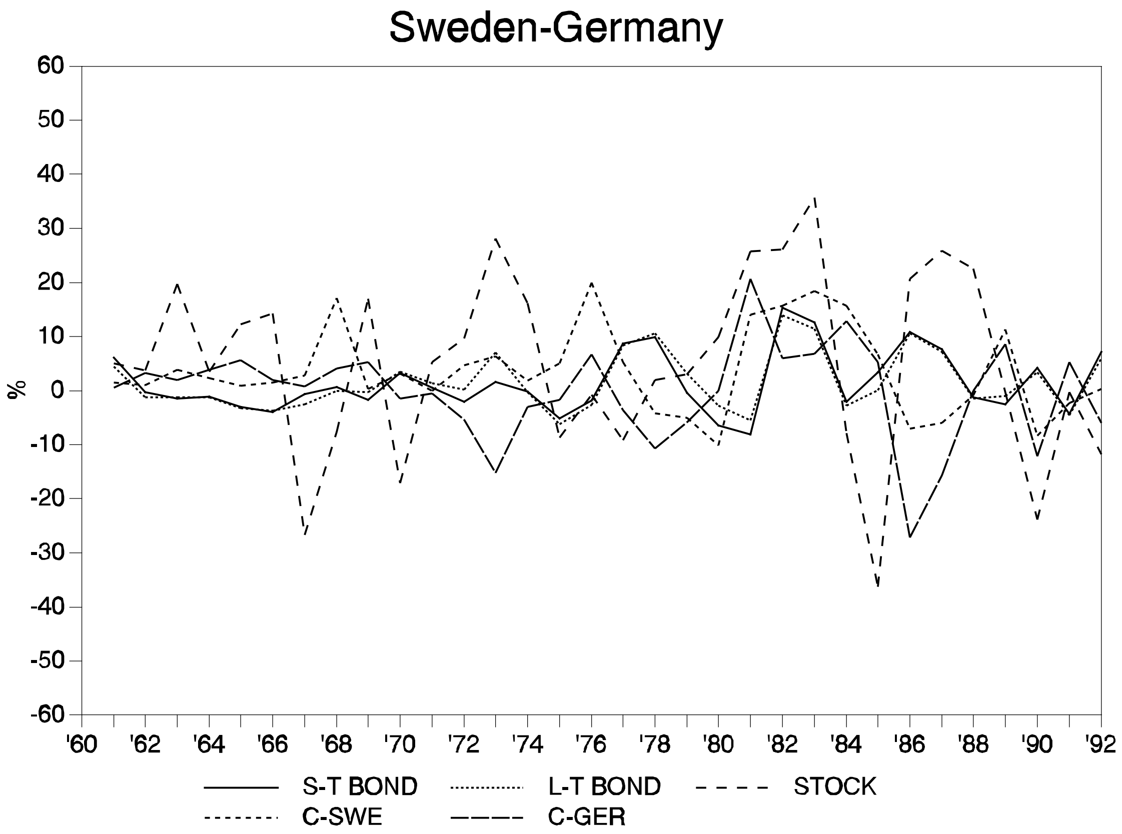
Ireland-Germany
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
%
'60 '62 '64 '66 '68 '70 '72 '74 '76 '78 '80 '82 '84 '86 '88 '90 '92
S-T BOND
L-T BOND
STOCK
C-IRE
C-GER

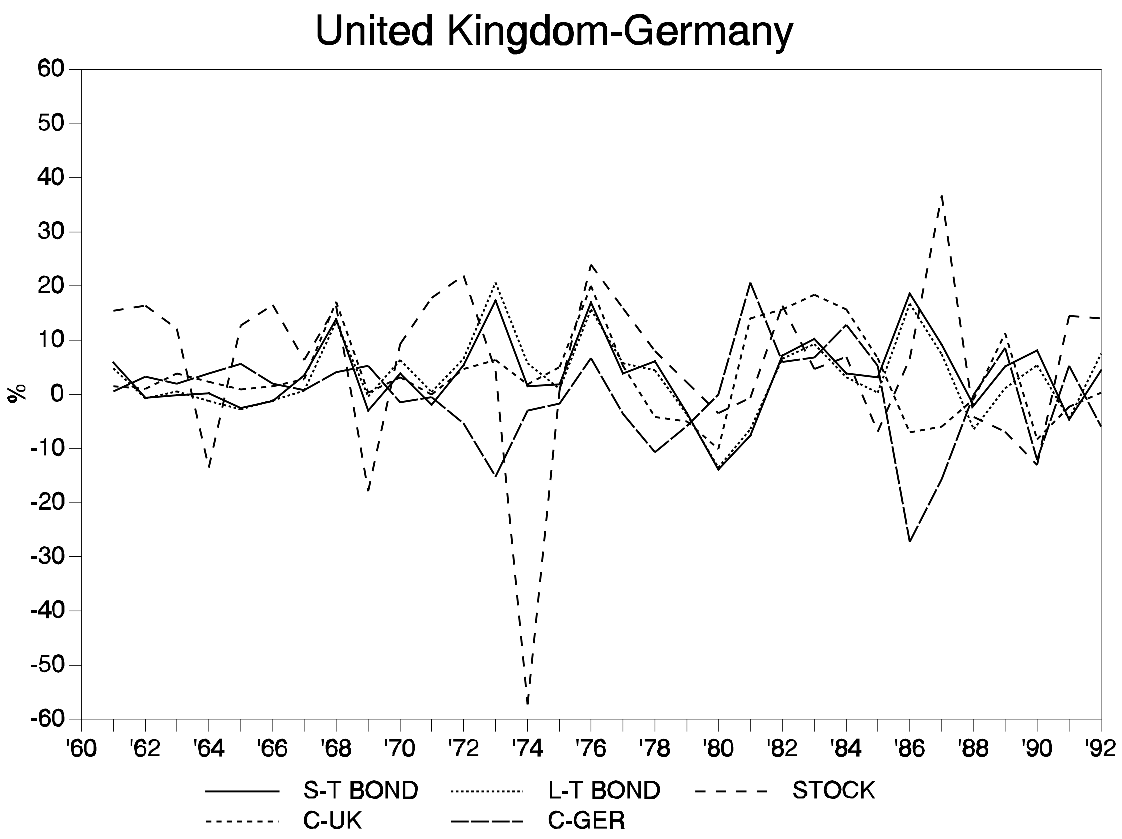


Italy-Germany
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
%
'60 '62 '64 '66 '68 '70 '72 '74 '76 '78 '80 '82 '84 '86 '88 '90 '92
S-T BOND
L-T BOND
STOCK
C-ITA
C-GER


Netherlands-Germany
%
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
'60
'62
'64
'66
'68
'70
'72
'74
'76
'78
'80
'82
'84
'86
'88
'90
'92
S-T BOND
L-T BOND
STOCK
C-NET
C-GER


Spain-Germany
%
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
'60
'62
'64
'66
'68
'70
'72
'74
'76
'78
'80
'82
'84
'86
'88
'90
'92
S-T BOND
STOCK
C-SPA
C-GER


Sweden-Germany
%
S-T BOND
L-T BOND
STOCK
C-SWE
C-GER


United Kingdom-Germany
%
S-T BOND
L-T BOND
STOCK
C-UK
C-GER