IIIS Discussion Paper

No.243/ February 2008

Indicators of regional financial integration

Agustín S. Bénétrix
Dept. of Economics and IIIS, Trinity College Dublin

Sébastien Wälti
Swiss National Bank and IIIS, Trinity College Dublin

IIIS Discussion Paper No. 243

Indicators of regional financial integration

Agustín S. Bénétrix
Sébastien Wälti

Indicators of regional financial integration*

Agustín S. Bénétrix†
Department of Economics and IIIS, Trinity College Dublin

Sébastien Wälti‡
Swiss National Bank and IIIS, Trinity College Dublin

First version: September 2007
This version: January 2008

Abstract

This book chapter provides for a review of quantity-based and price-based indicators of regional financial integration. These measures should be easy to construct and interpret, based on publicly available data, and available for many countries and regions over time. The chapter discusses the underlying datasets in great detail and explains the construction of various indicators. Several applications, mostly using the process of European integration as a case study, show that regional financial integration has increased over the last decades, in particular in Europe after the introduction of the euro. However, there has been a parallel process of financial integration at the global level.

JEL Classification: E44; F15; F21; F36; G15.

Keywords: Financial integration; indicator; globalisation; regional integration; European Monetary Union.

*Prepared for a book chapter in the *Handbook for Monitoring and Analysing Regional Integration Processes*, edited by Philippe De Lombaerde, Lelio Iapadre, Michael Schulz and Renato Flores. We are grateful to Philip Lane and the editors for comments and suggestions. Bénétrix gratefully acknowledges the financial support of the IIIS. The views expressed in this paper are those of the authors and do not necessarily represent those of the Swiss National Bank.

†Bénétrix: Department of Economics and IIIS, Trinity College Dublin, Dublin 2, Ireland. Email: benetria@tcd.ie Phone: +353 1 8963209.

‡Wälti: Swiss National Bank, Börsenstrasse 15, 8022 Zürich, Switzerland. Corresponding author. Email: sebastien.waelti@snb.ch. Phone: +41 44 6313943. Most of the work on this paper was carried out while Wälti was at the Department of Economics, Trinity College Dublin, Ireland.

1 Introduction

International financial integration has increased significantly over the last twenty years, both at the regional level and at the global level. A greater degree of financial integration carries important implications for academic researchers, central bankers, financial regulators and international investors. For example, financial institutions monitor closely the degree of international comovement among bond and equity markets since this comovement determines the size of the benefits from international portfolio diversification. Financial regulators seek to understand the sources of shocks for domestic financial institutions, while central banks assess the impact of greater financial integration on the transmission of monetary policy. As a result, there is a significant demand for indicators of financial integration that are relatively easy to construct and interpret, based on publicly available data, and available for many countries and regions over time. This chapter reviews some of these indicators, describes the underlying datasets, and presents some illustrative evidence.

The degree of financial market integration can be assessed in different, complementary ways. On the one hand, *de jure* measures of financial market integration rely on the dating of financial market liberalisations initiated by policymakers. The effects of such liberalisation episodes are typically examined using event-study methodologies. On the other hand, *de facto* measures focus on the outcomes of such liberalisations. The impact of policy decisions will develop into outcomes gradually over time and therefore, de jure and de facto measures will provide different, yet complementary views about the extent of financial market integration.

De jure measures of financial integration rely mostly on the information provided by the International Monetary Fund (IMF) in its *Annual Report on Exchange Arrangements and Exchange Restrictions*. The IMF provides for a binary indicator of capital account restrictions based on official statements by national authorities. The binary nature of this indicator is a significant weakness since it does not provide information about the intensity of capital controls[1]. More importantly, it does not allow to distinguish between

[1]Some researchers, such as Quinn (1997) and Chinn and Ito (2006), have transformed the binary

intra-regional financial integration and a region's integration with the rest of the world. As a result, de facto measures are now widely preferred as a means of characterising regional and global financial integration and this chapter discusses de facto indicators exclusively[2].

De facto measures are based either on the size and the location of foreign investments in equity and long-term debt, or on the degree of asset return comovements. The structure of this chapter reflects this traditional distinction in the literature. Section 2 will develop quantity-based indicators of regional financial integration, while section 3 will focus on indicators motivated by the asset pricing literature. Each section will detail the construction of the indicator, the underlying data, and present the results for several applications. The final section concludes.

2 Quantity-based indicators of regional financial integration

This section discusses our first set of indicators measuring the degree of regional financial integration (RFI). These are based on the quantity and location of foreign investments. Cross-country comparisons of the degree of international financial integration (IFI) with quantity-based indicators are relatively new. The reason is that they are based on measures of gross stocks of foreign assets and liabilities, the international investment position (IIP), which were not available until the International Monetary Fund's (IMF) first publication in 1997. At the time, the country coverage was less than a dozen with data available from 1980 and about thirty with data starting from the mid-nineties.

2.1 Indicators based on multilateral data

To fill this gap, Lane and Milesi-Ferretti (2001) have published the External Wealth of Nations (EWN) dataset. This database represented the first improvement of the IMF's measures of the international investment position. It also provided estimates for countries

classification into a more continuous measure.

[2]See Adam et al. (2001) for an exhaustive review including de jure indicators.

where stock data were not available, thereby expanding the country and the time coverage to 67 and 1970-1998, respectively. The EWN dataset relies on several international as well as national data sources, including the IMF's Balance of Payments Statistics and International Financial Statistics; the World Bank's World Debt Tables and Global Development Finance; the OECD statistics on external indebtedness; the Bank of International Settlements' data on banks' assets and liabilities by creditor and debtor; and national sources for the direct estimates of stocks and cumulative flows with valuation adjustments for indirect estimates. The dataset reports holdings by domestic residents of financial claims on the rest of the world, classified into five categories: portfolio investment, foreign direct investment, other investments, financial derivatives and reserve assets. Portfolio investment includes equity securities and debt securities, the latter including bonds plus money market debt instruments. Foreign direct investment is given by greenfield investment plus equity participations giving controlling stake (equity shares above 10 percent). Other investments include debt instruments such as loans, deposits and trade credits. Lane and Milesi-Ferretti (2007a) have taken advantage of the fact that a larger set of countries were publishing estimates of external assets and liabilities to extend their dataset to 145 countries and the time period to 2004. The EWN Mark II dataset is now the basis for cross-country comparisons of financial integration by means of quantity-based indicators.

Obstfeld and Taylor (2002) have argued that quantity-based indicators of international financial integration should take the growth in national and international economies into account. Rising indicators could be associated with an increase in the nominal values of assets and liabilities and not with market integration *per se*. In order to overcome this problem, they suggest to normalize foreign capital at each point in time by a measure of size. They show that an apparently good denominator would be the total stock of capital, whether financial or real. However, Goldsmith (1984) shows that financial capital has greatly increased as the number of balance sheets in the economy has expanded, and that could happen without any underlying change in the extent of foreign asset holdings. Morever, estimates of real capital stocks remain unreliable. Therefore, Obstfeld and Taylor (2002) propose to use the level of output measured in current prices in a common

currency unit as a scaling factor. They sustain that in the short run, the capital-output ratio should be an adequate proxy measure of the penetration of foreign capital in an economy.

Taking these considerations into account, Lane and Milesi-Ferretti (2007a) measure international financial integration (IFI) as the ratio of the gross stocks of foreign assets (A_t) plus foreign liabilities (L_t) over nominal gross domestic product (GDP_t):

$$\text{IFI}_t = \frac{A_t + L_t}{GDP_t} \tag{1}$$

Using this indicator, they show that the degree of IFI has grown dramatically over the last eighteen years in both industrialised and developing countries. Importantly, the indicator IFI_t measures the degree of international financial integration of a country and not the degree of regional financial integration. This is because the index is based on multilateral data, the EWN Mark II. One may think that an approximation can be obtained by adding up the IFI measures of each of the country members. However, this would give an indication of the degree of integration of the country members with the rest of the world, also taking other members of the region as part of the rest of the world.

Multilateral data can also be used to assess the direction of capital flows. Obstfeld (2004) adapts the Grubel and Lloyd (1975) index of intra-industry trade to cross-border asset trade. He conceives one-way asset trade, or 'development' finance as the export of currently available goods in return for the promise of future goods, giving rise to an imbalance in the current account, and two-way asset trade, or 'diversification' trade as the mutual exchange of differentiated claims to future output. He shows that the direction of investment can be measured by

$$\text{GL}_t = 1 - \frac{|A_t - L_t|}{A_t + L_t} \tag{2}$$

This index equals unity for a country with no net foreign assets or debt. This means that it has not engaged in intertemporal trade or that capital flows have diversification purposes. It is equal to zero when, for example, all liabilities are net liabilities. In other

words, they represent pure development finance.

One problem with this indicator is that it may not take the increase in leverage into account, that is an equal rise in assets and liabilities. Therefore, it is convenient to use GL_t in equation (2) together with IFI_t in equation (1). In this way, it is possible to assess the direction of asset trade controlling for the increase in leverage. Using this methodology and the EWN Mark II, Obstfeld (2004) shows that for emerging markets in general, diversification finance remains much less prominent than development finance. They receive large 'development' flows.

2.2 Indicators based on bilateral data

We have shown above that multilateral data cannot provide precise measures of regional financial integration. They only allow to compute the regional trend in gross stocks or to infer the direction of international financial investments. The recent development of bilateral databases now allows for the construction of regional quantity-based indicators for specific categories of assets.

We would mention at least three of these databases. The first one is the Locational Banking Statistics of the Bank of International Settlements (2006). This database provides locational statistics for cross-country bank loans and deposits vis-à-vis non-residents in all currencies or foreign currencies only. Loans comprise financial assets which are created through the lending of funds by a creditor to a debtor and which are not represented by negotiable securities. Deposits comprise claims reflecting evidence of deposits, including non-negotiable certificates of deposit, which are not represented by negotiable securities. The actual number of reporting countries is 40. The data is presented in quarterly frequency and the time coverage varies across reporters. For 14 countries, it starts in 1977, for 5 in 1983 and for the rest in 1997 or early 2000.

The second bilateral database is compiled by the United Nations Conference on Trade and Development. It gives information on aggregate inflows, outflows, inward stocks and outward stocks of foreign direct investment for a set of 196 countries. It covers the period 1970 to 2004 and it has annual frequency. The third database focuses on portfolio invest-

ment. The IMF publishes the Coordinated Portfolio Investment Survey (CPIS) which provides aggregate and bilateral data for portfolio equity, short- and long-term debt. For each country source, the CPIS reports holdings in up to 220 destinations - countries and international institutions. It was first conducted in 1997 with 29 participating economies. From 2001 onwards, it has been collected on an annual basis including, in 2006, 74 reporting economies.

Since the Locational Banking Statistics of the BIS are not publicly available, and Chapter 8 of this book deals with foreign direct investment, we will focus exclusively on indicators constructed on the basis of the Coordinated Portfolio Investment Survey of the IMF. An indicator of regional financial integration, hereafter RFI, is computed by decomposing the traditional measure of international financial integration into assets or liabilities held within the region, and assets or liabilities traded between the region and the rest of the world. That is, we decompose equation (1) into intra- and extra-regional financial integration. This indicator can be constructed using two different scaling factors: the size of total foreign assets and liabilities ($A_t + L_t$) or the nominal gross domestic product (GDP_t). On the one hand, scaling by $A_t + L_t$ gives information on the degree of 'home bias'. That is, the share of total foreign assets and liabilities traded within the region. On the other hand, the use of GDP_t as scaling factor not only adds to the previous the characteristic of being a good measure of foreign capital penetration, but it also captures the upsurge in gross stocks documented by Lane and Milesi-Ferretti (2007a).

To construct a measure of regional financial integration we sum equation (1) over the region's countries and add and subtract intra-regional trade of assets and liabilities in the numerator:

$$IFI^{*}_{R,t} = \frac{A_{R,t} + L_{R,t} - \Sigma_{i \in R}\Sigma_{j \in R}\left(A_{ij,t} + L_{ij,t}\right)}{GDP_{R,t}} + \frac{\Sigma_{i \in R}\Sigma_{j \in R}\left(A_{ij,t} + L_{ij,t}\right)}{GDP_{R,t}} \qquad (3)$$

Countries belonging to region R are indexed with i or j, where $i \neq j$. $A_{R,t}$ ($L_{R,t}$) is the sum of the region's countries total foreign assets (liabilities), and $GDP_{R,t}$ is the gross domestic product of the region. A_{ij} stands for country i's claims on country j and L_{ij} for country j's claims in country i. That is, country i's assets in j and country i's liabilities

held by j. This information comes from the CPIS. The first term of equation (3) measures the degree of extra-RFI, the second the degree of intra-RFI. This indicator can be applied to the whole portfolio investment or to the different CPIS sub-components: long-term portfolio debt, short-term portfolio debt and portfolio equity.

2.3 Regional financial integration and the euro

Bilateral data on cross-country asset holdings allow us to compute indicators of regional financial integration. There have been several applications in the literature. Lane and Milesi-Ferretti (2008), Lane and Milesi-Ferretti (2007b) and Lane (2006), examine how the creation of a region affects the investment pattern across country members. Lane and Milesi-Ferretti (2008) develop an empirical approach to explain cross-border equity holdings by exploiting the link between equity holdings, bilateral trade and informational proximity. With this empirical approach, Lane and Milesi-Ferretti (2007b) find that common membership to the European Monetary Union (EMU) raises bilateral portfolio equity holdings by 62 percent. Using a similar model, Lane (2006) shows that common membership to the EMU raises bilateral bond holdings by about 85 to 100 percent depending on the econometric specification.

Bilateral data can also be used together with multilateral data to monitor the evolution of RFI and IFI over time. The remainder of this section makes use of quantity-based indicators to study intra- and extra-regional financial integration for EMU members. Before constructing these indicators, we wish to mention that a number of missing data points have been addressed in three steps:

1. If total assets or total liabilities between a country pair are missing, we expand them backward or forward using the rate of change of total debt. This method gives a good approximation since the share of total debt in the total is very significant for most of the countries. For instance, the average share of portfolio debt in total for EMU countries in the period 1997-2005 ranges between 65.8 to 73.1 percent in assets and 58.3 to 76 percent in liabilities.

2. When a value in some sub-component is missing for assets or liabilities, we expand it with the rate of change of total assets or liabilities, respectively.

3. If there are no data for a certain year in any of the categories or aggregates, we expand them using the rates of change of the whole region by category.

2.3.1 The importance of portfolio investment

It is convenient to start by reporting the importance of the CPIS categories in the aggregate international portfolio using the EWN Mark II and the IMF's International Investment Positions. Table 1 presents the shares of portfolio equity and portfolio debt for eleven EMU countries in 2006[3]. The share of portfolio equity assets in total assets varies between 6.8 and 21.5 percent. Countries with the smallest share are Greece and Portugal, while the one with the largest share is Italy. Portfolio equity liabilities range between 3.5 to 35.9 percent of total liabilities. Belgium and Ireland are the countries at the extremes. Portfolio debt assets extend from 20.9 to 39.8 percent, while liabilities lie between 12.8 and 45.6 percent. For the first case, the countries at the extremes are again Belgium and Ireland while for the second, Belgium and Greece. The degree of penetration of each of these categories is computed using GDP as scaling factor.

INSERT TABLE 1 ABOUT HERE

The last row of Table 1 presents the weighted average of these shares. The weight for each country is given by the share of that category in the total of the region. For instance, 21.5 percent of the total foreign assets in Italy are portfolio equity, while the share of Italy in the total portfolio equity of the EMU is 12.9 percent. Therefore, to compute the weighted average, we multiply Italy's portfolio assets by 0.129. The same rationale is applied to the weighted average of portfolio equity liabilities, portfolio debt assets and portfolio debt liabilities. When variables are scaled by GDP, the weight for each

[3]We exclude Luxembourg to minimise the problems that arise with third-party holdings in major financial centers. For instance, securities issued by country B and held in an institution residing in country C by a resident of country A may not be properly traced. Lane and Milesi-Ferretti (2008, 2007c) discuss potential weaknesses of the CPIS dataset.

country is given by its share in the GDP of the EMU. Note that adding these weighted averages for assets and liabilities yields equation (3). For 2006, the table shows that the degree of international financial integration of the region in portfolio investment was 222.5, 78.7 in portfolio equity and 143.8 in portfolio debt.

INSERT TABLE 2 ABOUT HERE

In order to have a clear overview of the importance of portfolio investment, it is convenient to show the time pattern of all these shares. Table 2 reports the weighted average shares in the last row of Table 1 but for the period from 1997 to 2006. The first thing to notice is the upsurge in IFI documented by Lane and Milesi-Ferretti (2007a). The percentage change in IFI between 1997 and 2006 was 268.2, 199.1, 293.8 and 212.2 for portfolio equity assets, portfolio equity liabilities, portfolio debt assets and portfolio debt liabilities respectively. The table shows that portfolio shares are fairly stable. The mean rate of growth was 4.0, 2.4, 4.8 and 1.5 percent for portfolio equity assets, portfolio equity liabilities, portfolio debt assets and portfolio debt liabilities respectively. Finally, this table shows that the CPIS data constitutes between 31.2 and 45.6 percent of total foreign assets and between 47.8 and 56.5 percent of total foreign liabilities.

2.3.2 Intra- and extra-EMU financial integration

Knowing the importance of portfolio equity and debt, we can move to the assessment of regional financial integration (RFI). Figure 1 presents extra- and intra-EMU financial integration using the first and second terms of equation (3) for all years available in CPIS. We focus on long-term portfolio debt and portfolio equity. Between 1997 and 2006, portfolio debt behaves consistently with the findings of Lane and Milesi-Ferretti (2007a). Both intra- or extra-RFI experienced significant increases. Intra-RFI grew faster from 2001 onwards. The mean rate of growth of the intra-/extra-RFI ratio was 6.2 percent a year. From 1997 to 2001 portfolio equity also experiences an important increase in terms of GDP. However, there is no evidence of an acceleration in intra-RFI relative to extra-RFI as in the case of portfolio debt. In fact, portfolio equity experiences the opposite

trend. The mean rate of growth of the intra-/extra-RFI ratio for the period 2001-2006 was -1.8 percent a year.

INSERT FIGURE 1 ABOUT HERE

Table 3 reports, for each country member, the change between 2001 and 2006 of IFI together with the change in intra- and extra-RFI. Again, we see the significant increase in the quantity of foreign assets and liabilities, in this case using GDP in 2001 as a scaling factor to control for the changes in the denominator. At the top of the league we find Ireland with changes in IFI for portfolio equity and long-term debt equivalent to 630.2 and 906.4 percent of GDP, respectively. For this country, the increase in portfolio equity was biased in the direction of the rest of the world. Almost 71.2 percent of the change in portfolio equity corresponded to claims in and from the rest of the world. The same table shows that for of portfolio debt, the growth of intra- and extra-RFI was balanced. Most of the countries, however, show a relative increase in extra-RFI in portfolio equity and intra-RFI in portfolio debt.

INSERT TABLE 3 ABOUT HERE

Figure 2 shows the ratio between the change in intra-RFI and extra-RFI for portfolio equity and portfolio debt between 2001 and 2006. We plot the ratio of the changes in long-term portfolio debt on the vertical axis and the ratio of the changes in portfolio equity on the horizontal axis. We refer to these as the debt ratio and the equity ratio. The figure shows that all country members have strengthened bond trade with the rest of the EMU. All countries have debt ratios greater than one. Italy and Belgium exhibit the highest increases, with ratios of 3.62 and 2.6 respectively, while Ireland has the smallest increase with a debt ratio equal to 1.03.

INSERT FIGURE 2 ABOUT HERE

On the portfolio equity side, none of the country members experienced a relative increase in intra-EMU claims. That is, none of them show equity ratios greater than

one. Thus, when we put both ratios in a scatter plot, all EMU countries lie above the 45 degree line. Portugal is the country with the highest equity ratio at 0.95. Netherlands and Finland are those with the smallest equity ratios, at 0.20 and 0.21 respectively. To conclude, quantity-based indicators of regional financial integration for the EMU suggest that between 2001 and 2006, regional financial integration has strengthened in portfolio debt and decreased in portfolio equity.

3 Price-based indicators of regional financial integration

The detailed information available from the Coordinated Portfolio Investment Survey (CPIS) allows for the construction of very accurate indicators of bilateral and regional financial integration in the cross-section dimension. However, the survey has been conducted for recent years only and its short time dimension implies that we cannot fully characterize the evolution of regional financial integration over long periods of time. This limitation calls for a complementary approach usually referred to as the price-based approach. The construction of price-based indicators of bilateral and regional financial integration relies on high-frequency financial data which are easy to access, and cover long time spans.

A greater level of regional financial integration implies that asset returns within this region will be increasingly driven by regional factors rather than country-specific factors. The lower segmentation of domestic financial markets means that the proportion of domestic asset return volatility that is explained by the volatility of regional factors increases, thereby leading to stronger asset return comovements. The implementation of full financial liberalization within the European Union (EU) and the introduction of the euro in a subset of EU members have contributed to increasing the level of financial integration within this region of the world. To take the euro as an example, the existence of a common currency implies that currency risk disappears completely, so that the barriers to cross-border investment arising from the costs of hedging currency risk are fully eliminated. Furthermore, the associated common monetary policy should mean that

bond yields converge almost completely.

The literature makes use of correlation coefficients between domestic asset returns and a regional asset return to measure the degree of regional financial integration. Some studies have used the concept of variance ratios, which convey exactly the same information as correlation coefficients. We show that these two measures are really two sides of the same coin. We use the process of European financial integration as a case study. However, the measures that we present can be constructed for other regions of the world as easily as for the European region since high-frequency financial data are available for a large number of countries over a reasonably long time period.

3.1 Methodology

A greater level of regional financial integration means that national asset markets within this region become more exposed to common regional shocks. As a result, the correlation coefficient between individual national asset returns and a corresponding regional return should rise. This is our first price-based measure of regional financial integration. Solnik and Roulet (2001) and Adjaouté and Danthine (2004) show that the global pattern of correlations, that is the state of financial integration across various countries at a given point in time, can be captured through the cross-sectional dispersion of national asset returns. Intuitively, more correlated returns should exhibit a smaller standard deviation in the cross-sectional dimension, while less correlated returns will be associated with a larger standard deviation. This alternative approach provides for an instantaneous measure of financial integration, that is an indicator that is available for every period of time and allows for the identification of structural changes in the pattern of global correlations. This is our second measure of regional financial integration. Clearly, it cannot be computed on a country-by-country basis; it only provides information on the overall pattern of correlations across countries.

Correlation coefficients between individual asset returns and a corresponding regional return are closely related to the concept of variance ratios (Fratzscher, 2002; European Central Bank, 2007). To take an extreme example, suppose that a country's bond market

is perfectly segmented from other bond markets in the same region. Domestic bond market volatility will result entirely from country-specific shocks; regional shocks have no effect on local bond markets. Conversely, suppose now that the same country's bond market is fully integrated regionally, perhaps because of the introduction of a common currency. Domestic bond market volatility will now fully arise from nondiversifiable regional shocks. Intuitively, a greater degree of regional financial integration should translate into a greater role for regional shocks relative to country-specific shocks.

Suppose that changes in domestic bond yields in country i, denoted as $\Delta R_{i,t}$ are determined by changes in a reference bond yield, written as $\Delta R_{b,t}$ as well as a country-specific factor $\varepsilon_{i,t}$:

$$\Delta R_{i,t} = \alpha_i + \beta_i \Delta R_{b,t} + \varepsilon_{i,t} \tag{4}$$

where α_i is an intercept estimated for country i, and β_i is a slope coefficient for country i which captures the sensitivity of the domestic bond market to shocks in the reference bond market. Importantly, we assume that $E(\Delta R_{b,t}\varepsilon_{i,t}) = 0$. The variance of the change in the domestic bond yield is obtained as

$$\sigma^2_{\Delta R_{i,t}} = \beta_i^2 \sigma^2_{\Delta R_{b,t}} + \sigma^2_{\varepsilon_{i,t}} \tag{5}$$

and the proportion of domestic bond market volatility explained by regional shocks is simply computed as a variance ratio:

$$VR_{i,t} = \frac{\beta_i^2 \sigma^2_{\Delta R_{b,t}}}{\sigma^2_{\Delta R_{i,t}}} \tag{6}$$

The variance ratio provides information about the importance of regional shocks relative to country-specific shocks. A perfectly segmented bond market will exhibit a variance ratio equal to zero. An almost completely integrated regional bond market should yield a variance ratio converging towards unity. It is worth noting that in this one-variable model, the variance ratio is the R-squared statistic, which indicates the proportion of the variation in the dependent variable that is explained by the variation in the explanatory

variable.

The correlation coefficient is computed as the ratio of the covariance between changes in domestic bond yields and changes in a reference bond yield, to the product of the standard deviations. Thus,

$$\rho(\Delta R_{i,t}, \Delta R_{b,t}) = \frac{Cov(\Delta R_{i,t}, \Delta R_{b,t})}{\sigma_{\Delta R_{i,t}} \sigma_{\Delta R_{b,t}}} \tag{7}$$

An estimate of the coefficient β_i can be obtained by ordinary least squares as

$$\beta_i = \frac{Cov(\Delta R_{i,t}, \Delta R_{b,t})}{\sigma^2_{\Delta R_{b,t}}}$$

Rewriting the correlation coefficient, we get

$$\rho(\Delta R_{i,t}, \Delta R_{b,t}) = \beta_i \frac{\sigma_{\Delta R_{b,t}}}{\sigma_{\Delta R_{i,t}}} \tag{8}$$

It appears clearly that the correlation coefficient is simply the square root of the variance ratio (see equation (6)). Both measures provide the same ordinal information about the state of regional financial integration.

To summarize, lower financial market segmentation implies that the correlation between individual asset returns and a corresponding regional return should increase. The overall pattern of correlations at a given point in time can be captured by cross-sectional deviations of individual asset returns. Variance ratios convey the same information as correlation coefficients. The remainder of this section will use correlation coefficients and cross-sectional standard deviations to cast light on the state of regional financial integration. So doing, we should not forget that financial integration has also increased at the global level. Therefore, we always compute measures of financial integration at the regional as well as the global level, so as to make sure that rising financial integration at the regional level is not actually the result of global financial integration.

3.2 Data

To assess the degree of bond market integration, we focus on government bond yields with maturities of ten years. These yields are retrieved from Eurostat at the monthly frequency. The data availability varies from one country to another, ranging from the seventies and early eighties for countries such as the United States, Japan, Germany, France and Italy, to the late eighties and early nineties for Ireland, Greece, Portugal and Sweden.

Equity market integration is assessed using Datastream Global stock market indices. These indices cover a wide range of national stock markets and are computed on the basis of a representative sample of stocks within each national stock market. These indices are widely used because of their consistency and their comparability across countries. Moreover, they are available back to 1973 for most developed economies, thereby allowing for an examination of the degree of financial integration over the entire post-Bretton-Woods era. These indices are transformed into returns by taking percentage changes. We have gathered data at the daily frequency and averaged these for each week to obtain weekly data. Daily data remain somewhat problematic because of non-synchronous trading hours, while monthly data may not provide enough information to the extent that the computation of variance ratios and correlation coefficients requires a significant amount of data.

Correlation coefficients are computed with respect to a regional index return. Instead of using Datastream's regional indices, we compute our own indices as a weighted average of the returns of all the countries in a given region, excluding the country with respect to which the correlation coefficient (or the variance ratio) is calculated. Why are we doing this? Suppose that a country counts for fifty percent of a region's aggregate stock market. Computing the correlation between this country's return and the regional return will result in an upward bias by definition. Therefore, it is necessary to exclude the country with respect to which the correlation coefficient is calculated, in particular if this country is large financially speaking. Mathematically, the regional return used to calculate the correlation with the return of country j is written as

$$R^{j}_{REG,t} = \frac{1}{\sum_{k \neq j} w_{k,t}} \left[\sum_{k \neq j} w_{k,t} r_{k,t} \right] \tag{9}$$

The weights for each country are obtained as the ratio of this country's stock market capitalisation to the total market capitalisation of the countries in the region.

The choice of the currency denomination remains an important one. We make use of returns denominated in domestic currency. Many studies would usually rely on returns denominated in the same currency, typically the U.S. dollar, taking the view of an international investor. However, Fratzscher (2002) argues that such an assumption means that international investors do not have the ability to hedge any of their foreign exchange exposure. This is doubtful in today's growing world of financial derivatives. Moreover, a high degree of integration could result from exchange rate changes as opposed to true financial integration. These two arguments lead us to follow Fratzscher (2002) and to use returns expressed in domestic currency. In the end, we also made computations with returns expressed in U.S. dollars and the results remain essentially the same.

3.3 Evidence on bond market integration

Figure 3 depicts ten-year government bond yields for a sample of eleven participants to the European Monetary Union (EMU), three EU members that have not adopted the euro (United Kingdom, Sweden and Denmark), and the United States as well as Japan. The sample period goes from January 1993 until December 2006. Figure 4 graphs, for each month, the cross-sectional standard deviation for three subsets of our sample of countries: the EMU group of eleven countries, an EU group of fourteen countries (eleven EMU participants plus the three EU non-EMU countries), and a world group consisting of all sixteen countries. One may argue that it is a weakness of our approach that the world group does not contain more countries from many different regions in the world. Against this, we take the view that the flexibility in defining different subsets of countries is actually a strength. Regions and the world can be defined as is most convenient for the researcher.

INSERT FIGURES 3 AND 4 ABOUT HERE

Both figures 3 and 4 point to several important observations. Long-term government bond yields are significantly closer nowadays than in the past, with the exception of the particular case of Japan. The EMU group has experienced almost complete bond yield convergence; the elimination of currency risk after the introduction of the common currency implies a very high degree of substitutability of bonds. The cross-sectional standard deviation of EMU participants' bond yields is almost zero. Because of free capital mobility within the European Union, bond yields of EU members that are not participating in the monetary union are also very close to those of EMU members. An interesting case is Denmark. Even if Denmark has not adopted the euro, it is fixing its exchange rate with respect to the euro within narrow bands of fluctuation. As such, it is forced to mimic the monetary policy stance of the European Central Bank and Danish interest rates remain very close to those of the EMU countries.

INSERT FIGURE 5 ABOUT HERE

The same conclusions arise from the computation of correlation coefficients. These are useful since they can be computed for individual countries, in contrast with cross-sectional standard deviations. Figure 5 displays correlations for nine EMU members, and three EU non-EMU countries (United Kingdom, Sweden, Denmark). The sample period is divided into two sub-periods, going from 1993 to 1998 for the pre-EMU subsample, and 1999 to 2006 for the EMU subsample. The reference bond yield is the ten-year German government bond yield. Countries are ranked in a descending order according to their pre-EMU correlation coefficient. The evidence is striking. There used to be a core and a periphery before the introduction of the euro. Bond markets of countries such as the Netherlands, Austria, France, Belgium and Denmark were quite integrated with the German bond market even before the common currency. Other countries such as Sweden, Spain, Italy, Finland or Portugal exhibited very low levels of bond market integration when they had their own currencies. The advent of the euro and the associated elimination of

currency risk implies that all EMU countries have a correlation coefficient close to unity. The United Kingdom and Sweden exhibit lower coefficients since they have retained their own floating currencies.

3.4 Evidence on equity market integration

Figure 6 shows the cross-sectional standard deviations of equity market returns for four different groups from 1973 to 2007. The global group consists of thirteen countries from different regions of the world, namely Germany, France, Belgium, the Netherlands, Italy, Austria, the United Kingdom, Switzerland, the United States, Canada, Japan, Australia and Hong Kong. The EU group gathers Germany, France, Belgium, the Netherlands, Italy and the United Kingdom, while the EMU group is the same as the EU group, excluding the United Kingdom. The last group consists only of the United States and Canada, two countries that have historically been highly financially integrated. This last group provides a good benchmark to evaluate the level of regional and global financial integration.

INSERT FIGURE 6 ABOUT HERE

Three results are noteworthy. First, cross-sectional standard deviations are decreasing over time[4]. Financial integration is rising at the European level as well as at the global level. Second, as we argued above, the United States and Canada have been historically highly integrated. Yet, the European Union as a region is now more integrated than North America, while global financial integration is getting close. Third, cross-sectional standard deviations have always been lower in the European Union than at the global level. Therefore, regional financial integration is quite prominent in the EU and EMU, as one would expect from decades of policies aiming at real and financial integration.

INSERT FIGURE 7 ABOUT HERE

[4]Standard deviations are quite volatile in the short run. We make use of the Hodrick-Prescott filter to extract the long-run trend in the degree of financial integration.

Figure 7 extends the evidence by considering a wider set of countries over a shorter time period from January 1995 to May 2007[5]. Again, cross-sectional standard deviations are decreasing for all groups of countries, so that financial integration is clearly rising. Regardless of how it is defined, the European region is significantly more integrated than Latin America or the south-east Asian region. Furthermore, even though south-east Asia and Latin America were at similar levels of financial integration in the mid-nineties, the former region has been integrating more rapidly than the latter, which remains less integrated than at the global level.

Figures 8 and 9 present evidence based on correlation coefficients for four sub-periods. We focus on eleven participants to the European Monetary Union (EMU) as a case study. The first period coincides with early monetary integration with the creation of the European Monetary System in 1979 and the presence of capital controls in several countries. The second period witnessed the adoption of the Single Act and the removal of remaining capital controls, thereby achieving full capital mobility within the European Union. The third period was the convergence period towards the adoption of the euro, while the last period follows the creation of the monetary union. Figure 8 displays the correlation coefficient of individual stock market returns with an EMU return provided by Datastream, while figure 9 focuses on correlations with a world index return, also provided by Datastream. These indicators are useful in so far as they provide information over time, for each country separately.

INSERT FIGURES 8 AND 9 ABOUT HERE

[5]Global group: Germany, France, Belgium, Netherlands, Finland, Italy, Spain, Portugal, Ireland, Austria, Greece, United Kingdom, Sweden, Denmark, Norway, Switzerland, Hungary, Poland, Czech Republic, Turkey, Russia, United States, Canada, Japan, Australia, New Zealand, South Africa, Brazil, Argentina, Chile, Colombia, Venezuela, Peru, Mexico, India, China, Thailand, Malaysia, Philippines, Korea, Indonesia, Hong Kong, Singapore, Taiwan.
Europe group: Germany, France, Belgium, Netherlands, Finland, Italy, Spain, Portugal, Ireland, Austria, Greece, United Kingdom, Sweden, Denmark, Norway, Switzerland.
EU group: the Europe group except for Norway and Switzerland.
EMU group: the EU group except for the United Kingdom, Sweden and Denmark.
Latin American group: Brazil, Argentina, Chile, Colombia, Venezuela, Peru, Mexico.
South-east Asian group: Thailand, Malaysia, Philippines, Indonesia, Hong Kong, Singapore, Taiwan.

Financial integration has been increasing both at the regional and at the global level, thereby confirming the evidence obtained using cross-sectional standard deviations. All countries are more financially integrated at the global level nowadays than in the past. Moreover, almost all countries are even more financially integrated at the regional level, with the exception of Austria. There is less of a core and a periphery than in bond markets, even if one could tentatively consider a core group consisting of Germany, France, Belgium, the Netherlands, Italy and Spain, and a periphery gathering Ireland, Austria, Finland, Portugal and Greece. The fact that correlation coefficients are higher at the regional level essentially reflects deep integration of financial markets, not least because of the elimination of currency risk and full capital mobility across these countries.

4 Concluding remarks

We have reviewed two sets of indicators of regional financial integration. The first set of quantity-based indicators relies on the size and location of foreign investments in equity and long-term debt. Data on bilateral asset holdings allow for the computation of very precise measures of intra-regional and extra-regional financial integration. The second set of indicators comes from the asset pricing literature and provides a complementary view. It is particularly useful since data are available for long time periods and across many countries. Both sets of indicators show that regional financial integration has increased over time, while there has been a parallel process of global financial integration at the same time.

The indicators presented in this chapter are useful to assess the degree of regional financial integration. However, they can also be used to get a better understanding of the causes and the consequences of financial integration. There is a wide literature looking at the impact of rising financial integration on macroeconomic outcomes, such as economic growth (Kose et al., 2006; Ranciere et al., 2003), business cycle synchronization (Imbs, 2006; Kalemli-Ozcan et al., 2001), stock market cycles (Kaminsky and Schmukler, 2003), the likelihood of financial crises (Arteta et al., 2001) or domestic economic institutions (Ju and Wei, 2007). Other researchers have studied the sources of financial liberalization

(Abiad and Mody, 2005; Lane and Milesi-Ferretti, 2008) and the interaction between exchange rate regimes and regional financial integration (Cappiello et al., 2006; Wälti, 2006). Rising financial integration also brings regulatory issues at the forefront of the policy-making agenda. For example, should there be a central financial supervisor for financial markets in the European Union? There is no definite answer to this question and the policy framework for regional financial integration remains incomplete so far.

References

[1] Abiad, A. and A. Mody (2005), Financial reform: what shakes it? What shapes it?, *American Economic Review* 95(1): 66-88.

[2] Adam, K., T. Jappelli, A. Menichini, M. Padula and M. Pagano (2001), *Analyse, compare, and apply alternative indicators and monitoring methodologies to measure the evolution of capital market integration in the European Union*, European Commission Report.

[3] Adjaouté, K. and J. P. Danthine (2004), Equity returns and integration: is Europe changing?, *Oxford Review of Economic Policy* 20(4): 555-570.

[4] Arteta, C., B. Eichengreen and C. Wyplosz (2003), When does capital account liberalization help more than it hurts?, in E. Helpman and E. Sadka (eds.), *Economic Policy in the International Economy: Essays in Honor of Assaf Razin*, Cambridge: Cambridge University Press.

[5] Bank of International Settlements (2006), *Guidelines to the International Locational Banking Statistics*.

[6] Cappiello, L., P. Hördahl, A. Kadareja and S. Manganelli (2006), The impact of the euro on financial markets, ECB Working Paper 598.

[7] Chinn, M. and H. Ito (2006), What matters for financial development? Capital controls, institutions and interactions, *Journal of Development Economics* 81(1): 163-192.

[8] European Central Bank (2007), *Financial Integration in Europe*, Frankfurt: European Central Bank.

[9] Fratzscher, M. (2002), Financial market integration in Europe: on the effects of EMU on stock markets, *International Journal of Finance and Economics* 7(3): 165-194.

[10] Goldsmith, R. W. (1984), *Comparative National Balance Sheets: A Study of Twenty Countries, 1688-1978*, Chicago: University of Chicago Press.

[11] Grubel, H. J. and P. J. Lloyd (1975), *Intra-industry Trade: The Theory and Measurement of International Trade in Differentiated Products*, London: Macmillan.

[12] Imbs, J. (2006), The real effects of financial integration, *Journal of International Economics* 68: 296-324.

[13] International Monetary Fund (2002), *Coordinated Portfolio Investment Survey Guide*, second edition.

[14] Ju, J. and S.-J. Wei (2007), Domestic institutions and the bypass effect of financial globalization, NBER Working Paper 13148.

[15] Kalemli-Ozcan, S., B. Sorensen and O. Yosha (2001), Economic integration, industrial specialization and the asymmetry of macroeconomic fluctuations, *Journal of International Economics* 55: 107-137.

[16] Kaminsky, G. and S. Schmukler (2003), Short-run pain, long-run gain: the effects of financial liberalization, NBER Working Paper 9787.

[17] Kose, A., E. Prasad, K. Rogoff and S.-J. Wei (2006), Financial globalization: a reappraisal, IMF Working Paper 06/189.

[18] Lane, P.R. (2006), Global bond portfolios and EMU, *International Journal of Central Banking* 2(2): 1-24.

[19] Lane, P.R. and G. M. Milesi-Ferretti (2001), The external wealth of nations: measures of foreign assets and liabilities for industrial and developing countries, *Journal of International Economics* 55(2): 263-294.

[20] Lane, P.R. and G. M. Milesi-Ferretti (2007a), The external wealth of nations mark II: revised and extended estimates of foreign assets and liabilities, *Journal of International Economics* 73: 223-250.

[21] Lane, P.R. and G. M. Milesi-Ferretti (2007b), A global perspective on external positions, in R. Clarida (ed.), *G7 Current Account Imbalances: Sustainability and Adjustment*, NBER - University of Chicago Press.

[22] Lane, P.R. and G. M. Milesi-Ferretti (2007c), The international equity holdings of euro area investors, in R. Anderton and F. di Mauro (eds.), *The Importance of the External Dimension for the Euro Area: Trade, Capital Flows, and International Macroeconomic Linkages,* Cambridge University Press.

[23] Lane, P.R. and G. M. Milesi-Ferretti (2008), International investment patterns, *Review of Economics and Statistics*, forthcoming.

[24] Obstfeld, M. (2004), External adjustment, *Review of World Economics (Weltwirtschaftliches Archiv)*, 140(4):541-568.

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

[26] Quinn, D. (1997), The correlates of change in international financial regulation, *American Political Science Review* 91: 531-551.

[27] Ranciere, R., A. Tornell and F. Westermann (2003), Crises and growth: a re-evaluation, NBER Working Paper 10073.

[28] Solnik, B. and J. Roulet (2000), Dispersion as cross-sectional correlation, *Financial Analysts Journal* 56(1): 54-61.

[29] Wälti, S. (2006), Stock market synchronisation and monetary integration, mimeo, Trinity College Dublin.

Glossary

Bond: Debt issued mostly by central, regional and local governments or large companies, for a given maturity. The seller of a bond must repay the principal and pay interest to the buyer periodically.

Equity: Ownership interests of stockholders in a firm.

Euro: Name of the common currency shared by thirteen members of the European Union (Germany, France, Belgium, Netherlands, Luxembourg, Italy, Ireland, Portugal, Spain, Greece, Austria, Finland and Slovenia).

Financial integration: Degree of cross-border holdings of different types of financial assets by domestic residents. Also degree to which domestic financial markets are affected by external shocks relative to domestic shocks.

Globalisation: Tendency towards a greater integration of goods, capital and factor markets around the world.

Biographical note

Agustín Bénétrix is a PhD student in international macroeconomics at Trinity College Dublin. He holds a Master of Sciences in Political Economy from the University of Siena, Italy, and a Master of Sciences in Economics from the University of La Plata, Argentina. He has taught international economics at both these universities as well as at Trinity College Dublin since 2005. He has spent one academic year at the European University Institute as a visiting researcher. He is currently working on the project 'Macroeconomic Policy under EMU' led by Prof. Philip Lane at Trinity College Dublin. His research interests lie in international financial integration and exchange rates.

Sébastien Wälti is an Economist within the International Monetary Relations Unit of the Swiss National Bank, an External Research Associate of the Institute for International Integration Studies (IIIS) at Trinity College Dublin, and a Research Fellow of the Euro Area Business Cycle Network (EABCN). He was a Lecturer in Economics at Trinity College Dublin before joining the Swiss National Bank in January 2008. He holds a PhD in International Economics from the Graduate Institute of International Studies, Geneva, Switzerland. His research concentrates on various issues in international macroeconomics such as the measurement and the determinants of financial integration, exchange rate regimes, and the international transmission of real and financial shocks.

Table 1: Shares of portfolio equity and portfolio debt in total, 2006

	Portfolio Equity				Portfolio Debt			
	Assets		Liabilities		Assets		Liabilities	
Country	% TA	% GDP	% TL	% GDP	% TA	% GDP	% TL	% GDP
Austria	10.6	27.4	9.5	27.0	31.7	82.0	39.2	111.2
Belgium	13.9	67.7	3.5	16.0	20.9	101.9	12.8	58.3
Finland	21.4	45.6	32.5	73.5	26.5	56.6	28.2	63.9
France	11.0	31.7	15.3	43.6	26.9	77.2	26.6	75.5
Germany	16.8	33.2	13.3	23.4	22.3	44.0	37.6	65.8
Greece	6.8	4.2	14.0	19.6	39.4	24.4	45.6	63.7
Ireland	20.6	244.7	35.9	428.6	39.8	472.9	24.9	297.4
Italy	21.5	27.7	12.1	17.6	26.8	34.5	45.5	66.0
Netherlands	18.9	83.9	21.4	95.1	23.9	106.3	27.0	120.3
Portugal	7.7	13.8	12.4	33.0	35.7	64.1	23.4	62.4
Spain	11.5	16.1	13.1	26.4	28.5	40.1	38.5	77.2
W. Average	16.6	37.7	20.3	41.0	27.9	65.3	33.8	78.5

Table 2: EMU weighted average shares. Period 1997-2006.

	Portfolio Equity				Portfolio Debt			
	Assets		Liabilities		Assets		Liabilities	
W. Average	% TA	% GDP	% TL	% GDP	% TA	% GDP	% TL	% GDP
1997	12.6	10.2	18.0	13.7	18.6	16.6	29.8	25.1
1998	14.7	15.0	20.7	20.6	21.5	23.5	30.1	31.8
1999	18.8	22.2	27.7	29.2	22.4	27.6	28.8	33.6
2000	20.1	27.9	26.0	31.2	22.1	32.7	29.0	40.8
2001	16.9	24.5	22.0	27.1	25.0	38.0	30.8	44.6
2002	13.9	21.6	18.1	22.6	28.1	46.7	34.4	56.3
2003	14.9	25.5	17.9	26.0	29.4	52.1	35.2	62.2
2004	15.3	27.9	17.7	28.0	29.9	56.7	35.6	68.0
2005	16.5	30.9	19.6	31.8	29.2	56.8	35.0	67.8
2006	16.6	37.7	20.3	41.0	27.9	65.3	33.8	78.5

Table 3: Change in IFI and RFI by country. Period 2001-2006. Scaling Factor GDP 2001.

	Portfolio Equity			Long-term Debt		
Country	ΔIFI	ΔiRFI	ΔeRFI	ΔIFI	ΔiRFI	ΔeRFI
Austria	59.2	18.9	40.3	177.6	113.4	64.2
Belgium	108.2	39.7	68.5	140.1	101.2	38.9
France	70.3	22.1	48.2	137.6	83.0	54.7
Germany	34.2	8.1	26.1	94.6	54.0	40.6
Italy	45.7	11.9	33.8	82.5	64.6	17.9
Netherlands	120.0	19.7	100.3	262.4	159.8	102.6
Finland	81.7	14.1	67.7	107.0	69.3	37.7
Greece	32.6	8.9	23.8	134.5	91.8	42.7
Ireland	630.2	181.5	448.7	906.4	460.4	445.9
Portugal	27.4	13.3	14.0	132.8	94.1	38.7
Spain	41.0	13.6	27.4	170.5	111.4	59.2

Figure 1: Intra- and extra-RFI in EMU

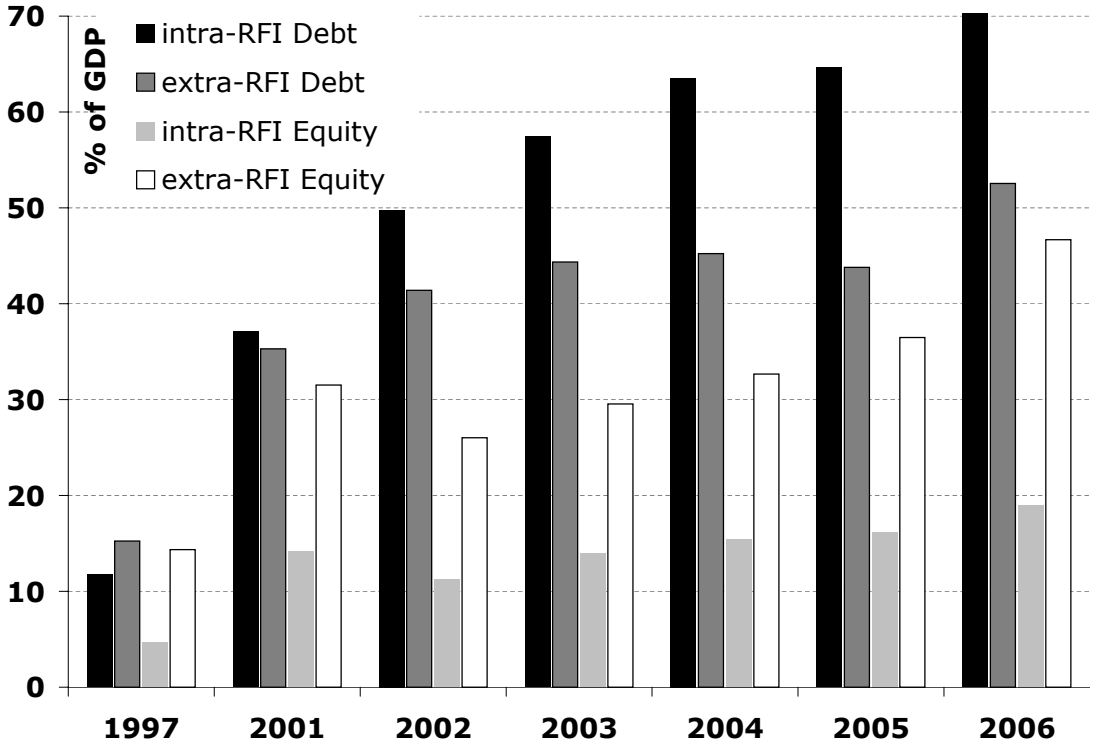


Figure 2: Change in intra-RFI and extra-RFI for portfolio equity and portfolio debt (2001-2006)

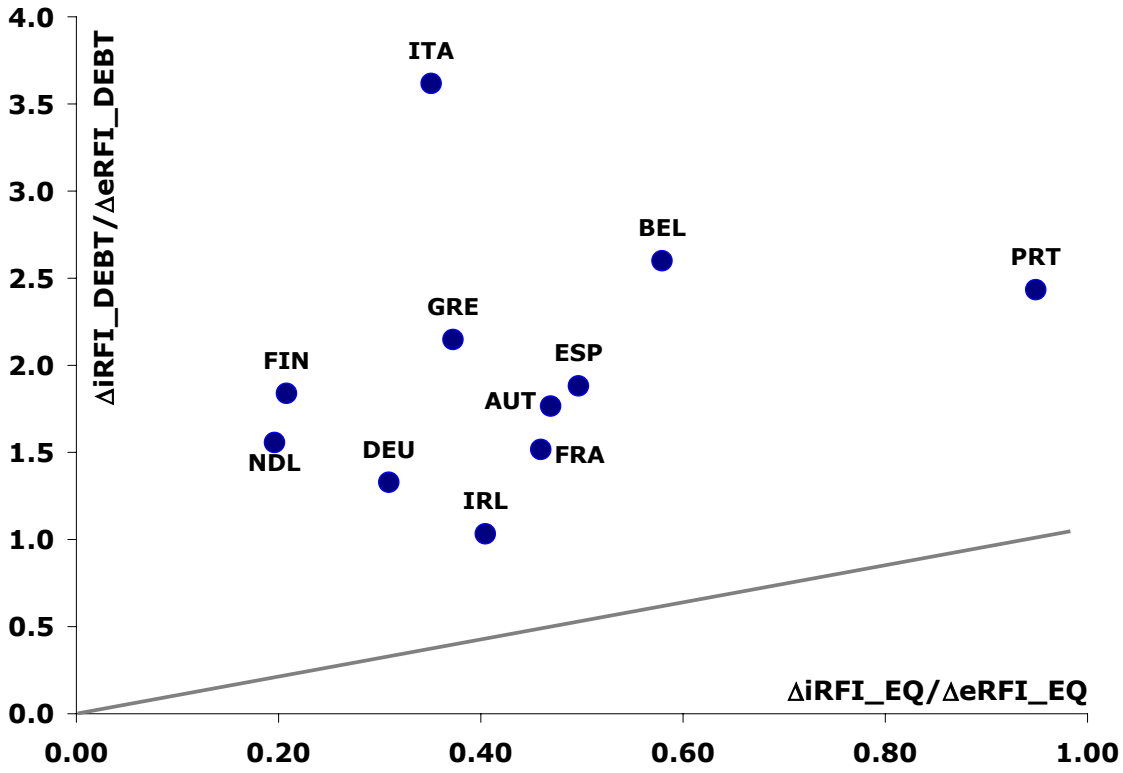


Figure 3: Ten-year government bond yields, 1993-2006

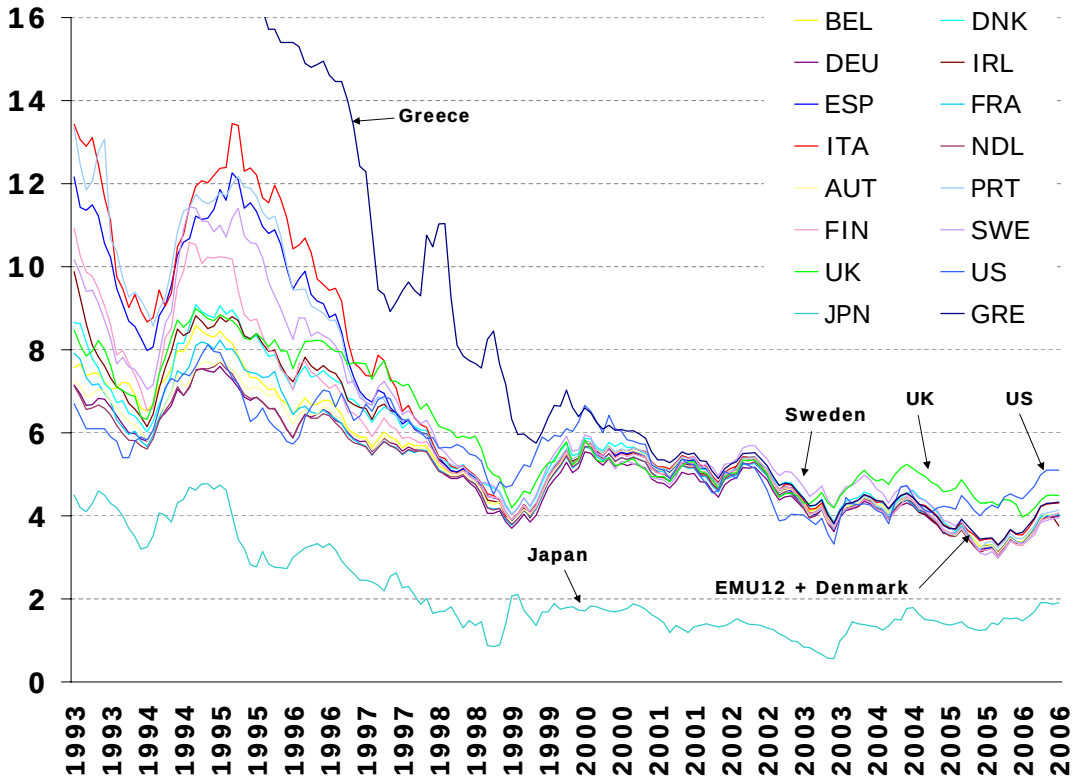


Figure 4: Cross-sectional standard deviation of ten-year government bond yields

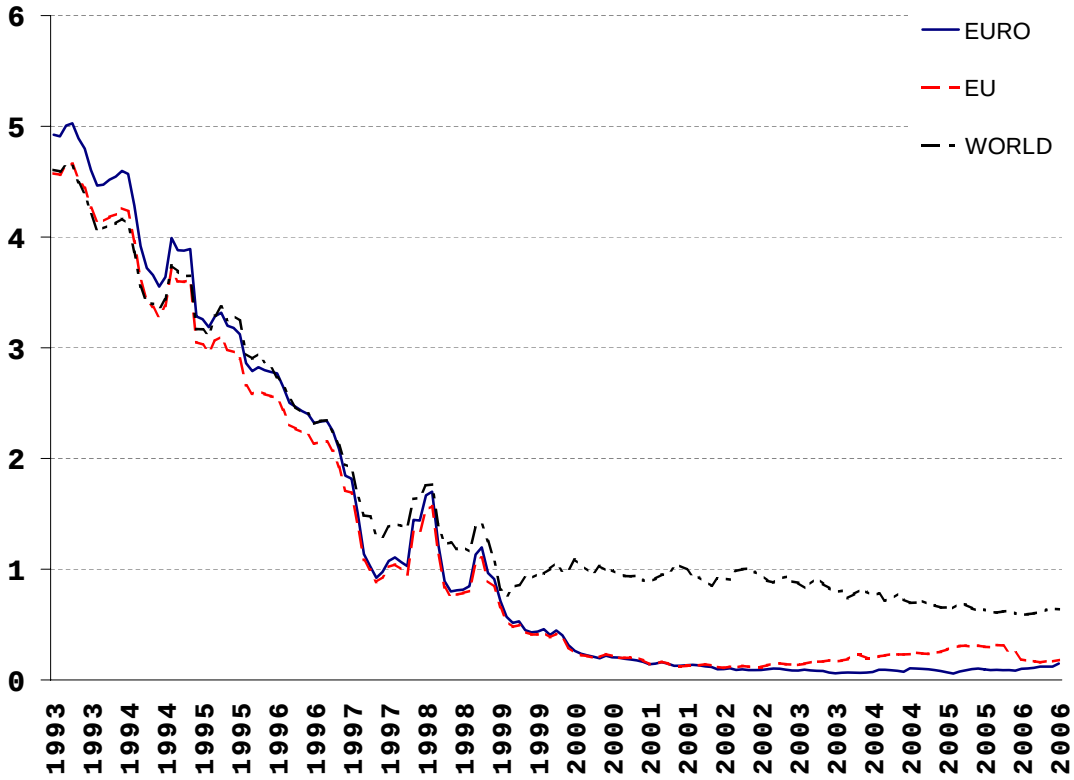


Figure 5: Bond market correlations before EMU and during EMU

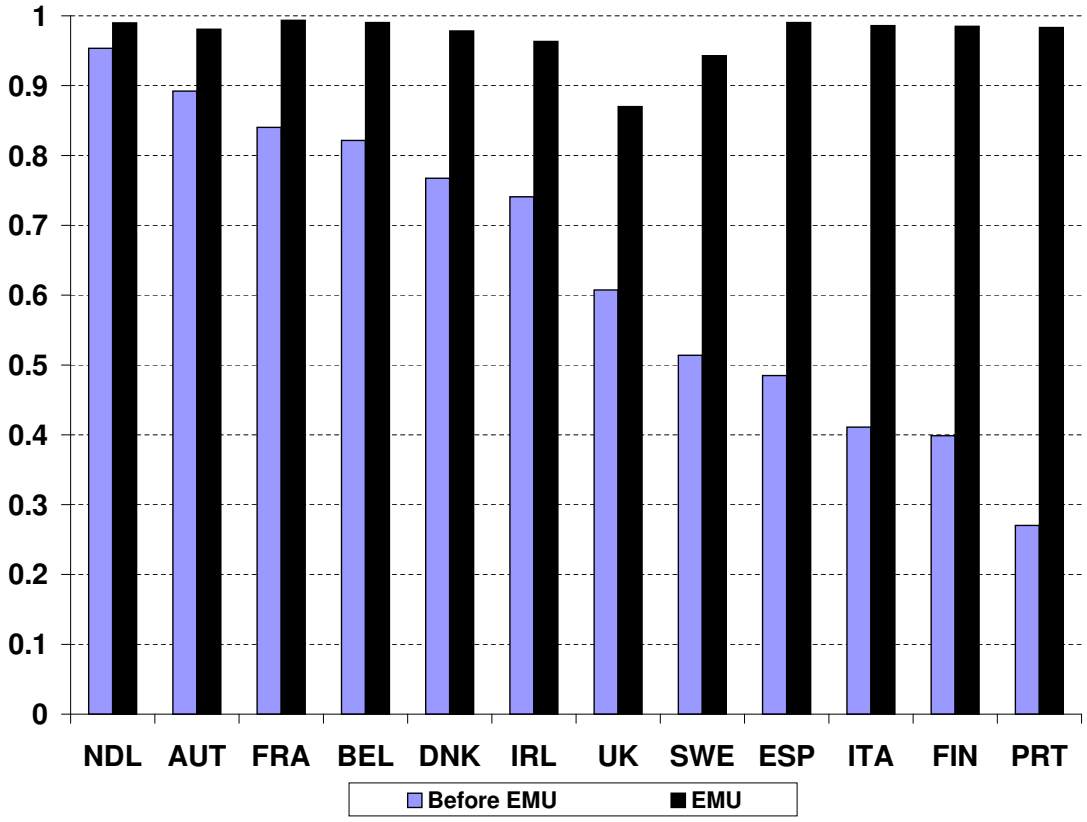


Figure 6: HP-filtered cross-sectional deviations of equity market returns, 1973-2007

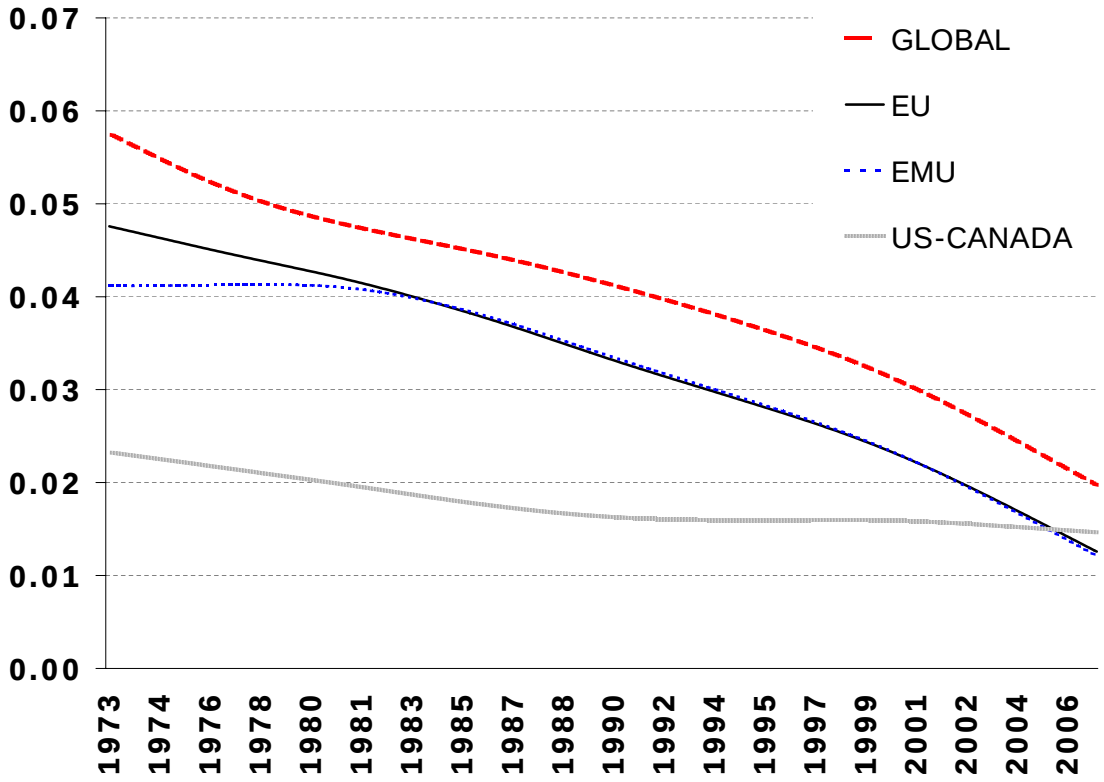


Figure 7: HP-filtered cross-sectional deviations of equity market returns, 1995-2007

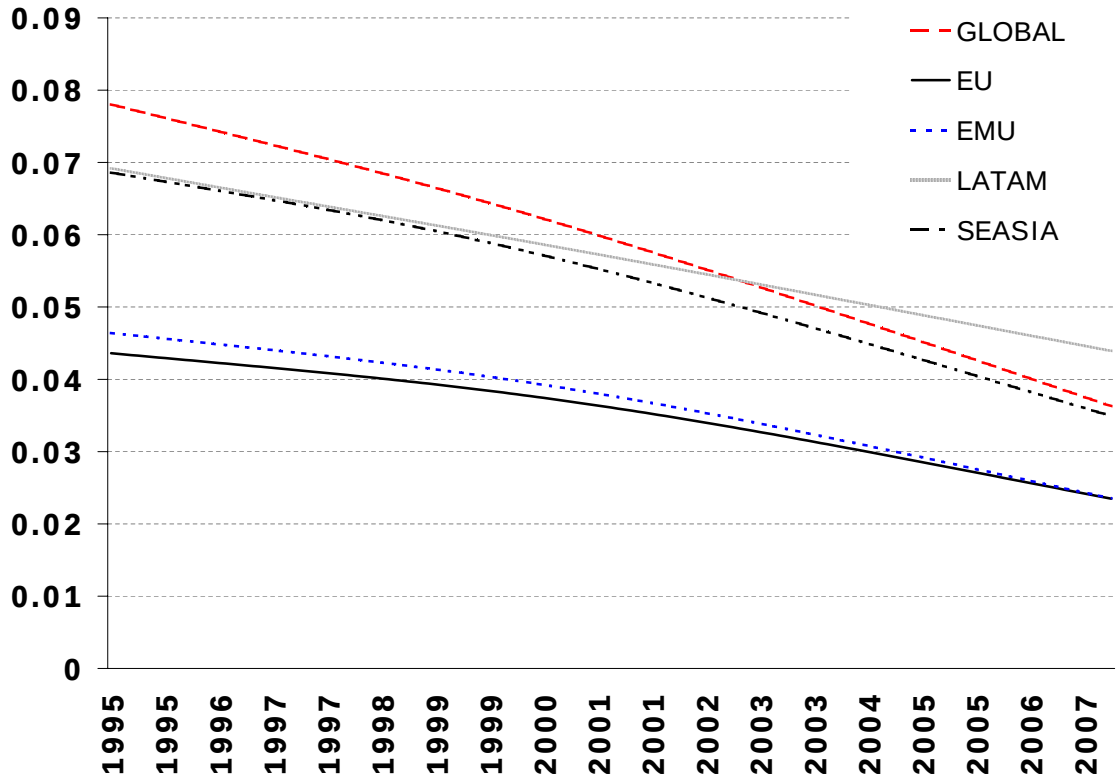


Figure 8: Return correlations to an EMU return, four sub-periods

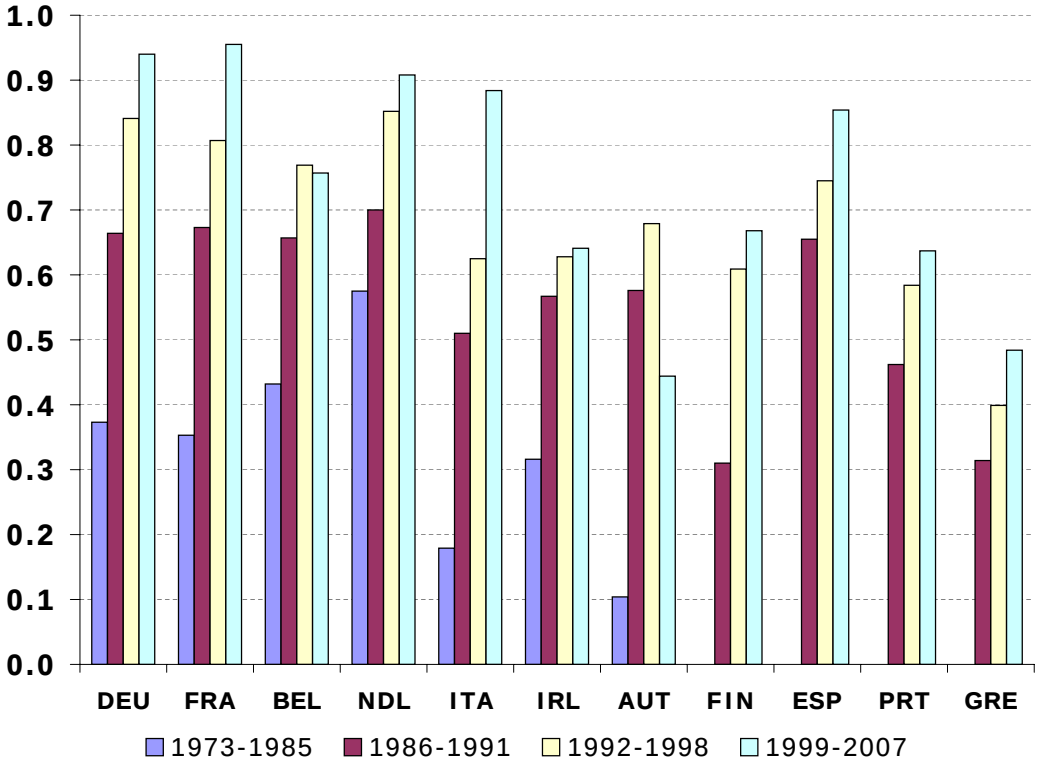
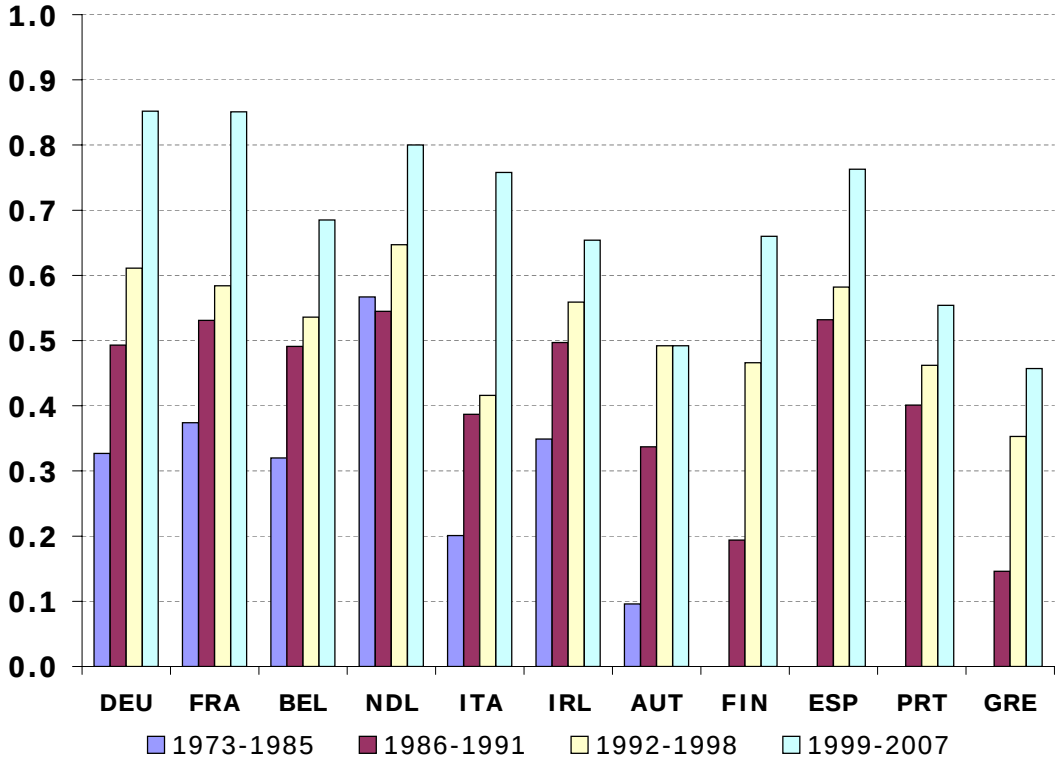


Figure 9: Return correlations to a world return, four sub-periods



Institute for International Integration Studies
The Sutherland Centre, Trinity College Dublin, Dublin 2, Ireland