Convergence of EMU Equity Portfolios

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Abstract

This paper evidences that equity portfolios of countries which joined the European Monetary Union have significantly converged after the integration. The dispersion of EMU countries' portfolios has indeed halved with respect to its pre-integration level and countries starting less integrated did integrate faster. This evidence can be interpreted as a combination of convergence of inflation rates and convergence of investment barriers. On the one hand, the common monetary policy might have driven a stronger comovement in inflation rates determining more similar hedging strategies for member countries. On the other hand, the common currency exposure might have homogenized bilateral investment barriers thus inducing more similar portfolio allocations for member countries. We find that the comovement of inflation rates has not significantly increased after the EMU inception pointing to an exclusive role of convergence in investment barriers.

JEL classification: F21, F30, F36, G11, G15

Keywords: financial integration; EMU; inflation hedging; investment barriers

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1 Introduction

The European Monetary Union (EMU) has been the greatest attempt ever made of financial integration. The literature has recently produced a great deal of work on alternative ways of measuring financial market integration with particular focus on EMU. The very definition of "integration" is quite ambiguous and depends greatly on the financial market analyzed. In equity markets, the benchmark theoretical setting of full integration is the one in which all investors hold the same portfolio, the value-weighted portfolio. However, the full integration setting does not necessarily imply the absence of investment barriers such as transaction costs or information barriers, it suffices that all investors face the same barriers. Accordingly, the financial integration in the Euro area is captured in this paper through a measure evaluating the degree of convergence of member countries' international portfolios. If the birth of a common currency area such as the Eurozone had the effect of inducing member countries to invest more similarly we should observe a convergence towards a Euro area representative investor. The peculiar elements characterizing the integration process are identified in two basic factors: the common currency and the common monetary policy (Fratzscher, 2002). Building on a variation of the Adler and Dumas (1983) model, the observed differences in portfolios may be due to different bilateral investment barriers or different inflation hedging strategies. On the one hand, the common currency's impact is reasonably reflected mainly on investment barriers making homogeneous the exposure to foreign exchange risk and making potentially more symmetric the bilateral informational barriers. The common monetary policy, on the other hand, is likely translating into convergence of inflation rates leading to more similar hedging strategies. If EMU inception has actually given rise to a convergence process of EMU equity portfolios it must be due to a combination of convergence of inflation rates and bilateral investment barriers.

We find that dispersion among EMU portfolios (EMU *within* dispersion) has substantially lowered after EMU integration with respect to both dispersion between EMU and NON EMU portfolios (EMU-NON EMU *between* dispersion) and portfolio dispersion among NON EMU countries (NON EMU *within* dispersion). We also uncover a convergence process among EMU members: countries which were more distant one another before EMU integration seem to have approached at higher speed. The dispersion measure derived from our theoretical setting allows to disentangle the role of convergence of inflation hedging and of convergence of bilateral investment barriers in determining equity portfolio convergence. When looking at the determinants of this convergence process we find out that the degree of comovement of inflation rates has remained almost unchanged after integration. Consequently, the observed equity portfolio convergence must be ascribed to bilateral convergence of investment barriers so stressing the prevailing role of common currency over common monetary policy. The evidence of the negligible role of inflation convergence allows not only to attribute the explanation of portfolio convergence to bilateral investment barriers but also, importantly, to "quantify" their convergence. Bilateral investment barriers are, indeed, not directly observable and empirical analysis usually gets around the problem by means of - always questionable - proxies. Our results, instead, allow to quantify the reduction of the "unobservable" investment barriers since portfolio convergence coincides with investment barriers' convergence.

The paper is structured as follows. In the second section we briefly review the empirical literature on financial integration in the Euro area. In the third section we build the theoretical framework. In the fourth section we describe the data. In the fifth section we describe the empirical analysis and derive results. The sixth section, finally, concludes.

2 Measures of integration on equity market

After EMU inception many works have been devoted to the investigation of the degree of stock market integration. The Report by Adam et al. (2002) is the first systematic work trying to organize the different measures of integration in financial markets. Their work has been followed, more recently, by Baele et al. (2004) who updated and integrated the previous work. Integration on financial markets is achieved when all economic agents face identical rules and have equal access to financial instruments or services: a perfect cross-market integration is understood as a situation in which there are no barriers such as taxes, tariffs, restrictions, information costs or any other costs which prevent investors from changing their portfolios instantaneously. In general, it is not possible to apply the same measure to quantify integration in different markets due to the very nature of financial instruments. Recent studies have analyzed the degree of European equity market integration from various perspectives.

A first strand of literature studies whether expected returns are determined by global rather than by local risk factors based on some specific asset pricing models (Bekaert and Harvey, 1995; Karolyi and Stulz, 2002; Hardouvelis et al., 1999). An important drawback of this methodology is that the results seem to depend heavily on the specification of the asset pricing model and, hence, on the correct identification of the relevant risk factors. A sub-group of the above literature can be considered the approach focusing on the relative importance of country and industry effect in explaining returns: a decrease in the importance of country effects is often interpreted as indicator of higher equity market integration. Baca et al. (2000), Cavaglia et al. (2000) and Flavin (2004) show that the importance of global industry factors has increased relatively to country-specific factors. Adjouté and Danthine (2000) measure the relative importance of country and sector effects by simply calculating the cross-sectional dispersion in country and sector returns, respectively: the higher the cross-sectional dispersion, the lower the correlations and the higher the diversification potential.

They find that the potential of diversifying across sectors increased considerably at the end of the 1990s to levels even higher than those allowed by country diversification. European stock markets have therefore become more integrated over time since returns in different European markets appear dominated more by EU-wide factors rather than by country specific factors.

The second methodology of analysis rests on equity return correlations. Fratzscher (2002) estimates a GARCH model with time-varying coefficients using data on daily returns from 1986 to 2000 finding an increase in correlation between stock returns within the euro area since the announcement in May 1998. Adjaouté and Danthine (2000) estimate the variance-covariance matrix of weekly returns from September 1990 to April 1999 and evidence a considerable increase in the correlation of stocks returns. Fratzscher (2002) and Adjaouté and Danthine (2000) differ, however, in the economic interpretation of the same evidence. Adjaouté and Danthine (2000) interpret the increase in correlation simply as a decrease in diversification opportunities due to the convergence of economic structure and the homogenization of economic shocks rather than to the disappearance of currency risk since the increase in correlation results both considering adjusted and unadjusted correlations. On the contrary, Fratzscher (2002) interprets the increased correlations as a symptom of greater integration. He asserts, in fact, that the elimination of exchange rate volatility and, to some extent, also monetary policy convergence, has played a central role in explaining the increased financial integration.[1]

A third strand of literature analyzes linkages across stock markets through the cointegration analysis. Yang et al. (2003) study the impact of EMU on the long-run, short-run and contemporaneous structures of integration among eleven European stock markets. They find that the long-run linkages among these markets have generally been strengthened after the establishment of EMU.

Finally, some authors consider quantity based indicators. These measures may convey interesting information about the dynamics of euro area equity market integration. A number of authors have interpreted the recent decrease in equity home bias as evidence of further integration. Adam et al. (2002) report an increase in international portfolio diversification for European investment funds, pension funds and insurance companies after integration. They also assess that, being the relative size of the local market rather stable over time, the indicator of home bias is almost identical to the change in foreign assets with the advantage that the latter does not rely on a benchmark which might be open to criticism. Recent evidence confirms that the equity home bias has been reduced at least within the euro area (Lane and Milesi-Ferretti, 2007).

In the present paper we adopt the quantity-based approach in order to assess the degree of integration among EMU countries after the EMU inception. The home bias reduction would an appropriate synthetic

[1] Croci (2004) evidences an increase in return correlations across the euro equity markets since mid-90s. The increase in correlation seems to depend not only on the relaxation of restrictions to capital mobility and of institutional barriers but also on higher informational market efficiency.

measure if the objective were the analysis of the level of *global* integration as in that case the standard benchmark is represented by the value-weighted portfolio. In our work, instead, we are interested in capturing the degree of integration within a subgroup of countries which experienced the same process of monetary integration regardless the degree of integration with the rest of the world. To pursue this objective we therefore opt for a bilateral dispersion measure among the EMU countries' portfolios. The theoretical framework we rely upon allows us to connect the observed portfolio dispersion to the convergence of inflation hedging and investment barriers. The introduction of the common currency is a factor likely affecting investment barriers' convergence while the single monetary policy is expected to influence mainly inflation hedging strategies. Consequently, the relative explanatory power of investment barriers over inflation hedging allows interestingly to highlight the relative impact of the single currency over the common monetary policy on stock market behavior.

3 Theoretical framework

3.1 The Model

In Adler and Dumas (1983) model with stochastic inflation the vector of portfolio weights in investor l's equity portfolio is made up of two components, the "logarithm portfolio", that is the portfolio driven by excess return and variance-covariance, and the "hedge portfolio", that is the portfolio hedging the investor's inflation risk.[2]

$$\mathbf{w}_l = \mathbf{\Omega}^{-1} \left\{ \tfrac{1}{\lambda}([\boldsymbol{\mu} - r\mathbf{i}] + \left(1 - \tfrac{1}{\lambda}\right)[\boldsymbol{\varpi}_l]\right\} \tag{1}$$

where $\mathbf{w}_l$ is the vector of investor l's portfolio shares, $\boldsymbol{\mu} - r\mathbf{i}$ is the vector of stock excess returns, $\mathbf{\Omega}$ is the matrix of instantaneous variances-covariances of nominal rates of returns, $\boldsymbol{\varpi}_l$ is a vector of covariances between nominal asset returns and country l's rate of inflation and λ is the investor's relative risk aversion coefficient.

We integrate investment barriers in the above setting adopting Gehrig (1993) approach. The investment barriers -either direct such as transaction costs or indirect such as information asymmetries- are assumed to modify the variance-covariance matrix in such a way that each investor l has a perceived variance of the asset issued by country k different from an investor residing in any other country.

[2] See Appendix A for details on the derivation.

For each investor l the vector of equity portfolio shares, $\mathbf{w}_l$, will be

$$\mathbf{w}_l = \mathbf{C}_l^{-1}\boldsymbol{\Omega}^{-1}\left[\tfrac{1}{\lambda}(\boldsymbol{\mu} - r\mathbf{i}) + \left(1 - \tfrac{1}{\lambda}\right)\boldsymbol{\varpi}_l\right] \tag{2}$$

where $\mathbf{C}_l$ is a positive-definite matrix whose generic element $\mathbf{C}_l^j$ captures the bilateral investment barrier for investor l holding asset j.

The equilibrium condition on each stock market j commands a rate of return equalizing the demand for asset j to the supply of asset j (market capitalization of asset j).

After normalizing by world market capitalization we obtain the following equilibrium demand by country l's investor

$$\mathbf{w}_l = \mathbf{D}_l^{-1}\mathbf{MS} + \left(1 - \tfrac{1}{\lambda}\right)\mathbf{C}_l^{-1}\mathbf{b}_l \tag{3}$$

where $\mathbf{D}_l = \mathbf{C}_l\boldsymbol{\Phi}$ and $\boldsymbol{\Phi}$ is a diagonal matrix whose generic element ϕ_j is the inverse of the average investment barriers faced when holding asset j. Consequently, $\mathbf{D}_l$ is a matrix capturing the *relative* (to average) bilateral investment barrier faced by investor l.

The vector $\mathbf{b}_l$ represents the inflation hedging coefficient of the regression of inflation deviation on stock returns (Cooper and Kaplanis, 1994)

$$\boldsymbol{\Omega}^{-1}\left(\varpi_l - \sum_{l=1}^{L} MS_l\varpi_l\right) = \mathbf{b}_l \tag{4}$$

If we define by p_l the inflation rate of country l then $\sum_{l=1}^{L} MS_l\varpi_l$ is the average world inflation rate and $\mathbf{b}_l$ is the vector of coefficients of the multiple regression of $(p_l - \sum_{l=1}^{L} MS_l p_l)$ on the vector of nominal returns. The regression coefficient $\mathbf{b}_l$ reflects, in fact, how far the returns can explain the deviation of investor l's inflation rate from the average inflation. The variation of the inflation rate constitutes a factor of risk the investor wants to hedge through optimal investment in risky assets. The higher the correlation of stock j's return with the deviation of country l's inflation from the average the higher the share of country j's equity held by country l since stock j is a good hedge against inflation risk.

This coefficient is obtained from the following regression

$$(p_l - \sum_{l=1}^{L} MS_l p_l)_t = b_l^0 + \sum_{j=1}^{N} b_l^j R_{l,t}^j + \varepsilon_{l,t}^j \tag{5}$$

Considering the portfolio share j held by country l's investor (where $\gamma = 1 - \frac{1}{\lambda}$)

$$w_l^j = \left(D_l^j\right)^{-1} MS^j + \gamma\left(C_l^j\right)^{-1} b_l^j \tag{6}$$

It can be noticed how the factor capturing investment barriers enters in a non linear way in our equation. How country j's market share determines the demand for asset j by investor l depends on the bilateral investment barriers of investor l relative to the average.[3] Investor l, for the fraction of her portfolio related to the "logarithm portfolio", will hold a share of assets greater (or smaller) than the market share in proportion to $\frac{1}{D_l^j}$ (inverse of *relative* bilateral investment barrier). As far as the "hedge portfolio" is concerned, instead, the country j's share in investor l's portfolio is determined by the inflation hedging properties of the considered stock, b_l^j, but proportionally to $\frac{1}{C_l^j}$ (inverse of bilateral investment barrier).

3.2 Measures of dispersion

Let us consider two investing countries l and y. We define by k_{ly}^j the *investment cost wedge,* that is the difference in bilateral investment barriers between country l and j in asset j's investment.[4]

$$C_y^j = (1+k_{ly}^j)C_l^j \Longrightarrow \left(C_l^j\right)^{-1} = (1+k_{ly}^j)\left(C_y^j\right)^{-1}$$

$$D_y^{j-1} = \frac{\left(C_y^j\right)^{-1}}{\phi^j} \Longrightarrow \left(D_l^j\right)^{-1} = \frac{\left(C_l^j\right)^{-1}}{\phi^j} = \frac{(1+k_{ly}^j)\left(C_y^j\right)^{-1}}{\phi^j} = (1+k_{ly}^j)\left(D_y^j\right)^{-1}$$

We define by Δ_{ly}^j the *asset j wedge* for the couple of countries l and y , that is the relative (to country y's portfolio share) wedge between the shares invested in asset j by the two countries

$$\begin{aligned}
\frac{\left|w_l^j - w_y^j\right|}{w_y^j} &= \frac{\left|(1+k_{ly}^j)\frac{\left(C_y^j\right)^{-1}}{\phi^j}MS^j + \gamma b_l^j(1+k_{ly}^j)\left(C_y^j\right)^{-1} - \frac{\left(C_y^j\right)^{-1}}{\phi^j}MS^j - \gamma\left(C_y^j\right)^{-1}b_y^j\right|}{\frac{\left(C_y^j\right)^{-1}}{\phi^j}MS^j + \gamma\left(C_y^j\right)^{-1}b_y^j} \qquad (7)\\
&= \frac{\left|(1+k_{ly}^j)\frac{MS^j}{\phi^j} + \gamma b_l^j(1+k_{ly}^j) - \frac{MS^j}{\phi^j} - \gamma b_y^j\right|}{\frac{MS^j}{\phi^j} + \gamma b_y^j} = \\
&= \left|\left(1+k_{ly}^j\right)\left(1+\gamma\frac{\left(b_l^j - b_y^j\right)}{\frac{MS^j}{\phi^j} + \gamma b_y^j}\right) - 1\right| \equiv \Delta_{ly}^j
\end{aligned}$$

The Δ_{ly}^jdepends on the *investment cost wedge* k_{ly}^j and on the difference between the inflation hedging

[3] Our approach delivers an equilibrium condition in line with Obstfeld and Rogoff (2001). They show how the share of country j's equity held by country l is a decreasing (increasing) function of the bilateral trading cost (efficiency) between l and j relative to the average trading costs between country j and all other countries.

[4] Note that we defined $\mathbf{C}_l$ as a positive definite matrix so that the expressions below always hold.

coefficients of country l and y in asset j.[5] The final objective of our analysis is the growth rate of the Δ^j_{ly}, that is its variation from the period before EMU integration to the period after integration conjecturing a negative growth rate induced by the monetary union.

$$\frac{\left(\Delta^j_{ly}\right)_{post} - \left(\Delta^j_{ly}\right)_{pre}}{\left(\Delta^j_{ly}\right)_{pre}} = \frac{\left|\left[1 + \left(k^j_{ly}\right)_{post}\right]\left(1 + \gamma\frac{\left(b^j_l\right)_{post} - \left(b^j_y\right)_{post}}{\left(\frac{MS^j}{\phi^j} + \gamma b^j_y\right)_{post}}\right) - 1\right|}{\left|\left[1 + \left(k^j_{ly}\right)_{pre}\right]\left(1 + \gamma\frac{\left(b^j_l\right)_{pre} - \left(b^j_y\right)_{pre}}{\left(\frac{MS^j}{\phi^j} + \gamma b^j_y\right)_{pre}}\right) - 1\right|} - 1 \tag{8}$$

In general $b^j_l \neq b^j_y$ so the growth rate of Δ^j_{ly} will depend both on the variation in the distance of hedging coefficients and on the variation of the *investment cost wedge* k^j_{ly}. However, if $b^j_l = b^j_y$ in both pre- and post-integration the above expression reduces to

$$\frac{\left(\Delta^j_{ly}\right)_{post} - \left(\Delta^j_{ly}\right)_{pre}}{\left(\Delta^j_{ly}\right)_{pre}} = \frac{\left|\left(k^j_{ly}\right)_{post}\right| - \left|\left(k^j_{ly}\right)_{pre}\right|}{\left|\left(k^j_{ly}\right)_{pre}\right|} \tag{9}$$

that is the growth rate of Δ^j_{ly} reduces to the growth rate of the *investment cost wedge* k^j_{ly}. This measure reflects the change in the distance between the share invested in asset j by country l and y. If the distance has decreased the growth rate is negative. To obtain the wedge between overall portfolios rather than between individual assets we need to compute the *bilateral portfolio wedge* (*bpw*) between country l and y. This is obtained adding up the *asset j wedges* and attaching to each asset j a weight equal to MS^j, that is the asset $j's$ market share.

$$bpw_{ly} = \frac{\sum_j MS^j \Delta^j_{ly}}{\sum_j MS^j} \tag{10}$$

This measures quantifies the distance between the observed equity portfolios of country l and y. Finally, to obtain a measure of dispersion of country l's portfolio from the EMU group we compute the *aggregate portfolio wedge* (*apw*) of country l. It is a more synthetic measure allowing to quantify the dispersion of country l's portfolio from a group Y of n countries. The *apw* of country l with respect to group Y is obtained by adding up the *bpw* with respect to each country y in the pool Y either attaching the same weight to each

[5] See Appendix B for derivation of Δ^j_{ly} under more restrictive assumptions of the model (alternatively, no investment barriers, symmetric investment barriers, no inflation hedging motive).

country y (unweighted *apw*)

$$apw_{l,Y} = \frac{1}{n} \sum_{y \in Y} bpw_{ly} \tag{11}$$

or weighting each country y by its market share (weighted *apw*) in the pool.

$$apw_{l,Y} = \frac{\sum_{y \in Y} MS^y bpw_{ly}}{\sum_{y \in Y} MS^y} \tag{12}$$

Procedures analogous to (8) are followed to compute the growth rates in *bpw* and *apw*.

4 Data

Since 1997 the IMF started releasing surveys on bilateral foreign portfolio positions of many investing countries (Coordinated Portfolio Investment Survey, CPIS) and since 2001 this survey is released annually. The CPIS dataset reports data on foreign portfolio holdings by residence of the issuer for many investing countries. Data are collected gathering security-level data from the major custodians and large end-investors.[6] We consider in this work the 1997-edition as benchmark for pre-EMU integration period and the 2004 edition, as benchmark for the post-EMU integration period. The 2001-edition -the first release after EMU integration- is also considered for robustness check. Unlike other papers using the same dataset (Lane and Milesi-Ferretti, 2008), we opt to limit the analysis to a subset of the countries participating in the survey. We selected them on the basis of their financial and, more broadly, economic importance.[7] We consider twelve countries, six EMU countries (Austria, Belgium, Finland, France, Italy, Netherlands) and six NON EMU countries (Canada, Denmark, Japan, United Kingdom, United States).[8] The destination countries are the same investing countries representing more than 75% of world market capitalization and covering almost 85% of the overall portfolio investment.[9]

The CPIS provides a unique perspective on cross-country bilateral equity positions allowing the implementation of empirical analysis on international portfolio allocation for a large set of investing countries.

[6] The CPIS dataset and information on data collection are available at www.imf.org/external/np/sta/pi/datarsl.htm.

[7] Moreover, since our theoretical model predicts all non zero portfolio weights, our sample of host countries has been restricted to destination stock markets with non zero liabilities. Alternatively, some authors prefer to include all investing and destination countries and run a Tobit regression, accounting also for zero portfolio holdings (Lane and Milesi-Ferretti, 2008). In our case, the very limited time span dictates a parsimonious number of stock return regressors to consistently derive the inflation hedging coefficients according to (5).

[8] Germany and Switzerland, although large and important countries, are excluded from the analysis since they did not participate in the 1997 CPIS. Greece is excluded from the pool of EMU countries since it did not participate in the 1997 CPIS and entered EMU in 2001. Luxembourg and Ireland are excluded, as usual in the literature, since they are considered as financial centers.

[9] The range of coverage in individual countries' portfolios is quite wide: it goes from 66% of Austria to 97% of Canada.

However, the above dataset contains information on foreign holdings only and does not include domestic positions. In order to derive the actual share of foreign assets we drew, from the *International Financial Statistics* (*IFS*), the outstanding foreign equity portfolio investments and the corresponding liabilities. Then, we derived the "foreign share", FS

$$FS_{i,t} = \frac{(FA)_{i,t}}{(MCAP_{i,t} + FA_{i,t} - FL_{i,t})} \tag{13}$$

where FA stands for "foreign equity assets", FL for "foreign equity liabilities" and $MCAP$ for "stock market capitalization". After having obtained the foreign share, FS, it is then possible to recover the share of each foreign holding in the overall portfolio.[10]

Stock returns and stock market capitalization are derived from *Datastream-Thomson Financials* and the inflation rates from the *International Financial Statistics* (*IFS*).

5 Empirical analysis

5.1 Portfolio dispersion: evidence

There is some controversy about the date to be considered as the relevant year in EMU integration. EMU was formally created in 1999 but 1998 was the pivotal year and the effects of the union could be anticipated in advance. On March 1998 the European Commission and the European Monetary Institute published their convergence reports, recommending the eleven countries to be admitted into the EMU. At the beginning of May 1998 the decision was formally announced in a meeting of the Heads of States in Brussels during which the bilateral irrevocable conversion rates were set among the member currencies. This was followed on 1 June 1998 by the official creation of the European Central Bank. What is, anyway, commonly agreed is that in 1997 whether the euro would have become a reality was still in doubt. This is the year we consider as "pre-EMU" period plausibly not incurring in any dating problem. We have chosen the 2004 year as "post-EMU" since we needed a sufficient number of observations since 1999 on to estimate consistently the hedging coefficients in the post-EMU period.[11]

[10] Baele et al. (2004) and Sorensen et al. (2008) follow the same procedure dealing with the CPIS dataset.

[11] However, as shown later, we have also derived results considering the 2001 - the first CPIS releas after EMU integration - as benchmark "post-EMU" year. Results under the two alternative specifications are consistent.

5.1.1 Portfolio wedge

The measure we adopt to check for the degree of integration of equity markets among EMU member countries is a measure of bilateral dispersion. In standard international asset pricing models, the value weighted portfolio represents the benchmark for global integration since it represents the optimal portfolio held by all investors if they were identical and faced identical barriers and sources of risks. Analogously, when the focus of the analysis shifts on the degree of integration *within* a sub-group of countries, such as the EMU members, the benchmark becomes the Euro area representative investor or, under a similar perspective, the closeness of EMU countries' portfolios. In this setting, therefore, we can observe full convergence within a sub-group even though there is divergence of the group from the rest of the world and, consequently, absence of global integration. A direct implication of this reasoning is that also the reduction in *home bias* often indicated as a plausible measure of EMU integration may be misleading: it addresses the question of global integration since the benchmark is the value weighted portfolio saying nothing about the within EMU integration. Lane and Milesi-Ferretti (2007) in a recent empirical contribution have also evidenced the trend towards a "Euro area bias", that is a bias of EMU countries towards equities issued by member countries. This important finding points to the reduction of investment barriers among EMU countries but it does not necessarily entail a higher degree of financial integration as meant in this paper. In fact, as stressed above, what need to be tested is the *homogenization* of investment barriers rather than *reduction* of investment barriers.[12] It may be the case, in fact, that the representative investors of the different EMU countries, though all increase their portfolio share invested in Euro assets, do follow diverging investment patterns and so doing dipart from the Euro area representative investor. An alternative choice to our measure of bilateral dispersion could be a measure of dispersion of EMU countries' portfolios around an EMU benchmark. However it would have risen the problem of choosing the appropriate benchmark against which to compare the observed portfolios. Furthermore, our choice of bilateral dispersion rests on two key reasons. The first is that it allows to capture the different convergence speed of the various pairs of EMU countries. The second is that it allows to derive, directly from our theoretical setting, testable implications and interpretations of the determinants of portfolios' dispersion. Table 1 reports the growth of *bilateral portfolio wedge* (*bpw*) from 1997 to 2004. This measure quantifies the extent to which two countries' portfolios have approached (negative growth) or diverged (positive growth).[13] The reported measure is obtained computing, for each country pair (l, y) the growth in *asset j wedge*, Δ_{ly}^{j}, for any asset j in the opportunity set, weighted by its market share. For

[12] Note that the two concepts are non at all equivalent unless considering the limit case in which the reduction in investment barrier leads to its elimination.

[13] Note that our definition of portfolio wedge depends on the country y you are taking as benchmark against which to compare the others. In fact, the each *asset j wedge* between country l and country y is computed relative to the country y's portfolio. It implies, in general, different results when computing the portfolio wedge between country l and y according to the benchmark country. For sake of simplicity, we report on the table the average growth rate of *bpw* for each couple (l, y) obtained averaging the two measures of *bpw*, l-based and y-based.

instance, we compute the distance of the investment in Japanese stocks for Austria and Belgium, and weight it by the Japanese stock market capitalization. We repeat the same procedure for all other assets in the portfolio and add them up weighting them by their market share so obtaining the growth of *bpw*. A first glance at the table evidences immediately a process of global integration. In fact, the growth of *bpw* is in general negative pointing to a decrease in portfolio dispersion from 1997 to 2004 for all countries in our sample. However the integration does not seem to be evenly shared by EMU and NON EMU countries. The bilateral portfolio wedge *within* EMU countries seem to be much larger than within NON EMU countries. The higher negative growth rates, i.e. the countries approaching faster, are among EMU countries: nine country-pairs out of fifteen display a drop in portfolio dispersion larger than 50%. Only two country pairs out of 36 show a reduction in bilateral portfolio wedge larger than 50% when matching one EMU country with a NON EMU country and no such a decrease is recorded within the NON EMU countries' group. Finland and Italy appear to be the two countries more strongly reducing their dispersion with respect to the other countries, especially with respect to EMU countries. This impression is confirmed when computing the growth of aggregate portfolio wedge (*apw*), that is a measure capturing growth in dispersion of a given country's portfolio from a pool Y of countries. We report in Table 2 the growth rates of *apw* for all countries considered, EMU and NON EMU. The "weighted" growth in *apw* is obtained weighting the growth of *bpw* by the relative market share of the corresponding country in the pool Y while in the "unweighted" growth all countries are equally weighted. For example, the "weighted" change in dispersion of Italy from the group of EMU countries is obtained by adding up the growth in dispersion of Italy from any EMU countries weighting each addend by the weight of the country in the EMU group. The impression of higher global integration is confirmed also by the aggregated measure: EMU and NON EMU countries have reduced their distance in portfolios from 1997 to 2004. EMU countries, however, show a *within* reduction in portfolio wedge larger than 50%, twice as large than the *within* reduction of NON EMU countries. Finland and Italy confirm to be the countries with the stronger reduction in dispersion with respect to EMU and NON EMU countries. Netherlands show a similar reduction with respect to EMU and to NON EMU while Austria, Belgium and France show to converge twice as fast to EMU countries than to NON EMU countries. For NON EMU investing countries, the growth in *apw* is always far below 50% except for Japan which reveals a stronger drop in dispersion relatively to other NON EMU countries, although below the average EMU reduction. The pieces of evidence above all contribute to suggest a deeper integration of EMU equity portfolios after the creation of the monetary union.

5.1.2 Portfolio convergence

The above evidence is, however, not sufficient to assess convergence of EMU portfolios. In fact, these results might be led by a combination effect of countries starting closer before integration and getting closer faster and countries starting more far apart and getting closer slowly or even departing one another after integration. In order to find out whether an actual convergent pattern has taken place among EMU countries we need to investigate how the *growth* in portfolio dispersion is related to the initial (pre-EMU) *level* of portfolio dispersion. Panel A of Table 3 reports the *level* of aggregate portfolio wedge (*apw*) for 1997 and 2004 for all investing countries with respect to the EMU and NON EMU groups. The reported "weighted" *apw* level is obtained according to expression (12) in the text. For instance, in order to compute the portfolio wedge of France with respect to Italy we add up the corresponding individual *asset j wedges* (7) with respect to all destination assets (Austria, Belgium, Canada, etc.)[14] weighted by their market share. We repeat the same procedure for France with respect to all other EMU countries so obtaining the portfolio wedge of France with all EMU countries. Finally, these measures are weighted by each EMU country's relative market share in order to obtain the aggregate portfolio wedge (12), that is the portfolio dispersion of France with respect to the EMU group.[15] We first have a look at the average level and then go deeper analyzing individual countries. It is immediately evident how the average level of aggregate portfolio wedge has decreased from 1997 to 2004 for all countries confirming the idea of increased global integration.[16] For NON EMU countries, the *within* NON EMU and the NON EMU-EMU *between apw* were very similar one another before EMU inception and remain very similar after the EMU integration, although at a lower level. On the contrary, for EMU countries, there was a large difference between the EMU *within* and the EMU-NON EMU *between apw* before EMU integration and it persists also afterwards. The *within* EMU *apw* was, in fact, one third of the *between* EMU-NON EMU *apw* before integration and it drops to one fourth after the integration. Looking at *apw* of individual investing countries we notice how for all countries we can detect a generalized decrease in *apw* with respect to both NON EMU and EMU. Among NON EMU investing countries we can notice how the decrease is quite modest for all countries and no systematic difference can be found between the two reference groups, EMU and NON EMU. The only exception is Japan, almost halving its *apw* with EMU countries and remarkably reducing the distance with respect to NON EMU countries. Among EMU countries we can notice how Austria, Belgium, France and Netherlands, all reduce their distance with respect to EMU countries, and

[14] Note that, in the dispersion measures adopted, *all* destination assets, either EMU or NON EMU, are considered. The EMU/NON EMU distinction refers uniquely to the investing country side.

[15] The reported "ALL weighted average" is obtained by weighting the aggregate portfolio wedges for each country by its relative market share. Similarly for the "EMU weighted average" and the "NON EMU weighted average".

[16] Results obtained for the *unweighted* average case, not reported here but available upon request, are slightly higher in the 1997 period (14.7, 6.4 and 23.0 with respect to ALL, EMU and NON EMU, respectively) while almost identical to the weighted average case in 2004.

to a lesser extent, to NON EMU countries.[17] Finland and Italy, emerge among EMU countries because of their high *apw* level before integration: the *between* EMU-NON EMU *apw* was almost three times larger than the EMU average for Finland and more than two times larger for Italy while the *within* EMU *apw* was almost twice as large for both investing countries. However, in 2004, the values of *within* and *between apw* for Finland and Italy drop dramatically and get almost in line with the EMU average. As noted in the previous sub-section, Finland and Italy were the EMU countries with the sharper drop in dispersion with respect to other EMU member countries. Now, if the countries with the higher pre-EMU *apw* level, i.e. the countries which were more far apart before integration, are also the ones approaching faster after integration it means that the EMU integration might have put in action a convergence process. In panel B of table 3 we report the relation of the growth rate of *apw* from 1997 to 2004 with respect to its initial level in 1997. We find that there is a negative correlation between the growth rate and level for the pool of countries in our sample: countries starting with a higher dispersion level are those experiencing the stronger reduction. Moreover, the convergence among EMU countries appears much stronger. The observations used to derive these correlations are, however, at aggregated level and too few to derive any sound conclusions. In order to derive support to the convergence hypothesis we need to step back disaggregating the *apw* into its components, the *bpw,* and deriving the relation between its growth rate and its initial level. In other words, we analyze the *bilateral* convergence process by considering the level and change in dispersion between portfolios. We plot the growth rate of *bpw* against its initial level in Figures 1-6. A first glance at the six graphs suggests that our conjecture on convergence is reliable since the observations are approximated by a negatively sloped fitting line. In figure 1 we report the scattered plot of the growth in *bpw*, as reported in Table 1, against its initial level in 1997 for all investing countries. We then draw a least squares line fitting the data (thick line) which results negatively sloped with a coefficient equal to -0.014 and adjusted R^2 - capturing how far the line fits the data - equal to 0.13. However, the growth rate reported on the vertical axis is naturally lower-bounded by -1. Accordingly, a straight line does not appear an optimal fitting curve as it is, by definition, unbounded. We choose to adopt, therefore, a functional form better accomplishing the objective of capturing the data behavior, that is a logarithmic function (thin curve). In the bottom of the graph we then report also the coefficient of the straight line fitting the growth rate of *bpw* to the log(*bpw*) that is -0.142 with the relative adjusted R^2 equal to 0.14.[18] In Figure 2 and 3 we plot the same graph but restricting the analysis to the *within* EMU

[17] This is the mirror result of the decrease in dispersion of NON EMU versus EMU countries. However, as already noted before, they are not quantitatively identical since the wedges are computed relative to the investing country's portfolio share.

[18] Since there are 12 investing countries we should have 132 pair-observations (each country compared to all other except itself). However, we exclude 4 outliers (they refer to between EMU/NON EMU observations) ending up with 128 observations. To dissipate any doubt on the potential driving force of the outliers, we have also computed the fitting lines with all observations. The outliers, by definition, alter the size of coefficients but in our case they do not bias the coefficient size in any systematic direction. In fact, the corresponding slope of the least squares straight line is lower (-0.004), statistically significant at 1% and with adj-R^2 equal to 0.06. In the logarithimc specification the slope is, instead, higher (-0.153), statistically significant at 1% and with adj-R^2 0.15.

sub-sample and to the *within* NON EMU sub sample, respectively. The interesting finding is that, for both specifications, linear and logarithmic, the slope of the fitting line for the *within* EMU sub-sample is twice as large as the corresponding coefficient for the *within* NON EMU sub-sample. The adjusted R^2 is also much larger in the *within* EMU case, being 0.32 against 0.19 of the *within* NON EMU in the linear specification case and 0.48 against 015 in the logarithmic functional specification.[19] When considering the convergence between EMU and NON EMU in Figure 4 the slope is close to the average one represented in Figure 1. Figure 5 and 6 display the convergence of EMU investing countries and NON EMU investing countries, respectively, with respect to all countries. The slope is, unsurprisingly, very similar since the two graphs reflect the same convergence process by two mirror perspectives.[20]

Finally, EMU inception seem to have homogenized portfolio allocation strategies boosting a convergence process among member countries.

To provide support to our hypothesis we consider the change between 1997 and 2001 which are the two years, pre and post EMU, closer in our dataset. We plot in Figure 7 the growth rates of *within* EMU *bpw*, *within* NON EMU *bpw* and *between* EMU-NON EMU *bpw* between year 1997 and year 2001.[21] The flatter fitting line corresponds to the *within* NON EMU convergence while the steeper corresponds to the *within* EMU convergence. Interestingly, in this shorter time span, there is no significant convergence among NON EMU countries and the convergence between EMU and NON EMU is almost identical to the one recorded in the longer period. We find that the pattern is very similar to the one found for the 1997-2004 period: the *within* EMU convergence is still there with a coefficient twice as large as the *between* EMU/NON EMU coefficient and three time larger than the (non statistically significant) *within* NON EMU slope. As expected, since the time span is shorter, the degree of convergence is lower in the *within* EMU case than in the 1997-2004 period underlining that the convergence process was already in action in 2001 and kept speeding up afterwards.[22]

5.2 Portfolio dispersion: determinants

If the EMU inception had an effect on equity portfolio convergence it may be due to several reasons. We identify two main channels through which the financial integration among member countries could have risen:

[19] For both the *within* EMU and the *within* NON EMU sub-samples there are no outliers so we mantain all 30 observations for each group.

[20] This result stresses how the peculiar stronger convergence of *within* EMU countries is not driven at all by the nature of the bilateral dispersion measure which is investing country-dependent. If it were the case we should observe a different convergence of EMU portfolios also with respect to NON EMU countries and so different convergence slopes in Figure 5 and 6.

[21] For sake of simplicity, we consider only the linear least square case since the logarithmic case shows a qualitatively similar pattern.

[22] We exclude one outlier for the *within* EMU *bpw* and two outliers for the *between* EMU-NON EMU *bpw*. Including the outliers the regression coefficient for the *within* EMU *bpw* would have been even larger (-0.031*) while the coefficient for the *between* EMU-NON EMU *bpw* (-0.004***) would have been even lower so further supporting our conjecture.

the common monetary policy and the single currency (Fratzscher, 2002). A common monetary policy should, in fact, increase the synchrony among member countries' inflation rates so making the investors choose more similar strategies to hedge inflation risk. At the same time, the presence of the single currency might make the representative investor hold more similar international equity positions as the investment barriers (direct, such as transaction costs and indirect such as informational barriers) might become more similar.[23] Next section describes how these two forces may determine the described evidence.

5.2.1 Inflation hedging

Some contributions investigating the convergence in inflation rates consider the correlation measure or the dispersion in inflation rate. In Figure 8 we report the standard deviation of inflation rates among EMU countries in the period 1993-2004 (solid line). For comparability, we also report the standard deviation of inflation rates for the NON EMU countries included in our analysis (dotted line). It seems quite evident how the average standard deviation among NON EMU countries has remained fairly stable over the period considered while the standard deviation of EMU countries decreases since the beginning of 1997 pointing to a homogenization of the inflation rates among member countries. However, the evidence of a lower dispersion across members is not sufficient to assess a stronger role for a common inflation hedging motive as, in our case, what matters in shaping optimal portfolios is the *comovement* of inflation rates across countries and therefore their covariance more than their standard deviation.[24] We report in Table 3 some descriptive statistics on inflation rates for EMU and NON EMU countries, distinguishing between the pre-EMU period and the post-EMU period. It is immediately evident how, for the sample of countries analyzed, there is no much variation in the covariance so that we do not expect a great impact on portfolios.[25] In order to size the impact of the inflation hedging motive we run regression (5). We instrument return $R^j_{l,t}$ by its lagged value $R^j_{l,t-1}$ where the orthogonality condition $E(R^j_{l,t-1}\varepsilon^j_{lt}) = 0$ holds. A GMM regression is, therefore, implemented returning, for each investing country, consistent estimates of the b^j_l coefficients, one for each destination country, i.e. twelve for each investing country. In order to estimate the above expression we use monthly data for the 6 years preceding portfolio holdings' date. Therefore, for 1997-stock holdings we use monthly returns for the period January 1993-December 1997, while for portfolio positions in 2004 we refer to January 1999-December 2004

[23] The recent literature has, in fact, emphasized the stronger informational linkages among EMU countries after the monetary integration (Lane and Milesi-Ferretti, 2007; Croci, 2004).

[24] Note that our results are not driven by the fact that we consider 1993-1998 as pre-EMU period while our pre-EMU portfolios are referred to December 1997. We computed, in fact, also the covariances and standard deviations of inflation rate when the pre-EMU period is assumed to finish in December 1997. We find that their relative size with respect to the post-EMU period remains very similar to what reported here. Also considering May 1998, the date of the formal announcement of EMU inception, as cut-off point does not alter our conclusions.

[25] Note that, when considering all EMU countries rather than only the countries included here the mean and standard deviation are only marginally affected while the average correlation slightly decreases from 0.58 to 0.54 and the average covariance ($1*10^3$) almost halves passing from 0.56 to 0.30. It somehow reflects the evidence of some divergence recorded by Honohan and Lane (2003, 2005). It also stresses that the divergent pattern is mainly due to smaller EMU countries such as Ireland (Honohan and Lane, 2005).

period. The number of observations, identical for the pre- and post-EMU periods, is dictated by the relatively short post-EMU period. In Table 4 we report the results of the Wald test on the difference of the estimated b_l^j hedging coefficients. For each pair of EMU countries we test 12 coefficients, corresponding to the number of destination assets. An equal, or not statistically different, hedging coefficient of Austria and Belgium with respect to Japanese assets implies that the two countries should have the same position in Japanese stocks in order to hedge inflation.[26] Our results support, in general, the hypothesis of no substantial difference in hedging strategies induced by EMU integration. The inflation comovement was, in fact, already quite strong in the pre-EMU period and has not remarkably increased after the integration. The Wald test does not reject the null hypothesis of equal hedging coefficients at 1% for 96% of the cases before EMU integration and for 100% for the post-EMU period.[27] The table reports for each EMU country-pair the number of different coefficients out of 12 and, in parentheses, the destination assets displaying different hedging properties with indication of the confidence level. The upper diagonal elements report the number of statistically different coefficients in the pre-EMU period while the lower diagonal elements refer to the post-EMU period. The maximum number of different hedging coefficients is 12 for each country-pair. We can notice, for instance, how hedging portfolios for Austria and France demanded different portfolio shares in Japan, UK and US in order to hedge inflation before EMU integration while the absence of different coefficients after EMU integration implies that their hedge portfolio has become identical.[28] However, only in very few cases the hedging coefficients result statistically different suggesting a very limited role of the inflation hedging motive in explaining the EMU portfolio convergence. In other words, there has been some convergence in inflation comovements after the integration, evidenced by the lower number of different coefficients, but the change is modest since it started from an already high pre-EMU level. In order to check the relevance of inflation convergence in driving our results we compute the portfolio dispersion and portfolio convergence excluding, for the relevant pair of countries, the destination assets showing different hedging properties. For instance, in the computation of the growth in bilateral portfolio dispersion between Austria and Finland, we exclude the UK and US assets for which the Wald test rejected the null hypothesis of equal hedging coefficients. We find that our results are unchanged. The negligible fraction of significantly different coefficients and the small size of the distances are, in fact, not pivotal for our results so that the observed dispersion in portfolio can be ascribed to dispersion in investment barriers. In other words, the observed reduction in portfolio dispersion

[26] Note that equal hedge portfolio does not command equal portfolio share since investing countries are allowed to differ also in terms of bilateral investment barriers.

[27] When the confidence interval is widened to 10% the percentage of not statistically different coefficients decreases to 90% and to 98% for the pre- and post-EMU period, respectively.

[28] We have performed 180 tests (6 countries, therefore 15 pairs, investing in 12 countries). We have considered as statistical significant differences the ones in which the Wald test rejected the null hypothesis provided at least one of the two hedging coefficients was different from zero. There was a 3% and 10% of tests, for pre-EMU and post-EMU period, respectively, rejecting the null when *both* coefficients were statistically not different from zero. In other words, they were two different "zeros" and, for our purposes, they have been considered as playing no role in determining portfolio dispersion.

is reasonably approximated by reduction in dispersion of bilateral investment barriers and, consequently, the observed convergence in EMU portfolios can be ascribed to convergence in investment barriers of EMU countries.

5.2.2 Investment barriers

After ruling out the role of inflation hedging, the explanatory burden falls entirely on bilateral investment barriers. The expression for variation of portfolio dispersion over time reduces, accordingly, to (9) and the only force driving the growth in *asset j wedge* between country l and y (Δ^j_{ly}) is the *investment cost wedge* k^j_{ly}. This crucial finding allows to re-interpret the results from an alternative point of view. The negative growth in *bpw* among EMU countries reported in Table 1 can be seen as a reduction in dispersion of bilateral investment barriers. The faster drop in distance is between Finland and Italy whose *investment cost wedge* drops by 83% and, in general, the stronger drops are related to Finland and Italy getting closer to other EMU countries. Netherlands, even though on average reduces its dispersion versus EMU countries, shows some anomalous features experiencing an increase *investment cost wedge* of 41% with respect to Austria and of 11% with respect to France. Table 2 conveys a more general idea of the investment wedge of different EMU countries with respect to the two reference groups, EMU and NON EMU. The drop in *investment cost wedge* among EMU countries is above 50%, meaning that the distance between bilateral investment barriers has halved in the period 1997-2004 considered. Finland and Italy are the countries showing on average the stronger reduction in distance from other EMU countries' portfolios which can be read as a reduction in distance of their bilateral investment barriers from other EMU countries' barriers. Analogously, Table 3 can be read in terms of *investment cost wedges*: in 1997 the *within* aggregate investment wedge of EMU countries was lower than the *between* EMU aggregate investment wedge and it kept on reducing with respect to both EMU and NON EMU countries. The level of k^j_{ly} is not very informative *per se* since, as we stressed above, symmetrical investment barriers command symmetrical portfolios. However, the *distance* of k^j_{ly} from the overall mean reveals the countries starting as less integrated and the *growth rate* of k^j_{ly} point out to those countries converging more rapidly. Finland and Italy, the countries which displayed the higher drop in dispersion, were also the countries having the higher pre-EMU *investment cost wedge* pointing to a convergence process in investment barriers. The convergence process in bilateral investment barriers is, finally, reflected in Figure 2. The common currency union had the effect of making the bilateral investment barriers - direct such as transaction costs or indirect such as information costs - more similar among the member countries. Since the convergence process is driven by convergence investment barriers rather than inflation convergence we stress a prevailing role of common currency on common monetary policy (Fratzscher, 2002) in determining convergence in equity portfolios.

6 Conclusions

We uncover a strong convergence among EMU countries' international equity portfolios after the creation of the monetary union. We investigate whether this evidence is due to inflation hedging or to investment barriers. We test the difference in inflation hedging coefficients in order to detect how far the common monetary policy, determining a higher comovement in inflation rates, might have induced similar hedging strategies thus driving the convergence in portfolio allocations. We find no support for the inflation hedging explanation since a remarkable comovement in inflation rates was already present before EMU integration. Convergence in bilateral investment barriers induced by the single currency is therefore recognised as the sole responsible for portfolio convergence. An interesting implication of this clear-cut finding is the possibility of quantifying the convergence in investment barriers: in the considered period (1997-2004) the dispersion in investing barriers among EMU countries has halved and countries starting less integrated in the system did integrate faster thus suggesting a convergence process fostered by EMU creation.

References

[1] Adam, K., Jappelli, T., Menichini, A., Padula, M., Pagano, M. Analyze, Compare and Apply Alternative Indicators and Monitoring Methodologies to measure the Evolution of Capital Market Integration in the European Union. Report to the European Commission 2002.

[2] Adjaouté, K., Danthine, J-P. EMU and Portfolio Diversification Opportunities. FAME Research Paper #31, International Center FAME, Geneve, 2000.

[3] Adler, M., Dumas, B. International Portfolio Choice and Corporation Finance: A Synthesis. Journal of Finance 1983, 38, 925-984.

[4] Ahearne, A.G., Griever, W.L., Warnock, F.E. Information Costs and Home Bias: An Analysis of U.S. Holdings of Foreign Equities. Journal of International Economics 2004, 62, 313-336.

[5] Baca, S.P., Garbe, B.L., Weiss, R.A. The Rise of Sector Effects in Major Equity Markets. Financial Analysts Journal 2000, September-October.

[6] Baele, L., Ferrando, A., Hördhal, P., Krylova, E., Monnet, C. Measuring Financial Integration in the Euro Area. Oxford Review of Economic Policy 2004, 20(4), 509-530.

[7] Bekaert, G. Harvey, C. R. Time-Varying Conditional World Market Integration. Journal of Finance 1995, 403-444.

[8] Cavaglia, S., Brightman, C., Aked, M. The Increasing Importance of Industry Factors. Financial Analysts Journal 2000, March-April, 31-39.

[9] Cooper, I.A., Kaplanis, E. Home Bias in Equity Portfolios, Inflation Hedging and International Capital Market Equilibrium. Review of Financial Studies 1994, 7(1), 45-60.

[10] Croci, M. Integration of the Euro Equity Markets: An Empirical Analysis. SSRN Working Paper Series 2004.

[11] Epstein, L. G., Miao, J. A two-person dynamic equilibrium under ambiguity. Journal of Economic Dynamics and Control 2003, 27(7), 1253-1288.

[12] Fratzscher, M. Financial Market Integration in Europe: On the Effects of EMU on stock Markets. International Journal of Finance and Economics 2002, 7, 165-193.

[13] Gehrig, T. An Information Based Explanation of the Domestic Bias in International Equity Investment. Scandinavian Journal of Economics 1993, 95(1), 97-109.

[14] Grossman, S., Stiglitz, J., 1980. On the Impossibility of Informationally Efficient Markets. American Economic Review, 70(3), 393-408.

[15] Hardouvelis G.A., Malliaropoulos, D., Priestley, R. EMU and European Stock Market Integration. CEPR Discussion Paper #2124, 1999, April

[16] Honohan P., Lane, P.R. Divergent inflation rates in EMU. Economic Policy 2003, 18, 357-394.

[17] Honohan P., Lane, P.R. Exchange Rates and Inflation under EMU: An Update. IIIS Discussion Paper Series # 31, 2005.

[18] Karolyi, G. A., Stulz, R. M. Are Financial Assets Priced Locally or Globally?. NBER Working Paper Series, #.W8994, 2002.

[19] Lane, P., Milesi-Ferretti, G.M. The International Equity Holdings of Euro Area Investors, in The Importance of the External Dimension for the Euro Area: Trade, Capital Flows, and International Macroeconomic Linkages (Robert Anderton and Filippo di Mauro, eds), Cambridge University Press, 2007.

[20] Lane, P., Milesi-Ferretti, G.M. International Investment Patterns. Review of Economics and Statistics 2008, 90(3), 538-549.

[21] Lewis, K. Trying to Explain Home Bias in Equities and Consumption. Journal of Economic Literature 1999, 37(2), 571-608.

[22] Obstfeld, M., Rogoff, K. The Six Major Puzzles in International Macroeconomics: Is There a Common Cause?. NBER Macroeconomics Annual 15, 339-390, 2001

[23] Rose, A.K., Van Wincoop, E. National Money as a barrier to International trade: the real case for currency union. American Economic Review 2001, 91(2), 386-390.

[24] Sercu, P. A Generalization of the International Asset Pricing Model. Revue de l'Association Francaise de Finance 1980, 1, 91-135.

[25] Solnik, B. The International Pricing of Risk: An Empirical Investigation of the World Capital Market Structure. Journal of Finance 1974, 47, 365-378.

[26] Sorensen, B. E., Wu, Y., Yosha, O., Zhu, Y. Home Bias and International Risk Sharing: Twin Puzzles Separated at Birth. Journal of International Money and Finance 2008, forthcoming.

[27] Uppal, R., Wang, T. Model Misspecification and Underdiversification. Journal of Finance 2003, 58.6, 2465-2486.

[28] Yang, J., Min, I., Li, Q. European Stock Market Integration: Does EMU Matter?. Journal of Business, Finance and Accounting 2003, 30, 1253-1276.

Appendix A: Model with inflation hedging and investment barriers

Inflation hedging

We model the inflation risk in the investor's problem following Adler and Dumas (1983). We consider L investors investing in N stocks and one risk-free asset. Lacking data on the specific securities exchanged between individuals, we assume that investors are restricted to hold national market indexes. Consequently, considering one investor and one asset per country, we deal with L source countries and N host countries. Hence, the vector of weights will have dimension $(N+1)x1$ while the portfolio variance-covariance matrix will be of dimension NxN since the $(N+1)th$ asset is riskless. All variables are expressed in a common currency chosen as numeraire.[29]

The investor's constrained optimization problem is the following

$$\underset{w^j}{Max}\ E\int_t^T V(C,P,s)ds \tag{14}$$

$$sub \quad dW = \left[\sum_{j=1}^{N} w^j(\mu^j - r) + r\right] Wdt - Cdt + \sum_{j=1}^{N} w^j\sigma^j dz^j \tag{15}$$

where W is the nominal wealth, r is the riskless instantaneous nominal interest rate, μ^j is the asset j's instantaneous expected rate of return, σ^j is the instantaneous standard deviation, C is the nominal rate of consumption, P is the price level index, V - expressing the instantaneous rate of indirect utility - is a function homogeneous of degree zero in (C,P) and w is the vector of investor's portfolio shares.

The instantaneous total rate of return on the market portfolio of country j is

$$dY^j/Y^j = \mu^j dt + \sigma^j dz^j$$

where z^j is a Wiener process and dz^j is a standard Gauss Wiener process with zero mean.

The price index of an investor l in the measurement currency follows the Brownian process

$$dP_l/P_l = \pi_l dt + \sigma_{l,\pi} dz_{l,\pi}$$

where π_l is the expected value of the instantaneous rate of inflation and $\sigma_{l,\pi}$ is the standard deviation of the instantaneous rate of inflation.

Denoting by $J(W,P,t)$ the maximum value of (14) subject to (15), we define by λ the investor's relative risk aversion coefficient

$$\lambda = -\frac{J_{WW}}{J_W}W$$

where J_W and J_{WW} are, respectively, the first and second partial derivative of $J(.)$ with respect to W.

This yields the optimal expected rate of return

$$\mu^j = r + (1-\lambda)\sigma^{j,\pi} + \lambda \textstyle\sum_{k=1}^{N} w_k\sigma^{j,k}$$

and the optimal portfolio allocation

$$\tilde{\mathbf{w}}_l = \tfrac{1}{\lambda}\begin{pmatrix} \mathbf{\Omega}^{-1}(\boldsymbol{\mu} - r\mathbf{i}) \\ 1 - \mathbf{i}'\mathbf{\Omega}^{-1}(\boldsymbol{\mu} - r\mathbf{i}) \end{pmatrix} + (1 - \tfrac{1}{\lambda})\begin{pmatrix} \mathbf{\Omega}^{-1}\boldsymbol{\varpi}_l \\ 1 - \mathbf{i}'\mathbf{\Omega}^{-1}\boldsymbol{\varpi}_l \end{pmatrix} \tag{16}$$

where $\mathbf{i}$ denotes a $Nx1$ vector of ones, $\mathbf{\Omega}$ is a NxN matrix of instantaneous variances-covariances of nominal rates of returns and $\boldsymbol{\varpi}_l$ is a $Nx1$ vector of covariances between nominal asset returns and country l's rate of inflation. The last element in each vector refers to the riskless asset. The first term in parentheses of the above equilibrium condition is often called "logarithm portfolio"[30], that is the portfolio driven by excess

[29] As shown by Solnik (1974) and Sercu (1980), the portfolio composition is independent from the numeraire considered.

[30] It is the portfolio held by the investor characterized by a unitary coefficient of risk aversion, i.e. a logarithmic utility function.

return and variance-covariance considerations, while the second is the "hedge portfolio", that is the portfolio hedging the investor's inflation risk.

The vector of weights in the investor l's equity portfolio is then

$$\mathbf{w}_l = \mathbf{\Omega}^{-1} \left\{ \tfrac{1}{\lambda}([\boldsymbol{\mu} - r\mathbf{i}] + \left(1 - \tfrac{1}{\lambda}\right)[\boldsymbol{\varpi}_l] \right\} \tag{17}$$

Information asymmetries

We integrate investment barriers following Gehrig (1993) approach.[31] The informational barriers are assumed to modify the variance-covariance matrix in such a way that the foreign investor has a higher perceived variance of the asset issued by country k than the investor residing in another country.[32]

For each investor l the vector of equity portfolio shares, $\mathbf{w}_l$, will be therefore

$$\mathbf{w}_l = \mathbf{C}_l^{-1}\mathbf{\Omega}^{-1} \left[\tfrac{1}{\lambda}(\boldsymbol{\mu} - r\mathbf{i}) + \left(1 - \tfrac{1}{\lambda}\right) \boldsymbol{\varpi}_l \right] \tag{18}$$

where $\mathbf{C}_l$ is a diagonal NxN positive definite matrix whose generic element C_l^j is the bilateral cost of holding country j's stock by country l's investor. Its reciprocal, $\dfrac{1}{C_l^j}$, stands for a variable capturing the investment "advantage" of country l investing in country j.

The equilibrium condition equating stock demand and stock supply will be

$$\mathbf{MS} = \mathbf{\Phi}\mathbf{\Omega}^{-1} \left[\tfrac{1}{\lambda}(\boldsymbol{\mu} - r\mathbf{i}) + \left(1 - \tfrac{1}{\lambda}\right) \sum_{l=1}^{L} MS_l \varpi_l \right] \tag{19}$$

where **MS** represents the vector of market shares of stock market indexes (supply side) and the right hand side is the (weighted) sum of stock indexes' demands (demand side). $\mathbf{\Phi}$ is a diagonal NxN positive definite matrix whose generic element, ϕ_j, is the *average* investment "advantage" in holding asset j.

$$\phi_j = \sum_{l=1}^{L} MS_l \frac{1}{C_l^j}$$

Let us define $\mathbf{D}_l = \mathbf{\Phi}\mathbf{C}_l$, where $\mathbf{D}_l$ is again a diagonal NxN positive definite matrix. We can rewrite the above expression (18) as

$$\mathbf{w}_l = \mathbf{D}_l^{-1}\mathbf{\Phi}\mathbf{\Omega}^{-1} \left[\tfrac{1}{\lambda}(\boldsymbol{\mu} - r\mathbf{i}) + \left(1 - \tfrac{1}{\lambda}\right) \boldsymbol{\varpi}_l \right] \tag{20}$$

where $D_l^j = \phi_j C_l^j$ and $\dfrac{1}{D_l^j} = \dfrac{\frac{1}{C_l^j}}{\sum_{l=1}^{L} MS_l \frac{1}{C_l^j}}$

and using the equilibrium condition (19) we get the following result

$$\mathbf{w}_l = \mathbf{D}_l^{-1}\mathbf{MS} + \left(1 - \tfrac{1}{\lambda}\right) \mathbf{C}_l^{-1}\mathbf{\Omega}^{-1} \left(\varpi_l - \sum_{l=1}^{L} MS_l \varpi_l \right) \tag{21}$$

$\dfrac{1}{D_l^j}$ represents the *relative* (with respect to world average) "advantage" of country l investing in asset j.

[31] Cooper and Kaplanis (1994) use the return reduction approach in modelling direct transaction costs. We chose this alternative solution since it allows to derive a more clear-cut and easily interpretable expression for bilateral portfolio dispersion.

[32] In a standard setting with asymmetric information (Grossman and Stiglitz, 1980), an informed investor has a lower perceived variance due to her private signal but, at the same time, her perceived expected return is generally also different from the uninformed investor's. It implies that it should be sometimes observed a "foreign-bias" when the domestic investor observes bad signals. Our perspective on information asymmetry is, instead, closer to the concept of "model uncertainty" or "Knightian uncertainty" (Epstein and Miao, 2003; Uppal and Wang, 2003). Roughly speaking, we assume that investor k's perceived uncertainty is different from investor l's, though both face the same perceived return.

In other words, the investor l will demand a share of assets greater than the market share in proportion to $\frac{1}{D_l^j}$ (inverse of relative investment barrier).

We can now notice how the covariance vector in parentheses pre-multiplied by the inverse of the variance-covariance matrix of returns is a vector of regression coefficients (Cooper and Kaplanis, 1994).

$$\mathbf{\Omega}^{-1}\left(\varpi_l - \sum_{l=1}^{L} MS_l \varpi_l\right) = \mathbf{b}_l \equiv \begin{pmatrix} b_l^1 \\ \vdots \\ b_l^j \\ \vdots \\ b_l^N \end{pmatrix} \tag{22}$$

If we define by p_l the inflation rate of country l then $\sum_{l=1}^{L} MS_l \varpi_l$ is the average world inflation rate and $\mathbf{b}_l$ is the vector of coefficients of the multiple regression of $(p_l - \sum_{l=1}^{L} MS_l p_l)$ on the vector of nominal returns.

Appendix B: Restricted model

We derive here the *asset j wedge* under restricted versions of the model: no investment barriers, symmetrical investment barriers, no inflation hedging.

No investment barriers

If there are no investment barriers then

$$C_l^j = 1 \; \forall l, j \Longrightarrow D_l^j = 1 \; \forall l, j$$

and (21) reduces to the following standard Adler and Dumas (1983) equilibrium model

$$w_l^j = MS^j + \gamma b_l^j$$

The the *asset j wedge* (Δ_{ly}^j) in expression (7) in the text reduces therefore to

$$\begin{aligned} \frac{\left|w_l^j - w_y^j\right|}{w_y^j} &= \frac{\left|MS^j + \gamma b_l^j - MS^j - \gamma b_y^j\right|}{MS^j + \gamma b_y^j} = \\ &= \gamma \frac{\left|b_l^j - b_y^j\right|}{MS^j + \gamma b_y^j} \end{aligned}$$

If comovement of inflation rates between country l and y is such that the hedging coefficients are not statistically different ($b_l^j = b_y^j$) we should, consequently, observe identical portfolio allocations across EMU countries. However, even though the Wald test does not reject in almost all cases the null hypothesis $b_l^j = b_y^j$, differences in portfolios are still remarkable. Investment barriers are therefore necessary to give an interpretation the observed portfolio dispersions.

Symmetric investment barriers

In this specification we allow for the presence of investment barriers but we assume they are symmetrical for all countries. Since $\left(D^j\right)^{-1} = \frac{\left(C^j\right)^{-1}}{\phi^j}$

$$w_l^j = \left(D^j\right)^{-1} MS^j + \gamma \left(C^j\right)^{-1} b_l^j$$

The the *asset j wedge* (Δ_{ly}^j) in expression (7) in the text reduces therefore to

$$\begin{aligned}
\frac{\left|w_l^j - w_y^j\right|}{w_y^j} &= \frac{\left|\frac{\left(C^j\right)^{-1}}{\phi^j} MS^j + \gamma \left(C^j\right)^{-1} b_l^j - \frac{\left(C^j\right)^{-1}}{\phi^j} MS^j - \gamma \left(C^j\right)^{-1} b_y^j\right|}{\frac{\left(C^j\right)^{-1}}{\phi^j} MS^j + \gamma \left(C^j\right)^{-1} b_y^j} = \\
&= \frac{\left|\frac{MS^j}{\phi^j} + \gamma b_l^j - \frac{MS^j}{\phi^j} - \gamma b_y^j\right|}{\frac{MS^j}{\phi^j} + \gamma b_y^j} = \gamma \frac{\left|b_l^j - b_y^j\right|}{\frac{MS^j}{\phi^j} + \gamma b_y^j}
\end{aligned}$$

Again, the differences in portfolio weights are entirely due to inflation hedging contradicting the empirical evidence of heterogeneity in portfolio allocations under equality of hedging coefficients. As pointed out above, the mere existence of investment barriers does not imply heterogeneity in portfolio positions.

Heterogeneous investment barriers without inflation hedging

Finally, we consider the case with heterogeneity in investment barriers but absence of stochastic inflation, that is we assume no role for stocks in hedging inflation. The equilibrium condition will be, therefore

$$w_l^j = \left(D_l^j\right)^{-1} MS^j$$

From the text

$$C_y^j = (1 + k_{ly}^j) C_l^j \Longrightarrow \left(D_l^j\right)^{-1} = \frac{\left(C_l^j\right)^{-1}}{\phi^j} = \frac{(1 + k_{ly}^j)\left(C_y^j\right)^{-1}}{\phi^j} = (1 + k_{ly}^j)\left(D_y^j\right)^{-1}$$

The the *asset j wedge* (Δ_{ly}^j) in expression (7) in the text reduces therefore to

$$\begin{aligned}
\frac{\left|w_l^j - w_y^j\right|}{w_y^j} &= \frac{\left|(1 + k_{ly}^j)\frac{\left(C_y^j\right)^{-1}}{\phi^j} MS^j - \frac{\left(C_y^j\right)^{-1}}{\phi^j} MS^j\right|}{\frac{\left(C_y^j\right)^{-1}}{\phi^j} MS^j} = \\
&= 1 + \left|k_{ly}^j\right| - 1 = \left|k_{ly}^j\right|
\end{aligned}$$

The case of inflation hedging coefficients not statistically different among EMU countries emerging from our analysis is observationally equivalent to the case of null inflation hedging. In both cases, in fact, portfolio dispersion is exclusively due to heterogeneity in investment barriers.

Tables

Table 1. Growth in *bilateral portfolio wedge*

The table reports the variation over time of the *bilateral portfolio wedge* (*bpw*), that is the portfolio wedge of each investing country *l* with respect to any other investing partner considered, EMU and NON EMU. We report here values for the weighted bilateral portfolio wedge that is the portfolio wedges computed weighting each destination asset by its market share (expression (9) in the text). The change is computed between year 1997 (pre-EMU) and year 2004 (post-EMU).

	oe	bel	fin	fr	it	nl	can	dk	jp	swe	uk	us
oe	-	**-6%**	**-72%**	**-30%**	**-40%**	**41%**	42%	50%	-38%	4%	-22%	-11%
bel		-	**-29%**	**-52%**	**-73%**	**-58%**	70%	-46%	-2%	-18%	-16%	-24%
fin			-	**-78%**	**-83%**	**-60%**	-66%	-35%	-32%	-37%	-42%	-38%
fr				-	**-65%**	**11%**	60%	-16%	-18%	2%	-27%	1%
it					-	**-58%**	-62%	-11%	-25%	-34%	-39%	-34%
nl						-	-25%	-7%	-17%	-17%	-25%	-32%
can							-	-8%	-43%	-14%	-40%	-11%
dk								-	-27%	-20%	-29%	-23%
jp									-	-36%	-41%	-38%
swe										-	-40%	-4%
uk											-	-41%
us												-

Table 2. Growth in *aggregate portfolio wedge*

The table reports the variation over time of the *portfolio wedge* for each investing country *l*. The *aggregate portfolio wedge* measures the distance of country *l*'s portfolio from the reference group (ALL/EMU/NON EMU). By row we report the investing country and by column the reference group, that is the group against which we measure the degree of integration. The variation in portfolio wedge is obtained as the growth rate of the unweighted and weighted *apw* which are reported in expression (10) and (11), respectively, in the text. The change is computed between year 1997 (pre-EMU) and year 2004 (post-EMU).

	ALL		**EMU**		**NON EMU**	
	unweighted	weighted	unweighted	weighted	unweighted	weighted
Austria	-32%	-20%	-49%	-28%	-15%	-19%
Belgium	-38%	-25%	-54%	-38%	-21%	-23%
Finland	-72%	-75%	-73%	-76%	-71%	-75%
France	-29%	-9%	-65%	-34%	7%	-6%
Italy	-61%	-64%	-66%	-50%	-56%	-65%
Netherlands	-47%	-52%	-56%	-35%	-37%	-55%
Canada	-12%	-12%	-18%	2%	-4%	-11%
Denmark	-19%	-34%	-13%	19%	-27%	-15%
Japan	-51%	-38%	-54%	-34%	-47%	-12%
Sweden	-39%	-38%	-43%	-23%	-33%	-18%
United Kingdom	-44%	-35%	-40%	-5%	-49%	-10%
United States	-23%	-23%	-31%	-3%	-12%	-32%
EMU	-55%	-39%	-68%	-52%	-42%	-35%
NON EMU	-31%	-27%	-33%	-9%	-29%	-24%

Table 3. **Convergence of portfolio**

The table reports in panel A the level of (weighted) aggregate portfolio wedge (*apw*) before EMU (1997) and after EMU integration (2004). It is computed following expression (10) in the text. By row we report the investing countries and by column the reference group (ALL/EMU/NON EMU) against which we consider the degree of integration. The higher the *apw* with respect to a reference group the lower the degree of integration with respect to it. The last row of panel A reports the average *apw* for all investing countries relative to the different reference groups. Panel B reports the correlation of the growth of portfolio wedge *apw* with the initial level of *apw* (before EMU integration). Correlations - relative to the different reference groups- are reported for all investing countries, for NON EMU countries and for EMU countries.

A. level of *aggregate portfolio wedge (apw)*

	1997			2004		
	ALL	**EMU**	**NON EMU**	**ALL**	**EMU**	**NON EMU**
Austria	5.0	4.2	5.8	3.6	2.2	5.1
Belgium	11.9	5.0	18.9	9.9	3.1	16.6
Finland	32.7	10.2	55.1	6.7	3.0	10.4
France	5.8	3.3	8.3	5.7	2.0	9.5
Italy	29.1	12.9	45.3	10.1	4.1	16.1
Netherlands	3.9	3.0	4.7	2.3	1.8	2.7
EMU weighted average	*12.5*	*5.9*	*19.1*	*6.4*	*2.6*	*10.3*
Canada	8.5	8.5	8.5	8.2	8.9	7.2
Denmark	4.6	2.5	7.6	3.3	2.6	4.2
Japan	18.7	20.5	16.0	10.3	10.6	9.8
Sweden	5.5	4.3	7.1	3.5	3.1	4.1
United Kingdom	3.5	3.0	3.6	2.6	2.4	2.4
United States	4.7	4.5	5.0	4.1	4.2	3.9
NON EMU weighted average	*7.4*	*7.6*	*7.1*	*5.2*	*5.4*	*5.0*
ALL weighted average	*8.1*	*7.3*	*8.7*	*5.4*	*5.0*	*5.7*

B. correlation (growth rate of *apw* - initial level of *apw*)

	ALL	**EMU**	**NON EMU**
NON EMU	*-0.45*	*-0.65*	*-0.22*
EMU	*-0.84*	*-0.92*	*-0.81*

Table 4. Inflation rate: descriptive statistics

The table reports descriptive statistics relative to inflation rate. Data are reported for EMU countries and NON EMU countries considered in the analysis. The first column reports the mean, the second column reports the average standard deviation, the third column reports the correlation and the fourth column reports the covariance. The pre-EMU period ranges from Jan 1993 to Dec 1998 while the period post-EMU ranges from Jan 1999 to Dec 2004.

	mean	average standard deviation	average correlation	average covariance ($1*10^3$)
pre-EMU (1993-1998)				
all countries	0.020	0.011	0.134	0.016
-EMU countries	0.021	0.010	0.445	0.027
-NON EMU countries	0.018	0.012	-0.027	-0.002
post-EMU (1999-2004)				
all countries	0.019	0.011	0.260	0.017
-EMU countries	0.020	0.007	0.485	0.028
-NON EMU countries	0.017	0.013	0.150	0.010

Table 5. Inflation hedging coefficients: significant differences

The table reports, for each pair of EMU countries (*l*,*y*), the number and (abbreviated) nationality of stock markets (*j*) in which the difference of the hedging coefficients is statistically significant. The null hypothesis $b^j_l = b^j_y$ is tested (Wald test) for all pairs of EMU countries and for all destination assets (180 tests: 15 country-pairs times 12 destination assets). The inflation hedging coefficients are computed over the period 1993:01-1998:12 for the pre-EMU period and over the period 1999:01-2004:12 for the post-EMU period. The upper-diagonal elements refer to the number of statistically significant coefficients in the pre-EMU period while the lower-diagonal figures refer to the post-EMU period. *** , ** , * indicate significance at the 1, 5 and 10% levels, respectively.

	Austria	Belgium	Finland	France	Italy	Netherlands
Austria	-	**1**(uk***)	**2**(uk**,us***)	**3**(jp***,uk***,us***)	**2**(jp**,us**)	**2**(us**,uk***)
Belgium	**0**	-	**0**	**2**(jp*,us***)	**2**(jp**,us***)	**1**(us*)
Finland	**0**	**0**	-	**0**	**0**	**0**
France	**0**	**0**	**0**	-	**2**(oe*,uk**)	**1**(it**)
Italy	**0**	**1**(dk**)	**0**	**1**(fin*)	-	**1**(uk*)
Netherlands	**2**(uk*,us*)	**0**	**2**(oe*,nl**)	**0**	**0**	-

Figures

Figure 1. Convergence of portfolios: all countries

The following figure plots the growth rate (from 1997 to 2004) of the bilateral portfolio wedge, *bpw*, on the initial level of *bpw* (in 1997) for all countries included in our sample. The thick line and the thin curve represent, respectively, the least squares line and the least squares logarithmic function fitting the data. The slope reported below the graph represents the standard OLS regression coefficient for the Linear Least Squares. For the Logarithmic Least Squares, the slope represents the OLS coefficient obtained regressing the growth rate of *bpw* on *log*(level of *bpw*). Adjusted R^2 for each fitting curve adopted is also reported.

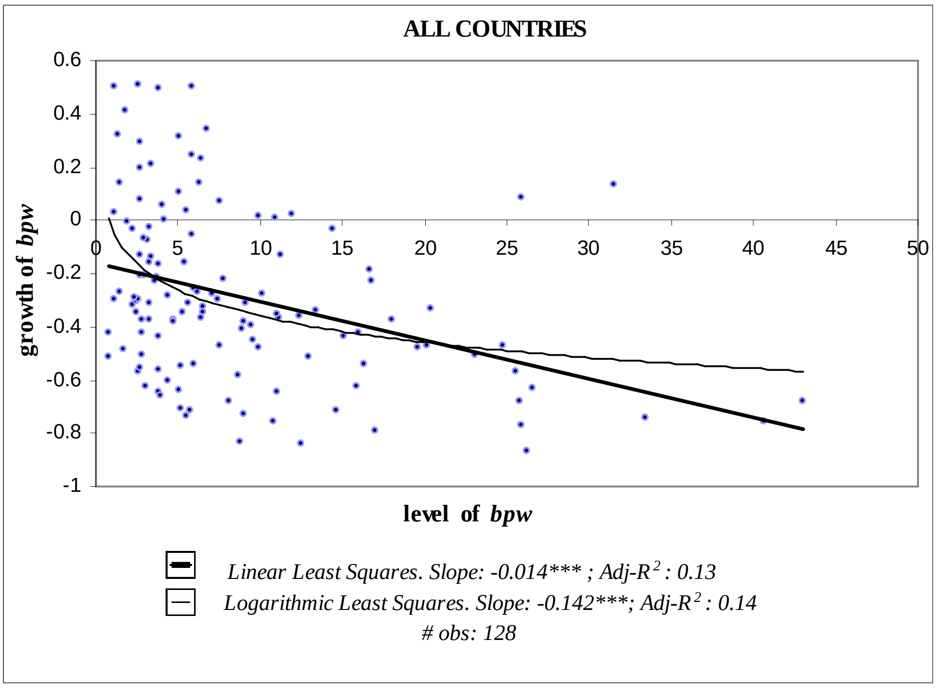

Figure 2. Convergence of portfolios: EMU/EMU

The following figure plots the growth rate (from 1997 to 2004) of the bilateral portfolio wedge, *bpw*, on the initial level of *bpw* (in 1997) for the EMU countries included in our sample (Austria, Belgium, Finland, France, Italy, Netherlands). Otherwise the figure is the same as figure 1.

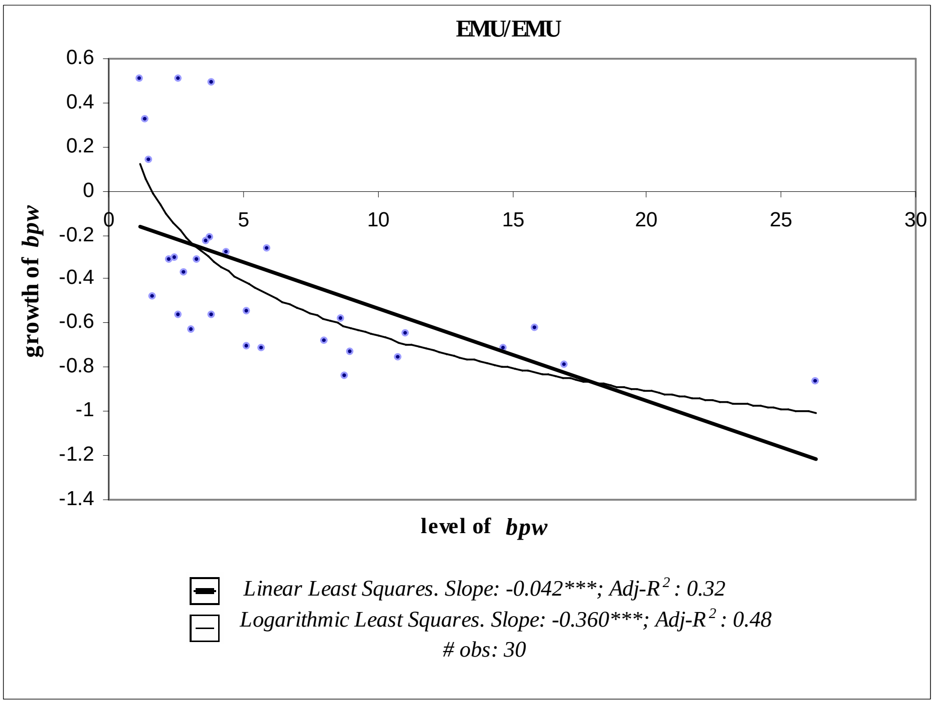

Figure 3. Convergence of portfolios: NON EMU/ NON EMU

The following figure plots the growth rate (from 1997 to 2004) of the bilateral portfolio wedge, *bpw*, on the initial level of *bpw* (in 1997) for NON EMU countries included in our sample (Canada, Denmark, Japan, Sweden, United Kingdom, United States). Otherwise the figure is the same as figure 1.

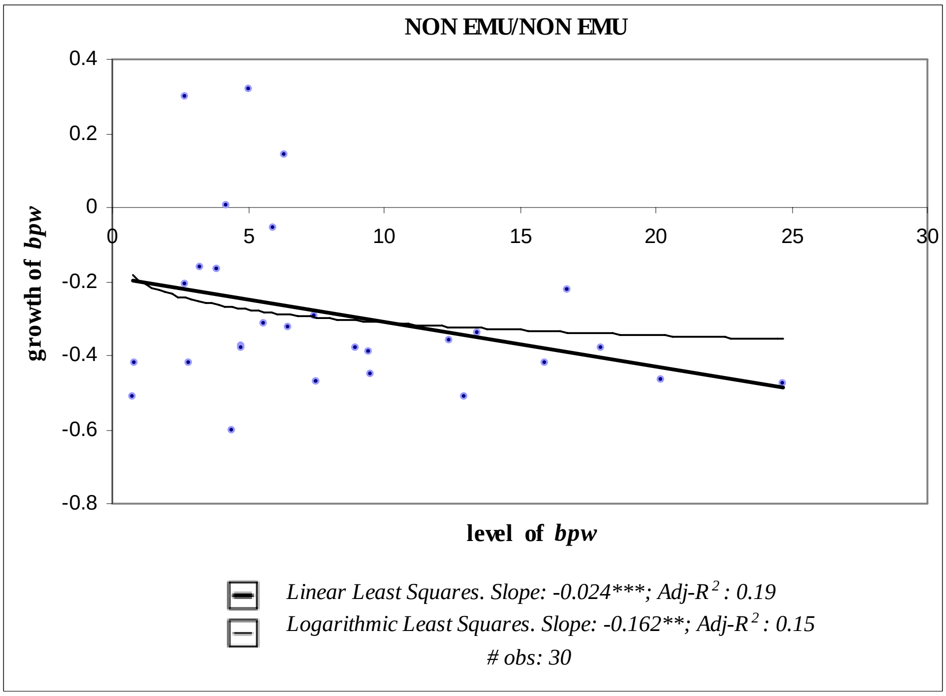

Figure 4. Convergence of portfolios: EMU/NON EMU

The following figure plots the growth rate (from 1997 to 2004) of the bilateral portfolio wedge, *bpw*, on the initial level of *bpw* (in 1997) for EMU countries versus NON EMU countries. Otherwise the figure is the same as figure 1.

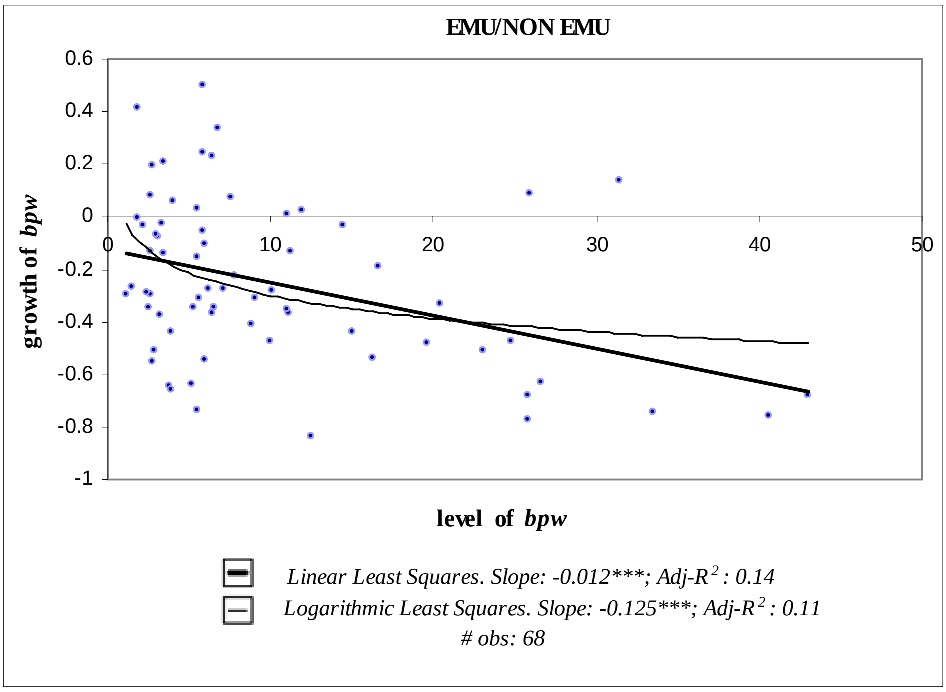

Figure 5. Convergence of portfolios: EMU/ALL

The following figure plots the growth rate (from 1997 to 2004) of the bilateral portfolio wedge, *bpw*, on the initial level of *bpw* (in 1997) for EMU countries compared to all countries included in our sample. Otherwise the figure is the same as figure 1.

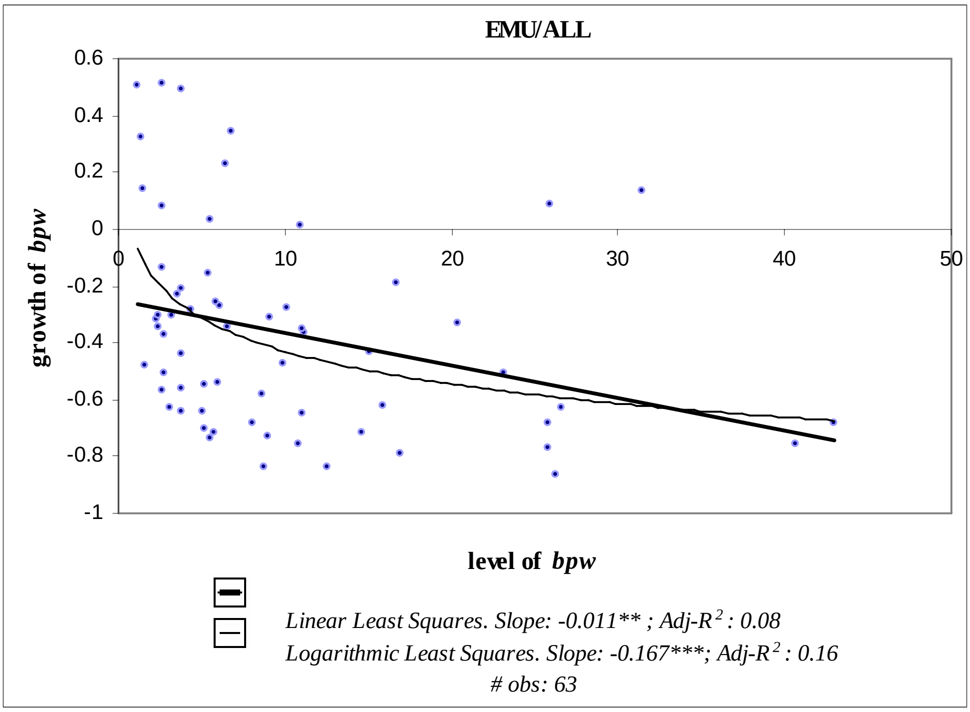

Figure 6. Convergence of portfolios: NON EMU/ALL

The following figure plots the growth rate (from 1997 to 2004) of the bilateral portfolio wedge, *bpw*, on the initial level of *bpw* (in 1997) for NON EMU countries compared to all countries included in our sample. Otherwise the figure is the same as figure 1.

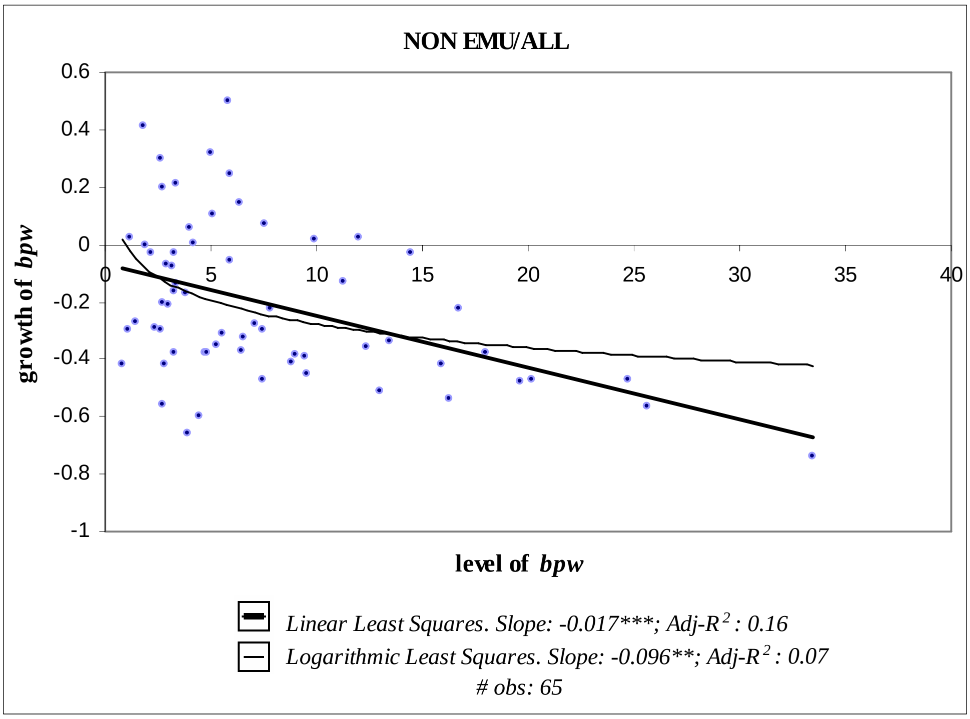

Figure 7. Convergence of portfolios: 1997-2001

The following figure plots the growth rate (from 1997 to 2001) of the bilateral portfolio wedge, *bpw*, on the initial level of *bpw* (in 1997) for EMU/EMU, NON EMU/NON EMU and EMU/NON EMU. The thick line represents the least squares line fitting the EMU/EMU data while the thin line and the dotted line represent the least square lines fitting, respectively, the NON EMU/NON EMU and the EMU/NON EMU data. The slope reported below the graph represents the standard OLS regression coefficient for the Linear Least Squares. Adjusted R^2 for each fitting line adopted is also reported.

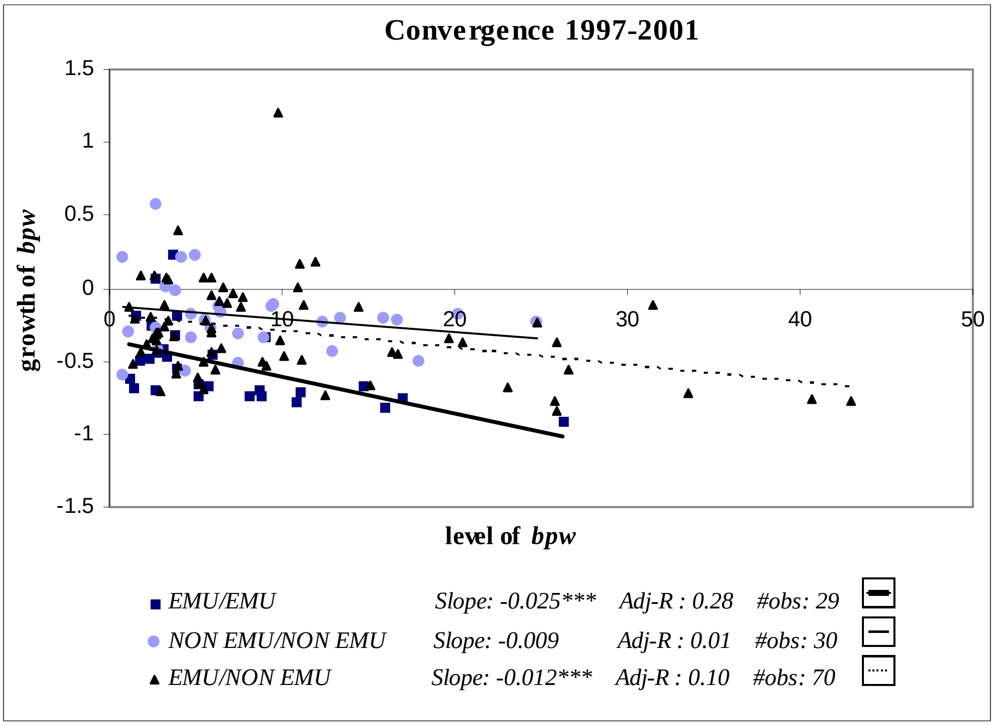

Figure 8. Standard deviation of inflation rates

The figure reports the standard deviation of monthly inflation rates of EMU countries (Austria, Belgium, Finland, France, Italy, Netherlands) and NON EMU countries (Canada, Denmark, Japan, Sweden, United Kingdom and United States). The time span is 1993:01-2004:12.