Testing Financial Markets Integration: a Structural Approach

Antonello D’Agostino
ECARES†, Université Libre de Bruxelles
September, 2003

Abstract

Using a sample of 15 years excess returns data, this paper tests the degree of financial markets integration for 5 European countries. Based on the static factor model of Stock and Watson (1998), a new method for disentangling and measuring international, national and sectorial shocks is proposed. Significant evidence points to an increasing integration, mainly due to the declining influence of the national factors and to the increasing influence of the sectorial factors. Global influences remain the most important excess returns driving forces. Since the middle of the nineties, sectorial factors have started dominating national factors. This finding suggests that equity allocation policies need to be revisited and adapted to the changing financial scenario.

*I wish to thank the Capital Markets and Financial Structure Division of the European Central Bank for its hospitality. I would also like to thank the participants at the internal meetings and in particular Jesper Berg, Efrem Castelnuovo, Murielle Demecheleer, John Fell, Domenico Giannone, Stéphane Guéné, David Marqués Ibañez, Michele Lenza, Jorge Rodrigues and Cristina Vespro for very helpful comments and suggestions. A special thank to Lucrezia Reichlin.

†ECARES, Université Libre de Bruxelles - CP 114 - av. Jeanne, 44, B-1050, Brussels, Belgium. Tel: +32-2-650 3356, e-mail: adagosti@ulb.ac.be, http://student.ulb.ac.be/~adagosti http://www.ecares.org
1 Introduction

In the last decade, increasing attention has been given to capital market integration. In Europe in particular, it is with the advent of EMU that this issue has become central both for investors and policy-makers. The portfolio hedging strategies faced by the investors need to be revised and adapted to this new political and economic environment. At the same time, policy-makers have to take account of the changes that are taking place in the countries, in order to shape at best their policy responses. For these reasons, measuring the extent of European capital market integration is actually one of the main concerns of the economic "actors".

Many methodologies have been implemented in the literature to address this issue. Perhaps the simplest approach is based on the computation of the correlation coefficient between stock returns in different countries, Taylor and Tonks (1989), Le (1991). The underlying intuition behind this measure is fairly simple: more integration implies more comovements between prices, hence higher correlation should signal higher integration. Despite its simplicity, this measure suffers a serious drawback. Since asset returns can be decomposed in a common and an idiosyncratic part, even if the markets are fully integrated, the idiosyncratic component could be important enough to drive down the correlation.

Another standard methodology for analyzing financial market integration is based on evaluating the barriers to arbitrage across markets, Portes and Rey (1999), Bekaert and Harvey (1999). The idea is that the lack of barriers should clearly facilitate integration. A possible disadvantage of this approach could derive from the fact that investors can easily circumvent barriers and taxes. Moreover, the presence of the equity home bias puzzle implies that even eliminating barriers, which represent a necessary requirement for integration, is not sufficient to promote cross border capital flows.

A different approach is based on testing a kind of International Capital Asset Pricing Model (ICAPM). This involves selecting an international mean-variance efficient benchmark portfolio and to compute the betas of the assets with respect to this benchmark, De Santis and Gerard (1997), Harvey (1989, 1991). If the hypothesis of integrated financial markets holds, then assets with identical risk characteristics and the same expected cash flows should have the same expected returns, which are determined by their betas with the benchmark portfolio. A downside of this method is that an inappropriate specification of the benchmark could produce erroneous results when testing
for the degree of integration.

Extensions from one source (ICPAM) to multiple sources of risk (APT, factor models) have also been proposed, Ferson and Harvey (1994). A limitation of these methods is that results may be very sensitive to the choice of the variables and a misspecification of the sources of the common risk could be very misleading. Moreover, both the ICAPM and APT approaches depend on the correct identification of the risk characteristics for each asset and this represents a very difficult task to achieve.

Another way of studying integration is to analyze the importance and the origin of the shocks. According to this definition, returns are linked by a set of common factors. Under full integration, just international factors can explain the correlation between asset returns, Beckers, Connor and Curds (1996). The main characteristic of this approach is that the excess return is decomposed into a global, a country, a sector and a specific component, generally by means of the dummy-variable model, a technique widely used in the literature (Heston and Rouwenhorst (1995), Beckers, Connor and Curds (1996)). This method has many desirable properties. In fact it can disentangle all the driving sources of asset returns; however, this is achieved by imposing very strong restrictions. Exposure to country (industry) factors is the same for all the companies belonging to the same country (industry), while it would be quite reasonable to assume that these exposures could vary across firms. In addition, the model imposes the even stronger condition that all stocks are equally exposed to global factors.

This paper proposes a new method of studying financial markets integration. Our framework is very close to that of Beckers, Connor and Curds (1996), but much more general. We measure the extent to which shocks are transmitted across markets, but, in our model, assets belonging to the same country or to the same sectors are not constrained to have identical risk exposure; they can "load" each factor in different ways\(^1\). The analysis is performed on a core of five European countries over time. We assume that asset returns follow a factor structure, that is they are the sum of two parts: a common part driven by few factors, which are common to all the assets, and an idiosyncratic part, which is asset specific. We propose a three steps procedure for measuring the sources of aggregate risk. In the first step, we

\(^1\)Brooks and Del Negro (2002) extend the dummy variables model by using a generalization of the EM algorithm. By using likelihood ratio tests, they show that the dummy variables model is strongly rejected by the data.
extract the international sources and evaluate their importance on the panel, by computing the principal components analysis on the whole dataset of asset returns. While the common part includes factors affecting all the series, the country, sector and asset specific dynamics are left in the idiosyncratic part. Unlike the asset specific characteristics, the sectorial and country components should be shared by the series belonging respectively to the same economic sector and to the same country. Then in the next steps, partitioning the idiosyncratic part in country and sector, we are able to extract information on these other two components, by computing again the principal component analysis on the partitioned idiosyncratic matrix. The relative contribution of the three factors in explaining the excess return total variance is estimated by projecting each series on the three components. Using the theoretical results of Stock and Watson (1998), we generalize the framework in a time varying set up and asses how these factors have evolved since 1988.

Significant evidence indicates increasing integration, mainly due to the declining influence of the national factors and to the increasing influence of the sectorial ones. The global influences (international plus sectorial) remain the most important excess returns driving forces.

The approach we propose should overcome some of the previously mentioned drawbacks for the following reasons. First, the decomposition in common and idiosyncratic parts allows to control for the specific idiosyncratic dynamics that could drive the researcher toward spurious results. Secondly, since the extent of the transmission of shocks requires not only the lack of barriers to capital flows, but also that capitals move across countries, our methodology should take the potential home bias puzzle into account. Third, our results are not affected by an erroneous selection of the factors, because our specification is based on an unobservable component model. Moreover, the method does not involve the identification of the risk characteristics for each asset, because it does not rely on a pricing model. Finally, as already said, it encompasses the "over-constrained" dummy-variable model.

Of course, all these advantages do not come without costs. The full effectiveness of the technique is achieved by working with very heterogeneous panels. This implies that our analysis should be theoretically performed on a very large dataset, involving many countries and many sectors. But the lack of data for some countries sometimes poses some limitations.

Our findings have important implication on the portfolio strategic equity allocation policies. Solnik (1974) demonstrated the optimality of the
diversification across countries relatively to that across industries, in terms of risk reduction. Since the seminal work of Solnik, portfolio managers have adopted the country dimension as the relevant one for the construction of their portfolios. The scope of the strategic portfolio allocation is to determine the relative importance of the factors affecting asset returns and predicting their future evolution. The increasing economic and financial integration in Europe, fostered by the decline of trade barriers and greater policy coordination, in the last years, has strongly reduced the importance of national factors. As consequence, in this new landscape, firms might have rationalized their activities globally. The increasing number of mergers and acquisition, in the last decade, gives support to this view. These economic and institutional developments, on the other side, can raise the importance of the global factors, such as the sectorial factors.

The empirical findings of this paper seem support this view. According to these results the strategic equity allocation policies need to be revisited and adapted to the changing financial and economic scenario.

The paper is organized as follows. Section II briefly describes the model. Section III describes the estimation technique and the data. Results are reported in section IV. Section V proposes some advice for portfolio management. Section VI summarizes the main contributions and offers some concluding remarks.

2 The Model

Let us suppose that \( y_{ijt} \), the excess returns in sector \( i \) and country \( j \) can be decomposed as the sum of four components:

\[
y_{ijt} = I_{ijt} + N_{ijt} + S_{ijt} + ID_{ijt}
\]

(1)

where, \( i = 1...I \) and \( j = 1...J \). \( I_{ijt} \), \( N_{ijt} \), \( S_{ijt} \) and \( ID_{ijt} \) are the international, national, sectorial and idiosyncratic (or firm specific) components respectively. Each component is the product of one or more functions in the lag operator \( L \) and an equal number of orthogonal shocks labelled as international, national, sectorial or idiosyncratic, depending on the component which they refer to. For example, in case of just one shock for each component, the model can be rewritten as:

\[
y_{ijt} = a_{ijt} (L)i_t + b_{ijt} (L)n_t + c_{ijt} (L)s_t + d_{ijt} (L)id_t
\]

(2)
where $a(L), b(L), c(L)$ and $d(L)$ are the polynomial functions and $i_t, n_t^1, s_t^1$ and $id_t^1$ are the aforementioned, unobserved, mutually uncorrelated (at all leads and lags) orthogonal shocks. This model generalizes that originally proposed by Forni and Reichlin (1999), allowing the common component to be generated by more than one shock. For example, the international component, and this will be the case considered here, could be thought as generated by two unobserved, orthogonal shocks, that is:

$$I_{ij}^t = a_{1t}^1(L)i_{1t} + a_{2t}^1(L)i_{2t}$$  \hspace{1cm} (3)

It is worth highlighting that in the previous specification we allow for heterogeneous responses of each variables to the shocks. The stock returns belonging to the same sector and the same country can react differently to the shocks; hence we relax the doubtful restrictions of the dummy variable model.

Finally, given the orthogonality assumption between shocks, the variance of $y_{ij}^t$ can be decomposed into the sum of the variances of the single components.

3 Estimation techniques

In order to estimate the previous model we assume that $X_t$, the panel of excess returns can be represented by a reduced number of series, also called common factors. This parsimonious way to describe a vector of variables is very appealing because the stochastic dimension of the panel is significantly reduced. Many studies have used common factors to describe features of macroeconomic and financial variables, but despite the simple idea the estimation task has been constrained by using a relatively small number of series; moreover very strong assumptions are sometimes needed to achieve the consistency of the estimated factors. Geweke (1977) and Sargent and Sims (1977) propose a factor model, in frequency domain, for a small number of variables. Engle and Watson (1981), Sargent (1989) and Stock and Watson (1991) estimate a factor model for small $N$ by using a maximum likelihood approach. Quah and Sargent (1993) propose a maximum likelihood method, based on the EM algorithm, for a slightly bigger cross-section dimension. Relevant contributions are due to Chamberlain and Rothschild (1983) and Rothschild (1983) that allow the idiosyncratic terms to be correlated and to Connor and Korajczyk (1986, 1988, 1993) that show the con-
istency of the factors² estimated by principal component in a large system with cross-sectional dependence among idiosyncratic errors. Recently Forni, Hallin, Lippi and Reichlin (2000a, 2000b), in frequency domain, and Stock and Watson (1998), in time domain, under milder assumptions, proposed estimation methods that can deal with many variables.

### 3.1 The factor model

Following Stock and Watson (1998), suppose that $X_t$, the $(N \times 1)$ vector of variables under analysis, can be written as:

$$X_t = \Lambda_t F_t + e_t$$

(4)

$$\Lambda_t = \Lambda_{t-1} + h\varsigma_t$$

(5)

where $F_t$ is a $(r \times 1)$ vector of common factors, $\Lambda_t$ is its matrix of time varying factor loadings, $e_t$ is a $(N \times 1)$ vector of idiosyncratic disturbances, $h$ is a diagonal $(r \times r)$ scaling vector and $\varsigma_t$ is an error term specific to loadings equation. Stock and Watson (1998) build the theory allowing the idiosyncratic terms to be slightly correlated across series, using the terminology of Chamberlain and Rothschild (1983) and Rothschild (1983), they allow for an approximate factor structure. They show the consistency of the factors even in the presence of changes in the loadings over time. The results will hold if the estimated number of common factors is greater than or equal the true number. The conditions concerning the time varying structure of the factor loadings allow for both moderate changes and large occasional jumps in the time series; this assumption in especially suitable when one believe that the series under analysis are characterized by these two features. For all the proofs and details to see Stock and Watson (1998).

Bai and Ng (2000) have developed criteria to identify the number of factors. They apply these methods to determine the number of factors on 8,436 stock returns. They find two factors for a sample of 4,883 firms whose returns are available for 60 months (mature firms) and four factors when they use the whole sample. We will rely on these criteria to set the number of common factors.

²They show the consistency of the factors for $N \to \infty$ and $T$ fixed.
The model put forward in this article includes three types of factors: international, national and sectorial. Each excess return series can be decomposed as the sum of these three components plus a specific idiosyncratic term. The first one is extracted by implementing the principal component analysis on the whole panel of series. Through this procedure, each series is decomposed in two parts: the common and the idiosyncratic. The asset specific, national and sectorial components are left in the idiosyncratic one. Notice that the national and sectorial factors are shared by groups of series; hence we extract the national factor by computing the principal component analysis on the idiosyncratic parts, obtained from the first step, of the series belonging to a specific county. Finally, we repeat the estimation procedure for the sectors. In this way, we should be able to end up having a set of orthogonal regressors. It is also worth noting that the factors are not uniquely identified. However this is not a problem in our context for two reasons: firstly we do not want to give these factors a structural interpretation; secondly these aggregates just span the same space of the factors, but this is enough to preserve the variance decomposition of $y_t^{ij}$.

3.2 The Data

Our dataset consists of monthly stock returns in excess of the eurocurrency rate (30-days Eurocurrency rates as proxies for the risk-free rate) on the London market. It includes 338 stocks belonging to 10 economic sectors and to 5 countries (Belgium (45), France (65), Germany (92), Italy (71) and the Netherlands (65)). The sample ranges from January 1988 to August 2002. The asset returns have been computed as the time difference of the logarithm of the total return index. The source is Datastream. Table 1 summarizes the value-weighted performance in countries and sectors in the analyzed sample. All the returns are measured in the same currency, the Euro and are expressed as percentage per month.

Table 1 reports summary statistics. In the whole sample, country returns are on average, as volatile as sectors returns. The only exception is for the

---

3The economic sectors are: basic materials, cyclical consumer goods, cyclical services, financial, general industries, information technology, non cyclical consumer goods, non cyclical services, resources and utilities.

4Total return index is a measure of a theoretical growth in value of a share. It takes the stream of dividends into account. Adjusted prices are used for its computation; they are a measure of the closing price adjusted for capital actions.
information technology and utilities sectors; while the former is very volatile the latter shows a rather low volatility.

Table 1

<table>
<thead>
<tr>
<th>Country/Industry</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>0.87</td>
<td>4.54</td>
</tr>
<tr>
<td>France</td>
<td>1.16</td>
<td>5.45</td>
</tr>
<tr>
<td>Germany</td>
<td>0.86</td>
<td>5.53</td>
</tr>
<tr>
<td>Italy</td>
<td>0.46</td>
<td>7.31</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>1.17</td>
<td>4.47</td>
</tr>
<tr>
<td>Basic Materials</td>
<td>0.84</td>
<td>5.48</td>
</tr>
<tr>
<td>Cyclical Consumer Goods</td>
<td>0.25</td>
<td>7.63</td>
</tr>
<tr>
<td>Cyclical Services</td>
<td>0.80</td>
<td>5.92</td>
</tr>
<tr>
<td>Financial</td>
<td>0.77</td>
<td>5.61</td>
</tr>
<tr>
<td>General Industries</td>
<td>0.92</td>
<td>5.68</td>
</tr>
<tr>
<td>Information Technology</td>
<td>0.40</td>
<td>10.52</td>
</tr>
<tr>
<td>Non Cyclical Consumer Goods</td>
<td>1.42</td>
<td>4.37</td>
</tr>
<tr>
<td>Non Cyclical Services</td>
<td>1.45</td>
<td>6.31</td>
</tr>
<tr>
<td>Resources</td>
<td>1.34</td>
<td>5.55</td>
</tr>
<tr>
<td>Utilities</td>
<td>0.93</td>
<td>2.92</td>
</tr>
</tbody>
</table>

4 International, national and sectorial influences

In this section, we estimate the influence of these different sources on the stock returns. According to a definition of Beckers, Connor and Curds (1996), markets become more integrated if the variance explained by global factors (international and sectorial) increases over time and/or the variance explained by the country factor declines.

To disentangle the contribution of all the different sources to stock returns movements over time, we first estimate the first two principal components on the whole panel. The number has been fixed according to the Bai and Ng’s criteria. Second, we estimate the first principal component on the partitioned covariance matrix of the idiosyncratic part, partitioned by countries. Finally we repeat the estimation procedure for the resulting idiosyncratic covariance.
matrix, cleaned also from the country specific effect, partitioned by sectors\textsuperscript{5}.

To capture the time-variation effects, we will use a rolling estimation technique on the factors previously estimated. We will use a window of two years and half starting from February 1988. In the presence of orthogonal factors, the variance of $y_{ij}^{t}$ can be decomposed into the sum of the variances explained by the single regressors. The average absolute value of the correlation coefficients among all the seventeen regressors (two international factors, ten sectorial factors and five national factors) is 0.0896. However, we compute the same measure only for the regressors involved in each equation (four in our case), for 338 equations. The average of all these quantities is 0.0548. Given that the magnitude of these measures is quite low the regressors can be considered orthogonal\textsuperscript{6}.

Figures 1-3 report the variances explained by the international, national and sectorial components respectively. They are weighted averages of the relative contribution of the three components to the $R^2$ statistics in 338 regressions. Weights are chosen according to the relative capitalization of the firms. The width of the window is two years and half; the date reported in the graph is that in the middle of the sample window.

The international component has followed a constant path since the late eighties, however the path is characterized by relevant movements that seem to be strongly affected by the international events. Indeed, there was strong decline of the variance explained by the component in the late '96, this decline culminated with a sharp drop in '98 and '99. These were years of strong turbulences and as Danthine, Giavazzi and von Thadden (2000) point out "...the double crisis of the Russian sovereign default and LTCM in the fall of 1998 have influenced investor behavior in 1999 in ways that are sometimes difficult to evaluate". However, since the beginning of '99, the explained variance has sharply increased, reaching its historical average level.

Figure 2 describes the path of the national component. The variance explained by the national factors increased at the beginning of nineties reaching a peak of almost 23%. From '91 to the end of '97 there had been a strong

\textsuperscript{5}In these cases the criteria proposed by Bai and Ng (2000) confirm the presence of one common factor in all the aggregate. Results are available upon request.

\textsuperscript{6}To asses the orthogonality of the regressors, other formal checks are performed. In particular, we check if the sum of the $R^2$ statistics computed for three different regressions including the international, sectorial and national factors separately, is equal to the $R^2$ resulting from the regression including all the factors. All these tests confirm the orthogonality among regressors.
reduction of its influence. During the ’97 it slightly increased again, but from ’98 on it has started declining toward its historical lowest value. This is one of the most relevant features of the stock markets integration; the vanishing of the influence of national factors. Finally, figure 3 reports the path of the sectorial component. This factor has experienced a constant increasing path since the late eighties, with a very slight decline at the end of the sample.

These last two components, differently from the international one, have followed a smoother path over the years. The smoothness can be linked to the nature of the factors which they are associated with. While the path of sectorial and national components might reflect structural changes and institutional developments that continuously have taken place during the years in these economies, the path of the international factor might be strongly affected by extra-national events that can abruptly change.

To sum up, we can conclude that the European stock markets are becoming more and more integrated. This comes out mainly from a strong decrease of national influences and from a strong increase of the sectorial ones.
5 Portfolio selection

The results found in the previous have important consequences for portfolio equity management. They are in contrast with the findings of Rouwenhorst (1999), while they are quite similar to those of Cavaglia, Brightman and Aked (2000). Rouwenhorst found that despite the convergence of interest rates and the harmonization of fiscal and monetary policy in Europe, the country effect has always been larger than the sectorial effect. Our evidence does not support this view. Figure 4 reports, in the same graph, the country and industry effects. In the mid nineties, the industry factors became more important than the country factors which, at the end of the sample, explained a very low percentage of the excess returns total variance.

These findings have important implications for portfolio managers. Since the seminal work of Solnik (1974), in which he shows that diversification across countries provides greater risk reduction than diversification across industries, traditional investors have adopted country selection for building portfolio diversifying strategies. But according to the previous results, they should now build strategies that take into account the sectorial dimension.
Figure 3: Weighted Average of the Variance Explained by the Sectorial Component

6 Conclusion

In this paper, the degree of financial markets integration for a core of five European countries (Belgium, France, Germany, Italy and the Netherlands), is tested on a sample of 15 years. We suggest a three step estimation methodology, based on the factor model proposed by Stock and Watson (1998), to disentangle and measure the time varying impact of international, sectorial and national shocks. Thanks to its generality, this approach should overcome part of the drawbacks of other methodologies used in the literature.

The international common factors seem to be the most important driving forces for the excess returns total variance. The influence of this source has been slightly constant since the end of eighties. We observe also a very strong increase of the sectorial components and, at the same time, a strong decrease, of the national factors, especially at the end of the sample. These empirical findings confirm a continuously growing degree of stock market integration among these countries.

In the middle of the nineties, moreover, the sectorial factors became more
important than the national factors in explaining the excess returns total variance. This is a new empirical finding. In order to improve their performances, portfolio-diversifying strategies need to be revisited and adapted to the new changing financial and economic scenario.
References

[1] Bai, J. and S., Ng, 2000, Determining the Number of Factors in Approximate Factor Models, Econometrica, Forthcoming


