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Abstract

This paper examines the integration of stock markets in Germany, France, Netherlands, Ireland and UK over January 1973-August 2008 at the aggregate market and industry level considering the following industries: basic materials, consumer goods, industrials, consumer services, health care and financials. The analysis is carried out by using correlation analysis, β-convergence and σ-convergence methods. β-convergence serves to measure the speed of convergence and σ-convergence serves to measure the degree of financial integration. It might be expected a priori that European stock markets have converged during the process of monetary, economic and financial integration in Europe.

This study offers evidence for an increasing degree of integration both at the aggregate level and also at the industry level, although some differences in the speed and degree of convergence exist among stock markets. Surprisingly, there is an upswing of cross sectional dispersion for health care industry, which is more prone to regional shocks. The other industries show a significant σ-convergence. The average half-life of a shock to convergence changes at a range from 5.75 days for aggregate market to 10.25 days for consumer goods.

Keywords: Financial integration, EU, stock markets, β-convergence, σ-convergence, correlation analysis

JEL Classification: C22, G12, G15, F36

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1. Introduction

In the last two decades, European financial markets have faced crucial structural and institutional adjustments with the aim of accelerating the financial integration in money, credit, bond, and equity markets. Integration of the financial markets adds to the effective transmission of common monetary policy and to economic growth by removing frictions and barriers to exchange and by allocating the capital more effectively[1]. It is important to monitor the state of integration in various segments of the market in order to identify areas where further initiatives are needed.

The focus of our paper is on equity market integration[2]. Integrated stock markets generate better opportunities for international investors by eliminating country specific risks and let them diversify their portfolios across countries. A larger pool of funds other than the limited local financing will be available for corporations. Integrated stock markets decrease the cost of capital. Hence, the number of productive investments increases, which flourishes the economic growth. In an economic environment where better risk-sharing opportunities exist, households will be able to smooth their consumption more efficiently. Moreover, interdependent stock markets are subject to spillovers resulting from shocks. Evaluating the dynamics of the equity market integration is, therefore, important for monetary policy makers.

The main objective of this paper is to investigate the existence and the degree of integration among stock markets in the five member states of the European Union (EU); Germany, France, Netherlands, Ireland, United Kingdom (UK); at the country as well as at the industry level. The following industries are under consideration: basic materials, consumer goods, industrials, consumer services, health care and financials.

[1] Agénor (2003)(2) provides a detailed review of the benefits and costs of international financial integration. He argues that benefits outweigh the costs as long as financial integration is carefully prepared and managed.

[2] Baele et al. (2004) (5) provide a discussion about the gains from integration of euro area equity markets and a review of equity market developments in Europe.

To address our questions, we utilize measures of financial market integration. Baele et al. (2004) (5) propose three major dimensions to quantify the state and the evolution of financial integration; i.e. price-based, news-based and quantity-based. In this paper we focus on the price-based dimension, which measure discrepancies in returns on assets. It is a direct test of the law of one price, which suggests that assets with the same risk factor and yield should be priced identically if financial integration is complete[3].The results of Baele et al. (2004) (5) point out that the unsecured money market is fully integrated, while integration is reasonably high in the government and corporate bond market, as well as in the equity markets. The credit market is among the least integrated, especially in the short-term segment.

Different studies and approaches have been undertaken to analyze and measure the progress of stock market integration in Europe indeed. The ECB publishes annual reports called "Financial Integration in Europe" [4] with the purpose of contributing towards the advancement of European financial integration and raising public awareness of the Eurosystem's role in supporting the financial integration process. These reports comprise equity market integration as well.

A part of the literature about stock market integration tends to assess how far global factors affect expected returns in national markets using specific asset pricing models[5]. Hardouvelis et al. (1999, 2006) (17) (18) estimate a conditional asset pricing model to determine the importance of EU-wide risk relative to country-specific risk, and they report a tendency toward higher market integration. Hardouvelis et al. (2004) (16) provide evidence for diminishing country effects and amplifying sector effects as stock market integration increases. The disadvantage of this part of the literature is that the results depend on the specification of the asset pricing model. Ayuso and Blanco (1999) (3) show that there has been an increase in the degree of stock market integration during the nineties using a refinement of the approach suggested by Chen and Knez (1995) (13). The disadvantage of this method is that it fails to control for the dynamics of the integration process.

Fratzscher (2002) (15) proposes a multivariate GARCH model to analyze the integration process of European equity markets since 1980s. This approach allows him

[3]See Adjouté and Danthine (2003)(14), Baele et al. (2004) (5) and Bekaert and Harvey (1997) (11) and Adam et al. (2002)(1).
[4]The first report was published on 28 March 2007 (7) and the second one was published on 29 April 2008 (8).
[5]See Bekaert and Harvey (1995)(10) and Stulz and Karolyi (2001) (20).

to evaluate the relative importance of regional shocks originating in the euro area with respect to global shocks coming from the rest of the world (US). He concludes that European equity markets have become more integrated with each other and have gained importance in world financial markets since 1996, and the exchange rate variability reduced in the mean time. The driving force behind these outcomes is suggested to be the convergence of interest rates.

Adam et al. (2002) (1) apply a quantity-based approach and report data on international portfolio diversification for investment funds, pension funds and insurance companies in Europe. Their results suggest that there is an increased financial integration of euro area equity markets, although considerable differences within euro area countries persist.

There are some studies that evaluate financial integration for some new EU member states within themselves and the with the euro zone, such as Cappiello et al. (2006) (12), Babetskii et al. (2007) (4) and Baltzer et al. (2008) (6). Cappiello et al. (2006) (12) use a factor model for market returns to show that the integration of the new EU member states with the euro area increased during the process of EU accession. The Czech Republic, Hungary and Poland are found to exhibit return co-movements both between themselves and with the euro area. Babetskii et al. (2007) (4) provide evidence for β- and σ-convergence of stock market returns in the Czech Republic, Hungary, Poland and Slovakia using country as well as sectoral indices. They do not find strong indications on the effect of the EU accession of all four countries. Baltzer et al. (2008) (6) use price-based, new-based and quantitiy-based measures to find that financial markets in the new EU Member States (plus Cyprus, Malta and Slovenia) are significantly less integrated than those of the euro area, whereas, there is strong evidence that the process of integration is well under way and has accelerated since accession to the EU.

The literature indicate a rising degree of equity market integration at least across old EU members. A further investigation could still illuminate more recent developments of integration process.

Our empirical study is based on correlation analysis, β-convergence and σ-convergence approaches. The correlation analysis gives us a general idea about the level and development of the integration process. The speed of integration is measured by β-convergence. Dispersion of financial returns across countries or industries, σ-convergence, shows how far various markets or industries deviate from integration.

This paper differs from the previous studies for two reasons. First, to the best of our knowledge, it is the first application of β- and σ- convergence on the data from old-established European stock markets; i.e. equity returns in Germany, France, Netherlands, Ireland and UK. Second, we apply these approaches not only to the aggregate market, but also to the industry level for a longer time span.

We analyze the time period from January 1973 to August 2008. This period has witnessed several critical economic events with the aim of monetary, economic and financial integration in Europe. How do these harmonization efforts have affected the integration of stock markets in the EU member countries? We might expect a priori that the returns of European stock markets have become more integrated during the process of integration. As the countries become more interdependent through trade, the expected cash flows and volatilities may converge giving rise to co-movement of profits and dividends of European companies, and consequently the valuation of equities may turn out to be more homogeneous. Additionally, as inflation rates and interest rates converge to a certain level across Europe, dividends and profits of companies are discounted at a similar rate, which may lead to converge of stock returns across countries. Another driving force under the expectation of stock market integration in Europe is the elimination of exchange rate risk with the introduction of the euro. A more volatile exchange rate of a country increases the risk premium in that country since investors require a higher return to get compensated for the higher uncertainty. Elimination of currency risk result in homogeneous reward to risk ratios across European stock markets. Finally, stock markets have become more synchronized due to improvements in computer and communication technology; and therefore due to a faster information transmission and processing.

Our results suggest briefly that the stock markets under consideration show an increasing degree of integration both at the aggregate market level and also at the industry level with some differences in the speed and degree of convergence. All the industries except health care industry show a significant σ-convergence, whereas there is an upward trend of cross sectional dispersion for health care industry returns.

This paper is organized into five sections. Section 2 summarizes the methods to measure convergence. The first subsection considers correlation analysis, the second subsection comprises β-convergence and the third subsection covers σ-convergence method. Section 3 considers the data and the empirical analysis of stock market integration in Europe. The final section concludes.

2. Methods to Measure Convergence

2.1. Correlations

In order to get a first impression about the degree of stock market integration, we will exercise a standard correlation analysis of stock market returns. We are interested in the correlations of aggregate market/industry returns with the corresponding benchmark returns which represent the market. The intuition of this approach is that the more integrated the markets are, the higher is the co-movement between their prices. It is worth noting that higher correlation alone is not a necessary or sufficient condition for greater market integration. The data should be examined further to be able to derive conclusions about stock market integration.

We compare the correlations in five different periods. 1973m1-1979m2 is the basis period . We also distinguish between the following periods: Establishment of European Monetary System (EMS) (1979m3-1990m6), stage one of EMU with the removal of all restrictions on capital movements (1990m7-1993m12), stage two of EMU commenced with the establishment of the European Monetary Institute(1994m1-1998m12) and finally stage three of EMU after the introduction of euro (1999m1-2008m8).

2.2. β-Convergence

β-convergence is an indicator borrowed from the growth literature, where it has been used to assess regional or cross-country per capita income and productivity convergence. Adam et al. (2002) (1) has proposed application of this concept to refer to the speed at which financial markets integrate. We run the following time series regression for the respective national market or industry to be studied:

$$\Delta R_{i,j,t} = \alpha_{i,j} + \beta_{i,j} R_{i,j,t-1} + \sum_{l=1}^{L} \gamma_l \Delta R_{i,j,t-l} + \epsilon_{i,j,t} \tag{2.1}$$

$$R_{i,j,t} = r_{i,j,t} - r_{b,j,t}$$

where $R_{i,j,t}$ represents the return spread at time t between the return of aggregate market or industry asset j in country i ($r_{i,j,t}$) and the respective benchmark return ($r_{b,j,t}$). α is the country and industry specific constant; and $\epsilon_{i,j,t}$ is the white-noise disturbance. The lag length L is based on the Schwarz information criterion. The main parameter of interest is $\beta_{i,j}$. Under the null hypothesis of no convergence, it is equal to or greater than 0. In this case, a shock to $R_{i,j,t}$ is permanent.

The fact that market capitalizations differ tremendously across countries and industries in the sample necessitates the construction of separate benchmarks for each industry (and also market) in a country excluding the industry (market) data of the country under consideration. The local markets in UK, Germany and France can have a larger influence on a single European benchmark yield, which would bias the estimates of convergence. Therefore, we construct a separate benchmark return for each country-industry pair omitting the country itself from the benchmark. The calculation of benchmark return for aggregate market/industry j in country i follows:

$$r_{b,j,t} = \sum_{\forall k \neq i} w_{k,j,t} * r_{k,j,t}$$

where k is the set of all countries and $w_{k,j,t}$ is the weight of industry/market j in country k which accounts for market capitalization of that country. In the end, we have 35 benchmark returns[1] for our analysis.

A negative β coefficient means that convergence takes place and the size of β is a direct measure of the speed of convergence. This allows us to compare integration across different industries, countries and sample periods. The larger is the beta in absolute value, the faster is the convergence. The intuition behind this reasoning is that returns in countries or industries, where returns are relatively high, tends to

[1] (6 industries + 1 aggregate market)* 5 countries entails calculation of 35 benchmark returns.

decrease more rapidly than those in countries or industries with low returns.

The half-life denotes how long it takes for the magnitude of a shock to become half of the initial shock. In our case, it is measured in days. It is calculated as follows[2]:

$$\textit{Half-life} = \frac{-ln(2)}{ln\,|1+\beta|} \tag{2.2}$$

2.3. σ-Convergence

β-convergence measures the speed of convergence, however, it does not indicate to what extent markets are already integrated. It is necessary but not sufficient for the existence of σ-convergence[3]. We investigate the cross sectional dispersion in stock returns, which can be calculated at each point in time by taking the standard deviation of industry or aggregate market returns across countries. For industry/market j, it is

$$\sigma_{j,t} = \sqrt{\left(\frac{1}{N-1}\right)\sum_{i=1}^{N}[r_{i,j,t} - \bar{r}_{j,t}]^2} \tag{2.3}$$

where $\bar{r}_{j,t}$ is the sample mean of returns for industry/market j at time t and N is the number of countries in the sample. Convergence takes place if the cross sectional dispersion of stock market returns decreases over time. For this reason, we control for the slope coefficient on a linear time trend in the following regression:

$$\sigma_{j,t} = \alpha_j + \gamma_j * t + u_{j,t} \tag{2.4}$$

In case cross sectional dispersion converges to zero, full integration is reached.

[2]This formula is only exact for simple AR(1) processes and a suitable approximation for higher autoregressive orders in the model.
[3]See Barro and Sala-i Martin (1995)(9) for a proof.

3. Empirical Analysis

3.1. Data

In our paper, stock market integration is analyzed using Datastream [1] stock market indices with a monthly frequency. Datastream indices cover a wide range of national stock markets and typically at least 80% of the total market capitalization for each country, which makes it a more accurate representation of the whole market. A number of sector indices are also included in Datastream. Since Datastream indices are consistent, homogeneous and thereby comparable across countries, they are widely preferred in empirical research. One of the most attractive features of this databank is that the stock market indices are available starting from January 1973 for the most developed economies. This makes it possible to investigate the whole period after the Bretton Woods System of fixed exchange rates.

Datastream country and industry indices are transformed into returns by taking percentage changes for our study. The data cover monthly stock returns in Euro[2] from January 1973 to August 2008 for five EU countries: Germany, France, Netherlands, Ireland and United Kingdom (UK). The time series were not long enough for the other member states. The aggregate market returns together with returns for the following industries for each country are investigated: basic materials, consumer goods, industrials, consumer services, health care and financials. Only for health care industry in Ireland, the time series starts later on July 1981. The benchmark indices are calculated as explained in section 2.2.

Table A.1 contains some descriptive statistics. Returns on industrial indices are more

[1] The author would like to thank the Financial and Economic Data Center (FEDC) of the SFB 649 at Humboldt University of Berlin for providing a guest account for Datastream.

[2] The stock indices for UK were in local currency. Exchange rates covering the whole sample period are extracted from World Market Monitor of Global Insight and the indices are transformed into Euro using those exchange rates.

volatile than the returns on market indices. This is not surprising, since the latter represents a more diversified portfolio. Volatility varies considerably across countries and also across industries. The returns in Ireland were very volatile which could be expected looking at relatively higher returns at this country. The return of consumer goods industry in Ireland disagrees with the traditional risk-return trade off, since it is the lowest of all returns yet it ran the highest risk.

Figure A.1 shows smoothed market return series during the whole sample period for all countries under consideration. The return series are smoothed only for illustration purposes in this graph using Hodrick-Prescott (HP) filter with a smoothing parameter, λ, of 14400 for monthly data. The returns move closer starting from 1990s, which might point out that common euro area factors became more important for the stock markets across Europe afterwards. In early 2000s, this co-movement becomes more striking. Yet, in the recent years, returns start to diverge again. For the rest of our analysis, we use "not filtered" data to calculate correlations, β and σ-convergence, due to the fact that smoothing the return data gives occasion to misleading outcomes arising from increased serial correlation in the series.

3.2. Correlations

Table A.2 serves for a preliminary analysis of correlations between aggregate market/industrial stock returns and the relevant EU benchmark returns. The first column reports the correlations in the basis period (1973m1-1979m2), and the succeeding columns show the change in correlation with respect to previous period. Due to lack of data for the health care industry in Ireland, the basis period is 1979m3-1990m6.

We examine the change in correlation structure by performing a specific test following Taylor and Tonks (1989) (21). If $\hat{\rho}$ is the sample correlation coefficient between two markets, a statistic ξ can be constructed as follows[3]:

$$\xi = \frac{1}{2}\ln\left(\frac{1+\hat{\rho}}{1-\hat{\rho}}\right) \sim N\left[\frac{1}{2}\ln\left(\frac{1+\rho}{1-\rho}\right), \frac{1}{T-3}\right] \tag{3.1}$$

where ρ is the population correlation coefficient and T is the sample size. The test

[3]See Kendall and Stuart (1967).

statistic for the equality of the correlation coefficients between period 1 and period 2 can be constructed as:

$$\zeta = \frac{\xi_1 - \xi_2}{var(\xi_1) - var(\xi_2)} \sim N(0,1) \tag{3.2}$$

The null hypothesis for the test is $H_0 : \rho_1 = \rho_2$. If the test statistic rejects H_0, we can conclude that there is a significant difference in correlation coefficients between two periods.

Table A.2 reports the test results. The correlation changes with " $*$ " indicate an increase and with " $**$" indicate a decrease in correlation coefficients with respect to the previous period at a significance level of 10%. When we look at *Table A.2*, we see a certain pattern in the change of correlation coefficients. The stock markets in Germany and France became significantly more correlated with the EU benchmarks for all industries at the first stage of EMU, when all the capital restrictions were removed. Netherlands's stock markets started to be more correlated with EU already before stage one, during the period of EMS. The significant increase in correlations of British stock markets started during EMS and continued at the first stage of EMU. Strikingly, the third period of EMU, which is after the introduction of euro, is the period when we observe most of the significant decreases in the correlation coefficients, especially in the health care industry. This might suggest that, at this stage of EMU, health care industries at almost all countries were affected by local factors rather than EU wide factors. The stock market returns in Ireland are less correlated with EU than the returns in other countries for all sectors. Ireland stock market seems to be isolated from other EU stock markets in that sense.

3.3. β-Convergence

We run the regression in (2.1) to see the speed of convergence for the aggregate market and industries in stock markets. The results are reported in *Table A.3*.

To start with, the constants in all regressions are not significantly different from 0, which denotes unconditional convergence of stock returns. All the β coefficients for all industries in all countries are significantly negative, which means that in fact convergence takes place for all. We can distinguish the speeds of convergence

looking at the size of the betas, which offer that the speed of convergence changes across countries and industries. The industries converge at a different speed than the market, which justifies an analysis at an industry level. We report the half-lives of shocks to return spreads in the second column of *Table A.3*. The average half-life of a shock to convergence is 5.75 days for aggregate market, 7.41 days for basic materials, 7.31 days for industrials, 10.25 days for consumer goods, 6.59 days for health care, 8.44 days for consumer services and 6.21 days for financials. This makes it more clear that the speed of convergence is quite different across industries. The reason why the overall market converges faster than the individual industries is that the market is actually composed of more industries than the ones analyzed in this study. There should exist some other industries that converge faster than the aggregate market.

There are some criticisms about the interpretation of the parameter β as the speed of convergence. The most recent one came from Hristov and Rozenov (2009) (19), who suggest that it is necessary to take the coefficients of lagged return spread differences into account to guarantee a convergent behavior. According to the authors, we need to look at the eigenvalues of the system matrix and the modulus of the largest eigenvalue is a natural measure of speed of convergence and modulus should be smaller than 1[4]. We verified that our framework fits into their definition of speed of convergence. We calculated the moduli of system matrices of our regressions separately and saw that they all have moduli smaller than one, which also means that all industries in all countries converge. We do not go into details here, but the results are available on inquiry.

For a robustness check, we also run a Andrews-Quandt break point test for all estimations of equation (2.1). Andrews-Quandt break point test checks whether there is a structural change in the original equation parameters. The null hypothesis for this test is that there are no breakpoints within trimmed data. Maximum LR F-statistics suggest that there exists a break point in betas from the industries health care and consumer services in Ireland at a significance level of 5%.[5] In other words, the speed of convergence changes significantly at certain times for the named industries and countries. It is interesting that, the significant break points exist for service industries, which are more prone to regional shocks; and for Ireland, of which stock market could be more affected by local shocks rather than EU wide shocks. The most likely

[4]Please refer to Hristov and Rozenov (2009) (19) for details.
[5]Results of Andrews-Quandt break point test for each estimation are available from the author on request.

break point location is 1979m12 for consumer services and 2005m12 for health care industry. The former corresponds to the year when the EMS was established and it is worth noting that the former is after the introduction of euro. There is a need for a closer look into the course of these industries at these certain times to be able to better explain the reasons behind the possible break points.

Another robustness check we perform is adding a business cycle component to our regression (2.1) in order to see whether stock market integration depends on the stance of the business cycle. In order to control for it, we define dummies for two episodes of business cycles: one for recession and the another one for expansion. The dates of these two episodes are based on Economic Cycle Research Institute (ECRI) data which provide business cycle peak and through dates from 1948 to 2008. Betas do not change significantly when we add the business cycle dummies to our regressions. There is no significant dependence on recession and expansion episodes. For the sake of brevity, we do not present the results here, but they are available on request.

It is possible to look at the dynamics of speed of convergence by calculating betas from moving window regressions. *Figure A.2* shows the time varying beta for the convergence of aggregate market returns in Germany to EU benchmark return. This plot suggest that convergence has been an ongoing process since 1973 but the speed has changed from time to time. We performed the same analysis for the other sectors and for all countries and got similar results.

3.4. σ-Convergence

We start our analysis of σ-Convergence by looking at the cross sectional dispersion across countries at market level. *Figure A.3* shows the standard deviation of aggregate market returns across the sample countries and the HP filtered standard deviation[6]. The smoothed cross sectional deviation gives us an idea about the long term trend of convergence. The graph shows that the standard deviation falls evidently but starts to increase in the mid 2000s. When we look at the cross sectional dispersions for each industry (*Figure A.4*), we observe that there is a decrease in volatility in all industries but the trend is not clear for health care industry. An

[6] λ, the smoothing parameter is taken as 14400 for monthly data.

upswing of standard deviations in the mid 2000s is observed for the following industries: basic materials, financials and health care. We run the equation 2.4 for the whole sample period to control for the slope coefficient on a linear time trend for all industries. The results are presented in the last column of *Table A.3*. The slope coefficients are all significantly negative at 5 % level accept the slope for health care industry. The long term trend of cross sectional dispersions has been upward for health care industry and downward for the other industries.

The evidence of decreasing convergence in the 2000s is just the opposite of what we expected. There are several arguments, which could have produced this outcome. First, the origins of the random shocks may be regional. When we consider the industries, where we observe decrease in convergence in the recent years, we see that they are generally the ones which may be susceptible to regional shocks; such as health care and financials. Alternatively, diminishing convergence might be a result of country-specific economic effect of global shocks. Heterogeneous industrial structures of countries, differences in the structure of the banking system and in the credit channel affect the transmission of global shocks to asset values in different ways. Even if a common monetary policy is fulfilled, the transmission of monetary policy to economic activity may divert across countries. Finally, if a country becomes more specialized in an industry, the contents of country indices become different leading to less synchronized returns. This is in fact consistent with market integration: different industries may be outstanding in each country. Therefore, economic shocks may selectively affect specific industries; hence effects on countries may differ. But a deeper analysis of the reasons behind the presented evidence is beyond the scope of this paper but leaves room for further research.

We performed a robustness check by analyzing the σ-convergence in two different episodes of business cycle: recession and expansion. The coefficients are not significantly different from each other except for health care industry. In this case, the slope coefficient is positive and significant at 5 % during expansion (0.002) but not significant during recession. This might suggest that some countries outperform the others in health care industry during expansionary episodes, which again results from exposure of health care industry to local shocks.

Finally, *Figure A.5* plots the smoothed[7] country and industry cross sectional dispersions. Country dispersion was higher than that of industry up to the introduction

[7]HP filtered with a smoothing parameter λ=14400.

of euro, hence convergence of returns across industries used to be better than that of across countries. Together with the introduction of euro, industry dispersion exceeded country dispersion. Therefore, country convergence of stock market returns became superior to industry wide convergence in the last stage of EMU.

4. Conclusion

This paper's main objective is to investigate the existence and the degree of convergence among stock markets in Germany, France, Netherlands, Ireland and UK at the country and industry level considering six different industries: basic materials, consumer goods, industrials, consumer services, health care and financials. We used correlation analysis, β-convergence and σ-convergence methods to deal with our questions. β-convergence serves to measure the speed of convergence and σ-convergence serves to measure the degree of financial integration.

To summarize our results, stock markets that we studied show an increasing degree of integration both at the aggregate market level and also at the industry level, although some differences in the speed and degree of convergence exist among stock markets. The average half-life of a shock to convergence changes at a range from 5,75 days for aggregate market to 10,25 days for consumer goods. Convergence has been an ongoing process since 1973 but the convergence speed has changed from time to time. There is a decrease in cross sectional dispersions for all industries, however, this is not the case for health care industry. We do not observe a significant σ-convergence of health care industry returns, which are more prone to regional shocks.

The finding in this paper should be investigated further. The scope of this paper is not that extensive to capture the impacts of regional and global shocks on European stock markets. Future research may explore different sources of shocks on stock market returns and their affects on convergence.

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A. Appendix

Table A.1.: Summary Statistics

	DE	FR	NL	IE	GB	DE	FR	NL	IE	GB
	Mean					Standard Deviation				
Market	0,47	0,68	0,55	0,69	0,53	5,12	6,08	4,95	6,53	5,92
B. Mater.	0,53	0,94	0,43	0,90	0,67	5,41	6,22	7,50	8,17	6,60
Indust.	0,50	0,85	0,39	0,46	0,63	5,65	7,27	8,62	9,94	6,83
Cons. Gds	0,38	0,44	0,75	-0,35	0,28	7,03	7,97	7,26	11,85	8,07
Hlth Care	0,53	0,71	0,46	1,11	0,76	4,45	6,15	5,64	10,22	5,64
Cons. Svs	0,23	0,55	0,57	0,78	0,52	5,80	7,04	5,84	6,91	6,36
Finan.	0,49	0,74	0,46	0,74	0,46	6,31	6,09	5,11	7,42	6,40

Figure A.1.: Returns of Aggregate Stock Markets

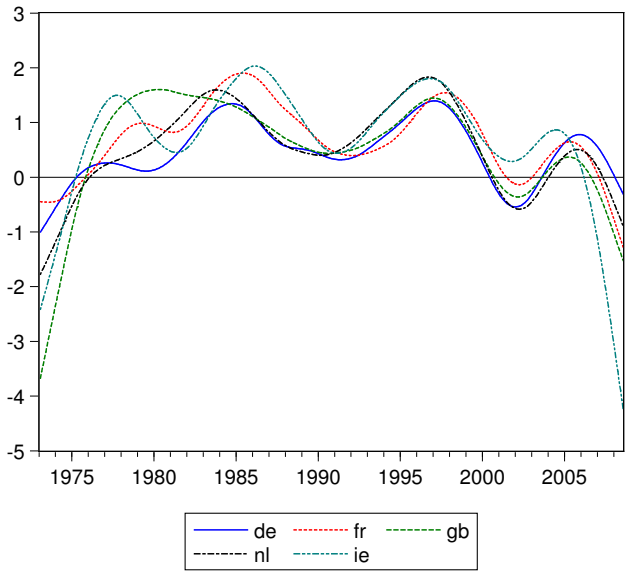


Table A.2.: Correlations of Stock returns with EU benchmark returns

	'73m1-'79m2	'79m3-'90m6	"90m7-'93m12	'94m1-'98m12	'99m1-'08m8
	Correlation	Change in correlation w.r.t. previous period			
GERMANY					
Market	0,535	0,006	0,278*	0,037	0,036
B. Mater.	0,460	0,042	0,275*	-0,012	-0,066
Indust.	0,556	-0,131	0,396*	-0,113**	0,156*
Cons. Gds	0,312	0,088	0,334*	0,087	-0,020
Hlth Care	0,389	0,095	0,184*	0,088	-0,141**
Cons. Svs	0,376	0,065	0,210*	-0,146	0,267*
Finan.	0,294	0,222*	0,240*	-0,008	0,068
FRANCE					
Market	0,525	0,049	0,272*	0,038	0,046*
B. Mater.	0,392	0,115	0,326*	0,035	-0,150**
Indust.	0,445	-0,025	0,409*	-0,044	0,063
Cons. Gds	0,216	0,264*	0,256*	0,068	0,020
Hlth Care	0,342	0,158*	0,127	0,174*	-0,229**
Cons. Svs	0,418	0,126	0,107	0,107	0,114*
Finan.	0,362	0,068	0,413*	-0,025	0,057*
NETHERLANDS					
Market	0,663	0,151*	-0,058	0,049*	-0,034
B. Mater.	0,632	-0,032	0,122	0,130*	-0,066
Indust.	0,562	-0,016	0,096	0,069	0,146*
Cons. Gds	0,220	0,204*	0,149	0,046	-0,133
Hlth Care	0,382	0,268*	0,011	0,019	-0,109
Cons. Svs	0,374	0,152*	0,253*	-0,027	0,115*
Finan.	0,688	0,086*	0,046	0,009	0,060*
IRELAND					
Market	0,398	0,235*	0,084	0,077	-0,163**
B. Mater.	0,355	0,254*	0,032	0,094	-0,082
Indust.	0,155	0,107	0,316*	-0,326**	-0,019
Cons. Gds	0,197	0,146	0,075	0,165	-0,001
Hlth Care	NA	0,471	0,032	-0,082	-0,254**
Cons. Svs	0,170	0,407*	0,009	-0,003	0,031
Finan.	0,594	-0,190**	0,220*	0,124	-0,050
UNITED KINGDOM					
Market	0,431	0,160*	0,175*	0,100*	-0,048
B. Mater.	0,408	0,175*	0,168*	-0,060	0,023
Indust.	0,408	-0,017	0,303*	-0,049	0,147*
Cons. Gds	0,346	0,065	0,206*	-0,121	0,118
Hlth Care	0,136	0,486*	0,027	0,049	-0,099
Cons. Svs	0,291	0,216*	0,094	0,126	0,070
Finan.	0,429	0,137*	0,105	0,122*	0,073*

The correlation changes with " $*$ " indicate an increase and with " $**$" indicate a decrease in correlation coefficients with respect to the previous period at a significance level of 10%.

Table A.3.: β, Half-life and Trend Coefficient Estimates

	β-Estimate	Half-life (days)	Trend Coefficient of σ-Convergence
MARKET			
DE	-0,977*	5,501	
FR	-1,006*	4,039	
NL	-1,047*	6,808	-0.007*
IE	-1,021*	5,359	
UK	-0,952*	6,868	
BASIC MATERIALS			
DE	-0,952*	6,863	
FR	-1,060*	7,384	
NL	-0,975*	5,621	-0.005*
IE	-1,077*	8,092	
UK	-1,102*	9,111	
INDUSTRIALS			
DE	-0,943*	7,258	
FR	-0,962*	6,372	
NL	-0,907*	8,771	-0.004*
IE	-1,086*	8,460	
UK	-0,974*	5,701	
CONSUMER GOODS			
DE	-1,169*	11,686	
FR	-1,181*	12,167	
NL	-0,939*	7,438	-0.007*
IE	-1,176*	11,970	
UK	-1,075*	8,013	
HEALTH CARE			
DE	-1,021*	5,385	
FR	-0,988*	4,670	
NL	-1,058*	7,310	0.002*
IE	-1,085*	8,444	
UK	-0,946*	7,139	
CONSUMER SERVICES			
DE	-0,919*	8,290	
FR	-0,927*	7,957	
NL	-0,965*	6,225	-0.008*
IE	-0,865*	10,369	
UK	-1,109*	9,382	
FINANCIALS			
DE	-1,013*	4,826	
FR	-1,000*	2,500	
NL	-1,061*	7,454	-0.005*
IE	-1,048*	6,853	
UK	-1,110*	9,436	

"$*$" corresponds 5% significance level.

Figure A.2.: Time Varying Estimate of Beta for Germany Market Return

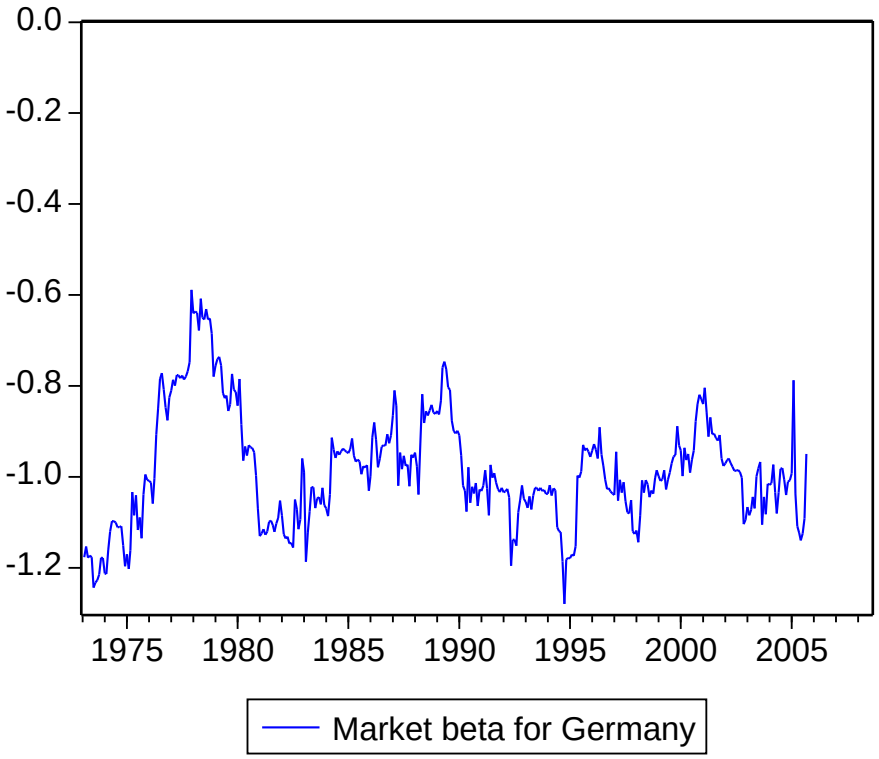


Figure A.3.: Cross sectional dispersion, Market

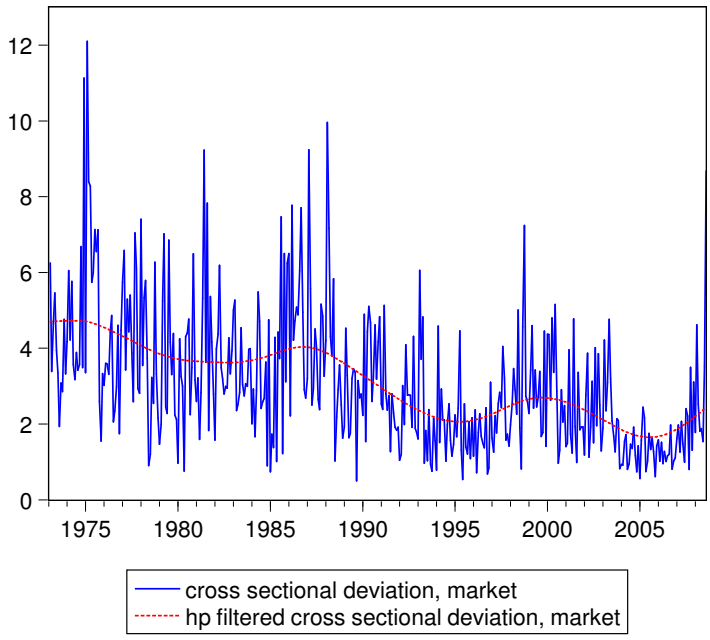


Figure A.4.: Cross sectional dispersion, Industries

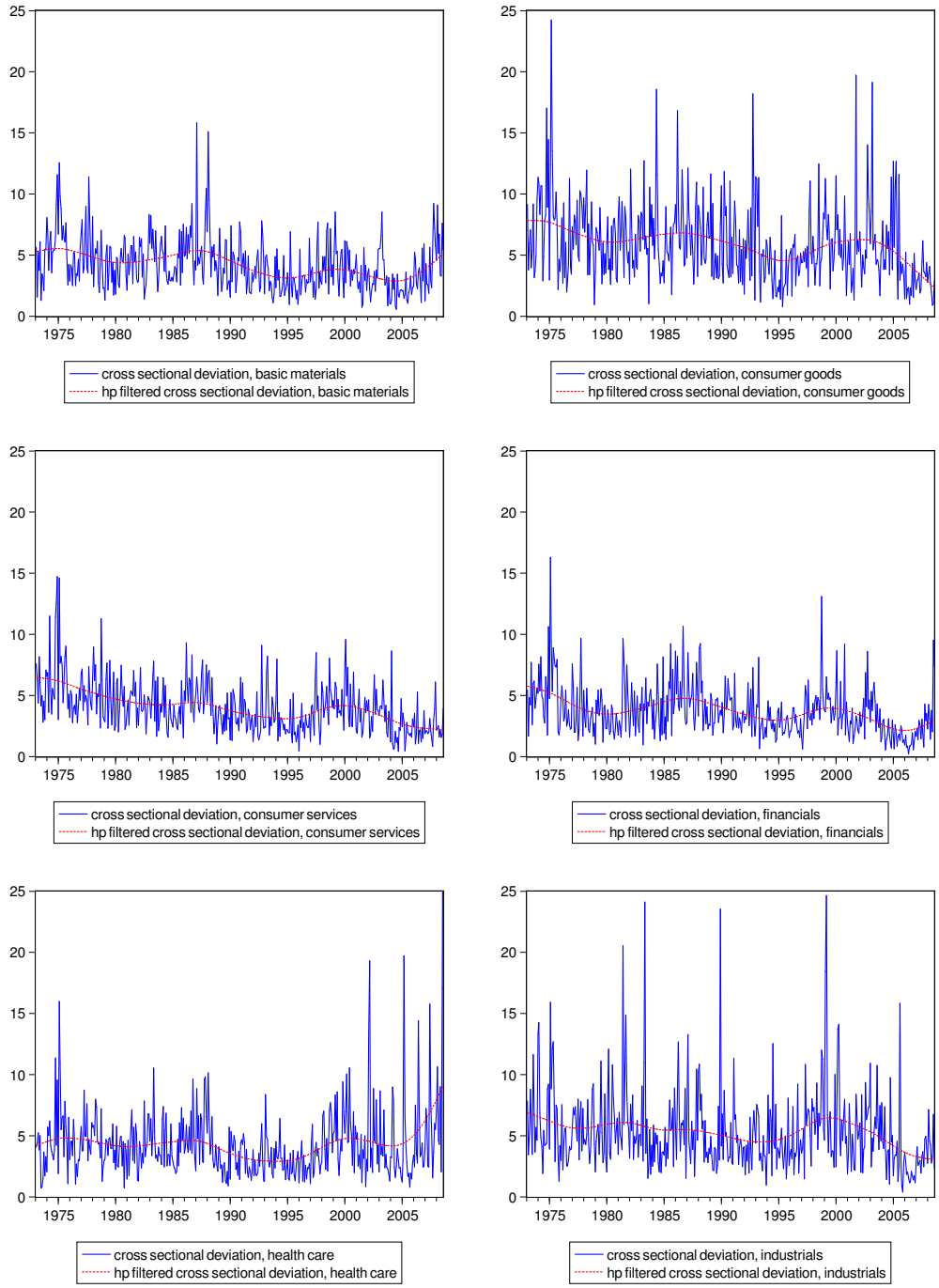
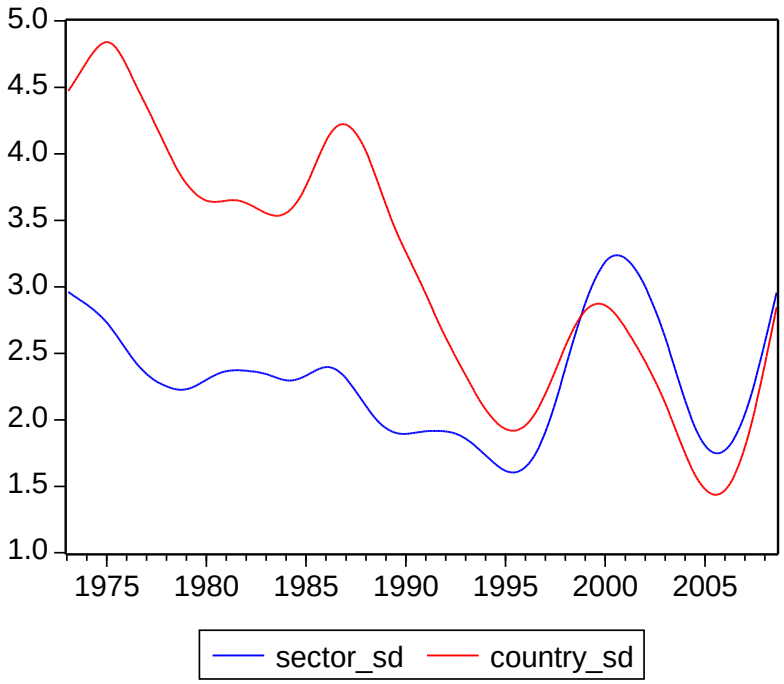


Figure A.5.: Cross sectional dispersions, Country-Industry Comparison



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