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European Economic Convergence in Stock Markets

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Abstract

The present research investigates the existence of convergence in price indexes and in volatility of price indexes across 17 European countries and examines whether financial development indicators could explain divergent or convergent phenomena in stock markets. A new methodology of panel convergence testing proposed by Phillips and Sul (2007b) is employed using data from Datastream database and World Bank's Financial Development and Structure Database. The empirical findings indicated full convergence in prices and in volatility but not in the case of financial development indicators where the results appear to be different.

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Introduction

At the beginning of the nineties, convergence along with the empirical results of its measurement became an economic issue of vital importance and was closely related with studies in long term economic growth. The concept of economic convergence can be seen as the reduction of differences between countries or regions. The neoclassical growth theory originated by Solow in 1956 was the first theory that influenced the way long run relationships of economies where studied. During that time a number of studies investigated convergence for a wide range of countries using cross sectional and time series approaches.

The concept of convergence is especially important for the European Union (EU) due to many economic, political and institutional changes during the last 25 years. The European Union was established by the Treaty of Maastricht on the 1st of November 1993, upon the foundations of the pre-existing European Economic Community. The following table presents the accession date and the population of each member state.

Table 1 Member States of EU

Country	Accession	Population
Austria	01 January 1995	8.340.924
Belgium	25 March 1957	10.666.866
Bulgaria	01 January 2007	7.640.238
Cyprus	01 May 2004	778.700
Czech Republic	01 May 2004	10.403.100
Denmark	01 January 1973	5.511.451
Estonia	01 May 2004	1.340.935
Finland	01 January 1995	5.312.415
France	25 March 1957	64.473.140
Germany	25 March 1957	82.218.000
Greece	01 January 1981	11.125.179
Hungary	01 May 2004	10.036.000
Ireland	01 January 1973	4.501.000
Italy	25 March 1957	59.619.290
Latvia	01 May 2004	2.266.000
Lithuania	01 May 2004	3.357.873
Luxemburg	25 March 1957	483.800
Malta	01 May 2004	407.810
Netherlands	25 March 1957	16.471.968
Poland	01 May 2004	38.115.641
Portugal	01 January 1986	10.599.095
Romania	01 January 2007	21.538.000
Slovakia	01 May 2004	5.400.998

Country	Accession	Population
Slovenia	01 May 2004	2.025.866
Spain	01 January 1986	46.063.511
Sweden	01 January 1995	9.253.675
United Kingdom	01 January 1973	61.003.875

Source: http://en.wikipedia.org/wiki/Member_State_of_the_European_Union

On January the 1st, 1999, 11 out of 15 European Union (EU) Countries formed the European Monetary Union (EMU) and adopted euro as their common currency. At the moment, there are 16 member[1] states with over 325 million people.

In order to be included at the EMU, the member countries had to adjust their fiscal, monetary and exchange rate policies and achieve convergence of their economies. Specifically each member country had to fulfil the following convergence criteria that were signed in December 1991 by the Maastricht Treaty (Eun and Resnick, 2007):

1. Keep the ratio of government budget deficits to gross domestic profit (GDP) below 3%

2. Keep gross public debts below 60 % of GDP

3. Achieve a high degree of price stability

4. Maintain its currency within the prescribed exchange rate changes of the Exchange Rate Mechanism (ERM)[2]

This process of closer economic and financial cooperation has led to nominal convergence of inflation and long term interest rates towards German levels and to better-balanced fiscal budgets among the member countries.

The introduction of the euro eliminated exchange rate uncertainty resulting in easier price comparisons. The increased price transparency improved competition through downside pressure on prices. Furthermore, reduced transaction and information costs combined with the elimination of currency risk promoted cross-border investment and trade within the euro zone. On the other hand, the main loss for the monetary union was the national monetary and exchange rate policy independence.

According to Hardouvelis, Malliaropulos and Priestley (2007), there are four channels through which EMU could affect the level of European stock market integration. First of all,

[1] Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia and Spain.

[2] European Exchange Rate Mechanism (ERM) was a system introduced by the European Community in March 1979, as part of the European Monetary System (EMS), in order to reduce exchange rate variability and achieve monetary stability in Europe. Moreover ERM contributed to the preparation for the Economic and Monetary Union and the introduction of the single currency, the euro.

the gradual abolition of barriers within the EU investment area and the indirect abolition of barriers through the common currency eliminated various legal restrictions for institutional investors and as a result increased investment opportunities across EMU countries. The second channel is the common monetary policy that led to “nominal convergence”[3] and as a result to a more homogenous valuation of equities across EMU countries. The third channel is the combination of common monetary policy and long run fiscal policy that may have led to “real convergence” i.e. an increased synchronization in business cycles and higher cross country correlations in expected real corporate earnings. The fourth channel is the introduction of the single currency that eliminated the currency risk and reduced the exchange rate risk of the EMU country stocks.

The aim of the present research is twofold. First of all, to investigate the existence of convergence in price indexes and in volatility of price indexes across 17 European countries and secondly to examine whether stock market development indicators can explain divergent or convergent phenomena in stock markets.

The research is based on a new methodology of panel convergence testing proposed by Phillips and Sul (2007b), which allows full or club convergence under a variety of possible transition paths. This new approach does not depend on stationarity assumptions and does not make any assumptions for homogeneity in technological progress.

The rest of this study is organized as follows: Section 1 describes the neoclassical theory of growth convergence originated by Solow. Section 2 examines the different approaches used to test the concept of convergence. Section 3 and Section 4 review the recent empirical literature of convergence and financial development and growth. Section 6 presents the methodology proposed by Phillips and Sul. Section 7 analyzes the empirical evidence while Section 8 concludes.

[3] Nominal convergence, in the case of EU countries, can be thought as a gradual convergence to inflation rates and to long term interest rates towards German levels that is used as a benchmark for EU.

1. The Neoclassical Growth Model

This chapter analyzes the neoclassical theory of growth convergence and attempts to explain the theoretical formulation which influenced a lot of studies on this issue.

The standard neoclassical growth model, originated by Solow (1956), has influenced the way long run relationships of economies were studied. Convergence, the tendency of log per capita income across different countries to be equalized over time, is one of the issues that Solow's growth model investigated.

Solow's growth model depends on the production function $Y = F(K, A, L)$ and assumes that the rates of saving, the population growth and the technological progress are exogenous. Assuming a Cobb Douglas production function, the production at time t is given by:

$Y(t) = K(t)^{a}(A(t)L(t))^{1-a}$, 0<α<1. (1), where Y is output, K is capital and A the level of technology.

Labor and Technology are assumed to growth at exogenous rates n and x respectively:

$L(t) = L(0)e^{nt}$ (2)

$A(t) = A(0)e^{xt}$ (3)

The savings rate (s) is constant and the depreciation rate of physical capital is δ. The number of effective units of labor, A(t)L(t), grows at rate n+x.

Defining k=K/AL as the capital per unit of effective labor and y=Y/AL as the level of output per unit of effective labor we get the evolution of k ($\dot{k}$):

$$\left.\begin{aligned}\dot{k}(t) &= sy(t) - (n+x+d)k(t)\\ y(t) &= k(t)^{a}\end{aligned}\right\} \dot{k}(t) = sk(t)^{a} - (n+x+d)k(t) \quad (4)$$

Equation 4 indicates that k converges to a steady state value k* defined as:

$$sk^{*a} = (n+x+d)k^{*} \Rightarrow k^{*} = \left(\frac{s}{n+x+d}\right)^{1/1-a} \quad (5)$$

Where k* is positively correlated to s and negatively correlated to the population growth.

By replacing the steady state of capital in the production function we get the following expression:

$$y = (\frac{s}{n+x+d})^{1/1-a} \Rightarrow \frac{Y(t)}{L(t)} = A(t)(\frac{s}{n+x+d})^{1/1-a}$$

If we substitute $A(t) = A(0)e^{xt}$ and rewrite the above equation in logs we get:

$$\ln(\frac{Y(t)}{L(t)}) = A(0) + xt + \frac{a}{1-a}\ln(s) - \frac{a}{1-a}\ln(n+x+d) \quad (6)$$

According to Mankiw, Romer & Weil (1992) the Solow model predicts not only the signs but also the magnitudes of the coefficients on saving and growth, i.e. for α=1/3 the elasticity of income per capital with respect to s is roughly 0.5 and with respect to (n+x+δ) is -0.5.

Dividing both sides of equation (4) by k(t) we get an expression for the growth rate of the capital:

$$\frac{\dot{k}(t)}{k(t)} = \frac{sk(t)^a}{k(t)} - (n+x+d) = sk(t)^{a-1} - (n+x+d) \quad (7)$$

The behavior of the company can be analyzed using equation 5. We can recognize two functions (Sala-i-Martin 1996): a horizontal line n+x+δ line which we call depreciation curve and a sloping $sk(t)^{α-1}$which we call the savings curve. Equation 5 indicates that the difference between those two lines is the growth rate of the capital. The neoclassical approach of diminishing returns[4] to capital ensures that the savings curve is downward slopping and Inada conditions[5] ensure that the saving curve is vertical at k=0 and approaches the horizontal axis as k tends to infinity. So we are sure that since the savings curve is always downward slopping there will be a unique intersection (k*). The crossing point from this intersection is called the steady state capital.

According to Sala-i-Martin (1996), if all companies have similar technology, saving rates and rates of population growth, then they will converge to a single steady state. In this

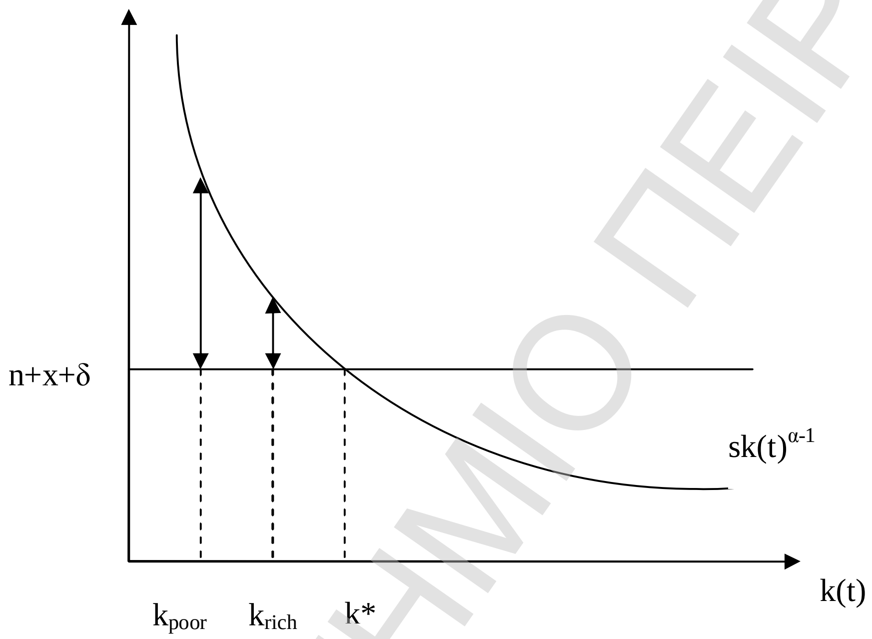
[4] Using the Cobb Douglas production function, $y=k^{α}$, we get:

Diminishing marginal product of capital: $f'(k) = ak^{a-1} > 0$, $f''(k) = -a(1-a)k^{a-2} < 0$

[5] Inada Conditions: $\lim_{k\to 0} f'(k) = \infty$, $\lim_{k\to\infty} f'(k) = 0$

case, (Figure 1), the growth rate of the poor economy will be larger than the growth rate of the rich one. As a result, if the only difference across economies is the initial capital then the neoclassical growth model predicts convergence meaning that poor economies will grow faster than the rich ones.

Figure 1 Representation of Depreciation & Savings Curve



One of the main disadvantages of the neoclassical growth model is that the steady state growth is determined exogenously. Moreover it makes the assumption about diminishing returns of the capital and that technological progress is homogenous.

2. Approaches to Convergence

Convergence research was a topic issue for a long period of time. During that time different approaches were used in order to study this phenomenon. This chapter examines the approaches used to test for convergence which can be broadly classified in cross sectional and time series.

2.1 Cross Sectional Approaches to Convergence

Following Salla-i-Martin's (1996) exposition, two types of cross sectional convergence can be definrd. B convergence exists in a cross section of economies if the relation between the growth rate of income per capita and the initial level of income is negative. In other words, if poor economies tend to grow faster than wealthy economies then β convergence exists. Another definition of convergence where the dispersion of real per capita income across groups of economies tends to fall overtime is called σ convergence.

These two concepts of convergence examine interesting phenomena that are conceptually different: σ convergence studies how the distribution of income evolves over time while β convergence studies the mobility of income within the same distribution.

Being different though, does not mean that they are not related. Supposing that β convergence holds for economies i = 1, 2,…, N, then the real per capita income for economy i can be approximated to:

$$\log(y_{it}) = a + (1-b)\log(y_{it-1}) + u_{it} \quad (8)$$

where α and β are constants with 0<β<1, u_{it} is the disturbance term with mean zero and variance s_u^2 that is assumed to be constant for all economies and independent over time and across economies.

Equation 8 can be transformed into $\log(\frac{y_{it}}{y_{it-1}}) = a - b\log(y_{it-1}) + u_{it}$ (9). So if β>0 then there is a negative correlation between growth and initial log income. The sample variance at time t can be given by:

$s_t^2 = \frac{1}{N}\sum_{i=1}^{N}(\log y_{it} - m_t)^2$ (10), where m_t is the sample mean of (log) income.

The sample variance is close to the population variance when *N* is large, and then equation 8 can be used to derive the evolution of s_t^2 over time:

$s_t^2 \cong (1-b)^2 s_{t-1}^2 + s_u^2$ (11).

The difference equation is stable only if 0<β<1, so β convergence is necessary for σ convergence. Given 0<β<1, the steady-state variance is $(s^2)^* = s_u / [1-(1-b)^2]$ (12). Combining equations 11 and 12 we get an expression for s_t^2 over time:

$s_t^2 = (1-b)^2 s_{t-1}^2 + [1-(1-b)^2](s^2)^*$ (13)

where the increase or decrease of s_t^2 towards the steady state depends on whether the initial value is above or below the steady state. So, β convergence is a necessary but not a sufficient condition for σ convergence.

Β convergence can be categorized in absolute and conditional β convergence. More specifically the concept of absolute β convergence assumes that all countries converge to the same steady state level meaning that the coefficient of initial income is negative in a “univariate” regression.

On the other hand conditional β convergence assumes that if economies have different technologies and preference parameters they can still converge but to different steady states. Meaning that in a cross sectional regression if we hold a number of additional variables constant and find that the coefficient of initial income is negative then conditional β convergence exists.

However, the use of cross section results is related with some problems. First of all cross section procedures assume the null hypothesis that no countries are converging with the alternative one that all countries are converging leaving out of investigation intermediate status. Moreover, cross sectional tests tend to spuriously reject the hypothesis of no convergence when economies have different long run steady states. Furthermore β convergence, which studies the speed of convergence of the output over time to its steady state value, assumes a deterministic growth process that could lead to spurious results if technological progress is actually stochastic.

2.2 Time Series Approaches to Convergence

Numerous studies investigated convergence using time series analysis because this approach depends on unit root and cointegration tests which are thought to be more valid when we use data for a log time of period. This time series version, which is thought to be a stronger notion of convergence, has two definitions. A weaker definition is stochastic convergence that demands convergence if the log of relative output is trend stationary and a stronger definition is deterministic convergence where log of relative output is level stationary.

Bernard and Durlauf (1995) proposed a new definition and tests for convergence based on a stochastic framework. They tested the hypothesis of convergence using time series rather than cross sectional methods. According to them, times series convergence is defined as follows:

Convergence in output: Countries i and j converge if the long term forecast of output for both countries are equal at a fixed time t: $\lim_{k\to\infty} E(\log y_{i,t+k} - \log y_{j,t+k} \mid I_t) = 0$

where $\log y_{i,t+k}$ is the log real per capita output and $\mathbf{I}_t$ denotes the information set.

Convergence in multivariate output: Countries p+1,…,n converge if the long term forecast of output for all countries are equal at a fixed time t: $\lim_{k\to\infty} E(\log y_{i,t+k} - \log y_{p,t+k} \mid I_t) = 0 \quad \forall p \neq 1$.

This definition of convergence examines if any pair of countries converges to zero as the forecast horizon tends to infinity. Both these two definitions require the output of the countries to be cointegrated with a cointegrating vector [1,-1].

Their analysis, which was based in multivariate techniques, considered output series from 15 OECD[6] countries over the period 1900–1987. They concluded that there is little evidence of convergence but a substantial evidence of cointegration across OECD

[6] Organization for Economic Cooperation and Development

economies implying that there is a set of common long run factors that influence international output growth among these countries.

Li and Papell (1999) examined the convergence of per capita output for 16 OECD countries by using time series techniques that incorporate structural breaks in order to provide evidence of deterministic or stochastic convergence. Their findings showed that there is evidence of deterministic convergence for 10 and stochastic convergence for 14 of the 16 OECD countries and that World War II was the major cause of the structural shifts of relative per capita outputs.

Yannick Le Pen (2005) examined the hypothesis of stochastic convergence for five industrial countries: United Kingdom, France, Germany, Japan and the United States from 1870 to 1994 (except for Japan for which the period is 1885-1994). Using the methodological framework of Park and Hahn, he tested and estimated a time varying cointegration relation between the United States and each other one. The variable that was used was per capita GDP.

He used four definitions of a time varying cointegration relation:

1. Time varying cointegration relation:

Suppose y_{it} and y_{jt} denote per capita GDP in logarithm for countries i and j. Each of the series contains a stochastic trend. There is a time varying cointegration relation between series y_{it} and y_{jt} if there is a parameter α and a sequence of parameters $(\beta_t)_{t=1,\dots,T}$ so that:

$y_{it} = a + b_t y_{jt} + u_t$ where u_t is a zero-mean stationary process.

2. Cointegration relation:

There is a cointegration relation between series y_{it} and yjt if there are two parameters α and β oo that:

$y_{it} = a + b_t y_{jt} + z_t$, where z_t is a zero-mean stationary process.

The hypothesis of stochastic convergence imposes that the parameters of the cointegration relation are fixed for a time period and known a priori.

3. Stochastic convergence and time varying cointegration.

Suppose there is a time varying cointegration relation between series y_{it} and y_{jt} :

$y_{it} = b_t y_{jt} + u_t$, where u_t is a zero-mean stationary process:

If β_t=1, for t є [t_0, t_0+h], we accept the hypothesis of stochastic convergence for this time period. Bernard and Durlauf (1995) assume that β_t=1 holds for the whole period.

4. Stochastic convergence

We accept the hypothesis of stochastic convergence between countries' i and j per capita GDPs y_{it} and y_{jt} if $e_{it} = y_{it} - y_{jt}$ is a zero mean stationary process:

This last definition implies that there is one cointegration relation between y_{it} and y_{jt} whose coefficients are known a priori.

His econometric methodology assumed that the relation between per capita GDP is not steady but it can fluctuate over time indicating whether convergence exists or not. The results revealed that for every pair of countries the hypothesis of a time varying cointegration relation was accepted and that per capita GDP convergence between these countries was a quite recent phenomenon.

According to Pesaran (2007), multivariate cointegration techniques for cross-country convergence are limited because they can only be used for a small subset of countries. On the other hand, applications of unit-root tests to output gaps measured with respect to a reference country are more practical, but they can lead to misleading conclusions due to different choices of the benchmark country. His study proposed a probabilistic version of the output convergence concept that does not require saving rates, population growths and initial endowments to be identical within the converging economies. Two countries can be thought as convergent if their output gap is a stationary process that can be true even if country output series are trend stationary and/or contain unit roots. This means that cointegration is necessary for convergence but not sufficient if series are trend stationary.

In fact, convergence requires the output series to be cotrended and cointegrated with a cointegrating vector [1,-1]. In his analysis, Pesaran, in order to be independent from a benchmark country, examined the unit root and trending properties of N(N-1))/2 log per capita output gaps $y_{it} - y_{jt}$ where i = 1,…, N-1 & j = i+1,…, N. Moreover he considered a number of average measures like $| y_{it} - y_{jt} |$ and $(y_{it} - y_{jt})^2$ and weighted the output gaps by relative population sizes.

Overall, pair wise approach has the advantage to be related more naturally to the club convergence literature but it must be used carefully in order to avoid sample selection biases associated with statistical grouping procedures. Pesaran’s results did not support the output convergence hypothesis and suggested that the identification of club convergence could be due to chance. Using PWT (Pen World Table) data over the period 1961–2000, the unit-root hypothesis was rejected at most, in the case of 370 out of 4851, possible output gap pairs, just around 7.6%, which is very close to the nominal significance level of 5% used for the test.

2.3 Heterogeneous Technology and Growth

The Solow growth model assumes homogeneous technological progress meaning that in a cross section analysis all economies have the same technological improvement rate over time even though they come from different initial income levels. Under this assumption, cross section income heterogeneity cannot be explained easily.

Phillips and Sul (2007a, 2007b, 2008) tried to overcome this difficulty by introducing time heterogeneous technology in their model allowing technological progress A_{it} to follow the path $A_{it} = A_{i0} e^{x_{it} t}$ (14). So, the parameter x_{it} (growth rate) may differ across countries and through time but can converge when $t \to \infty$ for all countries or for some groups of countries and with a common rate for each group. Under heterogeneous technology the transitional path of log per capita real income evolves as follows:

$$\log y_{it} = \log \tilde{y}_{i*} + (\log \tilde{y}_{io} - \log \tilde{y}_{i*}) e^{-b_{it} t} + x_{it} t \quad (15)$$

where β_{it} is the time varying speed of convergence that is dependent from the rate of technological progress (x_{it}) and is calculated as

$$b_{it} = b - \frac{i}{t}\log\left\{1 - d_{i1}\int_0^t e^{bp}(x^{ip} - x))dp\right\} \quad (16)$$

where $d_{i1} = 1/(\log k_{i0} - \log k_{i*})$ (17).

From equation (15) it is clear that when $x_{it} = x$ then the income differential between economies, ($\log y_{it} - \log y_{jt}$), can be explained only by their initial real effective per capita income. During transition periods though, when $x_{it} \neq x$, the technological differential $x_{it} - x_{jt}$ will also influence the income difference.

Phillips and Sul (2007a, 2007b, 2008) observed that the distribution of income across nations moves over time and in a way that it is not anticipated in most cases. Moreover, they observed that the diffusion of technology which influences economic performance may be quicker in some countries than it is in others. Thus, the paths of transition in economic performance vary across nations. In order to model and measure them econometrically they used a non linear factor model with a growth component and a time varying idiosyncratic component that allows heterogeneity across individuals and over time.

So they focused on economic growth relative to the average performance in a subgroup of economies or an individual benchmark e.g. US economy. With this method they used a simple time series regression test that involves a one side t test of the null hypothesis of convergence against the alternative of no convergence or partial convergence among subgroups. The log t test was employed in panels that consisted of income data from US states from 1929 to 1998, Western OECD countries from 1870 to 2001 and Penn World Table countries from 1970 to 2003.

The results revealed strong empirical support for economic transitioning and evolving membership of convergence clubs. Poor countries had negative growth rates and no evidence of economic transition towards a convergence club and Eastern European countries. Moreover, part of the former Soviet Union revealed U – shape transition patterns implying that they have passed all the three faces of transition in the examined period.

3. Literature Review for Convergence: The Case of Europe

Generally, numerous studies investigated the phenomenon of convergence for the EU countries during the last decade revealing different and mixed results.

Hardouvelis, Malliaropulos and Priestley (2007) examined how the process of economic and monetary integration in Europe during the 1990s and the adoption of the euro have led to a reduction in the cost of equity capital and to a convergence of the cost of equity within a given sector across EU countries or across different sectors within a given country.

They used a conditional asset pricing model with a time varying degree of stock market integration in order to relate the impact of EMU on the equity cost of capital with the change in the level of stock market integration. The results revealed that there is a strong convergence in the cost of equity across different countries within a given industrial sector but little convergence across different sectors of a given EMU country.

Brada and Kutan (2001) examined the convergence between German monetary policy and transition-economy candidates for EU membership, non-transition candidates and countries that have recently joined the EU. The prospects for convergence of monetary policies were investigated by how the candidate countries have been able to achieve some measure of convergence between the evolution of their money stock and that of Germany that was used as a historical proxy for the future monetary policy of the European Central Bank (ECB).

They used money stock as the most appropriate measure of convergence between transition-economy candidates for EU membership and the Euro-zone countries for two reasons. First of all, they were interested in policy convergence or else “the domination of transition-economy monetary policy by the Bundesbank and, ultimately, by the ECB” so this measure of money could best reflect the policy position of the monetary authorities because it captures much better central bank’s policy and is not so much affected by the intervention of other agents in the financial system. Moreover, broader measures of money may experience growth or contraction over time due to the financial system. Thus, in order to be focused on central bank policies and not on their outcomes, they used base money as a monetary aggregate.

The results revealed that the domination of national monetary policy by the Bundesbank characterized the behaviour of the most recent members of the EU, i.e. Austria, Finland and Sweden and that there was a strong connection between the Bundesbank's policies and those of Cyprus and Malta[7]. Among the transition economies, the ability to follow the policies of the Bundesbank was weaker for some countries like Hungary and Poland because they chose to follow an independent policy in the 1990s in order to gain in terms of growth and pace of restructuring but stronger for some other countries such as the Czech Republic and Estonia, who chose to follow the German monetary policy in the 1990s. So their current exchange rate against the Euro was relatively a reliable indicator of a sustainable parity against the Euro once they joined the EU.

Kutan and Yigit (2004) examined how EU integration affected productivity growth and convergence. To do so, they studied the performances of recent EU members before and after the membership and used their experience in order to derive some implications for the candidate members. They applied dynamic panel data estimation techniques with the assumption of heterogeneity in growth rates. The results for the EU members showed that the hypothesis of homogeneity in productivity rates resulted in biased downward convergence rates. Moreover, all coefficient estimates were positively affected with the membership in the EU meaning that the benefits of the integration occurred only few years after joining and that there was a higher degree of harmonisation in the convergence rates. The candidate countries resulted in different rates of progress and in a fast convergence rate towards the EU standards.

Kutan and Yigit (2005) examined the nominal and real convergence within the ERM for ten members that joined the EU in May 2004 by using data from January 1993 to December 2003. From these ten countries, eight were transition economies[8] and the other two were Cyprus and Malta.

Their analysis was concentrated on conditional stochastic convergence that does not require each country to converge to the same steady state but per capita income disparities between countries to follow a mean-stationary process. They used two benchmark countries, Germany that is considered the most important trading member and Greece as a peripheral

[7] Two of the market-economy candidates for EU membership
[8] Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Slovak Republic, and Slovenia

country and performed two different types of tests: the first test investigated the convergence of the whole group and the second test the performance of individual countries.

Industrial production was used as a measure for real convergence. On the other hand, nominal convergence was examined with tests for monetary policy convergence. In order to do so, they used interest rate spreads i.e. changes in nominal lending and deposit rates because they affect demand and time deposits and therefore the composition of the money supply. The measures for price level convergence were the CPI (Consumer Price Index) and PPI (Producer Price Index) indexes because they represent monetary policy outcomes and trade linkages between the countries.

Their findings indicated strong evidence of real stochastic convergence for all new members regardless of whether Germany or Greece was used as the benchmark. Regarding nominal convergence, the Baltic States exhibited the strongest convergence due to strong pegged exchange rate regimes and Central and East European Countries revealed weak convergence maybe because of their lack of fiscal discipline.

Until 2005 the studies for transition economies' convergence to German monetary policy had the same problems. First of all, the time period that was examined could cover different situations like recession, stabilization and then recovery, efforts to prepare for EU membership etc and therefore the degree of convergence to German could fluctuate over time. Moreover, it was very difficult to decide what variable to use in order to measure convergence.

So, Brada, Kutan and Zhou (2005) used the technique of rolling cointegration to obtain time-varying estimates of the convergence of macroeconomic variables within the EU and between transition economies and the EU and examined both monetary and real convergence. With this technique these issues could be fixed because it takes into account that data series can be more cointegrated during some parts of the sample period but less or not at all during other parts. Furthermore, with the use of rolling cointegration for a longer time period can be taken to test for cointegration and therefore eliminate the possibility of bias tests for cointegration.

They used the monetary base as a measure of monetary policy because it is a variable controlled by monetary authorities and the CPI (Consumer Price Index) and broad money (M2) as proxies for the outcomes of monetary policy. For real convergence, they used industrial output. In the analysis they included three groups of countries. The first group consisted of Germany and France that were used as benchmarks. The second group consisted of countries that had become recently members of the European Union, i.e. Austria, Portugal, Spain, and Sweden. For these countries they examined the degree of cointegration before and after their entry into the EU, providing a benchmark for the results of the transition countries. Finally the third group included the Czech Republic, Estonia, Hungary, Poland, and Slovenia.

The results showed that countries from the second group exhibited time varying cointegration with the benchmark countries over the period 1980–2000. Moreover, the transition economies exhibited cointegration using the variables M2 and prices, but not with the measure for monetary policy and with the variable industrial output.

Kim, Moshirian and Wu (2005) examined how EMU affected the stock market integration over the period of January 1989 to May 2003. They used a bivariate EGARCH framework with time-varying conditional correlations for two distinct groups of countries: a) The 12 eurozone members that have adopted the euro as a common currency (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain) and b) The non-eurozone countries that preferred not to be included to the EMU (Denmark, Sweden, UK), Japan and US (two major international stock markets).

The results showed that the political creation of EMU was necessary for the stock market integration because the tests revealed a unidirectional causality. Moreover it was shown that for the EMU members, the elimination of the foreign exchange risk was not so relevant with the increase of the stock market comovements but it was rather significant for smaller EMU members with historically different economic structures. Moreover they found that stock market integration is a seasonal process as the results revealed strong integration at January.

Anay (2006) analysed the integration level of second-round acceding and candidate countries with the EU portfolio during the accession period and investigated whether diversification opportunities existed. The accession period towards the EMU, demands acceding countries to converge with the EU standards and develop stronger trade linkages with EU-15. So that their business cycles become more and more dominated by EU-15 and therefore stock prices will be related with common global factors and not country specific factors.

The data used for this analysis were the weekly stock market price indexes of Bulgaria (SOFIX), Croatia (CRO), Romania (BET), Turkey (ISE100), Europe (Europe), European Union (EU) and United States (S&P500) for the time period of 27/10/2000 to 26/08/2005. All the prices were converted in natural logarithms and denominated in local currencies in order to obtain cointegration results based only on movements of asset prices. They used Johansen's cointegration approach and Engle-Granger causality test and found that Bulgaria, Romania, Croatia and Turkey had not yet resulted in complete financial integration with the European Union.

Jelnikar and Murmayer (2006) examined the hypothesis of conditional convergence within the fifteen countries of the European Union that became members before May 2004, and between the groups of these fifteen member states of EU and the ten countries that became members at the last enlargement. They used GDP per capita for all EU countries and the variables savings and depreciation rate for 50 years (1950 – 2000) for EU-15 and for EU-10 from 1995 to 2007 (predicted values).

In both samples, they found and proved highly statistically significant β convergence and σ convergence. Additionally, they revealed convergence of ten EU new members to the average level of standards of living of the fifteen countries of the EU from 1995 to 2007.

Kutan and Yigit (2007) used a stochastic endogenous growth model to investigate the impact of European Union on convergence and productivity growth for five recent members to the EU15 (Spain, Portugal, Austria, Finland and Sweden). In order to avoid the possibility to confuse the effects of regional events from those of integration they used France as a benchmark country and not Germany because they wanted to avoid a potential structural break in data due to its unification with East Germany.

The results showed improved rates of productivity growth after accession over and above the EU benchmark level. Moreover, an increased pace of overall growth was revealed due to capital accumulation as a result of Structural and Cohesion Funds. These funds helped new member states in the long run by allowing them to accelerate their pace in order to catch up the core EU-15 members.

Babetskii, Komarek and Komarkova (2007) investigated the existence of financial integration in stock exchange markets for four new EU member states (Czech Republic, Hungary, Poland, and Slovakia) in comparison with the euro area. Their measures of financial integration were based on the concepts of β convergence and σ convergence. They used standard and rolling correlation analysis, time series and panel regression, and the state-space model at a country level (using national stock exchange indices) as well as at a sectoral level (using banking, chemical, electricity, and telecommunication indices). Their results confirmed the existence of β convergence in stock markets both in national and sectoral level. Moreover, the shocks were diminishing with a speed of less than half a week and finally announcements like EU enlargement did not affect β convergence.

Soares (2008) used the cointegration methodology to investigate the international integration of sixteen European stock markets (12 members of the EMU, 2 members of the EU but not of the EMU and 2 not members of the EU) for the period from 02/01/2001 to 31/12/2005. The database was composed by weekly data and comprised 261 observations of each index.

He applied the Engle-Granger and the Gregory & Hansen models to test for stationarity of the long-term relations between each one national index and the international variables: a. the Europe index, b. the World index and c. the difference between the rates of growth of the World and the Europe indices. The results showed stationarity in the long-term relations with the international variables only with the third variable. Furthermore, the results of these tests did not show any difference of patterns between EMU and non EMU members and therefore other causes have also contributed to the international integration of financial markets, during the last two decades.

4. Financial Development & Growth: The Role of Stock Markets

The relationship between financial development and growth has been a topic of discussion in the macroeconomics and development literature for years. A lot of studies have been published during this time trying to explain their causality using cross country and time series analysis.

Cross country analysis generally reveals that countries with a better developed stock market and banking system experience higher growth in the long run.

Levine and Zevros (1998) investigated whether stock markets play a key role in economic growth by conducting a cross sectional analysis using data on 47 countries for the period 1976 to 1993. Stock market development was measured in various dimensions[9] using the following measures: aggregate stock market capitalization to GDP and the number of listed firms (size), domestic turnover and value traded (liquidity), integration with world capital markets, and the standard deviation of monthly stock returns (volatility).

Their purpose was to evaluate whether banking and stock market indicators were robustly correlated with current and future rates of economic growth, capital accumulation, productivity and private savings. The results revealed a strong and statistical significant relationship between stock market development and economic growth. Moreover, it was shown that banks and stock markets play different roles in the process of economic development. Finally, they found that stock market size, volatility, and international integration were not robustly correlated with growth and that private saving rates were not closely associated with any financial indicator.

An earlier paper by Atje and Jovanovic (1993) used a simple cross sectional model of the form $G_i = a_1 + a_2 I_i + a_3 S_i + a_4 N_i$ (18) where G is growth per capita, I is investment as a proportion of output, S is the product of stock market activity and investment and N is growth in the labour force. They assumed that investment and stock market activity were endogenous and for that reason they used lagged and not current variables. In a sample of 40 countries for the period of 1980 to 1988, they found that stock market development could better explain the subsequent economic growth rates than bank development. This finding

[9] Size, liquidity, international development and volatility.

was considered rather weak by the study of Harris (1997) who re examined the same model for 49 countries for the period 1980 to 1991 by using current variables in two stage least squares. His findings revealed that either with full sample i.e. developed and developing countries or with the sub sample of developing countries, stock market development did not have explanatory power.

Levine (1991) tried to explain the relationship between financial development, long run growth and policy by constructing a model that related the financial system with the steady state growth rate of per capita output. According to his study, stock markets help agents to manage liquidity and productivity risk, and therefore accelerate growth. Productivity risk arises because firms are subject to productivity shocks and discourages risk averse investors from investing in firms. Stock markets, on the other hand, give the opportunity to individuals for investment in a large number of firms and therefore diversify against idiosyncratic firm shocks. Liquidity risk arises when capital from firms is removed prematurely minimising liquidation return. Stock markets, however, allow agents that exhibit liquidity shocks to sell their stocks to other investors and therefore prevent premature capital removal. Consequently, stock markets accelerate growth by eliminating premature capital liquidation and by reducing liquidity risk encouraging this way firm's investment.

King and Levine (1993) ran cross-country regressions using data on 80 countries over the period 1960-1989 in order to investigate the relationship between financial development and long-run output growth. The results revealed that higher levels of financial development were positively correlated with faster current and future rates of economic growth, physical capital accumulation, and economic efficiency improvements and that financial development is a good predictor of long-run growth over the next 10 to 30 years.

Pagano (1993) tried to capture the potential impacts of financial development on growth, by considering a simple endogenous growth model where aggregate output (Y_t) is a linear function of aggregate capital stock (K_t): $Y_t = AK_t$ (19) According to this equation, productivity is an increasing function that depends on the aggregate capital stock K_t. For simplicity reasons, the following assumptions are taken into consideration: a) Gross investment equals $I_t = K_{t+1} - (1-d)K_t$ (20) and b) Existence of closed economy where

$fS_t = I_t$ (21), where S_t is the gross saving, I_t is the gross investment and (1-φ) is the proportion of saving that is lost due to financial intermediation.

From equation (19) the growth rate at time t+1 is $g_{t+1} = \frac{Y_t}{Y_{t+1}} - 1$. Using equation 20 and ignoring the time indices, the steady-state growth rate can be written as $g = A\frac{I}{Y} - d = Afs - d$ g (22) where s is denoted as the gross saving rate S/Y. Equation 22 shows that financial development can affect growth with three ways. A) Financial intermediation costs to 1-φ that goes to bank spreads and to commissions and fees. If the cost of intermediation is reduced, meaning raising φ, then the growth rate g increases. B) Financial intermediation increases the productivity of capital, A, and therefore the growth rate by collecting information for alternative investment projects and by providing risk sharing. C) Financial development has an ambiguous influence on saving rate and therefore in growth rate too. Therefore, Pagano concluded that the impact of financial development on growth depends on the financial market that is examined each time.

Aghion, Howitt and Mayer-Foulkes (2003) investigated the effect of financial development on convergence. The model that was used implied that all countries should converge in growth rates above some critical level of financial development, and that in these countries financial development has a positive but vanishing effect on steady-state GDP. They tested these implications with an interaction term between financial development and the country's initial relative output on 71 countries over the period 1960-1995 using a cross-country growth regression framework. The results showed that the coefficient of the interaction term was negative indicating that low financial development does not lead to convergence. It was also shown that the main channel through which financial development affects convergence is productivity growth.

They also examined whether financial constraints prevent poor countries from taking full advantage of technology transfer and as a result lead them to divergence from the world growth rate. Their theory had three basic points. The first starts with the acceptance of the idea that technology transfer is costly because the country must make technology investments in order to accept and adapt the foreign technologies. The second point is that the size of investment should increase in the same pace like global technology in order to keep innovation at the same rate. The third point is an agency problem that limits an innovator's access to external finance[10]. Their results suggested that despite technological transfer difficulties, financial development is among the most powerful forces to contribute non convergence after investigating and other variables like educational attainment and initial relative output.

Dellas and Hess (2005) investigated how stock returns are affected by financial development using a cross sectional analysis of 49 emerging and mature countries over the period 1980-1999. The results tended to be different depending on the indicator of financial development that was used and the currency of denomination of returns. Nevertheless, regardless of the currency that was used it was shown that the variance and the covariance of country stock returns were closely related to banking development.

Cross sectional approaches assume that countries have stable growth paths, share similar economic structure, populations and technologies which are quite different from reality. Moreover, it is difficult to utilise cross-country relationships since there are a lot of variables, positively correlated with growth and highly correlated among them. These difficulties have led authors to use time series approaches for individual countries in order to understand better the causality between finance and growth. Inevitably time series analysis can be limited because it requires long time series variables.

The evidence from these studies revealed that while the relationship between financial development and growth in a country is positive, this causality tends to vary considerably from one country to another meaning that finance influences economic growth in different ways across countries.

Demetriades and Hussein (1996) studied the relationship between financial development and economic growth by using times series techniques to 16 countries. The variables used for financial development were the ratio of bank deposit liabilities to nominal GDP and the ratio of bank claims on the private sector to nominal GDP.

[10] It is assumed that an innovator can defraud her creditors by hiding the results of a successful innovation. So, his access to external finance will be limited and he will face difficulties in keeping innovating at a given rate. This means that the lower the level of financial development in the country the lower will be the cost of fraud and the larger will be the disadvantage of backwardness.

According to the writers, a change in the stage of financial development will affect one or both ratios so an increase in those ratios could be thought as "financial deepening". For economic development, they used real GDP per capita measured in domestic currency in order to avoid problems associated with comparisons of per capita GDP across countries.

The results provided little evidence that finance is a leading sector in economic development. On the contrary, they found evidence that economic growth causes systematically financial development in few countries. Moreover, the tests showed that the results are country specific meaning that they vary across countries and that cross section country studies can be spurious as they take different economies as homogenous entities.

So, it is not appropriate to use the same policy to every country in the world just because cross-country studies revealed a positive association between finance and growth. More finance may mean more growth in some cases but not in others, so it is crucial to know whether this is right or not.

Arestis, Demetriades and Luintel (2001) questioned the results from previous cross sectional analysis and investigated the relationship between economic growth and stock market development in five developed economies[11] using banking system development, stock market development and stock market volatility in a VAR and VECM environment. Their results revealed that both stock markets and banks may promote economic growth with the latter at a greater range, meaning that bank based financial systems are more appropriate for long term growth than capital – market based countries. Finally, they found that although generally volatility in stock prises may reflect efficiency in stock markets, this might not be real.

Rousseau and Vuthipadadorn (2005) investigated the relationship of financial development and real economic performance for 10 Asian economies over the period 1950-2000 using time series approaches. Generally, they confirmed the results of Demetriades and Hussein (1996) that the relationship between finance and growth varies across countries. But more specifically they noticed that investment may be the key factor through which financial development influence growth in the emerging markets that were examined and that it can influence and other countries when they are at early stages of market development.

[11] Germany, United States, Japan, United Kingdom and France.

Demetriades and Law (2006) investigated whether institutions are important in the way finance affects economic growth. Additionally, they examined whether the relationship between institutional quality and financial development varies in accordance to the stage of economic development. They used a panel of observations for 72 countries for the period 1978–2000 that are grouped into three categories: high, middle and low-income based on the World Bank classification. The results suggested that financial development has larger effects on long-run economic development when the financial system is “embedded within a sound institutional framework”. This finding was consistent especially in poor countries, where it is not sure whether finance will give significant benefits, if institutional quality is low. Moreover, it was shown that financial development gives real economic benefits especially in middle-income countries. On the other hand, the effects of financial development in high-income countries were smaller than in middle-income countries but overall even in these countries the effects seemed to be larger when institutional quality was high.

Buelens, Cuyvers and Nieuwerburgh (2006) investigated the relationship between financial market and economic development for the case of Belgium. They used time series analysis in a data set of stock market development indicators for the period of 1830 to 2000. The results indicated strong evidence that stock market development caused economic growth in Belgium and that institutional changes, i.e. the removal of the restrictions both on the formation of limited liability companies and on trade in the shares of firms on the stock exchange, gave a time varying character in that relationship.

Arestis, Luintel, and Theodoridis (2008) examined whether financial structure is important for economic growth by analyzing 14 low and middle income countries using both time series and dynamic heterogeneous panel methods. First of all, they performed tests for cross country heterogeneity and they found that there is significant cross country heterogeneity between financial development, financial structure and economic growth and for this reason they used time series analysis. Moreover, they examined how financial development and financial structure changes when countries become more economically developed and richer, when countries' financial structure develops and converges to that of the US and when countries' level of overall financial development converges to that of the US. Their tests revealed that financial structure and development are important for output levels and economic growth. Overall, they concluded that financial structure matters for economic growth.

Baltagi, Demetriades and Law (2008) investigated whether trade and capital account openness could explain the pace of financial development and the way financial development varies across countries in recent years. Moreover, it was investigated whether the simultaneous opening of both trade and capital accounts is necessary to promote financial development by interacting these two terms in order to examine whether the impact of one type of openness depends on the degree of the other type of openness. The results suggested that trade and financial openness were statistically significant determinants of banking sector development and that relatively closed economies may benefit from opening up their trade or capital accounts. Moreover, promoting financial development in countries that are already open through additional opening may not have the results that are expected.

Michael Fung (2009) examined if convergence in financial development and economic growth exists using data for 57 countries for the period 1967-2001. The results revealed strong evidence for conditional convergence. Specifically, for middle and high income countries conditional convergence was found on both economic growth and financial development. Moreover it was shown that the relationship between financial development and growth is stronger at early stages of economic development. So, low income countries with a well developed financial sector are more likely to catch up high income countries than those with an under developed financial sector that are more likely to be trapped in poverty. This result confirmed the observed divergence between poor and rich countries.

Caprioli and Federici (2009) examined the dynamic relationship between financial development and economic growth by using a Vector-Autoregressive (VAR) framework in 39 countries in order to identify their dynamic interactions. The purpose of the paper was to find the macroeconomic cases under which the crises transmission channels are important. The results revealed that financial development is an important variable for the existence of a "credit crunch effect" and that more financial developed countries can avoid currency crises.

5. Methodology

5.1 Time Varying Factor Representation and Convergence

Phillips and Sul (2007b) showed how panel data can be transformed in terms of time varying common factor representation like: $X_{it} = g_{it} + a_{it}$ (23) where g_{it} represents permanent common components and a_{it} represents transitory components. Equation 23 contains a mixture of both common and idiosyncratic components. In order to separate them it can be transformed as follows: $X_{it} = \frac{g_{it} + a_{it}}{m_t} m_t \Rightarrow X_{it} = d_{it} m_t$ (24) for all i and t where m_t is a single common component and d_{it} is a time varying idiosyncratic component. So, d_{it} represents the distance between the common trend m_t and X_{it}.

For example, log per capita real income can be reformed in terms of a time varying common factor representation using this nonlinear factor model that involves the product of a time varying element, b_{it}, which measures individual transition effects and a common trend factor, m_t, which individual economies can share[12]. The extent to which economies share this common trend is relevant with their individual characteristics.

From equation (15) the actual transition path of log per capita real income can be:

$\log y_{it} = \log \hat{y}_{i*} + \log A_{i0} + (\log \hat{y}_{i0} - \log \hat{y}_{i*}) e^{-b_{it} t} + x_{it} t = a_{it} + x_{it} t$ (25)

where $a_{it} = \log \hat{y}_{i*} + \log A_{i0} + (\log \hat{y}_{io} - \log \hat{y}_{i*}) e^{-b_{it} t}$ (26).

As $t \to \infty$, the term $e^{-b_{it} t} \to 0$ and $a_{it} \to \log \hat{y}_{i*} + \log A_{i0}$. So for large t, $\log y_{it}$, follows a long run path that is determined by the term $x_{it} t$. The sources of this path ($x_{it} t$) are common across economies and can be depicted by the common growth component m_t. So equation 25 can be written as follows: $\log y_{it} = \frac{a_{it} + x_{it} t}{m_{it}} m_{it} = b_{it} m_{it}$ (27), where b_{it} measures

[12] This can be knowledge, technology, industry in developed countries, etc.

the part of common trend that economy i experiences. Generally b_{it} represents the transition path of one economy to the common steady state path determined by the term m_t [13].

5.2 Long Run Equilibrium and Convergence

Time series macroeconomics has two categories of analysis: long run and short run. Cointegration methods are used for long run analysis and stationary time series methods for short run dynamic behavior. The use of common stochastic trends helps long run analysis without the existence of cointegration and allows the modeling of transitional effects. If two variables X_{it} and X_{jt} have stochastic trends and are thought to be in long run equilibrium then the time series are considered to be cointegrated.

Another way to define relative long run equilibrium or convergence between such series is with use of the relative convergence condition. The difference between two time series is $X_{it} - X_{jt} = (d_{it} - d_{jt})m_t$ (28). Under transitional heterogeneity the condition for growth convergence is $\lim_{t\to\infty} d_{it} = d$ (29).

So when $t \to \infty$ then $d_{it} - d_{jt} \to 0$ and equivalently from the relative income differential equation $X_{it} - X_{jt} = (d_{it} - d_{jt})m_t$ we get $\lim_{t\to\infty} \frac{X_{it}}{X_{jt}} = 1$ (30) also known as the relative condition of convergence.

[13] During transition periods b_{it} depends on the speed of convergence b_{it}, the rate of technical progress x_{it} and the factor a_{it}.

5.3 Transition and Relative Transition Curves

Generally, equation 24, $X_{it} = d_{it} m_t$, has more unknown numbers than observations and it is therefore impossible to estimate the coefficient d_{it}. An alternative approach to model this element is by constructing a relative transition coefficient of the form $hit = \frac{X_{it}}{N^{-1}\sum_{i=1}^{N} X_{it}} = \frac{d_{it}}{N^{-1}\sum_{i=1}^{N} d_{it}}$ (31) that eliminates the common growth component m_t.

The variable h_{it} represents an individual path for each i relative to the average and for this reason it is called "relative transition path". Moreover, h_{it} measures the divergence of each i from m_t. So, by using this path we are able to measure this divergence and estimate whether it is transient or not.

Since our interest is the long run behavior in macroeconomic data, we have to remove the business cycle component in order to investigate the trend component. Hodrick - Prescot Filter is a smoothing method that is used in this case and uses only a smoothing parameter, λ that is determined by the frequency[14] of the data.

Properties of h_{it}

1. Under the existence of common transition behavior across countries we have $h_{it} = h_t$ across i.
2. Under the existence of ultimate growth convergence we have $h_{it} \to 1$ for all i as $t \to \infty$ which imply that although transition curves may differ across countries in the short run, in the long run ultimate convergence will come.

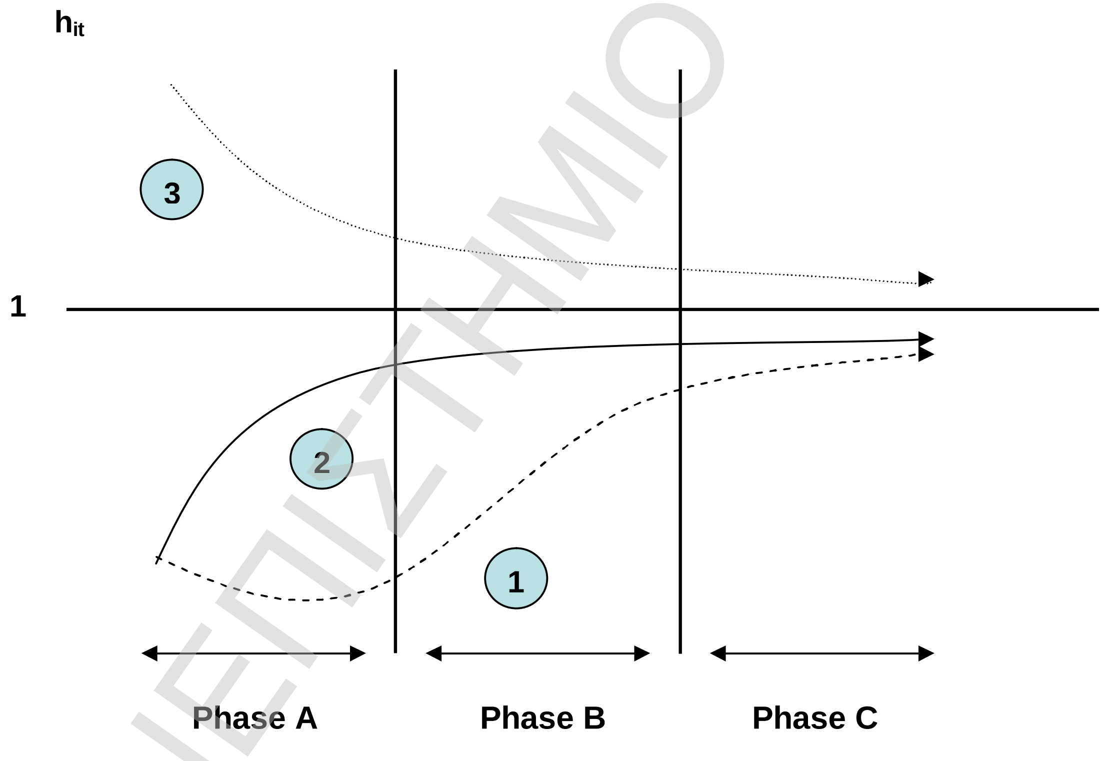
[14] λ=100 for annual data and 14.400 for monthly data.

The last property implies that the cross sectional variance of h_{it}, which gives a quadratic distance measure for the panel from the common limit, vanishes asymptotically. More specifically: $s_t^2 = \frac{1}{N}\sum_{i=1}^{N}(h_{it}-1)^2 \rightarrow 0$ as $t \rightarrow \infty$ (32).

On the other hand, when convergence does not hold then the distance is positive. Furthermore, s_t^2 may converge to a non zero constant and if it is positive we have club convergence. Also s_t^2 may be bounded over zero but not converge or sometimes diverge.

Figure 2 presents three examples of transition paths for three economies.

Figure 2 Transition Paths Examples



We can observe that although economies 2 & 3 have quite different initial points, they converge to unity at Phase C. More specifically, economy 2 starts from a low initial state and ends up to unity representing an economy that grows fast and has just been industrialized. Economy 3, on the other hand, represents an already advanced industrial economy as the initial state is high. Economy 1 has the same initialization as economy 2 but its transition curve involves a phase of divergence from the rest of the group, then a phase of a catch up period and in the end convergence. So, economy 1 can best represent a developing country.

5.4 Modeling and Testing Convergence

In order to design a statistical test for convergence a semiparametric approach is used that assumes the following form for the coefficient d_{it}:

$$\left.\begin{aligned} d_{it} &= d_i + s_{it} + x_{it} \\ s_{it} &= \frac{s_i}{L(t)t^a} \end{aligned}\right\} \quad d_{it} = d_i + \frac{s_i + x_{it}}{L(t)t^a} \quad (33)$$

Where d_i is fixed, x_{it} is iid (0.1) across i but may be weakly dependent over t, $L(t)$[15] is a slowly varying function, increasing and divergent at infinity, so when $t \to \infty$ then $L(t) \to \infty$. The parameter α represents the rate at which the cross section variation decays to zero over time.

This formulation which includes the slowly varying function $L(t)$ is important in order to ensure convergence (d_{it} converges to d_i) even if $a = 0$ at a very slow rate. Moreover, if d_{it} converges to d_i for all $a \geq 0$ and $d_i = d_j$ for $i \neq j$ then the model allows for transitional heterogeneity across i.

5.5 The log – t Convergence Test

The following procedure is based on a time series regression and involves a one side t – test of null hypothesis of convergence for all economies against alternatives like no convergence or partial convergence among some subgroups.

[15] For example $L(t) = \log t$ or $L(t) = \log(t+1)$.

The null hypothesis of convergence is: H$_0$: $d_i = d$ & $a \geq 0$. The alternative hypothesis is H$_A$: $\{d_i = d$ for all i with $a < 0\}$ or $\{d_i \neq d$ for some i with $a \geq 0$ or $a < 0\}$. The constructive steps for the procedure are the following:

Step 1: We construct the cross sectional variation ratio $\frac{H_1}{H_t}$ where

$$H_t = \frac{1}{N}\sum_{i=1}^{N}(h_{it}-1)^2 \quad (34)$$

Step 2: We run the following OLS regression

$$\log\frac{H_1}{H_t} - 2\log\left(L(t)\right) = \hat{a} + \hat{b}\log t + \hat{u}_t \quad (35)$$

For $t = [rT],[rT]+1,.....,T$ and r>0 and we compute a robust t statistic for the coefficient $\hat{b}(t_{\hat{b}})$. In this regression $L(t) = \log(t+1)$ and $\hat{b} = 2\hat{a}$ where $\hat{a}$ is the estimate of a in Ho.

The data begin from $t = [rT]$ and therefore a small fraction (r) of the time series data is discarded in order to be concentrated on what happens when the size of the sample becomes larger. Phillips and Sul (2007b), based on their Monte Carlo simulation experiments, suggested that $r = 0,3$ is a good choice.

Step 3: Apply an autocorrelation and heteroskedasticity one side t – test of the inequality null hypothesis $a \geq 0$ using $\hat{b}$ and a HAC[16] standard error for the long run variance of the residuals.

According to Phillips and Sul (2007b), the test statistic of $\hat{b}(t_{\hat{b}})$ is standard normally distributed asymptotically in order to employ standard critical values. By employing the conventional *t*-statistic the null hypothesis of convergence is rejected if $t_b < -1,65$. This null

[16] Heteroskedasticity, Autocorrelation, Consistent

hypothesis implies relative convergence If we change the null hypothesis to $a \geq 1$, we can test for absolute convergence which is equivalent to $\hat{b} \geq 2$.

5.6 Growth Convergence Clubs and Economic Transition

If the null hypothesis of convergence is rejected then there is evidence for divergence or club convergence. In order to investigate the possibility of club convergence Phillips and Sul (2007b) utilized a clustering mechanism that relies on a stepwise and cross section recursive application of log t regression tests.

The constructive steps for the procedure are the following:

Step 1: Last observation ordering

We order the individuals from the panel according to the amount of the last observation, or when time series volatility in X_{it} is observed, the ordering can be done according to the time series average over the last fraction of the sample. In this case the former approach is used.

Step 2: Core Group Formation

We select the first k highest individuals in the panel in order to form the subgroup G_k for $2 \leq k < N$. Then we run a log t regression test and calculate the convergence test statistic for this subgroup $t_k = t(G_k)$. We choose the core group size $k*$ by maximizing t_k over k according to the criterion $k* = \arg\max_k \{t_k\}$ with the condition $\min\{t_k\} > -1,65$. This condition ensures that the null hypothesis of convergence is supported for each k.

The criterion $k* = \arg\max_k \{t_k\}$ reduces the overall Type II error probability and ensures that the selected core group G_k has a very low false inclusion rate. In the case where there is a single convergence club with all individuals then the size of this convergence club is N. If the condition $\min\{t_k\} > -1,65$ does not hold in the case for k = 2 then we drop the highest individual from each subgroup and we create new subgroups $G_{2j} = \{2,..., j\}$ for $2 \le j \le N$.

Then we compute the t statistic $t_j = t(G_{2j})$. If the condition is not satisfied, then the procedure may be repeated again by dropping the highest individual in G_j and continue as before. If the condition does not hold for all the sequential pairs then we conclude that there are no convergence subgroups in the panel.

Step 3: Sieve individuals for Club Membership

We add one individual at a time to the core primary group of k^* members and then we run the log t test again. If the t statistic from this regression $(\hat{t})$ is greater than the chosen appropriate value (c*)[17] then we include the new individual in the convergence club.

Step 4: Stopping Rule

We form a subgroup of the individuals of which $\hat{t} < c$ in step 3. Then we run a log t test for this subgroup to see if $\hat{t} > 1,65$ meaning that this group converges. If so, we conclude that we have two convergent clubs: the core primary group and the second group. If not we repeat step 1-3 in order to investigate whether the second group can de subdivided into convergence clusters. If we can not find k in step 2 where $t_k > 1,65$, we conclude that the remaining individuals have divergent behavior.

[17] The choice of the appropriate c* is associated with the desired degree of conservativeness. By increasing c*, the risk of including a wrong member in the convergence club is reduced. In this case we set c*=0.

6. Empirical Evidence

6.1 Data Description

This section describes the data used for the analysis of price level, volatility and financial development convergence in stock markets. Due to data availability constraints, we examine 17 countries from the Euro area namely, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland and United Kingdom. From these countries, 15 are members of the EU and the other 2[18] have not joined the EU. Moreover, from the 15 EU members, 12 have joined the EMU and adopted euro as their common currency.

Price Indexes

For the analysis of convergence in price indexes, we use the monthly prices of the general indexes provided by the database of Datastream expressed in $ (in order to be expressed with the same currency). The period we use is from 01/03/1994 to 01/05/2009 due to data availability constraints and the need of a balanced dataset for the analysis. These series are reformed in order to have the same base date. More specifically, for each country we divide every observation with the first one and then multiple them with 100. With this procedure all country series have the same base date (01/03/1994).

Volatility Measures

For the analysis of convergence in volatility, we use two proxies[19]: absolute returns and squared returns. For the calculation of absolute returns we use the monthly prices of the general indexes aforementioned above for the period 01/03/1994 to 01/05/2009. The type we use is the following: $\text{Abs}(\ln \frac{P_{it}}{P_{it-1}})$. For the calculation of squared returns we use

[18] Norway and Switzerland
[19] Andersen, Bollersev, Diebold and Labys (2003) and Andersen and Bollersev (1998)

the daily prices of the general indexes aforementioned above, for the period 23/02/1994 to 13/05/2009. These series are reformed in daily returns and then raised in the power of 2. After this transformation the monthly squared returns is calculated by summing each month’s daily squared returns.

Table 2 describes each country’s price index along with its Datastream code.

Table 2 Price Index Description & Code

Country	Price Index Description	Code
Austria	AUSTRIA-DS MARKET $ - PRICE INDEX	TOTMOE$
Belgium	BELGIUM-DS MARKET $ - PRICE INDEX	TOTMBG$
Denmark	DENMARK-DS MARKET $ - PRICE INDEX	TOTMDK$
Finland	FINLAND-DS MARKET $ - PRICE INDEX	TOTMFN$
France	FRANCE-DS MARKET $ - PRICE INDEX	TOTMFR$
Germany	GERMANY-DS MARKET $ - PRICE INDEX	TOTMBD$
Greece	GREECE-DS MARKET $ - PRICE INDEX	TOTMGR$
Ireland	IRELAND-DS MARKET $ - PRICE INDEX	TOTMIR$
Italy	ITALY-DS MARKET $ - PRICE INDEX	TOTMIT$
Netherlands	NETHERLANDS-DS MARKET $ - PRICE INDEX	TOTMNL$
Norway	NORWAY-DS MARKET $ - PRICE INDEX	TOTMNW$
Poland	POLAND-DS MARKET $ - PRICE INDEX	TOTMPO$
Portugal	PORTUGAL-DS MARKET $ - PRICE INDEX	TOTMPT$
Spain	SPAIN-DS MARKET $ - PRICE INDEX	TOTMES$
Sweden	SWEDEN-DS MARKET $ - PRICE INDEX	TOTMSD$
Switzerland	SWITZ.-DS MARKET $ - PRICE INDEX	TOTMSW$
United Kingdom	UK-DS MARKET $ - PRICE INDEX	TOTMUK$

Stock Market Development Indicators

We are going to examine the convergence of the following indicators of financial development in order to assess whether they are responsible for convergent or divergent phenomena in stock market prices. These indicators are: Stock Market Capitalization which is used as a measure of the size of the stock market, Private Credit and Liquid Liabilities which are used to measure financial intermediation, Stock Market Total Value Traded and Stock Market Turnover Ratio which are used as measures of market liquidity. The source for all these indicators is from the World Bank's Financial Development and Structure Database (updated on May 2009) by the authors Thorsten Beck, Asli Demirguc-Kunt and Ross Eric Levine (http://go.worldbank.org/X23UD9QUX0). In cases of missing values in the dataset, we use the method of interpolation to extract them.

Stock Market Capitalization to GDP (Levine, Zevros 1998), henceforth Stock Market Capitalization is computed as the value of listed domestic shares on domestic exchanges divided by GDP. This is used as an indicator of market development and represents the size of the stock market relative to the economy. The period we use for this indicator is from 1996 to 2007.

Private Credit by Deposit Money Banks and Other Financial Institutions (Dellas, Hess 2005), henceforth Private Credit is computed as the value of credits by deposit money banks and other financial institutions to the private sector divided by GDP. This measure isolates credit issued to the private sector, as opposed to credit issued to governments, government agencies, and public enterprises and excludes credits issued by the central bank and development banks. It is broadly used as a measure of financial intermediation. The period we use for this indicator is from 1981 to 2006.

Liquid Liabilities to GDP (Dellas, Hess 2005), henceforth Liquid Liabilities is computed as currency plus demand and interest-bearing liabilities of banks and non bank financial intermediaries divided by GDP. This is a typical measure of financial intermediation. Financial intermediaries mitigate economic consequences of information and transaction costs and with the services they provide, they influence savings and allocation decisions. The period we use for this indicator is from 1983 to 2003.

Stock Market Total Value Traded to GDP (Levine, Zevros 1998), henceforth Stock Market Total Value Traded is computed as the value of domestic shares traded on domestic exchanges divided by GDP. This indicator measures the activity of stock market trading volume as a share of national output and therefore reflects liquidity relative to the size of the economy. The period we use for this indicator is from 1994 to 2007.

Stock Market Turnover Ratio (Levine, Zevros 1998) is computed as the value of domestic shares traded on domestic exchanges divided by the value of listed domestic shares (market capitalization). This indicator measures the volume of domestic equities traded on domestic exchanges relative to the size of the stock market and can be used to investigate the activity or liquidity of a stock market relative to its size. The period we use for this indicator is from 1996 to 2007.

6.2 Results from Phillips and Sul Methodology

Price Indexes Convergence tests

Table 3 reports the results of the panel convergence methodology for the case of price indexes. This table is divided in two cases. Case 1 reports the results of the full convergence $\log t$ test, meaning convergence among all sample countries. On the other hand, Case 2 reports the results of the clustering algorithm described in Chapter 6. The estimated value of b ($\hat{b}$) and the associated t statistic which are estimated from equation 35 are also stated in Table 1.

Case 1 in the following table indicates that the null hypothesis of convergence is accepted at the 5% level for the period under investigation. More specifically, the point estimate of b is 0,952 (t statistic: 16,884). This result implies the existence of convergence behavior in the price indexes of the 17 European countries.

Table 3 Price Indexes

Case 1: Full Convergence Test		
Period	**Countries**	**b**
1/3/1994 - 1/5/2009	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	0,952 (16,884)

Case 2: Club Convergence Test		
Period	**Group Membership**	**b**
1/3/1994 - 1/5/2009	**Group 1** Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	0,952 (16,884)

Notes:
1. t statistic in parenthesis
2. An asterisk (*) indicates rejection of the null hypothesis of convergence at 5% level.
3. $r = 0.4$
4. Source: Datastream

Figure 3 presents the initial series under investigation for the 17 countries before their transformation to relative transition paths.

Figure 3 Price Indexes (Initial Series)

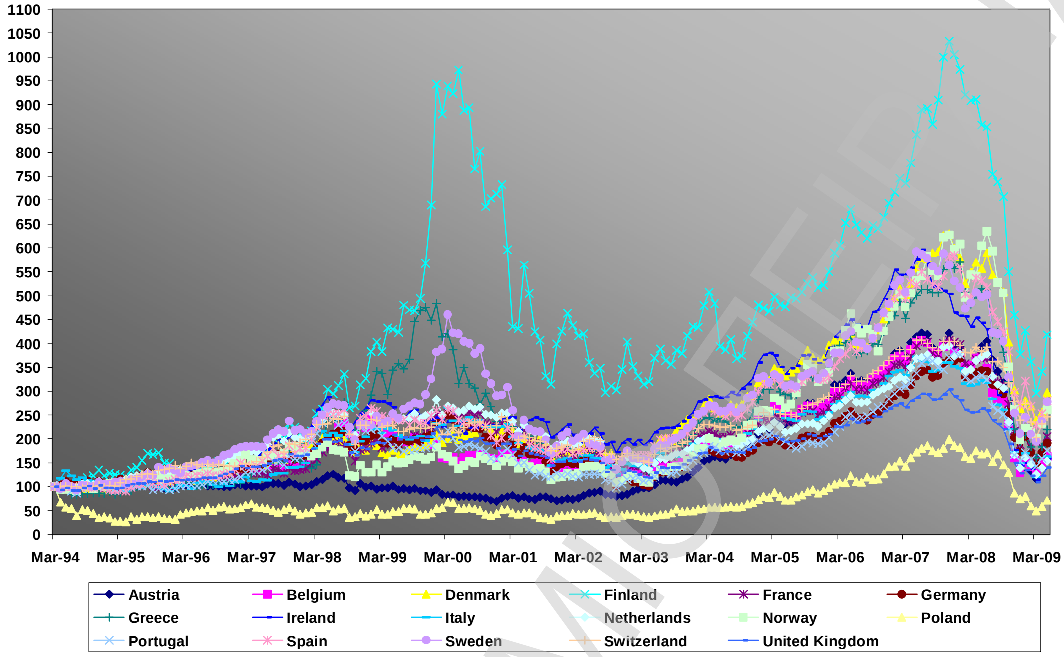


Figure 4 depicts the relative transition path of each country's price index. Visual inspection of these curves, gives an insight view of the expected outcomes of the testing methodology. These curves, as aforementioned in section 5, represent the path for each i relative to the average. Any curve that exceeds the number one indicates that the relevant price index of the country is above the cross sectional average and vise versa.

In theory, under the existence of full convergence we have $h_{it} \rightarrow 0$ for all i as $t \rightarrow \infty$ implying that although transition curves may differ across countries in the short run, in the long run ultimate convergence will come. Moreover the slope of each curve can be seen as the growth rate of the country's price index relatively to the cross sectional average.

So, from the following figure we see that the result of Table 3 is confirmed. More specifically we observe that the cross sectional variation of the sample is reduced when we move to the end of the sample period and all the lines tend to follow a common path. Poland's transition curve is at the lowest point compared with those of other countries. This is anticipated, for Poland is a developing country and one of the most recent members of the EU.

Figure 4 Relative Transition Paths – Price Indexes (Individuals)

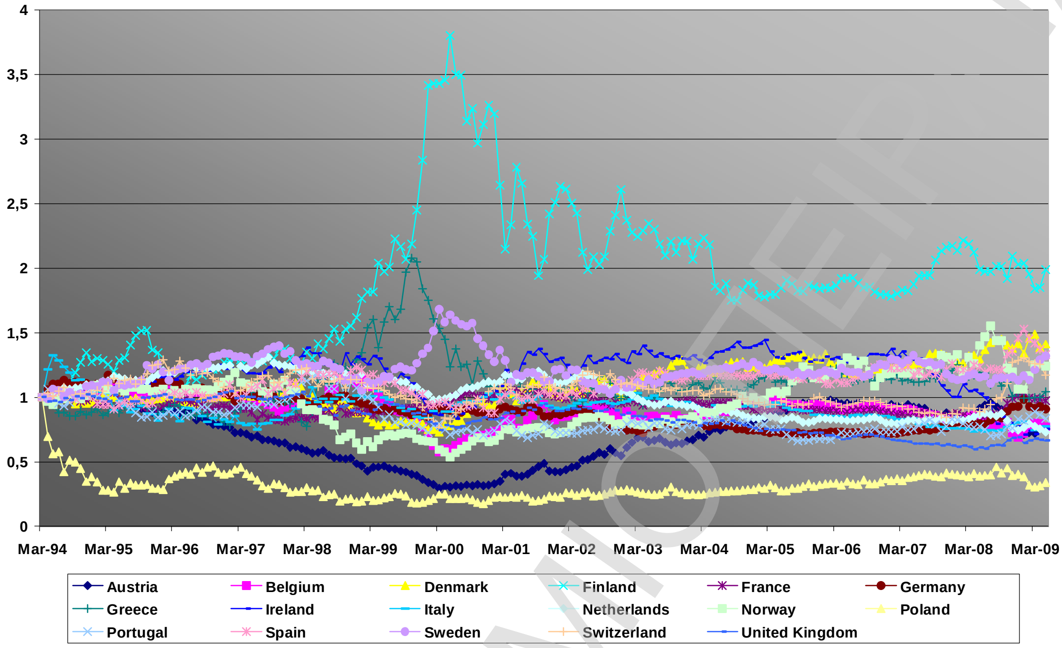


Table 4 reports the results for convergence in price indexes, like Table 3, with the difference that in this case a smaller fraction of data is discarded. Case 1 in this table indicates that the null hypothesis of convergence is accepted at the 5% level one more time, certifying the results of Table 3. The point estimate of b is -0,075 (t statistic: -0,437). The only difference in this table is Case 2 where the club convergence algorithm indicates that although full convergence exists, the countries can be separated in two convergent clubs. The first club with point estimate of b 0,277 (t statistic: -0,838) consists of countries that are above the cross sectional average and the second club with point estimate of b 0,364 (t statistic: 3,774) consists of countries that are below the cross sectional average.

Table 4 Price Indexes

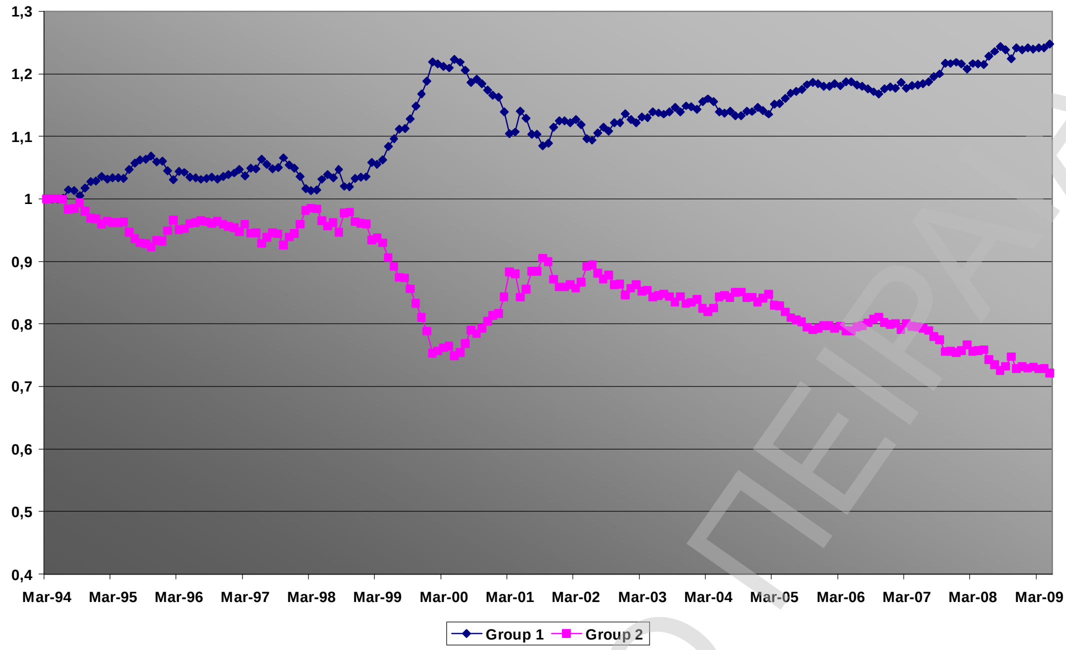
Case 1: Full Convergence Test		
Period	**Countries**	**b**
1/3/1994 - 1/5/2009	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	-0,075 (-0,437)

Case 2: Club Convergence Test		
Period	**Group Membership**	**b**
1/3/1994 - 1/5/2009	**Group 1** Austria, Denmark, Finland, France, Greece, Norway, Spain, Sweden, Switzerland	0,277 (0,838)
	Group 2 Belgium, Germany, Ireland, Italy, Netherlands, Poland, Portugal, United Kingdom	0,364 (3,774)

Notes:
1. t statistic in parenthesis
2. An asterisk (*) indicates rejection of the null hypothesis of convergence at 5% level.
3. $r = 0.2$
4. Source: Datastream

Figure 5 displays the relative transition curves of the two convergent groups indicated in Table 4. We can observe that each group's relative transition curve is a mirror of the other.

Figure 5 Relative Transition Paths – Price Indexes (Groups)



The following tables report the results of the $\log t$ tests for the cases of convergence in volatility and in stock market development indicators. The tables represent the structure of Table 3 & 4, i.e. Case 1 describes the results of full convergence test and Case 2 the results from the club convergence test. Moreover the initial series for each variable and the relative transition curves are also depicted in the figures that follow.

Volatility Convergence test

As aforementioned previously in Data Description, we measure the convergence in volatility by using two proxy variables, absolute returns and squared returns.

Table 5 reports the results for absolute returns. Obviously the null hypothesis of convergence is not rejected at the 5% level for the period under investigation. The point estimate of b is 0,425 (t statistic: 23,062). The results suggest the existence of full convergence behavior in absolute returns.

Table 5 Absolute Returns

Case 1: Full Convergence Test		
Period	**Countries**	**b**
1/4/1994 - 1/5/2009	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	0,425 (23,062)

Case 2: Club Convergence Test		
Period	**Group Membership**	**b**
1/4/1994 - 1/5/2009	**Group 1** Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	0,425 (23,062)

Notes:
1. t statistic in parenthesis
2. An asterisk (*) indicates rejection of the null hypothesis of convergence at 5% level.
3. $r = 0.2$
4. Source: Datastream

Figure 6 presents the initial series of absolute returns for the 17 countries under investigation before their transformation to relative transition paths. We can observe that these series do not move around the same mean through the whole period of investigation but only on specific fractions. Moreover, the cross sectional variation is high in some parts and low in other parts.

Figure 6 Absolute Returns (Initial Series)

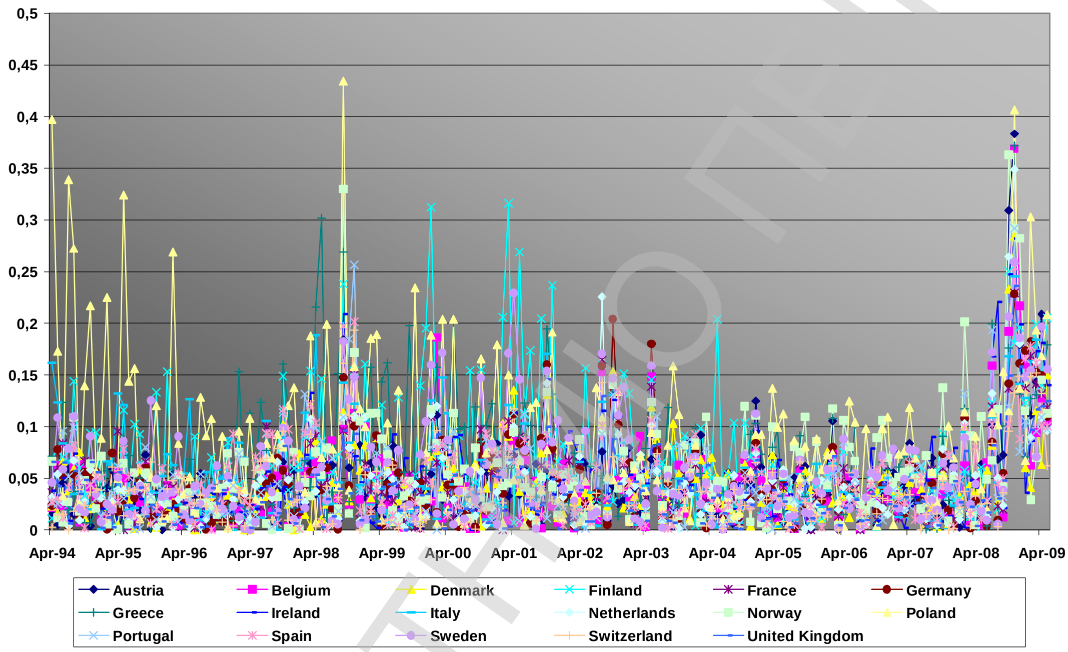


Figure 7 which illustrates the relative transition curves for this variable confirms the result from the table of full convergence. It is obvious that the cross sectional variation is extremely high at the beginning of the sample period but a considerable reduction is observed at the last period of investigation indicating that convergence has started.

Figure 7 Relative Transition Curves – Absolute Returns (Individuals)

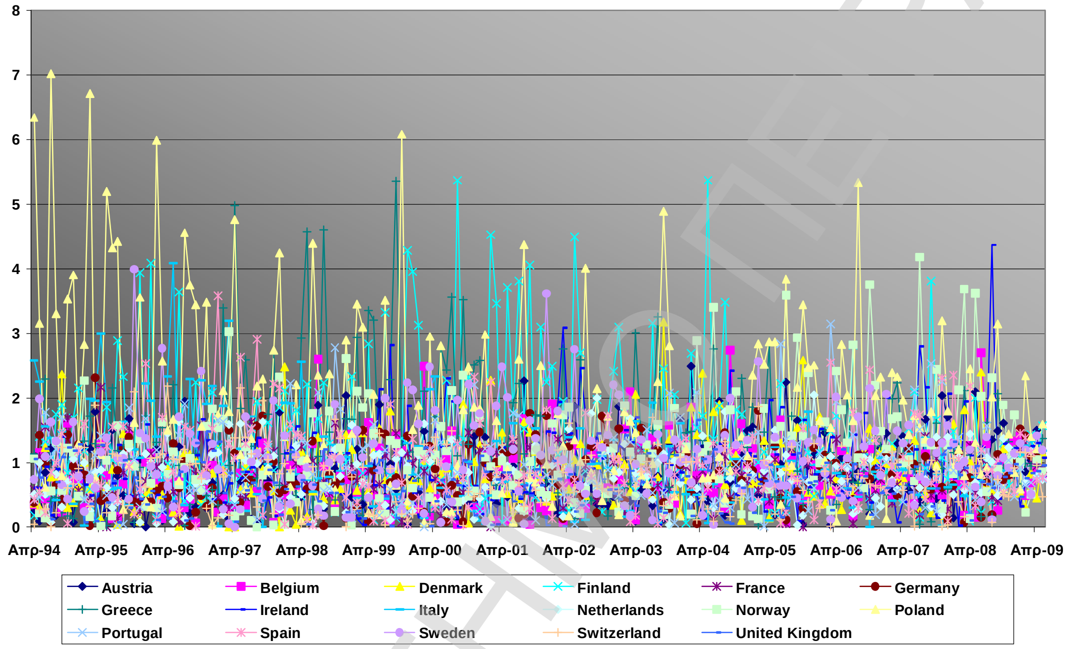


Table 6 reports the results from the second proxy we use for volatility, squared returns. In this case, the null hypothesis of convergence is not rejected at the 5% level similarly with the case of absolute returns. The point estimate of b is 0,444 (t statistic: 26,202).

Table 6 Squared Returns

Case 1: Full Convergence Test		
Period	**Countries**	**b**
1/3/1994 - 1/5/2009	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	0,444 (26,202)

Case 2: Club Convergence Test		
Period	**Group Membership**	**b**
1/3/1994 - 1/5/2009	**Group 1** Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	0,444 (26,202)

Notes:
1. t statistic in parenthesis
2. An asterisk (*) indicates rejection of the null hypothesis of convergence at 5% level.
3. $r = 0.2$
4. Source: Datastream

Figure 8 portrays the initial series of squared returns before their transformation in to relative transition curves. Clearly the variation of these series is extremely high in some fractions of the plot and extremely low in some others. This picture has similar behavior like in the case of absolute returns.

Figure 8 Squared Returns (Initial Series)

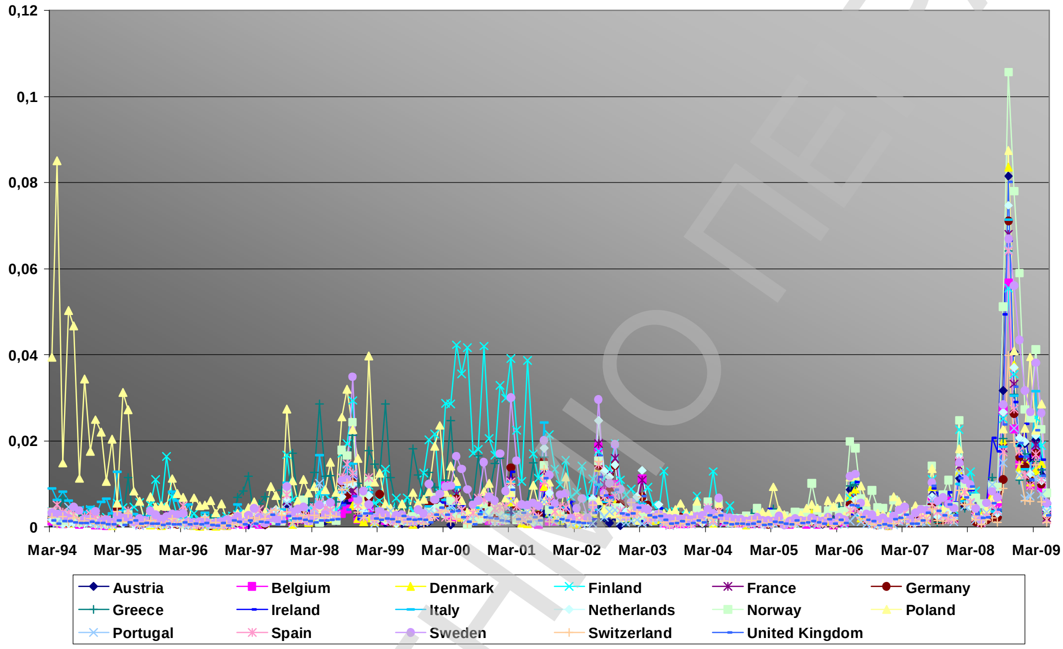
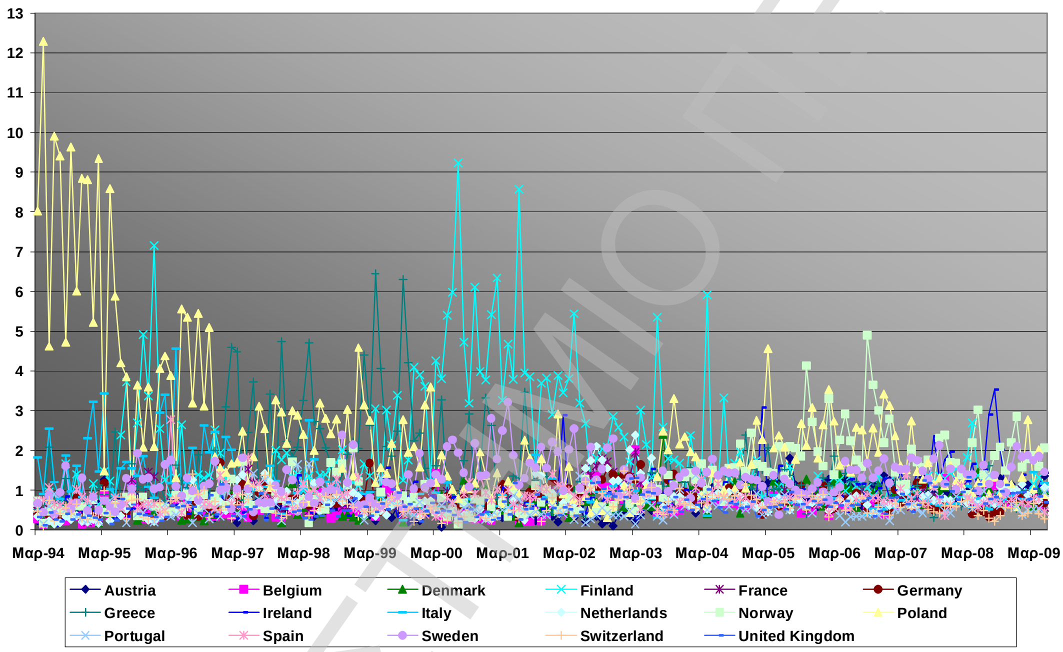


Figure 9 which illustrates the relative transition curves for this variable confirms the result from the table of full convergence. We can observe that the cross sectional variation is reduced as we proceed to the last period of investigation. Poland starts with a significant divergent performance from the rest of the group but then this phenomenon vanishes as time passes. Finland, on the other hand, exhibits divergence at the middle period of the sample but after 2004 she starts to follow the rest of the group.

Figure 9 Relative Transition Curves – Squared Returns (Individuals)



After the investigation of convergence behavior in prices and in volatilities of these prices, we proceed with the analysis of the four financial development indicators that were analyzed previously in data description. At this point we explore whether their results are significant with the full convergence results of prices and volatility measures.

Stock Market Capitalization

Beginning with Case 1 in Table 7, we observe that the results give a different picture. Clearly the null hypothesis of full convergence is rejected at the 5% level for the period under investigation. The point estimate of b is -1,465 (t statistic: -9,986). The results of club convergence test in Case 2 indicate the presence of 4 convergent clubs. The point estimate of b for the first club is -0,148 (t statistic: -0,907), for the second club 0,002 (t statistic: 0.005), for the third club -0,396 (t statistic: -0,541) and for the fourth club 0,848 (t statistic: 2,439).

Table 7 Stock Market Capitalization

Case 1: Full Convergence Test		
Period	**Countries**	**b**
1996 - 2007	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	-1,465 (-9,986)*

Case 2: Club Convergence Test		
Period	**Group Membership**	**b**
1996 - 2007	**Group 1** Austria, Belgium, Finland, Greece, Ireland, Netherlands, Portugal, Switzerland	-0,148 (-0,907)
	Group 2 Denmark, France, Norway, Spain	0,002 (0,005)
	Group 3 Poland, United Kingdom	-0,396 (-0,541)
	Group 4 Germany, Italy, Sweden	0,848 (2,439)

Notes:
1. t statistic in parenthesis
2. An asterisk (*) indicates rejection of the null hypothesis of convergence at 5% level.
3. $r = 0.1 \,\&\, 0.15$
4. Source: : http://go.worldbank.org/X23UD9QUX0

Figure 10 presents the initial series of the variable under investigation before their transformation in to relative transition curves. It is obvious that Switzerland's line is above all other countries. This is expected since Swiss equity market contains some of the world's largest companies and remains as one of the top financial centers in the world.

Figure 10 Stock Market Capitalization (Initial Series)

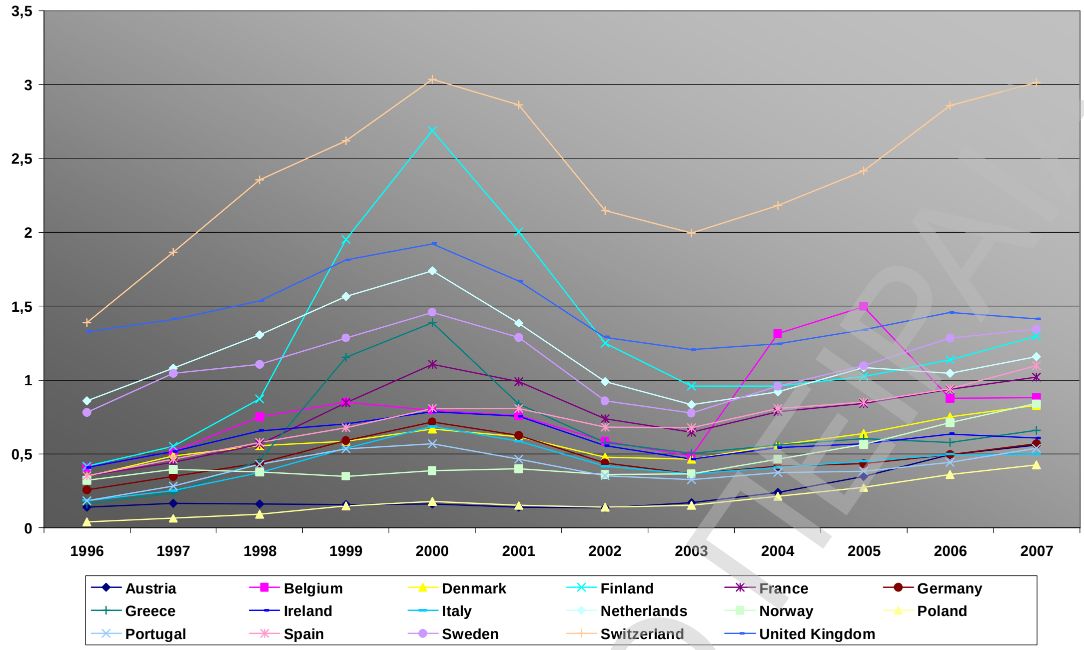


Figure 11 presents the relative transition curves for this variable and it is apparent that Case 1 of full convergence is rejected but still some countries can be formed into groups as Case 2 of Table 7 indicated.

Figure 11 Relative Transition Curves – Stock Market Capitalization (Individuals)

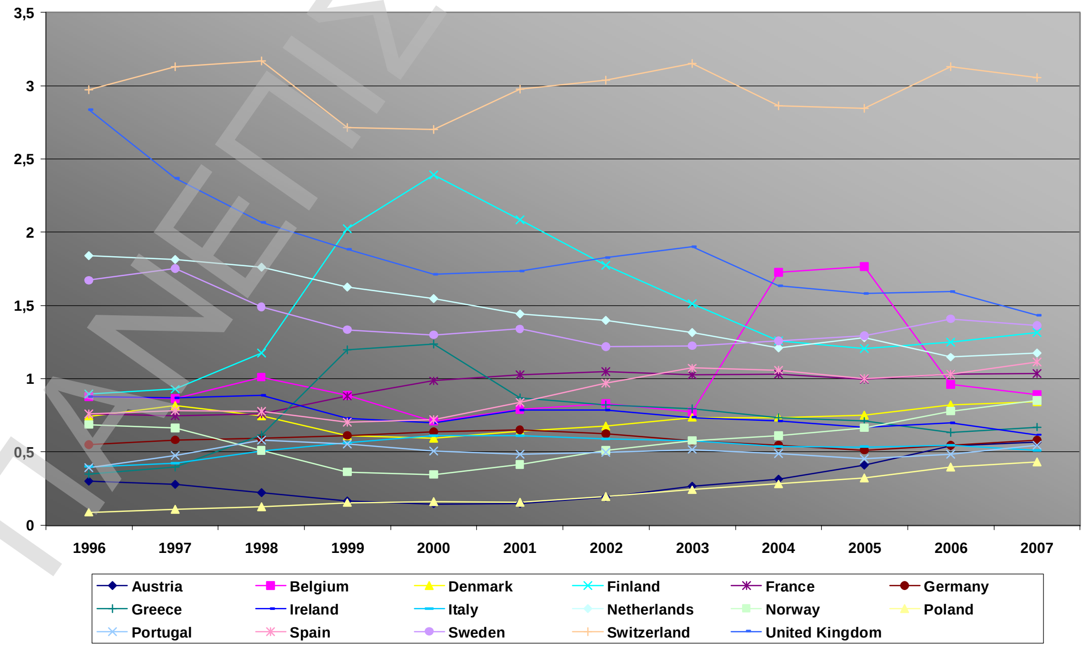


Figure 12 plots the relative transition curves of the formed groups indicated in Table 7 above. We can observe that only Group 1 is above the cross sectional average while Group 2 & 4 are below average and Group 3 fluctuates around unity. Moreover, the variation of these curves is considerably low and they seem to move towards a common path as time passes.

Figure 12 Relative Transition Curves – Stock Market Capitalization (Groups)

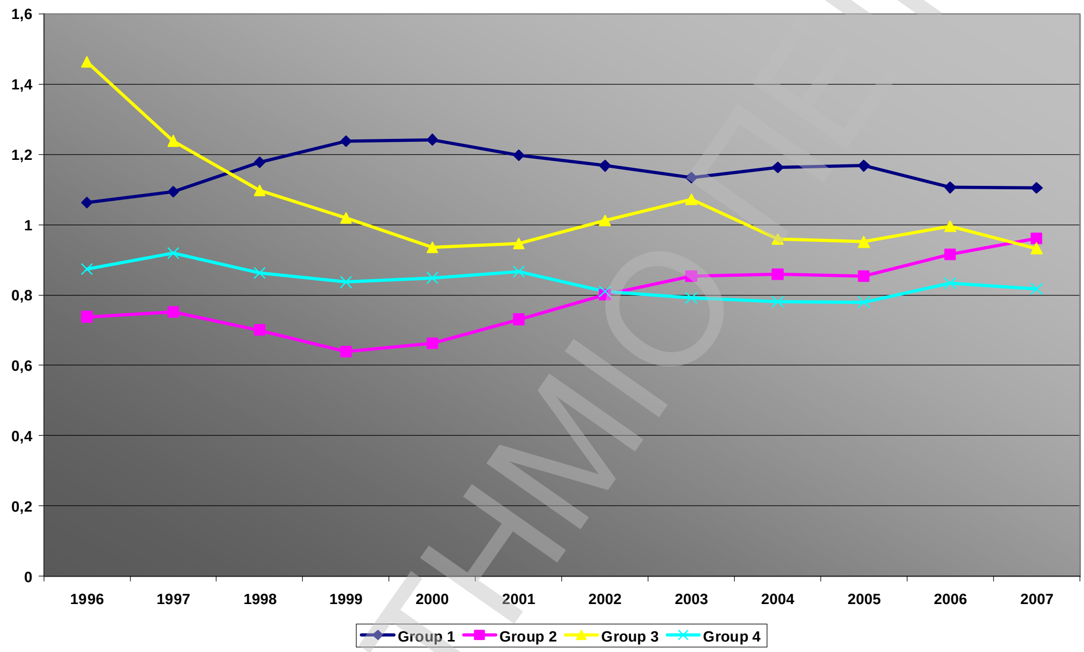


Table 8 reports the results for convergence in stock market capitalization, like Table 7, with the difference that in this case a larger fraction of data is discarded. Clearly the null hypothesis of full convergence is rejected at the 5% level for the period under investigation. The point estimate of b is -1,716 (t statistic: -8,665). The results of club convergence test in Case 2 indicate the presence of 3 convergent clubs. The point estimate of b for the first club is -0,011 (t statistic: -0,055), for the second club 0,349 (t statistic: 0,454) and for the third club -0,073 (t statistic: -0,105).

Table 8 Stock Market Capitalization

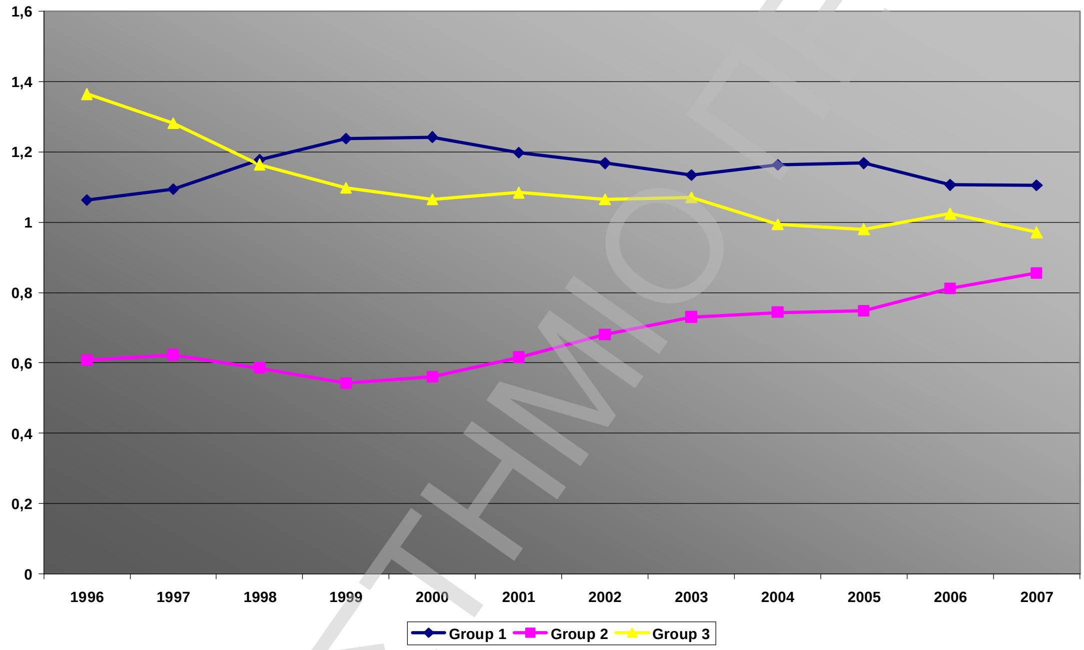
Case 1: Full Convergence Test		
Period	**Countries**	**b**
1996 - 2007	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	-1,716 (-8,665)*

Case 2: Club Convergence Test		
Period	**Group Membership**	**b**
1996 - 2007	**Group 1** Austria, Belgium, Finland, Greece, Ireland, Netherlands, Portugal, Switzerland	-0,011 (-0,055)
	Group 2 Denmark, France, Norway, Poland, Spain	0,349 (0,454)
	Group 3 Germany, Italy, Sweden, United Kingdom	-0,073 (-0,105)

Notes:
1. t statistic in parenthesis
2. An asterisk (*) indicates rejection of the null hypothesis of convergence at 5% level.
3. $r = 0.2$
4. Source: http://go.worldbank.org/X23UD9QUX0

Figure 13 plots the relative transition curves for the groups of Table 8. Group 1 consists of the same countries like in Table 7. The difference is that United Kingdom joint Group 4 and Poland Group 2 of the previous table. We can observe that Groups 1 & 3 move above the cross sectional average while Group 2 moves below this average and its distance from the other to 2 groups is obviously bigger at the beginning of the estimated period but as the time passes this gap vanishes and catches up the rest groups.

Figure 13 Relative Transition Curves – Stock Market Capitalization (Groups)



Private Credit

Table 9 reports the results for the case of private credit. It is apparent that the null hypothesis of convergence is rejected at the 5% level for the period under investigation. The point estimate of b is -0,768 (t statistic: -3,225). However the results in Case 2 suggest the existence of club convergence behavior. More specifically, 2 convergent groups are reported: Group 1 with point estimate of b -0,321 (t statistic: -1,502) and Group 2 with point estimate of b -0,187 (t statistic: -0,523).

Table 9 Private Credit

Case 1: Full Convergence Test		
Period	**Countries**	**b**
1981 - 2006	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	-0,768 (-3,225)*

Case 2: Club Convergence Test		
Period	**Group Membership**	**b**
1981 - 2006	**Group 1** Belgium, Denmark, Germany, Ireland, Netherlands, Norway, Spain, Switzerland, United Kingdom	-0,321 (-1,502)
	Group 2 Austria, Finland, France, Greece, Italy, Poland, Portugal, Sweden	-0,187 (-0,523)

Notes:
1. t statistic in parenthesis
2. An asterisk (*) indicates rejection of the null hypothesis of convergence at 5% level.
3. $r = 0.1$
4. Source: http://go.worldbank.org/X23UD9QUX0

Figure 14 presents the initial series of this variable before their transformation in to relative transition curves. Netherlands's line is extra volatile from 1994 to 1999.

Figure 14 Private Credit (Initial Series)

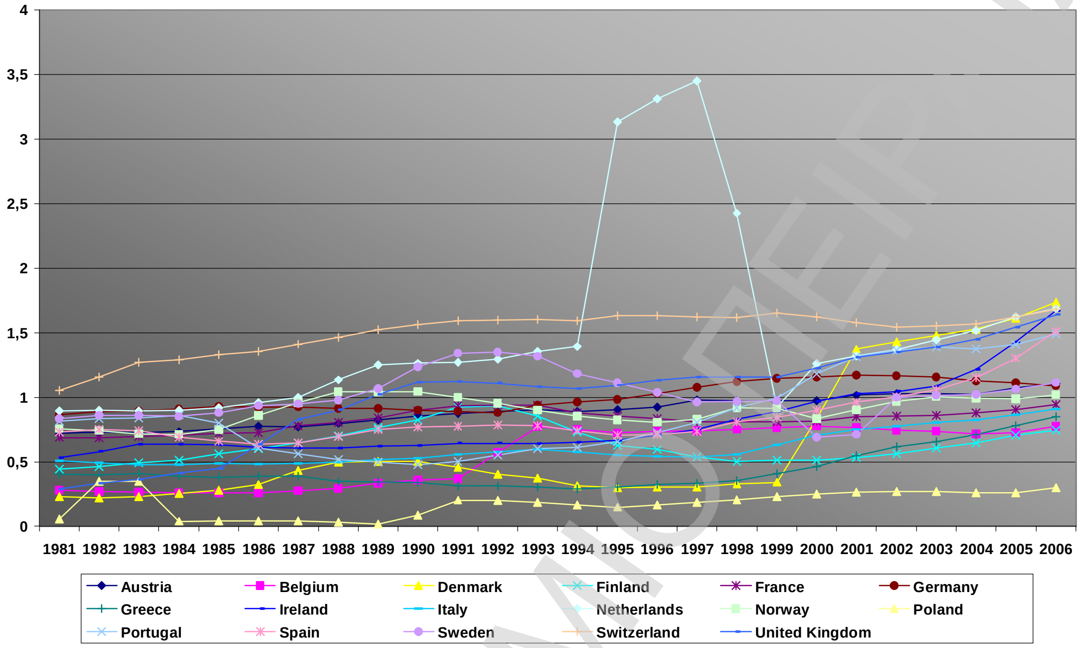
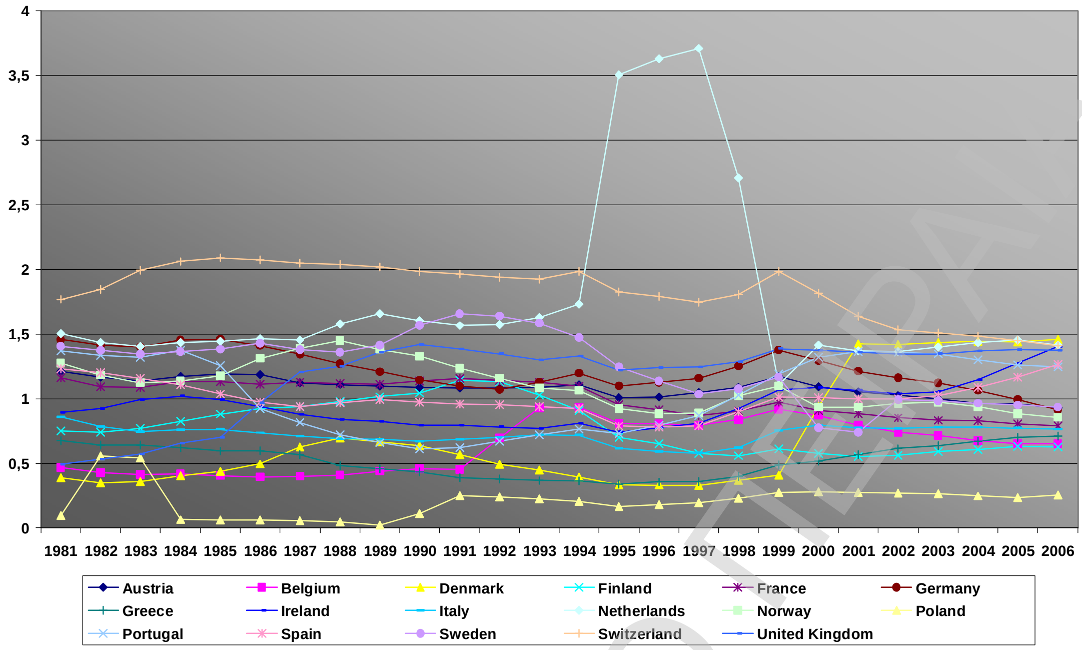


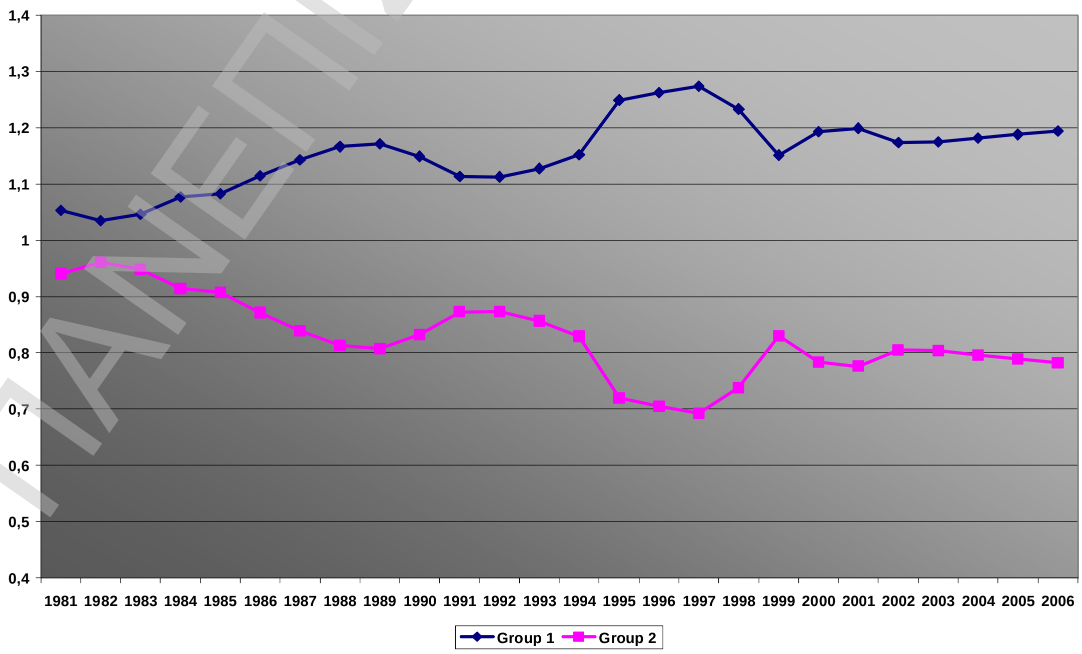
Figure 15 represents all the relative transition curves for private credit. We can observe that actually the case of full convergence does not exist and that some countries are above the cross sectional average, while other countries stand below of this average. Moreover, the distance between these curves does not seem to change over time, except for the case of Netherlands for the period 1994-1999, concluding that the cross sectional variation is extremely low.

Figure 15 Relative Transition Curves – Private Credit (Individuals)



From Figure 16 we can observe that the relative transition curves of the groups aforementioned in Table 9 are opposite. Group 1 is above the cross sectional average in contrast with Group 2 and the club variation can be considered high considering the distance between these two transition curves.

Figure 16 Relative Transition Curves – Private Credit (Groups)



In table 10 we repeat the tests that were done in the previous with the difference that a smaller fraction of the sample is used. The case for full convergence is rejected again as previously and 6 groups are found to be convergent. It is obvious that the tests reveal cross sectional heterogeneity as the number of clubs is three times bigger than previously.

Table 10 Private Credit

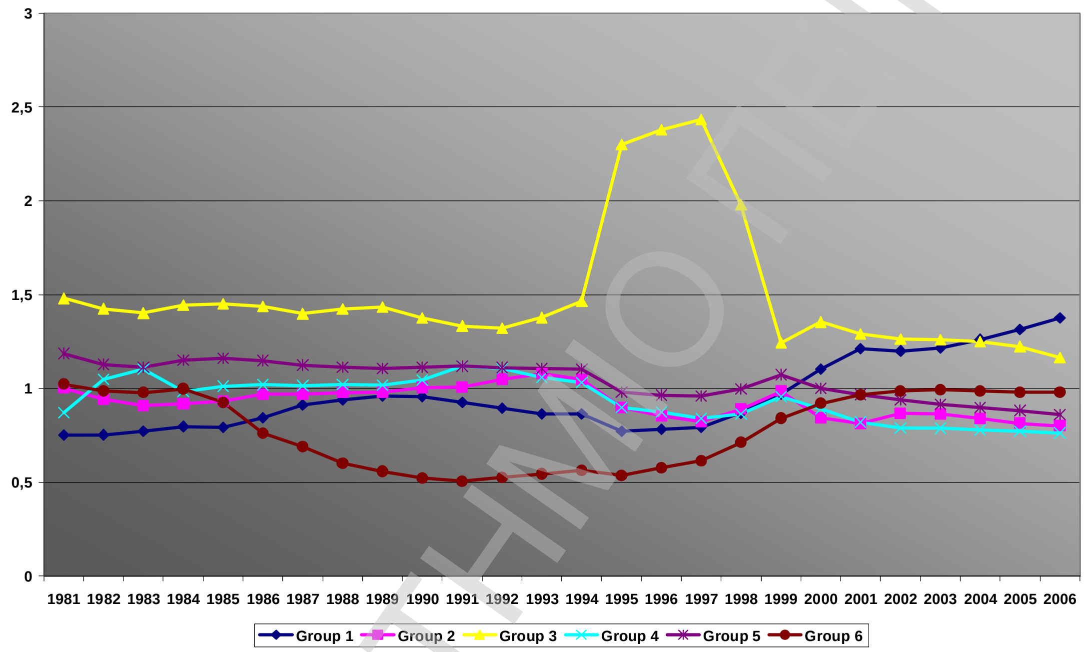
Case 1: Full Convergence Test		
Period	**Countries**	**b**
1981 - 2006	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	-0,795 (-2,502)*

Case 2: Club Convergence Test		
Period	**Group Membership**	**b**
1981 - 2006	**Group 1** Denmark, Ireland, Spain, United Kingdom	0,244 (0,339)
	Group 2 Belgium, Italy, Norway, Sweden	-0,196 (-0,268)
	Group 3 Germany, Netherlands	-1,088 (-0,827)
	Group 4 Finland, Poland, Switzerland	0,012 (0,033)
	Group 5 Austria, France	-1,110 (-0,784)
	Group 6 Greece, Portugal	-0,294 (-0,432)

Notes:
1. t statistic in parenthesis
2. An asterisk (*) indicates rejection of the null hypothesis of convergence at 5% level.
3. $r = 0.2$
4. Source: http://go.worldbank.org/X23UD9QUX0

Figure 17 plots the relative transition curves of the observed clubs. The variation seems to be low except from the period 1994-1999 where Group 3 is extremely volatile obviously affected of Netherlands's transition curve. Moreover, we can observe that after 1999 the cross sectional variation seems to be extremely low and the transition curves start to follow common paths.

Figure 17 Relative Transition Curves – Private Credit (Groups)



If we repeat the tests using a smaller fraction of the observations than before we find more complicated results. More specifically, the case of full convergence is rejected one more time and the test of club convergence reveals 3 convergent clubs and two divergent countries, Ireland and Portugal, which are not included in any group.

Table 11 Private Credit

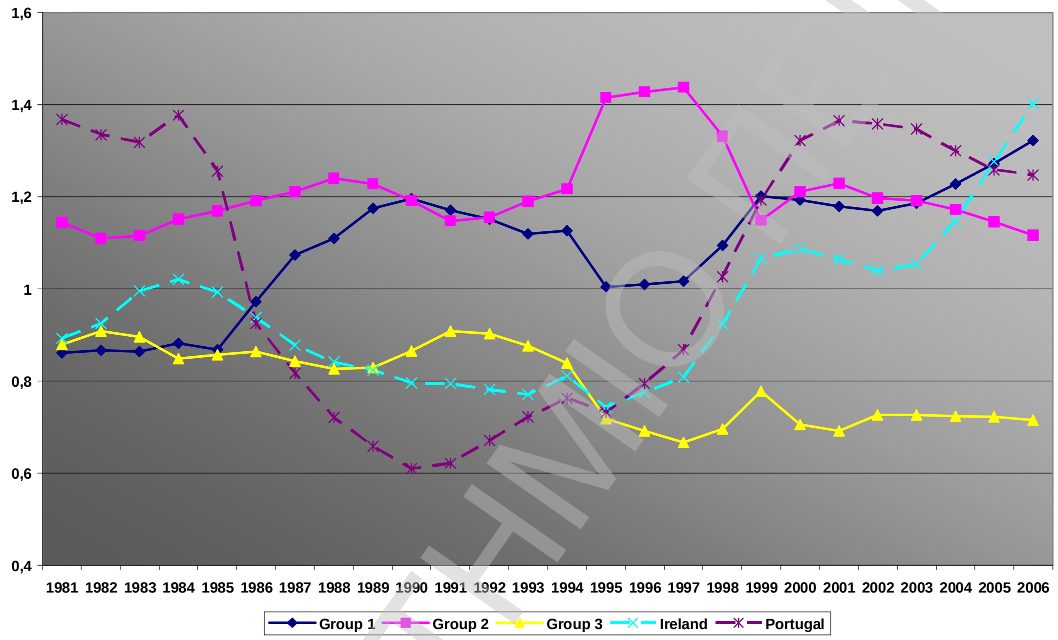
Case 1: Full Convergence Test		
Period	**Countries**	**b**
1981 - 2006	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	-1,559 (-2,872)*

Case 2: Club Convergence Test		
Period	**Group Membership**	**b**
1981 - 2006	**Group 1** Spain, United Kingdom	1,794 (-1,004)
	Group 2 Belgium, Denmark, Germany, Netherlands, Norway, Switzerland	-0,397 (-1,556)
	Group 3 Austria, Finland, France, Greece, Italy, Poland, Sweden	0,647 (1,235)
	No Convergence Ireland, Portugal	-4,068 (-2,680)*

Notes:
1. t statistic in parenthesis
2. An asterisk (*) indicates rejection of the null hypothesis of convergence at 5% level.
3. $r = 0.3$
4. Source: http://go.worldbank.org/X23UD9QUX0

Figure 18 display the relative transition curves aforementioned in the previous table along with two divergent countries. This diagram reveals extreme cross sectional variation and heterogeneity. More specifically, we observe that Group 3 has a downward slopping curve, Group 1 & 2 are above the cross sectional average and the curve of the one group is the mirror image of the other.

Figure 18 Relative Transition Curves – Private Credit (Groups)



Liquid Liabilities

Table 12 employs the analysis of the indicator liquid liabilities. In Case 1 the null hypothesis of convergence is rejected at the 5% level for the period under investigation. The point estimate of b is -1,046 (t statistic: -5,588). On the other hand, the results in Case 2 reveal club convergence behavior. More specifically, 3 convergent groups are found. Group 1 with point estimate of b -0,255 (t statistic: -0,535), Group 2 with point estimate of b -0,274 (t statistic: -0,628) and Group 3 with point estimate of b -0,487 (t statistic: -0,718).

Table 12 Liquid Liabilities

Case 1: Full Convergence Test		
Period	**Countries**	**b**
1983 - 2003	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	-1,046 (-5,588)*

Case 2: Club Convergence Test		
Period	**Group Membership**	**b**
1983 - 2003	**Group 1** Denmark, Finland, Italy, Netherlands, Switzerland	-0,255 (-0,535)
	Group 2 Belgium, Ireland, Norway, Spain, Sweden, United Kingdom	-0,274 (-0,628)
	Group 3 Austria, France, Germany, Greece, Poland, Portugal	-0,487 (-0,718)

Notes:
1. t statistic in parenthesis
2. An asterisk (*) indicates rejection of the null hypothesis of convergence at 5% level.
3. $r = 0.2$
4. Source: http://go.worldbank.org/X23UD9QUX0

Figure 19 presents the initial series of this indicator before its transformation in to relative transition curves. We can observe for one more time that Switzerland's line is above every other line while Poland's line is located at the lowest point of the graph. Moreover, Netherlands' line is extremely volatile for the period 1994-1999 just like in the case of private credit.

Figure 19 Liquid Liabilities (Initial Series)

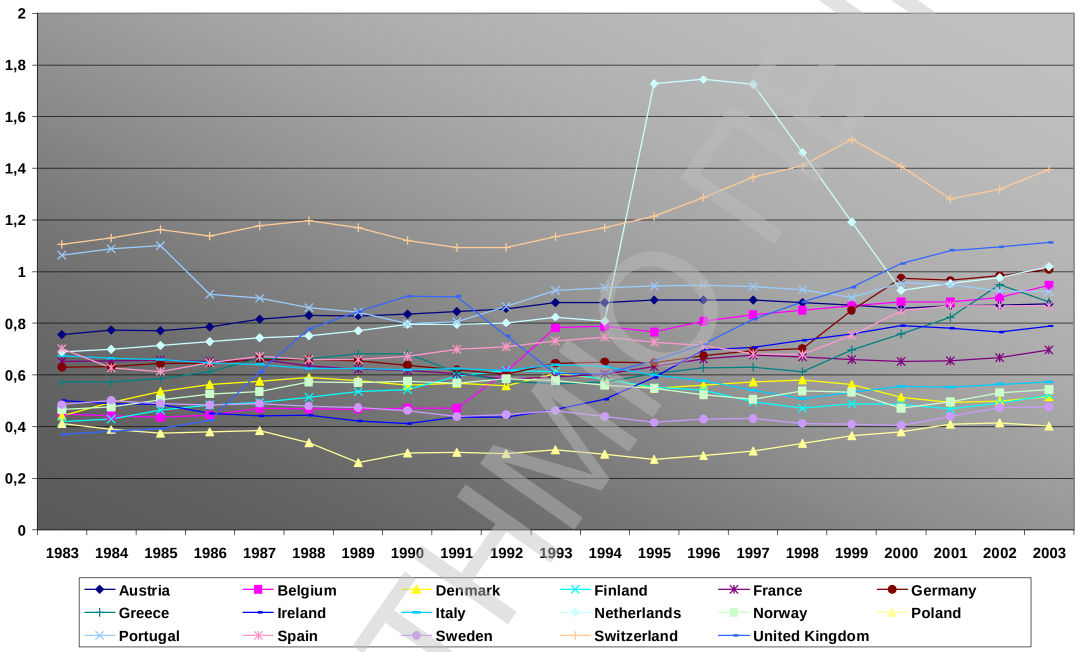


Figure 20 which presents the relative transition curves confirms the result of no convergence indicated in Table 12 above and that convergent club can possibly exist.

Figure 20 Relative Transition Curves – Liquid Liabilities (Individuals)

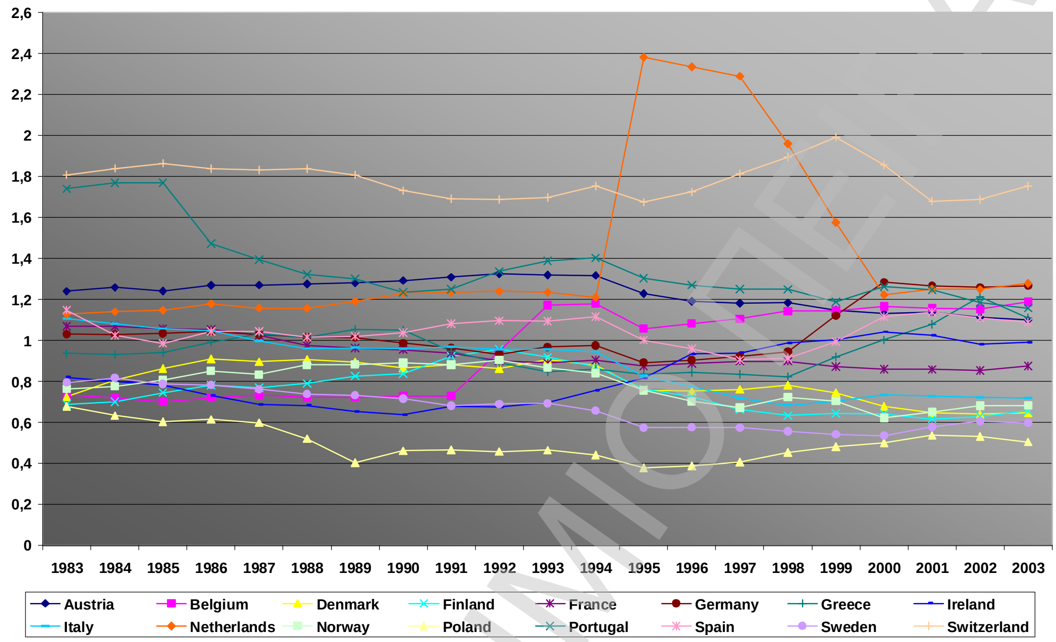
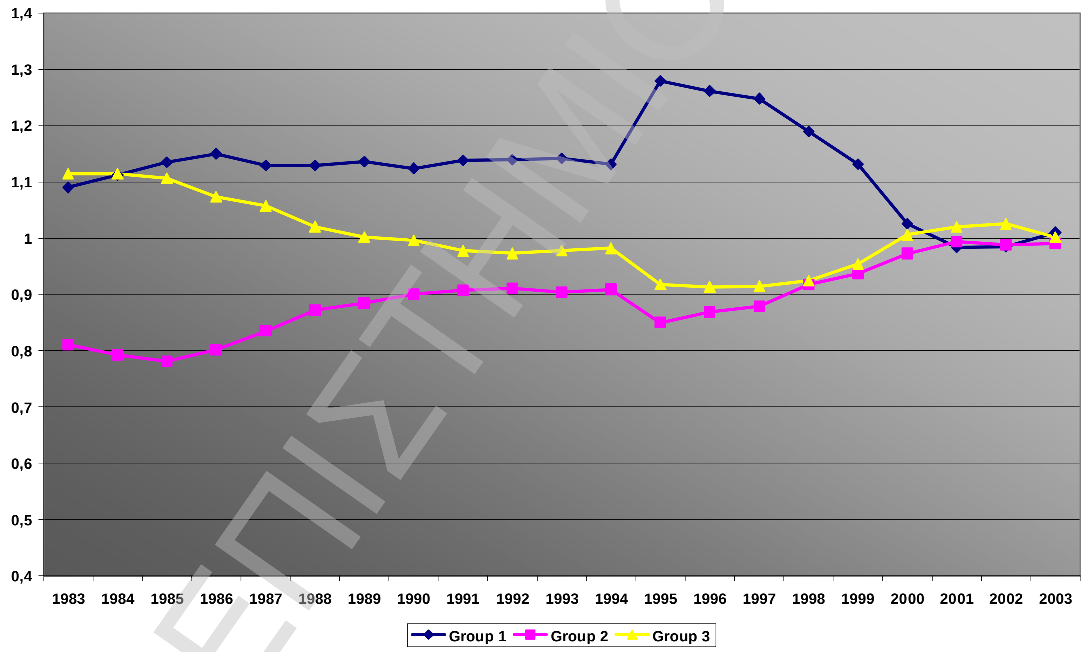


Figure 21 plots the relative transition curves for the groups indicated in Case 2 of Table 12 above. We can notice that the distance between these curves changes as we move towards the end of the sample period. More specifically at the beginning of the sample period Groups 1 & 3 seem to move together and above the cross sectional average while Group 2 presents a noticed gap with the remaining groups and moves below the cross sectional average. As time passes, we observe that Group 2 starts to catch up and move together with Group 3 while there is a noticed gap between Group 1 and Groups 2 & 3. At the end of the sample period, i.e. after 2000 the distance among the groups vanishes and they start to move together to unity indicating that convergence among these clubs may exist.

Figure 21 Relative Transition Curves – Liquid Liabilities (Groups)



By repeating the tests in Table 13 using a smaller fraction of the observations than before, we find for one more time that full convergence is rejected at 5% level with point estimate of b -1,538 (t statistic: -5,303). Moreover, the Club Convergence test indicates two convergent groups in contrast with the 3 groups of Table 12. More specifically, Group 2 and 3 became one group while Denmark and Italy drop from the first group and joined the second group.

Table 13 Liquid Liabilities

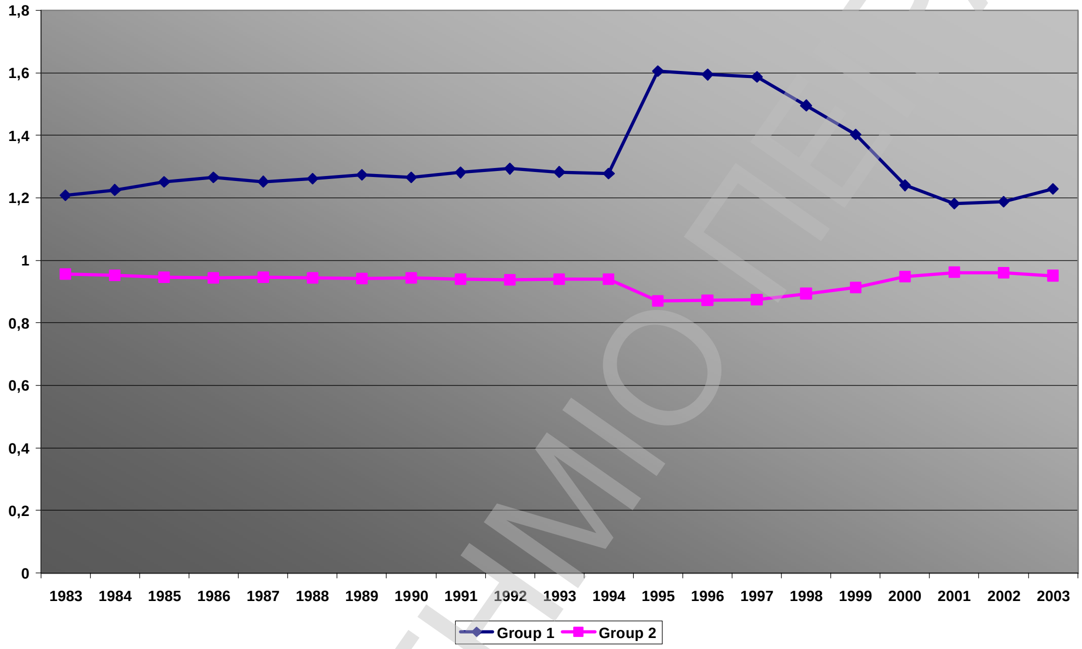
Case 1: Full Convergence Test		
Period	**Countries**	**b**
1983 - 2003	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	-1,538 (-5,303)*

Case 2: Club Convergence Test		
Period	**Group Membership**	**b**
1983 - 2003	**Group 1** Finland, Netherlands, Switzerland	0,374 (0,275)
	Group 2 Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Norway, Poland, Portugal, Spain, Sweden, United Kingdom	-0,497 (-1,241)

Notes:
1. t statistic in parenthesis
2. An asterisk (*) indicates rejection of the null hypothesis of convergence at 5% level.
3. $r = 0.3$
4. Source: http://go.worldbank.org/X23UD9QUX0

As indicated in Table 13 two convergent groups are formed with their relative transition curves plotted in the following figure. We can observe that the distance between these two curves is increased during the period 1993-1999 but it starts to vanish as time passes.

Figure 22 Relative Transition Curves – Liquid Liabilities (Groups)



Stock Market Total Value Traded

Table 14 presents the analysis of the indicator stock market total value traded. In Case 1 the null hypothesis of convergence is rejected at the 5% level for the period under investigation. The point estimate of b is -1,311 (t statistic: -5,781). The results in Case 2 reveal club convergence behavior. More specifically, 4 convergent groups are found. Group 1 with point estimate of b 0,432 (t statistic: 2,133), Group 2 with point estimate of b 0,467 (t statistic: 0,625), Group 3 with point estimate of b -1,324 (t statistic: -1,205) and Group 4 with point estimate of b -0,202 (t statistic: -0,770).

Table 14 Stock Market Total Value Traded

Case 1: Full Convergence Test		
Period	**Countries**	**b**
1994 - 2007	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	-1,311 (-5,781)*

Case 2: Club Convergence Test		
Period	**Group Membership**	**b**
1994 – 2007	**Group 1** Austria, Ireland, Norway, Spain, United Kingdom	0,432 (2,133)
	Group 2 Denmark, Finland, Italy	0,467 (0,625)
	Group 3 Portugal, Sweden	-1,324 (-1,205)
	Group 4 Belgium, France, Germany, Greece, Netherlands, Poland, Switzerland	-0,202 (-0,770)

Notes:
1. t statistic in parenthesis
2. An asterisk (*) indicates rejection of the null hypothesis of convergence at 5% level.
3. $r = 0.10$ & 0.15
4. Source: http://go.worldbank.org/X23UD9QUX0

Figure 23 depicts the initial series of the estimated indicator before their transformation in to relative transition curves.

Figure 23 Stock Market Total Value Traded (Initial Series)

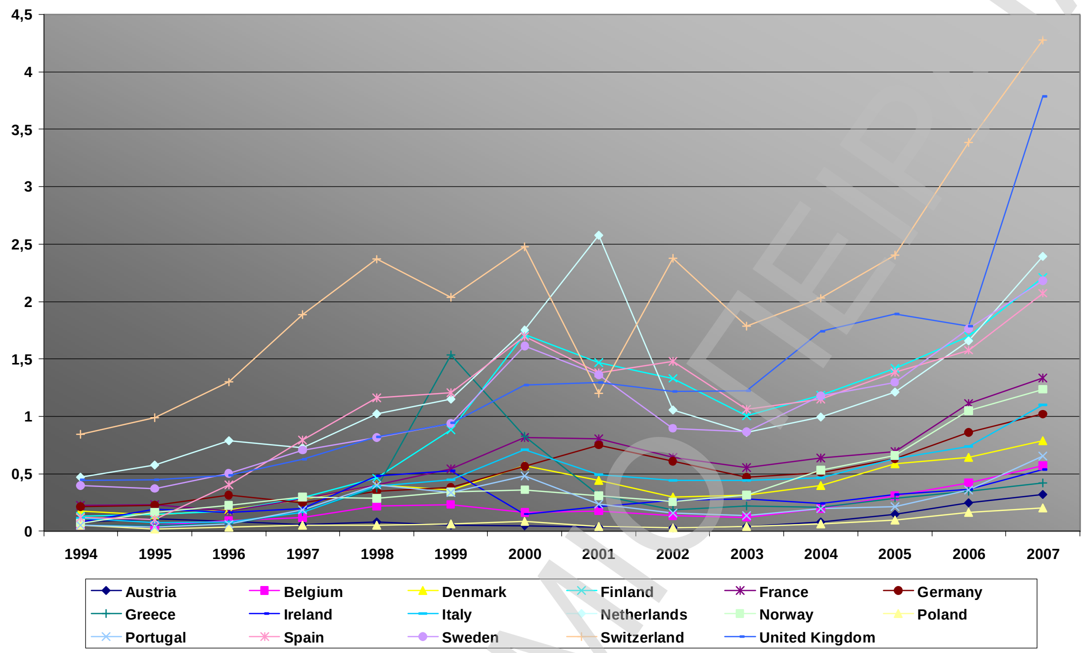


Figure 24 presents the relative transition curves for the specific indicator. The diagram verifies the results for absence of full convergence indicated in Table 14. Moreover the cross sectional variation is extremely high but we can still observe some countries' lines to move together.

Figure 24 Relative Transition Curves – Stock Market Total Value Traded (Individuals)

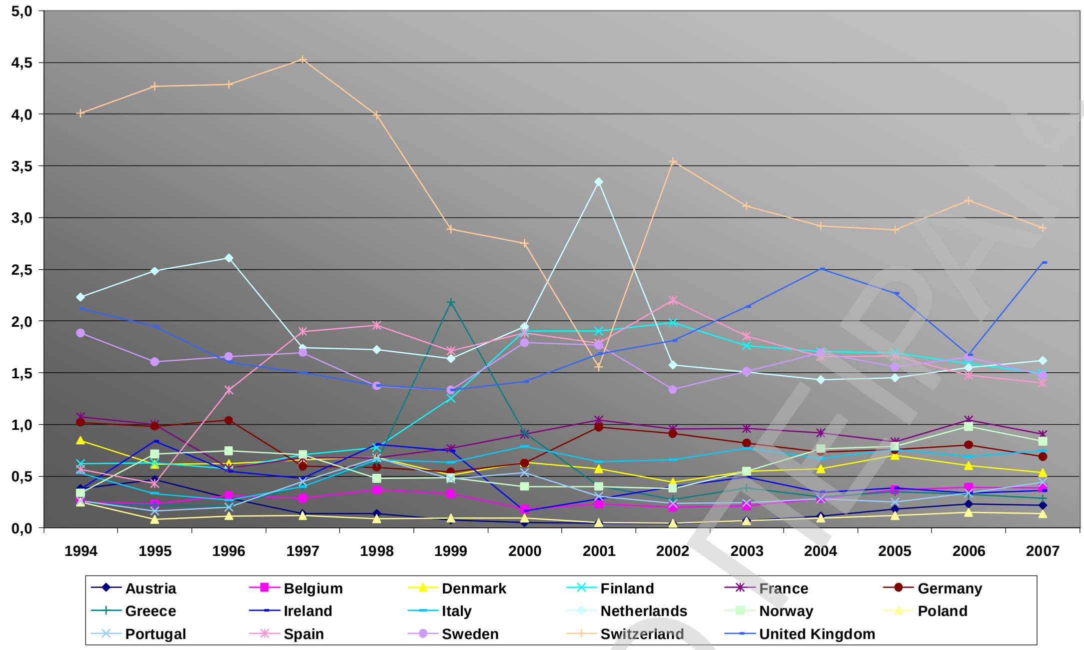
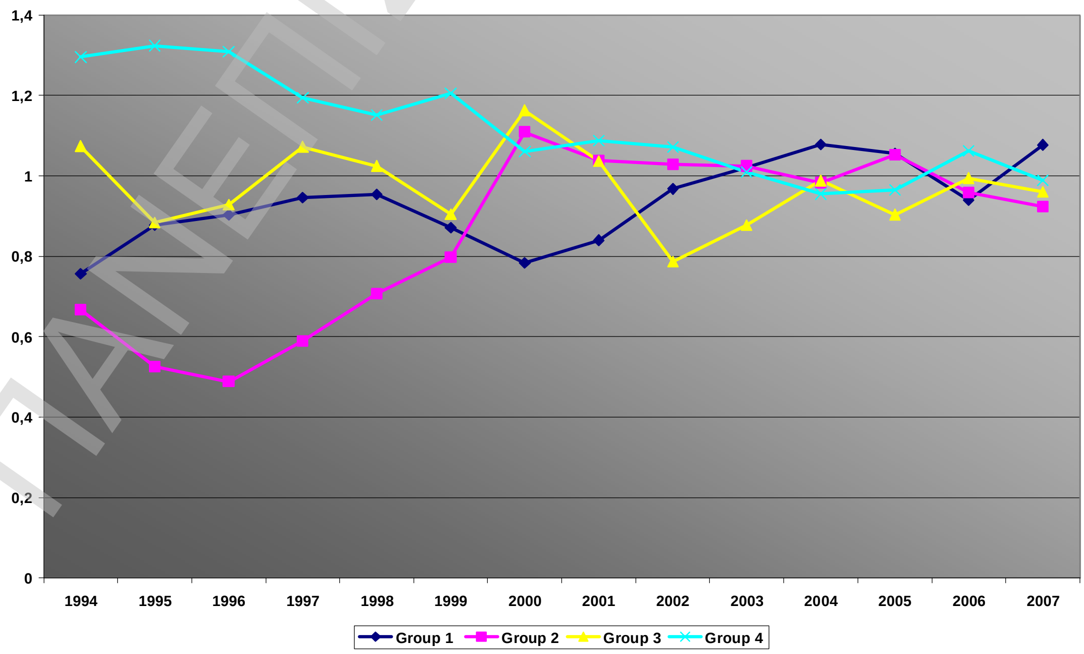


Figure 25 portrays the relative transition curves for the groups indicated in Table 14. The cross sectional variation of the groups is extremely high at the beginning of the period under investigation but as we move to more recent years their curves tend to converge to unity indicating the existence of convergence among group of countries.

Figure 25 Relative Transition Curves – Stock Market Total Value Traded (Groups)



By repeating the tests in Table 15 using a smaller fraction of the observations than before full convergence is again rejected at 5% level with point estimate of b -1,675 (t statistic: -5,651). Moreover, the Club Convergence test indicates 4 convergent groups like Table 14 but with some differences in the countries that compose each group.

Table 15 Stock Market Total Value Traded

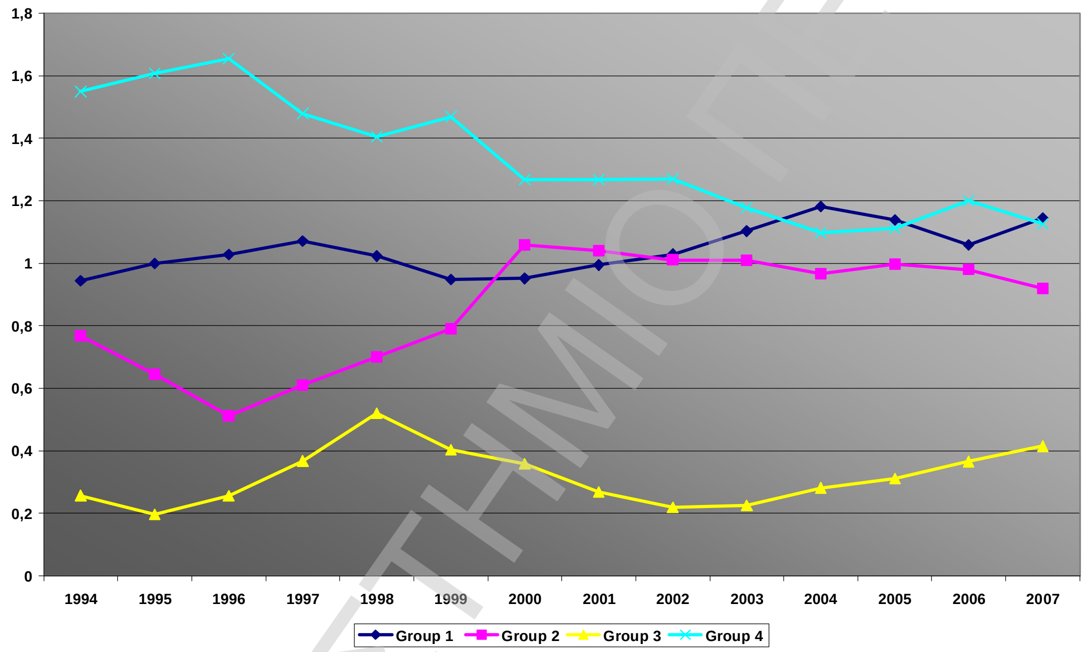
Case 1: Full Convergence Test		
Period	**Countries**	**b**
1994 - 2007	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	-1,675 (-5,651)*

Case 2: Club Convergence Test		
Period	**Group Membership**	**b**
1994 - 2007	**Group 1** Austria, Ireland, Norway, Spain, Sweden, United Kingdom	0,196 (0,681)
	Group 2 Denmark, Finland, France, Italy	-0,306 (-0,665)
	Group 3 Belgium, Portugal	-0,994 (-0,678)
	Group 4 Germany, Greece, Netherlands, Poland, Switzerland	0,446 (0,773)

Notes:
1. t statistic in parenthesis
2. An asterisk (*) indicates rejection of the null hypothesis of convergence at 5% level.
3. $r = 0.2$
4. Source: http://go.worldbank.org/X23UD9QUX0

Figure 26 displays the relative transition curves for the groups aforementioned in Table 15. The cross sectional variation of the groups is extremely high at the beginning of the sample period but starts to vanish as time passes. More specifically we observe that after the year 2000 Groups 1, 2 & 4 tend to converge while Group 3 appears to be divergent due to its gap with the other groups. However, we can still observe a tendency of the third group to catch up the others but it is still in premature levels.

Figure 26 Relative Transition Curves – Stock Market Total Value Traded (Groups)



By repeating the test and try to use a smaller fraction of observations than that of Table 15, we conclude to the following results summarised in Table 16. It is obvious that the convergent clubs are the same just like in Table 15 and for that reason the diagram for the relative transition curves of the groups is the same as Figure 26.

Table 16 Stock Market Total Value Traded

Case 1: Full Convergence Test		
Period	**Countries**	**b**
1994 - 2007	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	-2,153 (-5,809)*

Case 2: Club Convergence Test		
Period	**Group Membership**	**b**
1994 - 2007	**Group 1** Austria, Ireland, Norway, Spain, Sweden, United Kingdom	0,111 (0,306)
	Group 2 Denmark, Finland, France, Italy	-0,755 (-1,286)
	Group 3 Belgium, Portugal	-1,613 (-0,873)
	Group 4 Germany, Greece, Netherlands, Poland, Switzerland	0,286 (0,390)

Notes:
1. t statistic in parenthesis
2. An asterisk (*) indicates rejection of the null hypothesis of convergence at 5% level.
3. $r = 0.25 \; \& \; 0.30$
4. Source: http://go.worldbank.org/X23UD9QUX0

Stock Market Turnover Ratio

Table 17 presents the analysis of the indicator stock market turnover ratio. In Case 1 the null hypothesis of convergence is rejected at the 5% level for the period under investigation. The point estimate of b is -1,056 (t statistic: -7,134). The results in Case 2 are mixed. More Specifically 4 convergent groups are found: Group 1 with point estimate of b 0,732 (t statistic: 1,245), Group 2 with point estimate of b 0,696 (t statistic: 0,946), Group 3 with point estimate of b -2,766 (t statistic: 0,970) and Group 4 with point estimate of b 3,405 (t statistic: -4,114). Moreover two countries, France and Sweden were found to be divergent.

Table 17 Stock Market Turnover Ratio

Case 1: Full Convergence Test		
Period	**Countries**	**b**
1996 - 2007	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	-1,056 (-7,134)*

Case 2: Club Convergence Test		
Period	**Group Membership**	**b**
1996 - 2007	**Group 1** Belgium, Netherlands, Norway, Poland, Switzerland	0,732 (1,245)
	Group 2 Denmark, Finland, Germany, Ireland, Spain, United Kingdom	0,696 (0,946)
	Group 3 Greece, Portugal	2,766 (0,970)
	Group 4 Austria, Italy	3,405 (4,114)
	No convergence France, Sweden	-5,761 (-5,962)*

Notes:
1. t statistic in parenthesis
2. An asterisk (*) indicates rejection of the null hypothesis of convergence at 5% level.
3. $r = 0.2$
4. Source: http://go.worldbank.org/X23UD9QUX0

Figure 27 plots the initial series of the indicator under investigation before their transformation in to relative transition curves.

Figure 27 Stock Market Turnover Ratio (Initial Series)

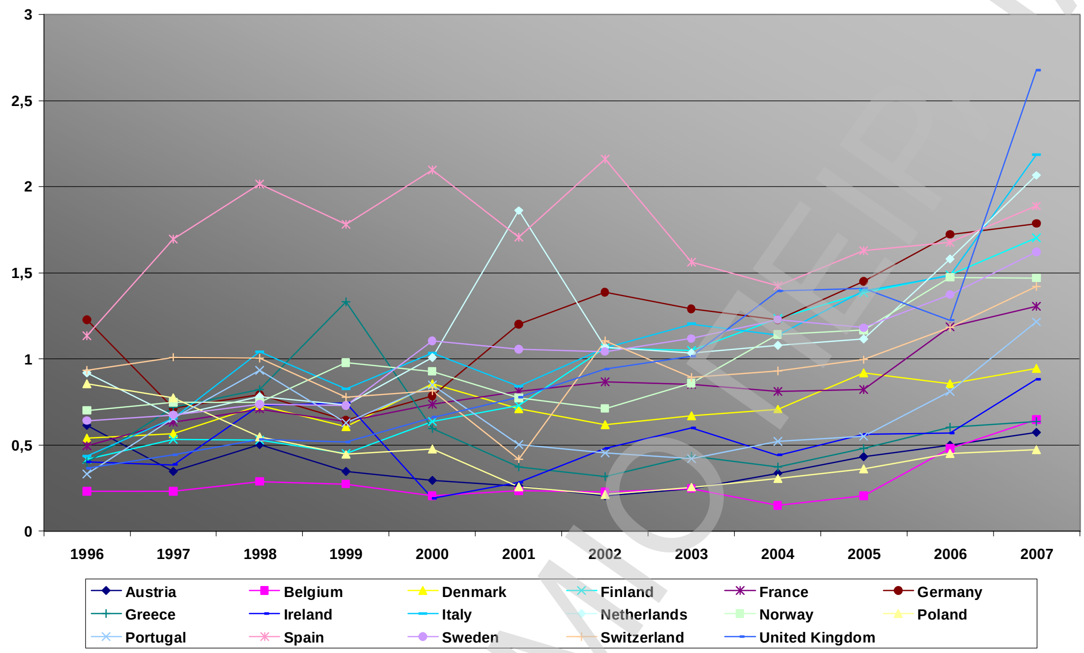


Figure 28 presents the relative transition curves of the 17 countries for the case of stock market turnover ratio. It is obvious that the cross sectional variation is high until 2004 but then the distances among these curves become more stable.

Figure 28 Relative Transition Curves – Stock Market Turnover Ratio (Individuals)

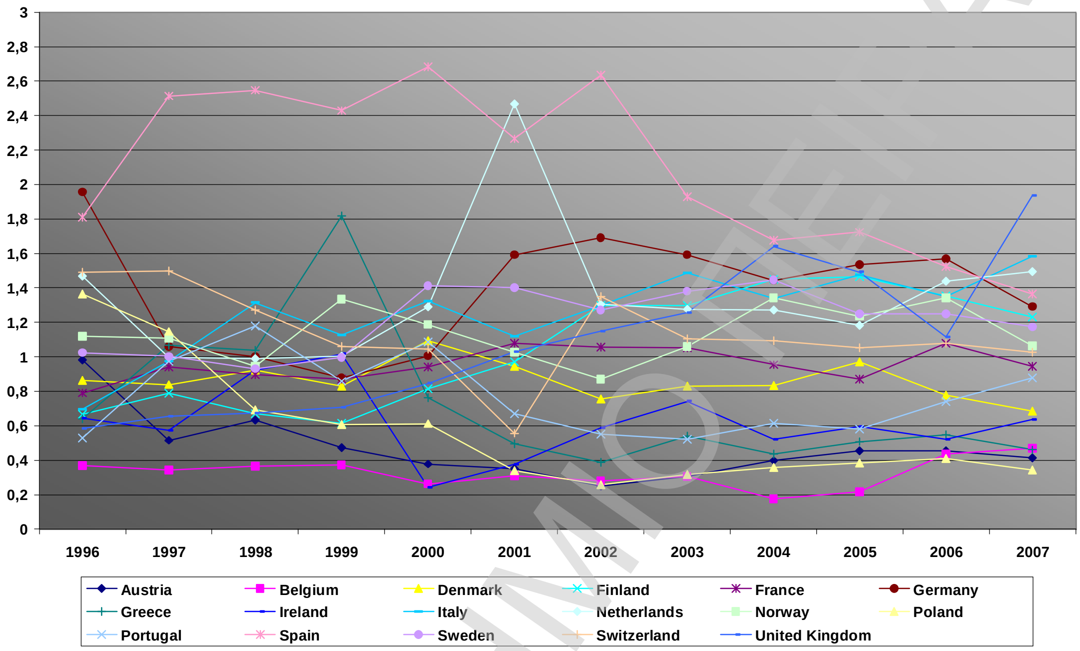
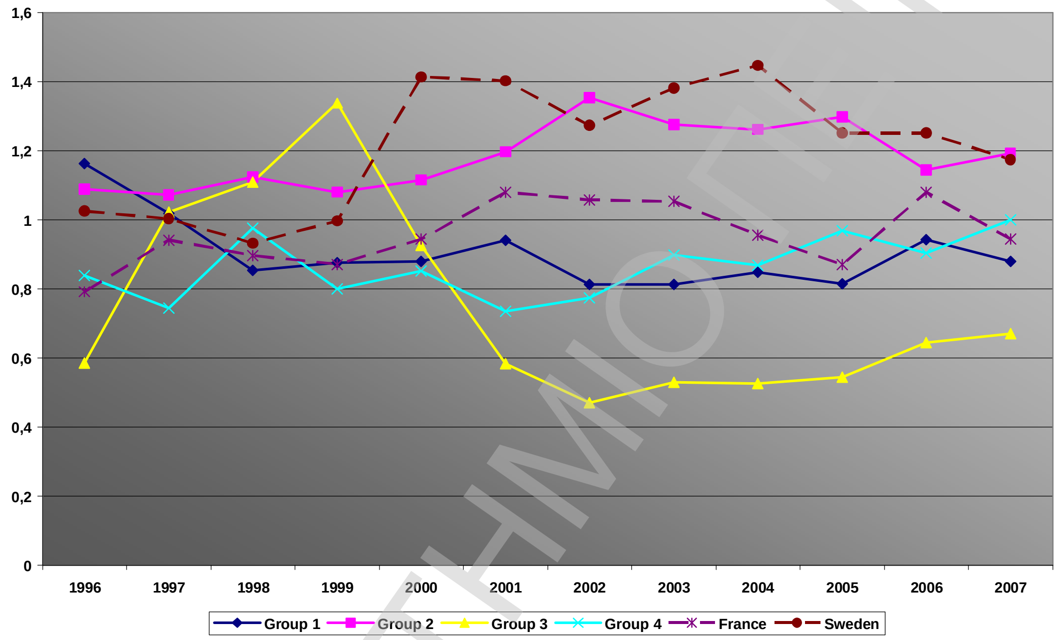


Figure 29 presents the relative transition curves indicated in Table 17. The groups are indicated with the bold lines while the divergent countries with simple lines. From the graph we can see that the cross sectional variation is high but as we move to the end of the sample period we observe that the distances among the curves of the Groups remain relatively stable and begin to move towards the same direction.

Figure 29 Relative Transition Curves – Stock Market Turnover Ratio (Groups)



If we repeat the procedure by abstracting more of the first observations than before we conclude again to reject the null hypothesis of full convergence at 5% level and to reform 3 Groups while three countries are found to be convergent. More specifically, we observe that the first group of the previous table is now enlarged with two more countries, Denmark and Spain. Moreover Greece and Portugal which created a group of two countries that converge is included at the second group in Table 18. Last but not least 3 divergent countries are observed in contrast with two indicated in the previous table.

Table 18 Stock Market Turnover Ratio

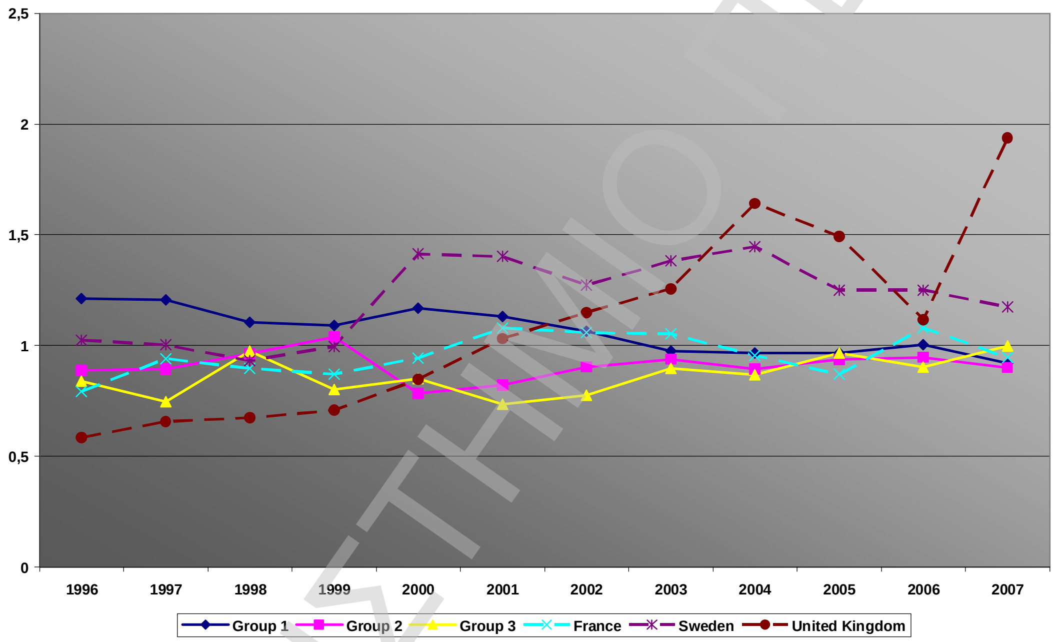
Case 1: Full Convergence Test		
Period	**Countries**	**b**
1996 - 2007	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom	-0,949 (-5,055)*

Case 2: Club Convergence Test		
Period	**Group Membership**	**b**
1996 - 2007	**Group 1** Belgium, Denmark, Netherlands, Norway, Poland, Spain, Switzerland	1,459 (2,093)
	Group 2 Finland, Germany, Greece, Ireland, Portugal	2,089 (2,185)
	Group 3 Austria, Italy	3,858 (3,495)
	No convergence France, Sweden, United Kingdom	-4,731 (-9,261)*

Notes:
1. t statistic in parenthesis
2. An asterisk (*) indicates rejection of the null hypothesis of convergence at 5% level.
3. $r = 0.3$
4. Source: http://go.worldbank.org/X23UD9QUX0

Figure 30 represents the relative transition curves of the groups aforementioned in the previous table. It is obvious from the figure below that the 3 convergent groups move closely. At the beginning of the sample period the cross sectional variation of the clubs is high but as the time passes their curves tend to converge to unity indicating the existence of convergence among groups. Moreover France, identified from the club convergence algorithm as a divergent country, moves very close to unity indicating the average country for stock market turnover ratio.

Figure 30 Relative Transition Curves – Stock Market Turnover Ratio (Groups)



7. Concluding Remarks

This study investigated the existence of economic convergence in price indexes, in volatility of price indexes and in financial development indicators and examined whether stock market development indicators could explain convergent or divergent phenomena in stock markets.

The research is based on a new panel convergence methodology developed by Phillips and Sul (2007b) that uses a non linear factor model with a common and idiosyncratic component (both time varying). Moreover, it incorporates the possibility of transitional heterogeneity and groups the sample countries into convergent clubs by using a stepwise algorithm. This methodology was used in price indexes from Datastream database and in a set of financial development indicators from World Bank's Financial Development and Structure Database.

The empirical findings suggest that the 17 European Countries exhibit full convergence in prices and in volatility but not in the case of financial development indicators where the results appeared to be mixed. More specifically, full convergence hypothesis was accepted for the case of price indexes and the relative transition curves indicated that the cross sectional variation was reduced at the end of the sample period. The measures used for volatility (absolute returns and squared returns), both resulted in the acceptance of full convergence hypothesis. The diagram of their transition curves revealed that the cross sectional variation was actually reduced and that the curves tented to move towards the same path.

On the other hand, all financial development indicators rejected the hypothesis of full convergence. For each indicator different countries were identified both in terms of their numbers and their synthesis. However, in most cases the relative transition curves of the groups revealed a reduction of their cross sectional variation and a tendency to follow a common course.

Overall, financial development indicators could not interpret the convergence in price indexes. This means that are other economic factors could explain stock markets' behavior such as inflation, interest rates, oil/energy prices, etc. Concluding, this study can be developed by examining other economic factors in order to understand the convergent behavior revealed in stock markets.

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