Is There Evidence of Real Economic Convergence in the European Union Before and Following the Financial Crisis of 2008?

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Economic convergence enhances the effectiveness of policy, increases resistance to asymmetric shocks, and encourages greater levels of economic prosperity and macroeconomic equality. With regards to the European Union (EU), whilst literature confirms pre-crisis convergence, works on post-crisis Europe has fallen victim to short time-samples, and incomplete data sets due to the omission of newer members of the Union. This paper calculates up to date regressions using a fixed-effects model, and measures dispersion using coefficients of variation to test for β and σ-convergence for real Gross Domestic Product (GDP) and Unemployment. In conclusion, this paper finds statistically significant evidence of β-convergence for pre-crisis Europe (1995-2008) and the entire period considered (1995-2014) for both real GDP and unemployment rates, but no evidence of post-crisis (2009-2014) convergence for either. Pre-crisis σ-convergence tends downwards for real GDP, though this is largely driven by rapid falls in dispersion across the EU-13, as the EU-15 experiences gradual divergence almost constantly. Unemployment rates converged between 2000 and 2007, but have sharply diverged following the crisis, spelling fears of hysteresis and permanent damage to the labour market.

1. Introduction

Economic convergence is a topic that has been the subject of much debate in recent years, with particular attention being paid to the nature of convergence within the European Union (EU). With the Treaty of Maastricht marking the formal beginning of what we now know as the EU, numerous macroeconomic controls and legislative reform came about, which intended to usher in a new era of economic synchronisation across Europe.

It is asked though, why is it important that convergence within such a collective is achieved? First, convergence is important for improving economic prosperity for poorer countries. By lifting them out of a state of low income and stagnation, not only will this improve national income and contribute towards economic development, it will have a knock-on effect on the efficiency enhancing properties of the single market, and the ease with which labour and investment can move across borders (Baldwin and Wyplosz, 2012). Convergence is also important for the efficient functioning of EU directive. Having economies be more similar in their macroeconomic makeup means fiscal directive, labour market legislation and, for Eurozone economies, monetary policy will be more universally applicable. This in turn will contribute to greater stability continent wide. By implication, the union will then be better suited to deal with asymmetric macroeconomic shocks (Heylen and Van Poeck, 1995).

Existing empirical works on convergence suggest a degree of confluence in the past, but recent studies lack consensus, particularly with regards to the post-crisis period. Given the importance of convergence to EU policy making and general macroeconomic stability, clarity is required on the topic. Hence, the purpose of this paper is to establish whether real convergence was achieved prior to and following the economic crisis of 2008, in terms of Gross Domestic Product (GDP), and also for labour markets.

This dissertation is structured as follows. Section 2 discusses the varying techniques used in existing literature when testing for convergence, and critically analyses past results. Section 3, the theoretical grounding for a study on convergence is covered, and the development of convergence theory over time with respect to real GDP is outlined, as well as the potential drivers of labour market convergence. In section 4, the chapter is divided into two sub-sections, covering the models used for testing the hypotheses of convergence of real GDP, and unemployment rates. The selected models are justified, and the economic variables and time period chosen are substantiated with reference to

existing literature. In section 5, data sourced from Eurostat, the World Bank, and the Penn World Table is used to test for β and σ-convergence, using a fixed effects model and coefficients of variation respectively. The results are analysed, and potential explanations for the observations are considered. In section 6, this paper will discuss the limitations of the study, and make recommendations for future literature also aiming to assess the topic of convergence. This is followed by final conclusions in section 7.

In summary, statistically significant evidence of β-convergence is found for both GDP per capita and unemployment rates between 1995 and 2014, and between 1995 and 2008. This paper does not find evidence of convergence in the post-crisis period for either variable, which is in line both with this paper's expectations based on economic theory, and existing empirical literature. This paper finds evidence of σ-convergence consistently across the entire period considered in terms of GDP per capita, though this is largely due to high levels of convergence for the EU-13[1]. Unemployment convergence is less general in its movement, with convergence detected prior to the 2008 recession but strong divergence following this, suggesting the failure of EU labour market legislation, and the lasting damage of the financial crisis.

[1] Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia

2. Literature Review

2.1. GDP Convergence in Existing Literature

Existing studies opt for two key methods of describing convergence. β-convergence, pioneered by economists Barro and Sala-i-Martin (1992), is defined as the catching up of poorer economies to wealthier ones, and is the preferred measurement of economic convergence for many studies. Work by Quah (1996) however, asserted that a negative relationship between growth and initial levels of output did not necessarily suggest a reduction in the dispersion of incomes across countries in the same sample. Hence, economists also consider dispersion of GDP over time, or σ-convergence, for which β-convergence is a necessary but not sufficient condition (Young *et al*, 2008).

Empirical works on convergence have focused on two different econometric techniques for analysing convergent behaviour: time series models and panel analysis. Multivariate time series models for calculating β-convergence, such as those seen in the writings on post-war Europe by Carvalho and Harvey (2005), were historically favoured, particularly over longer time horizons. The work of Carvalho and Harvey concluded that there was indeed economic convergence present, in the form of two distinct converging clusters: One composed of the richer core economies of Europe, and another containing the poorer, periphery economies. Similar work by Koukouritakis and Michelis (2006) using cointegration and common trend analysis also found evidence of GDP convergence across France, Germany and the 10 ascension countries of 2004[2]. Finally, recent work completed by the Bundesbank investigated long-run convergence patterns between 1970 and 2010 for the EU-27, using unit root testing methods. Their conclusions found no evidence of convergence for the EU overall, but similar to Carvalho and Harvey did find convergence of individual clusters within the EU (Borsi and Metiu, 2015).

Critically, time series models run a higher risk of multicollinearity than panel analysis, and critics argue that analysis of time series data often fails to explain *why* certain trends have happened, and rather just state *what* has happened (Wooldridge, 2002; Kmenta, 2015). Equally though, panel analysis, whilst able to control for country and time specific effects, often suffers from a lack of data for countries still in a state of infancy, which in turn leads to unbalanced panels. Despite this, many articles tend to favour panel analysis, such as the work by Crespo Cuaresma *et al* (2008). In their study of the EU-15[3], they found statistically significant evidence of both σ-convergence and β-convergence

[2] The EU-13 minus Bulgaria, Croatia, and Romania

[3] Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom

between 1961 and 1998, though critically their study is limited as their results cannot be applied directly to the ascension countries, due to profound structural differences between them and the EU-15.

Studies focused on recent years have also been supportive of convergence being present in the EU, as demonstrated by Vojinović and Próchniak (2009), and Cavenaile and Dubois (2011). The latter study considered β-convergence of GDP from 1990 to 2007 for the EU-27 using panel analysis. Their work found that not only was there statistically significant real GDP convergence across *all* countries, but also across the two clusters within the sample of the EU-12 and the EU-15. Their analysis however, fails to incorporate important events such as the economic crisis of 2008, and provides no breakdown and analysis of specific sections of the time frame considered, which may result in assertions that are only true for a portion of the period considered.

Unlike Cavenaile and Dubois (2011), the work by Hájek *et al* (2016) analysed shorter time periods within the overall period of 1995 to 2012, and found that σ-convergence was indeed present from 1995 to 2012 for all current 27 EU member states. However, β-convergence was only identifiable in a strong period of convergence in the early 2000s. This was arguably in part due to the ascension to the EU of the 10 Central and Eastern European (CEEC) nations that joined in 2004[4]. The acceleration in convergence acted to offset the absence of convergence following the crisis, and between 1995 and 2000.

Not all literature is supportive of convergence in later years, however. Dvoroková (2014) found no evidence of σ-convergence for the EU-28 between 2001 and 2012, though critically these results are arguably un-robust, not incorporating country-specific effects in their regression, as well as a failure to account for heteroskedasticity in error terms. A recent journal published by the European Central Bank (Zentralbank, 2015) suggested that whilst some degree of economic convergence has been present between 1999 and 2015, little real convergence has taken place among the core European economies in recent years. Since 1999 there is even evidence of divergence in GDP, denoted by maintained and even increasing income gaps with respect to average GDP.

From existing papers, therefore, one can see that conflicting evidence on convergence exists, and given the importance of convergence as goal for the EU, the need for clarity on the subject is patent.

[4] Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia.

2.2. Unemployment Convergence in Existing Literature

Contrary to literature on GDP convergence, early work on unemployment convergence was predominantly negative, with most studies concluding on the presence of statistically significant divergence. Heylen and Van Poeck (1995) were early authors on unemployment convergence in Europe, and found evidence of σ-divergence between 1979 and 1993 using coefficients of variation (CV). Similarly, Saint-Paul (2004) reported divergence for the EU-15 (minus Luxembourg but including Norway) from 1980 to 2004. Nickell (2003) accredits the divergence found in historical literature to increased taxes on labour, and sharp increases in unemployment benefits, leading to high unemployment for some countries, but effective wage moderation mechanisms leading to low unemployment rates for others. Castro and Soukiazis (2005) found that overall σ-convergence had declined between 1970 and 1983, but between 1983 and 1988 had increased again. Unemployment rate disparity then decreased yearly until 1996, after which it began increasing again. They also included work on β-convergence, using panel analysis with explanatory variables based on the Maastricht Criteria; their results found between 1980 and 2001 a statistically significant convergence of unemployment rates in Europe.

Perugini and Signorelli (2004; 2007) observed evidence of labour market convergence in two separate studies, first noting the existence of both σ-convergence and β-convergence between 1997 and 2003 for Eurozone economies, then β-convergence between 1997 and 2006 for the EU-15 for multiple labour market variables. Boeri and Garibaldi (2009) also found strong evidence of declining unemployment across the EU-15 between 1995 and 2007, and a reduction in regional and inter-country disparities leading to persistent convergence across the time considered. Both σ-convergence and a basic β-convergence model are considered, the latter an OLS estimate regressing changes in unemployment rates over the period onto initial rates of unemployment.

Similarly, recent work on convergence by Marelli and Signorelli (2010) noted σ-convergence for EU members following the Maastricht Treaty in 1992. However, they also noted persistent levels of unemployment disparity for newer members, in addition to some short-run fluctuations in recent years. Their results show β-convergence of unemployment was significant at the 1% level in Europe pre-crisis, but following 2008, strong divergence had offset any convergence experienced prior. Marelli and Signorelli argue that the existence of the single currency had acted to dampen the overall impact of the crisis, but the lack of effective governance and flexibility in macroeconomic policy response had led to permanent increases in structural unemployment. Recent work by Estrada *et al* (2013) also found strong evidence of convergence in unemployment rates in Europe between 1999

and 2007, though again found that the crisis of 2008 had substantially reduced the level of convergence present and undone much of the pre-crisis progress that had been made.

3. The Theory of Convergence

3.1. Gross Domestic Product

Existing theory on economic convergence is now considered, and used in tandem with existing empirical literature to make predictions of this paper's results.

The foundations of convergence theory lie in the work of Solow (1956), and his seminal Neo-Classical Growth Model, which postulated that in the long run all economies will converge to a "steady state" of economic growth. However, this model faced scathing criticism, primarily due to its numerous flawed assumptions. Firstly, the model hypothesises the existence of homogenous production functions, though in reality countries will have their own production functions, and their own individual growth horizons due to structural heterogeneities. Secondly, the model assumes perfect factor mobility, which in reality is determined by many non-economic factors such as political turmoil, personal tastes, and social barriers (Islam, 2003). It also assumes the free movement of technology across borders and thus an overall state of technological homogeneity, which is not accurate either. Contemporary research has developed growth models that emphasise the importance of technological heterogeneity, and how the path taken to long-run convergence is dependent on country-specific technological growth patterns (Howitt and Mayer-Foulkes, 2005). Finally, the model asserts unconditionally the existence of diminishing marginal returns, which was challenged by Romer (1990) as his own growth model predicted increasing marginal gains even for richer countries, due to the externality effects of research and development expenditure.

In response to these flaws, New Growth Models have come to the fore in an attempt to develop on the work of Solow, relaxing some of the assumptions discussed above. These models have postulated that common characteristics across countries may lead to "clubs" of economic growth, with groups of countries converging to common equilibria, based on cultural, institutional, and geographical factors (Desdoigts, 1999). Relating this to the EU, the single market guarantees free movement of labour, capital, goods, and services. Given the fluid nature of economic transactions, and high levels of social integration as a result of the Treaty of Maastricht, this paper postulates there is a high likelihood of economic convergence clusters within the EU. This will be characterised by sub-groups demonstrating σ-convergence, and by requirement the presence of β-convergence overall.

However, in post-crisis Europe, the asymmetric nature of the crash means different economies will be subject to varying levels of macroeconomic distress. The damage to economic institutions and

investment confidence, particularly in smaller countries, will likely have led to falls in foreign direct investment flows and capital movement, which in turn will reduce productivity and growth (Zentralbank, 2015). Small economies may also suffer at the hands of tight fiscal constraints imposed by the EU Stability and Growth Pact, as predicted by Buiter (1992) in his scathing critique of EU fiscal criteria. Additionally, the fact that budget deficits are themselves required to be proportionate to GDP, implies cyclical growth patterns will be exacerbated, thus making booms bigger and slumps more damaging. As a result of such ambiguity, regardless of the direction of the relationship, this paper expects statistically insignificant results for GDP convergence following the crisis.

3.2. Unemployment Rates

For unemployment convergence, the theory of its success is based on the maximisation of intra-EU labour mobility. Inflexibilities to work such as language, difficulties in finding jobs, and inadequate qualifications all act to increase frictional and structural unemployment. To encourage convergence and achieve higher levels of labour market harmonisation, theory suggests these barriers must be removed. EU labour market strategy and directive have generally been focused on reducing such barriers; through the 1990s at the centre of EU strategy was supply-side investment into vocational training and public employment services, in addition to controls on wage-setting policies (Van Rie and Marx, 2012).

In a slightly different vein, theory also suggests employment protection and generosity of unemployment benefits are strong determinants of labour flows, and hence convergence. Specifically, reducing the amount of employment protection, such as relaxing regulation of temporary contracts, is likely to lead to inward and outward movements of human capital, due to the lower costs of hiring and firing (Bentolila and Bertola, 1990). Similarly, reductions in unemployment benefits will increase the intensity and efforts with which jobs are sought after. Evidence from existing literature and data from the Organisation for Economic Co-operation and Development (OECD) suggests that employment protection has steadily been on the decline over the last two decades, though turned upwards following the crisis of 2008, whilst unemployment benefits have fluctuated but were lower in 2005 than in 1985 (Boeri and Garibaldi, 2009). Because of this, greater levels of employment mobility should in theory have been achieved up to this point, thus enabling labour market convergence. Higher levels of aggregate demand are also associated with higher levels of employment. Thus, the period of strong economic growth and investment continent-wide between 1995 and 2008 will likely also have resulted in universally lower levels of unemployment (Castro and

Soukiazis, 2005). Hence, this paper expects the presence of both β and σ-convergence prior to the financial crash.

Following the crisis however, the amount of macroeconomic turbulence created may have rendered existing policy useless, and undermined the progress created by greater market flexibility due to extreme deficiency of demand. Attempts to reinvigorate unemployment convergence following the crisis have been led by the EU in the form of new professional qualifications, supplementary pension rights, and systems to reduce frictional unemployment levels such as the pan-European job search network (Zentralbank, 2015). The presence of convergence therefore will be dependent on the effectiveness of this legislation, and country-specific labour market policy. Hence, following the crisis given a reduction of strictness of employment protection, deficiency of demand and a return to domestically focused policy, convergence again seems like an unlikely prospect.

4. Methodology

4.1. β-convergence

This paper begins the methodology section by describing the models used in the process of testing for *conditional* β-convergence, or convergence where heterogeneities exist in investment, savings, and capital growth (Islam, 2003). This paper opts for panel analysis for several reasons. Firstly, the pooling of cross-sectional and time-series data generates more observations than if these methods are used independently. This in turn creates a greater number of degrees of freedom. This is particularly important for analysis of economies that do not have freely available data, which is relevant for this study therefore, given the infancy of some economies at the beginning of the sample period. Additionally, panel data runs a lower risk of multicollinearity than time series data, and has a reduced likelihood of measurement error due to the presence of multiple data entries for each entity and each time period (Wooldridge, 2002; Hsiao, 2007).

As for the model selected, this will depend on whether country-specific effects are present, and in turn whether these effects are correlated with variable terms. Their existence can be tested for by forming a fixed effects model, using a Least Squares Dummy Variable estimator. A joint F-test is then conducted on the dummy variables which represent country-specific effects, testing the null hypothesis that they are jointly equal to zero. Calculations demonstrate a p-value of <0.01, which suggests that at the 1% significance level there are country specific effects to account for, meaning a pooled model is inappropriate, as they are unable to account for such effects.

In terms of random versus fixed-effects models, a Hausman test demonstrates at the 1% significance level that the coefficients of a random-effects model differ from those of a fixed-effects model, hence a random-effects model would be inconsistent. Using a fixed-effects model also makes sense intuitively, as by including the effects in the intercept term, country-specific effects can be treated as a parametric shift of the regression function (Greene, 1993). Finally, the model ensures that the regression errors are robust to heteroskedasticity, as it is unlikely the variance term will be constant over time (Stock and Watson, 2003).

In terms of the variables used, for GDP this study uses data extracted from the Eurostat website, and uses logarithms of chain linked values of real GDP per capita, with 2005 as the reference year. The change in real GDP is given as a yearly percentage change. In addition to GDP, a range of explanatory variables are included to model trans-EU heterogeneity, which will reduce omitted variable bias in the

results (Clarke, 2005). First, a fixed effects variable is included to account for time-invariant country-fixed effects, which is integrated into the intercept term, α_i. Inflation is included as a variable, as mainstream economic theory, and most empirical works (e.g. Barro, 1995) suggest that persistently high levels of inflation are of detriment to growth, though it is worth noting the specific nature of the causality within this relationship has not been firmly established. It is expected therefore, that the coefficient for the inflation variable will be negative. Data for inflation is taken from the World Bank archives, and is input as GDP deflator, as seen in Crespo Cuaresma *et al* (2008) to demonstrate price level changes for the economy as a whole.

The next variable included is government spending as a percentage of GDP, again sourced from the World Bank. Whilst Keynesian economic theory would suggest that higher levels of government spending are consistent with higher levels of economic growth, other empirical works suggest that this may not be always true and that the correlation may even be negative, as downward pressure created by debt and allocative inefficiencies may outweigh the short-term positives of fiscal expansion (Barro, 1997; Rogoff, Reinhart and Savastano, 2003; Eraslan and Toslu, 2016). Critically however, these results are subject to a degree of controversy, hence the expected direction of the coefficient is ambiguous.

Next, trade balance is included, as exports are theoretically a driver of economic growth. Again, empirical evidence supports this, with work by Harrison (1995) finding evidence of a positive coefficient for their variable for export strength when real GDP per capita was regressed onto it. This variable is included as "open-ness of the economy", or the percentage of GDP made up by export revenue. The fourth variable will be an investment proxy variable, due to economic theory suggesting a positive relationship between investment and growth, as well as past literature (Levine and Renelt, 1992). As is used in existing examples (Crespo Cuaresma *et al*, 2008; Varblane and Vahter, 2005) the variable chosen is Gross Formation of Capital, which is defined as outlays on additions to the fixed assets of the economy, plus net changes in level of inventories, measured in USD. Finally, the regression includes the human capital index, as theoretical growth modelling by Rebelo (1992) and Lucas (1988) strongly supports the positive impact of human capital on economic growth, as does empirical evidence (Barro, 1991). Based on years of schooling, and returns to education, the Human Capital Index from the Penn World Tables v9.0 is used here.

The model is therefore as illustrated below:

$$(1)\ \Delta Real\ GDP_{T-t,i} = \beta 1 Log\left(Real\ GDP_{t,i}\right) + \beta 2 Inflation_{t,i} + \beta 3 GovermentSpending_{t,i} + \beta 4 OpennessOfEconomy_{t,i} + \beta 5 GrossFormationCapital_{t,i} + \beta 6 HumanCapital_{t,i} + \alpha_i + \mu$$

For unemployment convergence, the presence of β-convergence is also tested for but using a substantially less complex cross-sectional model, which regresses the change in employment rates between 2014 and 1995 onto initial unemployment rates in 1995. An OLS estimator is used in this instance, and includes just a single variable and error term, hence testing for the existence of *unconditional* β-convergence. Existing literature has opted for such models due to the simplicity of the model, combined with respectable R^2 values and statistically significant results (see Marelli and Signorelli, 2010; Estrada *et al* 2012**).**

The regression for unemployment convergence is written as follows:

$$(2)\ \Delta Unemployment_{T-t,i} = \alpha_i + \beta Unemployment_{t,i} + \mu$$

Where $\Delta Unemployment_{T\text{-}t}$ denotes the difference in unemployment rates between initial time t, and the final period considered, T. α_i denotes the intercept term, whilst $Unemployment_t$ denotes unemployment rate at initial time t, with a coefficient equal to β. μ denotes the error term, and subscript i denotes the specific country which is being referenced in each instance. For this study, unemployment rates are defined as the percentage of the work force out of, but actively seeking employment.

By regressing the change in real GDP onto initial GDP, and the change in unemployment rate onto initial unemployment rate, one can confirm the presence of β-convergence if a statistically significant, negatively signed β coefficient is present on the leading independent variable of the regression, i.e. initial GDP, and initial unemployment rate.

4.2. σ-convergence

For σ-convergence, defined as the reduction in dispersion over time of a specific variable across countries, there are several methods of calculation that can be used. This study treats different techniques as interchangeable, though recent work by Dalgaard and Vastrup (2001) suggests that they may not be, due to non-logarithmic measures not accurately weighting results for countries based on

their total GDP. For the purpose of this study however, this critique is overlooked. This paper uses the technique of coefficients of variation (CV), which are used to calculate a normalised value of the average distance from the mean, which in turn acts as a measure of dispersion for any given variable.

The CV at time t is equal to:

$$(3)\ \sigma_t = \frac{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(X_{it}-\overline{X_t})^2}}{\bar{X}_t}$$

Where σ_t denotes the CV, n denotes the number of countries in the sample, X represents the variable of interest, $\bar{X}$the average value of X, and subscripts t and i denote the time and country associated with the relevant variable. On its own, this value is nugatory. However, the change in dispersion of X*over time* can be modelled via the movement of the CV between a time t, and a future time T years in the distance t+T. As the CV denotes a normalised deviation from the mean, one can assert that if $\sigma_{t+T} < \sigma_t$, then dispersion is falling and economies are converging in terms of X, and if $\sigma_{t+T} > \sigma_t$ then economies are diverging in terms of X.

Due to the composition of their formula, the proper functioning of CVs is strictly dependent on the mean value of a variable at time t not being close to, or equal to zero. This is because although the marginal change from one mean to another may be constant, the scaling effect may not be. For instance, a change from 1.9 to 1 will result in the CV numerator being multiplied by 2, but a change from 1 to 0.1 the next period will result in it being multiplied by 10. As an example, CVs for inflation rates for the EU-28 between 2010 and 2015 are calculated, to demonstrate the clear skewing effect as average inflation approaches zero in 2014 and 2015:

Table 4.1. CVs for Inflation Rates, 2010-2015 for EU-28

	2010	**2011**	**2012**	**2013**	**2014**	**2015**
CV	0.6378	0.232577	0.20302	0.71419	*3.085932*	*12.69903*

Note: Data taken from World Bank archives, using data for changes in consumer price index

Though in theory unemployment could possibly tend towards a very small number too, in practice this is not a real threat, and hence is not an obstacle in this paper's calculations. Because of this, CVs can be used to calculate σ-convergence for both real GDP and unemployment rates. Results are plotted

graphically with the CV on the vertical axis and time on the horizontal. The benefits of this are two-fold; not only are readers easily able to visualise the rise and fall of the CV over time, the direct impacts of macroeconomic shocks on a year-to-year basis can be seen, which in turn will aid analysis. The results on the graph are separated into four curves: The EU-28, the EU-15, the EU-15 minus Spain, Greece, and Portugal, and the EU-13.

The selection of years and countries for this study is partly given out of necessity due to the aim of the paper. The starting year is 1995, as a lack of data prior to this for several countries would have led to a heavily unbalanced panel. Additionally, beginning in 1995 accommodates for any short-term financial fluctuations that may have occurred following the European Monetary System Crisis of 1992-1993, and the creation of the European Union in 1993. After this, all years up to 2014 are included to maximise the number of observations, and to ensure coverage is as up to date as possible.

5. Results

5.1. β-convergence: Real GDP

Table 5.1. Regression Results for Test for β-convergence of Real GDP in EU-28

	Percentage Growth of Real GDP per capita 1995 - 2014	Percentage Growth of Real GDP per capita (pre-crisis) 1995-2008		Percentage Growth of Real GDP per capita 2009-2014
		With Human Capital Variable	Without Human Capital Variable	
Log Real GDP per capita ($)	-8.4274***	0.8922	-4.4895*	7.2513
	(2.8546)	(4.2120)	(2.4209)	(11.7704)
Inflation	-0.0738***	-0.1210***	-0.1262***	0.3067
	(0.0172)	(0.0132)	(0.0123)	(0.2907)
Openness of the economy	0.1040***	0.0600*	0.0477	0.2094**
	(0.0323)	(0.0305)	(0.0333)	(0.0864)
Gross formation of Capital	0.5043***	0.2213**	0.2766***	0.4286*
	(0.0877)	(0.0926)	(0.0894)	(0.2253)
Government Spending	-0.5683***	-0.4636**	-0.5780***	-1.1774***
	(0.1661)	(0.1957)	(0.1727)	(0.3513)
Human capital	-3.4282	-10.5350*	x	13.0647
	(2.9744)	(5.4591)	(x)	(13.0960)
Constant	90.5232***	28.0120	49.8864**	-112.4733
	(19.6258)	(29.3549)	(23.2735)	(118.1478)
R^2	39%	25%	24%	55%
F-test statistic	25.22	45.95	34.06	76.49

Note: All countries of the EU-28 included in all regressions. The real GDP series were taken from Eurostat website, Government Spending, GFC, and Inflation data sourced from World Bank website, Human Capital Index taken from Penn World Tables 9.0.
Heteroskedasticity robust standard errors given in brackets, ***(**) & [*] denote 1%, 5% and 10% significance levels respectively.

Table 5.1 provides the results of the real GDP regression, and includes the R^2 values and F-test statistics as summary measures, the former as a measure of goodness-of-fit and the latter testing the joint null hypothesis that all coefficients are equal to zero. Beginning with the F-test statistic, large values for all regressions run are observed, leading to the rejection of the null hypothesis of triviality of all coefficients at the 1% significance level, for all regressions run. In terms of the R^2 values, these denote the overall fit of the model, and the percentage of the variance in the dependent variable explained by the model (Floyd, 2010). The entire sample period has a value of 0.39 suggesting 39% of variance in country GDP growth can be explained by the selected independent variables. The second and third regressions have lower R^2 values of 25% and 24% respectively which, whilst suggesting the regressions do not have a strong fit, does not imply on its own that the results are of a poor quality or not useful. The R^2 value for the final regression run is the highest, and stands at 55%, suggesting that the final regression has the best fit even though, as subsequently noted, it has fewer significant coefficients.

As predicted by economic theory and existing literature, there is evidence of β-convergence in the first regression significant at the 1% level. The nonzero coefficient for the log of initial GDP implies growth rates are indeed negatively related to initial GDP levels. The inflation coefficient is demonstrated to be statistically significant at the 1% level and is negatively signed as predicted by theory, whilst the positively signed coefficients of gross formation of capital and the openness of the economy are significant at the 1% level. Government spending is also statistically significant at the 1% level, with the negative sign of the coefficient suggesting higher levels of government spending are associated with *lower* levels of GDP growth. The human capital coefficient is found to be negatively signed, converse to expectations, though not statistically significant even at the 10% level.

The second regression covering pre-crisis Europe exhibits a positive sign, though statistically insignificant coefficient, converse to expectations of significant β-convergence. Coefficients for inflation, openness and gross formation of capital are statistically significant at the 1%, 10% and 5% levels respectively, and government spending is found to be significant at the 10% level, with inflation and government spending again negatively signed, whilst gross formation of capital and openness have positive signs. Again, the human capital index is found to be negatively signed, though this time significant at the 10% level. This may be indicative of the fact that high human capital levels are associated with wealthier countries, which in turn according to theory will grow slower than poorer ones. Though, this would be inconsistent with a positive coefficient for initial GDP, as seen in this regression.

Note, that by removing the human capital variable readers are presented with a different set of results, whereby statistically significant β-convergence is found at the 10% level. Gross formation of capital becomes significant at the 1% level, and the constant term at 5%. This would in turn suggest a degree of multicollinearity between human capital and GDP, which is intuitive as higher levels of GDP are associated with more advanced economies, which typically bear features such as better literacy rates and better schooling rates, and the human capital index is a weighted measure of these variables.

In the final regression covering post-crisis Europe, there is a positive, though statistically insignificant relationship between growth rates and initial GDP levels, which is in line with recent literature by Hájek *et al* (2016). The reasons for this likely lie in the poor economic recovery seen by some of the smaller, weaker economies of the EU. Empirical evidence suggests that these economies have not reacted as positively to inward capital flows as expected, perhaps due to strong periods of growth prior to the crisis leading to over-expectations of their productive capacities (Zentralbank, 2015). Additionally, poorer countries have struggled with labour market performance in recent years, as detailed in section 5.2, which may have been reflected by low investment and slow growth rates. Finally, smaller nations may have grappled with the issue of EU fiscal constraints, meaning demand could not be sufficiently re-inflated post-crisis, as predicted by Buiter (1992).

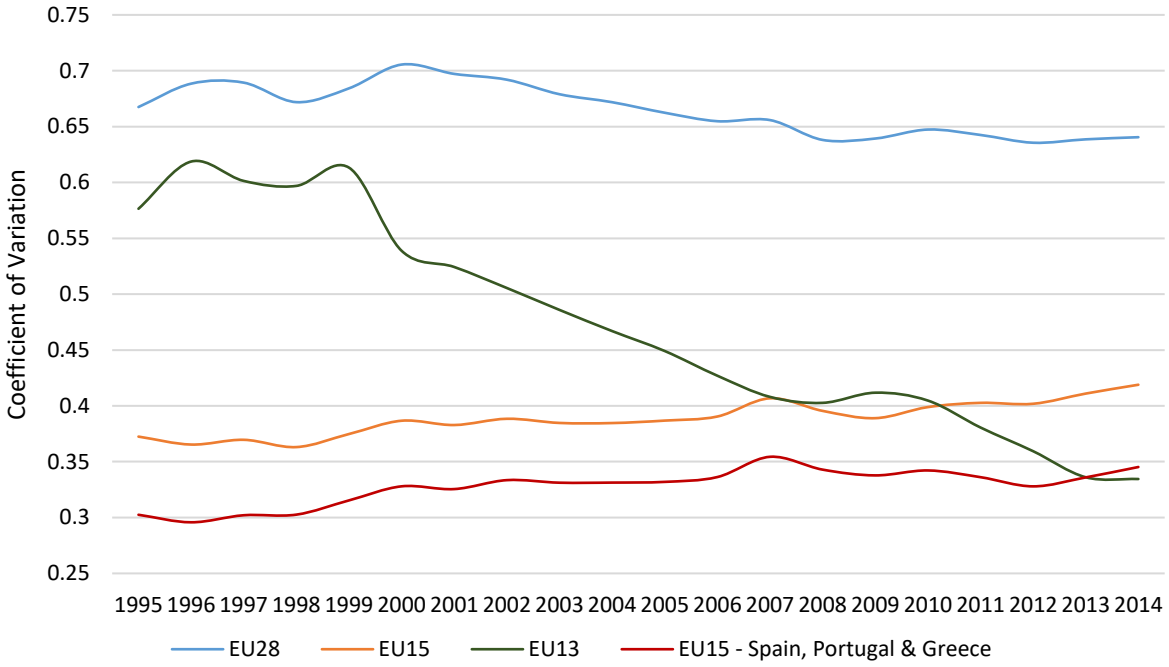
An interesting contrast between the final and previous regressions is the positive sign on the inflation coefficient, suggesting higher inflation is associated with higher levels of growth. This is likely just a demonstration of growth *causing* inflation, rather than the arguably antithetical process of inflation *encouraging* growth. Countries that have been able to rejuvenate and grow will have experienced small amounts of inflation, whilst stagnant economies with slow or negative growth will experience inflation close to zero, or deflation. Hence, a positive relationship between inflation and growth exists here, though use of instrumental variables and further analysis would be required to cement this assertion. Despite this, the inflation coefficient is not significant at any notable level, along with the constant term and the human capital coefficient. Government spending remains significant at the 1% level, openness of the economy at 5%, and gross formation of capital at the 10% level, all with positive coefficients, as seen with previous regression results.

5.2. σ-convergence of Real GDP

Figure 5.1 shows the movement of the CV for real GDP per capita across EU member nations. Results include data for the EU-28, EU-15, EU-13, and the EU-15 minus Spain, Portugal & Greece. From the

EU-28 line, it is clear that between 2001 and 2014 there has been a downward trend in dispersion, following an increase in dispersion following the recession of the early 2000s. Hence, the presence of σ-convergence for the EU overall across the period considered can be asserted. However, the EU-15 and the EU-13 lines show contrasting trends; strong evidence exists for of a convergence cluster for the EU-13, but ongoing divergence is noted across the EU-15. Even removing the "southern" economies of Spain Greece and Portugal does not alter the general trend of divergence, despite lower levels of dispersion overall. Though not included, CVs were also calculated for the EU-15 excluding Luxembourg to see if the very high levels of GDP per capita there were distorting the results. This curve was the same as seen in the previous instance of removing countries; the same trend but with a lower CV for each time period.

Figure 5.1. CVs for Real GDP per Capita



Source: Eurostat (2017)

5.3. β-convergence of Unemployment Rates

Table 5.2. Regression Results for Test for β-convergence of Unemployment Rates in EU-28

	Dependent Variable: Change in unemployment rates between 1995 and 2014	**Dependent Variable: Change in unemployment rates between 1995 and 2008**	**Dependent Variable: Change in unemployment rates between 2009 and 2014**
Unemployment rate$_{1995}$	-0.4489**	-0.7205***	-
	(0.2066)	(0.0642)	
Unemployment rate$_{2009}$	-	-	-0.3074
			(0.2609)
Constant term	4.9653**	3.5115***	4.2967*
	(2.2373)	(0.6593)	(2.4799)
R^2 value	15%	83%	5%
F-test statistic	4.73	126.02	1.39

Note: All countries of the EU-28 included in all regressions. Unemployment data sourced from World Bank website.
Standard errors are given in brackets, and *** (**) & [*] denote 1%, 5% and 10% significance levels respectively. These results are graphitised in Appendix I.

The first and third models demonstrate very low R^2 values, suggesting a poor goodness of fit for these regressions, in tandem with low F-test statistics. In contrast, the second model yields an exceptionally high F-test statistic, and a very high R^2 value of 83%, suggesting past unemployment rates are highly effective at explaining deviations in changes in unemployment between 1995 and 2008.

In terms of β-convergence, the results across all three regressions demonstrate a negative relationship between changes in unemployment rates and initial unemployment rates. The first regression details β-convergence being present at the 5% level, suggesting convergence overall for the period considered. The second regression, considering convergence pre-crisis, finds evidence of convergence at the 1% level, which is likely indicative of successful convergent policy, and superior flows of labour across the EU. Whilst one must be careful when discussing the nature of the causality of such a

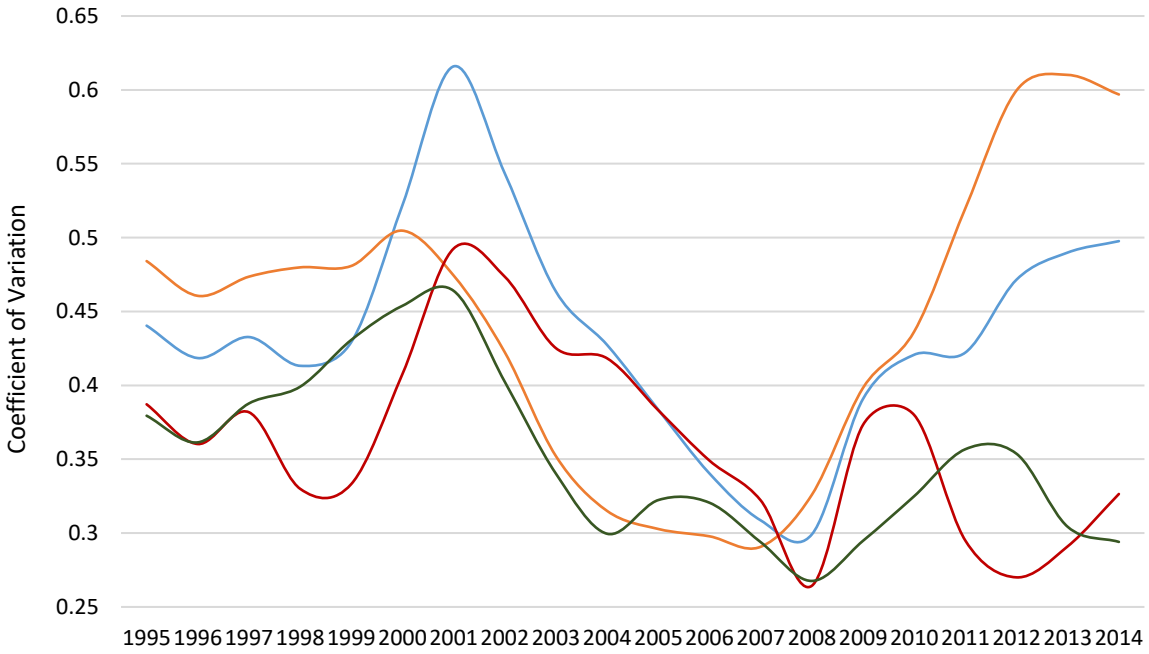
relationship, this conclusion is supported by evidence from existing literature by Perugini and Signorelli (2007), whose econometric analysis suggested that the most likely cause of unemployment convergence seen between 1997 and 2006 in EU economies, was indeed EU directive.

Finally, the third regression demonstrates a statistically insignificant coefficient for initial unemployment, meaning the null hypothesis of no convergence cannot be rejected even at the 10% level, implying a lack of convergence following the crisis period. This is likely in part due to stalling growth, and aggregate reduction in inward investment as a result of the financial crash (Checchi and Galeotti, 1993; Castro and Soukiazis, 2005). This will have acted to exacerbate the effects of a shift in legislative focus, from common international targets to domestic programmes, which will have reduced the propensity for countries to aim for convergence (Siljak, 2015).

Additionally, membership of the Eurozone will have induced rigidity with regards to monetary policy for many members of the EU, resulting in an inability to depreciate domestic currencies in response to the crisis. Lower interest rates would have allowed higher levels of borrowing and investment, to sustain a more productive business environment, and helped to keep export markets strong in the face of stagnation. This assumes however, that non-euro economies will always be more expansionary in monetary terms, which empirical evidence does not necessarily suggest.

5.4 σ-convergence of Unemployment Rates

Figure 5.2. CVs for Unemployment Rates 1995-2014



Source: World Bank (2017).

The first thing to note about Figure 5.2 above is that unlike GDP dispersion, there is not a general downward nor upward trend, but instead a series of fluctuations. For the EU-28, there is evidence of a strong increase in dispersion in 2000 around the time of the early 2000s recession, though after this a general downward trend is observed, and thus convergence up until 2008. After 2008 the series turns upwards once again, and continues to rise until the end of the sample period in 2014. Like existing literature therefore, upon first glance this paper's results demonstrate that the damage of the economic crisis seems to have undone the success of convergent policy over the previous 7 years.

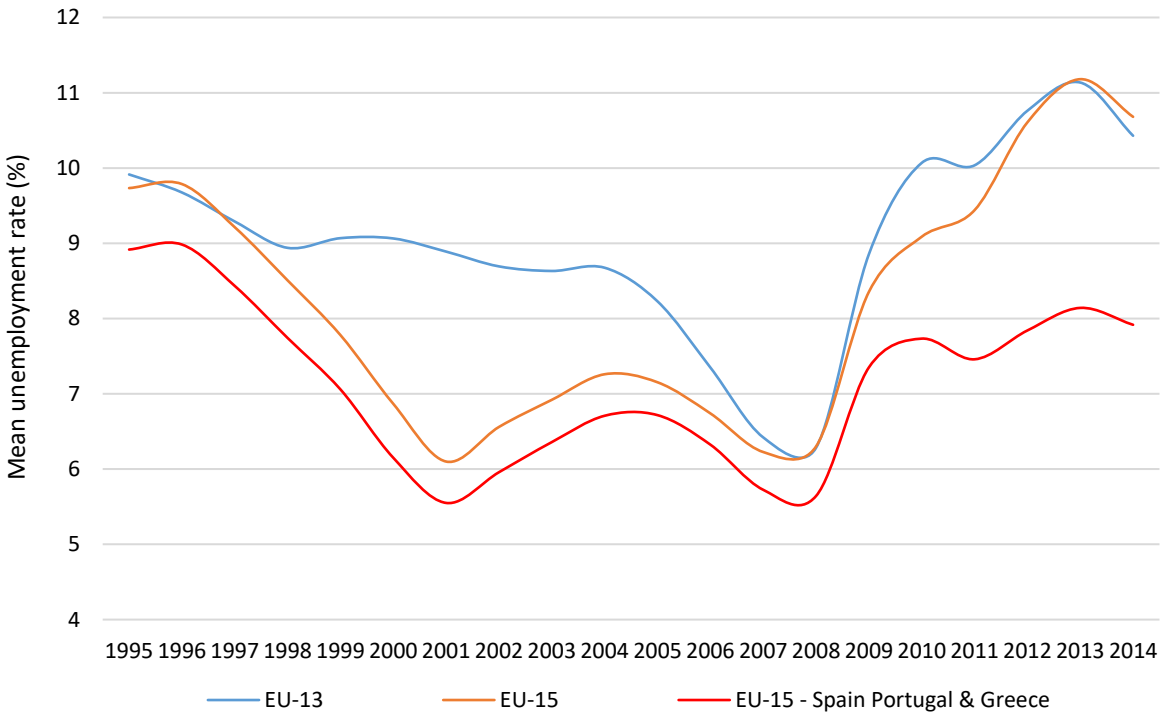
Analysing the series individually, there is a higher CV for EU-13 than for the EU-15 until 2001, where the line turns upwards sharply. Unlike the ascension countries, the EU-15 CV remains stable in the lead up and during the recession of the early 2000s. Following this, both series trend downwards for 7 years suggesting convergence in unemployment rates in the build-up to the 2008 economic crisis. After this though, both turn upwards, with the EU-15 series remaining on an upward trajectory until 2013, but with the EU-13 curve turning downwards in 2011-2012, suggesting unexpected convergence in recent years.

Whilst average levels of unemployment for both the EU-13 and EU-15 are similar, as will be shown below (see Figure 5.3), the poorer economies of Europe such as Greece, Spain and Portugal are pushing up average unemployment levels for the EU-15. This in turn impacts on the level of σ-convergence, as denoted by the *fall* of the EU-15 CV in 2011 when Greece, Spain and Portugal are excluded. This would suggest that their distance from the average was acting to skew results, and that in fact the majority of the EU-15 have been successful in reducing the extent of dispersion in unemployment rates between countries since the recession. This therefore, suggests that the EU-15 have made better progress in their recovery than the EU-13. It is postulated that the low CV for the EU-13, and high unemployment rates in Greece, Portugal and Spain are indicative of the uniform nature of high unemployment faced by poorer countries, due to a strong degree of rigidity of labour markets and low quality governance, in tandem with a profound deficiency of demand (Zentralbank, 2015).

Although evidence suggests that in recent years the EU-15 minus the three poorest members have made reasonable steps towards future convergence, the lack of β-convergence following the economic crisis, coupled with high mean levels of unemployment suggests lasting damage to the flexibility of labour. Structural deterioration of this form spells fears of hysteresis, which would result

in an inability for economies to return to their pre-crisis state in the short run, causing damage to domestic growth and limiting the opportunity for future convergence. Economic theory suggests resolving the issue of deep-rooted structural unemployment may require an increase in the number of supply side policies, akin to those introduced by the EU in the late 1990s. However, the original EU guidelines were generally vague and supportive of most policies, hence there was not a particularly strong degree of cross-country harmonisation with regards to legislation. Exenberger (2004) noted that the failure to impose directive with sufficient tenacity was a key critique of EU policymakers, hence, stricter imposition of future protocol is required.

Figure 5.3. Average Unemployment Rates Across EU-13, EU-15, and EU-15 minus Spain, Portugal and Greece



Source: World Bank (2017)

6. Limitations

Like all academic literature, this paper has numerous limitations to consider, that can in turn be used to critically evaluate its content and help make recommendations for future studies.

The paper's model for β-convergence of GDP, whilst successful in determining the existence of β-convergence in the sample period, did not make use of complex methods such as Phillips and Sul's (2007) clustering algorithm for advanced analysis of convergence clubs. Whilst the results demonstrate convergence within the EU-13 subgroup, the model is unable to detect clusters based on structural factors organically, and is unable to identify common growth horizons. Despite this constraint, this paper was able to identify that the poorer, southern economies of Europe act to distort results, and make unfair reflections of the EU-15's macroeconomic recovery, thus feels it fair to conclude that they should be included with the periphery economies in future empirical works.

Similarly, due to the constraints of an undergraduate dissertation this paper was unable to create a suitably complex model for modelling conditional unemployment convergence. It is also worth noting that unemployment itself is a notoriously difficult variable to measure. The reasons for this lie in the obvious issues surrounding the subjectivity its definition, and the fact that unemployment rates are themselves based on the participation rate and job opportunities, which means they are consistent with different *employment* rates (Perugini and Signorelli, 2007). As a result of this, future papers may be better suited to using employment rates for convergence analysis instead. A more critical issue regarding variables in general is the existence of endogeneity throughout the paper. This represents a problem as accounting for them is beyond the scope of this study. Future works may be suited to using more complex models such as the Generalised Method of Moments, in order to account for endogenous variables (Arellano and Bond, 1991).

It is also important to note that the panel used for the regressions in section 5 were not fully balanced due to a lack of data. This largely due to the infancy of the economic structures of some of the countries included in the regression, hence results are skewed in earlier years towards the more developed countries. Additionally, for both unemployment and GDP regressions, yearly data was used which leaves them vulnerable to the short-term fluctuations of the business cycle. As a result of this, future regressions would be suited to using several year groupings as their time periods to correct for this.

Whilst this paper's testing of two macroeconomic variables serves as a positive in the sense that two variables can be assessed within the confines of a single paper, it also means the intricacies of the analysis of individual variables are somewhat blunted. For example, existing literature by Kónya (2006) suggests that two-way causality exists between exports and GDP for several EU countries, a case which is also likely for other variables used, which may in turn bias this study's results and act to increase standard errors**.** This paper does not include the tools needed to observe and quantify such effects, such as instrumental variables calculated by a two-stage least squares estimator. As a result, this study is forced to hypothesise much of its discussion section, as whilst some trends can be analysed, the direction of causality and the extent to which different macroeconomic events may have impacted the convergence process is not always clear.

7. Conclusions

Whilst convergence is not a new topic in terms of empirical investigation, the base of literature written on the subject is growing rapidly, and is constantly evolving new and effective means of identifying and analysing this phenomenon. This paper has added to existing literature by using more recent data than current works, and has also included the recent EU addition of Croatia in its calculations. Incidentally, this has allowed this paper to more accurately model the progress of convergence following the crisis than existing literature. In addition to this, unlike many previous works which were criticised by Soukiazis (2002) for not doing this, this paper attempts to explain the mechanisms which have induced convergence. Instead of mindlessly regressing swathes of data, this paper has worked to establish the relationships between convergence and economic structures, macroeconomic shocks, and EU directive.

This paper finds strong evidence of β-convergence for both real GDP and unemployment rates across the entire period considered, and prior to the economic crisis. This paper was unable to detect statistically significant convergence following the crisis of 2008 for either variable. Similarly, σ-convergence calculations demonstrated a downward trend in dispersion of real GDP per capita for all member states and the EU-13, though a constant divergent trend for the wealthier economies of the EU-15. The latter trend was present even when removing the poorer southern European economies from calculations, and when removing anomalously wealthy states such as Luxembourg. In terms of unemployment rate dispersion, rates generally converged between 2001 and 2008, largely driven by rapid declines in dispersion across the EU-15 nations between 2000 and 2005. In recent years, dispersion has increased dramatically and in many ways undone the success of previous years. It is noted that by removing Spain, Greece, and Portugal from EU-15 calculations, reductions in dispersion since the crisis are detected, suggesting future convergence may not be an impossibility.

Whilst limited by size and complexity, this paper has successfully added to the existing body of literature on real convergence within the EU over the last 20 years. It is worth noting though, that literature on the existence of β-convergence and σ-convergence in real GDP and unemployment rates is reaching a point of saturation, and future works may be better suited to focus on the convergence of less commonly considered variables. Possible areas for testing include the convergence of inequality levels, levels of corruption, and poverty thresholds. Alternatively, studies may be better suited to assessing the causality of the mechanisms discussed in this paper in greater detail, such as the direct impact of the single currency on convergent behaviour. Not only does this create

opportunity for a greater breadth of analysis of convergence in general, consideration of other economic variables will help provide evidence to cement future EU directive, and assist in achieving the goal of economic convergence within the European Union.

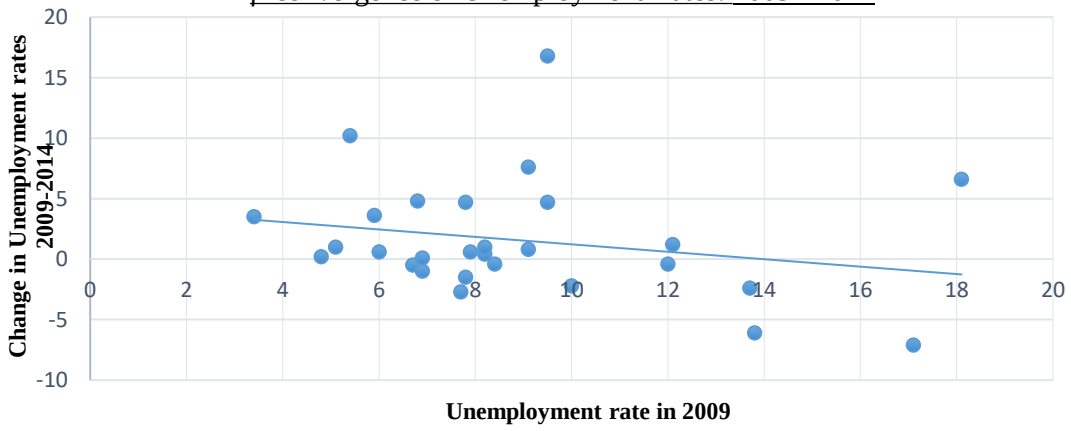
8. Appendices

Appendix A

β-convergence of Unemployment Rates: 1995 - 2014

β-convergence of Unemployment Rates: 1995 - 2008

β-convergence of Unemployment Rates: 2009 - 2014



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