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Economic Integration in the EU: Competitiveness and Convergence

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Declaration of Authorship

The author hereby declares that she compiled this thesis independently, using only the listed resources and literature.

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Abstract

The EU's lagging economic growth and global competitiveness require the promotion of technological innovation, the key determinant of long term economic growth. On the other hand, increasing disparities among EU member states require the promotion of convergence as they may threaten the EU's economic feasibility and political viability. Cohesion policy has adopted the dual role for the promotion of EU global competitiveness and EU economic cohesion; concepts incompatible by nature. The objectives of Europe 2020, specifically the promotion of technological innovation through investment in R&D, are assessed in terms of their compatibility with the objectives of Cohesion policy, specifically the reduction of disparities within the EU. An analysis of convergence in the EU determines that both beta convergence and sigma convergence are taking place, although large disparities in GDP per capita persist. An empirical analysis of the relative effects on GDP per capita of investment in R&D and investment in human capital determines that investment in human capital plays a significant role. Thus, key policy focus areas that meet the objectives of both Europe 2020 and Cohesion policy include investment in human capital as well as purposive diffusion of technology within the EU and the distribution of the benefits, economic and otherwise, of technological innovation enabled by the Single Market.

JEL Classification	R12, F15, O31
Keywords	economic integration, convergence, innovation, economic growth

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Abstrakt

Zpomalený ekonomický růst a nároky na globální konkurenceschopnost si v případě EU vyžadují uplatnění technologických inovací jako dlouhodobě klíčové determinanty ekonomického rozvoje. Na druhé straně si však vzrůstající disparity mezi členskými zeměmi EU vyžadují prosazení konvergenčního přístupu, aby neohrozily možnost uskutečňovat a politicky prosazovat ekonomickou koncepci EU. Kohezní politika hraje dvojjedinou roli na jedné straně podpory globální konkurenceschopnosti EU a na druhé straně podpory solidarity, což jsou ze své podstaty neslučitelné koncepty. Záměry strategie, ztělesněné v programu Evropa 2020, zejména pak podpora technologických inovací prostřednictvím investic do vědy a výzkumu, jsou vyhodnocovány s ohledem na jejich kompatibilitu s cíli kohezni politiky, tj. zejména snahou omezit disparity uvnitř EU. Analýza situace v EU ukazuje, že tu probíhají beta i sigma modely konvergence, ačkoliv přetrvávají velké rozdíly v HDP na hlavu. Empirická analýza relativních efektů investic do vědy a výzkumu a investic do lidského kapitálu na HDP per capita ukazuje, že druhý typ investic hraje významnou roli. Z toho plyne, že klíčové soustředění na oblasti, odpovídající cílům strategie Evropa 2020 a kohezní politiky zahrnují investice do lidského kapitálu stejně tak jako ščelovou difšzi technologií uvnitř EU a distribuci jejích efektů, ekonomických a také technologických tak, jak to umožňuje jednotný trh unie.

Klasifikace JEL	R12, F15, O31
Klíčová slova	ekonomická integrace, konvergence, inovace, ekonomický růst

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Acronyms

ERDF European Regional Development Fund

ESF European Social Fund

EU European Union

EU12 Member States with EU accession dates on or after 2004

EU15 Member States with EU accession dates before 2004

GNI Gross National Income

I$ International Dollar

ICT Information and Communication Technology

PPP Purchasing Power Parity

R&D Research and Development

Chapter 1

Introduction

It has long been recognised that technological innovation is the engine of long term economic growth.

EU economic integration seeks to increase long term economic growth of the EU and each of its member states through increasing the Single Market and the competitiveness thereof and therein, as well as increasing the EU's capacity for technological innovation, the key determinant of long term economic growth.

In response to the EU's present low economic growth and lagging global competitiveness in terms of innovation and technology, the EU presented Europe 2020: a ten year economic growth strategy with the objective of increasing the EU's global competitiveness and promoting a dynamic economy based on knowledge and innovation.

On the other hand, EU economic integration inevitably results in tendencies for the concentration of economic activity in economies that are already highly developed and competitive. The heterogeneity of member states in terms of development and competitiveness serves only to exacerbate the uneven distribution of economic activity within the EU and disparities among member states in terms of economic growth and competitiveness.

In the case that member states are not competitive enough to participate competitively in the Single Market and as a result experience low economic growth, unemployment and fiscal imbalances, then surely the EU will lose economic feasibility and political support.

Indeed, subsequent to the economic shocks of the recent global financial crisis and EU sovereign debt crisis, significant and widening disparities among member states emerged, most noticeably in terms of economic growth, unemployment—particularly with respect to youth unemployment—and fiscal imbalances—

particularly with respect to government debt. Such disparities have led to economic and political instability across the EU, and to questions as to the feasibility of the EU and the Single Market.

In recognition of such consequences of EU economic integration the Treaty establishing the European Community has as one of its aims the promotion of overall harmonious development and economic and social cohesion within the EU, and in particular EU Cohesion policy aims to reduce disparities between the levels of development of member states (EuropeanUnion (2006b)).

More recently, with the introduction of the Lisbon Agenda and thereafter Europe 2020, Cohesion policy is identified as one of the key delivery mechanisms of the Europe 2020 strategy which aims to promote the EU's global competitiveness and long term economic growth by *inter alia* promoting technological innovation through investment in R&D (EuropeanCommission (2010b)).

Investment in R&D tends to favour concentration of R&D activity which increases its efficiency and productivity. Furthermore R&D activity tends to concentrate in economies which are already developed and competitive; thus further increasing their competitiveness. Thus while investment in R&D is crucial in promoting the EU's global competitiveness and long term economic growth, it is likely that, without intervention, it will further exacerbate disparities among member states in terms of competitiveness and economic growth.

Secondly, the relative importance of investment in R&D in competitiveness and economic growth depends crucially on an economy's stage of development; investment in R&D is crucial for competitiveness and economic growth in advanced economies. Furthermore the various factors which affect competitiveness and economic growth, including investment in R&D, are interdependent and mutually reinforcing on economic growth; therefore the effects of investment in R&D on competitiveness and economic growth in an economy which is less than advanced may be limited by other economic factors.

Thirdly, investment in R&D is driven by the incentive to gain market power and to earn profits. The allocation of Cohesion policy funds by the public sector will likely lack such incentive. Consequently investment in R&D may be directed towards basic research by universities and public research institutes over applied research by firms and industry which is less conducive to technological innovation, and especially more so if the link between universities and public research institutes, and firms and industry is not strong. Furthermore investment in R&D may be less efficient and productive in terms of technolog-

ical innovation and economic growth if it is not driven by the incentive to gain market power and to earn profits.

Thus while Cohesion policy is increasingly aligned with the objectives of Europe 2020, it is questionable whether the objectives of Europe 2020 to promote investment in knowledge and innovation in regional development, based on the premise that it will contribute to EU global competitiveness and long term economic growth, are fully aligned with those of Cohesion policy.

The objective of this thesis is to assess the role of Cohesion Policy as one of the key delivery mechanisms of the Europe 2020 strategy; in particular, the relative importance of investment in knowledge and innovation in promoting the development and competitiveness of lagging member states and in reducing the disparities among member states.

Firstly, this thesis aims to assess the objectives of Europe 2020 in terms of Cohesion policy in the present context of both low EU economic growth and lagging global competitiveness and significant disparities among member states in terms of competitiveness and economic growth.

It has long been recognised that technological innovation is the engine of long term economic growth. While lagging economies may not benefit directly from investment in R&D, they can surely benefit from the diffusion within the EU of the results of technological innovation, as well as from the economic benefits derived from such technological innovation enabled by the Single Market. After all, the Single Market, in which all member states participate, plays a significant role in increasing the EU's capacity for technological innovation. Bearing in mind the need to promote the EU's global competitiveness, it is important to balance the incentives for technological innovation and the distribution of the economic benefits derived from technological innovation which is enabled by the Single Market.

Secondly, this thesis aims to assess whether convergence in the EU is taking place and, in terms of Cohesion policy, whether the disparities among member states is reducing.

Thirdly, this thesis aims to identify the key policy focus areas for Cohesion policy, in relation to the objectives of Europe 2020, for the promotion of the development and competitiveness of lagging member states and the reduction of disparities in GDP per capita across member states, and which best satisfy the objectives of both Cohesion policy and Europe 2020. The identification of such key policy focus areas for Cohesion policy is in the context of the approach

to the new programming period for 2014-2020 for which it is apparent that Cohesion policy will continue to focus on the objectives of EU2020.

T he thesis is structured as follows: Chapter 2 discusses the objectives of EU economic integration, and its consequences. Chapter 3 discusses Cohesion policy and its role in increasing the competitiveness of lagging member states as well as that of the EU globally, and in reducing disparities among member states. Chapter 4 provides an overview of the literature relating to economic growth and economic integration. Chapter 5 presents an analysis of convergence of member states within the EU. Chapter 6 presents an empirical model which aims to identify the key policy focus areas for Cohesion policy for the promotion of the development and competitiveness of lagging member states and the reduction of disparities in GDP per capita across member states, and which best satisfy the objectives of both Cohesion policy and Europe 2020. Chapter 7 summarises the findings and concludes.

Chapter 2

The Objective of Economic Integration is an Increase in Welfare

T he objective of economic integration is an increase in welfare. Welfare has numerous interpretations but for our purposes let us assume that it is defined by GDP per capita. Thus an increase in welfare refers to a high and rising standard of living represented by a high level of GDP per capita and sustained long term economic growth.

A high level of GDP per capita is reflected in the production capacity and efficiency of an economy presently for a given set of factors of production, technology, institutions and economic environment; let's call this the economic set. The production capacity of an economy is given by its stock of factors of production—capital, both physical and human capital, and labour—and technology. The efficiency of an economy is determined by the productivity of these factors of production within the context of the institutional and economic environment. This is the concept of static efficiency; the efficiency of an economy in the short term deriving from the efficient allocation of resources.

Sustained long term economic growth, on the other hand, is reflected in the *potential* of the production capacity and efficiency of an economy for a given economic set; that is, in its capacity to sustain long term economic growth for a given economic set. Scale economies and technological innovation continuously increase the productivity of a given economic set (Balassa (1965)). This is the concept of dynamic efficiency; the efficiency of an economy in the long term deriving from increasing returns to scale and technological progress (Balassa

(1965)).

Said in another way, with static efficiency an economy reaches its production-possibility frontier, that is the maximum production possible with given resources; whereas, with dynamic efficiency an economy is able to move beyond its production-possibility frontier and to increase the maximum production possible without increasing given resources (Balassa (1965)).

Let us pause here to distinguish between the concepts of innovation and technology and technological innovation. Innovation and technology refers to innovation arising out of market competition in terms of unique products and production processes, and sophisticated methods of business organisation and marketing. Such innovation and technology is enhanced through the clustering of firms and industries which contributes to innovation and technology through spillovers. Technological innovation, on the other hand, refers to the development of new, high technology, advanced products and processes in economies that are approaching the frontiers of knowledge; technological innovation in such advanced economies is the only source of long term economic growth.

Scale economies and technological innovation, which increase dynamic efficiency, derive from the existence of a large market—specifically high levels of consumption—and imperfect competition which together enable firms to internalise increasing returns to scale and to derive profits from investment in R&D.

Firstly, a large market enables scale economies which enable "production maximisation" and "trade optimisation" (Meade (1953)). Economies of scale increase production efficiency through scale and specialisation and increase consumption through increases in trade and the quantity and variety of consumer goods available (Balassa (1965); Krugman (1979)). In addition, increased competition in a large market continually induces innovation and technology in products and production processes which further increase scale economies (Balassa (1965)).

Secondly, a large market enables technological innovation as it presents a greater opportunity for firms to earn profits from investment in R&D, the key determinant of technological innovation. A large market reduces the uncertainty and costs associated with investment in R&D. Such technological innovation is likely to further increase the size of the market due to resulting increases in the technology of products and the efficiency of production processes. Furthermore, economies of scale in the R&D sector, enabled by a large market, increase the efficiency and productivity of investment in R&D: Econ-

omies of scale in the R&D sector reduce the fixed costs of investment in R&D and increase the availability and stock of existing knowledge and technology which facilitates further R&D (Balassa (1965); Rivera-Batiz & Romer (1991)).

Therefore, a large market and imperfect competition together enable scale economies and technological innovation, and enable firms to internalise increasing returns to scale and to derive profits from investment in R&D.

T he objective of EU economic integration is an increase in the static and dynamic efficiency of the EU and its member states (Balassa (1965); Baldwin (1989)). The removal of barriers to the free mobility of goods, services, labour and capital and the expansion of the market has two objectives: firstly, to foster competition and secondly, to benefit from scale economies and technological innovation. First, competition induced by the Single Market results in static efficiency: a once-off efficient reallocation of resources which increases their productivity, and which results in a once-off increase in real income. Second, scale economies and technological innovation induced by the Single Market result in dynamic efficiency: continuous increases in the productivity of resources which result in increases in real income over the long term.

An increase in dynamic efficiency, however, comes at a cost. Scale economies and technological innovation, which increase dynamic efficiency, are associated with imperfect competition which reduces welfare resulting from static efficiency (Balassa (1965)). Furthermore, scale economies and technological innovation tend to result in the concentration of economic activity and therefore an uneven distribution of economic activity, and by implication real income, within the EU.

In the context of increased competition in an increased market firms seek to increase their competitiveness by exploiting economies of scale in order to remain in the market and to earn profits; firms that are less competitive are forced to exit the market. As a result, oligopolistic market structures emerge, comprising fewer, larger, more competitive firms, and economic activity, and by implication real income, becomes concentrated within industries and countries, as well as within the EU. Economic activity tends to concentrate in highly industrialised or developed economies, thus economies that are initially competitive tend to become even more so (Balassa (1965); Krugman (1979; 1991)). In the case that an economy is not competitive enough to participate in the increased market, such changes in market structure may lead to a significant loss of industry accompanied by significant unemployment, low economic growth

and fiscal imbalances resulting partly from increased social spending. Thus on a national level, such consequences of EU economic integration make sense only if firstly, the resources that are freed up as a result of economic integration are re-employed productively elsewhere in the economy and secondly, the economy benefits from long term economic growth derived elsewhere in the economy as a result of EU economic integration.

In the context of increased competition in an increased market firms seek to increase their competitiveness through technological innovation in order to remain in the market and to earn profits. In addition an increased market enables investment in R&D as it reduces the uncertainty and costs associated with such investment. R&D activity tends to concentrate in highly competitive economies in which the institutional and economic environments are conducive to R&D, thus economies that are initially competitive tend to become even more so. Furthermore R&D activity tends to favour concentration as it increases the efficiency and productivity of R&D by reducing the fixed costs of investment in R&D and by increasing the availability and stock of existing knowledge and technology which facilitates further R&D (Rivera-Batiz & Romer (1991)).

Thus EU economic integration and the Single Market, while increasing dynamic efficiency of the EU through scale economies and technological innovation, inevitably result in an uneven distribution of economic activity, and by implication real income, within the EU whereby economic activity tends to concentrate in those economies that are initially competitive. As a result initially competitive economies are able to take advantage of and benefit from scale economies and technological innovation which result from EU economic integration and the Single Market in which *all* member states participate. Consequently, the competitiveness of initially competitive economies and their attractiveness for capital and labour is further increased (Balassa (1965); Krugman (1979; 1991)). The heterogeneity of member states in terms of competitiveness serves only to exacerbate the uneven distribution of economic activity, and by implication real income within the EU; member states that are less competitive are less likely to be able to participate competitively in the Single Market and to derive economic benefits from scale economies and technological innovation which result from EU economic integration and the Single Market in which *all* member states participate. In the absence of intervention, such uneven distribution of economic activity, once established, tends to persist and may result in low economic growth, unemployment, fiscal imbalances, and economic and political instability in member states that are less competitive. Therefore it

is essential that the economic benefits of EU economic integration, in terms of economic activity and employment, are equitably distributed among member states since all member states constitute the Single Market which enables increased competition and an increased capacity for scale economies and technological innovation in the EU. Policies for EU global competitiveness and long term economic growth are essential for a high level of GDP per capita and sustained long term economic growth in the EU; however it is essential that such policies are accompanied by policies for the equitable distribution of the economic benefits deriving from the Single Market and EU global competitiveness if the EU is to maintain economic feasibility and political support.

T he objective of economic integration is an increase in welfare. The effect of economic integration on welfare encompasses two aspects: an increase in real income (efficiency) and the redistribution of real income among economies (equity). Both aspects of welfare should be considered in an analysis of economic integration (Balassa (1965)).

Significant disparities in the distribution of real income among member states are apparent and persistent as presented in Appendix A.

The disparities in the distribution of real income tend to run along the lines of old EU15 and new EU12 member states, as well as along the lines of core and periphery member states. Disparities exist in the distribution of real income between the central and northern EU15 member states and the southern EU15 member states, Greece, Italy, Spain and Portugal. A similar core-periphery pattern is evident in EU12 although it is less pronounced than that in EU15.

Welfare in the EU can be increased through increases in real income resulting from long term economic growth in the EU and in each of its member states (efficiency) and through the redistribution of real income among member states (equity) in terms of the distribution of economic activity and employment, and the diffusion of technology or the distribution of economic benefits deriving from the Single Market.

Long term economic growth of member states requires that each member state is able to participate competitively in and benefit from the Single Market. The factors which are relevant to increasing the competitiveness of an economy depend crucially on its stage of development (WEF (2012b)): Economies that are less developed have lower productivity and are able to compete based on low prices which reflect low wages. At this stage of development competitiveness is increased through the quality of institutions, infrastructure and the

workforce, in terms of health and primary education, and a stable macroeconomic environment. As productivity and wages increase, economies compete based on the efficiency of production and product quality. At this stage of development competitiveness is increased through higher education and training, efficient goods, labour and financial markets, the ability to use and adapt existing technologies and a large market as these factors increase productivity. As economies exhaust production efficiencies, competitiveness is increased through the use of the most sophisticated business practices and production processes and an environment that is conducive to investment in R&D and technological innovation. Such advanced economies compete based on innovation in terms of unique products and processes and sophisticated methods of business organisation and marketing. The clustering of firms and industries increases efficiency and innovation and technology through increased opportunities for collaboration and spillovers. For economies that are approaching the frontiers of knowledge, technological innovation in developing new, high technology, advanced products and processes is the only source of long term economic growth.

Although technological innovation may not be an economic factor that is equally relevant to every member state's stage of development, innovation and technology and the results of technological innovation will surely increase long term economic growth of every member state. To this end, the diffusion within the EU of innovation and technology and the results of technological innovation is significant in promoting long term economic growth. Crucially, such diffusion requires high levels of human capital to promote the absorption of such innovation and technology within the EU, and the creation of further innovation and technology (Romer (1990); Rivera-Batiz & Romer (1991)).

Global competitiveness and long term economic growth of the EU requires an increase in dynamic efficiency deriving from scale economies and technological innovation. Crucially, investment in R&D, the key determinant of technological innovation and long term economic growth for the EU, should be concentrated where it is most efficient and productive. However, this concentration of R&D activity and the economic benefits deriving therefrom, while increasing the dynamic efficiency of the EU, will likely exacerbate disparities in real income among member states. Therefore, the economic benefits deriving from such technological innovation which benefit the EU as a whole should be distributed within the EU, through either purposive diffusion of technology, in terms of the distribution of economic activity and employment based on the

use of that technological innovation, for example through FDI, or through the distribution of economic benefits derived from that technological innovation through the EU budget in terms of Cohesion policy.

T he objective of EU economic integration is an increase in the competitiveness of the EU globally and of each of its member states, resulting from an increase in static and dynamic efficiency induced by the Single Market in which *all* member states participate.

Chapter 3

Policy Tools for Competitiveness and Convergence

T he EU operates as an economic entity in the global economy, yet at the same time it consists of 27 member states which operate as individual national economic entities in the global economy and within the EU. However, although they are part of the EU economy, the EU member state economies are not similar. As the EU increased in terms of member states it became increasingly heterogenous in terms of the member state economies which it comprised. Thus the EU has to walk two paths: on the one hand it has to continue to ensure the competitiveness of the EU in the global economy and the prosperity derived therefrom, and on the other hand it has to balance the growth and development of its member states. Of importance is the reduction in disparities in terms of economic prosperity between the member state economies. This is important for two reasons. First, if large disparities among member states persist, the EU will be perceived as unfair and will lose political support. Second, if the EU results in costs to member states that do not outweigh the benefits of EU membership, such as low economic growth, unemployment and fiscal imbalances, the EU may lose economic feasibility and political support.

Two EU policies are applicable in this respect. Europe 2020 which is outward looking, in other words a strategy for the EU in terms of its competitive position in the global economy, and Cohesion policy which is inward looking, in other words a policy for the EU in terms of its balanced economic growth and development and social and economic convergence among its member states.

E urope 2020 is the EU's strategy for promoting the EU's global competitiveness and long term economic growth by developing a dynamic and knowledge based economy (EuropeanCommission (2010a)). Europe 2020 emphasises the role of innovation and technology as the key driver of the EU's global competitiveness and long term economic growth (EuropeanCommission (2010a)). Specifically, this 'smart growth' strategy focuses on promoting investment in innovation, knowledge and human capital. To this end Europe 2020 focuses on a number of targets to be achieved by 2020, specifically:

1. to increase its investment in R&D to 3% of GDP[1]
2. to increase its employment rate to 75%[2]
3. to increase education attainment by increasing the tertiary education attainment rate to 40% of the population[3] and by reducing the early school leaving rate to 10%[4]

C ohesion policy is the EU's regional policy through which it aims to promote regional competitiveness and employment and to reduce social, economic and territorial disparities across regions (EuropeanUnion (2006c)). For the 2007-2013 programming period Cohesion policy was the second largest item on the EU budget, after Common Agricultural Policy, being allocated €347 billion, equivalent to 35.7% of the total EU budget (EuropeanCommission (2013c)).[5]

[1]This target relates to input into rather than output of R&D and innovation. The European Commission proposes to develop an indicator that reflects the intensity of R&D and innovation (EuropeanCommission (2010a)).

[2]This target relates to employment of the population aged 20-64 and envisages an increase in the employment rate from 69% (EuropeanCommission (2010a)).

[3]This target relates to the education attainment of the population aged 30-34 and envisages an increase in the tertiary education attainment rate from 31% (EuropeanCommission (2010a)).

[4]This target relates to early school leavers and envisages a decrease in the drop out rate from 15% (EuropeanCommission (2010a)).

[5]The EU budget is relatively small, amounting to 1.12% of EU GNI (EuropeanCommission (2013b))

For the 2007-2013 programming period Cohesion policy has three objectives receiving 81.5%, 16% and 2.5% of the Cohesion policy budget respectively[6], specifically:

1. Convergence
2. Competitiveness and Employment
3. European Territorial Co-operation

The convergence objective, which receives by far the largest portion of Cohesion policy funds, aims to reduce regional disparities.[7] Regions whose GDP per capita is below 75% of the average EU GDP per capita are eligible for convergence objective funds. However, regions whose GDP per capita is above this threshold *only because the 2004 and 2007 EU accessions reduced the average EU GDP per capita* are classified as 'phasing out' regions and continue to receive convergence objective funds until 2013.[8] In addition to the allocation of funds on this basis, member states, as opposed to regions, whose GNI per capita is below 90% of the average EU GNI per capita are eligible to receive funds from the Cohesion fund.[9] The Cohesion fund was established with the 2004 accession in order to support the convergence objective; although eligible members include old member states Greece, Portugal and Spain (EuropeanUnion (2006a)).

The competitiveness and employment objective aims to create jobs by promoting regional competitiveness in order to attract business and investment (EuropeanUnion (2006c)).[10] Regions are eligible for competitiveness and employment objective funds if they are not eligible for convergence objective funds. In other words, competitiveness and employment objective funds are allocated to *richer* regions in order to assist them in increasing their competitiveness through *inter alia* innovation, and education and training programmes. Regions who had previously been eligible to receive convergence objective funds

[6]For the 2007-2013 programming period Cohesion policy has a total budget of €347 billion. This budget is funded by the ERDF, ESF and the Cohesion fund, having budgets of €201 billion, €55 billion and €70 billion respectively.

[7]For the 2007-2013 programming period the convergence objective has a budget of €283 billion which amounts to 81.5% of the total Cohesion policy budget

[8]The 2004 and 2007 EU accessions significantly increased the EU population

[9]For the 2007-2013 programming period the Cohesion fund has a budget of €70 billion which amounts to just under 25% of the convergence objective budget.

[10]For the 2007-2013 programming period the competitiveness and employment objective has a budget of €55 billion which amounts to 16% of the total Cohesion policy budget.

are classified as 'phasing in' regions and receive additional funding to assist them in the competitiveness and employment objective (EuropeanUnion (2006c)).

C ohesion policy for the 2007-2013 programming period shows an increased alignment with the objectives of Europe 2020 (previously the Lisbon Agenda). Cohesion policy shows a significant emphasis on using cohesion policy funds for investment in knowledge and innovation, with more than €85 billion allocated to such investments (EuropeanCommission (2007)). €49.5 billion of this is allocated to investments aimed at the generation of innovation and new technology, such as investments that improve the capacity for innovation in firms and investment in R&D (EuropeanCommission (2007)), where such investment relies on the exploitation of existing "poles of excellence" (EuropeanCommission (2007), p7) or the improvement of existing capacity. The remainder is allocated to investments aimed at the diffusion and use of technology, specifically ICT, and the creation of employment through skills development and a more flexible and entrepreneurial business environment (EuropeanCommission (2007)). Indeed the European Commission's seventh progress report towards the 2014-2020 Cohesion policy programming period proposes that Cohesion policy investments should be selected on the basis of "the biggest contribution to smart, sustainable and inclusive growth" (EuropeanCommission (2011), p5) and by taking into consideration the Europe 2020 targets (EuropeanCommission (2011)).

The use of Cohesion policy in the delivery of the objectives of Europe 2020 is enforced through 'earmarking' provisions which influence the member states' allocations of cohesion funds. 'Earmarking' obliges EU15 member states and encourages EU12 member states to allocate the majority of cohesion policy funds to programmes that are aligned to Europe 2020 objectives such as *inter alia* investment in R&D, innovation and human capital. For the 2007-2013 programming period, the earmarking targets for the convergence objective and the competitiveness and employment objective are 60% and 75% respectively of the total allocated cohesion policy funds (EuropeanCommission (2007)). In total more than two thirds of cohesion policy funds are 'earmarked' for Europe 2020 objectives. Under the convergence objective, 65% of total cohesion policy funds are 'earmarked'; 74% and 59% of funds allocated to EU15 and EU12 respectively. Under the competitiveness and employment objective, 82% of total cohesion policy funds are 'earmarked'; 83% and 59% of funds allocated

to EU15 and EU12 respectively, although the number of programmes in EU12 under this objective is limited (EuropeanCommission (2007)). The largest portion of allocated funds under the convergence objective is 'earmarked' by Austria, United Kingdom and Belgium, and under the competitiveness and employment objective the largest portion of allocated funds is 'earmarked' by the Nordic countries—Sweden, Denmark and Finland—as well as Austria and United Kingdom (EuropeanCommission (2007); Nordregio (2009)).

Clearly, Cohesion policy has become one of the key delivery mechanisms through which the EU aims to deliver Europe 2020. This role has been assigned to Cohesion policy based on the premise that investment in innovation and R&D on a regional level throughout the EU will boost the EU's global competitiveness and long term economic growth while at the same time boosting regional development and economic growth. Furthermore the provisions for 'earmarking' cohesion policy funds ensure both that national strategies are strategically co-ordinated towards achieving the objectives of Europe 2020 and that significant resources, including those of member states, are directed towards those objectives.[11] Studies of disaggregated earmarking data have shown that there has indeed been a shift in the focus of cohesion policy programmes towards R&D and innovation away from infrastructure (Mendez (2011)).This shift is evident even in EU12 member states, such as Poland, Slovenia, Slovakia, Latvia, Cyprus and Czech Republic, who are not obliged to 'earmark' cohesion funds and who still require major investment in basic infrastructure (Mendez (2011)).

Thus Cohesion policy has evolved to achieve a double objective: competitiveness and cohesion. From the discussion above, it is apparent that the focus of Cohesion policy is shifting increasingly towards the promotion of EU competitiveness. This is evidenced by funds being allocated towards the competitiveness and employment objective, for which convergence regions are not eligible, as well as by the earmarking provisions. These attributes of Cohesion policy result in a significant portion of funds being diverted away from the most lagging member states to member states that are already relatively more, or in cases highly, competitive. Furthermore funds are diverted away from basic investment needs, such as infrastructure, to 'earmarked' programmes in lagging member states. In fact, competitive and technologically advanced EU15

[11]The Cohesion policy principle of additionality requires member state co-financing, stating that Cohesion policy funds should not replace the national or equivalent expenditure by a member state, which should, as a general rule, at least be equal to the amount of average annual expenditure in the previous programming period (EuropeanUnion (2006c)).

member states, including Denmark, Finland, Ireland, Netherlands, Sweden and United Kingdom, were able to allocate Cohesion policy funds allocated under the competitiveness and employment objective to invest in national strategies that promote innovation driven growth due to the alignment in national and Europe 2020 objectives (Mendez (2011)). For example, Denmark, one of the EU's, and the world's, most competitive countries, was able to invest 80% of its total allocation (€0.6 billion) towards investment in R&D and innovation in line with its national strategy based on the OECD's 'growth drivers' (Mendez (2011)).[12] Similarly, the Netherlands, another of the EU's, and the world's, most competitive countries, was able to invest 49% of its total allocation (€1.9 billion) towards knowledge economy, entrepreneurship and innovation objectives which included investment in several innovation clusters and innovation programmes in line with its national strategy of "backing winners" (Mendez (2011), p528).[13] Clearly such investments which enhance the competitiveness of already competitive member states using Cohesion policy funds are contrary to the spirit of cohesion and can only exacerbate disparities among member states. It does not seem sensible that the most competitive and technologically advanced economies in the EU continue to receive funds which further enhance their competitiveness under a policy the objective of which is to reduce social and economic disparities and to accelerate economic growth and development in the most lagging economies.

T he role of Cohesion policy has evolved over the years since the inception of the European Economic Community in 1957 from a policy tool essentially focused on intergovernmental budgetary transfers to one focused on regional development and economic growth (Mendez & Manzella (2009)). Following the signing of the Treaty of Rome in 1957, which *inter alia* aims to ensure "harmonious development by reducing the differences existing between the various regions and the backwardness of the less favoured regions" (EuropeanCommunity (1957), Article 2, p4), Community regional policy operated as an intergovernmental redistribution mechanism through funds established in favour of least-favoured regions (EuropeanCommunity (1977); Armstrong (1978)).

[12]Denmark was ranked 3 in The Europe 2020 Competitiveness Report 2012 and 8 in The Global Competitiveness Index 2012, both of which are compiled by the World Economic Forum (WEF (2012a;b)).

[13]The Netherlands was ranked 4 in The Europe 2020 Competitiveness Report 2012 and 7 in The Global Competitiveness Index 2012, both of which are compiled by the World Economic Forum (WEF (2012a;b)).

Regional policy was reformed in 1978 due to the recognition that little progress had been made in the way of reducing regional disparities (European-Community (1977)). Furthermore, it was recognised that the establishment of the common market had resulted in increasing the uneven distribution of economic activity and prosperity throughout the Community, especially between the richer regions and the less economically advanced regions who were at a disadvantage in the process of integration into the common market (EuropeanCommunity (1977)). Thus the aims of regional policy became twofold: to reduce existing regional imbalances in regions that were traditionally less developed or experiencing industrial or agricultural restructuring, and to reduce new regional imbalances that may arise as a consequence of further economic integration (EuropeanCommunity (1977)).

The most significant reforms in Cohesion policy took place in 1988. These reforms were induced by the internal market programme and the accession of Spain and Portugal in 1986 (and Greece in 1981) which had resulted in a significant increase in economic disparities among member states. Prior to 1988, Cohesion policy was concerned primarily with regional imbalances resulting from industrial decline and structural unemployment. The recognition that the internal market programme and increasing economic integration may further negatively affect member states whose economies were less competitive shaped Cohesion policy into a tool concerned with aiding economic restructuring and regional economic growth and development (Mendez & Manzella (2009)). This aspect is clearly evidenced by the introduction of the principle of partnership to Cohesion policy which requires the involvement of regional and local governments in the formulation and implementation of Cohesion policy.[14] The partnership principle aims to promote regional development in line with both regional needs and EU objectives, as well as to improve regional administrative and institutional capacities and capabilities through administrative requirements imposed by Cohesion policy.

Thus, since its inception Cohesion policy has evolved from an intergovernmental budgetary transfer mechanism to a regional policy that is implemented primarily through the promotion of regional development in order to promote overall harmonious development and economic and social cohesion, in partic-

[14]The 1988 reforms to Cohesion policy introduced four principles to Cohesion policy: *concentration* on objectives, *programming* involving multi-annual programmes presented by member states and approved by the European Commission, *partnership* with regional and local government, *additionality* requiring member state co-financing as Cohesion policy funds are not a substitute for national expenditure (Mendez & Manzella (2009)).

ular by reducing disparities between the levels of development of the various regions and the backwardness of the least favoured regions (EuropeanUnion (2006b), Article 158, p118).

In the 2007-2013 programming period, with the introduction of the Lisbon Agenda and thereafter Europe 2020, Cohesion policy has assumed the additional role of one of the principal policies through which the Europe 2020 economic growth strategy is to be realised, such that Cohesion policy contributes to smart growth through the integration of regional development and EU global competitiveness objectives (EuropeanUnion (2006c); EuropeanCommission (2010b)). This fusion of regional development and EU competitiveness objectives in Cohesion policy presents some problems, especially for most lagging economies.

First, most lagging economies tend to lack the institutional capacity required for administering programmes relating to innovation and investment in R&D. In general the majority of most lagging economies tend to lack the institutional capacity required for the effective absorption of Cohesion policy funds. Second, the objectives of EU competitiveness are likely to be incompatible with regional development objectives of most lagging economies since these economies are at a stage of economic development which is much less advanced than that of the EU. Third, the nature of innovation and R&D activity lends itself to developed and competitive economies and concentration since innovation is driven by competitiveness in large markets and benefits from economies of scale, collaboration and spillovers.

Firstly, lagging economies tend to lack the institutional capacity required for administering Cohesion policy due to lack of skills and experience; even more so they tend to lack the institutional capacity required for administering Cohesion policy programmes relating to innovation and investment in R&D (IsmeriEuropa (2010; 2012)). The administration of Cohesion policy requires the design, implementation, monitoring and evaluation of Cohesion policy programmes (IsmeriEuropa (2010)). In the 2007-2013 programming period, a number of EU12 experienced significant delays in implementing Cohesion policy programmes due to a lack of absorption capacity, skills and experience. Cohesion policy programmes relating to innovation and investment in R&D showed the most significant delays in terms of the selection of projects for Cohesion policy financing (IsmeriEuropa (2012); EuropeanCommission (2013a)). EU12 tend to lack a culture of innovation and business participation in innovation and R&D, and further they tend to lack governance of innovation and R&D policy (Is-

meriEuropa (2010)). In the 2007-2013 programming period, Cohesion policy funds under the convergence objective in line with Europe 2020 were used to invest in applied research, technology parks, clusters, centres of excellence, incubators and similar kinds of intermediary research institutions, and related infrastructure and equipment; however in EU12 there is some concern about the sustainability of these initiatives; especially since there appears to be a gap in the collaboration between universities and public research institutes, and firms and industry, as well as the lack of an environment that is conducive to enterprise, competitiveness and innovation (IsmeriEuropa (2010)). Furthermore, the earmarking of funds for programmes relating to innovation and investment in R&D within the context of a lack of institutional capacity, especially with respect to administering such Cohesion policy programmes, may result in delays in the implementation of programmes and the selection of projects such that it is more likely that Cohesion funds will not be received at all.[15]

Secondly, the objectives of EU competitiveness are likely to be incompatible with the development objectives of most lagging economies. In particular the earmarking of Cohesion policy funds may cause programmes to be chosen because they are aligned to Europe 2020 even though they may be incompatible with development priorities. Earmarking may divert funds from investments that are more relevant to most lagging economies such as infrastructure, human capital and institutional development (Mancha-Navarro & Garrido-Yserte (2008)). Although it is recognised that innovation and technology are the drivers of long term economic growth, the relative importance of innovation and technology in economic growth depends crucially on an economy's stage of development (WEF (2012b)). Economic growth depends on the productivity of each of the factors of production as well as on the institutional environment and economic environment in which they are embedded (OECD (2009)). These various factors which affect the production capacity and efficiency of an economy are interdependent and mutually reinforcing on each other and on economic growth. Innovation and technology increases the productivity of capital and labour; yet on the other hand, capital and labour are necessary to enable the creation and diffusion of innovation and technology. Furthermore the quality of the institutional and economic environment in which the factors of production are embedded plays a crucial role in creating an environment which is conducive to investment, enterprise, competition and innovation.

[15]Cohesion policy funds are decommitted if they have not been used within two years of their comittment.

Furthermore, significant financial resources are diverted from most lagging economies and their development priorities as a result of the competitiveness and employment objective, under which convergence regions are not eligible for Cohesion policy funds, and the earmarking provisions, under which programmes may be selected in terms of their alignment with Europe 2020 rather than their relevance to development priorities. This diversion of funds from most lagging economies and their development priorities is problematic in that in poorer economies investment in development is constrained by scarce fiscal resources and is unlikely to occur without Cohesion policy funds, whereas richer economies do not face such constraints (Begg (2009)).

Thirdly, the nature of innovation lends itself to developed economies and concentration. Innovation can not be driven by financial resources alone. Innovation is driven by competitiveness and the incentive to gain market power and to earn profit. In a competitive environment firms are driven to innovate in order to remain competitive and to stay in business. Having said this firms are the key drivers of innovation in an economy, and their demand for innovation is essentially the key driver of innovation and technology. In this light the business environment is the setting for the demand of innovation and the research environment, be it public or private, and its application to commercial objectives, as well as accumulated knowledge in public and private entities is the supply of innovation. Together innovation demand and supply create the market for innovation and it is the efficient functioning of this market which ultimately results in innovation and the creation and application of new technology.

The capacity for innovation and technology in an economy is determined by both the productivity of factors of production and the institutional and economic environment in which the factors of production are embedded. Various factors influence the productivity of factors of production, for example efficient infrastructure, highly skilled, educated and trained human capital, and the accumulation and application of knowledge and technology in both public and private entities. Various factors influence the efficient functioning of the market for innovation market, for example the quality of institutions, laws and regulations that favour innovation and the enterprise environment; primarily a competitive environment.

Furthermore the capacity for technological innovation is determined by scale and concentration, particularly with respect to investment in R&D (Rivera-Batiz & Romer (1991)). First and foremost a large market facilitates invest-

ment in R&D because it increases the prospects of profit by increasing returns to scale and reducing the uncertainty of investment in R&D. Concentration of innovation and research activity increases the rate of innovation and technological progress as it attracts capital, including human capital, and allows for collaboration between researchers and spillover effects to researchers and firms. Also, concentration of innovation and research activity increases the level and rate of innovation and technology as it results in an accumulation of knowledge and technology which facilitates discoveries of new ideas, technologies and applications and reduces the likelihood of duplication of effort.

Chapter 4

Literature: Economic Growth, Technological Progress, Economic Integration

Theories of economic growth tend to agree on one thing: technological progress is at the heart of long term economic growth. Although they differ in their formulation as to the determinants of technological progress, theories of economic growth concur that technological progress is the key driver of sustained long term economic growth.

Broadly speaking, theories of economic growth developed in two waves, from neoclassical growth models, during the 1950s and 1960s, in which technological progress is exogenously determined to endogenous growth models, during the 1980s and 1990s, in which technological progress is endogenously determined. Endogenous growth models which are based on the assumption of perfect competition are limited in their ability to explain fully the incentives for technological progress. However, once the assumption of perfect competition is replaced with that of imperfect competition, endogenous growth models explain the incentives for technological progress in terms of market power and profits.

The first wave of economic growth theory occurred during the 1950s and 1960s and relates primarily to neoclassical growth models which are based on the assumptions of perfect competition and constant returns to scale. Neoclassical growth models focus on two aspects of economic growth, namely the determinants of long term economic growth and the variation in economic growth rates across countries.

Neoclassical growth models explain long term economic growth in terms of capital accumulation. However, capital exhibits diminishing returns such that without technological progress, which increases the productivity of capital, long term economic growth would eventually cease. Thus neoclassical growth models show that technological progress, which is exogenously determined and assumed to be constant, is the determinant of long term economic growth.

Neoclassical growth models predict that over the long term, and as a result of diminishing returns to capital, economies tend towards a steady state in which the rate of long term economic growth is constant. When an economy deviates from steady state, its growth rate is determined by its distance from steady state, as a result of diminishing returns to capital: the further an economy is from steady state, the faster it will grow. Neoclassical growth models thus explain the variation in economic growth rates across countries.

The second wave of economic growth theory occurred during the 1980s and 1990s when economic growth theory was revived after a period of dormancy. Research on economic growth stalled after the mid-1960s as neoclassical growth models became highly technical and increasingly empirically irrelevant to development economists and policymakers (Barro & SalaiMartin (2004)).

Research on economic growth during this period focuses on aspects of economic growth which neoclassical growth models fail to explain. First, in neoclassical growth models the determinant of long term economic growth, the rate of technological progress, is exogenously determined. Thus endogenous growth models focus on the determinants of technological progress in order to determine the long term economic growth rate endogenously. Second, neoclassical growth models predict constant long term economic growth rates which is contrary to observations of increasing long term economic growth rates. Thus endogenous growth models include production functions that exhibit increasing returns to scale in order to explain increasing long term economic growth rates.

Endogenous growth models endogenise the determinants of technological progress and explain increasing long term economic growth in a variety of formulations, including capital accumulation in the form of human capital, positive spillovers resulting from investment in both physical and human capital, and inputs such as knowledge that generate positive externalities. Initially, endogenous growth models maintained the assumption of perfect competition. In order to do this, increasing returns to scale deriving from technological progress are assumed to be external to the firm. Since firms derive no benefit from technological progress, they have no incentive to invest in technological

progress. However, once the assumption of perfect competition is replaced with that of imperfect competition, firms are able to internalise increasing returns to scale deriving from technological progress, which enables them to earn profits and to receive compensation for investment in technological progress. In this way market power and the profit derived therefrom provides the incentive for investment in technological progress.

The revival of economic growth theory during the 1980s and 1990s, and the accompanying wave of new economic growth theories, led to numerous empirical studies testing the predictions of the neoclassical growth model, and specifically the prediction of convergence to steady state. This empirical research was made possible by the release of new cross country datasets which enabled the comparison of a large number of economies over a long period of time (Barro & SalaiMartin (2004)).[1]

The recent economic growth research, compared to that of the 1960s, places an emphasis on the relationship between theory and empirical data, and on the empirical relevance of economic growth research to development economists and policymakers (Barro & SalaiMartin (2004)).

4.1 Neoclassical Growth Models

In the 1950s and 1960s the most significant contributions to economic growth theory were those of Solow (1956) and Swan (1956) who contributed to the development of the neoclassical growth model as it is known today.

Solow (1956) built on the work of Harrod (1939) and Domar (1946) by relaxing the assumption that labour cannot be substituted for capital in production; in other words the proportion of capital and labour need not remain fixed in the production function (Harrod (1939); Domar (1946); Solow (1956)). This strict assumption in the Harrod-Domar model predicts that long term economic growth is "at best balanced on a knife-edge of equilibrium growth" (Solow (1956), p65). The Harrod-Domar model was accepted in its time, having been developed after the Great Depression; although today it plays a small role in the academic literature (Barro & SalaiMartin (2004)).

The following section presents a brief overview of the basic neoclassical growth model as it forms the basis for much of the economic growth literature.

[1] For example, Maddison (1982); Summers & Heston (1991)

The neoclassical growth model is based on two key equations: the production function and the capital accumulation equation.

The production function describes the combination of inputs into the production function in the form of capital and labour, and the resulting output.[2]

$$Y = F(K, L) = K^{\alpha} L^{1-\alpha} \tag{4.1}$$

where

Y = output
K = capital
L = labour
α = denotes the relative proportion of capital and labour

The production function is assumed to exhibit constant returns to scale and diminishing returns to capital.

Furthermore, it is assumed that competition is perfect: there are no economic profits. The returns paid to capital are equal to the marginal product of capital and wages paid to labour are to equal the marginal product of labour. Output is used entirely to compensate capital owners and labour.

The capital accumulation function describes the rate at which capital accumulates. Capital increases with investment in capital and decreases with depreciation.

$$\dot{K} = sY - dK \tag{4.2}$$

where

$\dot{K}$ = change in the capital stock
s = savings rate
d = depreciation rate

In the model it is assumed that capital owners and labour save a proportion of their compensation and that the remainder is used for consumption; the savings rate, s, is assumed to be constant over time and exogenously de-

[2]The neoclassical growth model was initially formulated excluding technology.

termined. Further, it is assumed that the economy is closed so that all savings are invested and all investments are used to accumulate capital. Depreciation of capital occurs during the process of production; the depreciation rate, d, is assumed to be constant and independent of the amount of output produced.

Since GDP per capita is the variable of interest in describing economic growth, the production function and capital accumulation equations are rewritten in per capita terms, specifically output per worker and capital per worker as follows:[3]

$$y = k^{\alpha} \tag{4.3}$$

where

$$y = \text{output per worker}$$
$$k = \text{capital per worker}$$

and

$$\dot{k} = sy - (n + d)k \tag{4.4}$$

where

$$\dot{k} = \text{change in capital per worker}$$
$$n = \text{population growth rate}$$

In the model it is assumed that the population growth rate is constant over time and exogenously determined.

Hence the mechanics of the model: Output per worker is dependent on the capital-labour ratio and is proportional to capital per worker. The growth rate of output per worker is equal to the growth rate of capital per worker. The growth rate of capital per worker is determined by the savings rate, the

[3]In this description of the model GDP per capita will be used interchangeably with output per worker. Strictly speaking the model is formulated in terms of output per worker, y, and capital per worker, k. In the model it is assumed that the labour force participation rate is constant so that the proportion of workers to the total population is constant. It is convenient to assume that the labour force participation rate is 1, so that every member of the population is also a worker and therefore output per worker is equivalent to GDP per capita.

population growth rate and the depreciation rate, all of which are exogenously determined and assumed to be constant. Thus the growth rate of capital per worker and therefore output per worker is determined exogenously.

A concept central to the neoclassical growth model is that of diminishing marginal productivity of capital. This concept of diminishing returns implies that the productivity of capital diminishes with each additional unit of capital; in other words, output increases at a decreasing rate for each additional unit of capital so that the increase in output derived from one additional unit of capital is less than the increase in output derived from the previous unit of capital. By implication, the lower an economy's capital per worker, the higher will be the contribution to output from an additional unit of capital and the higher will be the economy's growth rate. Thus the growth rate of output per worker diminishes as capital increases and therefore long term economic growth diminishes and eventually ceases to zero.

Deriving from the concept of diminishing returns to capital, the neoclassical growth model predicts that over the long term economies tend towards steady state. When in steady state an economy grows at a constant rate; the growth rate of output per worker is equal to the growth rate of capital per worker which is zero in the absence of technological progress. If an economy deviates from its steady state, this deviation from steady state will result in a change in growth rate which will last only temporarily until the economy adjusts and returns once again to its steady state. If an economy is below its steady state, it will grow at a faster rate until it reaches its steady state, and, due to the assumption of diminishing returns, the further below its steady state an economy is, the faster it will grow. Conversely, if an economy is above its steady state, it will grow at a slower rate. Therefore the neoclassical growth model predicts that the distance of an economy from its steady state will determine its growth rate and that the growth rate will be positively related to the distance from steady state (SalaiMartin (2006)). This is the concept of convergence.

The prediction that over the long term economies tend towards a long term economic growth rate equal to zero is contrary to observations of long term economic growth rates that are positive and tend to remain so over long periods of time. Thus, an element of technological progress was added to the neoclassical growth model such that technology was included as an input into the production function. Solow (1957) defines technological change to include "any kind of shift in the production function" including "slow downs, speed ups, improvements in the education of the labor force, and all sorts of things"

(Solow (1957), p312). Thus, for a given amount of inputs in the form of capital and labour, technological progress enables a larger quantity of output to be produced or alternatively, a given quantity of output can be produced with fewer inputs in the form of capital and labour. In this way the neoclassical growth model predicts that the rate of growth in capital per worker and output per worker is positive and equal to the rate of technological progress. The rate of technological progress is determined exogenously and assumed to be constant.

Thus, the neoclassical growth model predicts that the rate of technological progress determines the rate of long term economic growth, although the rate of technological progress, and by implication the rate of long term economic growth, is exogenously determined. Furthermore, the rates of saving, population growth and depreciation which determine the rate of capital accumulation are also exogenously determined and assumed to be constant.

Cass (1965) and Koopmans (1965) independently extended the Solow-Swan model by endogenously determining the savings rate. Cass (1965) and Koopmans (1965) based the determination of the savings rate on Ramsey (1928)'s savings model. Ramsey (1928), in addressing his question of "how much of its income should a nation save?" (Ramsey (1928), p543), developed a model which determines the proportion of income an economy should save in order to maximize its future consumption utility across time. Ramsey (1928) assumes a constant population and a constant level of technology.

The Ramsey-Cass-Koopmans neoclassical growth model is based on the same assumptions as those in the Solow-Swan model, apart from the endogenously determined savings rate (Cass (1965); Koopmans (1965)).

In the Ramsey-Cass-Koopmans model the predictions of steady state and convergence continue to hold, deriving from diminishing returns to capital. When in steady state an economy grows at a constant rate; in steady state the growth rate of capital per worker and output per worker are equal to the growth rate of *consumption per worker*, all three of which are equal to the rate of technological progress. The rate of technological progress is exogenously determined and assumed to be constant.

In the 1980s and 1990s during the revival of economic growth theory numerous empirical studies testing the predictions of the neoclassical economic growth model, and specifically the prediction of convergence to steady state, were conducted.

The results of such empirical research on convergence were mixed. The results of empirical research that was conducted based on samples of heteroge-

nous economies across the world showed that there was a lack of convergence worldwide. Indeed in some cases divergence seemed to be taking place (*inter alia* DeLong (1988); Romer (1986)). In the midst of the wave of new economic growth theory and new models of endogenous economic growth these results were interpreted as a failing in the predictions of the neoclassical growth model. However when such research was conducted based on samples of economies sharing similar characteristics, the results showed that convergence was taking place. This led to the notion that economies did not necessarily have the same steady state, but rather belonged to "convergence clubs" (Baumol (1986), p1079), being a group of economies that had similar characteristics and therefore similar steady states. As a result the distinction between the concepts of conditional and absolute beta convergence was made, where absolute beta convergence takes place only in the case when economies have similar steady states (Barro & SalaiMartin (1991; 1992); SalaiMartin (2006)).[4] Once this distinction was taken into account in empirical research, the results showed that convergence between countries tended to be in line with the predictions of the neoclassical growth model (*inter alia* Mankiw *et al.* (1992); Barro & SalaiMartin (1991; 1992); Barro (1996); Baumol & Wolff (1988)). On the contrary, Quah (1996) suggests that convergence is not taking place; instead economies are diverging such that the world income distribution will form "twin peaks", one on either end of the income distribution (Quah (1996)).

4.2 Endogenous Growth Models

4.2.1 The Economic Nature of Technology

The concepts presented here relate to theories of endogenous economic growth and are based on Romer (1990).

The costs related to the development and use of technology require imperfect competition.

Technological innovation is generated primarily through investment in R&D. Investment in R&D has a fixed cost associated with it and an uncertain outcome. The increase in investment in R&D does not result in a proportionate increase in technology; in fact investment in R&D may yield no investment at all.

[4]The concept of absolute beta convergence is that poor economies grow faster than rich economies. Convergence is discussed in detail in Chapter 5.

Once new technology has been developed, it's use has no additional costs and it can be used over and over again. In other words the marginal cost of the use of technology is zero. That is, the cost of the use of that technology to produce an additional unit of output is zero; the only costs incurred are those of capital and labour.

Under the assumption of perfect competition, firms are price takers and all inputs are compensated at their marginal product: capital is compensated at the marginal product of capital, labour at the marginal product of labour. However, since the marginal product of technology is zero it receives no compensation *even though a fixed cost has been incurred to develop that technology.*

Under the assumption of perfect competition, this cost structure has two important implications. First, firms, being price takers, make losses as they are not compensated for the fixed cost of their investment in the development of technology since the marginal product of technology is zero. Consequently they have no incentive to invest in the development of technology. Only if firms are able to derive compensation for their investment in the development of technology, will they have an incentive to do so. This requires the assumption of imperfect competition and the ability to exclude others from the use of that technology.[5] Furthermore, the profits resulting from the development of that technology, either through increased productivity and reduced costs or the ability to receive a higher price, provide an additional incentive to invest in the development of technology.

Second, the nonrivalrous[6] nature of technology results in increasing returns to scale. Whereas the required quantities of inputs of capital and labour increase in proportion to increases in production, the required quantity of input of technology does not since technology, once developed, can be used over and over again. Furthermore, increases in production reduce the fixed costs associated with investment in the development of technology.

4.2.2 Endogenous Growth Models

Arrow (1962), prior to the wave of endogenous economic growth models in the 1980s and 1990s, endogenises the rate of technological progress by assuming that increases in productivity are the result of "learning by doing"—the ac-

[5]Excludability is a legal and technological attribute. A good is excludable if the owner can prevent others from using it (Romer (1990))

[6]Rivalry is a purely technological attribute. A good is nonrivalrous if its use by one entity in no way limits its use by another (Romer (1990))

cumulation of knowledge and experience—during the production process. Increases in productivity result in increasing returns to scale; however these are external to the firm since it is assumed that technological progress resulting from "learning by doing" is immediately publicly available and not compensated by the market. Thus there is no incentive to invest in the development of technology. Furthermore such technological progress is a by-product of production and does not incur any costs; capital and labour are paid their marginal products. Thus the assumption of perfect competition is maintained. An important implication of "learning by doing" is that producers with an "early start" have a comparative advantage as they have a higher stock of knowledge and experience relating to the production process; investment in capital benefits producers in the present and in the future. Arrow (1962) does not take into account explicitly the accumulation of knowledge and experience outside of the production process and the effect of the quality of the labour force on productivity.

Romer (1986) endogenises technological change by including knowledge as an input into the production function. Crucially, knowledge has increasing marginal product, as distinct from the other factors of production capital and labour, which results in a production function that exhibits increasing returns to scale. The assumption of perfect competition is maintained as increasing returns are assumed to be external to the firm, as in the case of Arrow (1962).

Lucas (1988) endogenises technological change by including human capital as an input into the production function, as an alternative or complement to technological change, in a way similar to that of Arrow (1962) and Romer (1986). Lucas (1988)'s concept of human capital refers to the skill level of labour and it is accumulated through both "learning by doing" and education. Human capital affects current productivity, but it also affects the future accumulation of human capital. In the case of a closed economy, the initial endowment of human capital will determine the steady state, so that economies with a low initial human capital will reach a lower steady state and remain poorer although their long term economic growth rate may be similar to that of richer economies with a high initial human capital. In the case of an open economy, human capital accumulation through "learning by doing" is related to the production of goods in which that economy specialises, so that economies which specialise in goods with a low potential for the accumulation of human capital will accumulate human capital at a lower rate, and by implication, will have a lower economic growth rate. In this sense human capital accumulation

will intensify the comparative advantages amongst economies over time, and divergence between poorer and richer economies.

Romer (1990) first introduces the assumption of imperfect competition into the endogenous growth model because the assumption of perfect competition is incompatible with the determinants of technological progress: investment in R&D is driven by the incentive to gain market power and to earn profit. Romer (1990) is based on the neoclassical growth model augmented for the assumption of imperfect competition which allows market participants to be compensated for their investment in R&D, and furthermore provides an incentive for firms, in the form of profits, to invest in R&D. In contrast to previous models, Romer (1990) shows increasing returns to scale to be internal to firms and thus explains the incentive to invest in the development of technology. Romer (1990) emphasises the significant positive effect of human capital on long term economic growth through its role in contributing to R&D.

Grossman & Helpman (1991) and Aghion & Howitt (1992) made significant contributions to Romer (1990)'s R&D based economic growth model. These endogenous growth models are based on Schumpeter (1943)'s idea of competition; competition which is not perfect competition but rather "the competition from the new commodity, the new technology, the new source of supply, the new type of organization. . . —competition which commands a decisive cost or quality advantage and which strikes. . . at their [firms] foundations and their very lives" (Schumpeter (1943), p84). However, these endogenous growth models predict that the long term economic growth rate is proportional to the amount of R&D undertaken which is based on the number of researchers as a proportion of the population. Therefore these models are problematic in that an increase in the population results in an increase in long term economic growth. Subsequent research made various adjustments for such effects of scale on economic growth; however scale either in terms of the population or GDP per capita is shown to play a significant role in long term economic growth (Jones (1999)).

4.3 Economic Integration

The theories of long term economic growth discussed above relate primarily to a closed economy. This section presents literature relating to international trade and economic integration and their relationship to long term economic growth.

Balassa (1961) defines economic integration in terms of varying degrees of integration ranging from a free trade area to total economic integration which requires monetary, fiscal, social and countercyclical policies as well as a supranational authority whose decisions are binding for the member states.

Viner (1950) was one of the first contributors to the study of the welfare effects of preferential trade and economic integration resulting from static efficiency. Balassa (1965) expanded Viner (1950)'s analysis to include the welfare effects of economic integration resulting from dynamic efficiency; that is, the effects of scale economies and technological innovation on long term economic growth. Balassa (1965) distinguishes the welfare effects of economic integration between those arising from an increase in real income and those arising from the redistribution of real income; thus recognising that economic integration affects the geographical distribution of economic activity and real income (Balassa (1965)).

Theories on the determinants of international trade and economic integration, as with theories on the determinants of long term economic growth, generally remained within the framework of perfect competition and static efficiency which explained international trade in terms of the allocation of resources among countries. International trade theory was based primarily on factor proportions theory, which was derived from the concepts of comparative advantage and relative factor endowments (Ricardo (1817); Heckscher (1919); Ohlin (1933)); although the effects of economies of scale on international trade had been recognised (Young (1928); Balassa (1965)).

The effects of increasing returns to scale on international trade were increasingly recognised in the 1970s and 1980s which led to the development of new trade theory. At first, international trade models included increasing returns to scale but continued to be formulated such that increasing returns to scale were external to firms in order to maintain the assumption of perfect competition.

Krugman (1979) first formulated a model based on the assumption of imperfect competition in which increasing returns to scale were internal to firms.[7] Krugman (1979) shows that international trade occurs even if countries have identical factor endowments and technology, which is contrary to factor proportions theory. Instead Krugman (1979) shows that international trade is determined by profits derived from increasing returns to scale which are internal to firms. Krugman (1979) shows that increases in the market increase

[7]Krugman (1979)'s model incorporates a market structure of monopolistic competition based on Chamberlin (1962).

economies of scale in production due to increased consumption. This idea goes back to Smith (1776) that the division of labour is limited by the extent of the market. Krugman (1979) defines the market in terms of labour force.[8] In the context of monopolistic competition economies of scale result in increasing returns to scale which are internal to firms, decreasing prices and increasing real wages. An increase in the market occurs through trade, in which both trade partners benefit from an increase in the market; producers benefit from economies of scale and increasing returns to scale, and consumers benefit from decreasing prices and a greater quantity and variety of goods for consumption. Economies of scale resulting from trade induce agglomeration economies as producers seek monopolistic profits, and may induce migration towards agglomeration economies in which consumers seek higher real wages, lower prices and a larger quantity and variety of goods for consumption. The location of agglomeration economies depends on the initial distribution of the market, or in Krugman (1979)'s terms: the initial distribution of the labour force.

On the contrary Romer (1990), based on his model of endogenous economic growth, emphasises that the market is defined in terms of human capital as opposed to labour force and that it is a high level of human capital, not a large population, which promotes international trade and long term economic growth.

The idea of the significance of a large market on long term economic growth is found also in Rivera-Batiz & Romer (1991), who further expand on the concepts of increasing returns to scale and investment in R&D as the drivers of long term economic growth. Rivera-Batiz & Romer (1991) show that economic integration, which includes both the flow of goods and ideas, can increase long term economic growth of integrated economies if the R&D sector benefits from economies of scale and increasing returns to scale, even if economies have identical factor endowments and technology. An integrated R&D sector increases efficiency of investment in R&D as the overall fixed costs relating to the development of (the same) ideas do not need to be incurred more than once. Furthermore an integrated R&D sector increases productivity of investment in R&D as it increases the overall stock of knowledge from which future ideas can be derived. The flow of goods and ideas diffuse technology across countries and can increase the benefits of increasing returns to scale in two ways: first, the flow of goods and ideas reduces duplication of effort in generating ideas and

[8]The labour force is equivalent to population, as each member of the population is assumed to be a worker. Furthermore, the labour force represents the consumers.

technology that already exist and second, the flow of goods and ideas increase the availability of ideas and technology that can be used in the generation of future ideas and technology.

Baldwin (1989) distinguishes between the short term and long term effects of economic integration, based on Balassa (1965)'s concept of dynamic efficiency. In the short term, and based on the neoclassical growth model, the efficient reallocation of resources increases the productivity of capital and the economic growth rate; however, due to diminishing returns to scale, the rate of economic growth eventually returns to its steady state although the level of steady state may be increased. In the long term, and based on Romer (1986)'s endogenous growth model, inputs such as knowledge into the production function in the context of a large market result in increasing returns to scale and an increasing rate of economic growth in the long term.

Grossman & Helpman (1990), in a series of papers, use the concept of factor endowments and comparative advantage in the R&D sector to study the effects of R&D and R&D subsidies on international trade and long term economic growth (Grossman & Helpman (1990)). They show that international trade between countries with different initial factor endowments and comparative advantages in the R&D sector will result in the reallocation of resources within each country between the R&D sector and the manufacturing sector, and that the effects on economic growth resulting from this reallocation are complicated and, in cases, indeterminate. For example, if resources are reallocated to R&D in a country that has a comparative disadvantage in the R&D sector, through an R&D subsidy for example, then the resulting reallocation of resources among countries *may* result in decreased innovation and economic growth worldwide as R&D resources within a country that has a comparative advantage in the R&D sector shift out of the R&D sector. On the contrary, if resources are reallocated to R&D in a country that has a comparative advantage in the R&D sector, then innovation and economic growth worldwide must increase (Grossman & Helpman (1990)). Comparative advantage, however, may be acquired through trade if trade increases the rate of human capital accumulation or the rate of technology diffusion.

Baldwin & Venables (1995), in their survey of literature on economic integration, classify the effects relating to economic integration into three categories which are currently widely recognised in the literature relating to economic integration. Allocation effects relate to the static allocation of resources, scale economies and imperfect competition. Accumulation effects relate to the

medium and long term effects of changes in returns on investment which affect the accumulation of capital, including physical, human or knowledge capital. Location effects relate to the location of firms, and linkages and tendencies for the formation of agglomeration economies.

Chapter 5

Convergence in the EU

5.1 The Concept and Measurement of Convergence

There are two concepts of convergence in the classical literature, namely beta convergence and sigma convergence (SalaiMartin (2006)).[1] Beta convergence relates to the speeds at which economies grow over time, whereas sigma convergence relates to the change in disparities in GDP per capita across economies over time. Both beta convergence and sigma convergence are measured in terms of GDP per capita.

5.1.1 Beta Convergence: Conditional and Absolute

The concept of beta convergence derives directly from the neoclassical growth model, specifically its prediction that over the long term economies tend towards steady state as a result of diminishing returns to capital (Solow (1956)).

When in steady state an economy grows at a constant rate. If an economy deviates from its steady state, this deviation from steady state will result in a change in growth rate which will last only temporarily until the economy adjusts and returns once again to its steady state. If an economy is below its steady state, it will grow at a faster rate until it reaches its steady state, and, due to the assumption of diminishing returns, the further below its steady state an economy is, the faster it will grow. Conversely, if an economy is above its steady state, it will grow at a slower rate. Therefore the neoclassical growth model predicts that the distance of an economy from its steady state

[1] This terminology was first introduced by SalaiMartin (1990) (SalaiMartin (2006))

will determine its growth rate and that the growth rate will be positively related to the distance from steady state (SalaiMartin (2006)). This is the concept of *conditional* beta convergence.

The concept of *absolute* beta convergence is that poor economies grow faster than rich economies. The concept of absolute beta convergence, like that of conditional beta convergence, derives from the neoclassical growth model's prediction that over the long term economies tend towards steady state. The difference between conditional and absolute beta convergence, however, is that absolute beta convergence assumes that economies have similar steady states.

When economies have similar steady states, a poor economy grows at a faster rate than a rich economy since it will be further away from its steady state. On the contrary, when economies do not have similar steady states, a poor economy will not necessarily grow at a faster rate than a rich economy because each economy's growth rate is determined by its position relative to its own steady state. For example, a poor economy that is close to its steady state will grow at a slower rate than a rich economy that is far from its steady state.

Steady state can be determined by a variety of factors. Based on the neoclassical growth model steady state is determined by, for example, the stock of capital and labour, and the rates of technological progress, saving and population growth (Solow (1956)). Recent research has determined that other factors such as social preferences and institutional characteristics also play a role in determining steady state (Barro (1996)).

Beta convergence is generally measured by estimating a growth equation in the general form (SalaiMartin (2006)):[2]

$$\gamma_{i,t,t+T} = \alpha - b\log(y_{i,t}) + \epsilon_{i,t,t+T} \tag{5.1}$$

for

$$\gamma_{i,t,t+T} \equiv log(y_{i,t+T}/y_{i,t})/T$$

[2]This equation is based on the assumption that economies have similar steady states

and

$$b = (1 - e^{-\beta T})/T$$

where

$$\begin{aligned} log(y_{i,t+T}/y_{i,t})/T &= \text{annualised growth rate of GDP per capita} \\ \log(y_{i,t}) &= \text{logarithm of initial GDP per capita at time } t \\ T &= \text{length of time between two observations} \end{aligned}$$

If β>0 then *absolute* beta convergence is taking place.

In order to test the hypothesis of conditional beta convergence it is necessary to hold constant the steady state of each economy (SalaiMartin (2006)). This can be done in two ways.

The first method to hold constant the steady state is to include a set of variables that proxy for the steady state of each economy, in other words a set of factors that are specific to an economy and that are likely to determine its steady state (SalaiMartin (2006)). In this case (5.1) is adjusted to:

$$\gamma_{i,t,t+T} = \alpha - b\log(y_{i,t}) + \Phi X_{i,t} + \epsilon_{i,t,t+T} \tag{5.2}$$

where

$$X_{i,t} = \text{vector of variables that hold constant the steady state}$$

If β>0 then *conditional* beta convergence is taking place.

The second method to hold constant the steady state is to include in the sample only economies for which it is reasonable to assume similar steady states (SalaiMartin (2006)). With this method the hypothesis of conditional beta convergence can be tested using (5.1).

The rate of conditional beta convergence is generally faster than the rate of absolute beta convergence as poor economies are likely to be closer to their steady state in the case of conditional beta convergence than to a steady state

which is similar to that of rich economies in the case of absolute beta convergence (Monfort (2008)).

Clearly the results for such a measure of beta convergence are highly dependent on the selection of the model specification, with regards to either absolute or conditional beta convergence and, in the case of conditional beta convergence, on the selection of the set of variables or alternatively the sample of economies to be included to hold constant the steady state (Monfort (2008)).

The use of an average growth rate of GDP per capita to measure convergence may hide the effects of the dynamic characteristics of economic growth and economic shocks on convergence (Quah (1993)).

The measure of beta convergence does not provide information regarding either the changes in the level of GDP per capita or the changes in the distribution of GDP per capita across economies over time, which may be more insightful (Quah (1993); SalaiMartin (2006)).

5.1.2 Sigma Convergence

While the concept of beta convergence relates to the speeds at which economies grow over time, the concept of sigma convergence relates to the change in disparities in GDP per capita across economies over time. Clearly the concepts of beta convergence and sigma convergence are related because a poor economy will have to grow at a faster rate than a rich economy in order to catch up; however, the existence of beta convergence will not necessarily result in sigma convergence (SalaiMartin (2006)). A poor economy may grow at a faster rate than a rich economy but the disparity in GDP per capita may not change over time, for example, if the economies converge to different steady states or if economic shocks push the economies further apart. Therefore, although beta convergence is a necessary condition for sigma convergence to take place, beta convergence alone is not sufficient to result in sigma convergence (SalaiMartin (2006)). Said in a different way, the distribution of GDP per capita across economies may not change over time, although economies may move within that distribution of GDP per capita.

Sigma convergence is generally measured in terms of the standard deviation of a distribution of GDP per capita. Sigma convergence is measured using various other measures also, which include for example the Theil index, the Gini coefficient, the Atkinson index and the Mean Logarithmic Deviation (Monfort (2008)).

This section will focus on two measures of sigma convergence, namely the coefficient of variation and the Theil index.

The coefficient of variation is a measure of the standard deviation of a probability distribution of GDP per capita (TheWorldBank (1999)).

The coefficient of variation is defined as:

$$cv = \sigma/\mu \tag{5.3}$$

where

$$\sigma = \text{standard deviation}$$
$$\mu = \text{mean}$$

The coefficient of variation indicates the degree of variance of GDP per capita in relation to the mean; therefore it is more informative than if the standard deviation were presented on its own (Monfort (2008)).

The Theil index belongs to the Generalised Entropy class of measures, a characteristic of which is that they can be decomposed into components of within-group inequality and between-group inequality (TheWorldBank (1999)), such that:

$$\text{Inequality}_{total} = \text{Inequality}_{within} + \text{Inequality}_{between}$$

In the general formula for the Generalised Entropy class of measures the parameter α weights the distances between incomes at different parts of the income distribution, such that lower values of α correspond to more sensitivity of the measure to changes in the lower tail of the distribution and higher values of α correspond to more sensitivity of the measure to changes in the upper tail of the distribution.

The Theil index has α=1, such that it weights equally the distances between incomes at different parts of the income distribution (Theil (1967); TheWorldBank (1999)).

The Theil Index is defined as:

$$GE(1) = \frac{1}{n}\sum_{i=1}^{n}\frac{y_i}{\bar{y}}log\frac{y_i}{\bar{y}} \tag{5.4}$$

where

$$y_i = \text{GDP per capita of economy i}$$
$$\bar{y} = (\frac{1}{n}) \sum y_i = \text{arithmetic mean of GDP per capita}$$

5.2 Convergence in the EU

This section aims to test the hypothesis of convergence in the EU with respect to both beta convergence and sigma convergence. It is expected that both beta convergence and sigma convergence are taking place in the EU. In the context of significant disparities in GDP per capita across EU member states, the presence of sigma convergence is of greater interest than that of beta convergence, although beta convergence is a necessary condition for sigma convergence to take place. Furthermore sigma convergence relates directly to the objectives of EU Cohesion policy, specifically with respect to the reduction of disparities in GDP per capita across member states.

The measures for beta convergence and sigma convergence are calculated based on real GDP per capita (PPP indexed to 2005 international dollar) for the 27 EU member states. The data are obtained from the Penn World Table 7.1, with 1971 being the earliest available year (Heston *et al.* (2012)). The data are complete for the period 1971-2010 for all countries except for Slovakia, Czech Republic, Estonia, Slovenia, Latvia and Lithuania.[3] For the years in which data are missing, the measures are calculated based on the number of countries for which data are available and the calculations are adjusted accordingly where necessary.[4]

Luxembourg is identified as an outlier. In 2010 Luxembourg's real GDP per capita was I$75,590[5], whereas the next highest GDP per capita in the EU, that of Austria, was I$38,586. Luxembourg's real GDP per capita has been in the region of 1.5 to 2 times that of the next highest GDP per capita during the 1990s and 2000s, showing an increasing trend which started in the second

[3]For Slovakia, Czech Republic, Estonia, Slovenia, Latvia and Lithuania, data are complete for the periods detailed as follows: Slovakia: 1987-2010; Czech Republic, Estonia, Slovenia: 1990-2010; Latvia, Lithuania: 1993-2010

[4]1971-1986: 21 countries; 1987-1989: 22 countries; 1990-1992: 25 countries; 1993-2010: 27 countries

[5]PPP indexed to 2005 international dollar

half of the 1980s. For this reason the measures for beta convergence and sigma convergence excluding Luxembourg are also calculated and presented alongside the measures calculated for the 27 EU member states.

5.2.1 Beta Convergence in the EU

This section aims to test the hypothesis of beta convergence in the EU. The hypothesis will be tested using as an estimate a growth equation in the form (5.1) (SalaiMartin (2006)). It is expected that beta convergence is taking place in the EU.

The measure for beta convergence is calculated based on real GDP per capita for the 27 EU member states for the periods 1993-2010 and 2000-2010. The 1993-2010 period is selected as 1993 is the earliest year for which the data are complete. The 2000-2010 period is selected for comparative purposes as it corresponds to the period selected for the empirical model in Chapter 6.

In testing the hypothesis of beta convergence it is important to make the distinction between conditional and absolute beta convergence by determining whether economies have similar steady states, and to select the model specification accordingly. If economies do not have similar steady states, it is necessary to hold constant the steady state of each economy.

In testing the hypothesis of beta convergence in the EU, it is assumed that the 27 EU member states have similar steady states; thus the model specification in (5.1) is selected as an estimate. This model specification essentially measures absolute beta convergence, where $\beta>0$ indicates that absolute beta convergence is taking place, and β measures the speed of convergence.

It is considered not unreasonable to assume that the 27 EU member states have the same steady state for the following reasons.

The GDP per capita growth rate is plotted against initial GDP per capita for the 27 EU member states (excluding Luxembourg) for the periods 1993-2010 and 2000-2010 as shown in Figures 5.1 and 5.2 respectively.[6] The trend shows that member states with a lower initial GDP per capita tend to grow at a faster rate than member states with a higher initial GDP per capita. This observation corresponds to the concept of absolute beta convergence which holds when economies have similar steady states.

Secondly, the economies of the 27 EU member states are likely to have similar steady states if the factors that determine steady state are similar across

[6]GDP per capita is measured in terms of natural logarithm

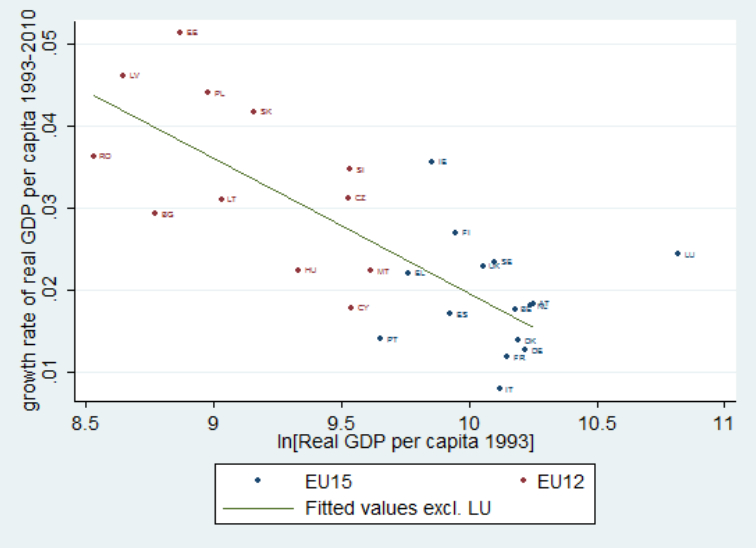

Figure 5.1: GDP per capita and growth rate 1993-2010

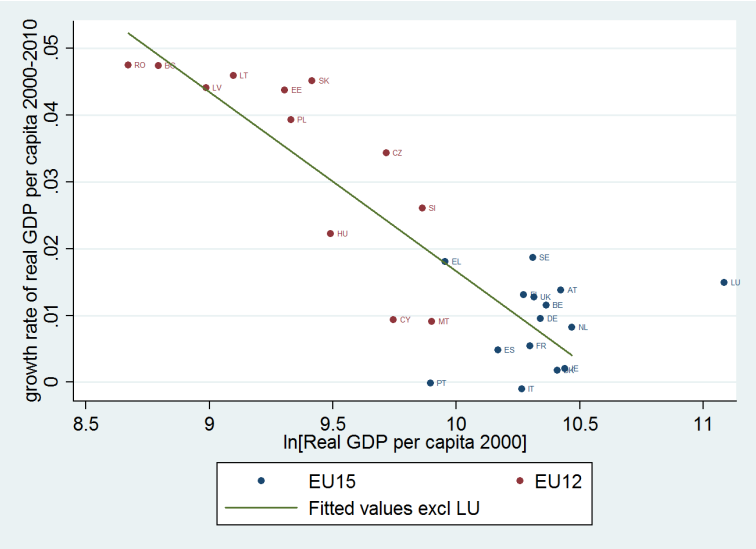

Figure 5.2: GDP per capita and growth rate 2000-2010

those economies. Such factors include, for example, the stock of capital and labour, and the rates of technological progress, saving and population growth, as well as social preferences and institutional characteristics (Solow (1956); Barro (1996)). The 27 EU member states are economically similar when considered on a worldwide level. Furthermore, the factors that determine steady state are relatively similar, particularly institutional characteristics, social preferences with respect to savings, leisure and fertility, as well as factors relating to technological progress, education attainment, rates of investment and population change. In addition, EU economic integration and monetary union and

the Single Market which allows the free mobility of goods, services, labour and capital is likely to induce greater similarity in the factors that determine steady state.

Lastly, the objective of the Treaty on European Union of a high degree of convergence of economic performance as well as the objective of Cohesion policy to reduce disparities across member states implies that the 27 EU member states are likely to have similar steady states (EuropeanUnion (2006b;c)).

Variable	reg1993	reg1993exclLU	reg2000	reg2000exclLU
ln_~20051993	-.01406793***	-.01643476***		
ln_~20052000			-.02332369***	-.02687021***
_cons	.16171446***	.18391593***	.25120477***	.28530191***
N	27	26	27	26
r2	.52610824	.60697791	.68764267	.77081615

legend: * p<.05; ** p<.01; *** p<.001

Figure 5.3: Estimation Results: Absolute Beta Convergence for EU27 and EU27 excluding Luxembourg

The results for the measure of absolute beta convergence in terms of the growth equation estimations for the periods 1993-2010 and 2000-2010 are presented in Figure 5.3.[7]

The variables ln20051993 and ln20052000 are equal to the natural logarithm of initial GDP per capita in 1993 and 2000 respectively, and the related result in the respective columns indicates the value of the b coefficient in (5.1).

The b coefficient is negative and statistically significant for both the 1993-2010 and 2000-2010 periods, whether or not Luxembourg is included in the estimation, which indicates that absolute beta convergence is taking place.

The b coefficient is used to calculate the estimated speed of convergence, β, in terms of (5.1).

The speed of convergence, β, is calculated for the periods 1993-2010 and 2000-2010 at 1.6% per year (1.9% per year excluding Luxembourg) and 2.6% per year (3.1% per year excluding Luxembourg) respectively. $\beta>0$ for both periods indicates that absolute beta convergence is taking place.

The speed of absolute beta convergence is greater for the 2000-2010 period which may be the result of increased convergence due to increased economic integration of EU12 resulting from the 2004 and 2007 EU enlargements, includ-

[7]Columns 1 and 2 present the results for the period 1993-2010, where column 2 presents the results excluding Luxembourg; similarly, columns 3 and 4 present the results for the period 2000-2010, where column 4 presents the results excluding Luxembourg

ing economic integration resulting from pre-accession, or due to the recovery of EU12[8] from the economic shock of transition from planned to market economy which started in 1989. In either case, as reflected in Figures 5.1 and 5.2, the GDP per capita growth rates of many EU12 member states increased in the period 2000-2010. The speed of absolute beta convergence is greater when Luxembourg is excluded for both the 1993-2010 and 2000-2010 periods.

The speeds of convergence, which are in the region of 2%, are in line with the "iron-law" rate of 2% (Barro (2012)). SalaiMartin (2006) estimates the speed of convergence to be within a narrow range centring on 2% per year; and the results of numerous studies of convergence reflect similar speeds of convergence (Barro (1996); SalaiMartin (2006); Barro (2012)). However, a speed of convergence at 2% per year is "quite slow" (SalaiMartin (2006), p1035) since it would take thirty five years to reduce the distance between initial GDP per capita and steady state by half (SalaiMartin (2006)).

In conclusion, the results show that absolute beta convergence is taking place in the EU.

5.2.2 Sigma Convergence in the EU

This section aims to test the hypothesis of sigma convergence in the EU. The hypothesis will be tested using two measures of sigma convergence, namely the coefficient of variation and the Theil index. It is expected that sigma convergence is taking place in the EU.

The measures for sigma convergence are calculated based on real GDP per capita for the 27 EU member states for the period 1971-2010.[9] The data are complete for the period 1971-2010 for all countries except for Slovakia, Czech Republic, Estonia, Slovenia, Latvia and Lithuania.[10] For the years in which data are missing, the measures are calculated based on the number of countries for which data are available and the calculations are adjusted accordingly where necessary.[11]

The measures for sigma convergence are further analysed for both EU15[12]

[8] except for Cyprus and Malta

[9] 1971 is the earliest year for which data are available.

[10] For Slovakia, Czech Republic, Estonia, Slovenia, Latvia and Lithuania, data are complete for the periods detailed as follows: Slovakia: 1987-2010; Czech Republic, Estonia, Slovenia: 1990-2010; Latvia, Lithuania: 1993-2010

[11] 1971-1986: 21 countries; 1987-1989: 22 countries; 1990-1992: 25 countries; 1993-2010: 27 countries

[12] EU15 are the 'old' member states, including member states that acceded to the EU prior

and EU12[13] separately in order to determine whether sigma convergence is taking place within each of these two groups, as well as to analyse the sources of sigma convergence (or divergence) between the 27 EU member states.

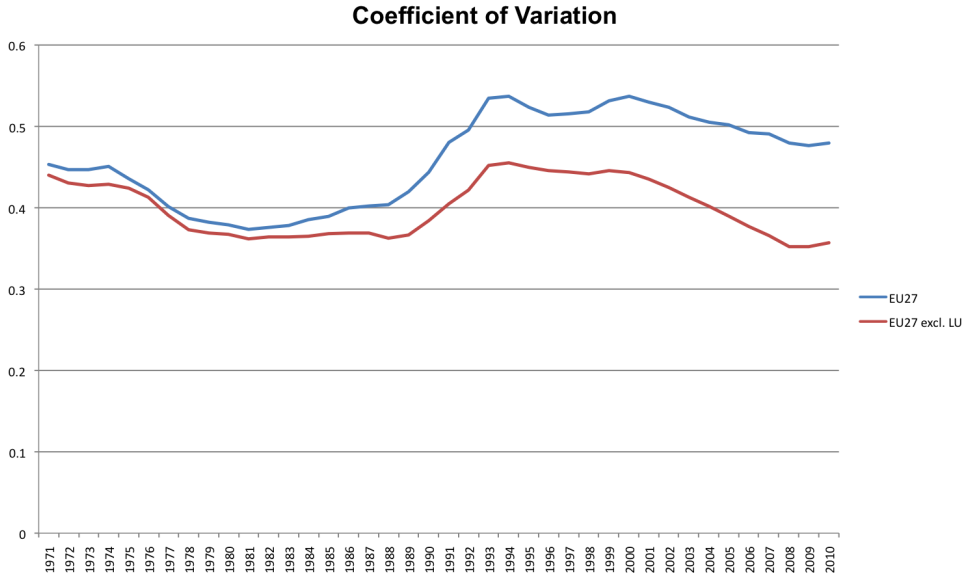

Figure 5.4: Coefficient of variation for EU27 and EU27 excluding Luxembourg

The results for the measures of sigma convergence for the 27 EU member states in terms of the coefficient of variation and the Theil index are presented in Figures 5.4 and 5.5 respectively.

The coefficient of variation and the Theil index for the 27 EU member states show a similar trend for sigma convergence. The variance in GDP per capita is at its lowest levels during the late 1970s and 1980s. In 1989 the variance in GDP per capita increases significantly, to its highest levels, and remains at these high levels during the 1990s, decreasing again only after 2000 to levels not quite as low as those seen in the late 1970s and 1980s.

The significant increase in the variance in GDP per capita in 1989, to its highest levels, corresponds to the start of the transition from planned to market economy for the transition economies in EU12; this transition caused a significant economic shock to the transition economies. The transition economies, previously relatively homogenous in an economic sense due to their being part

to 2004: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom

[13]EU12 are the 'new' member states, including member states that acceded to the EU in 2004 or thereafter: Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, Romania

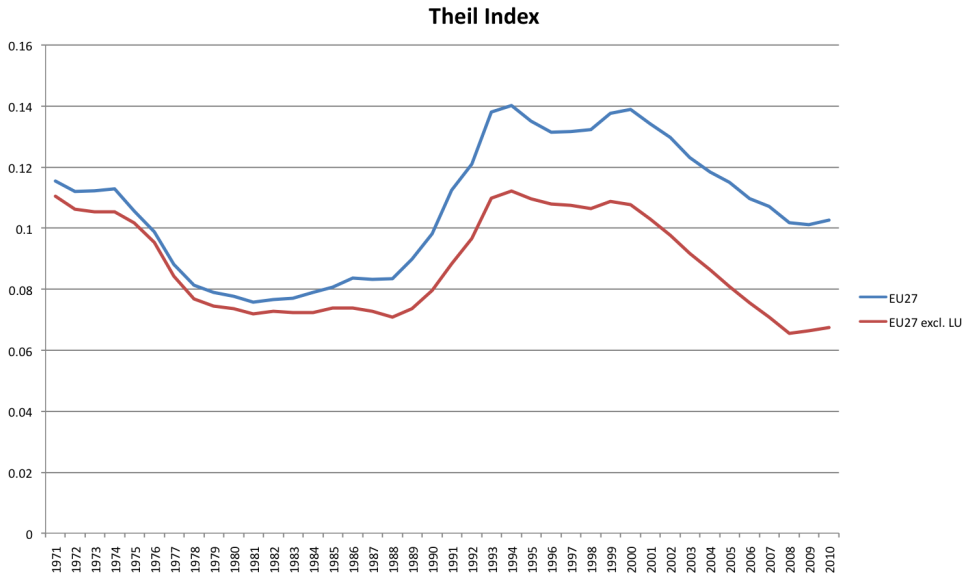

Figure 5.5: Theil Index for EU27 and EU27 excluding Luxembourg

of a centrally planned economy, became increasingly heterogenous as they followed varying paths in their transition from planned to market economy and were subject to varying economic and political forces.

The decreasing trend in the variance in GDP per capita in the 2000s corresponds to increased GDP per capita growth rates in EU12 and an increased speed of absolute beta convergence for the period 2000-2010 as observed in section 5.2.1. This result is in line with the expectation that beta convergence is a necessary condition for sigma convergence to take place. Increases in sigma convergence during the 2000s, similarly to beta convergence discussed above, may be due to the 2004 and 2007 EU enlargements, including economic integration resulting from pre-accession, or due to the recovery of EU12[14] from the economic shock of transition from planned to market economy.

The variance in GDP per capita shows an increasing trend after 2008 to 2010, the last year for which data are available. This increase corresponds to the start of the 2008 global financial crisis and Euro sovereign debt crisis. The extent of the increase in the variance in GDP per capita as a result of this economic shock remains to be seen as the consequences of the crises continue to be played out.

The coefficient of variation and the Theil index excluding Luxembourg show a similar trend for sigma convergence in the EU, to that when Luxembourg

[14]except for Cyprus and Malta

is included. It is clear, however, that Luxembourg accounts for a significant amount of the variance in GDP per capita in the EU; an increasing trend which started in the mid-1980s. In fact, the variance in GDP per capita excluding Luxembourg in the late 2000s reaches levels lower than those seen in the late 1970s and 1980s.

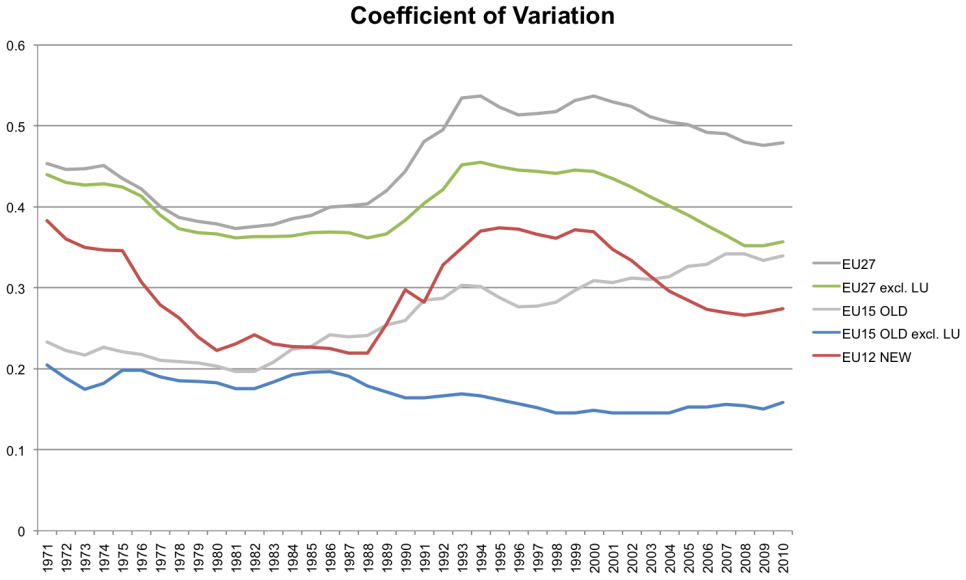

Figure 5.6: Coefficient of variation for EU15 and EU12 excluding Luxembourg

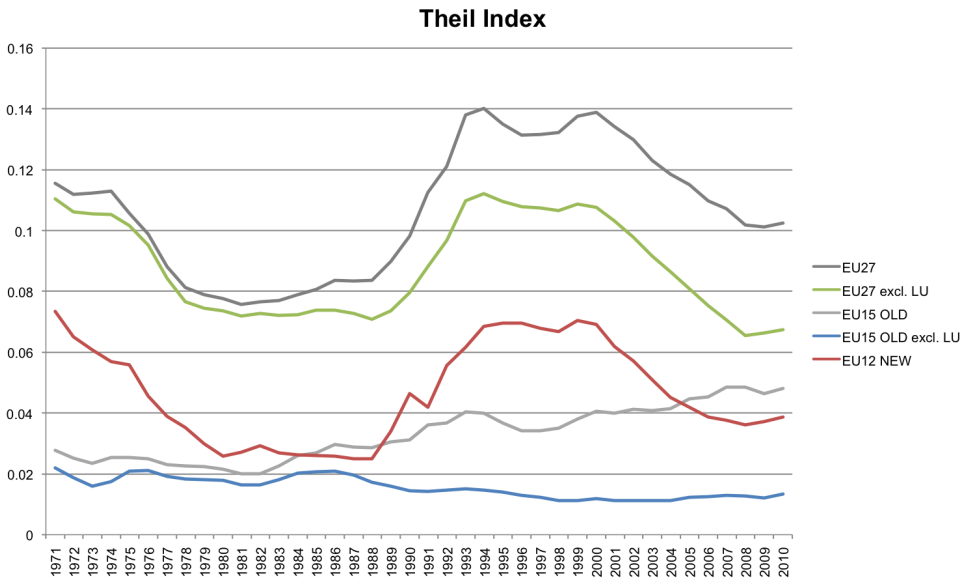

Figure 5.7: Theil Index for EU15 and EU12 excluding Luxembourg

The results for the measures of sigma convergence for EU15 and EU12

in terms of the coefficient of variation and the Theil index are presented in Figures 5.6 and 5.7 respectively.

It is important to note that a similar measure of sigma convergence for EU15 and EU12 does not indicate that the level of GDP per capita is similar for EU15 and EU12; it does indicate that *within each group* the *variance* in GDP per capita is similar.

The coefficient of variation and the Theil index show a similar trend for sigma convergence in EU15 and EU12.

It is clear, once again, that Luxembourg accounts for a significant amount of the variance in GDP per capita in EU15. The variance in GDP per capita in EU15, excluding Luxembourg, is at its lowest and remains stable for the period from the mid-1980s to 2010, the last year for which data are available. This decrease, albeit small, in variance in GDP per capita corresponds to the launch of the Single Market Programme with the signing of the Single European Act in 1986. This may imply that EU economic integration among EU15 has promoted sigma convergence in EU15, or conversely that EU15 economies have similar levels of GDP per capita regardless of EU economic integration.

On the contrary, the variance in GDP per capita in EU12 is highly volatile and is clearly the key driver of the trend in variance in GDP per capita in the 27 EU member states. The variance in GDP per capita in EU12 increased significantly in 1989 and decreased again only after 2000. As discussed above, this increase in variance in GDP per capita in 1989 corresponds to the start of the transition from planned to market economy, and the decrease after 2000 may may be due to the 2004 and 2007 EU enlargements or due to the recovery of EU12[15] from the economic shock of transition from planned to market economy.

It is interesting to note, however, that the *variance* in GDP per capita in EU12 was at levels similar to those in EU15 during the 1980s *prior to EU accession*. This implies that factors other than EU economic integration promoted sigma convergence in EU12, to its lowest levels, during the 1980s.

In conclusion, the results show that sigma convergence is taking place in the EU.

[15]except for Cyprus and Malta

Chapter 6

Policy Focus for Reducing Disparities in GDP per capita across the EU

How can disparities in GDP per capita across member states be reduced? Certainly poorer member states should promote faster economic growth in order to catch up to richer member states. However, economic growth is limited by an economy's level and quality of factors of production, technology, institutions and economic environment.

Based on the neoclassical growth model, if member states have similar steady states and absolute beta convergence is taking place in the EU then eventually member states will converge to similar levels of GDP per capita, although this may take a very long time. On the contrary, if member states do not have similar steady states, convergence in GDP per capita levels may never take place although economic growth rates may converge. Steady state embodies the production capacity and efficiency of an economy for a given set of factors of production, technology, institutions and economic environment; let's call this the economic set. Technological innovation, for a given economic set, increases steady state as it increases the potential of the production capacity and efficiency of an economy; that is, it increases the economy's potential for an increased steady state and sustained economic growth in the future. The elements in the economic set and technological innovation are interdependent and mutually reinforcing on economic growth, while the relative importance of each element depends crucially on the economy's stage of development. Accordingly, increasing the level and quality of the economic set and increasing

technological innovation, while acknowledging the interdependence of these factors as well as the economy's stage of development, leads to increases in the production capacity and efficiency of an economy presently and increases in its potential for an increased steady state and sustained economic growth in the future.

Based on the neoclassical growth model, economic policy can influence the steady state *growth rate* of GDP per capita only temporarily; while it can influence the steady state *level* of GDP per capita permanently and cumulatively.

Thus, with the aim of informing Cohesion policy, the model presented in this section focuses not on the growth rate of GDP per capita, but instead on the level of GDP per capita. Specifically, the model aims firstly, to determine those factors, in terms of Cohesion policy, most associated with high levels of GDP per capita and secondly, to provide a basis for informing the key policy focus areas of Cohesion policy for the reduction of disparities in GDP per capita across member states. The model and resulting recommendations are in the context of the approach toward the new Cohesion policy programming period for 2014-2020, which continues to focus on the objectives of Europe 2020, and in the context of the current economic environment in the EU and globally.

6.1 Methodology and Model Specification

The model aims to determine those factors, in terms of Cohesion policy, most associated with high levels of GDP per capita. The variables of interest are innovation and technology and human capital. These variables were selected for three reasons: First, they relate to objectives of Europe 2020; this enables an analysis of the compatibility of Europe 2020 objectives, in terms of EU competitiveness and economic growth, and Cohesion policy objectives, in terms of the reduction of disparities in GDP per capita across member states. Second, based on the economic growth literature, they are considered to have a significant influence on steady state; this enables an analysis of those factors most associated with high levels of GDP per capita across member states. Third, they are able to be influenced through Cohesion policy; this enables the targeted use of Cohesion policy in the reduction of disparities in GDP per capita across member states.

Member states are heterogenous, and country-specific characteristics will surely influence GDP per capita. The aim of the model is to analyse the relationship between GDP per capita and specifically the variables of interest,

namely innovation and technology and human capital; the determinants of GDP per capita are not of interest. Panel data analysis is used as it enables the analysis of the effects on GDP per capita of changes in the variables of interest while controlling for country-specific characteristics and unobserved effects that do not change over time.

The fixed effects and first difference estimators were selected, although the random effects estimator was also considered, because the fixed effects and first difference estimators eliminate time constant country-specific characteristics, even if these variables are unobserved.[1] This elimination of time constant variables allows for the analysis to concentrate on the effects on GDP per capita of the variables of interest; while on the other hand, it restricts the analysis to variables that change over time. In other words, the fixed effects and first difference estimators cannot estimate the effects of time constant variables or variables that change little over time, such as institutional quality or geographical region. In this sense the fixed effects and first difference estimators are limited in their ability to estimate the determinants of GDP per capita. On the contrary, the random effects estimator can be used to estimate the effects of time constant or slow changing variables and the determinants of GDP per capita.

A second reason for the selection of the fixed effects and first difference estimators is related to the assumption of strict exogeneity which determines the consistency of the estimators. The assumption of strict exogeneity requires that the independent variables are not correlated with the error term, which is composed of a time constant error, relating to time constant country-specific characteristics, and an idiosyncratic error, which is random. The fixed effects and first difference estimators are based on the assumption that the independent variables are not correlated with the idiosyncratic error, while the independent variables are allowed to be arbitrarily correlated with the constant error. The random effects estimator is much more restrictive in respect of this assumption as it requires that the independent variables are not correlated with both the constant error and the idiosyncratic error. In the context of this model, it seems unrealistic to assume that the independent variables are not related to time constant country-specific characteristics and are therefore not correlated with the constant error, especially considering the short time period used in this model. For example, investment in R&D is found to be correlated with

[1]The interpretation of the coefficients for the fixed effects and first difference estimators is the same, only the method of estimation differs (Wooldridge (2010))

geographical region. In the case that the independent variables are correlated with the constant error, the assumption of strict exogeneity pertaining to the random effects estimator will not hold, and the estimator will be inconsistent.

6.1.1 Fixed Effects

The fixed effects estimator general specification is:

$$y_{i,t} = \beta X_{i,t} + u_{i,t} + \epsilon_{i,t} \tag{6.1}$$

where

$$\begin{aligned} X_{i,t} &= \text{set of observed independent variables} \\ u_{i,t} &= \text{constant error which does not vary over time} \\ \epsilon_{i,t} &= \text{idiosyncratic error which varies over time} \end{aligned}$$

The fixed effect estimator model specification is:

$$lngdppc_{i,t} = \beta_1 rd_{i,t} + \beta_2 ed_{i,t} + \beta_3 emp_{i,t} + \gamma Z_{i,t} + u_{i,t} + \epsilon_{i,t} \tag{6.2}$$

where

$$\begin{aligned} lngdppc_{i,t} &= \text{ln of real GDP per capita} \\ rd_{i,t} &= \text{innovation and technology in terms of investment in R\&D} \\ ed_{i,t} &= \text{human capital in terms of education} \\ emp_{i,t} &= \text{human capital in terms of employment} \\ Z_{i,t} &= \text{set of observed control variables} \\ u_{i,t} &= \text{constant error which does not vary over time} \\ \epsilon_{i,t} &= \text{idiosyncratic error which varies over time} \end{aligned}$$

6.1.2 First Difference

The first difference estimator general specification is:

$$\Delta y_{i,t} = \Delta X_{i,t}\beta + \Delta \epsilon_{i,t} \tag{6.3}$$

where

$$\Delta y_{i,t} = y_{i,t} - y_{i,t-1}$$
$$\Delta X_{i,t} = X_{i,t} - X_{i,t-1}$$
$$\Delta \epsilon_{i,t} = \epsilon_{i,t} - \epsilon_{i,t-1}$$

The first difference estimator model specification is:

$$\Delta lngdppc_{i,t} = \Delta rd_{i,t}\beta_1 + \Delta ed_{i,t}\beta_2 + \Delta emp_{i,t}\beta_3 + \Delta Z_{i,t}\gamma + \Delta \epsilon_{i,t} \quad (6.4)$$

6.2 Dataset

A panel dataset was constructed comprising 27 EU member states for the 11 year period 2000-2010. Luxembourg was identified as an outlier and is consequently excluded from estimations. The panel is strongly balanced.

The dataset was constructed using data obtained from the following the databases:

1. Penn World Table v7.1 (2012), 1971-2010 (Heston *et al.* (2012))
2. Barro-Lee A New Data Set of Educational Attainment in the World (2013), 1950-2010 (Barro & Lee (2013))
3. Eurostat (2013) (Eurostat (2013))

6.3 Variables and their Measurement

6.3.1 Real GDP per capita

Real GDP per capita is the dependent variable since the model aims to determine those factors, in terms of Cohesion policy, most associated with high levels of GDP per capita across member states.

Real GDP per capita is measured in terms of the natural logarithm of real GDP per capita (PPP indexed to 2005 international dollar). The data were obtained from the Penn World Table v7.1 (Heston *et al.* (2012)). The data are complete for the period 2000-2010 for all countries.

6.3.2 Innovation and Technology

Innovation and technology is a variable of interest since it relates to the primary objectives of Europe 2020.[2] Cohesion policy has been identified as one of the key delivery mechanisms of the Europe 2020 strategy based on the premise that investment in innovation and R&D on a regional level throughout the EU will boost the EU's global competitiveness and long term economic growth while at the same time boosting regional development and economic growth, and thereby reducing disparities in GDP per capita across member states.

Secondly, innovation and technology is considered to have two significant effects on GDP per capita. Innovation and technology increases the production capacity and efficiency of an economy presently for a given set of factors of production, technology, institutions and economic environment. Such innovation is in terms of the development of unique products and processes and sophisticated methods of business organisation and marketing which increase the competitiveness of firms, as well as the clustering of industries and technological spillovers which increase the competitiveness of firms and industries and the economy in general. Technological innovation, on the other hand, increases an economy's potential for increased GDP per capita and long term economic growth. Such technological innovation is in terms of the development of new high technology, advanced products and processes that are approaching the frontiers of knowledge; such technological innovation occurs primarily through purposive investment in R&D.

Innovation and technology is measured in terms of the degree of investment in R&D, being R&D expenditures as a percentage of GDP, that is:

$$rd_{i,t} = \frac{\text{Investment in R\&D}_{i,t}}{\text{GDP}_{i,t}} \tag{6.5}$$

The data were obtained from Eurostat (Eurostat (2013)). The data are complete for the period 2000-2010 for all countries except for Greece, Malta and Sweden detailed as follows: Greece: 2001, 2003-2007; Malta: 2002-2010; Sweden: 2001, 2003-2010.[3]

Investment in R&D was selected as an indicator of innovation and technol-

[2]The Europe 2020 strategy has set a target of investment in R&D of 3% of GDP (EuropeanCommission (2010a)).

[3]9/286 observations missing

ogy as it is the indicator used in Europe 2020 to measure progress towards the objective of technology and innovation.[4]

This indicator is a measure of purposive investment in R&D with the objective of technological innovation which increases an economy's potential for long term economic growth. The indicator is limited in that it measures only the expenditures on investment in R&D, as opposed to the outcomes of investment in R&D. Certainly it is the technological innovation that results from investment in R&D that is the driver of an economy's potential for increased GDP per capita and long term economic growth. However such data tend to be scarce and incomplete.

Another limitation of investment in R&D as an indicator of technology and innovation is that it includes only a narrow measure of innovation and technology. The indicator excludes innovation and technology at a firm and industry level which relates to the development of unique products and processes, and sophisticated methods of business organisation and marketing with the objective of increasing competitiveness. The indicator also excludes the spillover effects of technology and innovation as a result of the clustering of firms and industries which increase the competitiveness of firms and industries within clusters. Furthermore if such spillover effects diffuse widely and rapidly, they can be an important source of innovation and technology for economy's with lower levels of investment in R&D, for whatever reason.Therefore investment in R&D may not capture all of the elements of technology and innovation in an economy.

Investment in R&D as a source of technology and innovation is relatively more important and feasible in economies that are at an advanced stage of development. Consequently, since advanced economies rely more on investment in R&D as a source of technology and innovation than less advanced economies, they will have higher levels of investment in R&D. For this reason, investment in R&D is limited as a measure of innovation and technology in economies at a lower stage of development. Furthermore it is limited as a source of innovation and technology in economies that are at less advanced stage of development, and therefore appears to be largely irrelevant to regional economic growth and development as proposed by Europe 2020. The Eurostat database has very limited data relating to four categories of innovation that may be more

[4]The Europe 2020 strategy has a target of investment in R&D of 3% of GDP (European-Commission (2010a)).

relevant to economies that are less than advanced, namely innovation in terms of products and processes, and business organisation and marketing.[5]

Nonetheless, bearing in mind the abovementioned limitations, investment in R&D is used as an indicator of innovation and technology to enable an analysis of its relevance to Cohesion policy as proposed by Europe 2020. Although the objectives of Europe 2020 capture other sources of innovation and technology, investment in R&D is used as an indicator of innovation and technology due to a lack of alternative relevant and complete data.

6.3.3 Human Capital: Education and Employment

Human capital is a variable of interest since it relates to the objectives of Europe 2020.[6]

Secondly, based on the economic growth literature, human capital is considered to have a significant effect on GDP per capita. Human capital embodies the knowledge, skills and experience of the workforce. Education increases the stock of knowledge and skills of the labour force. The concept of education is broader than only formal and higher education: vocational training and on the job learning and training are as significant as formal and higher education. Employment increases the stock of knowledge, skills and experience of the labour force; "learning by doing" plays a significant role in increasing productivity and innovation and technology (Arrow (1962)). Additionally, the stock of knowledge, skills and experience facilitates the creation and adoption of new innovation and technology, including spillovers, within firms and industries which further increase the productivity and competitiveness of firms and industries and the economy in general. Both of these effects increase the production capacity and efficiency of an economy presently for a given set of factors of production, technology, institutions and economic environment (Arrow (1962); Lucas (1988)). Furthermore high levels of human capital are crucial for technological innovation which increases an economy's potential for increased GDP per capita and long term economic growth.

Human capital accumulation can significantly affect GDP per capita. Economies which have an "early start" in an industry are able to accumulate higher levels of human capital through "learning by doing" and experience (Arrow

[5]The first year for which such indicators of innovation are available is 2010, and much of the data are incomplete.

[6]The Europe 2020 strategy has set the targets of 40% tertiary education attainment rate, 10% early school leaving rate and 75% employment rate (EuropeanCommission (2010a)).

(1962)). Furthermore, economies that specialise in industries or trade in goods and services that require high levels of human capital have a higher potential for the accumulation of human capital and will likely continue to accumulate higher levels of human capital in the future (Lucas (1988)). Therefore the effects of the accumulation of human capital are persistent and long term in nature.

Human capital is measured in terms of education and employment.

Education is measured in terms of education attainment, being the average years of secondary and tertiary education attained by the population over 25 years. The measure is lagged by ten years in order to take into account the long term cumulative effects of an "early start" in the accumulation of human capital. A lag period of ten years is chosen as it corresponds to the year 1990 which is the first year of transition from planned to market economy for EU12.[7] In this way the effects on GDP per capita of an "early start" in the accumulation of human capital is taken into account.

The data were obtained from the Barro-Lee education attainment database (Barro & Lee (2013)). The data are complete for the period 2000-2010 for all countries.

The indicator for education is limited in that it measures only formal education attainment but does not take into account education attained during vocational training and on the job learning and training which contribute significantly to human capital accumulation.

Employment is measured in terms of employments rates, being the percentage of the population aged 15-64 that is employed.

The data were obtained from the Eurostat database (Eurostat (2013)). The data are complete for the period 2000-2010 for all countries.

The indicator for employment is limited in that it measures only the extent of employment in an economy but does not take into account the level of knowledge, skills and experience accumulated in the labour force.

6.3.4 Control Variables

The vector Z contains observed control variables, derived from the neoclassical growth model, which vary over time, namely trade integration, population growth rate and savings rate.

[7] except for Cyprus and Malta

T rade integration represents the extent of EU economic integration and access to the Single Market.

Trade integration[8] is measured in terms of the degree of trade integration in the EU, being the ratio of an economy's EU trade to its total trade; that is:

$$ti_{i,t} = \frac{(\text{exports}_{i,t}^{EU} + \text{imports}_{i,t}^{EU})}{(\text{exports}_{i,t}^{total} + \text{imports}_{i,t}^{total})} \tag{6.6}$$

The measure was calculated using data obtained from the Eurostat database (Eurostat (2013)). The data are complete for the period 2000-2010 for all countries except for Bulgaria, Finland, Ireland, Romania and Slovenia detailed as follows: Bulgaria: 2006-2010; Finland: 2009-2010; Ireland: 2002-2010; Romania: 2007-2010; Slovenia: 2002-2010.[9]

T he population growth rate is measured in terms of the annual population change rate resulting from both natural change, that is births and deaths, and net migration. The data were obtained from the Eurostat database (Eurostat (2013)). The data are complete for the period 2000-2010 for all countries.

T he savings rate is measured in terms of the investment share of real GDP per capita (PPP indexed to 2005 international dollar). The data were obtained from the Penn World Table v7.1 (Heston *et al.* (2012)). The data are complete for the period 2000-2010 for all countries.

6.4 Results and Comparison of Estimators

6.4.1 Estimation Results

The results of the fixed effects and first difference estimations are presented in columns A_FE and A_FD respectively in Figure 6.1. Heteroskedasticity and autocorrelation consistent (clustered) standard errors were used as the idiosyncratic error term was found to be serially correlated in the fixed effects estimation; these results are presented in column A_FEr.[10] The first difference

[8] This measure of trade integration is based on an ECB working paper relating to EU trade integration (Mongelli *et al.* (2005)

[9] 26/286 observations missing

[10] Serial correlation was tested in STATA using a test statistic for panel data derived by Wooldridge (2002) (Wooldridge (2002), p282; Drukker (2003))

Variable	A_FE	A_FEr	A_FD	A_FDr
rd	.08191378**	.08191378		
ed	.077147***	.077147**		
emp	.02174139***	.02174139**		
ti	.00430034***	.00430034		
s	.00438366*	.00438366		
n	.03211587*	.03211587		
d_rd			.03419484	.03419484
d_ed			.03718602***	.03718602***
d_emp			.01411113***	.01411113***
d_ti			.00086276	.00086276*
d_s			.00698916***	.00698916***
d_n			.00297235	.00297235
_cons	7.8536528***	7.8536528***		
N	251	251	223	223
r				
r2	.61828923	.61828923	.59418884	.59418884
r2_w	.61828923	.61828923		
r2_b	.4731415	.4731415		
r2_o	.4599507	.4599507		

legend: * p<.05; ** p<.01; *** p<.001

Figure 6.1: Regression Estimation: 2000-2010

estimation using robust standard errors is presented for comparative purposes in column A_FDr.

In the fixed effects estimation the use of clustered standard errors results in the coefficient on investment in R&D not being statistically significant. The coefficients on education attainment and the employment rate are statistically significant in both estimations and show the expected positive sign. Education attainment has a more significant effect on GDP per capita than the employment rate. The results of A_FEr indicate that for a given country, as education attainment increases across time by one year, GDP per capita tends to increase by 8.0% *ceteris paribus*.[11] Similarly, as the employment rate increases across time by one percent, GDP per capita tends to increase by 2.2% *ceteris paribus*. These estimates appear to be high, especially in respect of education attainment.

In the first difference estimation the coefficients are smaller in magnitude than those in the fixed effects estimation. The coefficient on investment in R&D is also not statistically significant. The coefficients on education attainment and the employment rate are statistically significant and show the expected positive sign. As with the fixed effects estimation, education attainment has

[11]For the purposes of interpreting the estimation, the coefficients are expressed in terms of GDP per capita as opposed to the natural logarithm of GDP per capita, the basis of measurement for the dependent variable.

a more significant effect on GDP per capita than the employment rate; 3.7% and 1.4% respectively.

Thus the estimations present results that are similar in terms of the significance of the variables of interest and their relative magnitudes, although the estimate for education attainment in the fixed effects estimation is relatively high. The effect of investment in R&D on GDP per capita, while controlling for time constant country-specific characteristics, is not statistically significant. This result is in line with expectations that the relative importance of the elements of the economic set and technological innovation depend on the stage of development.

6.4.2 Comparison of estimators: Consistency and Efficiency

The fixed effects and first difference estimators are based on two assumptions which determine their consistency and efficiency respectively (Wooldridge (2010)). The first assumption relates to consistency and is the same for both the fixed effects and the first difference estimators. The assumption is that of strict endogeneity; that is, the independent variables are not correlated with the idiosyncratic errors.[12]

The second assumption relates to efficiency, specifically the homoskedasticity and serial correlation of the idiosyncratic errors (Wooldridge (2010)). The fixed effects estimator is based on the assumption that the idiosyncratic errors are not serially correlated, whereas the first difference estimator is based on the assumption that the idiosyncratic errors follow a random walk, which has substantial serial dependence (Wooldridge (2010)). When the assumption that the idiosyncratic errors are not serially correlated holds, the fixed effects estimator is more efficient than the first difference estimator; conversely the first difference estimator is more efficient when the idiosyncratic errors follow a random walk.

Accordingly, if the assumption of strict exogeneity holds, the choice in estimator depends on the idiosyncratic errors; although often the truth is somewhere between (Wooldridge (2010)). Serial correlation is tested in STATA using a test statistic for panel data derived by Wooldridge (2002) (Wooldridge (2002), p282; Drukker (2003)). The fixed effects estimator exhibits serial corre-

[12]The assumption of strict endogeneity for the fixed effects and first difference estimators allows the independent variables to be arbitrarily correlated with the constant error.

lation. Indeed the truth appears to be somewhere between, and thus the fixed effects and first difference estimators are interpreted in conjunction.

6.5 Conclusions

The model presented above aims to determine those factors, in terms of Cohesion policy, most associated with high levels of GDP per capita in order to provide a basis for informing the key policy focus areas of Cohesion policy for the reduction of disparities in GDP per capita across member states. The variables of interest are innovation and technology and human capital, measured in terms of education attainment and employment rate.

The conclusion based on the results of the fixed effects and first difference estimations is that, while controlling for time constant country specific characteristics, education attainment and employment rate are more significant than investment in R&D in their effects on GDP per capita and, by implication, in their contribution to the reduction of disparities in GDP per capita across member states.

The indicators are limited in some ways. Education attainment does not include vocational education and on-the-job education and training; the inclusion of such education will surely increase the effect of education on GDP per capita. The employment rate does not include the skill level of the labour force; a higher skill level of the labour force will surely have a greater effect on GDP per capita. Most importantly, investment in R&D does not include innovation and technology apart from purposive investment in R&D, and further it does not include the diffusion of innovation and technology; these elements will surely increase the effect of innovation and technology on GDP per capita and, even more so, these elements are likely to be more relevant to lagging member states which are at a less advanced stage of development.

This leads to the conclusion that investment in R&D is less relevant than investment in human capital in terms of Cohesion policy for the reduction of disparities in GDP per capita across member states. However, this is not to say that investment in R&D is not relevant. On the contrary, investment in R&D is relevant to advanced member states and crucial to the EU in terms of global competitiveness and long term economic growth. In terms of EU competitiveness, investment in R&D should be concentrated where it is most efficient and productive and where it provides the highest return. To the extent that advanced member states and the EU benefit from the concentration

of investment in R&D as a consequence, these benefits should be distributed through the EU in terms of technology diffusion, or in terms of the distribution of economic activity, employment or economic benefits.

Chapter 7

Conclusion

It has long been recognised that technological innovation is the engine of long term economic growth.

In the present context of the EU's low economic growth and lagging global competitiveness in terms of innovation and technology, technological innovation is crucial for the EU's global competitiveness and long term economic growth.

While such a strategy for the EU's global competitiveness and long term economic growth is important, it is important also that the EU promotes the competitiveness and long term economic growth of each of its member states at the same time. Firstly, the competitiveness of each member state can only add to the EU's global competitiveness. Secondly, the long term economic growth of each member state and the reduction in disparities among member states in terms of development and competitiveness is crucial in order to maintain the economic feasibility of and political support for the EU.

Indeed, the recent and ongoing Euro sovereign debt crisis has seen the emergence of significant and widening disparities among member states, most noticeably in terms of economic growth, unemployment—particularly with respect to youth unemployment—and fiscal imbalances—particularly with respect to government debt. Such disparities have led to economic and political instability across the EU, and to questions as to the feasibility of the EU and the Single Market.

Thus, Cohesion policy has as its objective the promotion of the development and competitiveness of lagging member states and the reduction of disparities among member states. More recently, within the context of Europe 2020, Cohesion policy is identified as one of the key delivery mechanisms of the Europe 2020 strategy, the key objective of which is technological innovation—

the engine of long term economic growth—through the promotion of investment in R&D and investment in human capital.

With the aim of identifying the key policy focus areas for Cohesion policy, in relation to the objectives of Europe 2020, this thesis set out firstly, to assess whether convergence in the EU is taking place and whether disparities among member states are reducing and secondly, to assess the objectives of Europe 2020 in terms of the objectives of Cohesion policy, specifically the relative importance of investment in R&D and investment in human capital in promoting the development and competitiveness of lagging member states and in reducing the disparities among member states.

Convergence in the EU is taking place in terms of both absolute beta convergence and sigma convergence. The measures for both absolute beta convergence and sigma convergence show that convergence was relatively high for the period 2000-2010. In terms of sigma convergence there is an indication of a slight increase in disparities in GDP per capita across member states after 2008, likely a result of the global financial crisis and Euro sovereign debt crisis. The extent of divergence as a result of the crises remains to be seen as the consequences of the crises continue to be played out.

The objectives of Europe 2020 appear to be not fully compatible with the objectives of Cohesion policy in terms of promoting the development and competitiveness of lagging member states and in reducing the disparities among member states.

Specifically, the Europe 2020 objective of investment in R&D is not fully compatible with the objectives of Cohesion policy. Investment in R&D tends to favour concentration of R&D activity which increases its efficiency and productivity. Furthermore R&D activity tends to concentrate in economies which are developed and competitive; further increasing their competitiveness. Thus while investment in R&D is crucial in promoting the EU's global competitiveness and long term economic growth, it is likely that, without intervention, it may further exacerbate disparities among member states in terms of competitiveness and economic growth.

Secondly, the relative importance of investment in R&D in competitiveness and economic growth depends crucially on an economy's stage of development; R&D is crucial for competitiveness and economic growth in advanced economies but plays less of a role in economies that are less advanced. The various factors which affect competitiveness and economic growth, including investment in

R&D, are interdependent and mutually reinforcing on economic growth; therefore the effects of investment in R&D on competitiveness and economic growth in an economy which is less than advanced may be limited by other economic factors.

Thirdly, investment in R&D is driven by the incentive to gain market power and to earn profits. The allocation of Cohesion policy funds by the public sector will likely lack such incentive. Consequently investment in R&D may be directed towards basic research by universities and public research institutes over applied research by firms and industry which is less conducive to technological innovation, and especially more so if the link between universities and public research institutes, and firms and industry is not strong. Furthermore investment in R&D may be less efficient and productive in terms of technological innovation and economic growth if it is not driven by the incentive to gain market power and to earn profits.

On the other hand, the Europe 2020 objective of investment in human capital is highly compatible with the objectives of Cohesion policy. Human capital increases economic growth through increases in the productivity of an economy and through increases in the capacity of an economy for the creation of knowledge and innovation and the absorption of technology, even though the economy may be less than advanced. Investment in human capital relates to investment in both education and employment. Investment in education incorporates formal and higher education as well as vocational training and on-the-job training. Investment in employment includes job creation, with a particular focus on high-skilled job creation which increases the potential for human capital accumulation.

Secondly, the relative importance of investment in human capital in competitiveness and economic growth is high for advanced and less advanced economies alike. Advanced economies benefit from human capital in respect of increased capacity for technological innovation, whereas both advanced and less advanced economies benefit from human capital in respect of increased productivity and increased capacity for the creation of knowledge and innovation and the absorption of technology. Furthermore although the various factors which affect competitiveness and economic growth are interdependent and mutually reinforcing on economic growth, human capital is acknowledged as having a particularly significant effect on both other economic factors which affect competitiveness and economic growth as well as on competitiveness and economic growth itself.

Thirdly, investment in human capital increases an economy's potential for competitiveness and long term economic growth. Investment in human capital presently increases human capital accumulation and consequently increases the stock of human capital in the future, thereby increasing the potential for technological innovation in advanced and less advanced economies alike.

Lastly, and crucially, investment in human capital must be accompanied by increased and purposive diffusion of technology within the EU which serves firstly, to increase technological innovation—the key determinant of long term economic growth—of the EU as a whole by increasing the stock and availability of knowledge and technology within the EU and secondly, to accelerate the development and competitiveness of lagging member states. While lagging member states may not benefit from investment in R&D directly, they may surely benefit from the technological innovation that results elsewhere in the EU as well as from the economic benefits deriving from technological innovation enabled by the Single Market. After all, the Single Market in which all member states participate plays a significant role in increasing the EU's capacity for technological innovation. Furthermore the concentration of activity related to technological innovation in economies where it is most efficient and productive results in the highest return for the EU as a whole. Since technological innovation which benefits the EU as a whole is enabled by the Single Market in which *all member states participate*, the economic benefits deriving from such technological innovation should be distributed within the EU, through either purposive diffusion of technology, in terms of the distribution of economic activity and employment based on the use of that technological innovation, for example through FDI, or through the distribution of economic benefits derived from that technological innovation through the EU budget in terms of Cohesion policy. Importantly such measures for the purposive diffusion of technology should increase employment and the rate of human capital accumulation in competitive and lagging member states alike. Bearing in mind the need to promote the EU's global competitiveness, it is important to balance the incentives for technological innovation and the distribution of the economic benefits derived from technological innovation which is enabled by the Single Market.

Thus with the approach toward the new Cohesion policy programming period for 2014-2020, which continues to focus on the objectives of Europe 2020, and in the context of the current economic environment in the EU and globally, it is recommended that the key policy focus areas for Cohesion policy, in

relation to the objectives of Europe 2020, be investment in human capital in terms of both education and employment accompanied by increased and purposive diffusion of technology, and the benefits derived therefrom, within the EU. Investment in education and employment should focus specifically on the development and acquisition of high skills, encompassing vocational training and on-the-job training, and the potential for human capital accumulation. Diffusion of technological innovation may take the form of collaboration, FDI or the implementation of higher technology (intra-)industry and production in member states that are less advanced. Purposive diffusion of technology, and the benefits derived therefrom, may occur through the distribution of economic activity and employment or through the distribution through the EU budget in terms of Cohesion policy. Importantly such measures for the purposive diffusion of technology should increase employment and the rate of human capital accumulation.

T his thesis contributes to current research in that the convergence analysis and empirical model are performed using the most recent available data to 2010 for the twenty seven EU member states, which allows the analysis to take into account the effects of the 2004 and 2007 EU accessions.

The analysis which forms the basis of the recommendations for the key policy focus areas for Cohesion policy is novel in that is considers the interrelationship between the objectives of Cohesion policy and Europe 2020 in conjunction with the interrelationship between investment in R&D and investment in human capital, and their relative importance in promoting competitiveness and reducing disparities in GDP per capita across member states. In addition, the analysis emphasises the significance of an economy's stage of development in determining the relative importance of investment in R&D and investment in human capital.

Furthermore the recognition of the role of purposive diffusion of technology is novel. Purposive diffusion of technology may play a significant role in promoting both EU global competitiveness and long term economic growth, as well as promoting the development and competitiveness of lagging member states, through specifically employment and human capital accumulation. Possibilities for promoting such purposive diffusion of technology would need to be further explored.

Further research may expand on the empirical model in order to take into account the effects of time constant country specific characteristics. It is recognised in the literature that factors such as institutional quality and environment and geographical region play a role in determining competitiveness and long term economic growth. Such factors may be relevant in reducing disparities in GDP per capita across member states.

Secondly further research may focus on possibilities for promoting purposive diffusion of technology in terms of Cohesion policy in order to promote the development and competitiveness of lagging member states and to reduce the disparities among member states, while at the same time promoting EU global competitiveness and long term economic growth. Such possibilities would need to balance the incentives for technological innovation and the distribution of the benefits deriving from technological innovation enabled by the Single Market.

Bibliography

Aghion, P. & P. Howitt (1992): "A model of growth through creative destruction." *Econometrica* **60**: pp. 323–351.

Armstrong, H. (1978): "Community regional policy: A survey and critique." *Regional Studies* **12**: pp. 511–528.

Arrow, K. (1962): "The economic implications of learning by doing." *Review of Economic Studies* **29**: pp. 155–173.

Balassa, B. (1961): "Towards a theory of economic integration." *Kyklos* **14**: pp. 1–14.

Balassa, B. (1965): *The Theory of Economic Integration.* George Allen & Unwin Ltd, London.

Baldwin, R. (1989): "The growth effects of 1992." *Economic Policy: A European Forum* **9**: pp. 247–281.

Baldwin, R. & A. Venables (1995): *Regional Economic Integration. In Handbook of International Economics*, volume 3. Elsevier, New York.

Barro, R. J. (1996): "Determinants of economic growth: A cross-country empirical study." *NBER Working Papers 5698* **National Bureau of Economic Research, Inc.**

Barro, R. J. (2012): "Convergence and modernization revisited, nber working papers 18295." In "National Bureau of Economic Research, Inc.", .

Barro, R. J. & J.-W. Lee (2013): "A new data set of educational attainment in the world, 1950-2010." *Journal of Development Economics* **forthcoming**.

Barro, R. J. & X. SalaiMartin (1991): "Convergence across states and regions." *Brookings Papers on Economic Activity* **1**: pp. 107–182.

Barro, R. J. & X. SalaiMartin (1992): "Convergence." *Journal of Political Economy* **100**: pp. 223–251.

Barro, R. J. & X. SalaiMartin (2004): *Economic Growth (2nd Edition)*. The MIT Press, Cambridge, MA.

Baumol, W. (1986): "Productivity growth, convergence, and welfare: What the long-run data show." *American Economic Review* **76**: pp. 1072–1085.

Baumol, W. & E. Wolff (1988): "Productivity growth, convergence, and welfare: Reply." *American Economic Review* **78**: pp. 1155–1159.

Begg, I. (2009): "The future of cohesion policy in richer regions." In "European Union Regional Policy Working Papers," .

Cass, D. (1965): "Optimum growth in an aggregate model of capital accumulation." *Review of Economic Studies* **32**: pp. 233–240.

Chamberlin, E. (1962): *The Theory of Monopolistic Competition: A Reorientation of the Theory of Value*. Harvard University Press, Cambridge, Ma.

DeLong, B. (1988): "Productivity growth, convergence, and welfare: Comment." *American Economic Review* **78**: pp. 1138–1154.

Domar, E. (1946): "Capital expansion, rate of growth, and employment." *Econometrica* **14**: pp. 137–147.

Drukker, D. (2003): "Testing for serial correlation in linear panel data models." *Stata Journal* **3**: pp. 168–177.

EuropeanCommission (2007): "Member states and regions delivering the lisbon strategy for growth and jobs through eu cohesion policy, 2007-2013 com(2007) 798." In "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions," .

EuropeanCommission (2010a): "Europe 2020 a strategy for smart, sustainable and inclusive growth com(2010)." In "Communication from the Commission," European Commission.

EuropeanCommission (2010b): "Regional policy contributing to smart growth in europe 2020 com(2010) 553 sec(2010) 1183." In "Communication

from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions," .

EuropeanCommission (2011): "Seventh progress report on economic, social and territorial cohesion: The urban and regional dimension of europe 2020 com(2011) 776 sec(2011) 1372." In "Report from the Commission to the European Parliament and the Council," .

EuropeanCommission (2013a): "Cohesion policy: Strategic report 2013 on programme implementation 2007-2013 com(2013) 210 swd(2013) 129." In "Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions," .

EuropeanCommission (2013b): *European Commission Financial Programming and Budget.* European Commission, http://ec.europa.eu/budget/index$_e n.cfm$.

EuropeanCommission (2013c): *European Commission Regional Policy - Inforegio.* European Comission, http://ec.europa.eu/regional$_p olicy/index_e n.cfm$.

EuropeanCommunity (1957): *The Treaty of Rome.*

EuropeanCommunity (1977): "Guidelines for community regional policy com(77) 195." In "Bulletin of the European Communities," .

EuropeanUnion (2006a): "Commission decision of 4 august 2006 fixing an indicative allocation by member state of the commitment appropriations for the convergence objective for the period 2007-2013 (2006/594/ec)." In "Official Journal of the European Union," .

EuropeanUnion (2006b): "Consolidated versions of the treaty on european union and of the treaty establishing the european community." In "Official Journal of the European Union," .

EuropeanUnion (2006c): "General provisions on the european regional development fund, the european social fund and the cohesion fund and repealing regulation (ec) no 1260/1999, council regulation (ec) no 1083/2006." In "Official Journal of the European Union," .

Eurostat (2013): *Eurostat*. European Commission, http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home.

Grossman, G. & E. Helpman (1990): "Trade, innovation, and growth." *American Economic Review* **80**: pp. 86–91.

Grossman, G. & E. Helpman (1991): *Innovation and growth in the global Economy*. The MIT Press, Cambridge, MA.

Harrod, R. (1939): "An essay in dynamic theory." *Economic Journ* **49**: pp. 14–33.

Heckscher, E. (1919): "The effects of foreign trade on the distribution of income." *Ekonomisk Tidskrift* **21**: pp. 497–512.

Heston, A., R. Summers, & B. Aten (2012): *Penn World Table Version 7.1*. Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania.

IsmeriEuropa (2010): "Expert evaluation network delivering policy analysis on the performance of cohesion policy 2007-2013: Policy papers on innovation." In "A report to the European Commission Directorate-General Regional Policy," .

IsmeriEuropa (2012): "Expert evaluation network delivering policy analysis on the performance of cohesion policy 2007-2013: Synthesis of national rreport 2011." In "A report to the European Commission Directorate-General Regional Policy," .

Jones, C. I. (1999): "Growth: With or without scale effects?" *American Economic Review* **89**: pp. 139–144.

Koopmans, T. (1965): *On the Concept of Optimal Economic Growth. In The Econometric Approach to Development Planning*. North Holland, Amsterdam.

Krugman, P. (1979): "Increasing returns, monopolistic competition, and international trade." *Journal of International Economics* **9**: pp. 469–479.

Krugman, P. (1991): "Increasing returns and economic geography." *Journal of Political Economy* **99**: pp. 483–499.

Lucas, R. (1988): "On the mechanics of economic development." *Journal of Monetary Economics* **22**: pp. 3–43.

Maddison, A. (1982): *Phases of Capital Development.* Oxford University Press, Oxford.

Mancha-Navarro, T. & R. Garrido-Yserte (2008): "Regional policy in the european union: The cohesion-competitiveness dilemma." *Regional Science Policy & Practice* **1**: pp. 47–66.

Mankiw, G., D. Romer, & D. Weil (1992): "A contribution to the empirics of economic growth." *Quarterly Journal of Economics* **107**: pp. 407–437.

Meade, J. E. (1953): *Problems of Economic Union.* The University of Chicago Press, Chicago.

Mendez, C. (2011): "The lisbonization of eu cohesion policy: A successful case of experimentalist governance?" *European Planning Studies* **19**: pp. 519–537.

Mendez, C. & G. Manzella (2009): "The turning points of eu cohesion policy, working paper report to barca report." *European Commission* .

Monfort, P. (2008): "Convergence of eu regions measures and evolution." In "European Union Regional Policy Working Papers," .

Mongelli, F., E. Dorrucci, & I. Agur (2005): "What does european institutional integration tell us about trade integration?" In "European Central Bank Occasional Paper Series No 40," .

Nordregio (2009): "The potential for regional policy instruments, 2007-2013, to contribute to the lisbon and gšteborg objectives for growth, jobs and sustainable development." In "Final Report to the European Commission, Directorate-General for Regional Policy," .

OECD (2009): *Regions Matter: Economic Revcovery, Innovation and Sustainable Growth.* OECD.

Ohlin, B. (1933): *Interregional and International Trade.* Harvard University Press, Cambridge.

Quah, D. (1993): "Empirical cross-section dynamics in economic growth." *European Economic Review* **37**: pp. 1353–1375.

Quah, D. (1996): "Twin peaks: Growth and convergence in models of distribution dynamics." *Economic Journal* **106**: pp. 1045–1055.

Ramsey, F. (1928): "A mathematical theory of saving." *Economic Journal* **38**: pp. 543–559.

Ricardo, D. (1817): *On the principles of Political Economy and Taxation.* John Murray, London.

Rivera-Batiz, L. & P. Romer (1991): "Economic integration and endogenous growth." *The Quarterly Journal of Economics* **106**: pp. 531–555.

Romer, P. (1986): "Increasing returns and long-run growth." *The Journal of Political Economy* **94**: pp. 1002–1037.

Romer, P. (1990): "Endogenous technological change." *Journal of Political Economy* **98**: pp. 71–102.

SalaiMartin, X. (1990): *On growth and states.* Ph.D. thesis, Harvard University.

SalaiMartin, X. (2006): "The classical approach to convergence analysis." *Economic Journal* **106**: pp. 1019–1036.

Schumpeter, J. (1943): *Capitalism, socialism and democracy.* Routledge, London.

Smith, A. (1776): *An Inquiry into the Nature and Causes of the Wealth of Nations.* Random House: New York.

Solow, R. M. (1956): "A contribution to the theory of economic growth." *The Quarterly Journal of Economics* **70(1)**: pp. 65–94.

Solow, R. M. (1957): "Technical change and the aggregate production function." *The Review of Economics and Statistics* **39(3)**: pp. 312–321.

Summers, R. & A. Heston (1991): "The penn world table (mark 5): An expanded set of international comparisions, 1950-1988." *Quarterly Journal of Economics* **106**: pp. 327–368.

Swan, T. (1956): "Economic growth and capital accumulation." *Economic Record* **32**: pp. 334–361.

Theil, H. (1967): *Economics and Information Theory.* North Holland, Amsterdam.

TheWorldBank (1999): "Inequality: Methods and tools." *The World Bank's website on Inequality, Poverty, and Socio-economic Performance, http://www.worldbank.org/poverty/inequal/index.htm* .

Viner, J. (1950): *The Customs Union Issue*. Stevens and Sons, New York.

WEF (2012a): *The Europe 2020 Competitiveness Report: Building a more competitive Europe*. World Economic Forum: Geneva.

WEF (2012b): *The Global Competitiveness Report*. World Economic Forum: Geneva.

Wooldridge, J. (2002): *Econometric Analysis of Cross Section and Panel Data*. The MIT Press, Cambridge, MA.

Wooldridge, J. (2010): *Econometric Analysis of Cross Section and Panel Data*. The MIT Press, Cambridge, MA.

Young, A. (1928): "Increasing returns and economic progess." *Economic Journal* **38**: pp. 527–542.

Appendix A

GDP per capita in the EU

The figures below present the distribution of GDP per capita in the EU across the twenty seven EU member states and across time. Luxembourg is identified as an outlier, therefore figures excluding Luxembourg are also presented alongside for comparative purposes.

A.1 GDP per capita in the EU across member states in 2010

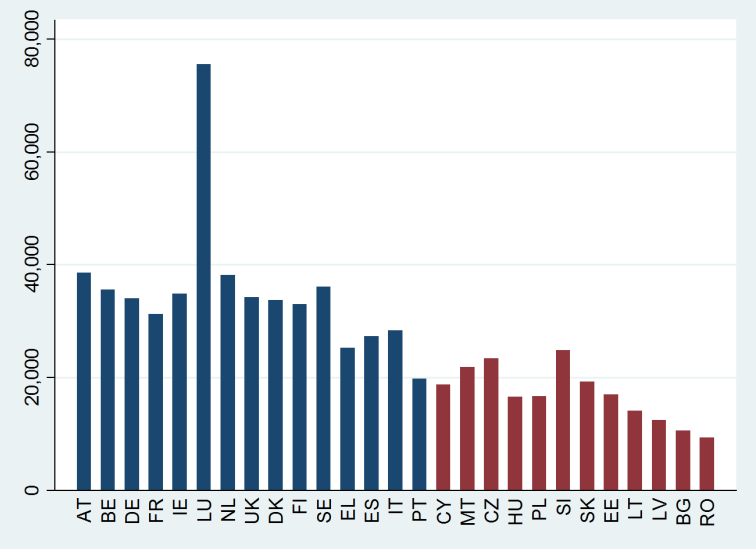

Figure A.1: GDP per capita in the EU across member states in 2010

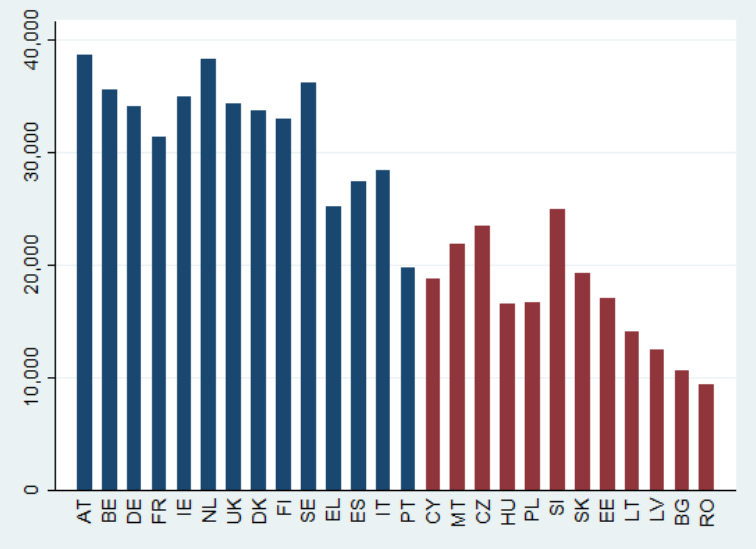

Figure A.2: GDP per capita in the EU across member states in 2010 excluding Luxembourg

A.2 Changes in the distribution of GDP per capita in the EU over time

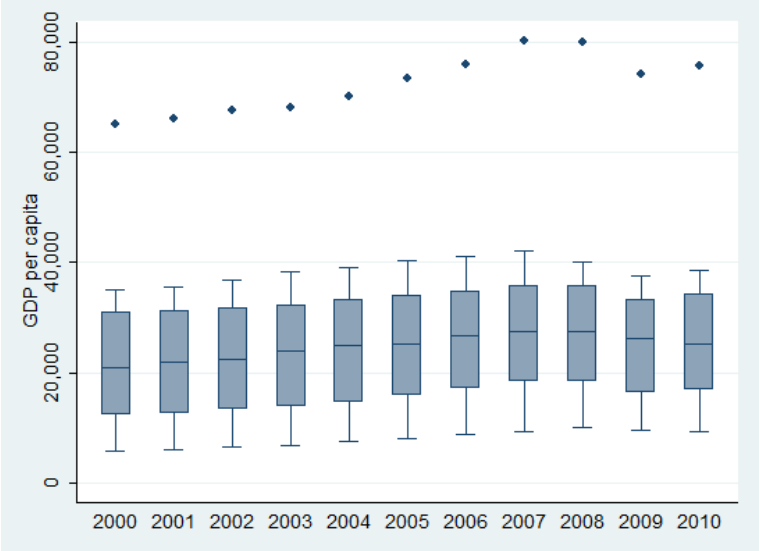

Figure A.3: Changes in the distribution of GDP per capita in the EU over time

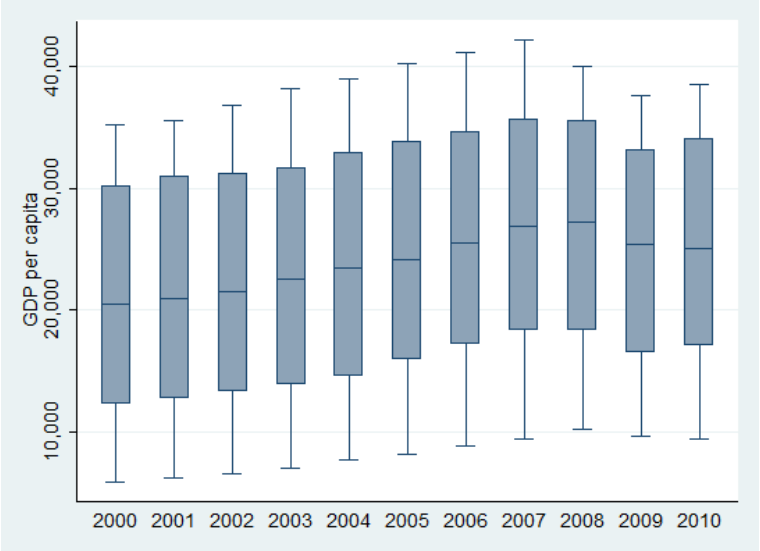

Figure A.4: Changes in the distribution of GDP per capita in the EU over time excluding Luxembourg