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# GROWTH AND REGIONAL CONVERGENCE: EVIDENCE FROM THE FINNISH PROVINCES AND SUBREGIONS, 1960 TO 1994.

**Abstract**

This paper concentrates on the regional convergence of productivity in Finland during 1960-94. We develop a framework for the empirical analysis by reviewing alternative theories of growth and convergence. We also discuss the most interesting convergence findings of Finnish and international studies, in order to gain some backround for comparisons.

This study uses data on the gross regional products of Finnish provinces and subregions. The results of the empirical study indicate that the growth and convergence experience of provinces has changed dramatically in 1980. In 1960-80 we found evidence for $\sigma$- and $\beta$-convergence and fast growth. However, after 1980 the growth of productivity has been slower, and the convergence estimates indicate regional divergence.

The study of small-scale subregions shows that there is a relatively high potential for the convergence of productivity in Finland. However, this potential varies much according to the economic cycles. During recession, hardly any convergence is likely to occur, but the distribution of regional productivity tends to become twin-peaked. On the other hand, boom years seem to provide a high potential for convergence and allow poor regions to move upwards in the productivity ranking order of regions.


KEY WORDS: economic growth, convergence, regional dynamics, economic fluctuations

# 1. INTRODUCTION

## 1.1 Backround of the study

Economic growth and its relationship to regional convergence has lately been one of the most discussed topics in economic literature. In regional science, these issues have been central ever since the 1950s, but in the last ten years the general economic interest in these topics has grown rapidly. The reasons for this are both the new theories of economic growth developed mainly since the 1980s and some newly found interesting empirical results concerning the convergence hypothesis. It has often been argued that convergence studies could provide a test for the alternative growth theories and it would thus be useful to find out whether the economies are converging or not. However, the phenomenon of convergence is interesting also as such, as we will see later in this study. In a world where economic differences between countries and regions are enormous, it is of great interest to find out whether these disparities are going to be permanent or whether they could automatically diminish in time. This is exactly what convergence economists are set out to do. It is possible to study convergence at many different levels: globally, between a group of countries or inside a given country, between regions using a number of alternative methods.

## 1.2 Aim and scope of the study

In this study, I will provide a conclusive overview of the theories of economic growth and convergence in order to form a sufficient backround for my own empirical study. Even though convergence studies have provided some very fruitful ideas and results, they have also been a subject of debate and critique. This issue and the alternative approaches offered will also be discussed in this study. The aim of the empirical study is to determine the extent and speed of convergence between regions in Finland, following the recent empirical tradition, and to compare these results to the empirical evidence collected by other studies, both Finnish and international. To begin with, I will define and limit the subject of my study a bit more precisely. The survey of

recent theoretical literature mainly concentrates on convergence issues, including as much literature about the neoclassical and endogenous growth theories as necessary for the understanding of the nature of convergence. However, I will demonstrate that convergence is also an important issue as such and not only as a part of growth theories, even though it could, in theory, be used as a test of the compatibility of different theories with the real world experience. Secondly, the empirical study of convergence will be made using regional GDP per capita figures, or rather gross regional products, in the tradition of Barro and Sala-i-Martin, as this is one of the clearest indicators of regional per capita productivities and incomes, and it is readily availabe to study. Accordingly, the aim of this study is to evaluate the convergence of regional incomes. On the other hand, gross regional product per capita or worker can be considered as a measure of regional output and productivity, meaning that we are, in a sense, assessing output convergence[1]. Income convergence in Finland has already been analysed by Kangasharju (1997a, b and c) who uses levied taxable per capita incomes as his data, so using gross regional products instead might bring a new insight in the issue in the Finnish context. It will be interesting to see whether using gross regional products will lead to similar conclusions as in Kangasharju, since this was the case when Barro and Sala-i-Martin (1992) analysed convergence in the USA.

The availability and nature of data sets its own limitations, too. The biggest difficulty is that harmonised statistical data on gross regional products in Finland only exist for the period of 1960-1994 , so this period is the one I will be concentrating on. The years for which data are available are 1960, 1970, 1973, 1976, 1978, 1980, 1982, 1984, 1986, 1988, 1990, 1992 and 1994. Even though the quality of data has proved to be one of the biggest difficulties in many empirical convergence studies, it has been possible to provide statistically sound and significant results. Thus, we can continue with the current available data with sufficient confidence. Another limitation proposed by the data is that the longest time series exists only on the level of 12 Finnish provinces, which, clearly, means that the sample is not very large. An alternative regional classification would be the 19 so-called NUTS 2 regions, which form the basic units of Finnish and the EU regional policy measures. The data for these NUTS 2 regions exist only for the period of 1988-95. This analysis, however, is not included in the study. The lowest level of regions for which statistical data are available in Finland (1988-94) are the 88 small-scale subregions which

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[1]See for example Armstrong and Vickerman (1995) for a more complete definition of output convergence.

the European Union defines as NUTS 3 regions. As the number of subregions is great enough, using this data offers a possibility to practise alternative methods in analysing regional convergence. As we can see, the longest time series divides Finland into just 12 regions, which is not very much. It would be more optimal to estimate regional convergence at lower regional level, but then the time series would be extremely short. Keeping in mind that there are regional differences in growth rates even inside provinces, we can interpret the results obtained with due caution.

## 1.3 The organization of the study

The structure of this study is as follows. After this introduction, the second chapter will provide some backround for the issue of convergence by introducing traditional and new theories of growth and explaining how they relate to convergence. The clear contrast of predictions about convergence or divergence between these theories will be one important subject of discussion. In chapter three I will have a closer look at convergence theories and the most recent developments in them. The criticisms and alternative approaches will also be evaluated. Chapter four provides an overview of the empirical studies and results concerning regional convergence. Most of the studies have been made in the USA or Europe, with some of them in other parts of the world. Lately, the regional convergence of the European Union has been much debated, due to the further integration and widening of the Union. Regional convergence between Finnish regions has been estimated by Kangasharju whose studies are also discussed in chapter four. The fifth chapter consists of my own empirical study beginning with the definition and formulation of the task, the data and the methods used, and finishing with the presentation and analysis of the convergence results for Finland from 1960 to 1994. The last chapter will conclude this study by reviewing the issues discussed and providing some future considerations.

# CHAPTER 2: ECONOMIC GROWTH AND GROWTH THEORY

## 2.1 Overview

Economic growth was studied very intensively in the 1950s, and also 1960s, when Robert Solow introduced his neoclassical theory of growth. Actually, the roots of growth theory come from several earlier economists, for example Ramsey, Harrod and Domar, but the first well formulated, consistent analysis of growth was made by Robert Solow and Trevor Swan in 1956. After some enthusiastic modelling attempts the development of growth theory seemed to come in a standstill in the early 1970s, and the economists lost the interest in modelling economic growth. However, in the 1980s it became fashionable again to try and understand why there are such large disparities in incomes between different countries, and why some countries continue to exhibit significant growth while others fall far behind. Thus, economists such as Romer, Lucas, Rebelo, Barro and Sala-i-Martin started developing the growth theory again, and have indeed introduced some new, interesting ideas.

Growth theory is studied here because it provides the backround for convergence literature, and understanding convergence is not possible without the basic knowledge of economic growth. Our analysis of growth will not be exhaustive but the idea is to discuss the models of growth as far as they are relevant for the convergence hypothesis. This chapter will first describe the traditional neoclassical growth theory by introducing various models, explaining their advantages and problems. After that, the so-called new growth theory will be taken into closer examination in order to look at the new sets of explanations it provides for growth. Finally, various models will be assessed, comparing their predictions and evaluating which one of the many alternatives could provide the most sound basis for my empirical study.

## 2.2 The neoclassical models of growth

The basic neoclassical model is a good starting point for our analysis of economic growth. Even though it is lacking in several respects, as we will see later, it still provides a simple and general framework for understanding growth.

### 2.2.1 The basic Solow-Swan model

The central idea of the Solow-Swan model [2] is that economic growth, or growth in the real per capita gross domestic product, can be explained by the accumulation of capital. But because the production function implies diminishing returns to capital, economic growth will eventually stop, unless there is continuous technological progress in the economy (Barro and Sala-i-Martin 1995, p. 10-11). Let us first have a look at the assumptions of this model and, after that, see how it is formalised.

The assumptions in this model are the standard neoclassical ones. The central feature of the model is the (homogeneous, first-degree) production function, which combines two inputs, capital and labour. Returns to both factors of production diminish with the amount of the factors used, and there are constant returns to scale. We are essentially studying a closed economy, so all the usual closed economy considerations hold. Later we will see what happens to the predictions of the model if we relax this assumption. Other standard neoclassical assumptions are the existence of perfect competition, firms maximising their profits and households maximising their utility. Also, there must be no externalities associated with production, consumption and so on. Finally, so-called Inada conditions[3] must hold, meaning that the marginal products of labour and capital fall to the neighbourhood of zero if the amount of them is increased to infinity, and if the amount approaches zero, the marginal products grow infinitely.

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[2] This model was developed by Robert Solow and Trevor Swan separately in 1956. See for example Solow (1956) or Swan (1956).
[3] The name of these conditions stems from the fact that they were introduced by Ken-Ichi Inada in 1963.

Let us now analyse the model more formally. Most of the following equations are taken from Mankiw (1995) and Barro and Sala-i-Martin (1995). To begin with, the central feature of the model is the production function, which is written in its basic form:

(1)        $Y = F(K, AL)$.

In the above equation $Y$ denotes output, $K$ physical capital, $L$ labour and $A$ reflects the level of technology in this given country. We can simplify the production function even more by dividing it with the amount of labour, when the capital-labour ratio is expressed as $k = K/L$ and output per capita as $y = Y/L$. We can thus rewrite equation (1) as follows:

(2)        $y = f(k)$.

Now we see that output depends purely on the capital-labour ratio. Let us next see how the amount of physical capital increases over time.

(3)        $\dfrac{dK}{dt} = I - \delta K = s \times F(K,L,t) - \delta K$,

where $s$ is a positive constant, $\delta$ is the (positive) rate of depreciation and $I$ is the amount of investments. Let us continue as we did before, and divide equation (3) by $L$, which gives us

(4)        $\dfrac{(dK/dt)}{L} = s \times f(k) - \delta k$.

We can now rewrite the left-hand side of the above equation by substituting capital-labour ratio $K/L$ with $k$, as we did before, so as to get a function which only depends on $k$. Let us also denote $(dL/dt)/L$ by $n$. We thus arrive at the fundamental Solow-Swan equation (5), which is introduced in Barro and Sala-i-Martin (1995, p.18).

(5)        $\dfrac{dk}{dt} = s \times f(k) - (n + \delta) \times k$.

This equation tells us that the capital-labour ratio grows together with the growth of savings rate $s$, and falls as labour force or depreciation rate grow. And the growth of capital-labour ratio will, as the model says, lead to growth in output. The model requires that diminishing returns to capital will eventually lead to a constant growth rate, a steady state, in which the change in capital-labour ratio in time is zero. The steady state capital-labour ratio is denoted by $k^*$. What this means is that

in a given economy the growth of per capita GDP converges towards a certain steady state value, which is determined by the savings rate and the speed at which the economy's population grows (Mankiw 1995, p.277).

Let us next see how the steady state is achieved in time. We can do this by simply observing the growth rate of capital in time, which we get if we divide equation (5) by the capital-labour ratio $k$.

(6) $\qquad \gamma_k = \dfrac{(dk/dt)}{k} = s \times \dfrac{f(k)}{k} - (n + \delta).$

The basic Solow-Swan model implies that if there is no technological progress in the economy, economic growth will only continue until the steady state is reached. This, of course, means that we cannot explain a real world situation where economic growth is a persistent, long-run phenomenon with this model, but we need to add more explanatory variables. In the neoclassical tradition these variables will be purely exogenous as we will see in the following section.

## 2.2.2 Solow-Swan model complemented with technological progress

As we have seen, continuous economic growth cannot be explained by the accumulation of capital, but we need to add technological progress into the model. To begin with, the nature of technology in the neo-classical model is exogenous, meaning that it is something that the economy just takes as given, and it is supposed to be a free good. Also, the same technology is available to all countries (Fagerberg 1994, p.1147). Finally, it is required that technological progress improves the productivity of labour, rather than the productivity of capital, because the latter would lead to controversies with the reaching of a steady state (Barro and Sala-i-Martin 1995, p.33).

Let us now simply introduce a new variable to our model to reflect the rate of exogenous technology growth $g$. The following equations are from Mankiw (1995, p.276).

(7) $\qquad \dfrac{dk}{dt} = s \times f(k) - (n + g + \delta) \times k.$

This equation tells us that, in addition to other variables, technological progress affects the growth of the capital-labour ratio in time, and thus affects the income growth, too. We can define the steady state values to see how income $y = f(k)$ is determined in the steady state.

$$(8) \qquad s \times f(k^*) = (n + g + \delta) \times k^*.$$

Here we see that income, let us call it GDP per capita, grows in the steady state exactly at the rate of technological progress g, since other variables are constant in the steady state.

The Solow-Swan model with technological progress is more realistic than the basic version, because now we can explain long-run economic growth. However, the model is still very unsatisfying, and for example Fagerberg (1994) and Mankiw (1995) criticise it for putting all growth down to an exogenous factor. These authors complain that using this neoclassical framework we cannot explain why countries grow at different rates. Mankiw (1995, p.280) also points out that the Solow-Swan model does not really explain the essence of economic growth, but it only states that there is growth.

There have been attempts to make the neoclassical growth model more realistic and general, for example by removing the assumption of closed economy. This is done by Barro et al (1995) in their article, and I will next introduce their general idea. Generalizing the model to open economies has to be done in order to study regional growth and convergence, as regions clearly cannot be seen as closed economies. Barro et al prefer the neoclassical model, because it implies the convergence of incomes, which is the phenomenon the existence of which they hope to prove. To begin with, we have to assume that there is only partial capital mobility, since perfect capital mobility in an open economy would lead to instantaneous convergence of incomes, and this, clearly, is extremely unrealistic. By partial capital mobility we mean that only physical capital, not human capital or labour, can be borrowed internationally[4]. Barro et al compare the situation described above with the closed economy one and notice that the implications of the model will not change dramatically. In fact, introducing the open economy considerations will not alter the

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[4] This idea seems very plausible, since even where the full mobility of capital and labour is allowed (as in the case of the European Union), the actual mobility can be far from perfect, as a certain natural degree of mobility barriers will always exist. Such cultural and other natural mobility barriers are studied for example by Gogel et al (1989).

steady state at all compared to that of a closed economy. However, the speed at which the economy approaches the steady state will be somewhat faster in an open economy with partial capital mobility. The aim of this model is to show that the predictions of the neoclassical model will remain intact even if we allow for open economies, and the economies will still converge to their steady states. Thus, we can use the closed economy model as an approximation of the real world situation. In the regional context this may be somewhat questionable, as we will see later.

### 2.2.3 The predictions of neoclassical growth models

As the implications of the neoclassical model are quite straight-forward and generally known, they will not be formalised here. For an interested reader there are several sources where the formal derivation of the following results can be found.[5] Mankiw (1995, p.277) finds five central predictions of the Solow-Swan model which do not conflict with the empirical evidence too badly. Firstly, all economies will converge to their steady states in the long run, regardless of their starting points. Secondly, the GDP per capita level in the steady state is determined by the level of savings and the growth of the country's population. Moreover, the only factor determining the GDP per capita growth in the steady state is the exogenous technological progress. Also, the rate of growth of GDP per capita in the steady state is exactly the same as the rate of growth of the capital stock. And finally, as the economy reaches its steady state, the marginal product of capital will be unchanged, but technological progress enhances the marginal product of labour.

The most interesting predictions of the neoclassical model for our purposes are the implications of convergence of GDP across economies. Barro and Sala-i-Martin (1995, p. 26-32) argue, that similar economies (in terms of their savings- and population growth rates and the depreciation rate) converge towards the same steady state value of GDP per capita, so that poor economies grow faster than the rich ones. This means that there is absolute convergence of incomes between the economies. However, this type of convergence is seldom observed empirically, and thus another type of convergence is introduced. Conditional convergence allows the economies to

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[5] See for example Solow (1956) or Barro and Sala-i-Martin (1995) for their interpretation.

converge towards different steady states, since it is more realistic to assume that the economies differ in many respects. Here, the economy that initially diverges most from its own steady state will grow fastest. These and other concepts of convergence will be discussed in the following chapter in more detail, but the most important message is: The neoclassical growth theory predicts convergence and catch-up.

## 2.2.4 Problems and critiques of neoclassical growth theory

So far it seems that the neoclassical theory of growth could provide a perfect starting point for studying convergence. However, there are several problems in the neoclassical approach, starting with the unrealistic assumptions that are required. It is, for example, hard to regard technology as a purely exogenous phenomenon, since creating advanced technologies is obviously an intentional process in all economies. Also, making international comparisons of growth would require the same production function for all countries, which seems unrealistic. As we see, the standard neoclassical assumptions leave a lot to be desired, but let us now concentrate on some of the more urgent problems these models face.

Most authors (for example Mankiw 1995 and Nijkamp and Poot 1996) see that the biggest problem with the neoclassical growth theory is its incompatibility with the real world situation. This means that the models cannot explain why income levels vary such a lot between countries. Empirical evidence shows that poor countries are not growing faster than the rich ones, but quite the opposite. Mankiw et al (1992) show that more variables need to be added to the models in order to explain huge international economic disparities.[6]

The second problem of the neoclassical growth theory is connected with its convergence predictions. Even though many studies have found evidence to support this convergence hypothesis, the actual rates of convergence have been much lower than the theory predicts. And, as most economies nowadays are open, convergence should be almost instantaneous, or at least

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[6] These added variables include for example various measures of human capital.

very rapid. Furthermore, Nijkamp and Poot (1996, p.6) note that even the USA has experienced some considerable divergence of regional incomes during a number of ten-year periods, a fact that contradicts with the neoclassical predictions. Thus, we can conclude that a big difficulty with the neoclassical growth theory is its incompatibility with empirical findings. This problem is what the new theories of growth tried to solve by constructing models which were closely connected with empirical findings. In the following section we shall examine these models in more detail.

## 2.3 New Growth Theory

This section will study the so-called new theories of growth, limiting itself to the models constructed in the 1980s and 1990s. It is true that there were some early attempts to model economic growth as an endogenous phenomenon in the 1960s[7], but as these attempts were not very successful, the interest in endogenous growth was lost until the 1980s. However, the idea of endogenous growth came back in the mid-1980s when Romer wrote his "Increasing Returns and Long-run Growth". Since then concepts such as human capital, knowledge, innovation and endogenous technological change have been used frequently in order to explain the different experiences of growth. Simultaneously, the "convergence versus divergence" -debate has been considered as a way to establish a connection between empirical findings and growth theories. As I already mentioned, the idea of the new growth theory was to relate closely to empirics and construct models which suit to empirical data. Let us now have a look at some of the most influential new growth models.

## 2.3.1 Introduction to endogenous growth models

Endogenous growth models were developed after the mid-1980s by economists such as Romer, Lucas, Aghion and Howitt to answer the question why there are such large growth differences between countries. As I will show in this section, the new models have responded to many of the

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[7]Such attempts were made for example by Arrow (1962) and Sheshinski (1967).

challenges that were set for them and have certainly brought new inspiring ideas to growth literature, but they have also been criticised for being impossible to test empirically and not being so fundamentally different from (or at least not any better than) the traditional growth theory. In this section I intend to introduce various models, beginning with the so-called AK- model, which has been used by many economists. We must keep in mind that such AK- type models are not consistent with convergence. So if convergence is found between countries or regions, it poses problems for the models discussed below.

## 2.3.2 The basic AK-model

The new growth theory gave up diminishing returns to factors of production and adopted a broader interpretation of capital. Romer (1986), for example, considers the accumulation of knowledge (which can be seen as kind of capital) to be the essence of growth and assumes no role for endogenous technological change. The idea of this model here is taken from Barro and Sala-i-Martin (1995, p.38-41) and Mankiw (1995, p.296-298). In this basic AK-model, we assume a constant returns production technology which is described by the production function

(9)     $Y = AK,$     $A > 0$

where we let K denote capital, including both physical and human capital as well as knowledge. The constant A indicates the level of technology. Mankiw (1995, p.296) shows that the effect of capital accumulation in the AK-model and the production function will together form the following equation.

(10)     $\dfrac{dY/dt}{Y} = \dfrac{dK/dt}{K} = sA - \delta.$

Thus, we can explain continuous income growth even in the absence of technological progress. Saving, in this model, appears to be a virtue, since it enhances economic growth permanently, differing thus from the neoclassical views. Mankiw (1995, p.297) argues that convergence in this model is nearly zero, and the steady state, if such a state even exists, is never reached (or

economies are in it constantly). Barro and Sala-i-Martin (1995, p.40) see this as a shortcoming of the AK-model, as, in their view, conditional convergence is a widely recognised phenomenon.

The AK-model provides a very simple framework in which endogenous growth can be analysed. However, there is a variety of more advanced models which include, for example, a more specific role for human capital, more than one sector, technological change and so on. Let us now move on to study these models and see what kind of implications they have in terms of convergence.

## 2.3.3 An endogenous growth model with human capital

Adding human capital variables into growth equations has been done, for example, by Lucas (1988) who argues that the accumulation of human capital will lead to cumulative growth. Including human capital, however, may not be such a simple procedure, because there is no single, unambiguous measure of human capital that could be used. Lucas argues that this problem can be solved by using just the individual's skill level. He also assumes that human capital causes external effects, meaning that low-skilled workers can gain in productivity when working with more skilled workers. The lucasian production function can be written as

(11) $Y = AK(t)^{\beta}[u(t)h(t)N]^{1-\beta}h_a(t)^r.$

Here, the average human capital level is represented by $h_a$, whereas $h(t)$ stands for the human capital of an individual worker. $N$ denotes the number of workers and $u(t)$ the working hours of an individual worker. There are also positive externalities associated with human capital, and these are represented by $r$.

Lucas' model considers both the growth of human- and physical capital, deriving thus the growth path that enables individuals to maximise their utilities constrained by the level of technology. Solving the optimisation problem, we get two different growth rates for the society, meaning the actual market growth $g$ and the optimal growth rate $g*$. Lucas (1988) argues that the existence of externalities leads to a market growth rate smaller than the optimum. The optimal growth rate can be written as

(12) $g* = [1 + \dfrac{r}{1-\beta}] \times v*,$

Here $v^*$ is the growth rate of human capital at the optimal level, which is affected by, for example, the investments in developing human capital.

Lucas' human capital model has some very fascinating predictions in terms of differences in incomes and growth rates between countries. Contrary to neoclassical theory, this model implies that countries which have a relatively high level of human and physical capital to begin with will also grow faster. If we hold other aspects constant, assuming countries to be identical in all other respects than human and physical capital accumulation, no convergence will happen, but there is a high possibility of divergence, instead. However, this need not be the case in all growth models including human capital, as we will next see.

Let us now have a look at an alternative approach for modelling human capital. Gemmell (1996, p.9-11) argues that the measures of human capital used in most growth models have been inadequate in many ways, making the models that include human capital rather questionable. He suggests that instead of simply using school enrolment rates as a proxy for human capital, we should distinguish three levels of education: primary, secondary and tertiary. These levels represent the different human capital skills which the workers have aqcuired, in addition to which there are the physical skills of workers. Gemmell constructs a model which ties together the growth of human capital and the growth of per capita incomes. He finds out that a countries with high levels of human capital tend also to have relatively high incomes per capita. Gemmell also shows that human capital enhances growth in many ways: directly and via making it possible to invest more into physical capital. In his empirical study Gemmel finds conditional convergence occurring between countries, meaning that including human capital into growth models can be in accordance with the convergence result. This proves that endogenous growth models need not necessarily exclude the possibility of convergence, meaning that convergence can be a feature in models other than neoclassical.

## 2.3.4 Introducing technological change to endogenous growth models

In this section we shall look at various growth models in which the technological progress is endogenised. Let us begin with one of the most influential new growth models, namely that of Romer (1990). We could certainly think of a number of ways to measure advances or developments in technology (for example the number of patents, R&D expenses and so on), but here we consider them as a widening of the varieties of goods in an economy, which indicates innovations and product development. Romer presumes that there is a specific sector for research in the economy which uses relatively much human capital, and a certain amount of human capital is required for innovations to occur. Another assumption is that there are diminishing marginal costs in innovation activity, meaning that inventions get cheaper the more advanced the economy is. This aspect causes endogenous growth to occur in this model. Finally, Romer assumes that spillover effects come in the form of reduced labour requirements as more innovations are made.

We skip the formal representation of Romer's model here, since it is not essential for understanding the following results.[8] The growth rate of an economy depends positively on the size of the aggregate labour force and the propensity to save, and negatively on the costs of R&D. The equilibrium growth rate occurs in a Pareto-optimal situation where labour is efficiently allocated between production and R&D. This allocation is done by political planning, meaning that the economy's ability to grow is determined partly by political forces. The implications of this model can be summed up as follows. If we assume that innovations and technological advances do not move freely internationally, we can expect countries to grow at different speeds. Thus, convergence may not be consistent with the model of technological change. However, it might be more reasonable to assume that the same technology is, at least partly, available to all economies. Moreover, Barro and Sala-i-Martin (1995, p. 238) argue that convergence can be added to such growth models, making them more realistic in terms of empirical evidence. Let us next have a look at a somewhat different growth model with technological progress, and see if the convergence property can be held in it.

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[8]The formalisation of Romer's model can be found for example in Barro and Sala-i-Martin (1995, p. 228-229) or Romer (1994, p. 3-22) in the Journal of Economic Perspectives.

Grossman and Helpman (1994, p.25-26) base their view of economic growth on industrial innovation and technological progress. They argue that even though it cannot be empirically confirmed, it would be reasonable to expect that endogenous technological progress enables continuous growth. Innovation and R&D are strategic ways to gain competitive advantage, leading to the accumulation of capital and economic growth. Contrary to the traditional neoclassical theory, there are external effects and spillovers, meaning that the economy will not automatically reach a stable, optimal growth path, but political forces must be added to control the growth. Grossman and Helpman (1994, p. 40-41) have less to say in terms of convergence, but they simply seem to assume that a catch-up is possible, if the less-developed country so wishes and has at least the minimum amount of resources required. They suggest that countries hoping to catch-up with the richer ones should not fully open themselves internationally, but first let their technological knowledge grow, for example by imitating the more advanced countries' technologies. Opening up to trade would then be more profitable, as the country would be more competitive internationally and could produce technologically advanced goods, and could then escape its backwardness.

Another approach to endogenous technological change is offered by Nijkamp and Poot (1996) who also have a clear view on how growth and differences in technology affect the regional distribution of incomes. The main issue in their study is the interdependence of economies, both countries and regions, which means that we should use open-economy models. The authors argue that the neoclassical model is inconsistent with the empirical evidence, meaning that in the real world capital, also human capital, seems to flow to richer countries and not to the poor ones. Nijkamp and Poot (1996, p. 16-19) argue that the growth rates at the steady state are different between regions, and incomes per capita may show a diverging trend. Also, contary to the neoclassical model, there may only exists a steady state if the growth rate in regions is exactly the same. Thus, it would seem that the growth experience tends to be very different between different countries and regions, and the reasons for this are technological differences, increasing returns to technological inputs and the interdependence of economies.

## 2.4 A comparison of growth models

In this chapter we have studied several different growth models and their predictions in terms of growth differences and convergence between economies. Let us now briefly compare the models studied and evaluate their suitability to the empirical evidence. Some economists argue that the neoclassical and new growth models are not all that different from each other, but they can rather be seen as complementary. However, the important differences come to light if we want to model economic convergence, where we notice that the choice of the model is very critical, indeed. The aim of this section is to establish a clear view of which model can provide the base for the empirical research on convergence. Clearly, this depends very much on the exact phenomenon one wants to study and the empirical data available.

All models studied above have their pros and cons, and constructing some kind of a ranking order between them on purely theoretical grouds would be impossible. The best way in which to compare them is probably to check how their predictions fit together with the empirical experience of growth. As we already discussed, the neoclassical model had some problems in this respects, but with adjustments these problems can be solved, as Mankiw (1995) shows. Jones (1995), on the other hand, performs empirical tests on endogenous growth models. He states that there has been no uniform growth experience in the OECD countries after the second world war and the growth rates have shown no continuous increase, even though the variables which should explain growth in endogenous growth models would clearly indicate that. Such variables are for example investment rates, population growth, export shares and so on (Grossman and Helpman 1991). These facts are very much contaradictory to the arguments of endogenous growth models. In particular, the AK model is inconsistent with the actual shortness of the periods during which a change in investment rate seems to affect growth. And secondly, the models of technological advances and R&D cannot explain why the growth rates have not changed dramatically, even though the labour force in R&D -sector has grown continuously.

As we can see, even though the neoclassical growth model has its problems, we cannot say that the new models would perform any better in the empirical context. Thus, economists, such as Barro and Sala-i-Martin, studying convergence have taken the neoclassical theory as their starting

point and modified it in the necessary respects. However, we must study the convergence literature more thoroughly before making any precise decisions about the approach we are going to take in the empirical study of convergence. This will be done in the following chapter, which purely concentrates on reviewing the various methods and theories standardly used in the convergence literature.

# CHAPTER 3: DIFFERENT APPROACHES TO CONVERGENCE

The so-called convergence hypothesis has aroused much discussion in the past few years. Empirical studies about convergence have been performed using a wide variety of data sets, both international and one-country. Simultaneously, many economists have discussed the theoretical backround and implications of economic convergence. In this chapter, we will mainly deal with the various theoretical issues concerning the convergence hypothesis, looking at a set of different approaches. Empirical studies are left to discuss in chapter four.

## 3.1 Introduction to the convergence hypothesis

As I explained in the previous chapter, different growth theories have very different views about how the distribution of income (or growth) develops regionally or globally. Issues like this can be studied by comparing a group of countries or regions, and establishing whether they are converging or diverging in terms of their incomes. If the per capita incomes between countries are becoming more similar in time, we are dealing with the absolute convergence hypothesis.[9] Galor (1996, p.1056) argues that the neoclassical growth theory is not necessarily suggesting that convergence will happen in this absolute sense, but rather that convergence is conditional to various structural characteristics. This means that countries will converge to their own steady states which may be different from those of other countries. In addition, Galor shows that neoclassical growth models can also be consistent with convergence clubs, meaning groups of similar countries converging towards each other but diverging from other convergence clubs. Thus, we can understand the convergence hypothesis, meaning per capita incomes in different countries converging in time, in absolute-, conditional- or club convergence sense. Convergence hypothesis is consistent with both the neoclassical growth theory and some endogenous growth models.

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[9] The central feature of the traditional convergence hypothesis is that it states that poor countries grow faster in per capita terms than the rich ones, and will, in time, catch-up with the world leaders. In recent literature this statement is renamed as the absolute convergence hypothesis (see for example Galor 1996). In addition to that we can distinguish the conditional convergence hypothesis, both of which will be discussed in this chapter.

It has often been argued that studying convergence can help us to evaluate different growth models and to distinguish which one of them is the most accurate. This method, however, has not been quite so fruitful, as for example Jones (1995) and Galor (1996) explain. First of all, there has not been a clear consensus on how convergence should be studied best. And secondly, it is not always so easy to find support for growth theories, because under different conditions they lead to different conclusions. Moreover, it may be rather questionable to argue that the observed rate of convergence is caused by a neoclassical growth process in which natural mechanisms lead the economy to its steady state growth path. Instead, it is possible that convergence is a result of policy measures which aim at reducing disparities between economies (regions, for example). As it is not possible to separate the natural rate of convergence from the effects of policy measures, convergence does not necessarily prove that the neoclassical growth theory is correct. However, it is easy to see that the convergence hypothesis provides an interesting object of study as such. As Barro and Sala-i-Martin (1991, p.107) explain, there are many important questions to which we can find an answer in convergence studies. Clearly, it is important to know whether poorer countries are growing faster than the richer ones, or whether the world is becoming an even more unequal place. In the regional context, making policy decisions and evaluations is easier if we know how regions are developing relative to each other.

As already noted earlier, this study seeks to reveal the existence of *regional* convergence. However, convergence studies have traditionally been performed at many different levels, most notably across states or countries. We must note, that performing convergence studies to find out whether poor countries grow faster than the rich ones is somewhat problematic, since countries differ from each other in many respects. Thus, absolute convergence is seldom found, but in order to eliminate the differences we are required to assess the existence of conditional convergence. Persson (1994, p.2) argues that studying absolute ("unconditional") convergence is more fruitful on the level of regions, since they are likely to be more similar than countries in terms of technologies and preferences.[10] We can safely expect this to be true in Finland, because it is a relatively small, homogenous country.

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[10] It has often been argued that studying regional convergence provides a test for the whole convergence literature, since the unability to find absolute convergence across regions of a given country would make the existence of absolute convergence across countries very unlikely, since countries are far more heterogenous than regions. See for example Evans and Karras (1996, p.384).

This chapter will first introduce the basic approach to convergence, which has been used by for example Barro and Sala-i-Martin (1995). This approach is essentially cross-section and based on a neoclassical framework. However, the cross-section approach has also been subject to much criticism, and a number of alternative approaches to convergence have been proposed. Alternative ways to assess convergence will also be discussed in this chapter in order to decide which methods are to be used in the empirical study.

## 3.2 Definitions and concepts of convergence

As already hinted above, we can distinguish several types of convergence, some of which work as prerequisites for the others. All these concepts of convergence are interesting and informative, since they give answers to different questions. This section will briefly introduce each concept and explain which phenomena they refer to.

### 3.2.1 σ-convergence

What most people understand by convergence is the diminishing inequality of incomes per capita in a set of economies. In fact, this phenomenon is exactly what σ-convergence is about, and thus it tells us how the income distribution of a given group of countries develops over time. The following interpretation is given in Sala-i-Martin (1996a, p.1020).

*Definition 3.1*
"A group of economies are converging in the sense of σ if the dispersion of their real per capita GDP levels tends to decrease over time."

Estimating σ-convergence can be done by measuring the dispersion of logarithmic income and the coefficient of variation across a number of economies. For σ-convergence to exist, we require that the dispersion diminishes over time. Sala-i-Martin (1996a, p.1020) writes the condition for σ-convergence simply as:

(13)        $\sigma_{t+T} < \sigma_t,$

where the dispersion of the logarithm of income, $\sigma_t$, falls monotonously from moment t to t+T.

At the first glance it may seem that $\sigma$-convergence tells us everything we want to know about the distribution of income across economies and how it evolves. However, this is not at all the case, since similar dispersions of per capita incomes can be created by many different relative growth patterns of economies, as Sala-i-Martin (1996a, p.1021) demonstrates. Moreover, Quah (1996c) argues that studying convergence as defined above will reveal us nothing about dynamical processes going on between the economies. This point will be discussed later in more detail, but it should now be clear that in order to understand the relative growth patterns of rich and poor economies, we need to introduce further concepts of convergence.

### 3.2.2 $\beta$-convergence

Some economists have argued that the concept of $\beta$-convergence has little relevance if we wish to describe the distribution of wealth or income across the different countries of the world.[11] This misconception, however, probably stems from the insufficient understanding of the implications of convergence hypothesis. As Sala-i-Martin (1996a) explains, for $\sigma$-convergence to exist, there must necessarily be $\beta$-convergence, too. This means that the existence of $\sigma$-convergence crucially depends on the existence of $\beta$-convergence. This condition, mind you, is not enough to ensure that the actual dispersion of income will diminish, but it may even become more inequitable, if, for example, regionally differentiated shocks occur. On the other hand, if we want to know if poor countries have greater growth rates than the rich ones, or whether a catch-up is likely to happen, and how soon, we need to study $\beta$-convergence, as the existence of $\sigma$-convergence will not reveal these issues. Thus $\beta$-convergence tells us how the economies move relative to each other in terms of their growth rates and per capita incomes.

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[11]This point has been made, for instance, by Quah (1993) in his writings that concern the Galton's Fallacy and its implications to convergence, and Friedman (1992).

The existence of β-convergence can be revealed by studying a growth equation such as in Sala-i-Martin (1996a).

(14)         $\gamma_{i,t,t+T} = \alpha - \beta \log(y_{i,t}) + \varepsilon_{i,t}$

The above equation tells us the growth rate of per capita income (gross domestic product, for instance) from time t to t+T in the economy i. As we see, it depends negatively on the initial starting income level only if β is greater than zero. Thus, we can simply write the condition for the existence of β-convergence as $\beta > 0$. Note, however, that the above method for the estimation of β-convergence refers to absolute convergence, meaning that the growth rate of an economy only depends on its initial income level. Following this, if all economies are supposed to be similar and converge towards the same steady state, poor economies grow faster and catch eventually the rich ones up, at least partly. As it is unlikely that all economies would be identical, we must present a further distinction of the types of convergence.

## 3.2.3 Absolute and conditional convergence

The above definitions of convergence have mainly been about the absolute convergence hypothesis, meaning that we expect countries to become more similar in terms of their economic and technological structures, which then leads to income convergence, as Galor (1996) explains. It has often been argued that the neoclassical model would imply absolute convergence, but for example Galor and Barro and Sala-i-Martin (1995) have shown this not to be the case. It can be demonstrated that the neoclassical model is actually consistent with so-called conditional convergence hypothesis. This means that countries do not necessarily converge towards the same steady state, since they have different technologies, preferences and so on, but only converge to their own long-run steady states. This means that the differences in income levels may be persistent in the long-run, and they do not diminish even if convergence occurs. Moreover, Sala-i-Martin (1994 p.745) argues that even the existence of *absolute* β-convergence (poor countries growing faster than the rich ones) will not guarantee that σ-convergence occurs, though this is really a very exceptional case.

Lately, the existence of conditional β-convergence has been much debated. Sala-i-Martin (1996b, p.1330) defines conditional β-convergence as follows.

*Definition 3.2*

"...a set of economies displays conditional β-convergence if the *partial correlation* between growth and initial income is negative."

In order to estimate the extent of conditional β-convergence, we must consider which factors differ across economies and then hold these variables constant. If, on the other hand, we do not hold constant any explanatory variables, we end up estimating absolute β-convergence, or as Sala-i-Martin (1996b, p.1330) puts it:

*Definition 3.3*

"If the coefficient of initial income is negative in a *univariate regression*, then we say that the data set displays absolute [beta-] convergence."

## 3.3 The classical cross-section approach to convergence

The cross-section approach to convergence is named "classical" after Sala-i-Martin (1996a), as he explains that its origins come from the neoclassical theory and it was also the first approach used in analysing convergence. According to Barro and Sala-i-Martin (1991, p.108), the basic idea in this approach is to consider a neoclassical growth equation, take a logarithm of it, and use it to indicate the way in which countries or regions move towards their steady states. The growth equation to be used in regressions when estimating absolute β-convergence is thus

$$(15) \qquad (\frac{1}{T})\log(\frac{y_{it}}{y_{i,t-T}}) = x_i^* + \log(\frac{Y_i^*}{Y_{i,t-T}})(1 - e^{-\beta T})(\frac{1}{T}) + u_{it},$$

where $y_{it}$ denotes the output or income per capita of economy i in the period t. $x_i^*$ is the measure of the income or output per capita growth rate of the economy in the steady state, $Y_i^*$ denotes the output per capita or worker in the steady state and $Y_i$ indicates the output per capita or worker, when not in the steady state, meaning that the economy is in the transition towards the steady state. Sala-i-Martin (1996a, p.1026) shows that the rate of β-convergence depends on the capital share of the economy, the rate of depreciation, population growth and productivity growth.

The data routinely used in regressions such as described above consist of gross domestic product per capita for a number of economies in a given period, or, alternatively, some other measure of per capita incomes. Barro and Sala-i-Martin mainly use GDP figures[12], and following that tradition, regional GDP per capita figures will also be used in this study, or, more exactly, gross regional product per capita.

As discussed above, measuring absolute convergence is only sensible when we can assume countries or regions to be very similar to each other. While this is not the case in the international context, the neoclassical tradition suggests measuring conditional convergence instead. For that purpose, we must be able to keep the steady states of all economies constant. Sala-i-Martin (1996a, p.1027-1028) suggests that we can either choose only economies that are very similar (which in my opinion could be quite reasonable in the regional context) or use given steady state imitating variables in the regression. Such variables could be, for example, technological parameters, the savings rate of the economy and other variables that affect $\beta$, such as described above. To do this, we end up estimating a somewhat different equation, such as in Sala-i-Martin (1996a, p.1024).

(16) $\qquad (\frac{1}{T})\ln(\frac{y_{it}}{y_{i,t-T}}) = a - [\ln(y_{i,t-T})](1 - e^{-\beta T})(\frac{1}{T}) +$ other variables.

In the above equation the additional variables are applied to keep the steady state constant.

In fact, there are a number of different variables that we might want to use, as Barro (1991) shows. However, many of these additional variables do not seem to change the convergence result considerably and do not improve the explanatory power of the model. The most interesting set of variables Barro uses are the various measures of human capital, since it has been argued that human capital is essentially a feature of the more recent endogenous growth models (for example Romer 1990 and Lucas 1988). Barro, however, demonstrates that even if we include human capital variables into the classical approach, the convergence result will be unchanged, meaning that poor countries will grow faster than the rich ones if their level of human capital is higher relative to their GDP per capita.

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[12]See for example Barro and Sala-i-Martin (1991) or Sala-i-Martin (1996a) or any study using the same method. Such studies are for example Persson (1994) and Hofer and Wörgötter (1997).

## 3.4 Critiques to the cross-section approach

To begin with, some economists, such as Danny Quah, criticise the whole convergence debate and argue that it is not very informative in understanding the differences in growth rates between countries. On the other hand, others target their criticisms towards certain methods of empirical analyses, and propose different ways in which convergence (or divergence) could be analysed. This section mainly discusses the latter type of arguments that are targeted against the cross-section approach.

## 3.4.1 The unit root argument and Galton's Fallacy

One of the main opponents of convergence theory is Danny Quah, who criticises the general idea of measuring income convergence, and the classical cross-section approach, in particular.[13] Firstly, Quah (1996b, p.1354) argues strongly against the traditional convergence hypothesis, saying that convergence is merely one of the many statistical, empirical phenomena, which does not necessarily have to be connected to economic growth. One can imagine many issues where the same idea of convergence can be used. He does admit, though, that it is interesting to know how economies grow relative to each other and whether there is a tendency for income inequality to diminish. In his opinion, however, such interesting questions cannot be answered by studying $\beta$-or $\sigma$-convergence in a cross-section of economies. Quah (1993b, p.427-428) counters the cross-section approach by saying that a dynamic phenomenon, such as economic growth, cannot be robustly analysed by simply comparing average growth rates of the countries, because it is likely that shocks occur throughout the sample period. As the validity of the cross-section method is questionable, Quah (1996b, p.1355) asks if the so-called two per cent result could result from some mechanical feature of the econometric regression model used.[14] Moreover, Quah believes that the uniform convergence result shows up because the growth process is stochastic, but in a unit-root manner.

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[13] See any of Quah's writings about convergence, for example Quah (1993a), (1993b), (1996a), (1996b) or (1996c).
[14] The most notable empirical finding of the classical cross-section approach is the so-called two-percent-result, meaning that it has been established that economies converge approximately at the rate of two per cent per annum.

Hart (1995, p.287-288) explains that in a cross-section regression there may be a tendency for the values in the upper and lower end of the spectrum to converge, or regress, towards the mean value of the sample. This problem is thus inherent in the cross-section analysis of convergence. Hart (1995, p.291) warns that in estimating growth we should categorize the data according to the initial incomes and not the income levels at the end of the sample period. Similarly, Quah (1993a, p.432-435) points out that the estimated rate of convergence, meaning the negative correlation between the preliminary income level and the subsequent growth rate, may arise because of the fallacy of regression. He proposes more direct methods for analysing the evolution of income distributions. In order to check if there are some inconsistencies in the cross-section method, this study will also analyse the regional income distribution using such direct tests of convergence. This issue will be discussed in more detail in the following sections.

To counter these criticisms, Sala-i-Martin (1996b, p.1339-1341) argues that it is very improbable that the convergence result would arise due to problems described above. The reason for this is that the income dispersion is not growing over time, as Quah suggests, but rather the contrary, which has been proven in several studies, for example Barro and Sala-i-Martin (1991). Thus, it seems that the convergence hypothesis cannot be neglected on purely statistical bases.

### 3.4.2 The dynamic nature of growth processes

Quah (1996c, p.1045-1048) argues against the use of traditional approach to convergence. In his opinion, the catch-up is an interesting phenomenon, but its existence cannot be established by estimating the rates of $\beta$- or $\sigma$-convergence. In fact, Quah maintains that no dynamic feature of the growth process will be revealed in a convergence analysis. Quah sees that one lack of the cross-section approach is that it cannot separate growth (the increase in output due to advances in technology) from convergence (the way in which different economies grow relative to each other). The problem in not being able to tell these two apart is that they do not necessarily occur simultaneously, as the neoclassical model would suggests. As I already commented before, it is possible that the same rate of convergence can be a result of several different growth patterns, meaning that distribution dynamics may, indeed, remain unrevealed. Thus, in order to recognise

possible convergence clubs, one needs to adopt some additional approach, too. The same issue is commented by Bernard and Durlauf (1996, p.167), who say that the cross-section approach makes it impossible to identify convergence clubs, meaning situations in which a set of countries converge towards each other, but the others do not. They propose an alternative method, too, and argue that using cross-section and time-series methods should always give opposite results. We should note, however, that such a result was not obtained by Kangasharju (1997a) for the Finnish subregions. Moreover, it has been shown that the neoclassical convergence approach can be quite consistent with convergence clubs hypothesis.[15] Another issue, though, is whether the existence of these clubs will be revealed in the so-called Barro-regressions.

Quah (1996c, p.1048) comments on the use of conditional $\beta$-convergence quite critically. In his opinion it is a completely irrelevant concept if we wish to understand the relative growth performances of a number of countries. Quah argues that it cannot help us to conclude whether the poorer countries grow faster than the rich ones. In my opinion, however, we cannot understate the importance of (conditional) $\beta$-convergence, since it is, firstly, the necessary condition for - convergence (which, indeed, tells us whether the dispersion of income is diminishing) and, secondly, it lends support to one of the main forecasts of the neoclassical theory. Another opponent of the conditional convergence approach is Cho (1996, p.670), who warns that the most common conditioning variables[16] are endogenous, which leads to a negative sign in the conditional convergence coefficient ($\beta$). He argues that the variables applied are correlated with the initial income level and, in some cases, with each other. Another problem, then, are the causality relationships, meaning that it cannot be said that a given factor (such as the high level of education) enhances growth, but it could also be a result from faster economic growth. Even though Cho's arguments are quite serious, I would like to conclude again that regional convergence could, theoretically, be estimated only in an unconditional manner, since the differences between regions are a lot narrower than those between countries. Thus, we could escape the conditioning problem by assuming same steady states for all regions.[17]

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[15] This statement has been proven by Galor (1996) who argues that a neoclassical growth model only implies conditional- and club convergence, and not, for example, absolute convergence, as often claimed.
[16] Cho is especially interested in the effect of the rate of population growth and investment-GDP-ratio, which many studies use as exogenous control variables. However, the same reasoning holds for many other control variables.
[17] As we will see in chapter 5, the problem of endogeneity also comes up in this study. It is true that finding a solution to this problem can be very difficult, or the solutions are often not very satisfactory.

### 3.4.3 Other sources of doubt

Several arguments have been put against the cross-section approach to convergence. We must note that some of the following arguments hold for other approaches, too. To begin with, some economists suspect that certain aspects of data can cause problems in empirical convergence studies. Armstrong (1994) criticises the country choices that for example Barro and Sala-i-Martin have made in their studies. This means that the poorest countries are often excluded from the studies (due to the lack of data or some other reason), and convergence is estimated across a group of wealthier countries, like the OECD or the European Union. Thus, it is possible that convergence is not so universal at all, but it may only happen between richer countries. Even though this may be a problem in cross-country studies, it should not cause any problems in my regional analysis, since no region will be excluded.

Cheshire and Carbonaro (1997), on the other hand, do not only doubt the results obtained by convergence empirics, but they are also opposed to measuring convergence using the classical methods and stating the observed convergence rates as proofs of neoclassical growth theories. The authors argue that there are a number of reasons why a given rate of convergence comes up in an empirical study, yet we have no means to tell these possible reasons apart. Thus it cannot be implied that convergence would indicate a neoclassical growth process. More importantly still, Cheshire and Carbonaro (1997, p. 39-40) propose that the way in which convergence is measured undermines the diversity of regional economic structures by describing regionally differing shocks and other factors in terms of simplified additional variables. According to the authors, the use of such regional dummy variables prevents us from finding out how regional economies work in reality.

Another problem often cited is the possible measurement error. This argument has been put forward by many authors, such as De Long (1988) and Friedman (1992). The reasoning is that if initial income levels are measured inaccurately, the subsequent rate of convergence may be overstated. Even though such measurement errors are often problematic in empirical analyses, Barro and Sala-i-Martin (1992) argue that it is not the case with their convergence studies. They base this view on the fact that the tests with lagged income levels produce same figures as

regressions described above. Also, as the connection between β- and σ-convergence is very clear in all their regressions, and as the measurement error is not relevant in the case of σ-convergence, we can reasonably conclude that the measurement error does not pose a great difficulty in convergence analysis.

Dowrick and Nguyen (1989, p.1020-1021) propose a further doubt of the convergence result, explaining that there are both data biases and (ex post) sample selection biases. These problems are, in their opinion, inherent in the classical convergence approach, but not in the approach they would prefer, meaning the so-called total factor productivity catch-up. However, as explained before, data problems do not cause such great difficulties in estimating convergence, especially not in a regional analysis. Finally, Evans and Karras (1996, p.384-385) criticise the method of classical convergence approach by saying that if we would not require the use of first-order autoregression and the conditioning variables, the convergence results would differ notably from the ones attained by traditional methods. They argue that if any convergence is likely to happen, it will occur between very homogeneous countries or regions, and even then the convergence will not be absolute. This statement will also be tested for in our empirical study, since the aim is to see if there is absolute convergence in income levels between Finnish regions, which can be argued to be very similar to each other in many respects.

To conclude, some of the arguments against the traditional convergence approach are quite robust, especially the ones concerning convergence clubs and intra-distributional dynamics, whereas others can easily be downplayed or do not hold in the regional context. Thus, the empirical study will use the Barro and Sala-i-Martin -method, but to check for convergence dynamics or other inconsistencies, other approaches will be included, too, meaning mainly the method used by Quah. Such methods will be discussed in more detail in the following section.

## 3.5 Alternative approaches to convergence

As we noticed in the previous section, a lot of criticism has been targeted towards the classical cross-section approach, and, as a result, many economists have proposed improved methods to

measure convergence. These approaches vary from time-series or pooled data methods and the ways in which cross-sectional data could be improved to completely different methods (which do not use regressions at all), such as matrix methods. This section will consider the latter types of approaches, concentrating especially in the work of Quah and Chatterji, both of whom show how to identify certain distributional features not addressed in the cross-section approach.[18] The possibility to improve the quality of data will be considered in the empirical part of this study.

### 3.5.1 Catch-up theory and convergence clubs

The catch-up theory assumes that there is a technological gap between the rich world leader country and the less developed economies. The growth of the rich country is determined by technological innovations, which are rather costly. The phenomenon of catch-up happens as the backward countries imitate the leader's technology, which is cheaper than innovating, and make leaps towards higher incomes. Thus, the growth in the poorer countries does not occur at a steady rate but happens in large, occasional jumps, and this phenomenon tends to reduce the technology gap. Thus, this theory is somewhat different from the traditional convergence theory, even though the result is rather similar. (Targetti and Foti 1997).

Dowrick and Gemmel (1991, p.263) explain that the potential for catching up comes from the existence of technological spillovers. The authors argue that this model can explain why the growth experience is so different among industrialised and less-developed countries. Where convergence occurs, it is a result of technological improvements in poor countries being greater than in the rich countries. Convergence usually happens in the middle income countries which do not have a very large gap to the leader. However, the poorest countries may be unable to close the technology gap, because their growth resources are inadequate. Against this backround we can easily understand how and why convergence clubs are formed. Note that this phenomenon could not be taken into account in the classical cross-section approach.

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[18] For other alternative approaches to measure convergence see for example one of the following: Button and Pentecost (1994), Dowrick and Nguyen (1989), Fisher and Serra (1996), Evans and Karras (1996) or Targetti and Foti (1997). Some of these approaches do not differ markedly from the regression method of the classical cross-section approach and are thus not discussed here.

Chatterji (1992, p.64-67) has developed a strategy to identify the existence of convergence clubs. The central idea is to determine the leader country and the gaps between the leader and the other countries. Then we can check if other countries are converging to the same steady state as the leader, in which case there would be no separate convergence clubs. However, it is possible that groups of countries are converging to different steady states than the leader (usually to inferior ones), and there may exist two or more convergence clubs. Chatterji describes the gaps as the following logarithmic equation:

$$(17) \qquad \ln(\frac{Y}{L})_{max,t} - \ln(\frac{Y}{L})_{i,t} = (1+b)[\ln(\frac{Y}{L})_{max,t-1} - \ln(\frac{Y}{L})_{i,t-1}],$$

Here we subtract the per capita income of each country i from that of the leader in periods t and t-1 in order to calculate the gaps. The number of convergence clubs responds the powers in the final equation of Chatterji, which is the version that most studies seem to prefer:

$$(18) \qquad G_{i,t} = A_1(G_{i,t-1}) + A_2(G_{i,t-1})^2 + A_3(G_{i,t-1})^3,$$

where $G_{i,t}$ stands for the gaps determined in equation (17). The number of convergence clubs depends on the gaps between the leader and different economies, and can be identified from the slope of the function in (18).

## 3.5.2 Danny Quah and distributional dynamics

As noted earlier, Quah has heavily criticised the cross-section approach to convergence. He finds that the cross-section approach is not appropriate for analysing income differences between countries, and the same holds in the regional analysis. Quah (1996a) argues that a suitable approach in analysing regional convergence would be one which takes into account the location of a region, meaning the areas which it is surrounded by, and the spillover effects. His main contribution, however, is the method which aims to analyse the dynamic nature of income disparities between economies in the long-run. For this purpose, Quah (1993b, p.430-432) uses so-called *Markov chain transition matrices*, which show the likelihoods for the poorer countries to become rich and vice versa. This likelihood can be understood as mobility inside a cross-section

of economies in the long-run, and thus we can check if there is a tendency for incomes to converge, or if the economies are destined to stay where they are in the income ranking order.

The approach described above also recognises the possible convergence clubs. Quah's (1996b, p.1368) explanation for convergence clubs, however, is quite different from the one used above.[19] As noted above, Quah assumes that countries are very much interdependent with their surrounding countries, and thus the forming of convergence clubs happens when countries endogenously decide about the membership of a club, or "coalition", as Quah calls them. As a result, the economic growth differs, so that convergence or divergence across countries is established. Quah's (1993b, p.432-433) results, just like his empirical methods, differ markedly from those obtained by Barro and Sala-i-Martin, as he finds no tendency for convergence in the international context, but rather a persistent divergence in income levels. Quah's transition matrix method will be explained and demonstrated more thoroughly in the following chapter and in the empirical section of this study, where we can see how it performs in practise.

### 3.5.3 Problems in the alternative approaches

The criticisms towards the approaches discussed here are not considered in detail, since many of the comments concerning the cross-section approach, meaning mainly the comments on the nature and problems of the data, are also valid here. However, Targetti and Foti (1997) have collected some of the biggest shortcomings of the alternative approaches. To begin with, the biggest problem in the technology gap and catch-up approach is that often the leader economy changes in the middle of the sample period. This phenomenon cannot be explained or taken into account, which may cause inconsistent results, depending on which country is chosen to be the world leader. The same problems of ex ante- and ex post selection of countries into groups apply for both of the above approaches, which means that the ability of these methods to explain convergent or divergent growth suffers. It must be noted, that the approach used by Quah has so far met little

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[19]Recall that in Chatterji (1992), Dowrick and Gemmel (1989) and many others, convergence clubs are formed as a result of technological diffusion, spillover effects and differing abilities of the countries to catch up.

criticisms, whereas the catch-up approach has been subject to much more discussion, reason probably being that it was introduced earlier.

This chapter should have provided us with a sufficient understanding of the main methods used in analysing economic convergence. Let us now move on to see what kind of empirical results have been attained by using these different methods and different data sets. This will be done in the following chapter, which discusses the most interesting convergence studies performed in recent years.

# CHAPTER 4: EMPIRICAL CONVERGENCE STUDIES

## 4.1 Introduction to convergence empirics

During the last ten years or so, the empirical convergence literature has been flourishing and now there is a vast array of interesting convergence studies at both regional and international levels. This chapter will introduce some of the main results found in international studies, together with a number of regional convergence estimates. These results, and possible conflicts between various studies, will be discussed in order to get a full picture of the outcomes of various methods used. In addition, the convergence studies performed by Kangasharju using Finnish subregional data will be discussed and analysed, so as to recognise the differences between this study and those of Kangasharju. On the other hand, we will also gain insight into the results we can expect this study to produce.

Many of the studies discussed in this chapter follow the method used by Barro and Sala-i-Martin, and the results for various data sets are also strikingly similar to each other. As a comparison, several studies using alternative methods will be introduced. This is done because some authors argue that the usually recorded two percent convergence result only comes up because of certain features in the empirical method.[20] This view will be considered, especially when regional convergence analysis is in question. We will see, that using the Barro and Sala-i-Martin -method can be well justified in regional studies, whereas it remains somewhat questionable in the international context.

## 4.2 International convergence studies between a cross section of countries

This section will introduce studies that use data from several countries in order to assess the extent of convergence in the whole world, or, rather, a large group of countries for which national

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[20] For such arguments, see for instance Quah (1993a) or Quah (1996c).

income data is available. Europe will be discussed in a separate section, as there are so many regional convergence studies available and as it offers such an interesting backround for comparisons with the Finnish convergence studies. As our main interest lies in the regional rates of convergence, the issue will be addressed more thoroughly than cross-country issues.

Generally, the main problem in cross-country studies is the poor quality and availability of data. As far as it comes to national income statistics, the data that exist are often not very suitable for cross-country comparisons, since the calculation principles for the gross domestic product, for instance, differ so much between countries and time periods. Moreover, the data are usually available from developed countries only, which is to say, the relatively rich OECD-countries. It could thus be argued that measuring convergence across countries gives no reliable results, for the reasons mentioned above. Barro and Sala-i-Martin (1992, p.242) have, despite all the difficulties, estimated convergence in a group of 98 countries and, in addition, in the group of OECD-countries. The attempt to measure unconditional $\beta$-convergence in 1960-85 in the former group of countries was, as could be expected, not very successful, in the sense that instead of there being any absolute $\beta$-convergence, it turned out that rich countries had continued to grow at a faster rate than their poor counterparts. This could be seen in the negative sign of $\beta$-coefficient ($-0.0037$). The finding is likely to be caused by the enormous differences in economic structures, preferences, education levels and other factors between countries. Thus it is not very sensible to assume that such different countries would converge towards the same steady state growth rate, but rather that their steady states are different from each other. According to this assumption, Barro and Sala-i-Martin (1992, p.242) continue by estimating the rate of conditional $\beta$-convergence in the same sample of countries, and notice that after the use of conditioning variables, the sign of $\beta$ becomes positive and is around the two percent level recorded in other studies (0,184, to be more exact). We must remember, however, that this result does not imply diminishing income or GDP gaps between countries, but the opposite can also be true. Barro and Sala-i-Martin, nevertheless, use this two percent -result as support for their convergence hypothesis.[21]

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[21]The convergence hypothesis, as discussed in the previous chapter means here the assumption that the income levels of a number of countries approach to a steady state level (which may or may not be identical) as time passes. If the steady state happens to be identical for all countries, then their national incomes become more similar in time.

Quah (1993a) criticises the use of standard convergence empirics, since, in his opinion, the main interest in growth dynamics is the mobility of income distribution among countries. In his view, σ- and β-convergence do not reveal how the income distribution evolves in time, and conditional β-convergence will not tell whether poor countries grow faster than the rich ones. For these reasons Quah introduces his alternative method, which aims to reveal the existence of convergence clubs, the polarisation of income distribution and the likelihood of poor countries becoming rich, or, alternatively, rich countries becoming poor. Unfortunately, Quah does not use this alternative method for estimating the income dynamics between the same 98 countries as Barro and Sala-i-Martin (1992), so the comparison between these studies is not quite accurate. Quah's sample consists of 118 countries during 1962-84, and includes more relatively poor countries than the 98 country sample. Quah divides the countries into five different income groups and then observes the mobility of countries from one group into another. Quah (1993b), as well as many other papers of Quah, concludes that, firstly, the mobility between groups is nearly non-existent, meaning that there is a tendency for poor countries to remain poor, whereas rich countries continue to be rich.[22] Secondly, Quah finds two convergence groups in this 118 country sample, namely a group of poor countries and a club of rich countries. In between of these groups, there is a small and diminishing number of countries, meaning that no middle-income group was found. This is what Quah (1996c, p.1046) calls the twin-peakedness of income distribution.

As we can see, the outcomes of these two methods discussed above are very much in conflict, or so it seems at a first glance. We must note that the neoclassical method used by Barro and Sala-i-Martin is actually not inconsistent with the existence of convergence clubs, but it is true that their existence can hardly be revealed by simply studying σ- or β-convergence. The most noteworthy difference between the above outcomes is that Quah suggests that no convergence exists in a large cross-section of countries, whereas Barro and Sala-i-Martin find slow, conditional β-convergence.

Let us now consider the results obtained by these two different methods a bit more thoroughly. We should remember that Barro and Sala-i-Martin do not claim that conditional β-convergence would automatically lead to σ-convergence, which is actually what Quah comes closest to with his Markov chain matrices. Thus, the above results may not really be inconsistent with each other.

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[22]See, for example, Quah (1993a) or (1996c).

We could argue that the countries converge towards their own steady states (which differ from each other) at the slow pace of two percent per annum, but the per capita income differences have remained unchanged·or even grown during the same period. This means that there has not been absolute σ-convergence, but, in fact, two different convergence clubs that diverge from each other. In this way, we can put the above studies together and conclude the complete story. This conclusion can be further supported by Chatterji (1992) who studies the existence of convergence clubs using yet another method, which has been described in the previous chapter. He included 109 countries into his sample, using per capita gross domestic products from years 1960-85. Chatterji, just like Quah, finds out that "the world"[23] is divided into two convergence clubs, a rich and a poor one, converging towards different steady states. Between these clubs, no convergence could be found. As I have shown in this section, most international convergence studies point towards the same picture of a world divided into two categories of countries, as could rather easily have been presupposed. We must remember, again, that such international studies are far from perfect, as already indicated earlier. Luckily, many of the problems plaquing international studies can be conquered when moving to a regional context. The following section will compare some regional convergence studies and their results, and see whether we can use the different methods in order to form a uniform picture, like we did in this section.

## 4.3 Regional convergence studies

This section will first look at one of the most discussed issues in the convergence debate, namely the convergence between regions of the European Union. Convergence between the EU-countries is in official publications claimed to be a well-established fact, but recently a number of papers have concentrated on the convergence of regional incomes.[24]There seems to be no consensus on the development of the regional structure of the European Union, as we will see in the following. This section also takes a look at regional converge the European Union. Convergence between the EU-countries is in official publications claimed to be a well-established fact, but recently a

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[23] The world is here approximated as the 106 countries used in the study.
[24] For results on convergence between the EU-member states see, for example, Barro and Sala-i-Martin (1991), Armstrong (1994), Armstrong and Vickerman (1995) or EU Regional Policies (1994, p.35).

number of papers have concentrated on the convergence of regional incomes. There seems to be no consensus on the development of the regional structure of the European Union, as we will see in the following. This section also takes a look at regional convergence studies performed using data from a given country, such as the USA, the UK, Austria and Sweden. We will see that, like with the European Union, convergence among the US states remains a somewhat controversial issue.

## 4.3.1 Regional convergence in the European Union

Throughout the 1990s the issue of European regional convergence has been hotly debated in economic and political publications. This has been motivated by the relatively large regional income disparities of the European Union and the political pressures from member states to develop a more effective regional policy. Thus, a number of studies have been performed in order to reveal the development of regional disparities, the knowledge of which could help in assessing the efficiency of regional policy measures.

We can again begin with a paper of Barro and Sala-i-Martin (1991) which concentrates on studying convergence at regional level. The authors use a sample of just seven European countries with altogether 74 regions. The basic problem with the European Union is that the member countries have joined it at different times, and, again, we must question the comparability of the data. Barro and Sala-i-Martin (1991, p. 144-147) use regional per capita GDP figures in 1950-85, and measure the rates of $\beta$- and $\sigma$-convergence. Their main finding is that $\beta$-convergence exists in the European Union for all decades considered. However, the estimates of unconditional $\beta$-convergence do not appear to be very stable, and, on the other hand, the standard errors are relatively large (up to 0,0212). The situation changes dramatically when a number of additional structural and regional variables are included. Barro and Sala-i-Martin argue that if we consider conditional $\beta$-convergence in Europe, we will find that the rate of convergence has remained

relatively stable since 1950s, except for the slight falling in the 1980s, and is, again, in the neighbourhood of two percent per annum.

Interestingly, other economists have estimated convergence among the European regions with very different results. Neven and Goyette (1995, p.52-54) use output, or gross domestic product, per head data of all the NUTS2-level regions of the EU member countries, from 1975 to 1990, and find out that the regional convergence experience differs between southern and northern regions of Europe. This means that until 1980 there was evidence of convergence between North- and South-Europe, but since then the southern regions have fallen behind, whereas growth and convergence have been rapid in the north. This pattern has lead to a clear North-South - divergence in Europe, the authors argue. β-convergence has not occurred during the period under question, if considered in the absolute sense. Moreover, Neven and Goyette (1995, p.54) find some evidence of minor σ-convergence, but it seems to be a very slow process. As we can see, these results are rather contradictory to those discussed above. One reason could be that the data used in this study includes more countries and regions than most other studies, including also the poorest member countries. Moreover, we can argue that the time period estimated by Neven and Goyette is a very short one and includes a number of exceptional periods.[26]

Let us now look at some other regional convergence studies about Europe and hope that they might shed more light in the conflicting results discussed above. To begin with, Armstrong (1994) criticises heavily the data used by Barro and Sala-i-Martin, for the reason that nearly all peripheral, poorer regions were excluded. This could be one explanation why other studies find less convergence than Barro and Sala-i-Martin (1991), since convergence is more likely to happen between richer and more homogenous regions. Armstrong agrees, in a sense, with Neven and Goyette (1995), as he also finds some evidence of a divergent core-periphery -pattern. For this reason, he suggests testing for convergence clubs in addition to other measures of convergence. The main addition Armstrong introduces is the use of improved data sets, meaning that all regions of every member country (12 countries in 1990) are now included. Moreover, it has been taken into account that in 1970 the way in which gross domestic product was calculated changed

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[26]Such exceptional or unstable periods were, for example, the oil shocks and the subsequent economic downswing in the 1970s, and, on the other hand, the universal boom of the late 1980s.

dramatically. Thus, it is not meaningful to estimate convergence during longer periods around the year 1970, like for example Barro and Sala-i-Martin (1991) have done.[27]

Using the extended data set described above, Armstrong (1994, p.7-8) re-estimates convergence in the European regions, using the same methodology as Barro and Sala-i-Martin (1991). The results do not change dramatically, even though the estimated rate of β-convergence falls a little. Nevertheless, β-convergence remains around two percent per annum during 1950-60 and 1960-70. After that, convergence has occurred to a somewhat smaller extent, just like Barro and Sala-i-Martin concluded. Moreover, it could not be established that southern and northern regions would form separate convergence clubs. Thus, the fears that Armstrong had concerning the poor quality of data were not justified, or, alternatively, the improvement of data was not great enough so as to change the results markedly.

Yet another approach to regional growth in Europe has been adopted by Fagerberg and Verspagen (1996, p.438-440) who try to identify the converging and diverging factors behind the European growth process. They concentrate on the fact that the speed of convergence fell after the 1970s, and argue that this may indicate that all possible convergence has already occurred and that the regional income differences in Europe are here to stay. The authors explain this finding by various diverging forces which slow down the convergence process. The possible diverging factors are tested empirically, and the authors find out that the most important regional differences are formed by research and development activities. Other diverging forces include the European Union investment funding, the composition of the GDP and differential unemployment rates.

Fagerberg and Verspagen (1996, p. 441-443) also apply the convergence clubs approach used by Baumol (1986) and Durlauf (1992). Contrary to most other studies, Fagerberg and Verspagen find three different convergence clubs in Europe.[28] The groups can be distinguished by the unemployment- and growth rates, and a number of additional variables, such as R&D -expenses. Basically, the group of most successful regions consists of French, German and Italian core

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[27]This is done in various studies by Barro and Sala-i-Martin, but only as an addition to shorter period, usually 10 year estimates.
[28]For comparison, see the studies discussed above: Neven and Goyette (1995), Armstrong (1994) and Barro and Sala-i-Martin (1991). Other useful references for convergence clubs in the European Union include Chatterji (1992).

regions, and the least successful regions are located in the northern and southern borders of the European Union.[29] The average group is formed mainly by Central-European urban regions.

As we can see, the results of Fagerberg and Verspagen (1995) contrast strongly with those of, for example, Chatterji (1992) or Barro and Sala-i-Martin (1991). The reason for this is likely to be the different variables used in the studies, but, nonetheless, it is remarkable that other studies show rather an even pattern of growth with convergence, whereas Fagerberg and Verspagen find large regional differentials and less potential for convergence.

## 4.3.2 Regional convergence in the U.S. States

Barro and Sala-i-Martin (1991, p.114-117) have studied the convergence of personal incomes in the U.S. States during 1880-1988. At first they assume $\beta$ to remain constant, and get an estimate of $\beta$-convergence of around two percent per annum, 0,0175. Nevertheless, it seems unlikely that $\beta$ would be constant across the whole period, and thus conditional convergence with additional variables is estimated. The rate of $\beta$-convergence does not change dramatically, but remains around the two percent level, at 0,0224. Barro and Sala-i-Martin (1991, p.121) conclude accordingly that the steady states of the U.S. States do not differ markedly from each other. On the other hand, $\sigma$-convergence shows a much more uneven pattern, meaning that the dispersion of regional income fell until the 1920s, then rose sharply until 1930 or so, falling again gradually until the 1980s, after which the tendency seems to be towards a greater income dispersion. All in all, the authors argue that the U.S. States display considerable convergence properties over the whole period in question.

Evans and Karras (1996, p.384) criticise sharply the approach used by Barro and Sala-i-Martin above. They adopt an alternative methodology to estimate convergence in the U.S. States in 1970-86, and find no evidence of absolute convergence. Moreover, Evans and Karras (1996, p.386) find large differences in regional steady states, quite unlike Barro and Sala-i-Martin (1991), which they

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[29]Note that the new member countries Finland, Sweden and Austria were not included in the data set used in this study. If they had been included, the geographical pattern of the EU-convergence might have been somewhat different.

explain by differences in the levels of technology and other factors of production. As we can see, regional convergence in the USA is not such an uncontroversial issue as commonly assumed. However, we must note that Evans and Karras were unable to question the existence of *conditional* β-convergence, so the evidence for that phenomenon still holds.

A further critique towards the empirical methods used by Barro and Sala-i-Martin (1991) in their study of the U.S. -convergence is proposed by Quah (1996b), who, once again, uses his Markov chain transition matrices to evaluate the characteristics of the regional distribution of income across the U.S. States from 1948 to 1989. Surprisingly, Quah (1996b, p.1372-73) finds out that the U.S. States display a relatively high mobility between rich and poor groups, which indicates convergence. Moreover, convergence is towards the same level of personal per capita income in all U.S. States, as no evidence for separate convergence clubs is found. Interestingly, Quah (199b) and Barro and Sala-i-Martin (1991) come to the same conclusion here, in spite of the different methods used. It would thus seem that at least conditional convergence has occurred in the U.S. States, and the conflicting result of Evans and Karras (1996) may be due to the very short time period used in their analysis, or some other reason.

### 4.3.3 Regional convergence studies in various European Union member countries

A number of convergence studies have been performed at the level of a single country in different European countries. This section will briefly report some of the most interesting recent studies, giving us some backround for comparisons with the Finnish convergence studies which will follow in the next section.

Let us begin with Great-Britain, which has been one of the most thoroughly studied countries in terms of convergence and other regional aspects. Chatterji and Dewhurst (1996) use the convergence-club method described in the previous chapter to analyse regional growth patterns in the UK during the period of 1977-91. Their main finding is that different convergence clubs can be recognised from the data, but the rate of convergence and the magnitude of income gaps fluctuate heavily between sub-periods. Most of the time, the London area has alone formed a

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superior growth, or-convergence, club, with all other regions either converging towards it or diverging from it. If the period is considered as a whole, Chatterji and Dewhurst argue that all regions tended to converge towards an income level of some 56 percent of that of London. However, in order to get more detailed information, the time-span has to be divided into shorter sub-periods. Interestingly, convergence seems to be the case in times of economic slumps, whereas divergence dominates during economic upswings. This should be a concern for regional policy planners, as it shows that not all regions are able to benefit from economic growth to the same extent.

A very recent study by Hofer and Wörgötter (1997) aims to compare regional and national productivity and income growth rates in Austria in 1961-89. Basically, the regional income per capita differences increased in the 1960s, diminished during the 1970s and grew again after 1982. As noted above, the authors also compare the relationship between regional and national per capita income, in order to find out if there exists an equilibrium between these two in the long term. However, there does not appear to be such an equilibrium relationship, but regional incomes vary independently from the national ones.

The most interesting finding of Hofer and Wörgötter (1997, p.8-9) for our purposes is that the rate of $\beta$-convergence, where it exists, has been very low between Austrian regions, only around one percent per annum over the whole period considered. However, the strongest convergence occurred in the 1960s, when the value of the $\beta$-coefficient was nearly 0,04. After that, the pattern reversed to divergent and all estimates of $\beta$-convergence are notably low when compared internationally to those of other developed countries. This is somewhat surprising, since Austria cannot be considered as a very heterogeneous country, which could have explained the slow pace of convergence. The results remain unexplained by the authors, but they suspect to find immobility of sector structures behind the lack of convergence. This should be taken into account in regional policy planning, as it is believed that policy measures can enhance the rate of convergence by improving the potential of the poorer regions.[30] Finally, Hofer and Wörgötter (1997, p.10) use the method of Barro and Sala-i-Martin, in order to test for conditional $\beta$-convergence and find out

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[30]Note that such a development occurred in the Finnish regions. Tervo (1991) noticed that convergence and catching-up speeded up in the 1960s, simultaneously with the adoption of active regional policy. It can thus be argued that the process of convergence and regional policy are likely to be interconnected.

that if suitable variables are added also Austrian data reveal the usual two percent rate of β-convergence. Thus, the rather universal two percent result seems to hold in Austria, too.

Let us now continue by looking at a regional convergence study performed using Swedish data. Persson (1994) has made a conclusive study of income convergence in the Swedish counties in 1906-90, using the methodology of Barro and Sala-i-Martin. According to Persson (1994, p.8), the year 1906 was marked by wide regional income disparities, whereas the year 1990 saw a much reduced income gap between the high- and low ends of the income spectrum. This alone could let us expect that income convergence has been the case between Swedish regions. And, indeed, there is clear evidence for income convergence in all subperiods, as well as during the period of 1906-90 as a whole.[31] However, the estimate of β-convergence for the 1980s is not significantly positive, meaning that there may even have been some divergence during that sub-period. Interestingly, the same experience has been recorded in many other European studies, and we may thus conclude that the 1980s were a spectacular time in terms of regional convergence.[32] This means, for example, that choosing some year of the 1980s as the start- or end year of the analysis might lead to somewhat distorted results.[33]

Persson (1994, p.12-17) expands the simple convergence analysis by considering how regional price differentials, sectoral shocks, migration and various policies affect the estimated speed of convergence. He finds that without the use of conditioning variables mentioned above, Swedish convergence remains above the levels recorded in many international studies, and also the speed of conditional β-convergence mostly lies above the usual two percent level, at around three percent per annum. Finally, Persson concludes that regional policies did not have any effect on the speed of convergence and migration only had some positive effects, just like the controlling of regional price differences. We can now move on to look at convergence results obtained using Finnish data, and see how similar the developments of regional income differences have been in Sweden and Finland, which are often said to be rather similar countries in terms of their economic structures.

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[31] Subperiods in this study were 1906-16, 1919-30, 1930-40, 1940-50, 1950-60, 1960-70, 1970-80 and 1980-90.
[32] See all studies discussed above for similar results.
[33] This fact must be taken into account in this study as well, as some regional data are available from 1988 only.

## 4.4 Convergence between the Finnish regions

So far, Finnish convergence studies have been rather rare, which is one of the reasons for conducting this study in the first place. This section will briefly review a number of studies made by Kangasharju, using data on taxable per capita incomes during the period of 1934-93. Kangasharju's choice of data deserves a little remark, since Barro and Sala-i-Martin (1992, p.279-281) found out that using personal income or gross regional product (which is to be used in this study) give almost exactly the same results. Thus, we can use the following results as a guideline of what we can expect to find out in this study. It is interesting to see whether the use of gross regional product and personal taxable income lead to same results in the Finnish case, as Barro and Sala-i-Martin were unable to explain why this was so in their study of the United States.

To begin with, Kangasharju (1997a, b and c) analyses Finnish σ- and β-convergence using a number of different methods described in the previous chapter in more detail. The existence of possible convergence clubs is also tested for by Kangasharju (1997b), as well as the possible catch-up tendency. Kangasharju (1997b, p.5) finds clear evidence for σ-convergence in the Finnish subregions, at a rate higher than in many other countries. However, the pace of convergence only remained high until the 1980s, just like in other European and non-European countries. Kangasharju (1997b, p.6-9) also uses the methodology developed by, for example, Chatterji (1992) in order to find out if there were separate convergence clubs among Finnish subregions, and if there had occurred any catch-up between the leading (richest) region, Helsinki, and the rest of the country. Conclusive evidence for the occurrence of a catch-up phenomenon was found for the whole period under examination. Moreover, all Finnish subregions seemed to belong in a single convergence club, with Helsinki remaining the leading region towards which all other regions were converging.

Finally, Kangasharju (1997b, p.10-11) adopts the Markov chain transition matrices, as introduced by Quah (1993b), to Finnish subregional data. He attempts to reveal the existence of mobility, and thus convergence, by examining the probabilities of poor subregions to become rich, and vice versa. Kangasharju's results reveal substantial probabilities for mobility, meaning that regions in the poorer income groups are more likely to move upwards in the income ranking than the richer

ones. This clearly indicates convergence towards the highest income state. The result is very much different from those obtained by Quah (1993b) using international data on the regions of Europe or a sample of 118 countries. We can thus argue that the likelihood of convergence at regional, one-country, level remains undoubtedly high, regardless of the method used in estimation. Thus, Quah's critiques towards the traditional approach to convergence seem to lose much of their power when we are interested in regional income convergence in a relatively small, homogenous country.

Kangasharju (1997c, p. 7-9) concentrates on examining the existence of Finnish $\beta$-convergence, and more exactly, conditional $\beta$-convergence. It is presupposed that Finnish subregions differ in terms of their steady-states, and this is taken into account by adding a number of control variables to the analysis. Kangasharju uses four regional dummy variables, dividing the country into parts according to the regions' geographical position. In addition, the shares of agriculture, industry and services are used, as well as the location of university town in the region, which can be seen as a provider of human capital. All in all, Kangasharju (1997c, p. 11-13) uses almost 30 different variables in trying to allow for differences in regional steady states. However, hardly any of the variables used in the analysis provide noticeable results, except those mentioned above. According to Kangasharju, the main differences in regional steady states can be summed up as follows: Åland and eastern Finland have the highest steady states, whereas originally industrialized regions had lower steady states. Contrary to that, relatively service-oriented regions had higher steady states, just like those regions which experienced rapid advancements in technology.

In the light of Kangasharju's results we must consider whether it is worthwhile to include a vast array of regional variables into our analysis when estimating conditional convergence with differentiated steady states. We can conclude that the number of necessary variables can be kept rather small, as Kangasharju noticed that most additional factors were highly insignificant. We must decide accordingly how possible regional differences are taken into account in this study, a point which will be discussed in the following chapter, as the settings for my empirical study are decided.

Let us now sum up the convergence findings in the Finnish subregions. Firstly, Kangasharju (1997a, p.3) presents the rates of σ-convergence in Finland, or rather the trend of diminishing standard deviation of regional taxable per capita incomes. The standard deviation has continuously fallen from 0,469 in 1934 to 0,160 in 1993, indicating that, especially in the last 30 years, σ-convergence in Finland has been more rapid than in many other countries. Secondly, Kangasharju (1997a, p.4) displays the catch-up performance of groups of regions with different taxable income levels towards a higher, or lower, income group. The author is able to show that, in international comparison, Finland demonstrates a relatively high potential for mobility between regional income groups.[34] Interestingly, regions are mobile to both upward and downward directions, and, on the other hand, the catch-up potential is higher for low-income than high-income groups. Behind this unlinearity lies the reason for the relatively high convergence figures. The strong intra-distributional mobility both upwards and downwards fits well together with the fact that Finnish σ-convergence is relatively high in international comparison. To conclude, let us remember that the degree of both conditional and unconditional β-convergence in Kangasharju (1997a, p.8) was very close to the usual levels recorded in many international studies. However, during the subperiod 1964-73, the rate of conditional β-convergence was as high as 6,1 percent per annum. All these results should be kept in mind as we move on to develop the settings for the empirical analysis of Finnish regional convergence in 1960-94.

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[34]See, for example, Quah (1996b, p.1371) for figures. The likelihood of countries to remain in their current income group ranges from 0,92 to 0,99, meaning that the situation is rather stagnated. In Kangasharju (1997a, p.4), on the other hand, the likelihoods of remaining in the same income group are around 0,64-0,88, figures that are much lower than those obtained by Quah.

# CHAPTER 5: REGIONAL CONVERGENCE IN FINLAND FROM 1960 TO 1994; THE EMPIRICAL ANALYSIS

## 5.1 Overview

This chapter will first introduce the methods used and then the results obtained in my empirical study of Finnish regional convergence. Two separate data sets were used to experiment with two different types of methods, namely those of Barro and Sala-i-Martin, and Quah. Firstly, the data on Finnish provinces forms a long enough time series to evaluate $\sigma$- and $\beta$- convergence, but as the number of provinces is so small, applying alternative methods would not be very sensible. Secondly, the 88 small-scale subregions form a large enough group to enable the analysis of regional growth dynamics when regions are divided into different income groups. This analysis was then taken a step further in order to see if economic fluctuations affect the direction of regional income mobility. In other words, I wanted to see if recession and boom years were different in terms of mobility towards the average income and, on the other hand, towards the ends of the income range.

Even though the previous chapter introduced earlier Finnish convergence studies in order to enable comparisons, we must remember that the settings of my study differ much from those of Kangasharju, meaning that the results may not be fully comparable to each other. However, it will be interesting to see whether provinces and subregions show similar convergence patterns. As mentioned above, I will use different data from those of Kangasharju, concentrating also on a different time-period. And importantly, the classification of regions between most of this study and those of Kangasharju is dramatically different. Despite these dissimilarities, we can safely expect many of the basic results to be rather similar, as regional taxable incomes and gross regional products are heavily correlated with each other.

## 5.2 The data

As already mentioned above, this study uses two data sets. The data on gross regional products in the Finnish provinces have been collected only from 1960 to 1994, after which the statistical classification of regions changed, and the observations are not annual. The years for which data are available are 1960, 1970, 1973, 1976, 1978, 1980, 1982, 1984, 1986, 1988, 1990, 1992 and 1994. The GRP figures had to be deflated in order to make the observations comparable. The deflation was done using the national cost of living index. We must note that using such an index may cause a slight measurement error, which tends to bias the $\beta$-coefficient upwards, as Barro and Sala-i-Martin (1995, p.392) warn. However, we must use the national index anyway, because there are no separate regional indices. The second data set consists of gross regional products in the 88 small-scale subregions from the period of 1988-94, and according to these figures, regions were divided into a number of income, or productivity, groups, so that the mobility analysis could be performed. The gross regional product of each region was divided by the national average. Both data sets were included because they allow the use of different methods to analyse convergence. On the other hand, the shorter time period provides an interesting object of study, as it is a very distinctive one in the history of the Finnish economy, meaning that it includes both the years of fast economic growth and very deep recession.

We should keep in mind that there are a number of problems involved in the use of both data sets. Firstly, the data on the GRP of the provinces suffer partly from the lack of homogeneity, meaning that there are changes in the way in which the GRP has been calculated from year to year. The biggest change occurred after 1970, when the prices used in calculating the GRP changed from factor- to producer prices. However, in a convergence analysis the main focus is on the relative levels of GRP, as we wish to see if initially poor regions have greater growth rates than the initially rich ones. Thus we can rely on the data in the sense that the relative growth rates of regions are mostly comparable. Secondly, Åland proves to be a somewhat problematic region, as it differs from the ordinary provinces in many ways. Since it is a very exceptional region in the Finnish context, some trial convergence estimates are made excluding Åland from the set. Another problem, then, is the length of the time-series in both data sets, but this cannot be helped, as the GRP data have not been collected for longer periods than those used in this study. Furthermore,

we must remember that 1994 may not be the best possible end-year for the analysis, because it was the turning point of a deep economic recession, when many regions had come over the downswing, but some had not. Keeping the above difficulties imposed by the nature of the data in mind, we can continue to follow the course of the empirical study.

## 5.3 General analysis of gross regional products and regional growth

In the beginning of the period, in 1960, the richest province was Uusimaa and the poorest one was Oulu. The GRP of Oulu was 59 per cent of that of Uusimaa. In 1994, however, the richest region was Åland and the poorest one was Pohjois-Karjala, and the GRP of the poorest region was 57 per cent of that one of Åland. Figure 1 shows the relative development of the GRP in the poorest and richest region, and the mean of GRP. We can see that the gap diminished first rapidly and then fluctuated until the early 1980s, when it was at its narrowest, after which it grew slightly until 1990 or so. After that the gap has remained unchanged, and the level of real GRP has fallen in the 1990s. The reason why the difference between the richest and poorest province has not diminished dramatically, as for example with the subregions, is the fact that the initial gap in 1960 on the level of provinces was not as wide as at subregional level.[35] It can easily be seen from figure 1 that no clear, continuous trend has existed in the development of the gap between the richest and poorest province. We must also note that the richest and poorest region in the end of the period are not the same as in the beginning of the period.

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[35]Compare the above figures with Kangasharju (1997c) who shows that the taxable income of the richest subregion was manyfold of that of the poorest subregion in 1960, after which the gap rapidly shrunk until the end of 1970s.

**The levels of GRP (log) in the richest and the poorest province, and the mean.**
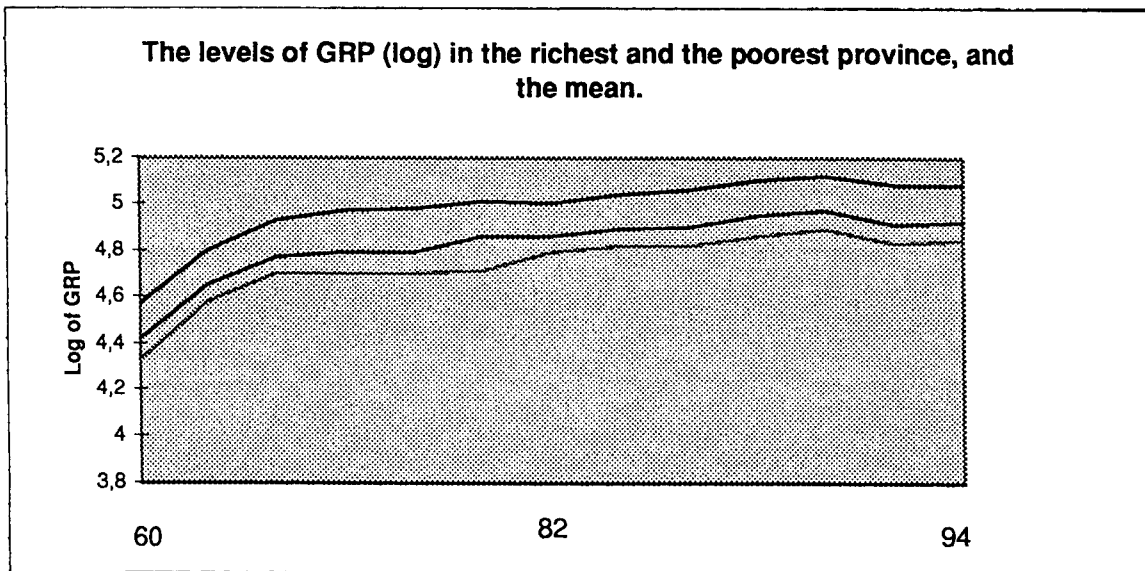
Figure 1: The levels of GRP in the richest and poorest province and the mean GRP.

When we look at the growth rates of GRP, we notice that the period can clearly be divided into two parts. The annual growth rates are calculated as follows.

$$(19) \qquad G_{t,t-T} = (\frac{1}{T})\log(\frac{Y_t}{Y_{t-T}}).$$

where $Y_{t-T}$ is the initial GRP per capita of the province and T is the length of the period. I noticed that until 1980 the productivity was growing fastly in all regions, the annual logarithmic growth rates reaching up to 0,033. The growth of the GRP was fast especially in the initially poor provinces: Oulu, Vaasa and Åland. The slowest growth occurred in Uusimaa, Turku ja Pori, Lappi, Kyme and Häme, all of which belonged to the richest regions at the beginning of the period. This clearly indicates convergence in 1960-80. After 1980, however, the growth was much slower than in the first half and has remained on low levels, except for the years from 1988 to 1990. On average, the annual logarithmic growth rates ranged from 0,002 to 0,007. The fastest growing regions were Uusimaa, Åland, Kyme and Keski-Suomi, of which only Keski-Suomi was a relatively poor region in 1980. This means that convergence seems less likely during the second half.

The idea of convergence analysis is to assess the relationship between the initial GRP per capita and the subsequent growth rate in a cross-section of regions. Thus figures 2 and 3 cross-plot the

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initial per capita GRP of each province and the growth rate, calculated as above. Figure 2 shows that a clear negative correlation exists, which means that we can expect to find absolute convergence before 1980. Figure 3 indicates, however, that after 1980 the convergence experience may have changed dramatically, meaning that initially rich provinces seem to grow much faster than the poor ones. As the general examination of regional growth shows, there seems to be a clear difference in growth and convergence before and after 1980. Next we will see how this difference can be confirmed when evaluating regional $\sigma$- and $\beta$-convergence more thoroughly.
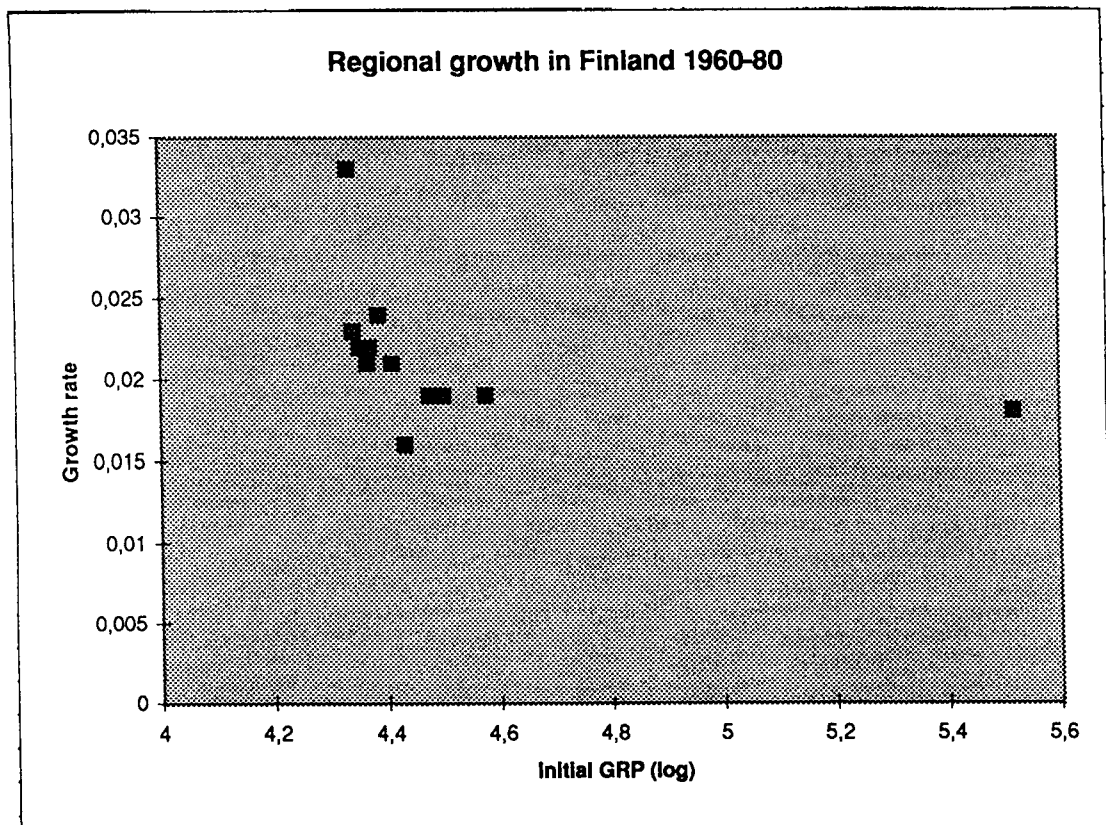


Figure 2: Initial GRP per capita and the annual growth rate 1960-80.
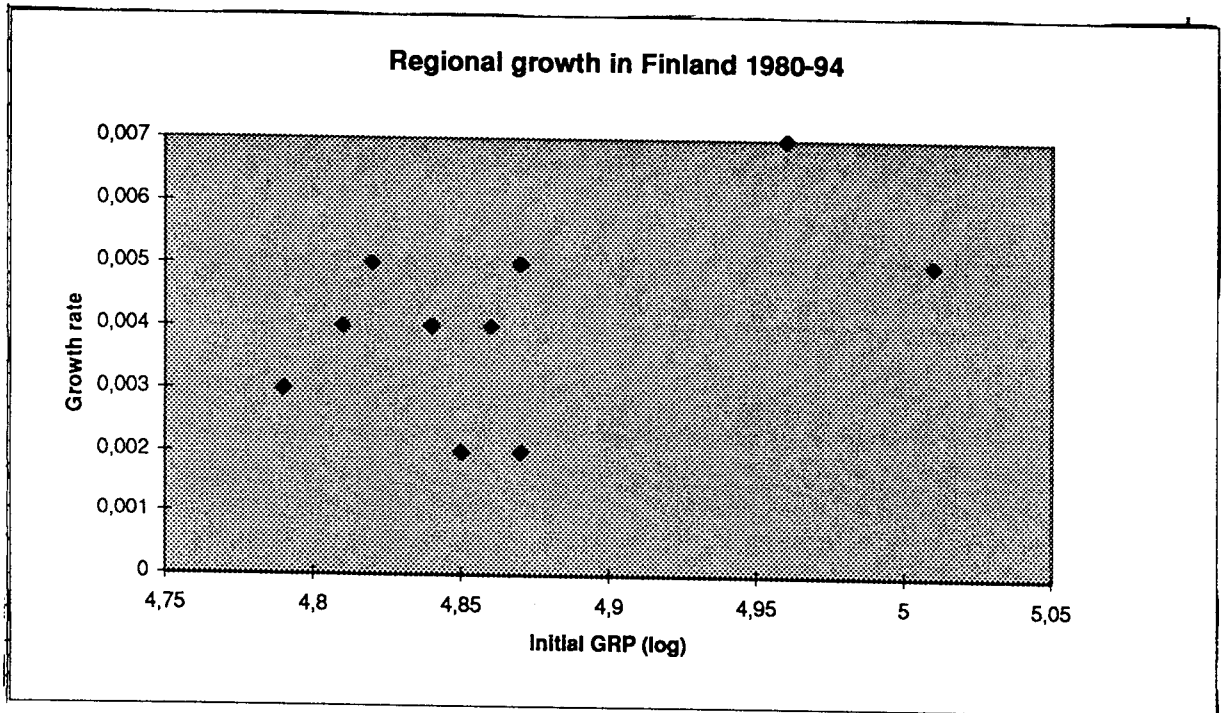
Figure 3: Initial GRP per capita and the annual growth rate 1980-94.

## 5.4 The analysis of σ- convergence

The analysis of σ-convergence in the Finnish provinces will be made by looking at given statistical features of the data. I wish to find out whether the gross regional products of the provinces have become more similar in time, meaning that the dispersion of GRP had fallen. The dispersion or inequality of per capita gross regional product is measured, according to Barro and Sala-i-Martin (1995, p.31), as follows.

(20) $$D_t = \frac{1}{N} \times \Sigma [\log(y_{it}) - \mu_t]^2.$$

In the above equation, $\mu$ is the mean GRP of the sample and N is the number of provinces. Using this equation, we can assess σ-convergence by observing the evolution of the standard deviation of gross regional product over time.

Tables 1 and 2 display the gross regional product data for the Finnish provinces. They show that the standard deviation of GRP has fallen until 1980 (when Åland is not included) but risen again

after that until 1990, after which it seems to remain stable. If all regions are included in the analysis, we still see that the dispersion falls clearly at first, remaining almost unchanged in the 1970s, but grows then continuously until 1994. The former conclusion is illustrated in figure 4, which shows how the regional dispersion of productivity has fluctuated during 1960-94. Note that this figure does not include Åland, as we cannot distinguish it from the ordinary provinces (by using some control variables) in the analysis of σ-convergence.

Table 1: GRP data for the Finnish provinces and Åland 1960-94.

| VARIABLE | YEAR(S) | MEAN | STANDARD DEV. |
|---|---|---|---|
| Log of GRP | 1960 | 4,418 | 0,077 |
| | 1970 | 4,652 | 0,065 |
| | 1980 | 4,857 | 0,067 |
| | 1990 | 4,974 | 0,073 |
| | 1994 | 4,915 | 0,078 |
| Growth of GRP | 1960-94 | 0,0146 | 0,0023 |
| | 1960-80 | 0,0218 | 0,0040 |
| | 1980-94 | 0,0042 | 0,0013 |
| | 1960-70 | 0,0233 | 0,0018 |
| | 1970-80 | 0,0205 | 0,0075 |
| | 1980-90 | 0,0118 | 0,0024 |
| | 1990-94 | -0,0146 | 0,0041 |

Table 2: GRP data for the Finnish provinces 1960-94 (Åland not included)

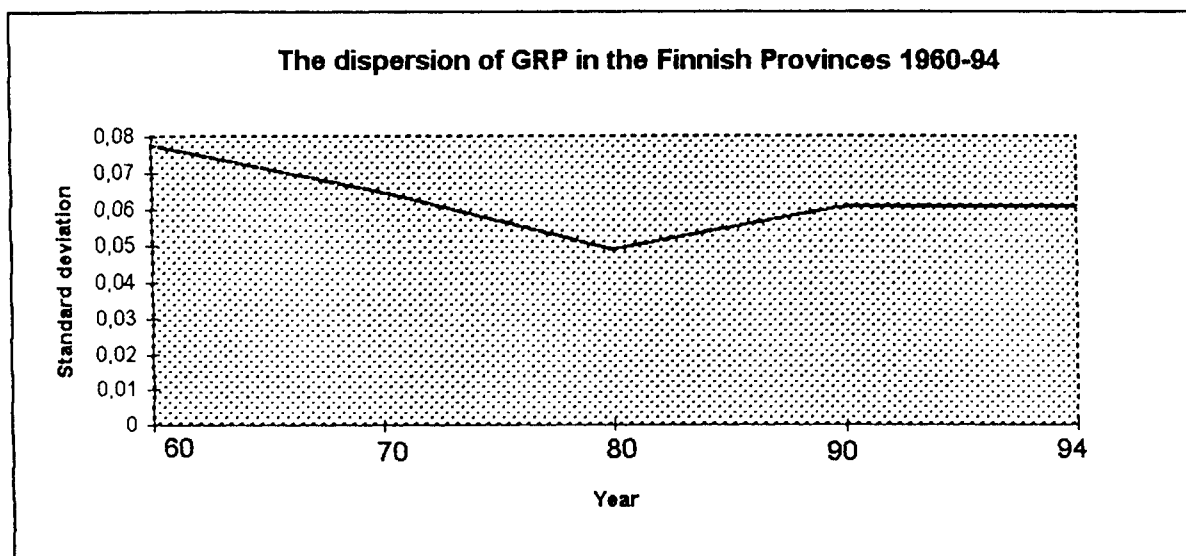| VARIABLE | YEAR(S) | MEAN | STANDARD DEV. |
|---|---|---|---|
| Log of GRP | 1960 | 4,424 | 0,076 |
| | 1970 | 4,658 | 0,064 |
| | 1980 | 4,842 | 0,049 |
| | 1990 | 4,961 | 0,061 |
| | 1994 | 4,900 | 0,060 |
| Growth of GRP | 1960-94 | 0,0140 | 0,0011 |
| | 1960-80 | 0,0208 | 0,0019 |
| | 1980-94 | 0,0041 | 0,0013 |
| | 1960-70 | 0,0234 | 0,0019 |
| | 1970-80 | 0,0185 | 0,0025 |
| | 1980-90 | 0,0120 | 0,0025 |
| | 1990-94 | -0,0151 | 0,0038 |



Figure 4: The dispersion of GRP per capita 1960-94.

As explained above, Åland is a very exceptional region and it is not a province at all, actually, but a much smaller region than the 11 ordinary provinces. Excluding it from the analysis could thus be justified, as it does not form a fully comparable unit with the provinces. In terms of growth behaviour Åland has also behaved in a very special way, meaning that it has developed from a poor, relatively agricultural region into the richest, most service-oriented region of the country. Excluding Åland from the analysis gives the dispersion somewhat more of a trend, but we still cannot deny the fact that the standard deviation of GRP grew in the 1980s at provincial level. This is an interesting finding, because it differs from the σ-convergence experience of the small-scale subregions. Kangasharju (1997b) noticed that σ-convergence between the 88 subregions was fast until 1980s, but slowed down after that. At provincial level, however, convergence is not only slower than earlier, but even some divergence of regional productivity seems to have occurred.

There are several possible reasons why σ-convergence shows a more fluctuating pattern at provincial level than at subregional level. Firstly, unlike the subregions, the provinces are large and include many very heterogeneous regions. Thus, the average per capita gross regional product may not represent very well the development of each individual subregion's GRP. For this reason, the convergence behaviour of provinces can be more erratic than that of the subregions. Secondly, the homogeneity problems of the data may have affected, as well, especially the level adjustments made in the calculation method of the GRP in the 1970s. Thirdly, the end year of the period, 1994, may be a problematic one as indicated above. In fact, after the economic recession of the 1990s, the regional disparities of productivity have started to grow even on the level of subregions.[36] And finally, Åland proves to be a somewhat problematic region, as it differs so much from the other regions. As we saw above, excluding Åland increases the estimated speed of σ-convergence. However, there is no need to exclude Åland when analysing β-convergence, as we can take its special character into account by adding a dummy variable in the regression analysis. Let us now move on to estimate β-convergence in the Finnish provinces.

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[36]The convergence of productivity across the subregions is analysed below. We notice that convergence seems very unlikely during the period of 1988-94. However, during the boom years in the middle of the period there has been significant convergence potential. This fact was downplayed by the divergent pattern in the recession years.

## 5.5 The analysis of β-convergence

The aim of this section is to find out whether the provinces that were poor in 1960 have grown faster than the initially rich ones. If this has been the case, we should find a negative relationship between the growth of productivity and the level of gross regional product, meaning that the Finnish economy had experienced absolute convergence. As explained above, this seems to have been the case until 1980, but not so much after that. If, however, the regional steady states differ from each other, we will not find convergence as defined above. It seems very likely that regional steady states are not identical, because the provinces differ so much from each other, and this must be taken into account in our analysis. Thus, I include variables that describe the economic structures of the provinces in the estimated equation. I use a non-linear least squares to estimate the following equation, just like Barro and Sala-i-Martin (1991) and many other studies.

(21) $\qquad (\frac{1}{T})\ln(\frac{y_{it}}{y_{i,t-T}}) = a - [\ln(y_{i,t-T})](1 - e^{-\beta T})(\frac{1}{T}) + \text{other variables.}$

I first estimate convergence during the whole period 1960-94 and then divide the period into two parts, as explained above. I also estimate convergence during each decade of the period. After estimating absolute convergence, I add a regional dummy to control for the exceptional behaviour displayed by Åland. And finally, I compare the regional economic structures and notice that there are wide differences in the relative importance of sectors in each province's GRP. These differences are used in forming additional "shock" variables, which are then applied to estimate conditional convergence. The results of each of these operations are discussed below.

### 5.5.1 Absolute β-convergence

Table 3 displays the results of the non-linear least squares described above. In those regressions all regions were included, but some additional regressions were made without Åland, in order to see how including it has affected the results. The first figure in each cell is the β-coefficient and the second one is the explanatory power of the model, $R^2$. We use the adjusted coefficient of determination, which takes into account the number of additional variables used. Under β is the standard error associated with the estimate of β, and under $R^2$, the standard error of the whole

regression. As we can see, during the whole period under question absolute β-convergence has occurred at the rate of 2,2 per cent per annum. This result is in line with both Finnish and international convergence studies. When the period is divided into two parts, we notice that convergence has been fast until 1980, 5 per cent per annum, whereas the β-coefficient gets a negative sign after 1980, meaning that no convergence has occurred. The fast convergence during the earlier period can be partly explained by the fact that Åland developed from one of the poores regions into the richest region during that period. A trial regression was made without Åland, and the rate of convergence in 1960-80 was then only 2,8 per cent per annum. Even though Åland was excluded, I still could not find any convergence in 1980-94, but the sign of β remained negative. Excluding Åland seemed to improve the explanatory power of the model during all periods ($R^2$ ranged from 0,23 to 0,76), confirming thus the suspicion that Åland's exceptional character may affect the results.

The period was then divided into four subperiods in order to see more clearly when convergence has occurred and when not. Again we see that convergence was around the 2 per cent level in 1960-70, and no convergence occurred in 1980-90 or 1990-94. However, it seems that convergence was very fast in the 1970s, which is exactly the time when Åland developed into the richest region. Thus we come to the conclusion that a dummy variable must be created to control for Åland in the regressions. We must also note that most results concerning absolute β-convergence are not statistically significant, because the standard errors are so large. This problem can be helped when we add dummies and other explanatory variables into regressions. Moreover, the last two decades show such growth and convergence behaviour which is in conflict with the theory we use. This means that it is actually the richest provinces which grow fastest, and not the poor ones. Thus the model is unable to explain such patterns of growth (see the explanatory power of the model).

Table 3: Regressions for GRP across the Finnish provinces, 1960-94.

| PERIOD | BASIC EQUATION | | REGIONAL DUMMY | | DUMMY AND CONDITIONING VARIABLES | |
|---|---|---|---|---|---|---|
| | $\beta$ | $R^2$ ($\sigma$) | $\beta$ | $R^2$ ($\sigma$) | $\beta$ | $R^2$ ($\sigma$) |
| 1960-94 | 0,0223 | 0,2081 | 0,0115 | 0,8594 | 0,0180 | 0,8988 |
| | (0,0108) | (0,0020) | (0,0005) | (0,0014) | (0,0006) | (0,0007) |
| 1960-80 | 0,0500 | 0,3144 | 0,0275 | 0,9384 | 0,0380 | 0,9582 |
| | (0,0329) | (0,0033) | (0,0012) | (0,0010) | (0,0012) | (0,0008) |
| 1980-94 | -0,0081 | 0,1245 | -0,0101 | 0,0781 | 0,0050 | 0,3823 |
| | (0,0003) | (0,0012) | (0,0003) | (0,0012) | (0,0003) | (0,0010) |
| 1960-70 | 0,0172 | 0,4122 | 0,0190 | 0,4199 | 0,0259 | 0,5257 |
| | (0,0010) | (0,0014) | (0,0010) | (0,0014) | (0,0008) | (0,0012) |
| 1970-80 | 0,0975 | 0,2227 | 0,0351 | 0,9438 | 0,0506 | 0,9499 |
| | (0,0692) | (0,0066) | (0,0027) | (0,0018) | (0,0030) | (0,0017) |
| 1980-90 | -0,0014 | -0,0984 | -0,0149 | -0,2044 | 0,0071 | 0,0834 |
| | (0,0026) | (0,0026) | (0,0016) | (0,0025) | (0,0019) | (0,0024) |
| 1990-94 | -0,0044 | -0,0733 | 0,0069 | 0,0192 | 0,0234 | -0,1515 |
| | (0,0085) | (0,0042) | (0,0083) | (0,0040) | (0,0109) | (0,0044) |

## 5.5.2 $\beta$-convergence with regional dummies

As noticed above, we mainly need a dummy variable for Åland. Otherwise the use of regional dummies did not have a great impact in my analysis. Thus the second column of table 3 displays the convergence results when an Åland-dummy was used. We can see that the explanatory power of the regressions was markedly improved, especially in the first half, but the speed of convergence reduced, like above when Åland was completely excluded. Again, the annual speeds of convergence mainly remain around 1-3 per cent, except for 1980-90, when the sign of $\beta$ stays negative. We must note, however, that the sign has changed in 1990-94, indicating that the period

of divergent growth may have come to an end in 1990. The years after 1980 still seem to be problematic for my analysis, though, and I come to the conclusion that more explanatory variables need to be added in the equation to reflect the steady state differences of the regions.

### 5.5.3 Conditional β-convergence

In this section I consider which additional variables should be used to allow regional differences in steady state growth rates. Such variables should, clearly, affect the growth rates and be exogenous. I follow the tradition of Barro and Sala-i-Martin (1995, p.391) and include a structural variable that compares regional economic structures to the national average structure. The formula of the variable is:

$$(22) \qquad S_{it} = \Sigma w_{ij,t-T}[\log(\frac{y_{jt}}{y_{j,t-T}})].$$

where j is the sector, i is the region and w is the weight of the sector in the region's GRP at the beginning of the period. National average GDP per capita is y and the length of the period is T. Thus this structural variable tells us the growth rate of each region in the case that all their sectors happened to grow as fast as the national average. In Finland, the agricultural sector has diminished continuously ever since 1960, whereas the service sector has rapidly grown. Thus it is understandable that the relatively agricultural regions cannot have grown as fast as the service-oriented ones, even if they may have had a lower initial income level. This fact is now controlled by the structural variable. In addition, the sectoral GRP statistics indicate that largest regional differences are in the share of services from the gross regional product, which is also taken into account in the additional control variables.

One potentially important variable I would have liked to use is the annual net migration rate of the provinces. This would have been too problematic, however, as the variable is clearly endogenous. This means that regions which are expected to grow in future are also likely to have the highest net migration rates. Thus we should extract the exogenous part of migration from the total rates,

which would have been rather a formidable task to perform in this study.[37] Some trial regressions were made including the average annual net migration percentages in the set of control variables. As we can see in table 4, this led to the diminishing of the β-coefficient when migration was used on top of all other variables, like it theoretically should. However, depending on the which set other explanatory variables was used, the adding of net migration rates caused the speed of convergence to grow, too, which is likely to be due to the endogeneity of migration rates. Thus migration was left out of the final regressions, because there was no satisfactory solution to the endogeneity problem.

Table 4: Convergence estimates with net migration as an additional variable. The effects to β compared to regressions not including net migration are reported in the last column.

| Explanatory variables | β | R² | St. Error | σ | The effect to β |
|---|---|---|---|---|---|
| GRP 60 + migration | 0,102 | 0,742 | 0,037 | 0,001 | positive |
| + regional dummy | 0,011 | 0,838 | 0,001 | 0,001 | negative |
| +structural variable | 0,054 | 0,912 | 0,021 | 0,001 | positive |
| +service-share | 0,009 | 0,855 | 0,001 | 0,001 | negative |

The third column of table 3 displays the rates of conditional convergence when additional variables were used in the regressions. We can see that the β-coefficient now gets a positive sign during all subperiods and the explanatory power of the model is further improved. During the whole period, the speed of convergence remains close to the 2 per cent level, but the estimates for subperiods

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[37]This was done in Barro and Sala-i-Martin (1995, p. 410-413) by using a number of instrumental variables in convergence regressions that could explain a part of the net migration rates, but would not directly affect the regional growth rates. When they added the net migration rates as such to the regressions, they got some unexpected results (β-coefficient became larger), due to the endogeneity of migration rates.

show that the speed of conditional convergence fluctuates quite heavily between the subperiods. The adding of explanatory variables did not change the fact that convergence has slowed down markedly (if not stopped completely) in the 1980s. It seems, though, that after 1990 conditional regional convergence has continued again.

## 5.5.4 The conclusion of convergence findings in the Finnish provinces

In this section I have estimated $\sigma$- and $\beta$-convergence in the Finnish provinces using gross regional products from years 1960-94. It was noticed that both growth and convergence of productivity were fast until 1980, but the pattern changed dramatically after that. After 1980 the productivity growth was much slower, on average, than in the earlier period and regional convergence seemed to stop completely. We might even argue that some divergence has occurred in 1980-90, as the dispersion of productivity grew. After 1990 the dispersion of gross regional products has remained unchanged, and it seems rather unlikely that convergence had occurred. This pattern in 1980-94 differs from that of the small-scale subregions, which only show a noticeable slow-down of convergence after 1980.[38] Thus we can clearly see how the regional classification used in convergence analysis affects the results.

## 5.6 Convergence findings from subregional data sets, 1988-94

The 88 small-scale subregions form the lowest regional level on which GRP data are available. Thus it is the optimal level to assess convergence, as large disparities inside the regions are unlikely to exist. This data provides an interesting object of study because it has only been produced recently and contains the deepest economic slump in the Finnish history after the second world war. However, as the time-series is so short, 1988-94, it makes no sense to estimate $\sigma$- or $\beta$-convergence as thoroughly as was done above, but we can experiment using some alternative empirics in analysing the convergence properties. $\beta$-convergence has been estimated for the whole

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[38] See Kangasharju (1997a, b, and c) for the results. These results were also discussed in previous chapter.

period just to see if there are differences in the convergence dynamics of the provinces and subregions, but a more detailed analysis was not considered as necessary. As table 5 shows, the annual rate of absolute $\beta$-convergence was more or less zero per cent, or slightly negative, if anything has to be said.[39] This result is very similar to that obtained using provincial GRPs, indicating that absolute convergence has not occurred in the 1990s. However, the explanatory power of the model is rather non-existent and the estimate is not statistically significant, meaning that making estimates for a period of only six years is not very productive. Moreover, the dispersion of GRP has remained almost unchanged, at around 0.01, meaning that no $\sigma$-convergence has occurred, either. However, we must remember that a six year period is far too short to say anything definite about regional convergence.

Table 5: Absolute $\beta$-convergence in Finnish subregions

| Period | $\beta$ | $R^2$ | Standard error | $\sigma$ |
|--------|---------|-------|----------------|----------|
| 1988-1994 | -0,00049 | 6.96e-005 | 0,00582 | 0,00587 |

Let us now move on to analyse the growth dynamics and convergence behaviour of the subregions. The idea is to assess the distribution of incomes, or productivity, across the 88 subregions, and see whether it tends to be straight or twin-peaked. Firstly, Markov chain transition matrices are formed, as in Quah (1996b), in order to evaluate the growth- and convergence dynamics. However, as the period of 1988-94 provides such a wide range of economic fluctuations, Quah's method is taken a step further and the year-to-year -transitions are analysed in more detail, so as to see if economic fluctuations have had an effect on the degree and dynamics of convergence. In this economic fluctuations -approach, the years are divided into recession and boom years according to the development of the average per capita GDP in Finland.

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[39] See appendix 3 where additional convergence results are reported.

## 5.6.1 Markov chain transition matrices

As explained above, the gross regional products of all subregions have been normalized, meaning that we consider them relative to the Finnish average per capita GDP. After that, the values of relative products are divided into intervals, which form five groups of regions. The idea is to observe the mobility of regions from one group into another and calculate the likelihoods of this mobility, and the likelihood of regions to remain in their original income group. Table 6 displays both the annual transitions and the six-year transition from 1988 to 1994. As we can see in the upper matrix, Finnish subregions display quite a high degree of mobility in the six-year -period under question, as the diagonal entries range from only 0,440 to 0,790, and the off-diagonals are relatively large. These figures imply that there are considerable convergence dynamics working across the subregions. However, there seems to be some tendency towards a vanishing average-productivity -group. This finding is mainly due to the end year, 1994, as we will see later when assessing the year-to-year -transitions. The lower matrix shows the yearly transitions from one income state into another, and leads to similar conclusions as the six-year matrix. The diagonal entries are again rather low, meaning that the likelihood of regions to move from their original group is noticeable. Also, some regions have even moved more than one income state up- or downwards, which means that large changes in GRP occur from one year to another, and this indicates strong mobility.

Table 6a: Gross regional product per capita, relative to Finnish average. A 5-state Markov Chain Matrix: A 6-year transition from 1988 to 1994.

| | | Upper endpoint | | | |
|---|---|---|---|---|---|
| (Number) | 65 | 75 | 85 | 100 | 145 |
| (16) | 0,688 | 0,313 | | | |
| (20) | 0,300 | 0,550 | 0,150 | | |
| (15) | | 0,200 | 0,470 | 0,330 | |
| (18) | | | 0,220 | 0,440 | 0,330 |
| (19) | | | | 0,210 | 0,790 |

Table 6b: Gross regional product per capita, relative to Finnish average. A 5-state Markov Chain Matrix: One-year transitions from 1988 to 1994.

| | | Upper endpoint | | | |
|---|---|---|---|---|---|
| (Number) | 65 | 75 | 85 | 100 | 145 |
| (72) | 0,750 | 0,250 | | | |
| (135) | 0,141 | 0,778 | 0,081 | | |
| (88) | | 0,114 | 0,739 | 0,136 | 0,011 |
| (118) | | 0,008 | 0,085 | 0,746 | 0,161 |
| (105) | | | 0,009 | 0,162 | 0,829 |

When compared internationally, Finnish subregional data reveal substantial likelihood of convergence to occur.[40] This result is consistent with that obtained by Kangasharju using regional

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[40] Compare these figures to those obtained by Quah (1996b, p.1371-1373) for the world and the U.S. States.

per capita taxable incomes. If we compare the subregional figures with the above provincial convergence results, we notice that the speed of convergence seems to be faster when using a more detailed regional classification.[41] As I already noted earlier, the convergence result obtained depends heavily on the statistical classification of the regions, and it seems to be optimal to estimate convergence on the lowest possible level.

## 5.6.2 The analysis of economic fluctuations and convergence

The idea of this section is to concentrate on the one-year transitions and see how economic fluctuations affect the degree and direction of mobility between regional productivity groups. As a result, we will be able to analyse the convergence potential in each of the transitions. The period 1988-94 can be divided into economic upswing- and downswing years, which is done according to the development of the Finnish average per capita GDP. We must note that even though the average GDP grew in 1994, some subregions were still suffering from the recession. The analysis can be completed better when the figures for 1995 are available, because then the recession was generally over. Here I denote years 1988, 1989, 1990 and 1994 as the upswing years, and the rest of the period as downswing. Next I observe each of the six transitions, counting the number of upward- and downward movements between groups, and see whether these movements occur in the poores or richest groups. The potential for convergence is understood as the simultaneous upward mobility from the poorest groups and downward mobility from the richest groups. If the pattern is the other way round, or the situation is very stagnated, I conclude that no convergence is likely to occur.

Table 7 gives a brief summary of the year-to-year -transitions showing the upward- and downward mobilities. In parentheses, after the upward mobility, there is the share of the two poorest groups in the upward movements, and after the downward mobility, the share of the two richest groups. There seems to be a clear connection between economic fluctuations and the convergence potential, as we will see in the following. To begin with, during the years of fast economic growth

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[41] Recall that at provincial level the 1980s and 1990s were a time of divergence, when absolute convergence was assessed. Subregions, however, showed no clear divergent trend during 1988-94.

1988-90 we can observe a very high mobility of regions from one income state into another. The upward mobility is highest in the poorest groups, 64 and 54 per cent of all movements in the respective transitions, whereas the richest groups cover most of the downward mobility. This clearly signals convergence and transition towards the middle income group. There seems to be no tendency towards a twin-peaked income distribution. Thus we can conclude that in Finland the economic upswing of 1988-90 has led to regional convergence of productivity and incomes. One reason for this is likely to be the migration of workers, which is high during boom years. As workers move from poor regions to rich, fast growing regions, the growth of per capita GRP slows down in the rich regions and accelerates in the poor regions. Thus, we should expect to find convergence of productivity and regional incomes during upswings, and less convergence during downswings, when migration of workers slows down. Let us see if this has been the case during the recession in the 1990s.

Table 7: The year-to-year upward and downward transitions between five income states, 1988-94.

| TRANSITION | UPWARD MOBILITY (% from the poorest groups) | DOWNWARD MOBILITY (% from the richest groups) |
|---|---|---|
| 1988-1989 | 14/88 (64) | 8/88 (75) |
| 1989-1990 · | 13/88 (54) | 11/88 (64) |
| 1990-1991 | 3/88 (33) | 15/88 (33) |
| 1991-1992 | 8/88 (13) | 8/88 (50) |
| 1992-1993 | 9/88 (33) | 12/88 (25) |
| 1993-1994 | 14/88 (58) | 5/88 (60) |

The transition from boom to recession happened in 1990-91, and we also notice a change in the mobility of regions. Upward mobility suddenly becomes very low, especially in the poorest groups, whereas downward mobility remains high. However, only a third of all downward mobility occurs in the richest groups, meaning that convergence potential is nearly non-existent. The situation is rather stagnated, with rich subregions remaining rich, middle income subregions falling behind and poor subregions remaining poor. Thus the end of the boom seems to have

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caused the end of regional convergence. The following two transitions, 1991-1992 and 1992-1993, both happened during the deepest recession years. We can observe low to average mobility of regions between groups to both directions. However, upward mobility is nearly zero in the poorest groups, or at least very low, and downward mobility mainly happens in other than the rich groups. This means that poor regions, again, remain poor, whereas rich continue to be rich. Hardly any convergence properties exist during the recession years, but the result points more or less towards a divergent growth pattern and the twin-peakedness of regional income distribution.

The last transition marks the change from economic recession to a new upswing, meaning that the overall per capita GDP starts to grow again, even though some regions still experience a slightly falling GRP. Again, we observe a noticeable change in the pattern of mobility as well as in the convergence properties. Upward mobility is now high, with much of it (58 per cent) occurring in the poorest groups. On the other hand, downward mobility is rather low, but most of it (60 per cent) occurs in the richest groups. Thus in 1994 convergence seems more likely again, as poor subregions begin to catch-up with the richer ones again, even though this process seems to be very slow. It would be very interesting to see if year 1995 continues the trend, but, unfortunately, the figures are not yet available.

The conclusions we can draw from the year-to-year -transitions are very clear, even though the end year is not fully an upswing year in all the subregions. Firstly, the evidence shows that economic fluctuations affect the dynamic convergence properties of the regions exactly in a way that could have been presupposed on theoretical grounds. In Finland, economic boom in the end of the 1980s and beginning of the 1990s enabled all regions to grow, and even so that the poor regions were catching-up with the rich ones. Conversely, downswing seems to have led to a much more stagnated situation, preventing convergence from happening. Interestingly, this is an opposite result to that obtained by Chatterji and Dewhurst (1996) who noticed that during slumps regional convergence and catch-up in Great-Britain were fast, whereas during booms there was divergence and the gaps between regions became wider. A possible reason behind these different results could be, for example, in differences in the regional migration rates of workers, meaning that the mobility of labour in Finland would be higher than in Great-Britain during boom years. As I was not able to compare the regional net migration rates of Finland and Great-Britain, we

can only speculate on what causes the convergence experience to be so different between these countries.

Apart from migration, the interconnection between economic fluctuations and regional growth patterns could be caused by many different factors. Clearly, convergence during economic booms results from the fact that all regions are able to benefit from the upswing, and even so that the poorest regions benefit most. On the other hand, when the aggregate economy is in a slump especially the poor regions find it difficult to maintain their level of productivity. This means that the economic development is not equal in all regions, and the regional trends do not follow exactly the fluctuations of the aggregate economy. One possible reason behind such pattern could lie in regional policy measures which aim at diminishing regional disparities. In other words, such policy measures could be expected to be more effective during economic upswings, when more resources are available. As we can see, it is possible to think of a number of reasons why economic fluctuations and convergence are connected, but more research is needed in order to confirm the factors behind this interconnection.

The analysis of subregional convergence dynamics during slump and boom years has shown that there is a clear relationship between regional convergence and economic cycles. This fact should be taken into account when choosing the start- and end year for an empirical convergence study, and, on the other hand, when analysing the results of such a study, as they may be distorted by the choice of the period. Furthermore, there are some implications to regional policy planning, meaning that it may be necessary to introduce additional policy measures during recessions to ensure that poor regions do not fall behind too badly.

### 5.5.3 The conclusions of the empirical study of the Finnish subregions

The latter part of this chapter analysed the dynamic convergence behaviour of the 88 small-scale Finnish subregions in 1988-94. Firstly, the rate of absolute $\beta$-convergence was estimated, and it proved to be rather non-existent. Similarly, no $\sigma$-convergence seems to have occurred, but the dispersion of GRP has remained unchanged. Secondly, two separate Markov chain transition

matrices were constructed in order to analyse the mobility of subregions from one income state into another. I noticed that the mobility was high, and the fear of a twin-peaked income distribution was not really justified. Finally, the year-to-year -transitions were analysed during the years of economic upswing and downswing. This analysis proved that a relationship exists between economic cycles and regional convergence properties, meaning that convergence is very likely during boom years, whereas it seems unlikely to occur during slumps. The result could possibly be explained by the fact that regional mobility of labour is higher during economic upswings, and its direction is towards the rich, fast growing regions. We can also think of many other factors which might contribute to the above phenomenon, but no testing was made to check if these factors really affect the interconnection of economic cycles and regional growth patterns. Thus there is still much to study in the interconnections between regional convergence, economic cycles and regional migration. This and other questions that could not be answered in this study are discussed in the following chapter which concludes the theoretical and empirical parts of this study.

# CHAPTER 6: CONCLUSIONS

In this paper I have studied regional growth and the existence of convergence in Finland during 1960-94. As a backround to the empirical study I introduced neoclassical and endogenous growth theories, and a number of alternative methods to analyse convergent growth patterns. The classical cross-section method of analysing convergence has become the dominant empirical method in the recent studies, and it was also used in this study. According to the classical convergence hypothesis, absolute convergence occurs when the regions that were initially poor experience faster growth rates than the richer regions. This will lead to diminishing income inequality between regions. On the other hand, the conditional convergence hypothesis states that each region converges towards its own steady state, and the speed of convergence is negatively related to the starting income level of the region. Thus, even if conditional convergence exists, income dispersion may not reduce at all, as regional steady states may be so different from each other.

The estimation of convergence was first performed at provincial level using the data on gross regional products, which link the product to the region where it was produced. Thus, it was possible to estimate the convergence of regional productivity. Secondly, convergence was analysed across the 88 small-scale subregions during 1988-94 using both traditional and alternative methods. According to the estimation results, convergence has occurred both in the Finnish provinces and subregions, but the speed of convergence has been noticeably low after 1980. It seems likely that even some divergence of productivity has occurred.

I found out that Finnish provinces experienced fast growth and convergence during 1960-80. However, this pattern changed dramatically in 1980, after which growth remained slow (except for a number of shorter periods) and convergence stopped completely. Moreover, the negative signs of the $\beta$-coefficient, especially in the 1980s, and the growing dispersion of GRP per capita indicate that some divergence has occurred. This result differs from the subregional convergence estimates of Kangasharju (1997a), who only noticed a substantial slow-down in regional convergence. According to Kangasharju, subregional income convergence was fast in the 1960s and 1970s, but very slow after that. Thus it seems that the convergence properties of provinces and subregions differ from each other.

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The analysis of σ- and β-convergence on the level of subregions did not give any clear results, but it seems that the dispersion of productivity has remained almost unchanged. Anyway, estimating convergence using the classical method in such a short period will not give very realistic results. Thus we adopted an alternative method to assess the convergence dynamics of the subregions. The analysis proved that Finnish subregions actually display a high convergence potential, but this potential varies greatly according to economic cycles. During boom years, subregions showed a significant likelihood of convergence, meaning that rich subregions move down and poor subregions up in the relative GRP ranking order. Conversely, no convergence seemed likely to occur during the years of economic slump, but the trend was more towards a twin-peaked distribution of regional productivity. One potential explanation for this pattern could lie in the regional net-migration rates, meaning that the regions which are expected to grow fastest during economic upswing also attract workers, which, in turn, cuts down the growth rate of per capita product. On the other hand, the outflow of migrants in the poorer region would tend to increse their GRP per capita. Such migration pattern could, in theory, explain why convergence occurs during boom years but not during slumps.

I would like to point out that the empirical studies of regional convergence performed using Finnish data are still far from complete. For example, there are a number of potentially important variables that could help to explain the growth patterns of the regions, but these variables cannot be easily used due to their endogeneity. Migration is one potentially very important explanatory variable, but in order to include it to the growth equations, we must first consider how to deal with the problem of endogeneity. One suggestion for future research would thus be to try and find a satisfactory method of including net migration in the convergence analysis. Another future consideration is the improvement in gross regional product statistics, which is currently being made. This means that the provincial data is being homogenized, so that the figures would be perfectly comparable from year to year. It would be interesting to see whether this affects convergence results. At subregional level, the data for 1995, which becomes available by the end of this year, could provide new insights in the interconnection between regional convergence and economic fluctuations, as it is more clearly a boom year than 1994. I would like to conclude that in a convergence analysis there is still much to be done, before we can get a complete picture of regional growth differences.

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