CONVERGENCE ACROSS KAZAKHSTAN REGIONS

by

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A thesis submitted in partial fulfilment of the
requirements of the
Robert Gordon University
for the degree of Doctor of Philosophy

March 2013

ABSTRACT

The issue of regional economic disparities is important for the Republic of Kazakhstan, which is going through a transition period from a planned socialist system to a market-based economy. This presents a large number of problems for a government seeking to balance development in order to avoid problems of inequality and political unrest and, at present, there is a shortage of the type of information that would be useful to formulate policy. The main aim of this thesis is to help make up some of this gap. It does so by examining various types of convergence process across the regions of Kazakhstan over the period of 1993-2009. Since different types of convergence reflect different aspects of the problem, we use a variety of concepts and empirical approaches in studying convergence across Kazakhstan's regions.

First, we approach convergence directly by studying the dynamics of standard deviation and coefficient of variation of per capita GRP level across Kazakhstan's regions, which is called σ-convergence. Next, we study absolute and conditional β-convergence using cross-section and panel approaches. Afterwards, we study the club-convergence proposing an approach that consists of two stages: clustering of regions and testing convergence within clusters. In studying TFP convergence, we use panel unit root tests. In addition, we apply the method of sector decomposition to reveal economic sectors, which promote either convergence or divergence across the Kazakhstan regions.

The results of this thesis show that, in general, regions of Kazakhstan diverged over the period of 1993-2009 in the sense of σ-convergence and absolute β-convergence. However, they demonstrated convergence in other recognised forms of convergence (conditional β-convergence, TFP-convergence, club-convergence) over various time spans within the 1993-2009 period.

For the government this means that convergence in Kazakhstan is not per se a process that accompanies economic development and that a strong regional policy is needed. In order to reduce economic disparities and preserve high rates of economic growth this policy should be complicated, club-specific, and directed to the equalization of production structure of regions and targeting the sectors promoting convergence.

ACKNOWLEDGEMENTS

The first person in the list of people to whom I would like to express my sincere gratitude is Professor Alex Coram, my principal supervisor. During my study, he has been patiently guiding my efforts in the right direction preventing me from being unfocused. His manner of research supervising is a good lesson for me. From the one hand, he gives necessary freedom for creative work to a student. From the other hand, he compels a student to focus research and to formulate clearly the aim and objectives of the study. I think it is good luck to have such supervisor.

I would like to tender many thanks to Professor Dorothy Williams, who constantly traced my progress as a research student and gave necessary support in various issues. Many thanks to Dr. Seonaidh McDonald for her kind support, especially at the final stage of my study.

This dissertation would be impossible if Dr. David Lal did not attract me to the Tempus Project that sponsored my PhD study at the Robert Gordon University. He inspired me to take this opportunity and kindly supported me when I came to Aberdeen. Special thanks to the staff of the Georgina Scott Sutherland Library, especially to Anne Nichol, who introduced me to the library resources and helped me use them effectively during my research. Besides, I would like to thank Martin Simpson, the Research Degrees Officer, who was so supportive and responsive. Without his help, it would be very hard to pass through all PhD study formal procedures.

Of course, this dissertation would not be written without the permanent support of my family: my beloved wife Dina, my elder sun Alimzhan, my daughters Dariya and Tamila, my father and mother.

Finally yet importantly, I would like to express my gratitude to the former rector of the East Kazakhstan State Technical University, Professor Galym Mutanov for the financial support of my trips to Aberdeen and for the possibility to combine my work and my study.

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LIST OF ABBREVIATIONS

AB/BB	Arellano-Bover/Blundell-Bond estimator
ADF	Augmented Dickey-Fuller Test of unit roots
CIS	Commonwealth of Independent States (includes most of former USSR countries)
FDI	Foreign Direct Investments
G7	A group of seven industrialized nations of the world, formed in 1976 (USA, France, Germany, Italy, Japan, United Kingdom, Canada)
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
GNP	Gross National Product
GRP	Gross Regional Product
GVA	Gross Value Added
IV	Instrumental Variables
LSDV	Least Squares with Dummy Variables
LSDVC	Kiviet-corrected LSDV estimator
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
OVBP	Omitted Variable Bias Problem
PPP	Purchasing Power Parity
PUR	Panel unit root test
R&D	Research and Development
RMSE	Root Mean Squared Error
SBC	Social Busyness Corporation
SEZ	Special Economic Zone
SPSS	Statistical Package for the Social Sciences
TFP	Total factor Productivity
USA	United States of America
USSR	Union of Soviet Socialist Republics

CHAPTER 1. INTRODUCTION

1.1 Importance of the Topic

Since it became an independent state in 1991 and after the period of economic recession caused by the switch from the planned socialist economy to the market-based relations, the Republic of Kazakhstan has undergone a period of rapid economic growth. The average growth rate of GDP over the last twelve years was 8.4% per year, reaching a maximum of 10.7% in 2006. Over the period between 1993 and 2009, the real per capita GDP of Kazakhstan has grown 2.4 times.

However, such a dynamic economic development was accompanied by growing differences across various regions of the country. The analysis of statistical data shows that, presently, the per capita gross regional product (GRP) varies across Kazakhstan regions much more than it used to in Soviet times. For example, in 1993, the ratio of real per capita GRP of the richest to the poorest regions was only 4.08, while in 2009, it rose to 11.5.

The increase of regional inequality in Kazakhstan has been a factor in a number of economic, social, and political problems. Among these has been the slowdown of economic growth caused by the necessity to direct a part of resources towards regional alignment, instead of the stimulation of growth; the increase of unemployment and social tension, and the consequent rise of separatist feeling, further magnifying the process of disintegration, and so on.

The urgency to find a solution to the specified problems has made research into the dynamics of regional inequality a hot issue for both policy makers and economists. In order to address these issues, we will consider various types of the convergence process across the Kazakhstan regions over the period of 1993-2009.

Many authors stress the importance of convergence studies across countries and regions. For example, Barro and Sala-i-Martin (1992a, p.223) claim: “A key economic issue is whether poor countries or regions tend to grow faster than rich ones.” Islam (2003, p.309) says that convergence is “a central issue around which the recent growth literature has evolved.” The problem of convergence across regions of a country is important from both practical and theoretical points of view.

1.1.1 Practical Motivation

The stable and balanced development of the regions should be a priority for any government that cares about territorial integrity, the prevention of social conflicts and crises, and ensuring a high standard of living for its citizens. This task gains special urgency during periods when the foundations of society are subject to radical reorganisation. Kazakhstan is currently at this stage of development.

From the practical point of view, the study of convergence is important because of the need to elaborate a policy directed towards diminishing regional disparities in economic development (Sala-i-Martin 1996). It is widely accepted that in cases where regional economic disparities are chronic (e.g. per capita income and unemployment rate) harmful economic effects inevitably follow. These in turn have negative social and political consequences (Armstrong and Taylor 2000).

Firstly, regional disparities in living standards produce resentment and disaffection in people who are poor through no fault of their own. For example, school leavers in wealthier regions of the country have far better employment prospects than their counterparts in rural regions.

Secondly, the persistently high level of unemployment in poor regions is a drain to a country in unemployment support, when the same people could be adding to the production output of the region if they were in employment. Higher unemployment also means a higher crime rate and social hardship, social consequences which inevitably follow in the wake of unemployment.

Thirdly, persistent regional economic disparities create spiralling economic costs in social infrastructure and public services in prosperous regions, and their under-utilization in poor ones.

Fourthly, regional disparities in economic growth can cause significant inflationary pressure in areas of low unemployment due to the intense competition for skilled labour through wage increases. This inflationary pressure then spreads to other regions and markets, especially the property market. High house prices in regions with low unemployment become a barrier to inward migration. Consequently, regional disparities in unemployment are aggravated while high house prices result in higher wage demands.

Fifthly, ill-judged regional policy may lead to the threat of separatism. The problem in the case of Kazakhstan will be discussed in greater detail later. Here, we shall only mention that the threat of separatism in Kazakhstan has two possible sources. The first is the separatism of the northern and eastern regions of the country, which border upon Russia and have a large Russian population. If the living standards in these regions are significantly lower than in other oblasts of the country and in neighbouring Russia, then the call could rise to separate from Kazakhstan and join Russia. Another possible source of separatism comes from western oil rich regions. If the regional policy of the country directed towards diminishing permanent economic disparities across regions of the country will use only the redistribution of incomes in favour of backward regions at the expense of more prosperous oil rich regions, then this could create separatist feeling in these areas.

Thus, policy makers are interested in knowing whether inter-regional disparities in levels or growth rates of income tend to diminish or rise over time. If they diminish, then the authorities need not be concerned about more equitable wealth distribution. In addition, it is useful to know about the persistence of poverty: do the relatively poor regions of two decades ago remain poor today? If poverty is not long-term, then decision-makers might be less motivated to elaborate programs designed to smooth out development levels in the regions.

Examples of such programs include the Regional and Cohesion Fund Policies undertaken by the Government of the European Community (Sala-i-Martin 1996), and the Strategy of Regional Development of the Republic of Kazakhstan until 2015. In order to assess the effectiveness of such programs and to promote successful regional policy, it is also necessary to know what sectors of the economy favour convergence, and what sectors favour divergence across the regions of a country. In other words, it is necessary to split the process of convergence or divergence into the parts for which various sectors of an economy are responsible, in order to pinpoint potential points of application of the efforts for the authorities.

Thus, the focus of this thesis, rising from the problems discussed above, is the study of convergence across the Kazakhstan regions, assessing the success or otherwise of policies to lowering economic disparities across the Kazakhstan regions, the scope of any observed convergence, and what sectors of the economy are responsible for it.

From a policy perspective, the results of this research could form the basis for effective regional policy geared to the existing situation, towards which the efforts of the Kazakhstan political and scientific community can be directed. From a theoretical perspective, this thesis contributes to the debate over the problem of convergence and methods of its study.

1.1.2 Theoretical Motivation

The problem of convergence is not only of practical importance, but raises some complicated theoretical and methodological issues, which are important in their own right. From the theoretical point of view, the notion of convergence was associated with the need to justify theories of economic growth. In general, it was believed that convergence was an outcome of the neoclassical theory of growth, while the later endogenous theories do not imply convergence and allow the regional per capita outputs to diverge (Islam 2003, Capolupo 1998).

In other words, many researchers tried to use the convergence hypothesis as a means to distinguish between two main approaches to economic growth, namely, neoclassical and endogenous (Sala-i-Martin 1996). For example, Rebelo (1991) and Romer (1986) used the empirical fact of the lack of convergence across countries all over the world as evidence in favour of endogenous growth theories, in contrast to the neoclassical approach. On the other hand, Mankiw, Romer and Weil (1992) showed that the traditional neoclassical model, modified to include human capital accumulation along with physical capital, was perfectly adequate to predict convergence across countries provided that capital accumulation and population growth are constant. This model explains existing cross-country differences in income per capita rather well.

However, with the appearance of other endogenous growth models predicting convergence, its presence or absence ceased to serve as a criterion in favour of either neoclassical or endogenous growth models. Among these endogenous models are both the models that directly predict convergence (Rebelo 1991, Nelson and Phelps 1966, Abramovitz 1986, King and Rebelo 1989, Jones and Manuelli 1990, Tamura 1991) and models that can predict convergence depending on the values of some parameters (Romer 1986, de la Fuente 2002a).

For the present time, from the methodological point of view, only the neoclassical approach provides an exact theoretical basis for the empirical study of convergence (Cavusoglu and Tebaldi 2006). Therefore, the theoretical motivation of this thesis is to try to empirically confirm the predictions of neoclassical growth theory, in framework of which convergence across the Kazakhstan regions is studied.

Another interesting theoretical motivation of this thesis is concerned with the transition type of Kazakhstan economy that is switching from the planned to market-based relations. Several empirical studies (Petrakos 2001, Iodchin 2007, Skryzhevska 2008) show that economic disparities across regions of transition countries tend to increase in contrast to developed economies. Therefore, it would be interesting to check whether the development of the Kazakhstan regions is similar to other transition countries with respect to the convergence/divergence issue.

1.2 Research Problems, Aim and Objectives of the Research

The main research problem considered in this thesis is the problem of the formation of regional policy in Kazakhstan directed to the diminishing of regional economic disparities across regions of the country. This policy should be based on rigorous theoretical and empirical analysis of the behaviour of these disparities. In other words, in order to have the possibility to make regional policy suggestions, we need to study convergence across the Kazakhstan regions. Under economic disparities, we mean various measures of economic inequality, differences in growth rates and levels of GRP or TFP, and differences in productivity levels of various economic sectors of Kazakhstan economy. The behaviour of these disparities is studied in the framework of various types of convergence. Thus, the aim of this research is *to study various types of convergence across the Kazakhstan regions*.

Although this aim is easy to state, it is not so straightforward to realize, and we need to break it down to a number of steps:

(1) First, it is necessary to determine the most appropriate theoretical framework for further empirical testing of convergence across the regions of Kazakhstan.
(2) Second, there are different concepts of convergence across countries and regions, which have different definitions, testing approaches and policy implications. Moreover, there are different empirical approaches to test the same type of convergence across regions

of a country. These different approaches give different empirical results and correspondingly different policy implications. Therefore, it is necessary to review these different concepts of convergence and approaches to empirical testing.

(3) Third, regions of Kazakhstan differ considerably in various aspects that could result in the lack of global convergence across them. Therefore, it is natural to try to reveal groups of regions with similar economic conditions that could promote convergence within these groups.

(4) Fourth, various economic sectors behave differently with respect to the convergence issue. Therefore, it is necessary to reveal the sectors that promote either convergence or divergence across Kazakhstan regions. This could provide the basis for further policy recommendations.

Thus, in order to deal with the issues raised in each of these steps it will be necessary to:

- study the predictions of various growth models on the issue of convergence;
- study different concepts and various empirical approaches to convergence research and to apply them to the investigation of convergence across Kazakhstan's regions;
- identify homogeneous groups of Kazakhstan regions according to the growth factors and to investigate various types of convergence within these groups;
- decompose the process of convergence across Kazakhstan regions into the inputs of various economic sectors and to reveal either convergence or divergence engines of the economic sectors.

1.3 Approach

In studying convergence across the Kazakhstan regions, a number of different concepts and empirical approaches will be used. This is because various types of convergence study different aspects of the problem, and therefore, a single approach will not give a full picture of the behaviour of inter-regional disparities. Therefore, it is important to clearly identify the different kinds of convergence and how we propose to study them in this thesis.

Firstly, we propose to study convergence across the Kazakhstan regions in terms of inter-regional variation in growth rate, output level, and TFP. This is an *across-economy* notion of convergence as opposed to the notion of *within-economy* convergence, which follows from the initial objective of the neoclassical growth theory to show that an economy tends to converge to the equilibrium under the assumptions of the factor substitution and diminishing returns to the capital accumulation (Islam 2003). In other words, the across-economy convergence studies convergence among economies of some group (group of countries or regions of a country), while within-economy convergence studies convergence of a single economy to its own steady state. In this thesis, we study across-economy convergence.

Secondly, the convergence across Kazakhstan regions is tested in terms of both *growth rates* and *levels* of various economic parameters, such as GRP or TFP. The notion of convergence in terms of rate of growth stems from the assumptions of the neoclassical growth theory on technological progress expanded to a global scale, implying that all economies benefit from technical progress equally and that all have the same steady state growth rate. The notion of convergence in terms of levels stems from the assumption of the similar aggregate production function for all economies, when levels of income in steady state are similar. This notion is also used when various economic indicators are compared directly across economies.

Although more precise definitions of various types of convergence will be provided later, provisionally we introduce the notions of β-convergence, σ-convergence, TFP-convergence and club-convergence as follows.

When economies that are poorer in a given sample, tend to demonstrate a faster growth rates than richer ones, thus narrowing income differentials, then the economies of such a sample are said to demonstrate β-convergence, and vice versa, when richer countries or regions grow faster, thus increasing their lead, then there is β-divergence in this sample. This notion of convergence answers the question: "... how fast and to what extent the per capita income of a particular economy is likely to catch up to the average of per capita incomes across economies?" (Barro and Sala-i-Martin 1991, p.112).

The notion of β-convergence is divided into conditional and unconditional (absolute) types. The latter suggests that the determinants of the steady-state position are equal for all the economies under consideration, while the former takes into account differences in the steady-state and implies that proper variables need to be added to the regression equation. Moreover, there are several empirical approaches to study β-convergence across states and regions. The commonly employed methods to study β-convergence are cross-section and panel approaches, which each have advantages and drawbacks.

In this research, we study β-convergence in the framework of the standard neoclassical growth model and an augmented neoclassical model with human capital. We use both cross-section and panel approaches to check β-convergence among the Kazakhstan regions, and to calculate the speed of convergence. This allows us to compare the results with each other and with what is known from the literature.

Another type of convergence that will be studied in this thesis, namely σ-convergence, is the strongest and most readily understandable notion of convergence. It studies the dynamics in time of the standard deviation or coefficient of variation of either income or output levels of considered economies. However, this type of convergence usually takes place only during short periods, even across the regions of the same country. It answers another question: "...how has the distribution of per capita income across economies behaved in the past and is likely to behave in the future?" (p.113). It does not provide any information regarding the speed of convergence and the structural parameters of the growth models. In this thesis, we also judge convergence directly by studying the dynamics of standard deviation and the coefficient of variation of per capita GRP level across the Kazakhstan regions.

In addition, regions of Kazakhstan differ considerably in terms of production structure, level of development, resource availability, geographical and climate conditions. These disparities can cause different growth paths and policy implications; therefore, it is important to discover homogeneous groups of regions which display the types of convergence mentioned above within them. Studying the global conditional β-convergence allows us to partly take into account some of these differences, but it does not give any information about the composition of these groups. This makes it necessary to study the club-convergence across the Kazakhstan regions. Although there are several ways to identify convergence clubs, we propose a new approach consisting of two steps. At the first stage, guided by cluster analysis and established growth factors, we shall identify several groups of Kazakhstan regions as candidates to the convergence clubs. At the second stage, we test σ-convergence and unconditional β-convergence across regions included in each cluster in order to determine whether identified clusters are convergence clubs or not.

While σ- and β- types of convergence deal with the levels and growth rates of gross regional products of economies, another type of convergence called TFP-convergence studies the relative behaviour of the levels and growth rates of total factor productivity (TFP). The TFP is a commonly used measure of technical progress, which is considered as one of the most important sources of economic growth and conditioning factor of convergence. Therefore, we shall include this type of convergence in the thesis. TFP measures the "intensive" part of the economic growth as opposed to the "extensive" part measured by the accumulation of inputs (capital and labour) (Sarel 1997). As we shall see later, there are several approaches to calculate TFP series; therefore, it is necessary to choose one for the testing of TFP convergence. In studying TFP convergence, we use a growth accounting methodology, which produces a panel of TFP series of Kazakhstan regions and allows us to use the panel unit root tests. These tests are more reliable when comparing with cross-section or time series methods. Using three such tests to study TFP convergence across the Kazakhstan regions helps us compare the results and make trustworthy conclusions. Moreover, we shall test TFP convergence within the above-mentioned convergence clubs identified according to the set of growth factors.

Afterwards, in order to reveal those sectors of the Kazakhstan economy which are either convergence or divergence engines[1], we shall perform a sectoral decomposition of the convergence process across regions of the country using two-step procedure. At the first step, the growth rate of per worker GRP is broken down into several parts: the growth rates of

[1] Under the term "engine" of convergence we mean sectors that promote either convergence or divergence across regions of the country.

different economic sectors, growth due to the structural shift, and growth due to the interaction of these parts. At the second step, these components are regressed on the logarithm of per capita GRP at the initial moment of time. This helps identify inputs of each part into the process of total convergence.

The approaches used in this thesis are not free of limitations. Some are caused by the choice of social and economic indicators, approximating variables and measures of regional inequality. Others come from the use of econometrical methods and the sporadic availability of statistical data. These drawbacks will be discussed in more detail in the Conclusion, with respect to the directions of further research.

1.4 Additional Definitions and Measurement

1.4.1 Regions.

Regional economics defines a region as a sub-national area unit. Most of the methods for delimiting the boundaries of a region fall into one of three categories: homogeneity, nodality, and programming (Richardson 1973).

According to the first criterion, areas belong to a specific region if they are considered homogeneous with respect to some key factor (economical, social, or political). It is supposed that their relationship with other parts of the region is more important than their internal differences.

The nodal criterion of including an area into some region is based upon whether it has closer links of inter-dependence with some larger centres, called dominant nodes, than with other large centres.

The programming approach is to define regions in terms of administrative and political areas. Such a region is called a programming or planning region. The main virtue of the programming approach, unlike the previous two, is the availability of statistical data that correspond to an administrative division of a country. The disadvantage is that administrative boundaries may be inconsistent with regional boundaries based on economic criteria.

In the case of Kazakhstan, regions (oblasts) are delimited according to a nodal approach: the capital of each region is also its pole or node of economical, social, and political activities. Exceptions include the cities of Astana and Almaty, which are located inside the Akmola and Almaty oblasts, respectively. According to the programming approach, these are considered separate administrative units, but as they are situated within these regions, they are also large nodes of them. Close links exist between Astana city and Akmola oblast, as well as Almaty city and Almaty oblast.

1.4.2 Economic Growth.

Economic growth is defined in the literature as a positive change in the level of production of goods and services by an economy over a certain period of time (Sidorovich 1997, Aghion and Howitt 1998, Thirlwall 1999, Barro and Sala-i-Martin 2003, Helpman 2004, and others). If economic growth includes inflation, then it is called a nominal growth. Real growth consists of nominal growth without inflation.

In the case of a nation, the growth rate of real gross domestic product (GDP) serves as a measure of economic growth. When a region of a country is considered, a measure of economic growth is the growth rate of the real gross regional product (GRP).

To compare various countries and regions with each other, the per capita GDP or GRP are used, which are obtained by dividing those sums by the quantity of population. However, the main weakness of per capita GDP or GRP, as a measure of economic growth is the fact that the per capita GRP growth can be obtained by either an increase in regional output or a fall in population quantity. Although these two phenomena are accounted in the same index, economically they represent opposing events: the former indicates real economic growth, while the latter reflects a negative social situation.

Some elements of a total internal product (gross national product) cannot be calculated at a regional level. Therefore, they are added up for a country as a whole (Regions of Kazakhstan 1993-2009a). In this connection, the total GRP calculated in all regions differs from the gross national product by the size of the added cost: the services rendered by official bodies to a society and services of financial intermediaries. Besides, the gross national product and the gross regional product differ in market prices by the size of taxes on products and imports. The amount of collected taxes cannot be distributed properly among separate regions because of the specificity of their accountability.

Nevertheless, the annual percentage change of the gross regional product (GRP) or the per capita gross regional product is here taken to be an accurate measure of economic growth in the Kazakhstan regions.

1.5 The Main Argument of the Thesis

The main findings of the thesis and their implications for policy can be formulated in several points.

Firstly, the Kazakhstan regions diverge in the sense of σ- and absolute β- types of convergence and converge in the sense of conditional β-convergence. This behaviour is caused by significant differences in steady state positions that in their turn are determined by differences in saving rate, population growth and other determinants of economic growth. For the government this means that convergence in Kazakhstan is not per se a process that accompanies economic development and that a strong regional policy directed towards the equalization of the steady state positions of the Kazakhstan regions is needed. Due to the revealed positive relationship between economic growth and inequality, this policy should be complicated, in order to reduce economic disparities and preserve high rates of economic growth.

Secondly, regions of Kazakhstan converge within the sub-groups of regions constructed according to the set of growth factors, namely, they demonstrate club-convergence pattern. From the policy point of view, this means that there is a possibility to elaborate club-specific regional policy, directed towards diminishing disparities across clubs.

Thirdly, regions of Kazakhstan converge in the sense of TFP-convergence although; this type of convergence also takes place across regions within sub-groups of regions. For the policy makers this means the necessity to promote convergence of TFP influencing long-term growth factors such as human capital. This policy could also be club-specific, however, the TFP-convergence clubs differ from σ- and β- convergence clubs.

Fourthly, the sectors of industry, construction, transport & communication, and service contribute to the convergence process. Therefore, the government should consider these sectors as targets of a policy of reducing of economic disparities across regions of Kazakhstan. The sector of agriculture contributes to neither convergence nor divergence across the Kazakhstan regions over the period of 2001-2009. Therefore, a policy is needed to diminish the share of this sector in the production structure of regions and to enhance the labour productivity in this sector.

1.6 Dissertation Overview

The thesis is structured as follows.

CHAPTER 2 introduces the problem of the uneven development of Kazakhstan describing geographical, natural, economic, and political issues of the development of the country and its regions. CHAPTER 3 describes the mechanisms which promote either convergence or divergence across states and regions, provides a classification of growth theories with respect to the convergence issue, and introduces definitions of various types of convergence. CHAPTER 4 describes empirical methodologies of testing various types of convergence across countries and regions including approaches to reveal convergence clubs and method of sectoral decomposition of convergence. In CHAPTER 5, we test two types of convergence across Kazakhstan regions: σ-convergence and β-convergence. In CHAPTER 6, the club convergence approach is applied to Kazakhstan regions. CHAPTER 7 contains a study of the TFP convergence across the Kazakhstan regions. CHAPTER 8 applies sector decomposition of convergence across Kazakhstan regions to reveal the contribution of each economic sector in the process of either convergence or divergence of the country. The final CHAPTER 9 reviews the theoretical and practical contributions of the dissertation, pointing out its limitations and outlining directions for future research.

Some substance of the thesis not directly connected to the main argument is placed in appendices. Appendix 1 provides a short description of the economic potential of the Kazakhstan regions. Appendix 2 reviews how the issue of convergence is interpreted in non-neoclassical theories of economic growth. Appendix 3 accommodates a literature review of human capital, outlining various approaches to its definition and measurement, and links human capital with economic growth and convergence.

CHAPTER 2.
THE PROBLEM OF UNEVEN DEVELOPMENT IN KAZAKHSTAN

2.1 Introduction

This chapter seeks to outline the major economic features of Kazakhstan in order to put the question of convergence in some context. It begins with a description of the geographical and natural conditions of the country, and proceeds to discuss the process of economic development of Kazakhstan and its regions during the years of independence with particular reference to the issue of regional economic disparities. It shows that the period of transition from the non-market economic system was rather complicated and accompanied by growing regional disparities in terms of both GRP and the poverty of the population. These disparities are acknowledged by the authorities in their efforts to elaborate appropriate territorial arrangements and diverse regional policies.

2.2 Kazakhstan – Geographical Situation and Administrative Division

The Republic of Kazakhstan became an independent state in 1991 after the break-up of the Soviet Union. It is a very large country, which spreads from the Caspian Sea and Volga steppes in the west to the Altay Mountains in the east, and from the West-Siberian lowlands in the north to the foothills of the Tien Shan Mountains in the south and southeast. It occupies an immense area of 2724.9 thousand square kilometres, which makes it the ninth biggest country in the world in size. Kazakhstan is located in the centre of the Eurasian continent, at the joint of two continents - Europe and Asia - and between the largest countries in the world, the Russian Federation and fast-growing China; in the neighbourhood of the states of Central Asia and the regions of the Near East and Southern Asia. However, the country is remote from the basic world commodity market and does not have a direct outlet to the sea (ocean).

The key economic branches of the industry - fuel and energy, mining and smelting - are well developed. However, the production structures of many regions of the country are not well balanced. Much of the economic structure of the country remains deformed and splintered. The bipolar nature of the economy - with its isolated sectors of raw export and poor competitive manufacturing - militates against integration. Northern and eastern regions of the country produce a superfluous quantity of the electric power whilst southern and western regions import it from other regions or nearby countries (Kyrgyzstan, Russia, Tajikistan).

There exists a transport and communication infrastructure covering all the territory of the country. The railway and highway network allows transporting among all regions with an exit to the adjacent countries. Kazakhstan automobile and railways are included into the structure of the international transport corridors. The seaport Aktau is used as a multimodal transport hub as a part of the international transport corridors "TRACECA" and "North-South." 21 airports operate in the country, of which 14 are committed to the provision of international flights. However, the transport infrastructure, a legacy of the Soviet period, is in unsatisfactory condition. It is inadequate to the modern requirements of a national economy and constrains the full inclusion of the republic into the international system of labour division. Railways and highways are characterized by low traffic capacity. Owing to intensive deterioration and destruction about 30% of the highway network needs major repairs, whilst 75% does not meet requirements for durability.

The life support infrastructures of the country are highly depreciated. Medium-sized cities and rural areas of the country have a poorly developed network of infrastructure. The physical deterioration of thermal power stations has led to reduced electric and thermal capacity. In 2010, it was estimated that thermal power stations has exhausted 50% of their peak resources. The components of social infrastructure are spread across the regions of the country in a non-uniform way. Access to more remote rural settlements is difficult. In big cities and regions with a sizeable migratory increase in population, the rates of development of social infrastructure are low.

According to the data of Statistical Agency, there are 16 836 000 inhabitants in Kazakhstan (the fiftieth place in the world). However, the population density is only 6.18 people per square kilometre. In latter years, the country has developed a positive demographic dynamic because of a rise in population. There are labour-abundant regions, which serve as a reserve of labour force in the country. Another demographic reserve is the presence of the Kazakh Diaspora in frontier regions of neighbouring states.

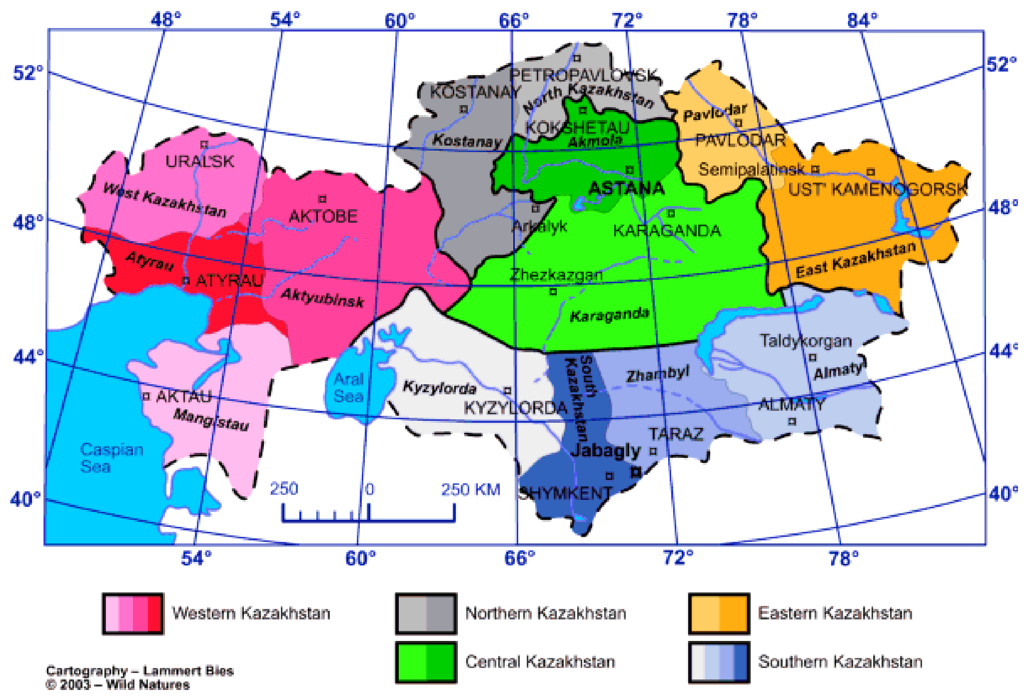

Figure 2.1: Oblasts of the Republic of Kazakhstan.

Politically, Kazakhstan is divided into 14 oblasts (equivalent to provinces in other countries). Each oblast is subdivided into rayons (districts) (Figure 2.1). Two large cities: Astana, the capital of the country, and Almaty, the former capital, enjoy special political status. Of the 14 oblasts of Kazakhstan, 12 are frontier regions. Evidence from developed and dynamically developing countries suggests that frontier regions are the key zones of growth in these states. They act as the centres of economic activity and promote the successful integration of the country into the world economic system. However, the administrative territorial structure of the country does not always match the situation on the ground. The practical borders of markets and human settlements do not always coincide with administrative borders. Some 11 cities of the oblast and 10 cities of rayon value do not merit their status. For example, the population of Zhem of the Aktobe oblast, does not exceed 2.5 thousand people whilst Kazalinsk of the Kyzyl-Orda oblast and Stepnjak of the Akmola oblast number around six thousand. The borders of the cities, as determined by rural districts years earlier, are not properly regulated.

2.3 Natural Resources of Kazakhstan

The Kazakhstan has some of the most extensive deposits of mineral resources in the world. The minerals of the country cover almost all the elements of the Table of Mendeleyev. The variety and richness of its mineral wealth supplies internal demand, and promises to open the international market to export. The Republic is first in the world for its explored reserves of zinc, tungsten and barite, second for its reserves of silver, lead and chromite, third for copper and fluorite, fourth for molybdenum, and sixth for gold (Morozov 2005). However, the distribution of mineral resources across the country is uneven. Most of the potentially rich stocks are concentrated in under-developed areas and remote from currently operating extracting enterprises.

Among the CIS countries, 90% of the general stocks of chromite, 60% of tungsten, 50% of lead, 40% of zinc and copper, 30% of bauxites, 25% of phosphorites, 15% of iron ore, and more than 10% of coal belongs to Kazakhstan.

Considerable stocks of oil and gas are concentrated in the western region of the country. These resources place Kazakhstan among the twenty largest oil-extracting states in the world, and make it a considerable force in the world market of power resources.

Today, the country competes in the international market in the sphere of extraction and export of power resources (oil, gas, and coal) and metals (iron, chrome, ferroalloys, steel, copper, aluminium, zinc and lead). The country also has vast agricultural resources, particularly in animal husbandry and grain production.

The rich stocks of hydrocarbon raw materials give global economic importance to the country and make the oil and gas industries the basic source of long-term economic growth. According to the latest estimations, the general stocks of oil and gas in Kazakhstan amount to 23 billion tons, out of which about 13 billion tons are concentrated on the Caspian shelf. In oil production, Kazakhstan ranks 18th in the world, having extracted about 76.5 million tons of oil in 2009. The largest importers of Kazakhstan oil, gas and oil refining products are Russia, Great Britain, Ukraine, Switzerland and Italy.

The Kazakhstan is among the ten leading manufacturers and exporters of coal in the world. Its share in the world production of coal is about 2 %, and almost 5 % in world export of coal. Developed coal fields number is around 30, with the majority located in northern and central parts of Kazakhstan. The most accessible and cheap coal in the CIS is extracted in the Karaganda oblast. Kazakhstan was the third largest manufacturer of coal in the Soviet Union, only lagging behind Russia and the Ukraine. Despite the decrease in volumes of output caused by the disintegration of the Soviet Union, Kazakhstan remains the chief manufacturer, consumer and exporter of coal in the republics of the former Soviet Union, providing almost half of the mineral. The largest consumer of Kazakhstan coal is Russia, followed by Ukraine. The general trend of growth of world consumption of coal is to the countries of the Asian - Pacific region, especially China and India, which gives Kazakhstan a strategic advantage in the manufacture and export of coal.

Kazakhstan possesses essential stocks of copper. In volume of production and export, the country is among the largest manufacturers and exporters of refined copper in the world. The chief importers of Kazakhstan copper are Italy and Germany. To maximise export income, Kazakhstan has reoriented the geographical structure of export from the post crisis countries of South East Asia and Russia to countries with a high demand for copper, such as the USA and the countries of Latin America. In spite of the fact that copper manufacture, as for nonferrous metallurgy as a whole, has kept its position in the world markets, the 2008 fall in world prices for basic metal products has lowered sharply the profitability of their manufacture. The creation of vertically integrated structures uniting all metallurgical processes, including extraction, processing, smelting, the manufacture of rolled metal and the finished product became decisive in turning around the problem.

Extensive land resources and a variety of natural and climate features allow a diversity of agrarian produce. The territory of the country includes ten natural agricultural zones. Agricultural land comprises 82% of all land in Kazakhstan. However, certain factors reduce productivity and increase the risk of agrarian manufacture. The quality of arable land is rather poor. Only 4.2 million hectares out of a total of 23.2 million hectares exceed 50 units of the quality of locality of arable lands (the measurement reflects the relative level of fertility), whilst 14.8 % of agricultural land are subject to water and wind erosion. Unproductive pastures are prevalent.

Most of the regions of the country are in a drought zone and have troubles with water delivery. Only 56% of surface water comes from within the territory of the country. The rest comes from outside, strengthening the dependence of some Kazakhstan regions on the water resources of adjacent states.

There are unique recreational resources in Kazakhstan that include natural complexes, cultural and historical monuments and objects of architectural interest. However, the majority of objects of the recreational infrastructure were constructed in the Soviet period. They are highly deteriorated and do not meet the international standards.

2.4 The Economic Development of Kazakhstan Since Independence.

2.4.1 By the Critical Line

In the short period since independence (twenty years is a short period in the life of nations), the economy of Kazakhstan has experienced the consequences of three economic crises. The first was the system crisis of the USSR, which caused the break-up of the Soviet Empire. The second was the Asian crisis of 1998 and the last was the global financial and economic crisis of 2007/08 (Alshanov 2011).

Kazakhstan started as an independent economy under the harsh conditions of the rupture of Soviet economic structures. As the country was the most integrated in the allied economy, the loss of the capacious market meant not just the depletion of commodity markets, but the collapse of all production. Kazakhstan’s industrial enterprises, especially mining and smelting, comprised a large part of the Soviet economy, even if management was subordinate to the central Soviet authorities. Its agricultural enterprises supplied the whole of the Soviet Union with grain, meat, milk, wool, clap and other products, ensuring the food safety of the country.

The break-up of the common state caused considerable economic and social loss for all the countries of former USSR, not least Kazakhstan. The general fall in the allied economy exceeded 50 %. For comparison, the Great Depression in the USA caused a loss of 29 %. The source of this crisis, which appeared the most severe trial for the country, lay in the planned Soviet economy.

Kazakhstan was able to put behind the worst effects of the disintegration of the USSR by 1997/98, which saw an advance from the nadir of previous years. In most former USSR countries, the bottom point was passed by 1997/98. However, some countries have not recovered even now.

This was the economic context of independence. It was necessary to grapple the whole complex of economic, social and political problems at once. The main choices were: to give economic freedom to citizens of the country; to integrate into the global economy; to provide people with worthy work; to create conditions for the obtainment of education and for health care, to take proper care of the elderly and children. These and similar decisions conditioned the formation and development of independent Kazakhstan.

"However, it is much easier to proclaim principles than to reach them. More uncertainty appeared than expected. There is a world experience, but each country bears the burden of change itself. Kazakhstan did not see a way back and went forward through the thorns" (Alshanov 2011).

2.4.2 The Creation of a New Social and Economic System

The formation of market relations was the biggest challenge in the transition to a new social and economic formation. It was necessary not only to declare economic freedom, but also to create practical conditions for its realization. One of the most important steps was the privatization of state property. As a result of four stages of privatization between 1991 and 2000, 34.5 thousand objects of state property were sold to new private proprietors for a total sum of 215.4 billion tenge. The process of privatization, the cause of so many furious and fierce disputes in the country, led to the emergence of a class of private entrepreneurs and free businessmen unknown previously.

As a result, the number of small-scale businesses has grown exponentially: in 1993 it was 19.0 thousand; in 2000 the figure was 67.0 thousand; in 2011 there were some 675.2 thousand small businesses. Employment in this sector has risen from 132.4 thousand people in 1997 to 2.5 million in 2011.

Similarly, in 1996, 39.5% of all property in the country was in the hands of the state and 57.1% was private. By 2010, the state share has decreased to 10.8 %, and the private share had risen to 72 %. Foreign property counted for 17 %. Already by 1997, 79 % of the volume of industrial output was produced by private enterprises and 6.6 % by the state. In 2009, 77 % of output was produced by private enterprise, 22.1 % by foreign-owned companies, and 0.9 % by the state. Private ownership had become the dominant force of economic relations in the country.

The economic role of the state has essentially changed. Its prime objectives now became the care of financial stability and maintenance of social development, the creation of reasonable conditions for business, and the regulation of economic and financial relations between the state and business.

For the creation of proper mutual relations between business and the state, a new legislative and normative legal system has been generated. The main social and economic principles have been fixed in the Constitution of the country. New Civil, Labour, Tax, and Customs Codes have been approved. The property right was guaranteed. Economic rights and freedoms - in particular, the right to free business - were granted. The conditions necessary for the realization of rights and freedoms were created during these years, underpinned by legal protection. The state has been trying to support business both directly - by providing financial aid - and indirectly, by continually decreasing tax rates.

As a result, business in the country has provided work for more than 6.2 million people, of which 2.7 million were self-employed. The income level of the population has significantly grown. The monthly average salary has increased from six thousand tenge in 1998 to 24 thousand in 2000, and to 93 thousand in 2011. The share of the population with an income below the living wage has been reduced by more than five times.

Flows of tax and other incomes into the budget have grown during the 20 years from 7.1 billion tenge in 1993 to 3505.3 billion tenge in 2009. Over the period of 1992-2000, a total of 2.1 billion tenge has arrived into the budget, and during 2006-2009 the total sum of receipts in the budget was 12.8 billion tenge, including tax revenues of 9.6 billion tenge.

A stable financial system has been put into place. This system is functional and constantly developing and evolving. The policy of easing the tax burden yielded fruits. Business development led to an expansion of the financial base of the country, and encroached into areas of social development, with the building of more schools, kindergartens and hospitals, and the implementation of large infrastructural projects, such as new highways.

The major factor of growth in the national economy of Kazakhstan has been a rapid recovery and the progressive development of key branches of that economy: the oil and gas sectors, mining, the iron and steel industry, non-ferrous metallurgy, transport and communication, agriculture. In 2009/10, the share of these branches accounted for 86 % of total output of the country, and the share of the mining branch accounted for 48.4 %.

2.4.3 In Competition for Investments

Extensive stocks of mineral resources, along with the rather low risk of political instability, have already made Kazakhstan the largest addressee of per capita foreign investments among the CIS countries.

In the initial years of independence, there was not large national capital in the country, making foreign investment in Kazakhstan a necessary option. Privatization itself was not enough to create sufficient capital. The established structure of Kazakhstan's national economy rested on heavy industry, which is high capital and energy consuming and demands considerable fixed and current capital. In order to renew large manufacture, an adequate large capital was needed. With few financial resources and in the absence of long-term capital investment from the former central government, it was necessary to attract investment from other sources.

A number of favourable factors characterize the investment climate in Kazakhstan. Firstly, the laws on foreign investments, on oil, on licensing and on privatization have created a legal base to facilitate foreign investment. Secondly, both the existing structure of the governance of the oil extracting sector and the tax - tariff system have been simplified. Thirdly, the geographical position of Kazakhstan in the centre of the continent opens it to access to the large export markets of Europe. During 20 years of independence, Kazakhstan has managed to develop a strategic investment course and clear investment policy, and both have been fruitful. A favourable climate for investors was created, long-term investments were legislatively guaranteed, and the preservation and execution of concluded agreements were provided.

As a result, during the years of independence, the volume of foreign direct investment into the national economy has exceeded 131.9 billion US dollars. More than 71 % of these were obtained in the last five years. In 2010, the volume of direct foreign investments to Kazakhstan reached 17.4 billion dollars (Figure 2.2). Foreign direct investments in Kazakhstan peaked in 2008 when the figure reached 19.8 billion dollars. According to the volumes of FDI, in 2009 Kazakhstan took 16th in the world; in 2010 – 19th, the fifth in Asia, and the second in the CIS after Russia. On this indicator, Kazakhstan was included among the leading developing countries and for a long time has been in the lead in Central Asia.

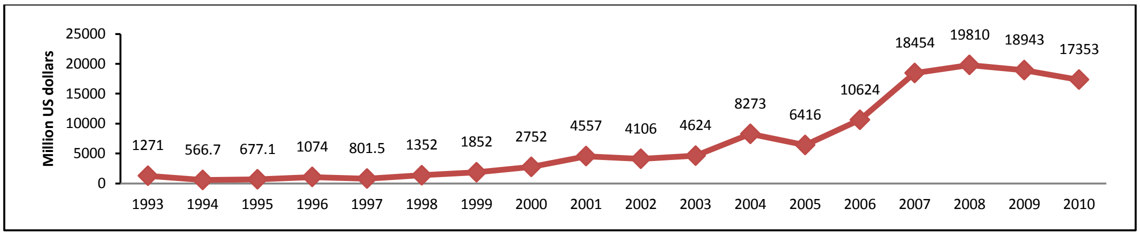

Figure 2.2: Foreign direct investment in Kazakhstan 1993-2010 (million US dollars)
Source: (Alshanov 2011)

Kazakhstan attracts large foreign investment in the development of the oil and gas sector. Foreign capital has been involved in 27 large-scale projects connected with the development of deposits, exploration, reconstruction of the processing enterprises, and the transportation of oil and gas.

The attraction of large-scale foreign investment, both direct and portfolio, became an important factor in the recovery of key branches of the Kazakhstan economy. Following the severe shortage of financial resources during early independence, these investments aided the restoration of key branches of the economy. In addition, they promoted the modernization and the transformation of these branches into the basic source of national wealth. This promoted the solution of the key problems of social and economic development in the country.

Now, amendments are introduced in the investment policy according to changed conditions. Foreign investors are chosen according to the needs of the country, with a mind to long-term steady development. The country aspires to expand geographic investment, proceeding from strategic targets and a reasonable balance of interests.

It is unquestionable that foreign direct investments have played and continue to play an important role in the growth of the national economy. Now, the country should provide a reasonable combination of national and foreign capital in the spheres of application and achieve their maximum effective utilization for an intensive diversification of the national economy.

2.4.4 The Basic Indicator - Steady Growth

Due to economic reforms, the favourable prices of the chief items of Kazakhstan export, and large volumes of foreign investment, Kazakhstan has achieved high rates of growth in its national economy. The average rate of growth of the economy for the last twelve years has been 8.4 %, and the maximum value – 10.7 % - was reached in 2006. These achievements place Kazakhstan among the frontrunners of dynamic economies in the world.

For the period of 1993-2010, the volume of real GDP of Kazakhstan in prices of 1993 has almost doubled (Table 2.1).

Table 2.1: Dynamics of real GDP of Kazakhstan over 1993–2010

	Real GDP of Kazakhstan (million tenge)*	Real GDP of Kazakhstan (million US dollars)*	Real per capita GDP of Kazakhstan (tenge)*	Real per capita GDP of Kazakhstan (US dollars)*
1993	29423.1	11404.3	1796.2	696.2
1994	25715.8	9967.4	1569.9	608.5
1995	23597.3	9146.2	1440.6	558.4
1996	23715.0	9191.9	1447.7	561.1
1997	24126.9	9351.5	1472.9	570.9
1998	23656.2	9169.1	1444.1	559.7
1999	24303.5	9420.0	1483.7	575.1
2000	26686.8	10343.7	1629.2	631.5
2001	30276.4	11735.0	1848.3	716.4
2002	33248.1	12886.9	2029.7	786.7
2003	36337.5	14084.3	2218.3	859.8
2004	39838.9	15441.4	2432.1	942.7
2005	43693.3	16935.4	2667.4	1033.9
2006	48371.6	18748.7	2953.0	1144.6
2007	52667.3	20413.7	3215.2	1246.2
2008	54403.3	21086.6	3321.2	1287.3
2009	55050.6	21337.4	3360.7	1302.6
2010	59081.6	22899.8	3606.8	1398.0

*Note: * All values are taken in constant prices of 1993.*
Source: Statistical Yearbook of Kazakhstan (1993-2010).

An analysis of the dynamics of GDP of the country for the past years shows that among 15 former Soviet Union countries Kazakhstan takes the third place according to the average growth rate of GDP over the period of 2000-2011 (Table 2.2).

Table 2.2: Growth rates of GDP of 15 former soviet countries (%)

Country Name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
Armenia	5.9	9.6	13.2	14.0	10.5	13.9	13.2	13.7	6.9	-14.1	2.1	4.6	**7.8**
Azerbaijan	11.1	9.9	10.6	11.2	10.2	26.4	34.5	25.0	10.8	9.3	5.0	1.0	**13.8**
Belarus	5.8	4.7	5.0	7.0	11.4	9.4	10.0	8.6	10.2	0.2	7.7	5.3	**7.1**
Estonia	9.7	6.3	6.6	7.8	6.3	8.9	10.1	7.5	-4.2	-14.1	3.3	8.3	**4.7**
Georgia	1.8	4.8	5.5	11.1	5.9	9.6	9.4	12.3	2.3	-3.8	6.3	7.0	**6.0**
Kazakhstan	9.8	13.5	9.8	9.3	9.6	9.7	10.7	8.9	3.3	1.2	7.3	7.5	**8.4**
Kyrgyz Republic	5.4	5.3	0.0	7.0	7.0	-0.2	3.1	8.5	8.4	2.9	-0.5	5.7	**4.4**
Latvia	6.9	8.0	6.5	7.2	8.7	10.6	12.2	10.0	-4.2	-18.0	-0.3	5.5	**4.4**
Lithuania	3.3	6.7	6.9	10.2	7.4	7.8	7.8	9.8	2.9	-14.7	1.3	5.9	**4.6**
Moldova	2.1	6.1	7.8	6.6	7.4	7.5	4.8	3.1	7.8	-6.0	7.1	6.4	**5.1**
Russian	10.0	5.1	4.7	7.3	7.2	6.4	8.2	8.5	5.2	-7.8	4.3	4.3	**5.3**

Federation													
Tajikistan	8.3	10.2	9.1	10.2	10.6	10.5	-15.7	21.7	21.2	3.9	6.5	7.4	**8.7**
Turkmenistan	5.5	4.3	0.3	3.3	5.0	13.0	11.0	11.1	14.7	6.1	9.2	14.7	**8.2**
Ukraine	5.9	9.2	5.2	9.4	12.1	2.7	7.3	7.9	2.3	-14.8	4.2	5.2	**4.7**
Uzbekistan	3.8	4.2	4.0	4.2	7.7	7.0	7.3	9.5	9.0	8.1	8.5	8.3	**6.8**

Notes: Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2000 U.S. dollars.

Source: World Bank (http://data.worldbank.org)

For this period, the place occupied by Kazakhstan on the economic map of the world has changed (Table 2.3).

Table 2.3: The place of Kazakhstan according to the value of GDP

in	**1992**	**1995**	**2000**	**2005**	**2010**
Central Asia	1	1	1	1	1
CIS	3	3	3	3	3
Europe			24	23	23
Asia			20	18	18
World			62	57	55

Source: (Alshanov 2011)

The dynamics of real per capita GDP has also changed. During 1993-2010 this indicator calculated in constant 1993 prices in Kazakhstan has grown by two times. According to a 2008 report from the United Nations, Kazakhstan is included among the group of countries with an above average level of per capita income (Alshanov 2011).

2.4.5 Income of the Population in Kazakhstan

Based on the growth of national economy, the nominal monetary income of the population has grown significantly (Table 2.4). For example, during the past ten years, the average per capita level of monthly nominal monetary income has grown 5.3 times and stands at 40473 tenge (Agency on Statistics of the Republic of Kazakhstan 2011).

Table 2.4: Social indicators in Kazakhstan

Indicator	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Average per capita monthly nominal monetary incomes of the population, tenge (estimation)	7670	8958	10533	12817	15787	19152	25226	32984	34282	40473
Average monthly nominal earnings, tenge	17303	20323	23128	28329	34060	40790	52479	60805	67333	77611
The average size of the appointed monthly pension (by the end of an year), tenge	4947	5818	8198	8628	9061	9898	10654	13418	17090	21238

The average size of the appointed monthly state hardship allowances (by the end of an year), tenge	3630	4095	4394	4602	6627	7528	8366	11319	12888	14037
The average size of the appointed monthly state address social help (by the end of an year), tenge	-	-	714	778	835	827	922	1162	1130	1194
The size of a living wage (on the average per capita), tenge	5655	6003	6457	6785	7618	8410	9653	12364	12660	13487
The ratio with the size of a living wage (on the average per capita), in percentage:										
Per capita monetary incomes	135.6	149.2	163.1	188.9	207.2	227.7	261.3	266.8	270.8	300.1
Monthly nominal wage	306.0	338.5	358.2	417.5	447.1	485.0	543.7	491.8	531.9	575.5
average size of the appointed monthly pension	87.5	96.9	127.0	127.2	118.9	117.7	110.4	108.5	135.0	157.5

Source: AGENCY ON STATISTICS OF THE REPUBLIC OF KAZAKHSTAN, 2011. Monitoring of Incomes and Population Standard of Living in the Republic of Kazakhstan (Analitical Report). Astana.

In 2010, average per capita expenses on consumption stand at 744.4 thousand tenge, which is above the indicator of 2001 (118.5 thousand tenge) by 6.3 times. In the last decade, monthly average nominal wages have grown by 4.5 times and amounted to 77611 tenge in 2010, allowing for essential branch differentiation. In 2010, the lowest wage remained, as before, in agriculture and averaged 36477 tenge.

However, the quintile distribution of incomes shows an insignificant increase in the monthly average income per capita in the first four quintiles, excepting the last (Table 2.5). So the per capita income of third and fourth quintiles exceed the living wage size only by 1.5-1.9 times, indicating that 80% of the population have incomes not exceeding twice the living wage, and half are in danger of being classified as poor.

Table 2.5: The share of incomes of the population by 20% (quintile) population groups

	The share of incomes of the population by quintile population groups* (%)				
	First group (lowest income)	**Second group**	**Third group**	**Fourth group**	**Fifth group (highest income)**
2001	6.33	10.98	15.86	22.92	43.91
2002	7.71	11.92	16.30	22.67	41.40
2003	7.94	12.22	16.74	23.08	40.02
2004	8.41	12.44	16.75	22.85	39.55
2005	8.45	12.45	16.81	22.81	39.48
2006	8.44	12.50	16.37	22.01	40.68
2007	8.54	12.55	16.45	21.92	40.54
2008	9.23	13.01	16.76	22.11	38.89
2009	9.72	13.56	17.24	22.46	37.02

2010	9.43	13.24	16.95	22.44	37.94

Note: without the scale of equivalence, according to established incomes.*

Source: AGENCY ON STATISTICS OF THE REPUBLIC OF KAZAKHSTAN, 2011. Monitoring of Incomes and Population Standard of Living in the Republic of Kazakhstan (Analitical Report). Astana.

The share of the quintile of the poorest segment of the population in national consumption is another social indicator. In Kazakhstan, in 2001-2010, the regular increase of the share of the quintile of the poorest segment of the population (as a whole by 3.1 percentage points) and the decrease of the share of the quintile of the richest population (by 5.97 percentage points) are observed. As a result, the ratio between the incomes of the population of the last and the first quintiles has decreased from 6.94 to 4.02 times.

2.4.6 Employment of Population

The most important factor in the reduction of poverty and the achievement of economic well-being is the opportunity to engage in productive work. The situation of the labour market is determined by two groups of indicators: employment and wages indicators.

The employment level of the population of the country tends to grow: from 89.6 % - in 2001 to 94.2 % - in 2010. The rate of unemployment, accordingly, was reduced by almost half from 10.4 % in 2001 to 5.8 % in 2010. The level of youth unemployment was reduced by 3.7 times (from 19.1 % in 2001 to 5.2 % in 2010). In addition, the average duration of unemployment was reduced by 1.7 times (from 14.9 to 8.9 months).

The most vulnerable section of the employed population are the self-employed, whose relative density in the number of the employed population remains considerable (33.3 % in 2010), despite the decrease of nine percentage points over the past ten years (since 2001). The highest relative density of independently employed population in 2010 remains in three regions in the southern part of the country (South Kazakhstan - 19.0 %, Almaty oblast - 13.5 %, and Zhambyl oblast - 10.6 %). The low efficiency and low incomes of this form of employment increase a risk of poverty for the self-employed population, excluding them from the pension system, social security, and the protection of workers' rights. In rural areas, the self-employment run an even greater risk of poverty, because part-time farm-work is the basic source of income and carries with it the loss of any right to social address aid. In 2010, less than one percent of the self-employed received state social address aid.

Those in households with lots of dependents (children, the jobless, pensioners, invalids, students) are also subject to poverty. In 2010, 79.5% of the population with incomes below a living wage lived in households consisting of five or more people: 14.8 percentage points above the indicator of 2006. According to the Ministry of Labour and Social Protection of the Population of the Republic of Kazakhstan, 60.9 % of the recipients of address social aid in 2010 were families with large number of children, 9.3 % - self-employed, and 9.0 % - unemployed.

2.4.7 The Influence of Oil Prices on the Development of Kazakhstan

Growth of economy of Kazakhstan since 1999 was accompanied by the substantial rise in prices for oil. For example, in 1998, the average annual oil price was 12.8 US dollars per barrel, while in 2011 it has reached 111 US dollars per barrel (Figure 2.3).

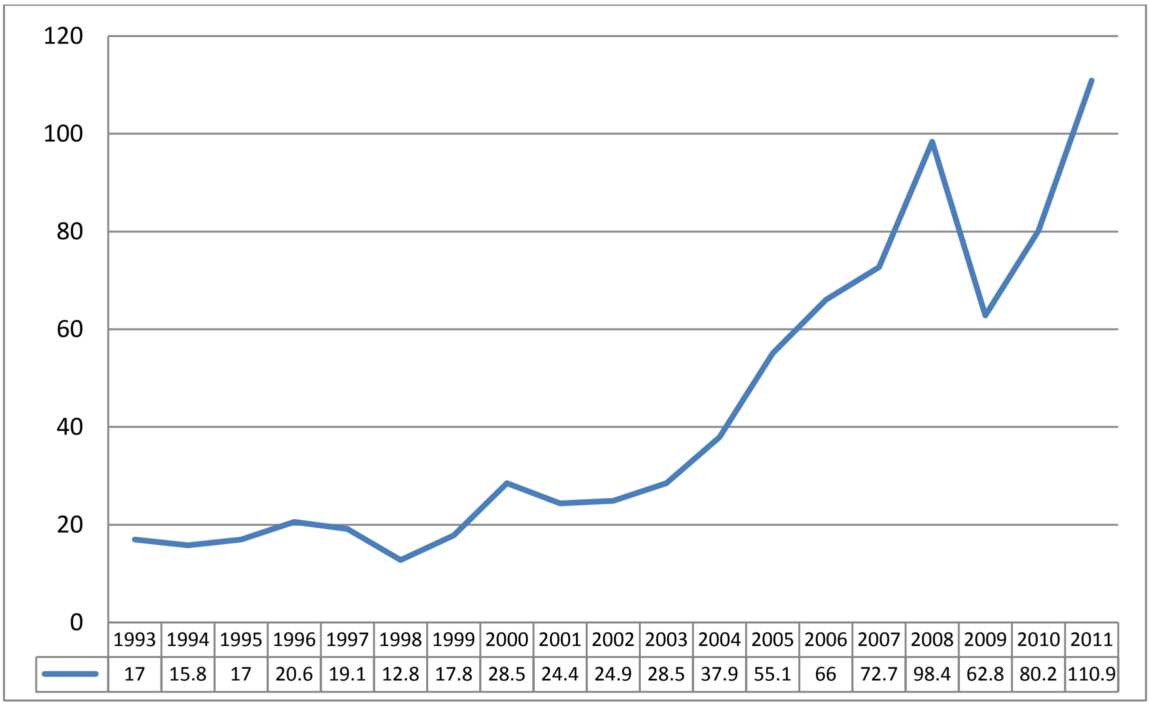

Figure 2.3: Average annual oil price (US Dollars/barrel)
Source: www.bloomberg.com

During the same period, the fast growth of manufacture of oil was observed as well. While in 1991 it was extracted 25.2 million tons of oil, by 2011 the oil extraction reached 80.4 million tons. In 2013, the oil production volume in Kazakhstan is predicted at the level of 83 million tons, in 2014 - 85 million tons, in 2015 - 95 million tons and in 2016 - 102 million tons. It is expected that by 2020, the oil production level will exceed 130 million tons and Kazakhstan will enter into the rank of ten largest oil-producing countries.

Due to the insignificant volumes of internal consumption, the most part of extracted oil goes for export. Exporting annually about 70 million tons of oil and having real tendencies of growth, Kazakhstan appears among world largest exporters. In the last decade, in the structure of export of Kazakhstan the crude oil occupied from 43% (in 2001) to 62 % (in 2010). It is hardly to find other factor than the oil price, on which the national economy more strongly depended for 20 years of independence.

Cumulative influence of price and physical factors rendered considerable effect on the growth of Kazakhstan economy. Nurakhmetov (2012) constructed a model, which demonstrates dependence of economy of Kazakhstan on oil prices in world markets. Using the economic theory and econometric analysis it has been proved that in the last ten years the economy of

Kazakhstan was in direct dependence of the prices for oil. The factor of correlation of GDP with the price for oil for this time interval is appeared to be equal to 0.88. In addition, a positive proportional relation between the oil prices and public revenues, and also between the oil prices and the state expenditures has been revealed. The correlation factors indicate that dynamics of incomes and expenses of the state on three quarters is explained by the dynamics of the oil prices.

The growth of oil prices and volumes of oil export has both positive and negative effects on the Kazakhstan economy. On the one hand, the rise in oil prices leads to higher growth of public revenues in comparison with the state expenditures, introducing thereby stabilising element of economy, and liberating the means that are subject to the direction to the National fund. This gives a possibility for the government to realize various programs directed to the development of infrastructure, education, social care, etc. The positive direct effect of the oil price can also be expressed in increase of inflow of investments into the internal oil sector, taking into account effects of demand for the expenses directed on other parties of economy.

On the other hand, results of the analysis conducted in (Nurakhmetov 2012), have shown that one of chief causes of inflation in the country is the rise in oil prices because the oil price determines the prices for other energy carriers. This factor influences dynamics of purchasing ability index (PAI) in much larger degree, than dynamics of factor expenses, in particular wages. In addition, Nurakhmetov (2012) shows that due to the high oil prices, the features of the "Dutch Disease" appear in Kazakhstan. The mechanism of "the Dutch disease" can be described in brief as follows (Corden 1984). Owing to the "boom" in resource sector, when the price for production of resource sector rises for a long time, and because of inflow of dollars to the country, national currency rises in price, making the production of non-resource sector less competitive. The growth of well-being resulting from the growth of incomes in resource sectors has short-term character. In the long-term prospect, the suppression of growth in non-raw branches leads to the slowdown of technical progress and, finally, to the retardation of growth of whole economy. In the case of Kazakhstan, an obtained equation of the rate of exchange (Nurakhmetov 2012) indicates that the increase of the oil price leads to the rise in price of tenge and results in the reduction of the non oil export.

As to the impact of oil prices on convergence across regions of a country, it is also twofold. On the one hand, due to the high oil prices, there appears a possibility for the government to direct financial resources to the alignment of economic levels of regions thus promoting convergence across them. On the other hand, the consequences of the "Dutch Disease" lead to the slowdown of economic growth in non-oil regions that deepens economic disparities among oil and non-oil regions.

In the case of Kazakhstan, the result of this complicated effect is partly picked up in the study of club-convergence (Chapter 6) when oil rich regions are found belonging to separate convergence clubs. However, it is difficult to disentangle the net effect of oil prices on convergence/divergence process across Kazakhstan regions, so it needs to be looked at it in more detail in a later study.

2.5 Regional Disparities in Kazakhstan

These economic changes affected Kazakhstan regions in different ways. The dynamic economic development of the country was accompanied by a growing disparity between its regions.

This has been a problem for the Kazakhstan authorities since independence in 1991. Their response was the Strategy of Territorial Development of the Republic of Kazakhstan, projected until the year 2015, whose main objective, as set forth in the preamble, was to reduce the distinctions between the regions of Kazakhstan.

2.5.1 Regional Disparities in GRP

An initial analysis of Kazakhstan regional disparities reveals that the gap between the richest and poorest regions has increased substantially.

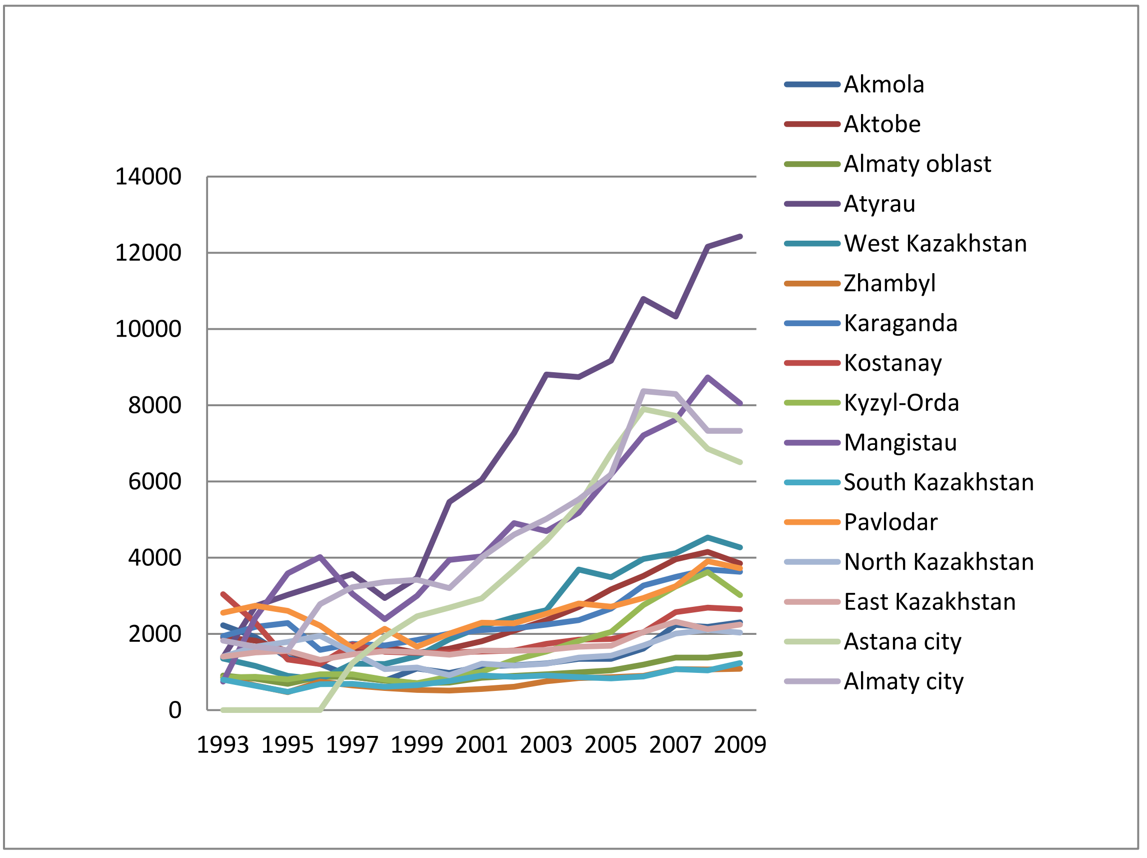

Figure 2.4: Real per capita GRP of Kazakhstan regions over the period of 1993-2009 (tenge in prices of 1993)
Source: Regions of Kazakhstan (1993-2009), author's calculation

The evolution of real per capita GRP of Kazakhstan regions over the period of 1993-2009 shown in

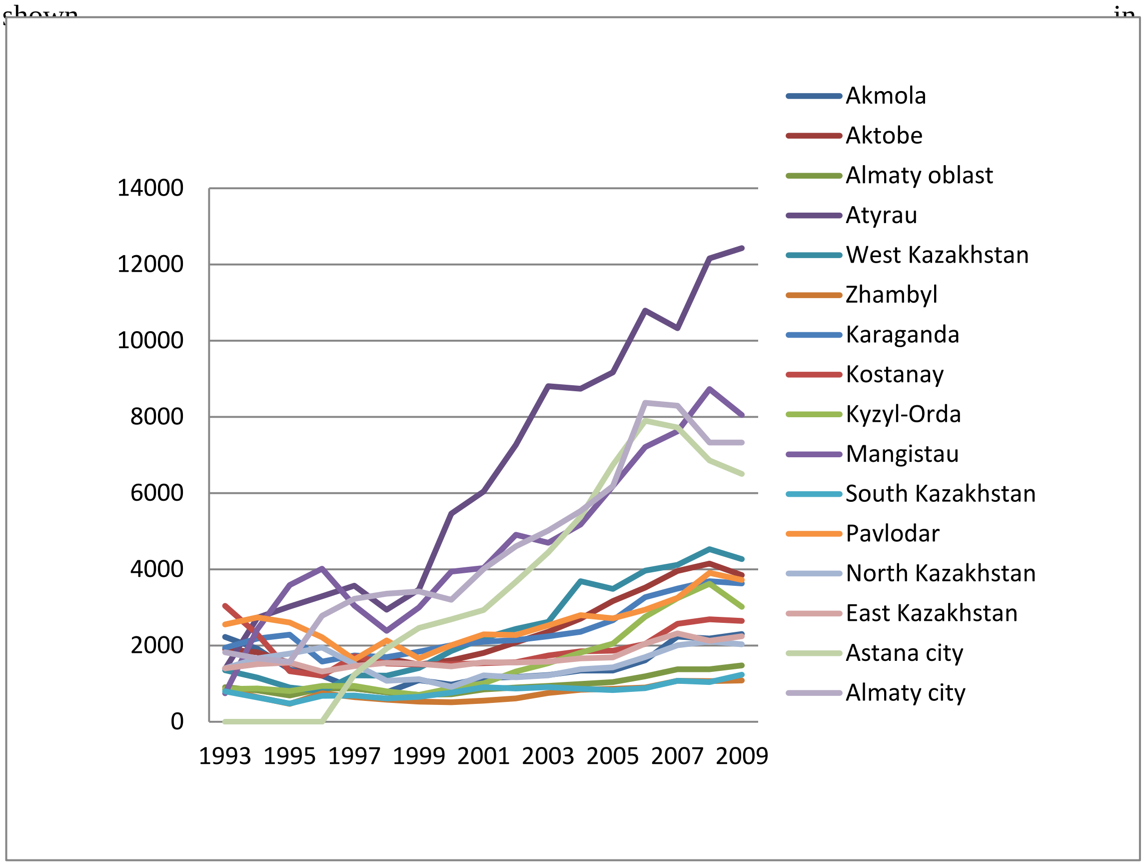

Figure 2.4 indicates that the disparities are becoming larger. For example, real per capita GRP of Atyrau oblast has grown more than 8.9 times from 1390 tenge in 1993 to 12429 tenge in 2009. For the same period, the same indicator from the South Kazakhstan oblast shows growth of 1.55 times. These disparities were minor until the end of the 80s, when the economic system was not market-based and the country itself was part of the USSR, and began to grow from the moment economic reforms commenced to transform the economy on a market basis.

In 1993, the three poorest regions were Mangistau, South Kazakhstan, and Zhambyl with an average per capita GRP of 798 tenge. The three richest oblasts were Kostanay, Pavlodar, and Akmola with an average per capita GRP level of 2606 tenge, i.e. the difference between the three poorest and the three richest oblasts was 3.26 times per capita GRP on average.

By 2009, the three poorest oblasts were Almaty, South Kazakhstan, and Zhambyl with an average per capita GRP level of 1582 tenge in the prices of 1993. The three richest regions consisted of Atyrau oblast, Mangistau oblast, and the city of Almaty with an average of 9266 tenge per capita GRP at 1993 prices. The difference between three richest and three poorest regions has reached 5.86 times.

In 1993, the difference between the richest region (Kostanay oblast) and the poorest one (Mangistau oblast) was 4.08 times. By 2009, the situation changed considerably: the gap between the richest region (Atyrau oblast) and the poorest one (Zhambyl oblast) has grown 11.5 times.

The economic performance of some regions has changed dramatically since independence. In 1993, the Mangistau oblast was the poorest region in the country with respect to per capita GRP. However, in 2009, it took second place among the richest regions due to the intense development of the oil and gas industries. The real per capita GRP of Mangistau oblast increased 10.8 times from 745 tenge in 1993 to 8045 tenge in 2009 (in the constant prices of 1993). The performance was repeated by other oil and gas rich regions: Atyrau, West Kazakhstan, Aktobe, and Kyzyl-Orda (Table 2.6).

Table 2.6: Real per capita GRP of Kazakhstan regions in 1993 and 2009.

Position	Region	Real per capita GRP in 1993 (tenge)	Position	Region	Real per capita GRP in 2009*
1	Kostanay	3044.78	1	Atyrau	12428.67
2	Pavlodar	2550.38	2	Mangistau	8045.41
3	Akmola	2223.76	3	Almaty city	7324.04
4	Karaganda	1943.69	4	Astana city	6502.86
5	Aktobe	1906.37	5	West Kazakhstan	4269.98
6	Almaty city	1825.90	6	Aktobe	3846.28
7	North Kazakhstan	1400.89	7	Pavlodar	3722.03
8	East Kazakhstan	1400.58	8	Karaganda	3631.57
9	Atyrau	1390.05	9	Kyzyl-Orda	3013.14
10	West Kazakhstan	1349.27	10	Kostanay	2645.48
11	Almaty oblast	910.52	11	Akmola	2303.56
12	Kyzyl-Orda	854.83	12	East Kazakhstan	2245.73
13	Zhambyl	853.04	13	North Kazakhstan	2033.83
14	South Kazakhstan	796.76	14	Almaty oblast	1479.39
15	Mangistau	745.39	15	South Kazakhstan	1234.13
16	Astana city**	-	16	Zhambyl	1082.77

Notes: tenge, in constant prices of 1993.*
*** in 1993, the city of Astana was incorporated into Akmola oblast.*
Source: Regions of Kazakhstan (1993-2009), author's calculation

Conversely, in 1993 the Kostanay oblast was the best performing region in terms of per capita GRP. In 2009, it took only 10th place among 14 oblasts and two cities. The Akmola oblast, third place in per capita GRP in 1993, dropped to 11th position in 2009. The three leading regions of 1993 (Kostanay, Pavlodar and Akmola) gave up their pole positions to other regions (Atyrau, Mangistau, and Almaty city).

The performance of the bottom three regions (Almaty oblast, South Kazakhstan, and Zhambyl oblast) is characterized by considerable downshifting. While in 1993 they took respective 11th, 14th, and 13th positions at the bottom of the table, by 2009, their performances considerably declined, resulting in them occupying the last three places among 16 regions.

From a geographical perspective, the three worst performing regions in terms of GRP per capita are located in the south of the country, constituting with Kyzyl-Orda oblast a Southern Economical Region (Figure 2.1). The four best performing oblasts - Atyrau, Mangistau, West Kazakhstan, and Aktobe - are located in the west part of the country and constitute a Western Economical Region.

The performances of regions with an average level of per capita GRP (Karaganda, North Kazakhstan, East Kazakhstan), located in the east, north, and centre of the country (Figure 2.1), has declined during the past 17 years, falling down the table by 2-6 places. Their lead positions are now occupied by oil and gas producing regions.

The average growth rates of real per capita GRP of Kazakhstan regions for the period of 1994-2009, displayed in Figure 2.5, vary significantly. For example, the indicator for the Kostanay oblast is 0.91% per year while in the Mangistau oblast it is equal to 23.45% per year. There are four regions with low average growth rates: Kostanay oblast at 0.91% per year; Akmola oblast at 2.05% per year; Zhambyl oblast at 3.2% per year; and East Kazakhstan oblast at 3.34% per year. At the same time, there are regions with very high average growth rates of per capita GRP: Mangistau oblast at 23.45% per year; Atyrau oblast at 16.99% per year; Astana city at 16.1% per year; Almaty city at 10.74% per year; Kyzyl-Orda oblast at 9.3% per year; West Kazakhstan oblast at 9.1% per year.

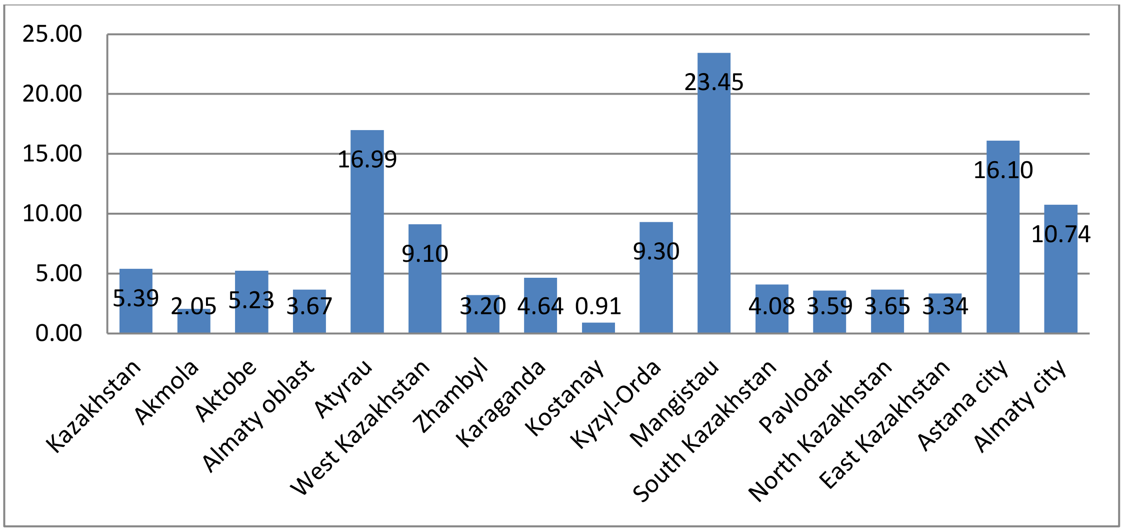

Figure 2.5: Average growth rates of real per capita GRP of Kazakhstan regions over 1994-2009 (% per year)

Source: Regions of Kazakhstan (1993-2009), author's calculation

2.5.2 Regional Differentiation of Poverty

Along with the considerable economic progress of Kazakhstan and, despite the distinctions in growth rates of GRP across regions of the country, the level of poverty decreased in all regions. During 2000-2010, the average poverty level was reduced by almost five times (Table 2.7).

However, poverty remains one of the most serious problems in Kazakhstan, especially in the rural regions. Despite a marked progress in poverty reduction, a considerable part of the population is on low incomes and can be categorised as part of the poor population. Therefore, in 2008, Kazakhstan pledged to reduce the amount of people living in the countryside with an income below living wage by half[1].

Regional differentiation of poverty tended to reduction (Table 2.7). For instance, in 2000, it made 12.4 times: 59.7% - in Mangistau oblast and 4.8% - in the city of Almaty. In 2010, the regional differentiation of poverty was reduced by 4.5 times: 11.6 % in Mangystau oblast and 2.6% in the city of Almaty. The reduction of poverty serves as additional proof that economic growth has had a positive impact on poverty levels, and not only in areas with high rates of growth.

Table 2.7: The share of population with incomes below living wage* (%)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Kazakhstan	31.8	28.4	24.2	19.8	16.1	9.8	18.2	12.7	12.1	8.2	6.5
Akmola	28.9	21	18.6	16.4	14	10.1	25.4	16.6	8.7	5.9	4.4
Aktobe	18.3	29.8	22.6	19	14.3	12.3	17.2	10.3	7	6.3	6
Almaty oblast	46.2	39.3	36.3	25.3	15.2	8.5	21.3	18.1	20.1	15.5	6.6
Atyrau	49.6	40.7	34.1	32.7	29.1	25	23.8	13	12.9	10	5.9
West Kazakhstan	12	27.3	28	17.1	14.4	9.5	13.2	10.3	10.2	8.2	6.7
Zhambyl	47.7	48.2	35.8	30	18.3	10.8	23.6	9.9	11.3	4.8	5.3
Karaganda	18.6	22.8	19.3	15.1	13.5	6.4	20.2	8.5	4.9	3.9	3.8
Kostanay	22.3	25.5	22.3	21	19	13.4	14	10.4	9	6.8	6.4
Kyzyl-Orda	51.6	39.5	32.3	27.1	26.5	16.3	37.5	24.6	24.3	10.4	6.7
Mangistau	59.7	45.9	39.8	26	21	13.6	26.5	26.9	32.4	22.6	11.6
South Kazakhstan	52.8	39.2	27.5	26.1	23	13.3	14.1	14.3	13	11.7	11.5
Pavlodar	14.9	16.6	21.6	17.1	14.5	4.7	12	8.3	8.8	6.2	4
North Kazakhstan	11.9	10	14.3	11.9	12	8.2	22.3	16	11	7.3	5.4
East Kazakhstan	15.4	21.1	20	16.9	14.9	8.2	12.5	9.8	9.9	6.6	8.4
Astana city	11.6	2.2	2.2	2.1	1.1	1.1	5.5	3.2	3.8	3.9	3.4
Almaty city	4.8	4.9	4.1	3.9	2.8	0.3	12.1	8.5	13.7	3	2.6

*Notes: *In 2006 a new design of calculation of poverty level was introduced.*
Source: AGENCY ON STATISTICS OF THE REPUBLIC OF KAZAKHSTAN, 2011. Monitoring of Incomes and Population Standard of Living in the Republic of Kazakhstan (Analitical Report). Astana.

In 2010, the group of regions with the least levels of poverty included the cities of Astana, Almaty and the oblasts of Karaganda, Pavlodar and Akmola (Table 2.8). The highest level of poverty was found in the East Kazakhstan, South Kazakhstan and Mangystau oblasts. In 2001,

[1] It should be mentioned that at calculation of the level of poverty of the population in the Republic of Kazakhstan according to the international recommendations, a correction factor is used. It corrects necessary levels of per capita incomes in various households by the size. In Kazakhstan, this indicator makes 0.8. The equivalence scale takes into account an economy of expenses of households due to the effect of joint residing of its members. Without using an equivalence scale in the estimation of the level of poverty its value can be overestimated.

this group also included areas of the southern part of Kazakhstan (Almaty, Kyzyl-Orda, and Zhambyl oblasts).

Other Kazakhstan oblasts are included among regions with an average level of poverty (the North Kazakhstan, Aktobe, West Kazakhstan, Kostanay oblasts). Such regions as Zhambyl, Almaty, Atyrau, and Kyzyl-Orda oblasts, which earlier were included in the group with high poverty levels now belong to the group with moderate poverty levels.

Surprisingly, the level of poverty is high in oil-rich oblasts. In 2010, Mangistau oblast had the highest level of poverty (11.6%), whilst at the same time, taking second place among the regions with the highest level of per capita GRP. Other oil-rich regions also have high levels of poverty: Aktobe (6%), Atyrau (5.9%), West Kazakhstan (6.7%), Kyzyl-Orda (6.7%). This would indicate that oil incomes do not go towards ameliorating social problems in these regions.

Table 2.8: Grouping of oblasts according to the poverty level in 2010

Level of poverty	The region's name
Low (2.6-4.4 %)	The cities of Astana and Almaty, Karaganda, Pavlodar and Akmola oblasts
Average (5.3-6.7 %)	Zhambyl, North Kazakhstan, Aktobe, Atyrau, Almaty, West Kazakhstan, Kostanay, and Kyzyl-Orda oblasts
High (8.4-11.6 %)	East Kazakhstan, South Kazakhstan and Mangystau oblasts

Source: AGENCY ON STATISTICS OF THE REPUBLIC OF KAZAKHSTAN, 2011. Monitoring of Incomes and Population Standard of Living in the Republic of Kazakhstan (Analitical Report). Astana.

Figures about distinctions in poverty levels classed by region can be supplemented by figures about distinctions classed by territorial location (city/village). Despite the considerable reduction in the scale of rural poverty (over the last 10 years its level was reduced by 5.9 times), this indicator from 2010 still remains high at 10.1% and exceeds urban poverty by almost three times (Table 2.9).

Table 2.9: The dynamics of city and rural poverty in Kazakhstan

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
The share of population with incomes below the living wage* , %										
Total	46,7	44,5	37,5	33,9	31,6	18,2	12,7	12,1	8,2	6,5
City	36,0	33,0	24,7	23,4	20,2	13,6	6,9	8,1	4,1	3,7
Rural	59,4	58,4	53,2	47,1	45,6	24,4	18,1	15,9	12,1	10,1
The share of population with incomes below the value of minimum food basket[1)], %										
Total	16,1	13,8	9,1	6,3	5,2	2,7	1,4	1,2	0,6	0,4
City	10,7	8,6	4,9	3,9	2,4	1,8	0,7	0,6	0,2	0,3
Rural	22,6	20,1	14,2	9,4	8,5	3,8	2,1	1,7	0,9	0,6

Notes: For the aim of comparison with the data for 2006, the new method of measuring the living wage, introduced since January, 1st, 2006, is followed for the data for 2001-2005.*

Source: AGENCY ON STATISTICS OF THE REPUBLIC OF KAZAKHSTAN, 2011. Monitoring of Incomes and Population Standard of Living in the Republic of Kazakhstan (Analitical Report). Astana.

The highest level of rural poverty in 2010 has remained in the Mangistau oblast at 21.2%, while as a whole across the area it measured 11.6%. In addition, rural poverty above the mean level of the country is registered in the areas of South Kazakhstan (13.3%), East Kazakhstan (12.8%), Atyrau (11.6%), Aktobe (11.1%), and Kostanay (10.6%). The level of rural poverty exceeds urban poverty by more than four times in Atyrau (9.7%), Pavlodar (6.6%), and Kostanay (4.1%) oblasts. The highest level of urban poverty in 2010 was found in South Kazakhstan at 8.5%. This, along with its high level of rural poverty, has earned South Kazakhstan second place in the group of regions with high levels of poverty. Again, high level of rural poverty are found in oil-rich regions such as the Mangistau, Atyrau, and Aktobe oblasts.

Rural poverty is caused or exacerbated by the following factors:

– The high number of children of rural families and subsequent high dependent loading;
– The migration of the population (especially youth) from the countryside to large cities (it is caused by a lack of prospects in employment, the low level of earnings, and the absence of access to vocational training schemes);
– The weak development of the private sector in the countryside, heightened by poor infrastructure and lack of access to markets and finance. Residents in these areas, for example, are frequently hindered from starting a business by the lack of mortgaging means to obtain loans and credits.

In order to obtain more information about the poor population, the indicators of the depth and sharpness of poverty are also used. The depth of poverty reflects the average size of the income of the poor population, measured against the population of the whole country. In Kazakhstan, from 2001 to 2010, the depth of poverty was reduced by 13.5 times and stands at 1.1 % (Table 2.10).

An additional characteristic of the depth of poverty is given by the indicator of its sharpness. It shows inequality among the poor population - the degree of dispersion of incomes of poor population from their average value. The poverty sharpness shows "how very poor the poorest person in society is," (Agency on Statistics of the Republic of Kazakhstan 2011, p.7) that is, it measures inequality among the poor population. Since 2001, poverty sharpness in Kazakhstan has been reduced by 21.7 times and stands at 0.3 % (Table 2.10).

The processes of stratification of society by income level and the degree of economic inequality of the population are determined by means of special coefficients of differentiation, which measure the ratio of income of the most and least provided groups of the population. One of them is the coefficient of funds representing a ratio of monetary incomes of 10% of the richest and 10% of the poorest population. From 2001 to 2010, it was reduced 1.5 times and stands at 5.7 (Table 2.10).

The coefficient of concentration of incomes (the Gini index) is another indicator of the inequality of the population according to income. The value of this indicator with the decile (10%) interval of income groups was reduced 1.2 times: from 0.339 (considerable inequality), to 0.278 (moderate inequality) (Table 2.10).

Table 2.10: Poverty indicators in Kazakhstan

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Depth of poverty, %	14.8	13.3	10.2	8.3	7.5	3.9	2.4	2.3	1.3	1.1
Sharpness of poverty, %	6.5	5.5	3.9	2.9	2.5	1.3	0.8	0.7	0.3	0.3
Funds coefficient, times	8.8	8.1	7.4	6.8	6.8	7.4	7.2	6.2	5.3	5.7
Gini index[1)] (by deciles)	0.339	0.328	0.315	0.305	0.304	0.312	0.309	0.288	0.267	0.278

Notes: [1)] The coefficient of concentration of income or the Gini index allows to estimate numerically the degree of inequality of the population by income. It establishes the degree of the deviation of an actual distribution of income by numerically equal groups of the population from the line of their uniform distribution. The statistical measure of equality of income fluctuates from 0 to 1, meaning at 0 - a perfect equality of incomes at all groups of the population, at 1 - a perfect inequality when all income belongs to one person

Source: AGENCY ON STATISTICS OF THE REPUBLIC OF KAZAKHSTAN, 2011. Monitoring of Incomes and Population Standard of Living in the Republic of Kazakhstan (Analitical Report). Astana..

2.6 The Territorial Arrangement of Kazakhstan

The distribution of economic potential of Kazakhstan developed during the Soviet period, now, does not fit the new situation of being an independent economic system. This causes the distortion of economic structures and remaining disintegration of internal economic spaces.

The active integration of Kazakhstan into the world economic system is restrained by the narrow specialization of the country in the world and regional division of labour. Remote from the world commodity market, its isolation is aggravated by under-developed transport and communication infrastructures.

The development of the economy in market conditions has revealed both competitive advantages and the lack of a cohesive economic system in the country, characterised by different means of adaptation to market competition. It has led to considerable recession in different regions and to the appearance of depressed areas and settlements. As a result, regional disproportions have increased, and now, despite natural migratory streams, a substantial part of the population of the country live in economically backward areas.

An earlier population settlement pattern does not correspond to the current spatial economic structure of the country. Some small cities and settlements established on the basis of mineral deposits that have been exhausted, or those remote from large development centres, have become depressed areas.

Of 60 small cities, ten can be included in this category. With respect to the potential of social and economic development, of 7512 rural settlements, 1204 (with a population of 1.8 million people) have high development potential, 5625 (5.2 million people) have average development potential, 595 (189.9 thousand people) have low development potential and 88 are not populated at all.

Coordination between the central and local executive bodies in the management of territorial development is poor. The issues of territorial planning are regulated by various authorities and are inefficiently coordinated at the central level.

Some factors inhibiting the steady territorial development of Kazakhstan include:

- the narrow, basically mineral, specialization of the country into a regional and world division of labour; transit dependence and economic isolation, and, accordingly, reinforcement of the inertness of the development of the country and its economic backwardness;
- the deindustrialization of considerable territory owing to low competitiveness and the eradication of traditional industries;
- the degradation of economic space due to the backwardness of the transport and communication network; the focus of many infrastructural projects on transit economy rather than the wider unity of economic space;
- competition with the adjacent states of the region in the formation of trade, economic, transport, and communication corridors, and with the big cities of adjacent states in the formation of regional centres of international integration;
- an outflow of the agricultural population to the cities and subsequent depopulation of rural territory;
- demographic pressure and unapproved migration from the adjacent states in the frontier regions of the country;
- the degradation of the living environment due to the deterioration of the ecological situation, strengthening the anthropogenic influence on nature and, as a result, reducing the territories favourable for residing and economic activities.

2.7 The Threat of Separatism in Kazakhstan.

As mentioned earlier, growing regional economic disparities risk the rise of regional separatism. Currently, there are two potentially dangerous sources of separatism in Kazakhstan.

The first is the separatism of the northern and eastern areas of the country (North Kazakhstan, Kokshetau, Pavlodar, East Kazakhstan oblasts), which are inhabited mostly by Russian-speaking people. The roots of this go back to the 19th century and are associated with the so-called "Siberian Separatism" and the name of G.N.Potanin (Niyazov 2009). These areas border upon Russia and have close economical, cultural, and kindred links with it. The influence of the Cossacks – a social estate, which goes back to the time of the Russian Empire, is significant in these oblasts. Separatist sentiments were especially vocal in the first years of independence, when some politicians called for separating these regions from Kazakhstan and joining Russia. With the growth of the Kazakhstan economy and the improvement of the welfare of citizens these sentiments have diminished, but have not disappeared altogether. They may increase again if living standards in these regions decline more than in other oblasts of the country.

Another potentially dangerous source of separatism is situated in the western oil and gas rich regions of the country, especially the Mangistau oblast. The Kazakhs of the Aday tribe predominantly inhabit this region. It is worth mentioning that this key tribe of the Junior Zhuz – a group of tribes of the ancient Kazakhs - initiated the split of the united Kazakh state, which allowed it to fall under the authority of the Russian Empire in the 18th century. Now, on the territory of the former Junior Zhuz, the sentiment to create an independent state away from Kazakhstan has reappeared with new energy. The statement that "… while Aday people feed the whole country, they starve themselves …" (Tynalin 2011), has some currency in this region. Underpinning such statements is the desire to control oil and gas resources independently from Astana. This type of separatism is called "separatism of riches" (Syroezhkin 2009). It resembles the movement that urges separating the northern part of Italy from the less developed southern part.

2.8 Regional Policy in Kazakhstan

The chief official documents that determine the regional policy of Kazakhstan are: 1) The Strategy 2030. Message of the President of the Country to the People of Kazakhstan (1997) ; 2) Strategy of Regional Development of the Republic of Kazakhstan until 2015, approved by the Decree of the President of the Republic of Kazakhstan No167 at 28.08.2006 ; 3) The State Program of the Forced Industrial Innovative Development in 2010-2014 approved by the Decree of the President of the Republic of Kazakhstan No958 at 19.03.2010 ; 4) The Prognostic Scheme of the Territorially Spatial Development of the Country until 2020 approved by the Decree of the President of the Republic of Kazakhstan No118 at 21.07.2011.

2.8.1 Aim and Objectives of the Regional Policy in Kazakhstan

According to these documents, the aim of regional policy in Kazakhstan is to create conditions conducive to the well-being of the population on the basis of the development and an effective utilisation of the social and economic potential of each region and economic branch of the country. The government regional policy of the Republic of Kazakhstan is directed at the formation of a rational system of the spatial territorial organization of the country, focused on the territorial concentration of people and capital in prospective areas and priority poles of growth, an intensive development of highly urbanized zones, entrepreneurial activity, maintenance of productive employment and a favourable life environment for the population.

The primary objectives of the regional policy of the country are (*The Prognostic Scheme of the Territorial Spatial Development of the Country until 2020*):

- the maintenance of the polarized development of the country by means of stimulation of territorial concentration of industrial and labour resources in the “growth points”, which are prosperous and economically viable areas;
- the stimulation and controlled development of the processes of urbanization and agglomeration for the foundation of innovative economy in big cities;
- the maintenance of innovative industrialization and diversification of the national economy and each region into priority spheres, the development of hi-tech branches and industrial clusters;
- the support of small and moderately-sized businesses in all regions of the country;
- the formation of competitive economic specialization of regions in the inter-regional and international division of labour;
- the utilization of the advantages of the transit situation of the country on the Eurasian continent and the formation of the axial system of spatial territorial development directed at the strengthening of internal coherence of the country;
- the formation of the perspective structure of functional zones of territorial development with the organization of recreational and industrial zones, and specially protected natural territories. The appropriate allocation of agricultural, forestry, and residential zones;
- to complement the prospective placement of the engineering infrastructure (transport, power and water delivery) with the delivery of productive forces and population settling;
- to introduce the mechanism of state-private partnership in all spheres, branches of economy, and at a regional level;
- the modelling of optimal rural settling;
- the development of human capital and the increase of the mobility of the labour force of the country;
- to formulate the optimal system of settling of the population and the placement of social institutions, directed to increase the inflow of youth in prospective regions and the maintenance of the equal access of the population to social services guaranteed by the state, especially in rural and the remote areas;
- optimization of the administrative territorial organization of the country with adherence to the principle of territorial integrity. The gradual reduction and integration of areas and settlements;
- an improvement of the ecological conditions of territories. The enhancement of the ecological safety of the population by the maintenance of rational nature management and the decrease of ecological load on the environment;
- the development of frontier territories and the creation of conditions for the strengthening of trade, economic, migratory, industrial, scientific, and cultural contacts;

- the protection of people and society. The creation of conditions for the decrease in risks and minimization of damage from anthropogenic failures, accidents and acts of nature by the development of the infrastructure of counteraction to seasonal high waters and flooding, mud flows, landslips, avalanches, fires and earthquakes on the territory of the country and its regions.

2.8.2 Basic Approaches to the Territorial Spatial Development of the Country

Territorial concentration.

For Kazakhstan, with its huge sparsely populated territory and poorly developed infrastructure, the concentration of manufacture and population has great value. As experience shows, the modernization effect is higher at population density of about 40-50 people per square km. Therefore, the territorial development of Kazakhstan should be concentrated in local territories, using them to include the country and its regions in the global economic processes. The transition to polarized development was declared as a main principle of the territorial policy of Kazakhstan. It was assumed that the formation of areas and poles of concentrated economic space would gradually achieve the reasonable economic density of the population there. The most dynamic of the developing cities and regions would integrate into the global and regional markets and become "locomotives" for the development of other regions of the country, acting as growth poles. In the long run, the purpose of polarized development is the diversification of an economy based on modern innovative industrial technologies.

Urbanization and the formation of agglomerations.

The new economy, which has important ramifications for development in large cities, became the bedrock for the territorial-spatial organization of the Republic of Kazakhstan. It assumes the formation and development of clusters, focused on hi-tech manufactures in priority branches of a national economy, with the concentration of such clusters in urbanized regions.

This was to be promoted by the support of agglomerations, in which the key resources of the territories were concentrated: financial, human, innovative, natural, ecological, and cultural. The formation of agglomerations is to become the key form of the territorial organization of Kazakhstan regions with its low population density. This was the tool to promote the growth of the economy and well-being of the population.

The development of agglomerations is associated with the further urbanization of the country (within 15-20 years the share of urban population is to reach 70%). However, actual rates of the formation of agglomerations depend on economic development and the availability of labour force in big cities and suburban territories. The main constraint on the development of agglomerations is the limitation of human resources, which are concentrated mainly in the south of the country.

Innovative development.

In order to increase the level of innovative activity in the country, it is necessary to create favourable economic, financial, fiscal, personnel and infrastructural conditions. An innovative leadership should also be expressed in administrative innovations, which are easier to achieve in cities and directed towards the implementation of foreign innovative technologies, knowledge and know-how. By 2020, it is hoped, Kazakhstan will obtain the features and attributes of the innovative-type state.

The new economy, together with the creation of high-tech industry, is associated with the development of trading systems and the formation of logistical centres for the processing of the streams of goods, finance and information.

Axial system of spatial development.

The first order strategic axes of the territorial development of the country occur in the following three directions.

The northern axis stretches along the cities of Ust-Kamenogorsk, Semey, Pavlodar, Astana, Kostanay (Kokshetau, Petropavlovsk), Aktobe, and Uralsk. It has an exit on the Caspian (Atyrau, Aktau) and Almaty (Taldykorgan, Dostyk) territorial economic systems. The entire perimeter of the axis borders on the frontier regions of the Russian Federation.

The southern axis starts from the border of the People's Republic of China (Dostyk, Horgos) and stretches along the cities of Taldykorgan, Almaty, Taraz, Shymkent, Kyzyl-Orda, Atyrau, and Aktau. The entire perimeter borders the frontier regions of the Central Asian states.

The central axis spreads along the cities of Astana, Karaganda, and Almaty with branches to Balkhash, Dostyk and an exit to China and Zhezkazgan. There is a prospective exit of this axis in the direction of seaports of Western Kazakhstan.

At present, of the three axes of the first order, only the Southern one carries out the function of integrating a rather densely populated territory. The realisation of the spatial effect of the two other axes is supposed to develop with creation of necessary economic preconditions.

At the same time, the formation of effective spatial organisation within the territory of Kazakhstan demands more contingency, to be supplied through the formation of additional planned axes (2nd and 3rd order), connecting the chief regions. The formation of the axial system of spatial development, as well as the formation of agglomerations, faces objective barriers from low population density and the rarefied network of cities.

Advancing development of an infrastructure.

For effective spatial territorial development, an increase in territorial integrity, and the realization of the transit potential of the country the development of national transport, power, telecommunications and other infrastructure has great value. On this issue, in particular, due importance can be given to the formation of the transport corridor «Western Europe - Western China». This international level project has considerable synergetic impact on the development of neighbouring regions from the development of small and average businesses, service industry, tourism, and other sectors of the regional economy.

Without the advancing development of all kinds of infrastructure, the realisation of new investment projects within the limits of the policy of industrial innovative development would be more complicated. The creation of a modern infrastructure is also essential to the mobility of the population.

The formation of competitive specializations and strategies of regions.

The creation of competitive specializations among the economies of the Kazakhstan regions is predicated on pre-existing economic specializations and their perceived comparative advantages in the international market-place. First, the pre-existing comparative advantages associated with large mineral resources and the plenitude of farm land for the cultivation of grain production needs to be understood.

Based on the analysis of the resources of the regions, outlining their economic potential and describing attendant problems, a specific strategy for the regions was defined.

The formation of agglomerations around the big cities, adequately provided by favourable living conditions, became the main direction of the further development of the system of the settling of population.

This approach, in line with the general policy of redefining cities as large economic centres, owing to economy of scale, allows for the optimization of budget expenses to create and develop living infrastructures, raises the quality of services given by the state to the population, and creates zones of organized urban environmental life.

The social and economic development of the country are to provide to the citizens an access to the social services, guaranteed by the state, employment possibilities, an achievement of certain standards of social infrastructure and quality of environment.

This is especially important for regions with an agricultural specialization, a senescent population and sparsely populated territories. Currently, some 2.2 million people live in remote areas of the country, and fall short of the three hour accessibility to basic social services guaranteed by the state.

In order to increase the base level of the provision of cultural and community services to the population of the peripheral territories, it is necessary to choose those regional centres to which a part of functions of inter-settlement cultural and community services should be transferred. In certain cases, the service of groups of administrative areas most remote from regional centres is maintained in the cities not being the regional or district centres. For this purpose, the town-planning specifications, regulating a provision of the population by socially significant services, is reconsidered, depending upon the role and status of the settlements in the regional system of settling.

2.9 Non-Market Sources of Convergence/Divergence Regarding Kazakhstan and Their Contribution to Income Regional Pattern.

In addition to the market convergence mechanisms that will be discussed in Chapter 3 and operate in all economies, there are a set of non-market mechanisms operating in the economy of Kazakhstan, which have direct impact on economic growth and convergence across regions of the country.

2.9.1 Alignment of budgetary provision of regions of Kazakhstan

The most important mechanism, which influences convergence/divergence behaviour of Kazakhstan regions, is alignment of budgetary provision of regions of Kazakhstan. Due to the non-uniform level of development of regions of Kazakhstan and their role in a national economy, they have essential distinctions at a size of taxable base, and, hence, various possibilities in formation of the income part of their budgets. Therefore, with the aim of alignment of budgetary provision of regions of Kazakhstan, the budgetary system includes a mechanism of budgetary alignment assuming redistribution of incomes among areas and between republican and regional budgets.

According to the Budgetary Code of the Republic of Kazakhstan, transfers of general character (subventions) and target transfers are entered in incomes of local budgets. On the one hand, under the excess of prognostic volume of incomes over prognostic volume of expenses of a local budget, budgetary withdrawals from the local budget to the higher budget are applied. On the other hand, under the excess of prognostic volume of expenses over prognostic volume of incomes of a local budget, budgetary subventions to the local budget from the higher budget are applied. In this way the budgetary system provides budgetary alignment of incomes of local budgets by granting transfers from the republican budget. This non-market mechanism promotes convergence across Kazakhstan regions.

However, the operating methodology of calculation of transfers of the general character does not allow regions to increase their own resources. A rule, according to which incomes exceeding prognostic volume of expenses of the local budget are withdrawn to the republican budget, has a negative consequence - restraint of the initiative of local authorities in expanding of own taxable base and increasing of taxes collection rate. This leads to the slowdown of economic growth of regions and the country as a whole (Kysykov 2012).

The chief problem of local budgets is a lack of own financial resources. The reasons of the reduction of a share of own incomes of local budgets are connected with changes in budgetary and tax legislations and specifications of distribution of taxes, dues and tariffs between the levels of budgetary system. Since only those tax revenues which have stable character (individual income, social and property taxes) are to be paid directly to local budgets, the local authorities are confined in their possibility to influence essentially on the formation of their own budgetary incomes (The Code of the Republic of Kazakhstan "On taxes and Other Compulsory Budget Charges"). The volume of the taxes arriving in local budgets, only indirectly depends on the degree of development of manufacture, business, investment activity, structural reorganisation of economy of regions. This circumstance explains the weakness of own sources of replenishment of the income part of local budgets and determines high degree of dependence of the majority of regions of the country on the financial aid from central government.

In 2010, a relative density of transfers has made 61.7 % of the republican budget, including subventions – 26.8 % from total amount of incomes of local budgets. Now, 13 out of 16 regions of the Republic of Kazakhstan are dependent on subventions from the republican budget, that is, they are not capable to solve problems of social and economic development of a territory at the expense of their own internal financial sources. Every year the given dependence only amplifies that reduces stimulus of local state structures to development of own taxable base.

Thus, this non-market mechanism of budget alignment has two opposite effects on the economy of the country. On the one hand, it directly promotes convergence across regions of the country by the redistribution of financial resources. On the other hand, it suppresses economic activity, hampers technical progress and economic growth in leading regions.

2.9.2 Special Economic Zones

Another important non-market mechanism which operates through the stimulation of technical progress in regions is the creation of special economic zones.

According to the Law of the Republic of Kazakhstan «On special economic zones in the Republic of Kazakhstan», a special economic zone (SEZ) is understood as a part of territory of the country with precisely designated borders in which a special legal regime zone operates aiming the realization of priority kinds of activity.

Now in the Republic of Kazakhstan nine special economic zones operate: "Astana - a New City" in the city of Astana; "Seaport Aktau" in Mangistau area; "Park of Information Technologies" in the city of Almaty; "Ontystik" in the South Kazakhstan area; "National

Industrial Petrochemical Technopark" in Atyrau area; "Burabai" in Akmola area; "Pavlodar" in the Pavlodar oblast; "Saryarka" in the Karaganda area; "Horgos - East Gate" in Almaty area. These special economic zones are to implement the following objectives: the activization of international economic relations; the accelerated development of a region, the support of branches of economy and the solution of social problems; the attraction of investments, technologies and modern management, the creation of highly effective and competitive manufactures. For the companies working in these SEZ the full exemption from corporate, land and property taxes and partial exemption from the added cost tax are provided. There are also additional tax privileges for participants of SEZ "Park of Information Technologies" and SEZ "Astana - a New City".

Special economic zones promote economic growth of respective regions due to the mobilisation of investments and acceleration of technical progress. As to the influence of SEZs on convergence issue, in general, when special economic zones are created in the backward areas aiming to promote their economic growth, they play positive role in convergence across regions of a country. However, in Kazakhstan, special economic zones are mainly created according to the sectoral principle, i:e. in order to develop a specific sector of the economy, namely: "Park of Information Technologies" in the city of Almaty - IT sector; "National Industrial Petrochemical Technopark" in Atyrau and "Pavlodar" in the Pavlodar oblast - chemical and petrochemical industry; "Saryarka" in Karaganda area – metallurgy; "Burabai" in Akmola area – tourism; "Ontystik" in the South Kazakhstan area – the light industry; "Horgos - East Gate" in Almaty area – transport and logistics. Only two out of nine SEZs were created according to the territorial principle, in order to promote economic development of respective areas. These are "Astana - a New City" in the city of Astana and "Seaport Aktau" in Mangistau area. Therefore, the role of special economic zones in convergence across Kazakhstan regions is unclear and demands special research, which is out of the scope of this thesis.

2.9.3 Investment preferences

The third non-market mechanism, which is also directed to the intensification of technical progress in regions, is investment preferences. The measures of the support of investment activities in Kazakhstan are determined by the Law “On Investments”. They refer to both domestic and foreign investors and include:

- exemption from the custom duties on import of equipment, accessories, raw materials and spare parts necessary for the implementation of investment projects;
- state natural grants in the form of lands, buildings, constructions, machinery and equipment, computer facilities, measuring and regulating devices, industrial and service equipment, vehicles, except for passenger cars;
- exemptions from land and property taxes in an order provided by the Tax Code;
- privileges for the legal bodies realizing strategic investment projects in settlements with

low level of social and economic development.

These preferences together with other measures of state support of investment activity caused substantial growth of the volume of investment in Kazakhstan (see Section 2.4.3). However, in spite of the wide range of investment privileges determined by the law, the majority of investment activities of foreign companies are still concentrated in mineral resource sectors. Since among the investment preferences are those directed to the development of backward regions, it is obvious that they should play a positive role in the convergence across Kazakhstan regions.

In studying conditional β-convergence across Kazakhstan regions (Chapter 5) we take into account an investment variable as a conditioning factor of convergence and discover its positive role in convergence process. In order to determine a role of investment preferences in convergence across Kazakhstan regions it is necessary to determine what part of the investments comes due to these privileges. This is rather complicated issue and demands special consideration in a future research.

2.9.4 The Fund of National Well-Being «Samruk - Kazyna» and Development Institutions.

Another important non-market mechanism influencing development of Kazakhstan economy is the Fund of National Well-Being "Samruk-Kazyna". It was created with the aim of the increase of competitiveness and stability of national economy and for the lessening of the influence of possible negative changes in world markets on the economic growth of the country by joining efforts of all state companies in various sectors of the economy and all state development institutions. 44 subsidiary and depended companies are included in the Fund. Together with affiliated organizations the total number of companies of the Fund has reached 404. The Fund includes large national companies such as KazMunaiGaz (oil and gaz), KazAtomProm (nuclear fuel), KazTransGaz (oil and gaz transportation), Kazakhstan Temir Zholy (railroads), KazPochta (post), KazakhTelecom (telecommunications), KEGOG (electricity) and others, which are the monopolistic producers in corresponding sectors of the economy. The key purpose of “Samruk-Kazyna” is to manage shares of national development institutions, national companies, and other legal entities in order to maximize their long-term value and competitiveness in the world markets.

At the first international investment forum Astana Invest – 2010, an operating director and the member of the executive board of the fund, Kairat Aitekenov said that "The authorized capital of the Fund has made more than 24.4 billion US dollars, that is comparable with the budget of the country, assets of the fund exceeded 71 billion US dollars that is 52% of GDP of Kazakhstan". The share of the added value of Fund's companies in Kazakhstan's GDP according to various estimates has made from 9 to 23%.

Within the fund several development institutions operate. These are financial institutions and social business corporations. The financial development institutions include:

– Bank of Development of Kazakhstan which is specializing on the financing of non-raw sectors of the economy of Kazakhstan;

– National Agency on Technological Development which is coordinating measures of the support of innovative activity in Kazakhstan;

– Fund of Development of Business "Damu" which was created for the assistance to the development of small and medium businesses;

– Investment Fund of Kazakhstan which assists in realisation of the industrial-innovative policy of the Republic of Kazakhstan.

A considerable role in acceleration of the diversification of the national economy and maintenance of the sustainable development of regions is played by social-business corporations (SBC), carrying out their activity in seven macro regions of Kazakhstan (SBK "Zhetisu", "Ontustik", "Caspian Sea", "Saryarka", "Batys", "Tobol", "Ertis"). Each corporation is a regional institution of development operating by the delivered state assets in a corresponding region of the country, including sites of not mastered lands and deposits. SBC are created in the status of national companies and play a role of generators of projects and attracting investment on their realisation. The social business corporations operate in following directions:

– assistance to the development of business activity in regions and increase of investment attractiveness of domestic commodity producers in the internal and external markets;

– development and implementation of investment projects of regional scale;

– development of competitive manufactures, on the basis of rehabilitation, re-structuring of unprofitable organisations;

– participation in realisation of regional agricultural projects;

– assistance in maintenance of the Kazakhstan content in a region's production structure through interaction with local producers of goods, works and services;

– development and implementation of various social projects.

Thus, the Fund of national well being "Samruk-Kazayna" and its development institutions play an important role in economic development of Kazakhstan regions. They accumulate financial resources and direct them to the development of infrastructure, small and medium business, competitive non-raw sectors and agriculture in regions of the country. However, due to the non-market nature of the fund and its institutions there are some problems of the effectiveness of investment projects and functioning of companies included in Samruk-Kazyna. In addition, such considerable presence of the state in the economy distorts free market competition and complicates functioning of other companies (Yarovoy 2011).

The role of the Fund "Samruk-Kazyna" and its development institutions in the convergence process across Kazakhstan regions is also twofold. On the one hand, such institutions as social-business corporations are specially designed for the promotion of regional economic development and convergence across regions. On the other hand, investments of large oil and gas companies of the Fund are directed mainly to oil rich regions that promote divergence across regions of the country.

Thus, the role of non-market mechanisms in convergence/divergence of Kazakhstan regions and their contribution to regional economic pattern is complicated and demands thorough investigation. However, in this thesis we plan to concentrate on market sources of convergence as a first slice at the problem and to leave non-market mechanisms for future research.

2.10 Summary

Kazakhstan passed through a difficult transition period in its development and succeeded in securing high growth rates in the economy and decreasing the poverty levels of its population. The exploitation of rich mineral resources, the appeal of foreign direct investments, and the stimulation of entrepreneurial activity were factors in the rapid economic growth of the country.

However, regional disparities in terms of both GRP and poverty levels accompanied economic growth. These disparities caused economic, social, and political problems for the authorities and may impede future development. They are partially recognised by the government, which attempts to overcome them by elaborating respective territorial arrangement and regional policy.

Nevertheless, there is a lack of in-depth analysis of the dynamics and causes of these disparities. The problem is a lack of understanding about the process of convergence across the regions, hampering the effectiveness of policy recommendations made by the Kazakhstan authorities. A careful examination of convergence requires rigorous statistical and econometric analysis.

CHAPTER 3.
LITERATURE REVIEW AND THEORETICAL ELABORATION

3.1 Convergence-Divergence Mechanisms and Growth Theory

The literature contains a number of different approaches to the problem of convergence and these can best be understood by starting with the mechanisms that underlie the process of convergence. De la Fuente (2002a, p.3) finds that contrasting predictions on convergence rest on "... the very basic assumptions about the properties of the production technology at a given point in time and about the dynamics of technological progress". These mechanisms determine convergence/divergence behaviour as follows.

1. The first mechanism of convergence across countries or regions is the existence of decreasing returns to scale on capital (this, in the broad sense, includes both physical and human capital). Decreasing returns on capital mean that income grows with decreasing rates as capital accumulates; that is, the marginal productivity of capital decreases with its accumulation. This reduces both the contribution to the growth of capital investments and the incentive to save. Therefore, growth tends to slow down over time. Countries with scarcer capital stock will grow faster than those with richer stock of capital because they enjoy larger returns from capital investments. An open economy assumption reinforces this result because the flows of mobile factors and international and/or inter-regional trade will further equalize the local product per worker and factor prices. If increasing returns to capital are assumed, then the opposite divergence process dominates. That is, rich countries or regions exhibit tendency to grow faster than poor economies and the disparity widens because the return on investments grows with the per worker capital stock.
2. The second factor determining the divergence or convergence tendency of income per capita or productivity level is a technological progress. The differences across countries or regions in the production or adoption of new technologies result in differences in long-term growth rates. As de la Fuente (2002a) points out, technical progress can be either a divergence or convergence factor. If a model assumes diminishing returns on technological capital, then the technical efficiency levels tend to equalize gradually. On the other hand, if scientific or production experiences reduce the cost of additional innovations, the cross-country distinctions in technological levels will persist in the long-term. Abramovitz (1986) points out another possibility of technical progress to be a convergence factor. According to him, less advanced countries profit by the international dimension of the public good properties of technological knowledge, absorbing foreign technologies and adapting them to their own production processes. Followers "... do not have to reinvent each wheel" (de la Fuente 2002a, p.4). Hence, they can grow faster than a technological leader because they do not have to find the

necessary expenses for the development of new technologies. This mechanism could considerably influence the convergence process, especially for industrialized countries capable of using the benefits gained from technological imitation.

3. In addition to the two main convergence mechanisms discussed above, de la Fuente (2002a) points out a third factor, which is of great practical importance, though less relevant in theoretical models. This factor acts through the reallocation of productive forces across various sectors of an economy; in other words, through structural change. Poor countries have more possibilities to reallocate the flow of resources out of such a low output sector as agriculture (because typically they have a relatively large agricultural sector) into manufacturing or service sectors, which give more returns on investments. This process has been observed over the past few decades in countries like China, Taiwan, India, and so on. An earlier example is the USSR with its special "Program of Industrialization" launched in 1929. As a result of this initiative, the former agricultural country turned into an industrialized power and moved to second place in the world (after the US) in industrial production. Over the period 1930-1940 the USSR had the highest growth rate in the world.

It can be argued, however, that the third mechanism is a particular case of the first one. For example, Islam (2003, p.347) says that "… Changes in the sectoral composition usually find reflection in changes in capital intensity, so that the latter may subsume the former." In addition, the majority of convergence studies are based upon one-sector models in which structural changes are impermissible. Therefore, in this research, we will take into account only two main mechanisms of convergence: capital deepening and technological diffusion.

It follows that, taking into account the two main above-mentioned factors or mechanisms responsible for producing of either divergence or convergence patterns, the growth models can be divided into three groups with various predictions of the time frame of the income disparities among countries and regions.

In the first group of models which predict convergence of per capita income levels or growth rates, either the first or second factor acts. The main representative of this group is the traditional neoclassical growth model (Solow 1956, 1957), where physical capital accumulation results in convergence. Some endogenous growth models holding the property of diminishing returns to capital (Rebelo 1991, King and Rebelo 1989, Jones and Manuelli 1990) also belong to this group. The convergence predictions of other endogenous models belonging to this group stem from the second convergence factor, namely technological progress. In these models, this factor acts either through the "catching up effect" (Nelson and Phelps 1966, Abramovitz 1986) or human capital convergence (Tamura 1991).

In the second group of growth theories neither first nor second factor acts. They predict the increase of per capita income disparities across economies that cause divergence in the long-term. This group includes some models of endogenous growth based upon the increasing or constant returns assumption and models which incorporate a hypothesis of the endogenous property of the rate of technological progress. Among the main representatives of the models belonging to this group are:

- AK models (Harrod 1939, Domar 1946, Frankel 1962), in which divergence follows from the constant returns to scale assumption;
- R&D models (Spence 1976, Dixit and Stiglitz 1977, Ethier 1982, Romer 1987, 1990a, Grossman and Helpman 1991, Aghion and Howitt 1992). In these models, divergence follows from the increasing returns property, which, in turn, follows from the accumulation of knowledge.
- Lucas model (Lucas 1988), in which divergence follows from increasing returns on human capital accumulation.

The third group of models predicts mixed convergence/divergence behaviour depending on the values of some parameters, which reflect the two main convergence factors described earlier. For example, the model of learning-by-doing (Romer 1986, Arrow 1962, Sheshinski 1967) predicts either convergence or divergence behaviour depending on whether or not the externalities from learning-by-doing are sufficient to offset the influence of diminishing returns. Another model with mixed predictions on the convergence / divergence issue is the model of De la Fuente (2002a). In this model, the values of such parameters as the rates of investment in physical or human capital, R&D investments, and the speed of technological diffusion determine whether convergence takes place.

Cavusoglu and Tebaldi (2006) surveyed the empirical literature on economic growth evidencing in favour of convergence hypothesis. They grouped the papers according to the testing model or the type of convergence they studied. The conclusion was that empirical literature provides support to the neoclassical models and the conditional convergence hypothesis. At the same time, they found that the convergence predictions of the basic endogenous growth theories are not empirically confirmed. In addition, endogenous growth models do not provide a rigorous mathematical framework for the testing of convergence hypothesis. Therefore, in this research, an empirical work rests mainly upon the neoclassical growth model.

In what follows, we provide a detailed discussion of this model. Other models from each of the above-mentioned groups are described in Appendix 2.

3.2 Neoclassical Growth Model and Notion of β-Convergence

There are three reasons for including a detailed mathematical description of the neoclassical growth model in this research:

(i) it is necessary to understand the theoretical mechanisms that underpin convergence processes to explain major economic growth disparities over time and across economies;

(ii) most convergence discussions have been conducted within the framework of the neoclassical growth model rather than the alternative endogenous growth models;

(iii) most of the empirical procedures to test various types of convergence, used in this thesis have been developed within the framework of the neoclassical growth model.

The neoclassical growth model belongs to the group of growth models, which predict convergence across states and regions due to the decreasing returns to capital accumulation. It was originally devised by Robert Solow, a US economist, in revolutionary works (Solow 1956, 1957) that made such an indelible contribution to the development of growth theory.

3.2.1 The Solow-Swan Model

In this study, we deal with the neoclassical model of Solow and Swan (Solow 1956, Swan 1956) because, on the one hand, it gives all the necessary theoretical material for the empirical study of convergence, and, on the other hand, it is sufficiently simple to understand and use.

This model assumes an exogenous technological progress and considers saving as constant and given exogenously. It should be noticed that Cass (1965) and Koopmans (1965), inspired by the work of Ramsey (1928), introduced the endogenous behaviour of the saving rate into the neoclassical model. However, this model is similar to the Solow-Swan model since it predicts convergence in terms of growth rates, which is conditional on an economy's steady state position determinants.

The idea of the aggregate production function lies at the core of the neoclassical growth model:

$$Y(t) = F(A(t), K(t), L(t))$$

where $Y(t)$ is the real output, $K(t)$ is the stock of capital, $L(t)$ is the stock of labour force, and $A(t)$ is the technology term.

A production function is called neoclassical if it satisfies the following three conditions (Barro and Sala-i-Martin 2003):

1) F exhibits positive and diminishing marginal products with respect to each input;

2) F exhibits constant returns to scale, i.e. it is a homogeneous function of degree one;

3) The marginal product of capital (or labour) approaches infinity as capital (or labour) goes to zero and approaches zero as capital (or labour) goes to infinity. The last property is termed Inada conditions.

According to the form that technical progress takes, it could be capital saving, labour saving or neutral. Each generates the same amount of output with relatively less corresponding input. The neutral option does not save relatively more of either input. In this thesis, we use the two popular definitions of neutral technological progress.

A technological innovation is called Hicks-neutral, after Hicks (1932), if, for a given capital/labour ratio, the ratio of marginal products remains constant. Hicks-neutral production function takes the following form:

$$Y(t) = A(t)F\big(K(t), L(t)\big), \quad \dot{A}(t) \geq 0$$

The Cobb-Douglas form of this production function, which satisfies the properties 1)-3), looks as follows:

$$Y(t) = A(t)K(t)^{\alpha}L(t)^{1-\alpha} \tag{1}$$

Here, α and $(1-\alpha)$ are the elasticities of capital and labour with respect to output $(0 < \alpha < 1)$.

The innovation is called Harrod-neutral, after Harrod (1942), if for a given capital/output ratio, the relative shares of inputs KF_K/LF_L remain unchanged. In this case, the production function can be written as:

$$Y(t) = F(K(t), L(t)A(t)), \quad \dot{A}(t) \geq 0 \tag{2}$$

This form is called labour augmenting technological progress because it promotes output growth at the same rate as the growth in the labour stock. The Cobb-Douglas form of the production function (2) can be rewritten as follows:

$$Y(t) = K(t)^{\alpha}(A(t)L(t))^{1-\alpha} \tag{3}$$

The neoclassical model with technical progress allows the possibility of a steady growth in output per worker in the long-term. Moreover, Barro and Sala-i-Martin (2003) present the proof of the result that only labour augmenting technological progress turns out to be compatible with the existence of the steady state (the steady state is by definition a situation when various quantities grow at a constant rate).

3.2.2 Absolute and Conditional Convergence

In order to study the convergence predictions of the Solow-Swan model with technological progress, Barro and Sala-i-Martin (2003) assumed that the production function includes labour-augmenting technological progress expressed in equation (2) where $A(t)$ grows at the constant rate x:

$$A(t) = A_0 e^{xt} \tag{4}$$

They introduce the variables: $\hat{L} = LA(t)$, which is called the effective amount of labour in the steady state, and $\hat{k} \equiv \frac{k}{A(t)} = \frac{K}{LA(t)} = \frac{K}{\hat{L}}$, which is the amount of capital per unit of effective labour (p.35). The production function then takes the following intensive form:

$$\hat{y} \equiv \frac{Y}{LA(t)} = F(\hat{k}, 1) \equiv f(\hat{k}) \tag{5}$$

It turns out that the growth rate of $\hat{k}$ denoted as $\gamma_{\hat{k}}$ is a decreasing function of $\hat{k}$ and satisfies the equation:

$$\gamma_{\hat{k}} = \frac{sf(\hat{k})}{\hat{k}} - (x + n + \delta) \tag{6}$$

Where s is a saving rate, n is a growth rate of population, δ is a capital depreciation rate (Barro and Sala-i-Martin 2003). That is, larger values of $\gamma_{\hat{k}}$ correspond to smaller values of $\hat{k}$.

From the economic point of view this means that for a group of structurally similar closed economies those with lower values of $\hat{k}(0)$ and $\hat{y}(0)$, i.e. initially less developed, have higher rates of growth of $\hat{k}$, and consequently higher rates of growth of $\hat{y}$. “Structurally similar” means that these economies have the same values of saving rate, population growth rate, rate of capital depreciation, and also the same production function $f(\dots)$.

Here the notion of absolute or unconditional convergence arises. “The hypothesis that poor economies tend to grow faster than rich ones – without conditioning on any other characteristics of economies – is referred to as *absolute (or unconditional) convergence*” (Barro and Sala-i-Martin 2003, p.26).

Equation (6) can be rewritten in the form:

$$\gamma_{\hat{k}} = (x + n + \delta)[\frac{f(\hat{k})/\hat{k}}{f(\hat{k}^*)/\hat{k}^*} - 1] \tag{7}$$

where $\hat{k}^*$ is the value of $\hat{k}$ corresponding to the steady state position.

Equation (7) implies that for given $\hat{k}^*$ the reduction in $\hat{k}$, which raises the $\frac{f(\hat{k})}{\hat{k}}$, increases the value of $\gamma_{\hat{k}}$. However, a lower $\hat{k}$ corresponds to a higher $\gamma_{\hat{k}}$ only if $\hat{k}$ decreases with respect to the steady-state value $\hat{k}^*$.

This means that the neoclassical model predicts convergence in the sense that “… an economy converges to its own steady state, and the speed of this convergence relates inversely to the distance from the steady state” (p.29).

Thus, if the supposition of the same parameters across all economies is dropped, then the heterogeneity across economies is allowed and a concept of *conditional convergence* appears (Barro and Sala-i-Martin 1992a). The main idea of the notion of conditional convergence is that the further an economy is from its own steady state position the higher its rate of growth. In other words, conditional convergence follows from the model in the sense that if the steady state determinants are being controlled, a higher rate of growth of real per capita income is generated by its lower starting value. Specifically, $\frac{f(\hat{k})}{\hat{k}}$ should be high with respect to the steady-state value, $\frac{f(\hat{k}^*)}{\hat{k}^*}$.

If the steady-state value, $\hat{k}^*$, of a poor economy is as low as its current value, $\hat{k}$, then it will not have high growth rate. That is, the neoclassical model allows that the poor economy can have lower growth rates than the rich one, perhaps because of bad government policies, or poor infrastructure, or chronically low growth rates that decrease the production function level.

As the steady state value, $\hat{k}^*$, depends on the rate of saving, s, and other conditions which influence the level and the structure of the production function, the model assumes that these determinants of $\hat{k}^*$ should be held fixed to uncover the predicted inverse dependence between initial positions and growth rates. For a set of comparatively similar economies, such as the regions of the same country, the steady-state position differences may be small, and the absolute convergence pattern would be observed. For a heterogeneous broad group of economies, however, the differences in the steady-state positions will be large.

According to Islam (2003, p.314), "... from a conceptual point of view, the most important distinction is probably between conditional and unconditional convergence." This could be illustrated by an example with a possible policy of alignment of regional development. If in a sample, a rather high absolute convergence is observed, then there is no necessity for carrying out a regional policy, as the convergence process occurs by itself. The only necessary measures would become the actions for the smoothing of short-term fluctuations, because convergence by itself is a long-term process. In a case of slow absolute convergence, the policy of the government should be directed to the acceleration of the process, by elimination of initial distinctions in incomes per capita. In a case of conditional convergence, when regional disparities (considered by the government as undesirable) can exist for infinitely long, measures directed at smoothing of long-term regional development are necessary. These measures should have long-term character and influence fundamental factors of the economic development of regions.

3.2.3 Notion of β-Convergence and Speed of Convergence

According to Barro and Sala-i-Martin (2003, pp.36,53), a log-linear approximation of equation (6) rewritten for the Cobb-Douglas case (3) in the neighbourhood of the steady state takes the form:

$$\gamma_{\hat{k}} = \frac{d\log\hat{k}}{dt} \cong -\beta\log\frac{\hat{k}}{\hat{k}^*} \tag{8}$$

where

$$\beta = (1-\alpha)(x+n+\delta) \tag{9}$$

The coefficient β determines the speed of convergence from $\hat{k}$ to $\hat{k}^*$. It gave the common name β*-convergence* to both above-mentioned terms of absolute and conditional convergence (Barro and Sala-i-Martin 1990). This type of convergence takes place if $\beta > 0$.

Barro and Sala-i-Martin (2003, p.37) show that the growth rate of $\hat{y}$ satisfies the equation:

$$\gamma_{\hat{y}} \cong -(1-\alpha)(x+n+\delta)\log\frac{\hat{y}}{\hat{y}^*} = -\beta\log\frac{\hat{y}}{\hat{y}^*} \tag{10}$$

This equation is similar to equation (8). The convergence coefficient β for $\hat{y}$ is the same as that for $\hat{k}$ and indicates the speed at which an output of an economy per effective worker, $\hat{y}$, reaches its steady state value, $\hat{y}^*$, which, in the case of Cobb-Douglas type production function (3), is given by the following equation:

$$\hat{y}^* = A_0 e^{xt}\left[\frac{s}{x+n+\delta}\right]^{\frac{\alpha}{1-\alpha}} \tag{11}$$

(Mankiw, Romer and Weil 1992, Barro and Sala-i-Martin 1995, 2003).

For example, the value $\beta = 0.05$ means that the gap between $\hat{y}$ and $\hat{y}^*$ vanishes at the rate of five per cent per year. The time required for half of the initial gap to be closed is called the half-life of convergence. It can be computed from equation (10), which is a differential equation in $\log\hat{y}(t)$ with the solution:

$$\log\hat{y}(t) = (1-e^{-\beta t})\log\hat{y}^* + e^{-\beta t}\log\hat{y}(0) \tag{12}$$

The time t for which $\log\hat{y}(t)$ is halfway between $\log\hat{y}(0)$ and $\log\hat{y}^*$ satisfies the condition $e^{-\beta t} = \frac{1}{2}$. Hence, $t_{\frac{1}{2}} = \frac{ln2}{\beta}$. If $\beta = 0.05$, then the half-life is equal approximately to 14 years.

Barro and Sala-i-Martin (2003, p.37) point out two properties of the convergence coefficient $\beta = (1-\alpha)(x+n+\delta)$.

The first is that the convergence speed β is independent of the saving rate, s. This property reflects two mutually neutralizing forces that cancel exactly each other in the Cobb-Douglas case. On the one hand, given $\hat{k}$, induces greater investment and, hence, a higher convergence speed. On the other hand, a higher rate of saving leads to the higher capital intensity in the steady state position, $\hat{k}^*$, and consequently the lower capital average product in the neighbourhood of the steady state and lower speed of convergence.

The second property is that the convergence coefficient, β, is independent of the level of technology, $A(t)$. Similar to the case with saving rate, s, distinctions in $A(t)$ have two mutually neutralizing impacts on the speed of convergence, which are fully cancelled in the Cobb-Douglas case.

Barro and Sala-i-Martin (2003, p.37) assume benchmark values $x = 0.02$, $n = 0.01$, and $\delta = 0.05$ per year, which are reasonable for the US economy.

According to equation (9), for given parameters x, n, and δ, the capital-share parameter α determines the speed of convergence β. If a narrow concept of physical capital is used, a conventional value of α is about one third (Denison 1962, Maddison 1982, Jorgenson, Gollop and Fraumeni 1987). If $\alpha = \frac{1}{3}$, then equation (9) implies $\beta = 5.6$ percent per year, and the half-life of 12.5 years. These are relatively short transitions, which are too high to conform to the empirical evidence. Barro and Sala-i-Martin (2003, Ch.11-12) show that the range from 1.5 to 3.0 percent per year of the convergence coefficient β better fits the data. To conform to the observed approximate convergence rate of 2% per year the neoclassical model needs the value $\alpha = 0.75$. This share is reasonable for a broader notion of capital that includes both physical and human capital. The model with these two types of capital is called an augmented neoclassical model and will be described in the next section (Mankiw, Romer and Weil 1992).

Islam (2003) rewrote equation (12) taking the time interval $[t_1, t_2]$ instead of $[0, t]$ and substituting $\hat{y}^*$ from equation (11) and obtained the neoclassical growth – convergence equation of the type:

$$\log \hat{y}(t_2) - \log \hat{y}(t_1) = \left(1 - e^{-\beta t}\right)\frac{\alpha}{1-\alpha}\log(s_{t_1}) - \left(1 - e^{-\beta t}\right)\frac{\alpha}{1-\alpha}\log\left(n_{t_1} + x + \delta\right) - \left(1 - e^{-\beta t}\right)\log \hat{y}(t_1) \quad (13)$$

where t_1, t_2 are the time moments, $\tau = t_2 - t_1$; β is the speed of convergence determined by equation (9) and is considered to be the speed at which an economy moves to steady state level. This equation will be used later when we will discuss convergence study methodologies.

3.2.4 Empirics of β-convergence

The hypothesis of absolute or unconditional β-convergence receives mixed confirmations in the literature. There are several stylized empirical facts concerning unconditional β-convergence.

The first fact is, if a broad range of countries is considered, no absolute convergence across them is observed. Such examples can be found in (Baumol 1986) – for 72 countries for the period of 1950-1980 and (Barro and Sala-i-Martin 1992a) - for 98 countries for the period of 1960-1985.

The second fact is, if the consideration is focused on the groups of countries with similar economic characteristics, then there is a negative dependence of the rate of growth of the real per capita GDP on the level of the logarithm of this variable at the initial time point that confirms the hypothesis of unconditional β-convergence. Barro and Sala-i-Martin (1992a) found that if the consideration is limited to the 20 original OECD countries, then the correlation coefficient between the 1960 logarithm of the real per capita GDP and the average rate of growth of the real GDP per capita over the period of 1960-1985 is negative. In other words, the absolute convergence takes place across this sample.

As to the absolute convergence across the regions of the same country, the stylized fact in the literature is that regions of developed countries tend to demonstrate unconditional β-convergence behaviour. The main argument for this is that the differences in institutions, preferences, and technology among regions of the same country are certainly much smaller than among countries. This is because households and firms of various regions of a country share a common government, legal system, and institutional setup. In addition, they have similar traditions and culture and access to similar technologies. Another factor leading to the absolute convergence across regions is that inputs are more mobile across regions than across countries. Labour force and capital can move from one region to another much easier than among countries. Barro and Sala-i-Martin (1991) studying convergence across 73 Western Europe regions since 1950 found that these regions do demonstrate absolute convergence expressed in negative dependence between the average rate of growth of GDP per capita and the logarithm[1] of it at the initial year of the period. Barro and Sala-i-Martin (1992a) observe absolute convergence across the US states over the period of 1880-1988 with the convergence speed of about 2% per year. Barro and Sala-i-Martin (1992b) test the β-convergence pattern in terms of per capita income across 47 prefectures of Japan over the period of 1930-1990. They discovered that the average rate of growth of prefectural per capita income over 1930-1990 is negatively correlated with the logarithm of income per capita in 1930. In other words, absolute

[1] The use of logarithms of income or output per worker instead of functions per se is usual practice in convergence research because, on the one hand, it linearizes production function and, on the other hand, it does not distort results when the growth rate – initial level dependence is studied.

convergence exists across Japanese prefectures. The convergence speed is estimated to be about 2.8% per year.

However, several authors observed the opposite behaviour of the regions of some transition economies. For example Skryzhevska (2008) and Iodchin (2007) report of absolute β-divergence among regions of the Ukraine and Russia respectively. Petrakos (2001) studies convergence across regions of four former socialist countries of Poland, Hungary, Romania and Bulgaria and discovers that these countries also demonstrate absolute β-divergence. The explanation of this fact comes from the "... socialist regional policy of equality that was dominant during the Soviet time" (Skryzhevska 2008, p.3). This policy aimed to reduce economic disparities across regions, sometimes to the detriment of economic efficiency. Although the goal of this policy was not realized during the Soviet period, the cessation of the efforts in this direction due to the breaking up of the socialist system has led to the increase of regional inequality in these countries.

3.2.5 Augmented Neoclassical Growth Model

Mankiw, Romer and Weil (1992) argue that although "...the Solow model correctly predicts the directions of the effects of saving and population growth, it does not correctly predict the magnitudes" (p.408). They augmented the Solow model by incorporating an explicit process of human capital accumulation into the neoclassical growth model. Their convergence equation relates the growth rate of output to investment rates for both human and physical capital. In this model, the human capital is included into the base neoclassical exogenous growth model as a production factor similar to physical capital and labour.

The notion of human capital is an important and complicated issue per se. However, the focus of this thesis is not human capital but convergence. Therefore, we provide a review of various definitions of human capital, approaches to its measurement, the comparison between human and physical capital, and the role of human capital in economic growth in Appendix 3.

The production function with the Harrod neutral technological progress takes the form:

$$Y = K^{\alpha} H^{\beta} (AL)^{1-\alpha-\beta} \tag{14}$$

where Y is an output, K is physical capital, H is human capital, L is labour force, A is the level of technology, α and β are the parameters of the production function, $\alpha, \beta > 0;\ \alpha + \beta < 1$.

Similar to the Solow-Swan model, a part of the output is invested in the expansion of physical and human capital: $\dot{K} = s_K Y,\ \dot{H} = s_H Y$, where s_K, s_H are the saving rates of physical and human capital respectively. Note that in this variant of the model there is no amortization of both physical and human capital. Growth rates of technical progress and population are constant and given exogenously: $\dot{A} = g_A A,\ \dot{L} = nL$.

The division of both sides of (14) by the AL gives an intensive form of the production function:

$$y = k^{\alpha} h^{\beta} \tag{15}$$

where $k = \frac{K}{AL}$ is the physical capital endowment of an effective unit of labour, $h = \frac{H}{AL}$ is the human capital endowment of an effective unit of labour, $y = \frac{Y}{AL}$ is an output per worker.

The model has a steady state under the following conditions:

- growth rates of intensive variables per effective labour unit are equal to 0 : $g_y = g_k = g_h = g_c = 0$, where c is per capita consumption;
- growth rates of per capita variables are equal to the exogenous growth rate of technical progress: $g_{\frac{Y}{L}} = g_{\frac{K}{L}} = g_{\frac{H}{L}} = g_{\frac{C}{L}} = g_A$, where C is consumption;
- gross values of variables increase in the rates equal to the sum of growth rates of population and technical progress: $g_Y = g_K = g_H = g_C = g_A + n$;

The growth rate of wage is equal to the growth rate of technical progress; marginal products are constant in a steady state. Steady state level of per capita output is determined by saving rates of physical and human capital, technical progress and population growth.

$$\ln \frac{Y^*}{L} = \ln A - \frac{\alpha + \beta}{1 - \alpha - \beta} \ln(n + g_A) + \frac{\alpha}{1 - \alpha - \beta} \ln S_K + \frac{\beta}{1 - \alpha - \beta} \ln S_H$$

Elasticity of the output on the saving rate of physical capital, with $\alpha = \frac{1}{3}, \beta = \frac{1}{3}$ is equal to 1. This fact is more consistent with empirical data than the Solow - Swan model is. As authors of the model point out, there are two reasons for this.

Firstly, a higher rate of saving and a lower growth rate of the population; given other equal conditions, correspond to a higher income level that causes higher level and saving of human capital.

Secondly, the accumulation of human capital can correlate with saving rate and population growth rate, which increase their role in the level of per capita income.

Thus, the model of Mankiw, Romer and Weil (1992) ascribes to human capital a significant role in the production process. However, in this model, following the neoclassical tradition, human capital obeys the law of diminishing returns inconsistent with what is observed in the literature.

As to the convergence issue, the augmented Solow model expressed by equation (14), in which human capital enters as a production factor, predicts that economies with similar determinants of steady state converge in terms of income per capita yet with a lower rate of convergence than the textbook Solow model implies.

3.2.6 Convergence and Human Capital

The studies on the influence of human capital on convergence began with Barro (1991). Together with the initial income variable, he includes human capital in growth regression equations and finds it an important conditioning factor. He states that "... for a given starting value of per capita GDP, a country's subsequent growth rate is positively related to initial human capital" approximated by school-enrolment rates. "Moreover, given the human capital variables, subsequent growth is substantially negatively related to the initial level of per capita GDP" (p.409).

There are many empirical works, which use the augmented neoclassical model with human capital for studying convergence. For example, Holtz-Eakin (1992) studied conditional convergence across the US states emphasizing the possible disparities in steady states even among the regions of a country. He uses an augmented version of the neoclassical convergence equation derived from the model of Mankiw, Romer and Weil (1992), which includes human capital stock as a production factor. Including variables that approximate the determinants of steady state and implementing a variant of pooled regression, he obtains an estimate of the conditional convergence rate at about four per cent per year.

Soukiazis and Cravo (2008), in the framework of the model of Mankiw, Romer and Weil (1992), use new proxies of human capital such as publications and patents ratio and the patent/articles ratio to examine the convergence process across countries with human capital as a conditioning factor. Their results show that these proxies of human capital control the different steady states among economies well enough. In addition, they show that different levels of human capital affect countries differently, according to their levels of economic development. Convergence is conditional on different human capital levels. Namely, higher levels of human capital, approximated by the patent ratio or the patent / publication ratio, control better the convergence process among most advanced OECD countries, while lower levels of human capital, expressed by the average years of schooling, explain better the convergence process among less developed countries.

Henderson and Russel (2005) incorporate human capital into Kumar and Russel (2002) analysis of international macroeconomic convergence using nonparametric production–frontier methods. Among other conclusions, they found that "... about one-third of the increase in mean productivity … was, in fact, the result of the accumulation of human capital" (p.1170).

O'Neill (1995) examines the contribution to changes in income dispersion of each of three components of national income: one due to education levels; one reflecting the return to education; and a residual component. He concludes that while convergence in education levels among the developed countries results in a reduction in income dispersion, income levels across the world as a whole over the period 1967-1985 have diverged, despite substantial convergence in education levels. The reason for this lies in an increase in the return to education due to the recent shift in production techniques towards high-skilled labour. This tendency, when combined with the large differences that still exist in education levels between the developed and less developed countries, has led to income divergence, despite the significant reduction in the education gap over the period. This is an explanation why a growth factor such as human capital influences developing and developed economies in different ways.

A similar point of view is expressed by Manuelli and Seshadri (2005), who find that an accumulation of production factors, including human capital, is more valid than TFP when taking into account the large differences in per capita output. Measuring human capital, they take into account its quality and show that it plays a decisive role in determining the wealth of economies. The approach they used implies that the quality of human capital differs considerably across countries according to level of development. This leads to large distinctions in human capital stocks that in turn lead to differences in output per capita.

3.3 Other Concepts of Convergence

In addition to the notion of β-convergence considered above, there are other notions of convergence used in the literature, which consider different aspects of the problem of the relative behaviour of regional economies.

3.3.1 σ −Convergence.

While, the notion of β-convergence naturally follows from the neoclassical growth model, another type of convergence, namely σ-convergence, is not related ingenuously to any growth model. According to the view of some authors (Friedman 1992, Quah 1993, and others), the convergence should be tested directly by studying the dynamics of the dispersion of the growth rate and/or income level across economies, instead of indirect testing through the sign of the initial income variable in the regression equation. This approach to test the behaviour of across-economy disparities is closest to the intuitive notion of convergence. If it is studied in these terms, then the concept of σ-convergence appears, where σ is an indication of standard deviation of the cross-sectional distribution of either growth rate or income level (Barro and Sala-i-Martin 1990, 1992a). When the dispersion of output levels or growth rates diminishes over time, then the process of σ-convergence takes place, and vice versa, when the dispersion grows over time the process of σ-divergence takes place.

However, some authors (Iodchin 2007) consider a wider definition of σ-convergence as a decrease in the time of the socio-economic differences across countries or regions. This gives flexibility in that both a large set of indicators of social and economic development of the regions, and their various numerical characteristics, including statistical measurements of inequality, can be used for the analysis of σ-convergence.

As variables for studying σ-convergence, any social and economic indicators, usually used for the estimation of the development of a country or region, could be taken, including GRP or GDP, incomes and expenses of households, investments, levels of poverty, unemployment, crime, etc. The differences of these indicators across regions depend on what statistics are used to measure them. These could be dispersion, standard deviation, coefficient of variation, coefficients of concentration, skewness and kurtosis. The first three statistics represent the indicators of differentiation, which describe the spread of observations from an average. The fourth group describes the concentration of observations and includes the Gini index, quintile and decile coefficients, indexes of entropy. The fifth and sixth statistics show the degrees of deviation in a sampling distribution.

Besides, for the analysis of the dynamics of differentiation it is possible to use such simple descriptive statistics as the ratio of minimum and maximum values or their ratio to an average. It should be noted that these characteristics do not reflect the real spread of regions, but show only the amplitude of fluctuations, i.e. they do not concern differentiation.

In this thesis we will use standard deviation and coefficient of variation as measures of differentiation. Both these variables are based on the dispersion, which being the second central moment shows the spread of an indicator around an average:

$$D(X) = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2$$

The standard deviation is a square root of the dispersion:

$$\sigma(X) = \sqrt{D(X)} \tag{16}$$

It has the same dimension as a considered variable. The coefficient of variation is calculated based on the standard deviation and has no dimension. That is, it possesses similar informativity allowing to compare different indicators. In the simplest case the variation coefficient is the ratio of the standard deviation $\sigma(X)$ to the mean $\mu(X)$:

$$C_v = \frac{\sigma(X)}{\mu(X)} \tag{17}$$

The variation coefficient has an essential advantage with respect to the dispersion and standard deviation, which are of limited use in the analysis of differentiation. Their drawback is the presence of dimension and dependence on a scale that does not allow comparison of indicators having different units of measure.

A simple example demonstrates this. Let us say, at the initial time moment, that the GRP of two regions be one and two; the rates of economic growth of these regions throughout N years to be equal, and their GRPs have grown by 10 times. It would be logical to assume that the difference between the two regions has not changed. However, if we use such indicator as a standard deviation, at the initial moment of time it is equal to 0.5, while at the final moment of time it is equal to five. Hence, in spite of the fact that one region remained twice as poor as the other, the growth of differentiation has been 10 times. However, on the application of the coefficient of variation such paradox does not arise. It is the same at both the beginning and the end of the period because it has no dimension (Iodchin 2007).

The empirics of σ-convergence is similar to the empirics of absolute β-convergence in that usually σ-convergence is observed across regions of developed countries (Barro and Sala-i-Martin 1991, 1992a, 2003), while regions of transition countries tend to demonstrate σ-divergence (Petrakos 2001, Iodchin 2007, Skryzhevska 2008, Shiltcin 2010).

3.3.2 Interrelation between β and σ Convergence

In spite of the fact that the notion of σ-convergence is not related directly to any growth model, it is related to the notion of β-convergence as follows.

It is obvious that β-convergence is a necessary condition for the σ-convergence because the disparities of initial income will grow boundlessly if the rich grows faster than the poor, i.e. if there is a β-divergence. However, Barro and Sala-i-Martin (2003) show that even if a group of economies demonstrates unconditional β-convergence, the dispersion of income per capita does not necessarily tend to decrease over time: that is, β-convergence is not a sufficient condition for the σ-convergence. The details are as follows.

Under the assumption that absolute convergence takes place for a sample of economies, $i = 1, \dots, N$, the behaviour of the real per capita output of an economy i can be described according to equation (13) rewritten in the following form:

$$\log \frac{y_{it}}{y_{i,t-1}} = a - b \log y_{i,t-1} + u_{it} \qquad (18)$$

Where a and b are constants, and $0 < b < 1$. The condition $b > 0$ suggests absolute convergence because the relation between $\log y_{i,t-1}$ and the annual growth rate $\log \frac{y_{it}}{y_{i,t-1}}$ is negative. A higher coefficient b means a faster convergence. Here, u_{it} is a disturbance term, which includes short-term shocks of the saving rate, a growth rate of population, the production function, and other determinants of the steady state. It is assumed that u_{it} has zero average and the identical variance σ_u^2 for all economies.

It is possible to rewrite equation (18) in the following form: $\log y_{it} = a + (1 - b) \log y_{i,t-1} + u_{it}$, from which the overtime behaviour of the dispersion of income per capita $D_t =$

$\frac{1}{N}\sum_{i=1}^{N}[\log\ y_{it} - \mu_t]^2$ can be derived assuming the existence of a large number of observations and a sample dispersion could serve as a measure of the dispersion.

$$D_t \approx (1-b)^2 D_{t-1} + \sigma_u^2$$

This first-order difference equation for dispersion has a steady state given by $D^* = \frac{\sigma_u^2}{1-(1-b)^2}$. Hence the dispersion corresponding to the steady state diminishes with b, and grows with the disturbance term variance σ_u^2.

The evolution of D_t can be expressed as

$$D_t = D^* + (1-b)^2(D_{t-1} - D^*) = D^* + (1-b)^{2t}(D_0 - D^*) \quad (19)$$

where D_0 is the dispersion at time 0.

Since $0 < b < 1$, equation (19) implies that D_t can monotonically either diminish or grow to D^* with the time. The behaviour of D_t depends on the sign of $(D_0 - D^*)$ that is whether the initial variance D_0 is greater or smaller than the variance corresponding to the steady state, D^*. Hence, the β-convergence is not a sufficient condition for σ-convergence.

The next section describes another concept of convergence, namely TFP convergence, which is widely used in the literature.

3.3.3 TFP-Convergence

The study of convergence across Kazakhstan regions would be incomplete if the issue of total factor productivity (TFP) convergence was not also taken into consideration because the TFP serves as a well established measure of the level of technology. As mentioned above, convergence in terms of levels and/or growth rate of income or output can be a consequence of the twofold process of technological catch-up and capital accumulation. Therefore, the convergence study can focus either on the parameters of the processes of capital deepening or technological catch-up (Dowrick and Nguyen 1989, Wolff 1991, Dollar and Wolff 1994, Dougherty and Jorgenson 1996, 1997, and others). As the level of technology is usually approximated by total factor productivity (TFP), the studies of these researchers have been focused on whether or not the TFP levels of countries have come closer.

Recent literature clearly shows how misleading an assumption of homogeneity of technological level is. Many authors indicate that most cross-country disparities in income per capita levels follow from disparities in TFP levels, but not from differences in factor accumulation (Klenow and Rodriquez-Clare 1997 2, Hall and Jones 1999, Lucas 2000, Easterly and Levine 2001, and others). Even in closely related areas and regions of a single country, considerable disparities in TFP have been identified (Boldrin and Canova 2001, de la Fuente 2002b). Therefore, an important question in the convergence debate is whether these disparities in TFP are persistent or not. Here, the concept of TFP-convergence arises. Two economies are said to converge or diverge if the initial TFP disparities diminish or increase over time, correspondingly.

The notion of TFP-convergence refers to the behaviour of TFP, in terms of which the distinctions among economies are measured. In this, it differs from the discussed earlier notions of β- and σ- convergence, which refer to the behaviour of the differences in levels or growth rates of per capita output or income. According to Dowrick and Nguyen (1989, p.1010), "… TFP convergence implies a tendency for income levels to converge, but such a tendency may be masked or exaggerated if factor intensity growth varies systematically with income."

In order to study TFP convergence, it is necessary to introduce the notion of TFP itself and the methods of its measurement. The literature defines total factor productivity as the ratio between real output and real factor inputs. According to Griliches (1996), Diewert and Lawrence (1999), and others, an idea of total factor productivity was firstly mentioned in the works of Tinbergen (1942) and Stegler (1947).

Two main factors have been thought to contribute in major part to the process of sustaining growth: accumulation of inputs and a technology level. Many authors emphasize the key role of the first one, as an engine of economic growth in developing areas such as Eastern Asia, the Middle East, and Northern African economies (Krugman 1994, Collins and Bosworth 1996, Young 1995, Abu-Qarn and Abu-Bader 2007).

The neoclassical approach assumes that the returns to physical capital and labour diminish as more of these production factors are accumulated by an economy. Therefore, their importance in steady economic growth is limited, and the key factors of long-term growth are exogenously determined by technological progress. Such a prediction became more solid with the advent of endogenous growth theories, which emphasize the importance of education, knowledge, and new technology transfer. Currently, most economists agree that the major determinant of long-term economic growth is technological change.

However, it is impossible to measure directly the changes in technology of an economy and therefore the literature tends to use the total factor productivity approach. Lipsey and Carlaw (2004) refine three main positions on the contribution of total factor productivity in evaluating technological change.

The first group, represented by Young (1992), Krugman (1994), and Barro (1999), argues that technological change can be directly measured by changes in TFP. The second group (Nelson 1964, Jorgenson and Griliches 1967, Hulten 2000) holds an opinion "...that changes in TFP do not measure changes in technology, but do ideally at least, measure the associated super-normal profits, externalities and "free lunches" (Lipsey and Carlaw 2004, p.1125). The third opinion doubts that TFP measures anything useful (Abramovitz 1956, Griliches 1995).

This research, however, uses total factor productivity as a measure of technological progress. Therefore, the problem of measuring TFP arises. There are three widely used methods of measuring TFP (Diewert and Lawrence 1999, Chen 1997).

The first approach, called econometric, is based upon the explicit utilization of an aggregate production function for econometric estimates. The second method of measuring TFP is called a method of index numbers. According to this approach, it is not necessary to specify an aggregate production function. There are many different index numbers and in order to select from them, economic and axiomatic approaches are usually used (Diewert and Lawrence 1999).

The third approach to TFP measurement is the growth accounting method, which takes its origins in Solow (1956, 1957). Due to these works, the TFP growth rate is often called “Solow residual”. According to this approach, total factor productivity can be calculated "either as a geometric index in levels or as an arithmetic index in rates of change"(Carlaw and Lipsey 2003, p.461).

In this thesis, we calculate TFP series as a geometric index assuming the case of Cobb-Douglas production function of the types (1) and (3). In the case of Hicks-neutral technological progress (equation (1)) the expression for TFP is given as follows:

$$A(t) = TFP = \frac{Y(t)}{K(t)^{\alpha} L(t)^{1-\alpha}} \qquad (20)$$

In the case of Harrod-neutral labour augmenting technological progress (equation (3)) the TFP levels can be calculated from (3) as follows:

$$A(t) = TFP = \left(\frac{Y(t)}{L(t)}\right) / \left(\frac{K(t)}{Y(t)}\right)^{\frac{\alpha}{1-\alpha}} \qquad (21)$$

Thus, the crucial role in the calculation of TFP, whatever approach has been chosen, belongs to the proper choice of a production function, which specifies the interaction between inputs and output, and the appropriate quantitative measurement of production factors. Next, we describe the measurement of main production factors: physical capital and labour.

Physical Capital.

Chen (1997) points out that the assessment of physical capital input is the greatest problem in the measurement of production factors. Since it is widely realized that physical capital is the main contributor to economic growth in many countries, it is very important to investigate thoroughly such crucial issues as the content of physical capital, its aggregation/disaggregation level, the choice of deflators, the capital valuation, adjustments due to the capacity utilization, and depreciation evaluation methods.

Since the stock of capital cannot be evaluated directly, it is necessary to use indirect methods to measure it, for example, by value. There are two opportunities to value physical capital: user value and resource cost. Due to the availability of data, the traditional approach is to measure physical capital at resource cost. The quality improvements of capital could be accounted for by the changes in cost. However, there is a tendency to understate the capital value if, for example, a technological innovation raises the capability of a capital unit to generate revenue by a larger quantity than the growth of its selling price. One approach is to add this difference in the change of recorded nominal price (Gordon 1990). Another approach (Denison 1972) is to show this difference in TFP or residual, rather than in measuring the output of physical capital.

An important part of the change of the capital input quality is due to technological progress included in the newer capital stock (Phelps 1962, Matthews 1964, Hulten 1992). Hulten (1992) shows that embodied technological change is responsible for more than twenty per cent of the 'residual' or TFP.

Another problem in the measurement of capital input is the issue of its composition. One has to decide whether to take land into consideration and whether the capital stocks of public and non-profit sectors should be included. Physical capital capacity utilization should also be taken into account in measuring capital input (Creamer 1972). An unemployment rate (Solow 1957) or the relative utilization of power sources (Jorgenson and Griliches 1967) can serve as measures of under-utilization of capital.

Gross or net depreciation is another of the problems in measuring capital input. Some authors use gross capital (Solow 1957, 1962, Denison 1962,). Others, using capital net of depreciation, argue that the net of depreciation measure of capital tends to overstate because it is dominated by obsolescence rather than by physical deterioration, and obsolescent equipment is usually used in the production process (Kennedy and Thirlwall 1972, Miyamoto and Liu 2005).

In assessing the level of capital input to the production function, we use the conventional assumption that it is proportional to the capital stock level. To assess the last the perpetual inventory method (PIM) is usually employed (Abu-Qarn and Abu-Bader 2007). This method can be expressed by the following equation:

$$K_t = (1-\delta)^t K(0) + \sum_{i=0}^{t-1} I_{t-i}(1-\delta)^i \qquad (22)$$

This formula assumes that the year t capital stock is equal to the capital stock at an initial year net of depreciation (at an annual rate δ) plus the sum of the stream of net investments. It can be rewritten as:

$$K_t = I_t + (1-\delta)K_{t-1} \qquad (23)$$

This equation is commonly used for the estimation of physical capital and evaluates it at a resource cost. It takes into account depreciation of physical capital and quality improvements, which are accounted for by the changes in cost. Besides, one can choose appropriate deflators for the investment indicators. However, this approach does not take into account the composition of physical capital and its capacity utilization.

As data on investments are available from statistical sources, in order to calculate data series on capital stock it is necessary to estimate the capital stock $K(0)$ at an initial point. If a direct benchmark study for a capital stock is unavailable, then a rough estimate is used.

There are several methods to produce estimates of the initial value of the capital stock (Hall and Jones 1999, Abu-Qarn and Abu-Bader 2007, Ezaki and Sun 1999, Islam, Dai and Sakamoto 2006). In this thesis we employ the approach based on the fact that the impact of the estimate of the initial capital stock fades away over a long period of time. Hence, it is appropriate to take an arbitrary estimate of $K(0)$. Therefore, as an initial stock of capital, we take the book cost of fixed assets available from the statistical sources.

Labour

Similarly to physical capital, the notion of embodied change is applicable to the labour input. According to Chen (1997), most of the studies which use the growth accounting approach have applied adjustments concerning the quality of labour force expressed in education attainment level or the age-sex composition.

As a rule, the work services provided by the occupied population are considered as the contribution of labour input to economic growth. The worked man-hours can be the simplest estimation of the expense of labour. However, as is well known, work is a non-uniform indicator and depends at least on the qualification of the workers and other factors (gender, age, branch specialization, etc.). Denison (1962) shows that the work contribution can vary, even if the total number of the worked hours is constant. Therefore, in order to measure the labour input more accurately, a detailed breakdown of labour categorised by the hours worked and marginal productivity is needed. However, information about hours worked at a regional level was made available only recently by the state statistical service of Kazakhstan, which essentially reduces the horizon of analysis.

An alternative way of estimating labour used in production is possible. It is based on available statistics on employment. However, the criteria of employment instead of hours worked influences the interpretation of the TFP indicator. If labour expenses are exclusively estimated by the number of occupied workers, then growth not explained by production factors (TFP), includes a component pertinent to qualitative changes of the labour force (sex and age structures, educational level and qualification of occupied people, the distribution of the labour force among the branches, etc.). In this research we use the data on occupied population as a measure of labour input for calculating total factor productivity series.

3.3.4 Club-Convergence.

In many cases, the convergence of the types described above, takes place not across a whole sample of countries or regions but across sub-groups of the sample. This leads to the notion of club-convergence, which cannot be considered a type of convergence similar to the above-mentioned notions of β-, σ-, and TFP convergence because it only reflects the sample within which convergence is studied. In other words, the club-convergence looks at convergence clubs with respect to β-, σ-, or TFP types of convergence.

The club-convergence term was introduced to the literature by Baumol (1986) who failed to find a convergence pattern across a broad range of countries, but refined some small groups of similar economies across which absolute convergence took place. This means that while convergence in the large sample as a whole does not take place, there can exist 'clubs' of economies within which some types of convergence can be observed.

The club-convergence hypothesis implies that the per capita output of countries or regions similar in such fundamental factors as GDP per capita, human capital stocks, infrastructure, preferences, government policies, climate, geography, etc. tends to converge in the long-term (Paas et al. 2007).

Baumol (1986) refines convergence clubs from the group of 72 countries over the period of 1950-1980. The first is the club of 16 industrialized countries. The set of points representing these countries demonstrates a negative correlation between growth rates of GDP per capita and the initial (1950) level of GDP. Another club is one of the socialist planned economies, which also demonstrate a negative dependence between growth rates and the initial value of GDP. Within both of these groups absolute convergence is observed.

Fischer and Stirböck (2004) distinguish the club-convergence as the club-specific tendency in which each region of a club evolves towards its club-specific steady state position. The steady-state growth rates across this club are the same.

Cappelen (2004) points out that the club-convergence hypothesis does not contradict the convergence predictions of the standard neoclassical growth model because if countries or regions are allowed to be heterogeneous, they will converge to their own steady state positions. The hypothesis of club-convergence allows multiple and only locally stable steady-state equilibrium. This relaxes the key limitations of the majority of cross-sectional regional growth empirical analysis, as pointed out by Durlauf (2001) about a single steady-state, which takes place for all regional economies in a sample. This single steady-state presents the case in the absolute and conditional convergence hypotheses.

Martin (2001) shows that differences in the basic growth parameters (for example, technological level and human capital endowment), or weak knowledge spillover effects among regional economies, cause the convergence of incomes per capita to the multiple club-specific equilibrium levels among similar types of economies. Convergence across the clubs may not exist at all.

Thus, the concept of club convergence is capable of explaining empirically such phenomena of modern economy as clustering, polarization, and permanent poverty.

3.3.5 Sectoral Convergence

While the notion of club-convergence deals with sub-groups of countries or regions within which β-, σ-, or TFP- types of convergence are tested, it leaves open the possibility to split the convergence process in other dimension, namely, in the dimension of various sectors of the economy. Here, the concept of sectoral convergence arises, which is contrary to the notion of aggregate convergence. While the latter studies convergence of per worker or per capita GDP of the whole economy, the former studies convergence of the per worker gross value added of separate sectors of the economy. It helps answer the question: which branches of an economy promote convergence and which branches promote divergence? It also reveals the role of sectoral change in the convergence process of an economy, by disaggregating productivity to the sectoral level (Bernard and Jones 1996a, 1996b, Doyle and O'leary 1999).

Like club-convergence, the notion of sectoral convergence cannot be put in one rank with the notions of β-, σ-, or TFP convergence because it reflects only economic sectors in which these types of convergence are studied. For example, O'leary (2003) studies sectoral convergence across Irish regions in terms of σ-convergence, while Wei-Kang Wong (2002, 2006), Rodrik (2011) and others study sectoral convergence in terms of unconditional β-convergence.

Sectoral convergence is more than theoretical, it also has a significant practical aspect because it helps reveal branches - engines of convergence - and thereby produces recommendations concerning regional inequality. By supporting such branches, a government not only promotes their development, but also reduces disparities across the regions of the country.

3.4 Summary

In this chapter, we have classified growth theories according to their convergence/divergence predictions: those that predict convergence, those that predict divergence, and those that have mixed predictions depending on the values of some parameters. This classification is related to two main convergence mechanisms, namely diminishing returns to capital and technical progress. However, we have found, only the neoclassical growth model provides a rigorous mathematical framework for the empirical study of convergence. Therefore, in this thesis, we study empirically convergence across Kazakhstan regions in the framework of this model, the detailed description of which was presented in this chapter. We also considered an augmented Solow model, which includes human capital as one of the production factors. This model will be used in our empirical testing of convergence across Kazakhstan regions.

In addition, this chapter introduced various concepts of convergence, such as β-convergence, σ-convergence, TFP-convergence, club-convergence, and sectoral convergence. From these types of convergence only the notion of β-convergence is tightly related to the neoclassical growth model.

Finally, it is worth mentioning the chronology of convergence. According to Islam (2003), convergence research started with the concept of absolute convergence and then moved to the notion of conditional convergence. Both these kinds of convergence were initially tested using the β-convergence notion. The concept of σ-convergence appeared later. At the same time, the notions of TFP-convergence and club-convergence began to appear in the literature.

CHAPTER 4.
REVIEW OF CONVERGENCE STUDY METHODOLOGIES.

4.1 Introduction

In the previous chapter, we introduced the notions of β-, σ-, TFP, Club- , and sectoral convergence, which will be tested empirically in the case of the Kazakhstan regions. As these types of convergence suppose diverse empirical approaches, this chapter reviews various empirical methodologies of convergence study.

Empirical approaches to study convergence across countries and regions can be classified as follows: informal cross-section, formal cross-section, panel, time-series, and distribution approaches (Islam 2003).

This classification has been made mainly according to the data sets used to test convergence among countries or regions. The formal and informal cross-section approaches use one-dimensional cross-section data sets collected by observing many countries or regions for the same year or averaged over the same period. The panel approach considers two-dimensional panel data sets, which consist of the observations of many countries or regions for many time moments. The time-series approach studies a sequence of observations of some economic variables, ordered according to time.

There is some compliance, though not unique, between the convergence concepts discussed above and empirical approaches. For example, the σ-convergence has usually been tested using a distribution approach, which studies the behaviour of the distribution of cross-section income as a whole. The β-convergence, either conditional or absolute, has been tested using formal and informal cross-section, panel and time-series approaches, which have generally considered convergence across countries or regions in terms of growth rates and income levels. The TFP-convergence has been tested using time-series and panel approaches. The study of club-convergence demands two kinds of approaches. Firstly, it is necessary to identify convergence clubs. Secondly, it is necessary to study convergence within these clubs. The sectoral convergence is studied using the method of sectoral decomposition.

4.2 Approaches to study β – convergence

The assumption of diminishing returns of the neoclassical growth theory suggests higher marginal productivity of capital for a capital-poor country. This means that poorer economies tend to grow faster than richer ones in the case of similar rates of saving. Hence, the subsequent growth rate should negatively correlate with the initial income level. In the growth - initial level regression equation, the sign of the coefficient of the variable approximating the income at the initial point, determines whether or not the negative correlation exists. This property is usually used for the empirical testing of β-convergence. Initially, all studies of β-convergence used the cross-section approach, which is divided into the informal cross-section approach and the formal cross-section approach (Islam 2003).

4.2.1 Informal Cross-Section Approach.

A distinct feature of regressions which use the informal cross-section approach, is that the growth–initial level regression forms were not formally derived from theories of growth. It does not follow that these works do not have bonds with theoretical models at all, only that these connections are less formal.

In the previous sections, three groups of growth theories with different predictions of the behaviour of inter-regional or international income differences have been identified. The first group of models consists of both traditional neoclassical and some endogenous growth models. These models predict the convergence across countries and regions. The second group consists of some endogenous growth models with the incorporated assumption of increasing returns and other models, which account for the endogeneity of the rate of technological progress. These models predict the divergence across economies. The third group of models has mixed convergence/divergence predictions depending on the values of some parameters of the models.

However, the main testable empirical difference among these groups of growth theories is the sign of the partial correlation between the initial level of the per capita income and the rate of its growth. If the sign of the estimated coefficient is negative, then there is a negative partial correlation between the variables, and the hypothesis of convergence is confirmed. If the sign of the estimated coefficients is positive, there is positive correlation between the income per capita at time t and its initial value, and it is said that divergence across economies takes place.

This means that a reasonable way to test the relevance of each group of growth theories with a more appropriate interpretation of the growth empiric is to estimate a convergence equation. The convergence equation is a regression model with the growth rate of per capita income or output per worker serving as a dependent variable, and the initial value of the same indicator serving as an explanatory variable. The criterion for the discrimination between three groups of models with alternative predictions on convergence is the sign of the estimate of the coefficient of the initial value of the income per capita or output per worker.

However, many authors point out the necessity to control some variables that may influence the growth rate of countries or regions belonging to the sample (de la Fuente 2002a, Barro and Sala-i-Martin 1991). This is dictated by the fact that, according to both the neoclassical and catching-up models, the convergence process holds only under certain conditions. For example, in the seminal neoclassical model of Solow (1956), the long-term income level is determined by the rates of population growth and saving. Similarly, Abramovitz (1986) emphasizes that the degree to which the potential of technological followers for the rapid growth would be realized in a given economy depends on the presence of necessary macroeconomic and political conditions and its "social capability" to adopt new technologies. In a nutshell, the underlying differences in "fundamentals" across economies could distort the estimated equation relating the growth rate and the initial income. Therefore, such differences should be controlled during the regression exercise if the economies are not identical. In order to control these disparities, the corresponding variables should be placed in the right hand side of the regression equation that relates the initial level and the rate of growth.

Based on the above discussion, a "minimal" econometric equation for the informal empirical convergence analysis is:

$$\Delta y_i = a + \sum_{k=1}^{K} \gamma_k x_{ik} + b y_{i0} + \varepsilon_i \qquad (24)$$

Where Δy_i is the growth rate of the per capita income or the output per worker in an economy i over the period t; y_{i0} is the same variable at the starting point of the period t; x_{ik} are variables that capture the "fundamentals" of economy i; ε_i is the random disturbance term (de la Fuente 2002a).

The most cited example of studies exploring the informal cross-section approach is that of Baumol (1986) in which he presents the study of unconditional convergence across 16 OECD countries. Strong evidence of absolute convergence across these countries is given by the negative and significant coefficient of the variable representing the initial income in the regression equation. However, when the extended set of 72 countries is considered, the hypothesis of unconditional convergence is not proved. That is, the choice of the sample is a decisive factor in the presence or absence of unconditional convergence in Baumol's study.

Some studies present the evidence of conditional convergence across various samples including additional variables representing such relationships as inflation – output, Philips curve relationship, etc. in the regression equation (Kormendi and Meguire 1985, Grier and Tullock 1989).

4.2.2 Formal Cross-Section Approach.

The formal cross-section approach to convergence study switched the discussion from the issue of "... broad presence or absence of convergence to one about precise values of structural parameters of the growth model" (Islam 2003, p.324).

Since the works of Barro and Sala-i-Martin (1992b) and Mankiw, Romer and Weil (1992), in which the regression equation formally follows from the neoclassical specification, the central stage of convergence research has been occupied by the neoclassical growth – convergence equation (13). This is the equation which relates the growth rate and the initial level with coefficients formally dependent on structural parameters of the neoclassical growth model. It is used to conduct empirical studies of β-convergence and to calculate the speed of convergence using cross-section empirical data.

However, the convergence prediction of the neoclassical growth theory received only partial empirical support depending on the data about groups of economies. Barro and Sala-i-Martin (1992a, 1991, 2003) give various examples of such groups of countries. In the first one, they test convergence among a broad cross section of 118 countries over the period from 1960 to 1985. The growth rates were essentially uncorrelated with the initial position of the logarithm of real per capita GDP at the start of the period, 1960. This sample rejects the hypothesis of absolute convergence.

In the second example, they examine a more homogeneous group of 20 advanced economies that were included in the OECD at the beginning of the sample period. In this case, the hypothesis of absolute convergence was proved. Initially poorer economies did demonstrate significantly higher growth rates of the per capita output.

Positive empirical support becomes stronger when study turns to an even more homogenous group of continental US states, each considered as a separate economy. Absolute convergence can be distinctly seen in the diagram where the per capita personal income growth rates for each state from 1880 to 1990 against the logarithms of personal income per capita in 1880 was plotted.

As Islam (2003), referring to Durlauf & Quah (1999), points out, the estimation of β obtained from cross-section data is often treated as the speed at which poorer countries or regions overcome their income lag from richer economies. The results on conditional convergence across countries presented in (Barro and Sala-i-Martin 1992a) and (Mankiw, Romer and Weil 1992) show that sample countries converge with the speed of convergence at about 2% per year.

The assumption of equal steady states, and consequently of absolute convergence, becomes more plausible when regions within the same country are considered. There are many regional convergence studies using the formal cross-section approach concerned with the regions of the USA, Japan, Germany, UK, France, Italy, Spain, Canada (Barro and Sala-i-Martin 1992a, 1992b, Sala-i-Martin 1996). For example, Barro and Sala-i-Martin (1992a) find obvious evidence of absolute convergence across US states using the Cass-Coopmans version of the neoclassical growth model. The estimated rate of convergence is proved to be approximately 2% per year.

However, Islam (2003, p.324) emphasizes the main drawback of the cross-section approach: "… having just one data point for a country provides a weak basis for estimation of the convergence parameter, which refers primarily to a within-country process". To overcome this limitation the research on convergence switched gradually from the cross-section to a panel approach.

4.2.3 The Panel Approach to Convergence Study.

In studying convergence, it is necessary to take into account the two main sources of convergence mentioned earlier: capital deepening and technological diffusion. The influence of these sources is reflected by the presence of corresponding parameters in the equation of the steady state income level given by equation (11). However, it is difficult to take account of both these factors in the framework of the cross-section approach because it assumes identical technologies across economies. This assumption of technological homogeneity impedes any systematic process of diffusion of technology that contradicts empirical results and casual observation (Coe and Helpman 1995, Coe, Helpman and Hoffmaister 1997, Bayomi, Coe and Helpman 1999).

If neglected, these technological differences across economies cause the so-called Omitted Variable Bias Problem (OVBP) (Islam 2003, Lee, Pesaran and Smith 1997). To illustrate this problem it is necessary to rewrite equation (13) in terms of per capita income or output. It permits rectification of the productivity level term in explicit form:

$$\ln \hat{y} = \ln \frac{Y}{AL} = \ln \frac{Y}{L} - \ln A = \ln y - \ln A_0 e^{xt} = \ln y - \ln A_0 - x$$

Therefore, the rewritten and rearranged equation (13) takes the form:

$$\ln y_{t_2} = \left(1 - e^{-\beta\tau}\right) \frac{\alpha}{1-\alpha} \ln s_{t_1} - \left(1 - e^{-\beta\tau}\right) \frac{\alpha}{1-\alpha} \ln\left(n_{t_1} + x + \delta\right) +$$

$$e^{-\beta\tau} \ln y_{t_1} + \left(1 - e^{-\beta\tau}\right) \ln A_0 + x(t_2 - e^{-\beta\tau} t_1) \qquad (25)$$

The OVB problem arises from the necessity to relegate the productivity shift term A_0, on the right hand side of equation (25) to the error term in a cross-section regression. The reason for this is the absence of good measures of A_0 and even, if some approximations are used, a part of A_0 still remains unobservable or immeasurable and yet correlated with explanatory variables.

In addition to the above-mentioned problem of technological differences in the traditional cross-section approach, Byrne, Fazio and Piacentino (2009) formulated two other problems. The first is that the control variables included in the conditional convergence equation are unlikely to control all the cross-economy differences, which means that the assumption of identical first-order autoregressive properties is unfeasible. The second is that the time series variations and dynamic properties of the data cannot be dealt with in the framework of the cross-section approach. Therefore, in order to overcome these problems, the panel approach to the empirical testing of convergence is used.

According to (Islam 2003, p.325), equation (25) can be rewritten using the panel data literature notations:

$$y_{it} = (1+\gamma)y_{i,t-1} + \gamma\psi x_{i,t-1} + \mu_i + \eta_t + \varepsilon_{it} \qquad (26)$$

where

$y_{it} = \ln y_{t_2}$, $y_{i,t-1} = \ln y_{t_1}$, $(1+\gamma) = e^{-\beta\tau}$, $\psi = -\frac{\alpha}{1-\alpha}$, $x_{i,t-1} = \ln s_{i,t-1} - \ln(n_{i,t-1} +$ $x+\delta)$, $\mu i=1-e-\beta\tau \ln A0$, $\eta t=xt2-e-\beta\tau t1$, εit is an error term.

In the framework of the panel data approach, it is possible to partly neutralize the OVB problem by expressing technological differences across economies in the form of individual (region) effects, μ_i. From the convergence point of view, the panel data approach helps distinguish between the effects of capital accumulation expressed by the saving rate s_i, as well as the technological and institutional disparities expressed by the individual effects term, μ_i.

Islam (1995) deals with μ_i using the correlated-effects model and the accompanying Minimum Distance estimator proposed by Chamberlain (1980) because A_0 is correlated with s and n, and so, the random-effects specification of μ_i is not applicable. The results of Islam (1995) and Knight, Loyaza and Villanueva (1993), who used this estimator, show that the assumption of technological differences produces much higher estimated values of β, and consequently, much lower values of α, which are in a good agreement with the observed empirical values.

Among other studies concerned with the panel data approach used for the estimation of the fixed-effects convergence models for various regional samples, De la Fuente (2002a) mentions the works of Marcet (1994), Raymond and Garcia (1995), de la Fuente (1996), Tondl (1997), and Gorostiaga (1998). Their results show very rapid (at rates of up to 20% per year) convergence of regional economies towards very different steady states in contrast to earlier studies of Barro and Sala-i-Martin and other authors with slow (at rates of about 2% per year) convergence to a common income level.

Many cross-national studies also point out the fast convergence (at rates of up to 12% per year) to very different steady states, the dispersion of which can only be partly explained by observed disparities in the growth of the population and investment ratios rates (Islam 1995, Knight, Loyaza and Villanueva 1993, Canova and Marcet 1995, Caselli, Esquivel and Lefort 1996).

In both regional and cross-country types of studies, the statistical significance of many standard conditioning variables is observed to be low, the estimated values of physical capital share are rather low, and the values and significance of the fixed effects show that the crucial role in explaining the income level diversity belongs to persistent differences in total factor productivity.

4.3 The Time-Series Approach to Convergence Study.

Another approach to investigate convergence is to use time series econometric methods (Carlino and Mills 1993, Bernard and Durlauf 1996, Evans 1996, Evans and Karras 1996a). According to this approach, there is convergence across two economies, i and j if their outputs per capita, $y_{i,t}$ and $y_{j,t}$, meet the following condition:

$$\lim_{k\to\infty} E\left(y_{i,t+k} - a \cdot y_{j,t+k} \middle| I_t\right) = 0 \quad (27)$$

where $E(\ \ |I_t)$ means expectation value under the condition I_t, which is all information available at time t.

This convergence definition is rather ambiguous for cases involving more than two economies case. In such multi-economy cases, as a measure of convergence, some researchers have considered deviations from a reference economy. In this approach, instead of $y_{i,t}$ the term $y_{1,t}$ is included in equation (27), where the subscript one is a reference economy's index. Others have used deviations from the mean in their analysis of convergence. In this framework, instead of $y_{i,t}$ the mean value, $\bar{y}_t$, is taken.

The time-series approach in defining convergence assumes also the possibility of absolute and conditional convergence. A variant of absolute or unconditional convergence is represented by $a = 1$ in equation (27), and vice versa, the case with $a \neq 1$ in equation (27) represents a sort of conditional convergence.

Within the time-series approach to the convergence study, it is necessary to distinct between "deterministic" and "stochastic" convergence. This difference is concerned with whether the "deterministic" or "stochastic" trend is allowed when the existence of unit root is tested in the deviation series (Islam 2003).

The key assumption in deriving the convergence equation for the time-series approach is that $x_{i,t-1}$ remains constant over the sample period in equation (26) (Islam 2003, p.333). Then $\gamma\psi x_{i,t-1}$ can be subsumed under the term μ_i because it becomes time invariant. Substituting $t_2 = t$ and $t_1 = t - 1$ in the expression for η_t gives

$$\eta_t = g(t_2 - (1+\gamma)t_1) = g\big(t - (1+\gamma)(t-1)\big) = (1+\gamma)g - \gamma g t$$

For a particular economy, $(1+\gamma)g$ remains constant over time, and hence can also be ascribed to term μ_i, so that η_t becomes equal to $-\gamma g t$. Taking into account these changes, rearranging equation (26), and suppressing the country subscript i results in the following Dickey-Fuller equation with a drift and linear trend widely used for the time-series analysis of convergence (Dickey and Fuller 1979):

$$y_t = \mu - \gamma g t + (1+\gamma) y_{t-1} + \varepsilon_t \tag{28}$$

where μ includes country specific terms $\gamma\psi x_{i,t-1}$ and $(1+\gamma)g$; ε_t is an error term.

The γ should be negative or, respectively, $(1+\gamma)$ should be less than one for the convergence in general sense. Therefore, the question of convergence is reduced to whether or not y_t has a unit root.

There are many examples of time-series studies of convergence across countries (Lee, Pesaran and Smith 1997, Evans 1996, Evans and Karras 1996a) and regions (Carlino and Mills 1993, Lowey and Papell 1996, Evans and Karras 1996b). Lee, Pesaran and Smith (1997) extend the traditional unit root analysis to a larger-than-usual sample of developed countries. They find that the null hypothesis of the presence of the unit root can be rejected for only a few countries out of 102. However, some researchers show that the introduction of simple trend breaks, which is one of the forms that varies in $x_{i,t-1}$, leads to a considerable increase in the number of rejections of the unit root (Zivot and Andrews 1992, Ben-David and Papell 1995, 1998, Lumsdaine and Papell 1997, Ben-David, Lumsdaine and Papell 2003). This means that it cannot be asserted that the time-series analysis produces evidence of no "within convergence" (Islam 2003, p.334).

The time series approach substantiates some type of a conditional convergence hypothesis. Therefore, the inferences deduced from the time series convergence studies have been similar to those made by studies using either the panel or cross-section techniques.

Carlino and Mills (1993) analysing income per capita of eight US geographic regions apply the augmented Dickey-Fuller test to the equation similar to (28) and reject the hypothesis of the presence of the unit-root for the majority of the US states, confirming the evidence of conditional convergence. Lowey and Papell (1996) extend the analysis of Carlino and Mills (1993) by endogenizing the timing of the break and disaggregating level considering 22 regions of the US instead of 8. Again, the unit-root hypothesis is rejected for the majority of regions, providing evidence of convergence. The results of Evans and Karras (1996b) of the analysis of the pooling deviation data across US regions reject the hypothesis of the unit-root, even when trend breaks are not comprised. A similar unit-root analysis of pooled deviation (from average) data for a set of 56 countries is conducted by Evans and Karras (1996a). Their results yield the rejection of the hypothesis of the unit-root, and consequently, of conditional convergence across economies included in the sample.

4.4 Distribution Approach

The distribution approach concentrates on σ-convergence and on the time path of the distribution of cross-section income, contrary to the cross-section, panel, and partly the time-series approaches, which investigate β-convergence most of the time.

Islam (2003) distinguishes two methodologies for empirically testing σ-convergence across countries or regions. The first one is a direct approach, which consists of computing the variance of the cross-section distribution of the logarithm of per capita income of the economies included in a sample and plotting it against time (Lee, Pesaran and Smith 1997). A similar approach was developed by Danny Quah (1996a, 1996b) which focused not only on the variance of the cross-section distribution, but also on the evolution of the entire shape of distribution.

The second approach is to formulate a statistical test for σ-convergence using the knowledge that the speed of β-convergence and dispersion of the logarithm of per capita income are algebraically related[1] (Lichtenberg 1994, Carree and Klomp 1997).

In this research, we use a direct approach plotting against the time of the standard deviation and/or coefficient of variation of the cross-section distribution of the logarithm of real per capita GRP of Kazakhstan regions: this method is simple, visual, and demonstrative.

The empirical evidence of σ-convergence depends heavily on the considered sample. For example, Lee, Pesaran and Smith (1997) using direct methodology demonstrate that σ-convergence is valid for the OECD countries. However, for the larger sample of 102 countries they found that output variance had grown from 0.77 to 1.24 between 1961 and 1989. This is the case with the Kazakhstan regions too, as is obvious when we test σ-convergence within convergence clubs.

4.5 Approaches to Study Club Convergence

4.5.1 Existing Empirical Approaches to Club Convergence

As the presence or absence of convergence across countries or regions depends heavily on the composition of the economies included in the sample, there is the possibility that several groups with different convergence behaviour will be found within a given set. These groups are usually called convergence clubs, and a considerable bulk of literature is devoted to the empirical study of club convergence and to approaches for the identification of convergence clubs.

For example, Alexiadiz and Tomkins (2004) study the existence of convergence clubs among the regions in Greece over the time span of 1970-2000. They employ the time-series approach and two empirical approximations of the common convergence point. The first proxy is the mean of the real per capita GDP over all economies included in the club, and the second is the leading economy's per capita GDP. They define club convergence either as diminishing deviations from the average or as diminishing disparities in per capita GDP compared to the leading economy. Their results show that while all the regions of Greece, taken as a whole, do

[1] See equations (13), (18), (19)

not demonstrate a common convergence pattern, some regions do prove to follow a convergence path. However, the main disadvantage of this method consists in the limiting possibility of identifying several convergence clubs. The authors do not consider a possibility that economies, diverging from the average per capita GDP, could form separate convergence clubs.

Li (1999) investigates convergence patterns among 113 countries using the time-series approach. He examines whether countries converge to the group average by incorporating different grouping methods and using two tests (Augmented Dickey-Fuller (ADF) and Kwiatkowski, Phillips, Schmidt, Shin (KPSS)). The results of these tests confirm the existence of a convergence club: specifically that rich countries converge and poor countries diverge. However, since economies are grouped based upon either their per capita output levels at the beginning of the sample (1960) or the intervals of the US 1960 income level, this grouping method does not take into account the effect of growth factors on the development of considered countries.

Feve and Le Pen (2000) study club convergence across 92 countries over the period of 1960-1989 using a switching regression approach. Their results do not conform to the conventional results on convergence across most developed countries. In order to select convergence clubs, they propose "...to use a sample separation information provided by initial per capita GDP" (p.313). Again, the lack of the method is that it neglects the influence of growth factors during the considered period.

Mora (2005) groups European regions into convergence clubs using an Optimum Grouping Criteria based on an inequality measure. He defines this measure as inter-group Gini index of per capita GDP considering a representative value for each group. Three groups have been constructed under an optimum criterion that maximizes inequalities between these groups. An absolute β-convergence of the global sample and the first group is shown. However, the lack of this method consists in using a single index, namely GINI index of per capita GDP, in the grouping procedure.

Durlauf and Johnson (1995) abandoned the linear model commonly used for considering the cross-country growth patterns in favour of the multiple regime approach in which different economies are grouped according to their initial conditions. They use two different control variables to classify economies with similar initial situations. The first one is output per capita at the starting point of the sample period. According to them (p.368), “... most multiple steady state models predict that if economies are concentrated around several steady states, then their initial per capita output levels fall into non-overlapping categories”. The second variable is the adult literacy rate at the beginning of the sample period. This variable may be interpreted as a proxy for the human capital stock. According to these two variables, the sample set of countries is segregated into four groups: high output / high literacy, high output / low literacy, low output / high literacy, and low output / low literacy. It is shown that the growth trajectories within each group are different. They also identify different steady-state regimes using the regression tree analysis. This methodology provides a general nonparametric way to identify multiple data regimes from a set of control variables. The regression tree analysis divides the sample into low, intermediate, and high output countries. It reveals that a split according to output is preferable to one according to literacy. The results of Durlauf and Johnson (1995) demonstrate the consistency of the behaviour of growth rate with a multiple steady-state approach. However, the main disadvantage of this method consists in using only initial values of considered factors for grouping of economies.

Corrado, Martin and Weeks (2005) test a presence of regional convergence clubs across the European Union, relying upon the trends of per capita Gross Value Added (GVA) over the period of 1975-1999. They extend the clustering approach explored by Hobijn and Franses (2000). This method allows to identify endogenously the quantity and composition of regional convergence clubs applying a pair-wise test for stationarity of regional disparities in GVA per capita. The club convergence is considered in the sense that regional per capita disparities among members of a given club tend towards zero (in the case of unconditional β-convergence) or towards some finite, club specific non-zero value (in the case of conditional convergence). The innovation of their approach is that the resulting convergence clubs are checked against a number of hypothetical unifications proposed by recent regional growth and convergence theories (for example, a core-periphery dichotomy). In spite that this method accounts for several groups of factors and possible change of cluster membership, it does not produce decisive set of convergence clubs relevant to the considered period of time and various types of convergence.

Canova (2004) uses a predictive density approach to study the quantity and membership of convergence clubs in a group of European regions. He suggests an approach to examine formally whether the per capita income distribution exhibits convergence clubs. The groups' quantity and the situation of the break points are determined where the proper ordering of the cross section units is unknown. The approach, based on the predictive density (marginal likelihood) of the data, allows evaluation of the parameters of each group in a uniform manner. This method is a natural extension of the standard technique employed for the identification of the quantity of heterogeneous groups in a cross section when the quantity of groups, the location of the breaks, or the ordering of units are unknown. However, apart from the previous approaches, Canova (2004) makes allowance for another level of heterogeneity within groups in the form of prior ordering that confines the coefficients of the members in a group to have the same distribution, but allows the distribution of the units' coefficients in different groups to vary. The approach employed in estimating the parameters of each group after determining the number of groups and the location of the break points, belongs to the Empirical Bayes (EB) tradition. It uses predictive densities to evaluate the parameters and posterior analysis in order to make inferences concerning the functions of the model coefficients.

Contrary to Durlauf and Johnson (1995), Canova (2004) admits heterogeneity within the groups at the costs of applying constraints to the time series characteristics of the data. He stresses four features which distinguish his approach from existing ones: the possibility for groups to have different covariance matrices, the utilization of serially correlated data, the criteria employed to ascribe units to groups (predictive ability versus within group variance), and the shortage of information about number of break points. Canova (2004) fulfils an identification of convergence clubs in regional data of European regions by employing the initial conditions and measures of geographical and threshold externalities as grouping criteria. At the European country level, the indicators for threshold externalities, geography, human capital, government policies, and access to technologies are employed to search for clubs. He finds natural clustering of units in four groups of regional per capita income and two groups of the national per capita income. However, a disadvantage of this approach is that all the conditioning variables are not considered simultaneously for grouping of European regions and obtained clubs are not checked with respect to various types of convergence.

The Markov chains approach is used by Carluer (2005) in order to highlight distribution dynamics: it describes the process of transition towards a finite set of positions over a given period. This avoids the need to curtail *a priori* the variety of possible evolutions and permits the consideration of the whole plurality of regional trajectories to reveal the convergence or divergence process itself. He uses this approach to discover the divergence process across Russian regions over the period of 1985-1999. The main result of this study is the detection of the divergence in the growth process and polarization effect among the regions of Russia, when the poor become poorer and the rich become richer. However, in spite this approach takes into account dynamical property of club membership, it uses only one indicator, namely per capita GRP or GDP of considered economies.

4.5.2 A Proposed Approach to Identify Convergence Clubs.

There are several approaches to discovering convergence clubs among countries and regions with their advantages and drawbacks. However, the approach used in this research differs from the above approaches and is based on the clustering of Kazakhstan regions into homogeneous groups according to the set of growth factors. The clusters obtained after the application of the cluster analysis are then considered as candidates to represent convergence clubs. Afterwards, the convergence hypothesis among the regions included in each group is tested.

Cluster Analysis.

To compare Kazakhstan regions according to the growth factors, and to discover relatively homogeneous groups among them, cluster analysis is applied. The aim of the clustering of Kazakhstan regions is to divide them into homogeneous groups using some mathematical criteria of the classification quality. Clustering quality criteria includes the following informal requirements:

- the objects of the same groups should be close enough;
- the objects of the different groups should be dissimilar to each other;
- given other equal conditions, the distribution of the objects by groups should be uniform.

An advantage of cluster analysis is that it permits group objects not just by one parameter, but by a whole group of characteristics. Furthermore, cluster analysis, in contrast to most of mathematical and statistical approaches, does not put any constraint on the type of object investigated, and allows source data of an arbitrary nature. In addition, cluster analysis can handle large volumes of information and reduces significantly large data arrays of socioeconomic information into compact and handy size.

We shall use cluster analysis to discover homogenous groups of Kazakhstan regions according to chosen growth factors, with the aim to test club convergence hypothesis across economies included in each cluster.

The results of a majority of clustering techniques depend heavily on the calculation of a matrix of similarities or distances between entities, and therefore these quantities should be defined properly. There are three concepts of similarity and distance to be considered – between entities, between an entity and a group of entities, and between two groups of entities.

A similarity coefficient measures the relationship between two entities, given the values of a set of p variates common to both. In general, similarity coefficients take values in the range from 0 to 1. For quantitative variables, the most commonly used measure of similarity between entities is the product moment correlation coefficient. Everitt (1980) considers some measures of similarity for the entities described by various types of data: binary, qualitative and quantitative. He concludes that, although the choice between similarity and distances measured in clustering is difficult to make, the balance of evidence would seem to favour distances.

We use the following definition of distance measures. A numerical function $d(x, y)$ of pairs of points of a set E is said to be a metric for E if it satisfies the following conditions:

1) $d(x, y) \geq 0; d(x, y) = 0$ if $x = y$;

2) $d(x, y) = d(y, x)$;

3) $d(x, z) + d(y, z) \geq d(x, y)$.

The third condition is referred to as the metric inequality, or more commonly as the triangular inequality. It is the one most useful for differentiating between distance measures and similarity measures.

The most commonly used distance measure is the Euclidean metric, where the distance between points i and j denoted by d_{ij} is defined as

$$d_{ij} = \left\{\sum_{k=1}^{p}\left(x_{ik} - x_{jk}\right)^2\right\}^{\frac{1}{2}} \tag{29}$$

Where x_{ik} is the value of the k-th variable for the i-th entity. Usually variables are standardized before employing Euclidean distance by taking $z_{ik} = \frac{x_{ik}}{\sigma_k}$, where σ_k is the standard deviation of the k-th variable, to avoid the problems caused by different unit scales.

The most obvious difference between similarity and distance measures is that whilst the former takes values between 0 and 1, the latter can take any positive value (Everitt 1980).

However, a range of values for a distance measure can be easily transformed into a corresponding set of values for a similarity function. For example, it can be a transformation such as

$$s_{ij} = \frac{1}{1 + d_{ij}}$$

The reverse transformation is much more difficult because of the necessity for the distances to satisfy the triangle inequality.

One of widely used methods for calculating of between group similarity and distance measures is to use group means for the p variables in the formulae of inter-individual measures. For example, the substitution of mean values into the Euclidean distance formula gives:

$$d_{XY} = \left\{\sum_{i=1}^{p}(\bar{x}_i - \bar{y}_i)^2\right\}^{\frac{1}{2}}$$

where $\bar{x} = \left(\bar{x}_1, \bar{x}_2, \dots, \bar{x}_p\right)$, $\bar{y} = (\bar{y}_1, \bar{y}_2, \dots, \bar{y}_p)$ are corresponding mean vectors for groups X, Y. A between-group similarity measure can be calculated by finding the correlation coefficient between $\bar{x}$ and $\bar{y}$.

Another issue in applying cluster analysis is what kind of clustering techniques to use. Cormack (1971) proposes a classification of cluster analysis techniques into roughly the five types given below.

- Hierarchical techniques – in which the clusters themselves are classified into groups, the process being reiterated at different levels to constitute a tree;
- Optimization techniques – in which the groups of entities are composed by the optimization of a clustering criterion. The clusters are mutually exclusive, thus forming a division of the set of entities;
- Density or mode-seeking techniques – in which clusters are made up by searching for areas containing a relatively dense concentration of entities;
- Clumping techniques – in which the clusters or clumps can overlap;
- Other methods that do not fall clearly into any of the above-mentioned groups.

These types are not necessarily mutually exclusive, and several clustering methods can be placed in more than one category.

Hierarchical techniques, in their turn, can be subdivided into agglomerative methods, which proceed by a series of subsequent fusions of N entities into clusters, and divisive methods, which divide the set of N entities subsequently into a better partition.

SPSS[1] offers, in total, seven methods of hierarchical agglomerative methods of association: between-groups linkage, within-group linkage, nearest neighbour, furthest neighbour, centroid clustering, median clustering, and Ward's Method. The essence of Ward's Method is to regard each object as a separate cluster at the beginning of clustering process. Then, during the clustering process, clusters are combined into larger clusters until only a sole cluster remains. At every step of the process, the information loss that results from joining objects into clusters, is approximated by the aggregate sum of deviations squared of every entity from the average of the cluster it belongs to. At any stage of the analysis, those clusters are combined the fusion of which leads to minimal growth in the sum of the squares of errors (Everitt 1980).

Kronthaler (2005), referring to Backhaus et al. (1996) and Everitt, Landau and Morven (2001), claims that the method of Ward when compared with other hierarchical unification methods that use as fusion criteria a minimization of the distance between clusters, is superior to alternative approaches and generates rather homogenous clusters. Therefore, in this thesis, we use Ward's minimum-variance method when discovering clusters of Kazakhstan regions.

Since highly correlated variables tend to dominate cluster analysis, and are responsible for disfiguring results, it is necessary to check correlations among used variables and to exclude highly correlated variables before starting cluster analysis (Kronthaler 2005).

Due to the different unit scales of used variables, the problem of different weighting can arise. To avoid this problem, we standardize all variables by the z-transformation, which is carried out under the formula:

[1] Statistical Package for Social Sciences

$$z = \frac{x-m}{\sigma} \tag{30}$$

Where x is non-standardized variable, z is standardized variable, m is a mean value of a sample, σ is a standard deviation of a sample. Therefore, z-normalization reduces values of the variables to the uniform range [-3;+3].

The crucial question of cluster analysis is that of fixing upon the optimal number of clusters. Often, the change of the corresponding function serves as a criterion of unification (of a number of clusters). In our case, for example, it is a squared Euclid distance defined using normalized values:

$$\text{dist} = \sum_{i=1}^{n}(x_i - y_i)^2 \tag{31}$$

The grouping process should be accompanied by the consistent increase of criterion's value. The appearance of abrupt jump could be interpreted as a feature of the number of clusters that are inhered objectively in studied aggregate. It means that we should stop the clustering process at the point when the coefficient's value increases abruptly. Otherwise, relatively far situated clusters could be unified with each other (Everitt 1980).

Similarly, the main issue in the study of TFP convergence discussed in the next section is "How to obtain TFP series of the set of considered economies?" and "How to study convergence across them?"

4.6 Approaches to Study TFP Convergence

4.6.1 Empirical Research on TFP Convergence.

In his review of TFP literature, Islam (2001 11) emphasizes three various approaches to international comparisons of TFP. These are the time-series growth accounting approach, the cross-section approach, and the panel regression approach.

The time series growth accounting approach to the international TFP comparison was initially limited to small samples of G7 or OECD countries because of stringent data requirements. Later the methodology was applied to China's provinces (Miyamoto and Liu 2005, Ezaki and Sun 1999). This approach, which utilizes the time series of individual economies separately on a country-by-country basis, takes absolute and relative forms.

In the absolute form, the growth rates of TFP obtained within individual economies are then analysed and compared without bringing different countries' time series data to a common denominator. Here, the comparison of economies is limited to that of the growth rates of TFP, but not the levels of TFP. The absolute form of the time series growth accounting approach is as old as the research of TFP itself. The focus of initial growth accounting studies was conducted on the proportions issue: namely the issue of which part of the growth of output can be attributed to the measured growth of inputs and which part can be ascribed to the growth of TFP? There are many other studies using this approach (Domar et al. 1964, Denison 1967, Barger 1969, Kuznets 1971, Bergson 1975). Jorgenson and his colleagues (Ezaki and Jorgenson 1973, Christensen, Cummings and Jorgenson 1980 13, Jorgenson 1995a, 1995b) raise the computation of TFP to a high level of sophistication introducing the "...use of Divisia and translog indices to growth accounting, integrating income accounting with wealth accounting and connecting growth accounting with multisectoral general equilibrium analysis" (Islam 2003, p.471).

The relative form of the time-series approach to TFP convergence study overcomes the limitation of the absolute form giving the relative TFP levels of countries because data for various economies are reduced to a common currency and then analysed with reference to either the mean of the sample or a benchmark economy. This form was initiated by Jorgenson and Nishimizu (1978) and then developed in (Wolff 1991, Dollar and Wolff 1994, Christensen, Cummings and Jorgenson 1981).

The cross-section approach to international TFP comparison can be divided into cross-section growth regression and cross-section growth accounting methodologies.

The cross-section growth regression method initiated by Chenery, Robinson and Sirquin (1985) is to run cross-section regression, where growth rate is considered as a dependent variable and a set of economic indicators as explanatory variables. In addition to the standard neoclassical parameters, such as the saving and the growth rates of labour force, variables representing "structural sources of growth" (Islam 2001 11, p.475) are included. The residuals from these regressions have the potential to make TFP comparisons.

The cross-section growth accounting methodology proposed by Hall and Jones (1996, 1997) is similar to the time series growth accounting method, but now implemented along a cross-section direction. The main idea here is to apply the differentiation or differencing procedure in the cross-sectional dimension instead of the time direction which is usually applied. The direction in which index moves depends on the way economies are ordered.

Islam (2001 11) addresses the advantages and weaknesses of the cross-section growth accounting approach. Speaking of the advantages, he first points out that it is not necessary to impose a particular type of aggregate production function except for the purposes of differentiability and constant return to scale. Second, factor share parameters are permitted to differ across economies. Third, econometric estimation is not required in this approach; hence, the problems associated with such estimation can be avoided.

However, there are several weaknesses to this approach. Firstly, the necessity of prior ordering of countries can cause the sensitivity of indices to the ordering chosen. Secondly, the result can depend on the inclusion/exclusion of countries. Thirdly, the postulate of an invariable rate of return across economies, based on which the particular country values of the parameters of factors share are computed, is not confirmed by empirical studies. Fourthly, by using data of capital stock (as opposed to rates of investment) and human capital differences in cross-country TFP comparison, there is room for considerable error.

The panel approach to TFP convergence stems from recent attempts to explain the cross-country growth patterns (Islam 1995).

Assuming a Cobb-Douglas form (3) of the aggregate production function (2) where $L(t)$ is labour growing at an exponential rate n and $A(t)$ is labour augmenting technology that also grows at an exponential rate x, one can arrive to equation (25).

It should be noticed, that among the right hand side terms of equation (25), there is A_0 that is an initial level of TFP of certain economy. If it is assumed that x is constant across the economies in the sample, then the relative TFP level of either of the two economies is equal to the ratio of their baseline TFP levels and remains unchanged over time.

$$\frac{A_i(t)}{A_j(t)} = \frac{A_{0i}e^{xt}}{A_{0j}e^{xt}} = \frac{A_{0i}}{A_{0j}}$$

Hence, under the assumption of common TFP growth rates, the ratios of estimated initial TFP levels can be considered proxies of relative levels of TFP.

As has been pointed out above, relegating A_0 to the disturbance term of the regression equation may cause the problem of omitted variable bias. The panel data procedures can help overcome this problem by indirectly controlling for variations in A_0 and producing estimates for A_0.

The panel approach to TFP convergence study assumes a procedure that includes two stages. The first is the panel estimation build upon model based variables to yield estimation of A_0. Next, the determinants of differences of technology are found by analysing the estimated values of A_0 (Canova and Marcet 1995).

There are several advantages of the panel approach compared to the cross-section growth accounting approach. Firstly, in this method, no preliminary ordering of economies is required. Secondly, the inclusion/exclusion of countries is less influential on the results. Thirdly, this method is flexible with respect to the inclusion of human capital and with regard to the use of either capital stock or investment rate data.

However, some weaknesses of the approach are pointed out by Islam (2001 11). Firstly, a particular type of aggregate production function is required to implement this method. Secondly, the factor share parameters are assumed to be homogeneous across economies. Thirdly, as the method relies on econometric estimation it is subject to some estimation problems. Among them are small sample and endogeneity biases. The former arises because most panel estimators have asymptotic theoretical properties in their nature. The latter may arise because of the estimation procedure.

Di Liberto, Pigliaru and Mura (2007, p.7) point out that the approach of Islam (1995) "... rules out technology convergence by assumption," because "... all economies are assumed to grow at the same technological rate according to the process $\ln A_{it} = \ln A_{i0} + xt$, whatever their level of technological knowledge...". This sharply contradicts the technological catching-up hypothesis, which imply that during the period of transition to the steady state, where all countries or regions demonstrate the same long-run growth rate of technology, x, the technology level of lagging economies grow faster than common rate, x.

They note that the probability for the disparities in TFP levels to be not stationary over the sample time span increases with the time dimension of a panel since the technological catching-up mechanisms are more likely work. Therefore, the presence or absence of TFP convergence should be tested by considering TFP levels obtained by estimation of equation (26) over various periods. This approach is intended to reveal whether or not the observed TFP values are compatible with the catching-up hypothesis.

Thus, various approaches to study TFP convergence rely on different methods of calculating the TFP series of considered economies and different testing procedures. In this research, we use growth accounting methodology to calculate the TFP series and panel unit root tests to study TFP-convergence across Kazakhstan regions.

4.6.2 Panel Unit Root Tests

According to the traditional informal cross-sectional approach to the convergence study, the ordinary least squares (OLS) method is applied to equation (24) with the set of control variables and initial output taken as regressors. However, Evans (1996) following on from Friedman (1992) concludes that if ε_i is correlated with y_{i0} , then the OLS estimates of the parameters of equation (24) are biased, except under highly restrictive conditions that $[y_i - \frac{1}{N}\sum_{i=1}^{N} y_i]$ is a stationary process and the cross-economy disparities are continual. If these assumptions are fulfilled, then the sample of countries or regions said to converge and the conclusions on the heteroscedastic-consistent t-ratio of b and the F-ratio from γ_k of equation (24) are valid.

Evans and Karras (1996b) propose to use the following equation in order to test the stationarity of the demeaned series.

$$\Delta(y_{it} - \bar{y}_t) = \theta_i + \varphi_i\left(y_{i,t-1} - \bar{y}_{t-1}\right) + \sum_{s=1}^{l} \lambda_{is}\Delta(y_{i,t-s} - \bar{y}_{t-s}) + \nu_{it} \quad (32)$$

Where $\bar{y}_t = \frac{1}{N}\sum_{i=1}^{N} y_{it}$; ν_{it} is a series of randomly distributed shocks; φ_i is negative if economies converge and zero if they diverge; λ_i is a group of parameters for the serial correlation terms; θ_i is a fixed effect.

This approach is valid under much less restrictive conditions than the traditional one. However, Byrne, Fazio and Piacentino (2009) point out two limitations. The first is the untenable assumption that ν_{it} is uncorrelated. The second is the possibility that φ_i is equal to zero even if only a part of the economies in the set diverges.

In this research, following Evans and Karras (1996b) and Byrne, Fazio and Piacentino (2009), we use the time series approach to study TFP convergence across the Kazakhstan regions. This means that rather than apply the time series methods to equation (32) written in terms of output per capita, we use the same equation written in terms of the demeaned series of the logarithm of TFP:

$$\Delta TFP_{it}^{*} = \theta_i + \varphi_i TFP_{it}^{*} + \sum_{s=1}^{l} \lambda_{is} \Delta TFP_{i,t-s}^{*} + \nu_{it} \tag{33}$$

where $TFP_{it}^{*} = \ln(TFP_{it}) - \frac{1}{N}\sum_{i=1}^{N} \ln TFP_{it}$; TFP_{it} is the total factor productivity of the region i at time t.

To overcome the limitations of the approach of Evans and Karras (1996b) mentioned above, we use recent achievements of the panel unit root test technique.

The first test is one elaborated by Levin and Lin (1992) and further improved in (Levin, Lin and Chu 2002). It is similar to the test developed by Evans and Karras and can be regarded as a pooled augmented Dickey-Fuller (ADF) test. Similar to the univariate ADF, under the null hypothesis the test assumes that the series is non-stationary or integrated of order one. Using this test the time effects, individual effects, and possibly a deterministic trend can be taken into account. The drawback of this test is the assumption of the same autoregressive coefficient φ_i for each cross-section in the panel. This is potentially restrictive because it presumes the same speed of convergence to the mean of all cross-sections.

Im, Pesaran and Shin (2003) propose a test with less restrictive than in (Levin, Lin and Chu 2002) alternative hypothesis. The null hypothesis of it is that all the series are non-stationary. As in the Levin et al. test, it allows for common time effects, possible time trends, lags to account for serial correlation, and individual effects. Nevertheless, this test presumes that only a portion of the series is stationary under the alternative hypothesis.

These two tests are most commonly used in panel unit root literature (Byrne, Fazio and Piacentino 2009). However, Sarno and Taylor (1998) have proposed a multivariate variant of the augmented Dickey-Fuller test, which is an alternative to Levin et al. and Im et al. tests. It has some advantages when compared with them. Firstly, unlike the above-mentioned tests, it allows for the potential cross-sectional dependence of errors. Secondly, while the Levin et al. test is better to use for large N, small T panels, the Sarno and Taylor test can merely be used with panels where $T > N$. Hence, it is useful to study club-convergence. However, in this test, rejection of the null hypothesis of non-stationarity is possible even if only one of the series in the panel is stationary. This means that the rejection of the null hypothesis cannot be taken as evidence of full convergence.

Maddala and Wu (1999) offer another alternative to Levin et al. and Im et al. testing procedure. They propose to use Fischer's test, which is based on the combining of the p-values of individual unit root tests of each cross-sectional unit. Under the null hypothesis, the test assumes that all the series are non-stationary, while the alternative one assumes that at least one series in the panel is stationary. Banerjee (1999, p.616) notices, that "... the obvious simplicity of this test and its robustness to statistic choice, lag length, and sample size make it extremely attractive." Another advantage of this test is that it does not demand a balanced panel.

4.7 Sectoral Decomposition of Convergence

This section describes an empirical methodology which is called convergence decomposition. There are two forms of the decomposition of convergence: sectoral decomposition and channel decomposition. The former decomposes convergence according to the branches of an economy, while the latter decomposes convergence according to the production factors (Wei-Kang Wong 2001, 2002, 2006, 2007). In this research, the method of sectoral decomposition is applied to the analysis of inter-regional convergence in Kazakhstan.

Sectoral decomposition of convergence identifies the contribution of separate sectors (branches) to the convergence (divergence) process. In addition, it reveals an input of structural shifts in the convergence (divergence) process of a regional (national) economy.

In spite of the large literature on sectoral convergence (Bernard and Jones 1996a, 1996b, Gouyette and Perelman 1997, Freeman and Yerger 2001, Pascual and Westermann 2002), the empirical evidence is still inconclusive. Wei-Kang Wong (2002, 2006) proposed a new method of the analysis of the contribution of separate sectors to the convergence process. In particular, he proposed the β-decomposition method (further - a decomposition method). As the author stresses, the given method has a number of advantages in comparison with earlier offered ones.

Firstly, it avoids the problem of the use of purchasing-power parity (PPP) among sectors. It needs only PPP among the countries.

Secondly, the decomposition method takes into account all components that contribute to the process of convergence. These are: the growth of productivity in each sector, structural shifts in the economy expressed in the change of the structure of employment, and interaction between these two processes. That is, the decomposition method allows the division of convergence into three components.

The principle of the method is explained by the example of the conditional convergence equation (24). On the one hand, the growth rate of per capita output submits the following equation:

$$\Delta y_i = a + \sum_{k=1}^{K} \gamma_k x_{ik} + b y_{i0} + \varepsilon_i$$

On the other hand, it can be decomposed into a sum of different components, according to the growth in k sectors (Maddison 1952):

$$\Delta y = \sum_{j=1}^{k} \alpha_j \Delta y_j + \sum_{j=1}^{k} \alpha_j \Delta s_j + \sum_{j=1}^{k} \alpha_j \Delta y_j \Delta s_j \quad (34)$$

where y is output per worker, α_j is initial share of j-th sector in the economy, Δy_j is growth rate of output per worker in j-th sector, Δs_j is the growth rate of employment in j-th sector. The first term in the right side of equation (34) represents an effect of the influence of the growth of the labour productivity in the sectors on the total growth subject to the constant structure of employment and at an initial share of the given sector in a national economy. It can be seen from equation (34) that the effect of growth of labour productivity, in its turn, can be decomposed into the components measuring growth of productivity in the sectors. The second term shows an effect of structural shifts, i.e. an influence of the reallocation of a labour force across branches on economic growth at the assumption of constant labour productivity of each sector. The given effect has a positive or negative sign depending on whether a sector's share in a labour force has increased or fallen. The third term represents an interaction of the first two effects (covariance of the first two terms). It takes a positive value if the sectors, in which labour productivity grew faster than average growth, have increased their shares in a labour force; and negative if the share in a labour force has decreased.

Equations (24) and (34) describe the same effect - growth of total labour productivity. Connecting together their right parts, we can see that the initial per capita output influences per worker output growth through three channels: within-sector growth of labour productivity, structural shifts and the interaction effect.

$$b = \sum_{j=1}^{k} b_{Growth\ of\ productivity\ in\ j-th\ sector} + b_{Shift\ effect} + b_{Interaction\ effect} \quad (35)$$

where b is an estimate of the coefficient on the logarithm of output per worker at the initial time point in equation (24), $b_{Growth\ of\ productivity\ in\ j-th\ sector}$, $b_{Shift\ effect}$, $b_{Interaction\ effect}$ are the corresponding estimates of the coefficients if we use as the dependent variable in equation

(24) either a sector j's output weighted growth of labour productivity, or the shift effect, or the interaction effect.

Equation (35) describes sector decomposition. It asserts that poorer countries can grow faster than rich ones, if they have faster growth of labour productivity across sectors, faster overflow of a labour into the more productive, or a mixture of the first two conditions. In particular, $b_{Growth\ of\ productivity\ in\ j-th\ sector}$ assesses the contribution of the growth of productivity in sector j to the total convergence.

In order to illustrate this mechanism, let us assume that the j-th sector is an industrial one. A negative value of b_j specifies that, at the transition to the steady states, the growth of productivity of the industry in the poorer countries is higher than in richer ones. Hence, the growth of labour productivity in the industry should lead to general convergence. On the contrary, positive value of b_j means that the rich countries have faster growth in industry, i.e. growth in industry leads to divergence. The relative contribution of the industry to general convergence is equal to b_j/b. If an absolute value of this expression is close to zero, an industry does not render the essential influence on convergence (divergence). A sector which has the highest absolute value of the negative b_j/b, could be considered a main engine of an aggregate convergence of labour productivity.

The last two summands of equation (35) $b_{Shift\ effect}$, and $b_{Interaction\ effect}$, express the effects on convergence of reallocation of sectors and interaction.

A negative value of $b_{Shift\ effct}$, shows that, in the poorer countries, there is a faster overflow of labour force into more productive sectors. In this case, structural shifts in economy lead to convergence. Usually, effect of interaction is close to zero, specifying that this effect is practically absent and does not render significant influence on convergence.

The given method of decomposition does not depend on comparative productivity across sectors. However, it depends on the sectors' rates of growth of labour productivity and shares of labour force occupied in them. It also depends on the general comparative labour productivity level across economies. Existing estimations of PPP are constructed for exactly such comparisons. Therefore, this method allows avoiding a problem with the use of PPP (Wei-Kang Wong 2002).

In order to apply the decomposition on the real data, it is necessary to decompose the rate of growth of the output per worker on the components according to equation (34). Then it is required to regress these components on the logarithm of initial per capita output, a constant, and other conditioning variables according to equation (24). Significant estimations of b in regression equations specify the contribution to the labour productivity convergence of sectors, structural shifts and their covariance respectively.

4.8 Summary

In this chapter, we reviewed various empirical approaches to the convergence study. Islam (2003) points out the gradual advance from ‘informal cross-section’ to ‘formal cross-section,’ and then to the ‘panel’ approach of the study of convergence. The ‘distribution’ and the ‘time-series’ methods evolved collaterally.

The results of many empirical tests of convergence depend on used empirical methodology, which rests upon available data. In this research, we use several empirical approaches. The σ-sigma convergence hypothesis is checked using the distribution approach. In the study of absolute β-convergence across Kazakhstan regions, we use the cross-section approach. However, for the better comparison of results, the conditional β-convergence is checked using both cross-section and panel approaches. As to the TFP-convergence across Kazakhstan regions, we use the panel unit root tests to check correspondent hypotheses on the presence or absence of unit roots. The club-convergence is tested using the two-step methodology, which assumes a clustering of the set of regions and further checks for convergence within clusters using one of the above-mentioned approaches. In addition, in this thesis, we use the sectoral decomposition method, to study the input of various branches into the process of convergence across Kazakhstan regions.

CHAPTER 5.
σ- AND β- CONVERGENCE ACROSS KAZAKHSTAN REGIONS

5.1 Introduction

To evaluate more precisely the convergence or divergence patterns of per capita gross regional product across Kazakhstan regions we start with the most popular σ- and β- types of convergence. This study allows to reveal whether a strong regional policy directed towards the reducing of economic disparities is needed or the process of convergence takes place per se and the government does not need to worry about regional inequality. In addition, the study of conditional β-convergence helps identify conditioning factors responsible for the convergence/divergence behaviour and towards which the regional policy should be directed.

We test the σ-convergence hypothesis across Kazakhstan regions by studying the time-behaviour of both standard deviation and the coefficient of variation across the Kazakhstan regions. This helps determine the influence of the scale effect on the dynamics of differentiation, which is displayed in the case of standard deviation. In studying unconditional β-convergence we use cross-section approach, while the conditional β-convergence is tested using both cross-section and panel approaches.

5.2 σ-convergence across Kazakhstan Regions

To study σ-convergence across Kazakhstan regions we use the direct approach described in Section 4.4, which consists of computing the standard deviation or coefficient of variation of the logarithm of real per capita GRP of the economies included in a sample and plotting it against time.

Afterwards, in order to reveal a relationship between σ-convergence and the economic growth of the country, we attempt to discover a link between the level of differentiation across Kazakhstan regions, expressed by either standard deviation or coefficient of variation of the logarithm of real per capita GRP, and an aggregate trend of economic dynamics of the whole country, expressed by the growth rate of the total real per capita GRP. In order to check the statistical relationship between these variables, we use the following regression equation.

$$Dif_t = aI_t + b + u_t,\ t = 1994, \dots, 2009 \tag{36}$$

where Dif_t is either the standard deviation (σ_t) or coefficient of variation (C_v) of the logarithm of real per capita GRP across Kazakhstan regions in year t, I_t is the growth rate of the total real per capita GRP of the country, b is a constant term u_t is the disturbance term.

5.2.1 Data

Data of the nominal gross regional product of oblasts since 1993 is taken from the Regions of Kazakhstan statistical issue (1993-2009a). This indicator measures factor incomes derived from production within a region. Barro and Sala-i-Martin (1992a) stress that GRP figures represent the income accruing to factors from the goods and services produced within a region. Then, we deflate the nominal figures by the aggregate GDP deflator available from the Statistical Yearbook of Kazakhstan (1993-2009b). Since we use a common deflator for each region at a point in time, potential measurement errors can occur. After dividing this data with the size of the population of corresponding regions, we obtain a sampling of the real per capita GRP across the Kazakhstan regions (Table 5.1).

Table 5.1: Real per Capita GRP of Kazakhstan Regions.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Akmola	2223.76	1915.33	1365.76	1206.61	871.45	774.87	1089.44	975.50	1149.64	1173.05	1225.18	1346.88	1345.60	1609.34	2230.77	2183.40	2303.56
Aktobe	1906.37	1819.55	1545.75	1256.40	1573.53	1662.71	1503.46	1611.42	1802.02	2085.67	2362.77	2705.06	3167.58	3523.93	3959.19	4150.60	3846.28
Almaty oblast	910.52	823.06	688.91	871.73	869.32	771.14	707.27	725.75	849.67	899.81	944.25	992.09	1043.03	1194.98	1375.21	1377.85	1479.39
Atyrau	1390.05	2729.62	3023.49	3296.23	3567.00	2937.28	3473.56	5464.16	6042.99	7267.52	8807.54	8740.11	9168.19	10788.19	10325.96	12159.75	12428.67
West Kazakhstan	1349.27	1158.35	900.17	805.31	1215.99	1209.04	1409.29	1857.44	2193.74	2433.72	2620.54	3688.26	3482.65	3964.43	4119.55	4529.96	4269.98
Zhambyl	853.04	646.69	473.62	745.35	643.30	575.87	529.85	515.98	550.25	616.61	759.12	837.01	865.80	902.68	1073.29	1068.22	1082.77
Karaganda	1943.69	2180.73	2287.31	1582.70	1739.17	1699.86	1838.24	2005.50	2102.52	2145.44	2246.06	2357.84	2667.35	3264.86	3498.82	3685.16	3631.57
Kostanay	3044.78	2294.52	1330.90	1209.59	1725.94	1531.62	1507.63	1512.71	1540.53	1562.65	1736.26	1850.65	1864.95	2039.18	2571.64	2685.51	2645.48
Kyzyl-Orda	854.83	875.74	807.90	937.06	940.28	799.71	709.16	883.30	1007.72	1318.35	1538.58	1812.09	2048.72	2758.39	3243.01	3621.91	3013.14
Mangistau	745.39	2428.09	3591.62	4013.57	3051.97	2386.17	3001.21	3937.80	4032.97	4909.79	4697.92	5173.44	6186.83	7209.52	7620.86	8729.95	8045.41
South Kazakhstan	796.76	636.88	474.79	682.61	686.35	616.55	657.64	760.82	906.52	873.68	907.96	867.87	830.38	879.38	1076.74	1041.53	1234.13
Pavlodar	2550.38	2740.44	2607.12	2219.13	1625.78	2135.12	1666.62	2005.91	2294.72	2273.62	2526.82	2794.95	2710.38	2940.93	3254.16	3906.00	3722.03
North Kazakhstan	1400.89	1664.50	1790.54	1951.25	1511.85	1075.84	1113.83	913.43	1213.72	1170.44	1216.69	1380.31	1424.30	1698.50	2010.63	2108.52	2033.83
East Kazakhstan	1400.58	1514.41	1553.66	1322.65	1463.67	1548.65	1522.09	1449.25	1558.84	1552.07	1579.09	1660.41	1685.08	2046.66	2317.65	2128.99	2245.73
Astana city	0.00	0.00	0.00	0.00	1235.35	1921.62	2465.12	2690.89	2928.86	3669.88	4446.15	5378.63	6737.01	7897.23	7722.48	6852.88	6502.86
Almaty city	1825.90	1661.22	1571.68	2779.52	3224.70	3357.55	3418.16	3199.52	4011.10	4603.84	5016.74	5528.28	6182.96	8368.32	8289.28	7327.92	7324.04

Notes: Tenge in constant prices of 1993.
Source: Regions of Kazakhstan (1993-2009), author's calculation

5.2.2 Results

At first, we calculate the time-series of the standard deviation of the GRP across Kazakhstan regions over the period of 1993-2009 using equation (16) and plot them against time. Figure 5.1 shows the time path of the standard deviation of relative gross regional product per capita (defined as a logarithm of per capita GRP measured in deviations from its inter-regional average) of Kazakhstan regions over the period of 1993-2009. The case of the Kazakhstan regions shows a contradiction with what is reported in most available regional samples of developed countries (de la Fuente 2002a, Barro and Sala-i-Martin 2003), but conforms to the experience of the regions of transition countries (Petrakos 2001, Iodchin 2007, Skryzhevska 2008).

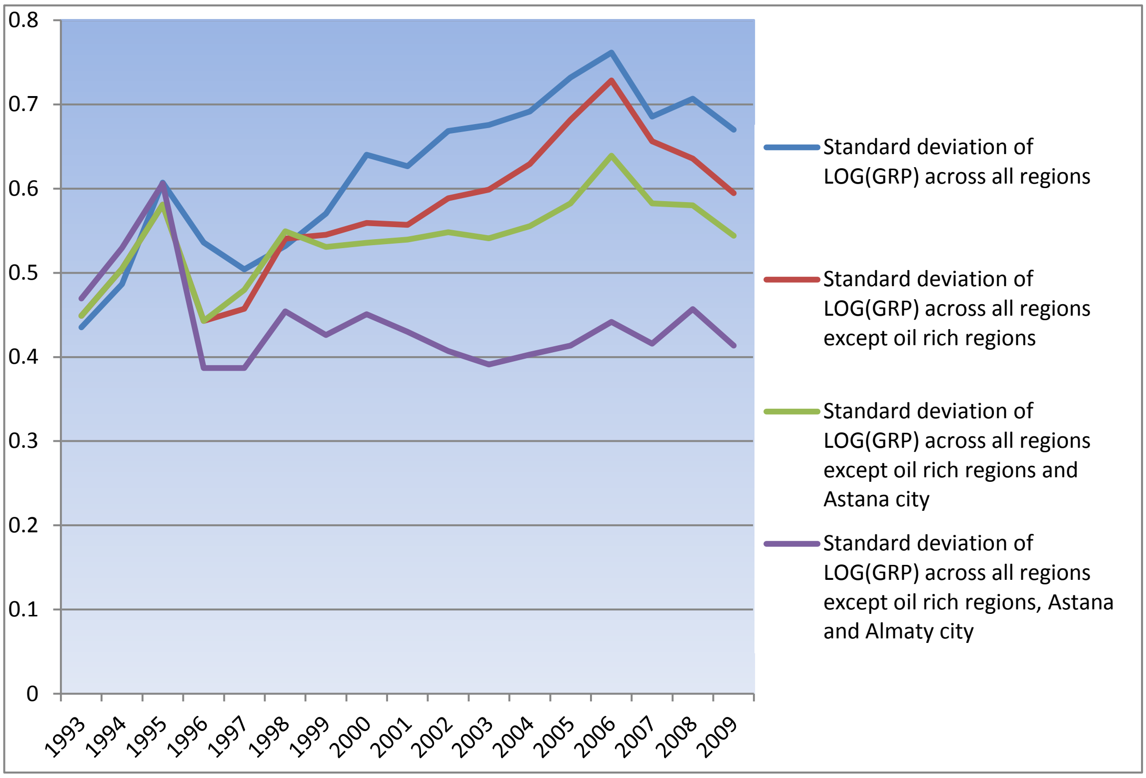

Figure 5.1: σ-convergence across Kazakhstan regions over the period of 1993-2009 in terms of standard deviation

The pattern of σ-convergence across Kazakhstan regions rather can be called σ-divergence. Over the period as a whole, across all 16 regions, the standard deviation of logarithm of real per capita GRP has grown by approximately 54%. However, there were four convergence sub-periods (1995-1997, 2000-2001, 2006-2007, and 2008-2009), when the level of inequality fell insignificantly (Figure 5.1, blue curve).

This phenomenon can be explained by several reasons. The first is the rise of oil prices over the observed period. If the oil-rich oblasts (Aktobe, Atyrau, Kyzyl-Orda, West Kazakhstan and Mangistau) are excluded from the sample, the curve becomes more flat, but still growing.

Despite the exclusion of these untypical regions, the standard deviation has grown approximately by 32.5% (Figure 5.1, red curve).

The second reason is the shock related to the movement of the capital to the city of Astana. It is an extraordinary case because a huge amount of government resources has been spent on the construction of new administrative, educational, and cultural infrastructures over the last 13 years. If we exclude Astana and the oil rich regions from the sample, the time path of standard deviation expressed by the green line exhibits more moderate growth (21%). The inclination of the curve is not so abrupt, but the tendency remains the same as before. The rest of regions of Kazakhstan demonstrate σ-divergence over the period of 1993-2009 (Figure 5.1, green curve).

In addition to Astana and the oil-rich regions, the exclusion of Almaty city from consideration, changes the behaviour of a standard deviation of logarithm of real per capita GRP. It now decreases over the period by 12% indicating σ-convergence across the remaining eight regions (Figure 5.1, purple curve). Almaty city is the former capital of the country, and is still a centre of economic activity for the whole country. Its economy has been characterized by impressive growth over the last 17 years.

There are examples in the literature of similar σ-divergence patterns over periods characterized by external or internal shocks such as oil prices or demand for agriculture production. For example, across US states in the period 1920-1930, or across Spanish regions in the period 1960-1964 and 1980-1983 (de la Fuente 2002a).

Another reason of the observed σ-divergence across the regions of Kazakhstan is the transition period from a planned Soviet economy to a market-based one. This σ-divergence behaviour is similar to the behaviour of regions of such transition countries as Poland, Hungary, Romania and Bulgaria (Petrakos 2001), Russia (Iodchin 2007), and Ukraine (Skryzhevska 2008).

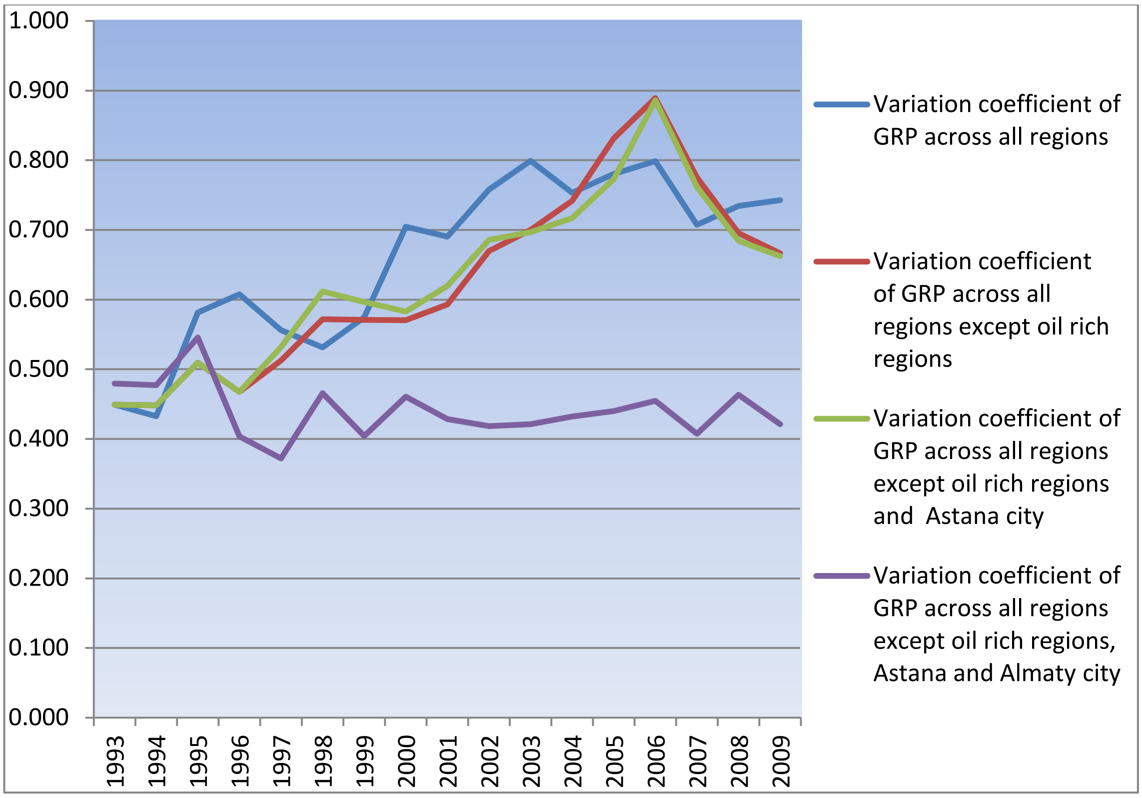

Figure 5.2: σ-convergence across Kazakhstan regions over the period of 1993-2009 in terms of coefficient of variation

We shall go on to use the coefficient of variation of the real per capita GRP across the Kazakhstan regions as a measure of regional differentiation according to equation (17) in order to study σ-convergence. Plotting it against time, we observe almost the same picture (Figure 5.2). Again, over the period as a whole and across all regions, the variation coefficient has grown (by 65%). When we exclude oil-rich regions and the city of Astana from the sample, the variation coefficient is still growing (up to 48% and 47% respectively). If we additionally exclude the city of Almaty, the coefficient of variation falls by 12%.

As for the relationship between σ-convergence and the economic growth of the country, the results of the regression of equation (36) are presented in Table 5.2. As can be seen from the first line of the table, the relationship between the standard deviation of the logarithm of real per capita GRP across Kazakhstan regions and the growth rate of real per capita GRP of the country is positive and significant at 5% confidence level. The similar result is shown in the second row of the table, which presents the results of the regression of the same equation with the coefficient of variation taken as a dependent variable. Again, the estimate of the coefficient of the independent variable is positive and significant at 5% confidence level.

Table 5.2: Linear regression of the σ-convergence on the real per capita GRP of the country

Dependent variable	a				b				Adj R^2
	Estimate	St. error	t-value	Sig.	Estimate	Standard error	t-value	Sig.	
Standard deviation across all regions (1994-2009)	0.679	0.252	2.699	0.017	0.594	0.022	26.796	0.000	0.295
Coefficient of variation across all regions (1994-2009)	0.069	0.025	2.737	0.016	0.079	0.002	35.642	0.000	0.349

This means that higher growth rates of real per capita GRP in the country are associated with higher levels of inequality. A similar result was obtained by Petrakos and Saratsis (2000) for Greek regions over the period of 1970-1995, Petrakos, Rodríguez-Pose, et al. (2003) for European regions of several EU countries over the period of 1981-1997, Shiltcin (2010) for the Russian regions over the period of 1998-2007, and others. This phenomenon is discussed in details by Petrakos, Rodríguez-Pose, et al. (2003) who suggested "... an alternative dynamic framework" (p.1) for the study of convergence across some European regions, using an econometric equation connecting inequality with growth rates, levels of GDP, and the measure of integration into the European Union. They found that both long-term convergence and short-term divergence processes coexist, and described a pro-cyclical pattern of regional inequalities. The reason is that "... dynamic and developed regions grow faster in periods of expansion and slower in periods of recession" (p.1). In other words, growth impulses are realized mainly at the expense of more economically developed and productive regions, which are more capable to exploit their advantages and increase the gap between them and less productive regions. Berry (1988) argues that the deepening or lessening of regional disparities depends on whether a country is in a growing or recession phase of the economic cycle. This opinion, that directly links high growth rates with increasing economic disparity is in accordance with Myrdal's (1957) reasoning of the spatially cumulative nature of growth and the argument of the influence of agglomeration economies on the regional allocation of resources (Krugman 1991b, 1993). A logical basis for this statement is that a new cycle of economic expansion begins in more developed regions, where the combination of the effects of agglomeration and the size of market promote an advantage over other regions. These effects could be connected to the higher quality of human capital, the R&D activities in a region, the links between science and industry, the inter- and intra- sectoral interactions among firms and so on (Petrakos, Rodríguez-Pose, et al. 2003).

This phenomenon has both theoretical and practical implications. From the theoretical point of view, it confirms a hypothesis of Petrakos, Rodríguez-Pose, et al. (2003) that along with the long-term convergence tendency predicted by the neoclassical growth model and realised by the diminishing returns of capital, there is a short-to-medium-term divergence tendency, caused by the agglomeration economies. However, the issue of the relative prevalence of these opposite tendencies is still unclear and needs further research.

The phenomenon is also important from the policy-making point of view. It means that economic growth is not the main driver for decreasing regional disparities, which "have a pro-cyclical character and tend to increase in periods of economic expansion" (p.20). A positive relation between economic growth and regional disparities means that the former will inevitably generate the latter no matter what other factors may influence the evolution of regional inequality. So regional policy directed towards diminishing of regional inequalities should be permanent and be provided with a sufficient budget. It could be said that regional inequality is some sort of "price" for economic growth, which should be paid in the form of regional policy.

5.3 Unconditional β-Convergence Across Kazakhstan Regions.

5.3.1 The Model

The next step to study convergence across the Kazakhstan regions is to test the hypothesis of β-convergence. As discussed earlier, the latter can be either unconditional (absolute) or conditional. We shall start with the unconditional β-convergence.

In the framework of the neoclassical growth model, we use the equation employed by Barro and Sala-i-Martin (1992a), which follows from (12) and produces the following relationship between output per capita at the time $t_0 + T$ and the steady-state value y^*:

$$\frac{1}{T}\log\frac{y_{i,t_0+T}}{y_{i,t_0}} = x + \left(\frac{1-e^{-\beta T}}{T}\right)\log\frac{y^*}{y_{t_0}} + u_{i,t} \qquad (37)$$

where x is the rate of technological progress (the model assumes an exogenous labour augmenting technological progress expressed by equation (4)), $u_{i,t}$ is a disturbance term.

For the fixed x, T, β the average rates of growth are the higher the greater the gap between the initial and steady state values of y, i.e. convergence is conditional on the steady-state value y^* of an economy.

Under the assumption of constant values for x and y^* across regions (Barro and Sala-i-Martin 1992a) the average rate of growth of real per capita GRP over the interval between two points in time, t_0 and $t_0 + T$, is given by the equation:

$$\frac{1}{T}\log\frac{y_{i,t_0+T}}{y_{i,t_0}} = A\log y_{i,t_0} + B + u_{i,t_0,t_0+T} \tag{38}$$

where $A = -(\frac{1-e^{-\beta T}}{T})$, $B = x + \left(\frac{1-e^{-\beta T}}{T}\right)(\log y^* + xt_0)$, u_{i,t_0,t_0+T}. is a distributed lag of the error terms $u_{i,t}$ between the dates t_0 and $t_0 + T$. The constant term B, which is assumed to be independent of i, shifts because of the trend in technology with a change in the starting date t_0. The factor A of $\log y_{i,t_0}$ declines in magnitude with the length of the interval T for a given value of β. It means that in the linear regression estimation the coefficient is predicted to be the smaller the longer the time interval over which the growth rate is averaged. This is because the growth rate declines as income increases, i.e. the influence of the initial position of income on the average rate of growth declines as the time interval increases.

The speed of convergence β can be calculated either directly (Barro and Sala-i-Martin 1992a) from equation (38) using nonlinear least squares regression or indirectly (Paas et al. 2007) getting estimates of A and B from equation (38) by means of the ordinary least squares regressions and calculating the estimates of the rate of convergence β as follows:

$$\beta = -\frac{1}{T}\ln(1 + AT) \tag{39}$$

As the estimation results with respect to values and the significance of the speed of convergence and other coefficients are almost identical in the case of Kazakhstan regions, further, we use linear least squares regression approach and calculate the speed of convergence β from equation (39).

5.3.2 Data

We use the data of the real per capita gross regional product y_{it} for a cross section of 14 Kazakhstan regions (oblasts) and two node cities (Astana and Almaty) over the period of 1993-2009 (Table 5.1). Following Alshanov (2011), Sabden (2011) and others, we divide this time span into two sub periods: 1993-2000 and 2000-2009.

The first sub-period can be called a transition period from the planned to the market-based economy, accompanied by the redistribution of property and structural reorganization. During it, the legislative base for market relations was established, macroeconomic stability was provided, and privatization of the majority of state enterprises was finished. Due to the structural reorganization of the Kazakhstan economy and the Asian financial crisis of 1997-1998, this sub period is characterized by low rates of economic growth both for the country as a whole and in most regions. Seven regions out of sixteen demonstrated negative average growth rates over this period (Table 5.3). At the same time, such oil-rich regions as Atyrau, West Kazakhstan, and Mangistau showed very high growth rates of real per capita GRP over this period (Mangistau – 42.37%; Atyrau – 26.04%; West Kazakhstan – 7.4%). The two capitals, Astana and Almaty, are also among leaders in economic development (Astana - 31%, Almaty – 11.14%).

The second period of 2000-2009 is much more economically successful for the Kazakhstan regions. It is characterized by stable and rapid economic development in all regions of the country. Average growth rates of regions vary from 4.28% to 16.41% per year. The average growth rate of the country is equal to 8.6% per year. However, due to the world economic crisis of 2008, the growth rate of the country made up 3.3% in 2008 and 1.2% in 2009 (Table 2.2).

Table 5.3: Average growth rates of real per capita GRP of Kazakhstan regions

Region	Average growth rate of real per capita GRP over the period of 1993-2000	Average growth rate of real per capita GRP over the period of 2000-2009
Kazakhstan	0.69	8.6
Akmola	-8.99	8.53
Aktobe	-1.40	10.07
Almaty oblast	-2.37	7.79
Atyrau	26.04	14.68
West Kazakhstan	7.40	12.57
Zhambyl	-4.05	7.69
Karaganda	1.59	7.22
Kostanay	-6.51	6.05
Kyzyl-Orda	1.33	16.41
Mangistau	42.37	10.97
South Kazakhstan	1.57	7.00
Pavlodar	-1.33	8.70
North Kazakhstan	-4.35	7.09
East Kazakhstan	0.83	4.28
Astana city	31.00	10.93
Almaty city	11.14	8.75

Source: Regions of Kazakhstan (1993-2009), author's calculation

Thus, we study β-convergence across Kazakhstan regions over three periods: 1993-2009, 1993-2000, and 2000-2009.

5.3.3 Results

Table 5.4 contains the results of the linear least squares regressions in the form of equation (38) for the 14 Kazakhstan regions and the cities of Astana and Almaty. The rate of convergence β is computed using equation (39).

Table 5.4: Absolute β-convergence across Kazakhstan regions

Sample	A				B				Rate of convergence β	Adj R^2
	Estimate	St. error	t-value	Sig.	Estimate	Standard error	t-value	Sig.		
All regions 1993-2009	-.044	.026	-1.673	.116	.369	.189	1.952	.071	0.076	.107
All regions 1993-2000	-.088	.056	-1.576	.137	.654	.406	1.610	.130	.137	.090
All regions 2000-2009	.001	.009	.080	.937	.078	.063	1.244	.234	-.001	-.071

The regression results presented in Table 5.4 do not confirm the hypothesis of absolute β-convergence across the Kazakhstan regions over any of the three sub-periods under consideration. The coefficient of initial level of per capita GRP is never statistically significantly different from zero, although it is negative in the regressions over the 1993-2009 and 1993-2000 periods.

Obtained regression results are confirmed by the scatter charts relating growth rates of logarithm of real per capita GRP to the logarithm of initial levels of real per capita GRP of the Kazakhstan regions. These charts presented in Figure 5.3 - Figure 5.5 do not display any systematic tendency for the dots to form negatively sloping lines.

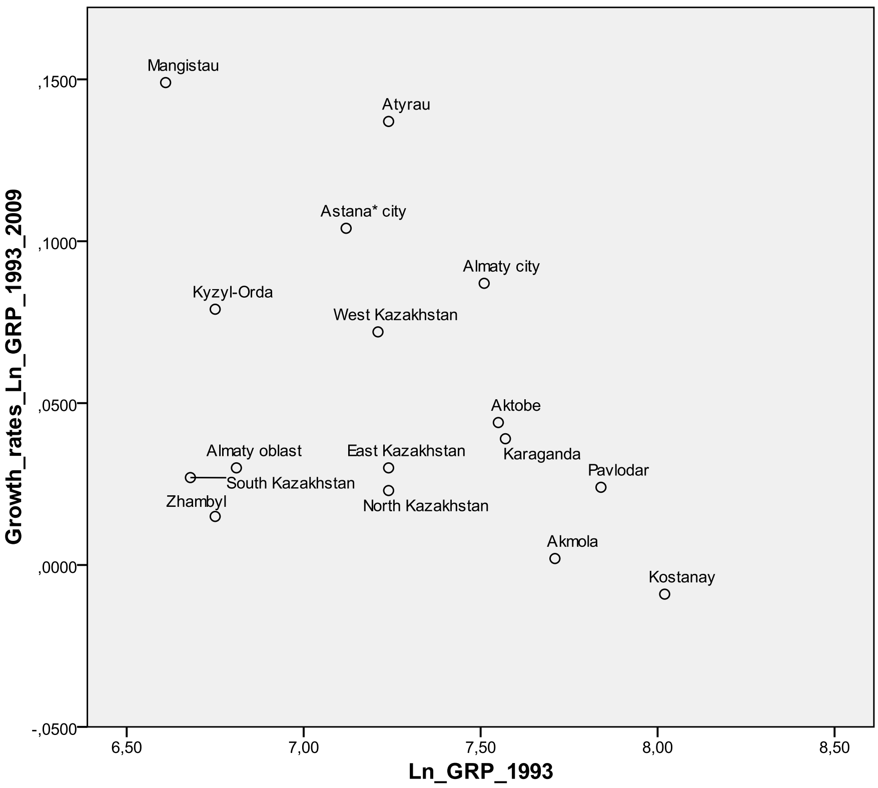

Figure 5.3: Scatter plot for convergence across Kazakhstan regions over the period of 1993-2009

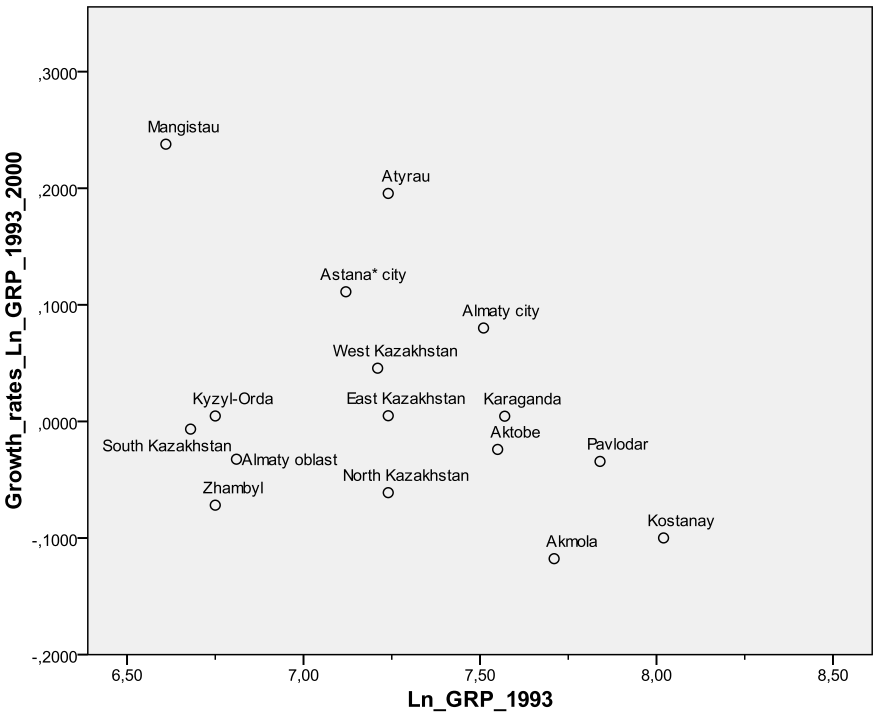

Figure 5.4: Scatter plot of convergence across Kazakhstan regions over the period 1993-2000

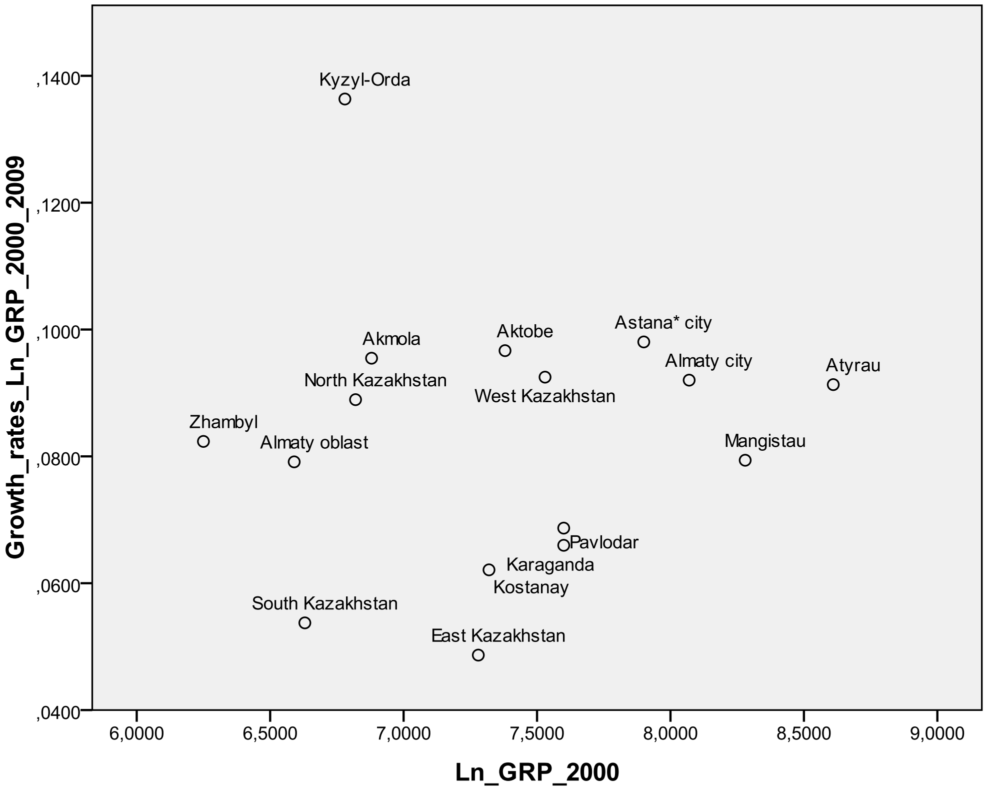

Figure 5.5: Scatter plot of convergence across Kazakhstan regions over the period of 2000-2009

Thus, the Kazakhstan regions considered altogether do not demonstrate the unconditional β-convergence over the sub-periods of 1993-2009, 1993-2000, and 2000-2009. These results contradict what is observed in the literature concerning absolute β-convergence across regions of the developed countries (Sala-i-Martin 1996), but are similar to the lack of absolute β-convergence across regions of transition countries (Petrakos 2001, Iodchin 2007, Skryzhevska 2008). Moreover, they do not contradict the predictions of the neoclassical growth model, which supposes the convergence of each region towards its own steady state position. The statistical insignificance of regression coefficients could be caused by the considerable differences in steady state positions across the Kazakhstan regions. Therefore, to explain fully the convergence behaviour of the Kazakhstan regions we need to control some variables responsible for these differences, i.e. to study conditional β-convergence across Kazakhstan regions.

5.4 Conditional β-convergence across Kazakhstan Regions.

To study conditional β-convergence across the Kazakhstan regions we use the two empirical approaches discussed earlier: the formal cross-section approach and the panel approach. As most of initial β-convergence studies have used the cross-section approach it is natural to compare the results obtained for the Kazakhstan regions with those discussed in the literature. The reason for using the panel approach is that it gives results which are more reliable for avoiding such problems of the cross-section approach as omitted variables bias problem or time series variations and dynamic properties of the data. Additionally, it is important to compare the results obtained by using both approaches.

5.4.1 The Cross-Section Approach.

The Model

If we drop the assumption of constant steady state values y^* across regions in equation (37), then the conditional convergence model with added control variables written for region i is given as:

$$\frac{\log y_{i,t_0+T} - \log y_{i,t_0}}{T} = \alpha - \frac{1}{T}\left(1 - e^{-\beta T}\right)\log y_{i,t_0} + \sum_{j=1}^{K} \gamma_j X_j + \nu_i \qquad (40)$$

where y_{it} is the real per capita gross regional product at time t; X_j are conditional variables, which control for differences in steady state positions across economies, γ_j are respective coefficients.

In studying conditional β-convergence, the key issue is to select appropriate variables that proxy the steady state of regions of a country. In the literature, "… more than 50 variables have been used in this type of analysis and have been found to be significant in at least one regression" (Siriopoulos and Asteriou 1998, p.543). However, the most frequently used are variables that approximate saving rate and population (Mankiw, Romer and Weil 1992, Barro and Sala-i-Martin 2003).

In order to obtain a statistically significant model, it is necessary to have at least 3-5 observations per one factor (Borodich 2000, Berezhnaya and Berezhnoy 2006). Therefore, we cannot include too many control and environmental variables in the model. As there are only 16 observations (regions), the maximum number of explanatory variables is five. The first variable, which must be included in the model, is the logarithm of initial per capita GRP. The second variable is a free term, which takes into account the influence of omitted factors. Therefore, only three additional factors can be included in the model to control the shocks that might have an influence on the growth rates of Kazakhstan regions. It is important to select the requisite factors to have maximum influence on the dependant variable.

Conditioning Variables and Data

In order to control the shocks that may influence the rates of growth of Kazakhstan regions, several additional variables are considered.

Barro and Sala-i-Martin (2003) use the ratio of real gross domestic investment to real GDP (I/Y) as one of the control variables in their convergence study across countries. Their motivation is based on the fact that, in the neoclassical growth models of Solow-Swan and

Ramsey, the higher values of I/Y raises the steady-state output level per effective worker. In the present research, we use the logarithm of the ratio of real gross regional investments in fixed assets to the real gross regional product as the average value over our chosen sub-periods.

To control the possible influence on the per capita output growth rates from a population change, Austin and Schmidt (1998) use the data of the population change over the considered time span. The variable reflecting the growth of population is calculated as the difference of logarithms of population at the end and at the beginning of a considered period divided by the length of the time span.

Many regions of Kazakhstan have sizeable shares of their output originating from agricultural sources. Agricultural output is highly changeable, and is often an important factor of economic growth in rural areas. Therefore, one of the selected variables is the share of the output accounted for by the agricultural production in the base period. It takes into account the shocks in the agricultural sector. It is assumed that the variations in agricultural output described by the share variable capture the diversity of the importance of agriculture to the regions. As the shares of the agricultural sector are available only for 1997-2009, the average value over this period is taken as a measure of the importance of agriculture in terms of the output of a region (Barro and Sala-i-Martin 1992a).

Thus, we take three extra variables, which are denoted as follows: Pop_i is the variable reflecting population change; $Agry_i$ is the variable reflecting agricultural share in gross output; I_div_Y is the logarithm of the ratio of real gross regional investments in fixed assets to the real gross regional product.

Results

Table 5.5: Conditional convergence across Kazakhstan regions over the period of 1993-2009

		Unstandardized Coefficients		Standardized Coefficients	t statictics	Sig.
		B	Std. Error	Beta		
1993-2009	(Constant)	.527	.091		5.766	.000
	Ln_GRP_1993	-.049	.012	-.460	-4.166	.002
	Ln_I_Div_Y	.053	.009	.587	5.563	.000
	Ln_Pop	-1.147	.406	-.479	-2.822	.017
	Ln_Agry	-.022	.004	-.784	-5.983	.000
	Adjusted R Square				.907	
	Std. Error of the Estimate				.014	
	F statistic				37.632	
	Significance				.000	

	Rate of convergence	0.097

Table 5.5 contains results of the regression analysis of equation (40) over the period of 1993-2009 obtained using the Ordinary Least Squares method. There are three control variables reflecting saving rate, population growth, and share of agriculture in the model. The regression model is significant and has the high value of adjusted R^2. All the coefficients are highly significant and have predicted signs. For example, the logarithm of initial GRP enters with a negative sign indicating that initially poor Kazakhstan regions were growing faster than rich ones over the chosen period. The variable approximating logarithm of the saving rate enters with a positive sign that confirms a positive dependence of the growth rate on the saving rate. The variable approximating logarithm of population growth enters with a predictable negative sign reflecting the fact that per capita growth rate negatively depends on population change. As to the variable reflecting the share of the agricultural sector, it enters with a negative sign. This confirms the widespread opinion that the share of agricultural sector negatively influences the growth rate of an economy. The speed of convergence is calculated using equation (39), where A is the coefficient of the logarithm of GRP at the initial year. Over the period of 1993-2009 Kazakhstan regions converged at the speed of 9.7% per year.

Table 5.6: Conditional convergence across Kazakhstan regions over the period of 1993-2000

		Unstandardized Coefficients		Standardized Coefficients	t statictics	Sig.
		B	Std. Error	Beta		
1993-2000	(Constant)	.949	.286		3.317	.007
	Ln_GRP_1993	-.105	.039	-.462	-2.703	.021
	Ln_I_Div_Y	.062	.031	.404	1.982	.073
	Ln_Pop	-.853	.867	-.207	-.984	.346
	Ln_Agry	-.006	.002	-.609	-3.193	.009
	Adjusted R Square				.745	
	Std. Error of the Estimate				.050	
	F statistic				11.935	
	Significance				.001	
	Rate of convergence				0.190	

Table 5.6 presents ordinary least squares regression results of equation (40) over the period of 1993-2000. Again, the regression model is significant and has a rather high level of adjusted R^2. The logarithm of the initial GRP enters significantly at the 2.1% confidence level and has a negative sign confirming the hypothesis of convergence. The variable approximating saving rate enters with a positive sign and is significant at 7.3% confidence level. The variable reflecting

population growth enters insignificantly with a negative sign. The variable ln_$Agry$, which reflects the share of the agricultural sector in an economy enters highly significantly with a predicted negative sign. The speed of convergence over this period is equal to 19% per year.

Table 5.7: Conditional convergence across Kazakhstan regions over the period of 2000-2009

		Unstandardized Coefficients		Standardized Coefficients	t statictics	Sig.
		B	Std. Error	Beta		
2000-2009	(Constant)	.357	.143		2.505	.029
	Ln_GRP_2000	-.029	.016	-.897	-1.796	.100
	Ln_I_Div_Y	.029	.014	.688	2.100	.060
	Ln_Pop	-.556	.639	-.441	-.869	.403
	Ln_Agry	-.012	.008	-.969	-1.437	.179
	Adjusted R Square				.161	
	Std. Error of the Estimate				.019	
	F statistic				1.718	
	Significance				.216	
	Rate of convergence				0.033	

As to the period of 2000-2009, the regression model described above is insignificant and has the value of the adjusted R^2 equal to 0.161 (Table 5.7). The logarithm of the initial (2000) GRP enters with a negative sign and is significant at the 10% confidence level. Among conditioning variables, only the logarithm of the saving rate enters positively and is significant at the 6% confidence level, while logarithms of the population growth and share of agricultural sector enter insignificantly, however with predicted negative signs. The speed of convergence is equal to 0.33% per year.

Thus, the regions of Kazakhstan do demonstrate conditional β - convergence to their steady state positions over the period of 1993-2009 and sub-periods of 1993-2000 and 2000-2009 with the three additional factors included in the regression equation as control variables, intending to control the shocks that may have an influence on the growth rates of the regions. The average speed of convergence over the whole period of 1993-2000 is equal to 9.7% per year.

However, the process of convergence took place mainly in the first sub-period of 1993-2000 with a speed of 19% per year, while the sub-period of 2000-2009 is characterized by the considerably lower speed of 3.3% per year. This result contradicts the empirical evidence of convergence across regions of the United States, Japan, and five European countries, as discussed in (Sala-i-Martin 1996), where "... the speeds at which regions of different countries converge over different time periods are surprisingly similar: about two percent per year" (p.1349).

In addition, the speeds of convergence for the regional data sets estimated in a variety of studies do not change considerably when the conditioning variables that are usually included in the cross-country regressions are held constant. In the case of Kazakhstan regions, it is quite the contrary: the inclusion of conditioning variables change the situation from the absence of absolute β-convergence to the presence of conditional one. The transition type of the Kazakhstan economy could explain this.

5.4.2 Panel Approach to Test $\boldsymbol{\beta}$-convergence across Kazakhstan Regions

The reason for applying the panel approach to convergence study across the Kazakhstan regions lies in the econometric difficulties that production function differences create in the framework of single cross-section regressions. The panel data approach makes it possible to take account of the distinctions in the aggregate production functions across the Kazakhstan regions in the form of unobservable fixed individual effects. Therefore, the objective of this section is to test the presence of conditional β-convergence across the Kazakhstan regions using the panel approach.

We follow the methodology developed by Islam (1995) who deviating from Mankiw, Romer and Weil (1992), introduces the possibility of correlation between the unobservable differences in TFP and other regressors. He uses a suitable panel approach to estimate the equation:

$$y_{it} = \gamma_1 y_{i,t-\tau} + \beta_1 x_{1i,t} + \beta_2 x_{2i,t} + \mu_i + \eta_t + \varepsilon_{it} \tag{41}$$

where

$y_{it} = \ln y_{t_2}$, $y_{t-\tau} = \ln y_{t_1}$, $\gamma_1 = 1 + \gamma = e^{-\beta\tau}$, $\beta_1 = \left(1 - e^{-\beta\tau}\right)\frac{\alpha}{1-\alpha}$, $\beta_2 = -\left(1 - e^{-\beta\tau}\right)\frac{\alpha}{1-\alpha}$, $x_{1i,t} = \ln s_{i,t}$, $x_{2i,t} = \ln(n_{i,t} + x + \delta)$, $\mu_i = \left(1 - e^{-\beta\tau}\right)\ln A_{0i}$, $\eta_t = x(t_2 - e^{-\beta\tau}t_1)$, ε_{it} is the transitory error term, which varies over time periods and across the regions and has a zero mean value.

This equation follows from equation (26) after rewriting it in the conventional notation of the panel literature. Here, the technology is summarized by two terms: the component $\eta_t = x(t_2 - e^{-\beta\tau}t_1)$ that captures the time trend and the common growth rate of the technology, and a time-invariant component $\mu_i = \left(1 - e^{-\beta\tau}\right)\ln A_{0i}$ that changes across regions and is supposed to control cross-regional technology levels.

It is worth mentioning that Mankiw, Romer and Weil (1992) and Islam (1995) point out that this term covers various unobservable factors like climate, institutions, geography, policy and so on. However, regions of the same country are relatively homogeneous with respect to these factors.

Since technology is probably correlated with other regressors, Di Liberto, Pigliaru and Mura (2007), referring to Baltagi (2003), propose to use a fixed-effect estimator. After the estimation of individual intercepts, a proxy of TFP can be easily computed by:

$$A_{0i} = \exp(\frac{\mu_i}{1-e^{-\beta\tau}}) \quad (42)$$

Hence, the degree of cross-region technology heterogeneity can be obtained using this methodology.

Following Di Liberto, Pigliaru and Mura (2007), we modify equation (41) writing it in a difference form aiming to control the presence of a possible stochastic trend (the common component of technology across the regions) and of a time-trend component η_t. This allows us to avoid the problem of cointegration. We use Kazakhstan data of the per worker gross regional product to estimate the following equation:

$$\tilde{y}_{it} = \gamma_1 \tilde{y}_{i,t-\tau} + \sum_{j=1}^{2} \beta_j \tilde{x}_{ji,t-\tau} + \mu_i + u_{it} \quad (43)$$

where $\tilde{y}_{it} = y_{it} - \bar{y}_t$, $\tilde{x}_{it} = x_{it} - \bar{x}_t$; $\bar{y}_t$ and $\bar{x}_t$ are the averages across the country at time t.

The variable $x_{1i,t} = \ln s_{it}$, which is the logarithm of the saving rate, is approximated by the logarithm of the ratio of the regional investment to GRP. The variable $x_{2i,t} = \ln(n_{it} + x + \delta)$ represents the logarithm of the sum of the rates of growth of population n_{it}, exogenous technology growth x, and depreciation rate δ. Usually in the literature, as a standard assumption of this type of regression, $x + \delta$ is assumed to be equal to 0.05 (Mankiw, Romer and Weil 1992, Islam 1995, Di Liberto, Pigliaru and Mura 2007). However, in the case of Kazakhstan, the growth rate of the population of some regions in some years was less than -0.05. Therefore, we take $x + \delta = 0.065$ in order to make the expression $x_{2i,t} = \ln(n_{it} + x + \delta)$ meaningful.

We use lagged values $\tilde{x}_{1i,t-\tau}, \tilde{x}_{2i,t-\tau}$ assuming that investments and population growth are more likely to influence growth with a one-year lag (Di Liberto, Pigliaru and Mura 2007).

The coefficient of the lagged dependent variable produces a proxy of the speed of conditional convergence β, according to the equation: $\gamma_1 = e^{-\beta\tau}$. Individual effects μ_i approximate the TFP heterogeneity degree.

Following Islam (1995), additionally to equation (43), which is written in expanded (unrestricted) form, we deal with the restricted form of this equation:

$$\tilde{y}_{it} = \gamma_1 \tilde{y}_{i,t-\tau} + \beta_1 \tilde{x}_{i,t-\tau} + \mu_i + u_{it} \quad (44)$$

where $\tilde{x}_{it} = x_{it} - \bar{x}_t$, $x_{it} = \ln s_{it} - \ln(n_{it} + x + \delta)$, $\bar{x}_t$ - is an average across all regions, $\beta_1 = \left(1 - e^{-\beta\tau}\right)\frac{\alpha}{1-\alpha}$.

This equation is obtained after imposing some constraints to the coefficients of the investment and population growth variables to be equal in magnitude, but opposite in sign.

Equations (43) and (44) represent a dynamic panel data model with fixed individual effects. It is not a simple task to choose an appropriate estimator for it (Islam 1995, Di Liberto, Pigliaru and Mura 2007).

Nickell (1981) shows that the Least Squares with Dummy Variables (LSDV) estimator, usually used for panel models, is not consistent for finite T, and the expression for the inconsistency for $N \to \infty$ is bounded of order T^{-1}. Anderson and Hsiao (1982) propose two simple instrumental variable (IV) estimators that use as an instrument the second lags of the dependent variable, either differenced or in levels. A more efficient GMM (Generalized Method of Moments) estimator for the first difference model is proposed by Arellano and Bond (1991). Their estimator produces consistent estimates in a dynamic panel model with the presence of both endogenous variables on the right hand side and measurement error. However, Blundell and Bond (1998) and Bond, Hoeffler and Temple (2001) show that the Arellano and Bond estimator is downward biased in the cases of small T, and either the closeness of the autoregressive parameter to one (this means a highly persistent series) or the high values of the variance of individual effect relative to the variance of transient shock. As a solution, Blundell and Bond (1998), extending the work of Arellano and Bover (1995), propose a system GMM estimator called the Arellano-Bover/Blundell-Bond estimator.

Bruno (2004b) points out a common weakness of all the above-mentioned estimators, namely that their properties hold for large N. This means that if the panel data consists of a small number of cross-sectional units then these estimates can be imprecise and severely biased.

Estimates based on the correction of the bias of LSDV is an alternative approach to the IV-GMM estimation. Kiviet (1995) approximates the small sample bias of the LSDV estimator using higher order asymptotic expansion techniques to include the terms of the order at most of $N^{-1}T^{-1}$. To make these approximations operational for bias correction and estimation he proposes to supersede in the approximation formulae the true parameters with the estimates from some consistent estimators.

Using the Monte-Carlo analysis, Kiviet (1995) and Judson and Owen (1999) show that the bias-corrected LSDV estimator often produces better results than the IV-GMM estimators in terms of bias and root mean squared error, especially when T and N are small or moderately large. Their analysis shows that for dynamic panels with $T \leq 20$ and $N \leq 50$ the corrected LSDV and

Anderson-Hsiao estimators are more consistent than the GMM of Arrelano and Bond. Besides, in spite of having a higher average bias, the corrected LSDV estimate proves to be more efficient than the Anderson-Hsiao estimate.

Kiviet (1999) presents a more accurate expression of the bias to include terms of the order at most of $N^{-1}T^{-2}$, the first-order term of which evaluated at the real parameter values, is shown by Bun and Kiviet (2003) to be able to take account of more than 90% of actual bias.

Di Liberto, Pigliaru and Mura (2007) compare the results obtained by using various estimators of the dynamic panel data of the Italian regions and find that the Kiviet-corrected LSDV estimator is the best procedure to estimate the model (43) with samples having small values of T and N.

Our Kazakhstan regional panel contains 16 regions over the period of 1993-2009. We have $T = 16$ observations for each of the $N = 16$ regions. According to the above discussion about possible estimators, and given the panel dimension, two estimators are used to compare their results with the aim to assess their robustness.

The first is the Kiviet-corrected LSDV estimation procedure for equation (43) both in expanded and restricted forms using the Stata[1] routine *xtlsdvc* elaborated by Bruno (2004b). This Stata procedure executes the Kiviet-corrected LSDV estimator built on the Bruno (2004a) theoretical approximation formulae and estimates a bootstrap variance covariance matrix for the corrected estimator. Monte-Carlo experiments carried out in (Bruno 2004b), in order to compare the performance of *xtlsdvc* with other dynamic panel data estimators in terms of bias and root mean squared error (RMSE) for N small (10 and 20 units), show that the three variants of LSDVC computed by *xtlsdvc* surpassed LSDV, Arrelano and Bond, Arrelano and Hsiao, and Blundell and Bond estimators in terms of both criteria. Therefore, we use the Kiviet-corrected LSDV estimator as a benchmark.

The second is the Arellano-Bover/Blundell-Bond linear panel-data estimator, which is realized by the Stata procedure *xtdpdys*.

Besides, in order to see the difference of the panel approach results from those of the cross-section approach, we first run single cross-section regressions similar to those accomplished by Mankiw, Romer and Weil (1992). For these experiments, y_{it} is the logarithm of per capita GRP in 2009, while $y_{i,t-1}$ is the same in 1993; s and n are the averages of the rates of saving and growth of population over the period of 1993-2009.

The results of these regressions are shown in the second column of Table 5.8 and Table 5.9. The former gives the results of the estimation of the regression equation (43) in unrestricted

[1] Stata is a general-purpose statistical software package

(extended) form, while the latter contains estimation results of the restricted equation (44). The restricted estimation results reveal the unique estimated value not only of the speed of convergence β, but of the capital share parameter α as well.

Table 5.8: Estimation of the Solow model (unrestricted equation (43))

	Cross-section regression	Kiviet corrected LSDV estimator	Arellano-Bover /Blundell-Bond estimator
Number of observations	16	251	251
$\ln y_{i,t-1}$	0.679** (0.291)	0.825*** (0.033)	0.918*** (0.030)
$\ln s_{i,t-1}$	0.915** (0.314)	0.058** (0.020)	0.095*** (0.021)
$\ln(n_{i,t-1} + x + \delta)$	0.384 (0.600)	-0.059*** (0. 025)	-0.095*** (0.027)
R^2	0.64		
Implied β	0.024	0.193	0.086

*Notes:.1. The asterisks *, **, and *** mean the level of significance at the 10%, 5%, and 1% respectively ,2. robust standard errors are in the parentheses.*

When we run the cross-section regression, the corresponding speed of convergence is 2.42% per year for the unrestricted equation (43) and 6.44% per year for the restricted equation (44). The value of the capital share $\alpha = 0.62$ is very high, contrary to the conventional value of 0.33 for the Solow model (Mankiw, Romer and Weil 1992). Among the regressors, the coefficient of the population growth is not significant, while the coefficients of the saving rate and of the lagged dependent variable are significant. For the restricted equation (44), the coefficient of the sum of population growth and saving rate is significant.

Table 5.9: Estimation of the Solow model (restricted equation (44))

	Cross-section regression	Kiviet corrected LSDV estimator	Arellano-Bover /Blundell-Bond estimator
Number of observations	16	251	251
$\ln y_{i,t-1}$	0.357 (0.329)	0.843*** (0.033)	0.925*** (0.029)
$\ln s_{i,t-1} - \ln(n_{i,t-1} + x + \delta)$	1.040** (0.383)	0.061*** (0.015)	0.091*** (0.016)
R^2	0.408		
Implied β	0.064	0.171	0.078
Implied α	0.624	0.278	0.548

*Notes:.1. The asterisks *, **, and *** mean the level of significance at the 10%, 5%, and 1% respectively ,2. robust standard errors are in the parentheses.*

The results of Kiviet-corrected LSDV estimation are shown in column three of Table 5.8 and Table 5.9. The estimates of the coefficient of the saving rate are positive and significant at 1% confidence level in both unrestricted and restricted equations. The estimate of the coefficient of the population growth variable is negative and significant at 1% confidence level confirming the theoretical prediction of the Solow model. The speed of convergence is 19.3% and 17.1% per year for the restricted and unrestricted equations respectively. The capital share α is assessed to be 0.28 that is close to the usually used in the literature (Mankiw, Romer and Weil 1992).

In the last column of Table 5.8 and Table 5.9, the results of the estimation of equations (43) and (44) using Arellano-Bover/Blundell-Bond estimator are presented. The results show high and significant values of the coefficient of the lagged dependent variable: 0.918 for the unrestricted equation and 0.925 for the restricted one. The corresponding speeds of convergence are 8.6% and 7.8% per year. The implied value of the capital share α is 0.55. In the unrestricted equation, the coefficient of the saving rate is positive and significant at 1% confidence level, while the coefficient of the population growth variable is negative and significant at 1% confidence level.

It should be noticed that the estimates of the coefficients of the saving rate and population growth variables in the unrestricted equation have opposite signs and very close absolute values. This confirms the model presented by equation (43).

Summing up, the panel approach to the convergence study across the Kazakhstan regions within the framework of the neoclassical growth theory produces the following results.

- The Kazakhstan regions do demonstrate conditional β-convergence over the period of 1993-2009.
- The speed of convergence calculated with the help of various estimators for two types of the regression equation (43) and (44) varies from 7.7% per year for the Arellano-Bover/Blundell-Bond estimator to 19.2% per year for the Kiviet-corrected LSDV estimator.
- The implied value of the capital share α calculated on the basis of regression coefficients γ_1, β_1 in the restricted equation (44) according to the formula $\beta_1 = (1-\gamma_1)\frac{\alpha}{1-\alpha}$, varies from 0.28 for the Kiviet-corrected LSDV estimator to 0.55 for the Arellano-Bover/Blundell-Bond estimator, which are similar to those observed in the literature.

5.4.3 β-Convergence and Augmented Neoclassical Model

Next we study conditional β-convergence in the framework of the augmented neoclassical model of Mankiw, Romer and Weil (1992) with human capital. This model was discussed in Section 3.2.5. Equation (14) rewritten for region i at time t takes the form:

$$Y_{it} = K_{it}^{\alpha_1} H_{it}^{\alpha_2} [A_{it} L_{it}]^{1-\alpha_1-\alpha_2}, \ 0 < \alpha_1 + \alpha_2 < 1 \tag{45}$$

where Y_{it} is GRP of region i at time t; $K_{it}, H_{it}, L_{it}, A_{it}$ are physical capital, human capital, labour, and the level of technology, respectively; α_1 and α_2 are the physical and human capital respective output elasticities. According to the standard neoclassical assumption, A_{it} grows exogenously at constant rate x, given by $A_{it} = A_{io}e^{xt}$.

Soukiazis and Cravo (2008), following Mankiw, Romer and Weil (1992) and Islam (1995), obtain from equation (45) an equation to test convergence in GRP per capita terms:

$$y_{it} = \gamma_1 y_{i,t-\tau} + \beta_1 x_{1i,t-\tau} + \beta_2 x_{2i,t-\tau} + \beta_3 x_{3i,t-\tau} + \mu_i + \varepsilon_{it} \quad (46)$$

where

$y_{it} = \ln y_{it_2}$, $y_{i,t-\tau} = \ln y_{it_1}$, $\gamma_1 = 1 + \gamma = e^{-\beta\tau}$, $y_{it_j} = \frac{Y_{it_j}}{L_{it_j}}$, $j = 1,2$;

$\beta_1 = \left(1 - e^{-\beta\tau}\right)\frac{\alpha_1}{1-\alpha_1-\alpha_2)}$, $\beta_2 = -\left(1 - e^{-\beta\tau}\right)\frac{\alpha_1+\alpha_2}{1-\alpha_1-\alpha_2}$, $\beta_3 = \left(1 - e^{-\beta\tau}\right)\frac{\alpha_2}{1-\alpha_1-\alpha_2}$,

$x_{1i,t} = \ln s_{it}$, $x_{2i.t} = \ln(n_{it} + x + \delta)$, $x_{3i,t} = \ln s_{h,it}$,

$\mu_i = \left(1 - e^{-\beta\tau}\right)\ln A_{i0}$, $\eta_t = x\left(t_2 - e^{-\beta\tau}t_1\right)$

ε_{it} is the transitory error term that varies across regions and time periods and has mean equal to zero, $s_{h,it}$ is the investment in human capital in a region i at time t. Other variables have the same meaning as in equation (41).

Equation (46) is almost equal to equation (41) with the chief difference in the term $\beta_3 x_{3i,t-\tau}$, which reflects the investment in human capital in a region. Therefore, we use the same methodology, namely, panel data approach to regress equation (46) as in section 5.4.2.

As an approximation of investment in human capital $s_{h,i,t-1}$ we take the ratio of the number of graduates of higher education institutions to the total working age population of a region i at time $t-1$. It is supposed that these graduates enter a labour market and improve the human capital level of a region, similar to the investment in physical capital. We take these data with a one-year lag, assuming that the human capital investment will influence next year's growth. These data are available from the statistical issue Regions of Kazakhstan (1993-2009a) and are displayed in Table 5.10. For the study of convergence across the Kazakhstan regions conditioned on human capital accumulation our time-frame is the period 1993-2009. Data on GRP and the physical capital accumulation rate of the Kazakhstan regions are the same as in Section 5.4.2.

Table 5.10: The number of graduates in higher education institutions

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Akmola	2800	2558	2429	2777	2526		1286	1437	2015	2711	3364	4780	5926	6465	6880	6125	6877
Aktobe	1800	1733	2075	1624	1621	1707	1781	1884	3453	4532	5676	6302	6596	6476	6732	6081	6086
Almaty oblast	1000	897	1020	807	932	1095	889	1146	977	994	1082	1332	2446	2866	2683	2787	2862
Atyrau	1000	1161	1027	1330	1782	1540	1588	1571	1909	1836	2888	3317	4332	4205	4297	6185	5310
West Kazakhstan	1400	1509	1716	1801	1441	1246	1530	1996	2060	3010	3761	4749	5632	6619	7814	8032	7293
Zhambyl	2500	2260	2672	2384	2418	2217	2460	2848	3581	4629	5971	6744	8429	8814	9105	8744	8377
Karaganda	7300	6558	6890	6867	7323	6759	7059	8158	9041	11420	10118	13209	16133	16336	17035	18729	15537
Kostanay	2200	1489	1285	1177	2942	3221	3141	3764	3846	4340	5132	6269	7317	8719	9263	11127	8462
Kyzyl-Orda	1300	1982	2419	2672	1307	1855	2116	2092	2688	3171	3358	3436	4289	4903	4456	4841	4534
Mangistau	200	279	321	375	602	685	833	919	1049	1122	1641	1990	2740	3519	4016	3286	3111
South Kazakhstan	3100	2765	3307	3432	3580	4393	4834	5323	7022	8665	11015	15630	21643	21277	21074	24276	20311
Pavlodar	1300	1284	1167	1386	1602	1620	1830	2270	2702	2934	3735	4710	6910	6985	7456	6467	6192
North Kazakhstan	1700	1604	1778	2503	1908	2074	978	994	1357	1841	2297	2719	3461	3697	3919	4101	3365
East Kazakhstan	3800	3795	3508	3959	3922	4292	4660	5880	6119	7145	7951	9552	11061	11802	11523	13013	12163
Astana city						2636	2534	2867	3133	3298	5117	5682	7849	8229	10176	12712	10255
Almaty city	17500	15662	14311	16813	16955	16430	17926	21415	22894	25490	29575	33499	39429	44728	52056	60179	55281

Source: Regions of Kazakhstan (1993-2009)

Table 5.11 presents results of two panel tests of equation (46) modified to a difference form similar to (43). The first is the Kiviet-corrected LSDV estimator and the second is the Arellano-Bover/Blundell-Bond estimator. Both dynamic panel data estimators are described in Section 5.4.2.

Table 5.11 Convergence across Kazakhstan regions and human capital

	Kiviet corrected LSDV estimator	**Arrelano and Bover /Blundell and Bond estimator**
Number of observations	251	251
$\ln y_{i,t-1}$	0.823*** (0.033)	0.911 *** (0.030)
$\ln s_{it}$	0.064** (0.020)	0.109*** (0.020)
$\ln(n_{it} + x + \delta)$	-0.044** (0.026)	-0.103*** (0.029)
$\ln s_{h,it}$	-0.055* (0.038)	0.018 (0.046)
Implied β	0.194	0.093

*Notes:.1. The asterisks *, **, and *** mean the level of significance at the 10%, 5%, and 1% respectively ,2. robust standard errors are in the parentheses.*

The results of these two estimators reveal the conditional β-convergence of Kazakhstan regions conditioned on the physical capital investment rate, rate of population growth, and human capital investment rate. The speed of convergence is 19.4% per year for the Kiviet corrected LSDV estimator and 9.3% per year for the AB/BB estimator. These are very close to the results of the estimation without human capital variable (19.3% and 8.6% respectively, see Table 5.8).

The Kiviet corrected LSDV estimator produces an insignificant and negative estimate of the human capital investment variable $s_{h,it}$, while the AB/BB estimator produces an insignificant and positive estimate of this variable. Estimates of all other coefficients are significant and have values very close to those for the regression without human capital investment variable (Table 5.8). The results show that investment in human capital does not play an important role in the process of convergence across the Kazakhstan regions over the period 1993-2009. This confirms the conclusion of Soukiazis and Cravo (2008) that "... higher levels of human capital are found to have negative or insignificant effect on growth in the less developed countries..." (p.138).

5.5 Conclusion

The study of σ-convergence across the Kazakhstan regions showed that, in spite of several short sub-periods of σ-convergence, the regions of Kazakhstan demonstrated divergence in terms of both standard deviation and coefficient of variation of the logarithm of real per capita GRP, over the period of 1993-2009. In addition, the regression analysis revealed a positive and significant relationship between the cross-regional differentiation, expressed by either standard deviation or coefficient of variation, and the growth rate of the real per capita GRP of the country. That means that the higher the growth rates, the higher the differentiation across regions.

As to the absolute β-convergence, the analysis revealed that the Kazakhstan regions considered together do not demonstrate unconditional β-convergence over the sub-periods of 1993-2009, 1993-2000, and 2000-2009.

These results conform to the similar results of σ- and absolute β- divergence across regions of transition countries (Petrakos 2001, Iodchin 2007, Skryzhevska 2008, Shiltcin 2010) and do not contradict the predictions of the neoclassical growth model, which supposes convergence of each region towards its own steady state position.

Both the cross-section and panel approaches reveal that the regions of Kazakhstan do demonstrate conditional β-convergence to their steady state positions over the period of 1993-2009 and sub-periods of 1993-2000, 2000-2009. However, the speed of convergence is much higher than the 2% per year observed in the literature for developed countries.

As to the convergence in the framework of the augmented neoclassical model with human capital, the analysis revealed that the human capital variable has a negative or insignificant effect on the convergence process across the Kazakhstan regions. The estimates of the coefficients of the investment and population variables, as well as the speed of convergence, do not change considerably when compared with the Solow-Swan model approach.

The lack of σ- and absolute β- convergence across the whole set of the Kazakhstan regions revealed that they differ considerably in terms of determinants of the steady state positions. These differences were partly exposed by the study of conditional β-convergence, which revealed that such conditioning variables as investment rate, population growth, and the share of agriculture have significant and either positive or negative effects on the growth rates of the Kazakhstan regions.

Here, the hypothesis arises that among the set of Kazakhstan regions there are some subgroups with similar steady states and convergence within them. The conditional convergence approach does not answer the question of the number and potential composition of these groups. Therefore, it is necessary to study club-convergence across the Kazakhstan regions.

CHAPTER 6.
CLUB CONVERGENCE ACROSS KAZAKHSTAN REGIONS

6.1 Introduction

The aim of this chapter is to discover homogeneous groups (convergence clubs) within the Kazakhstan regions, which converge to their common steady states in terms of σ-.and absolute β- types of convergence. This helps determine club-specific regional policy directed to the reducing of economic disparities among clubs of regions.

In testing the club-convergence hypothesis, we propose a new approach, which consists of two steps. The first step is the clustering of Kazakhstan regions according to a chosen set of growth factors. The second step is to test convergence within revealed clusters of regions. Thus, the starting point for the study of the club convergence across the Kazakhstan regions is the clustering of them into homogenous groups.

6.2 Cluster Analysis of the Kazakhstan Regions

Cluster analysis deals with the problem of grouping a given set of objects or individuals identified by a set of numerical measures. The objects are grouped into a number of clusters so that elements within the same cluster are similar, while elements from different clusters are dissimilar in some sense (Everitt 1980). These clusters then are the candidates to serve as convergence clubs; therefore it is necessary to identify a set of numerical measures which describe each element of a set of regions.

As we are planning to study club convergence across Kazakhstan regions in terms of equation (38), which connects the growth rates of logarithm of real per capita GRP with the logarithm of its initial level, it is natural to cluster regions according to factors influencing these growth rates.

6.2.1 Identifying Growth Factors.

Although the aggregate model does not exist that includes all the basic mechanisms of regional growth, it is possible, however, to refine factors which are important for it.

According to the basic neoclassical growth model (Solow 1956), capital accumulation is the main determinant of per capita economic growth. Although the importance of this factor falls due to the diminishing marginal product of capital, we shall include it for the clustering of the Kazakhstan regions.

However, endogenous growth models in their turn focus on sources of growth based on technological factors aiming to overcome this limitation of the neoclassical growth model. They stress the importance of innovativeness fuelled by research and development activities (Romer 1990a, Aghion and Howitt 1992). Therefore, we take innovative and R&D activities as growth factors for our cluster analysis.

Another regional economic growth factor is provided by the agglomeration advantages. This factor is stressed mainly by the supporters of new economic geography (Krugman 1991a, Ottaviano and Puga 1998, Fujita, Krugman and Venables 1999). Agglomeration economies depend on spillovers, synergy, the size of the market, and the effects of the labour market. Rosenthal and Strange (2004), after surveying the empirical works on agglomeration economies, emphasise that spatial proximity and access to markets raise the possibility of interactions, and promote regional economic growth. Therefore, in this thesis, we take the spatial proximity of a region to the main economical poles of the country as one of the growth factors for the clustering of the Kazakhstan regions.

Another important factor of economic growth is infrastructure. Many authors stress its substantial influence on the development of countries and regions (Barro and Sala-i-Martin 1995, Easterly and Rebelo 1993, Esfahani and Ramirez 2003, and others). Therefore, in this research, we take the infrastructure variable as one of the factors for clustering the Kazakhstan regions.

The next step is to describe these factors by available statistical data.

6.2.2 Data

Capital accumulation is approximated by the real per capita investments in fixed assets available from Regions of Kazakhstan (1993-2009a), which reflect the rate of enlarging and maintaining the capital stock of a region. They also serve as an approximation of the attractiveness of a region for private entrepreneurship and the learning effects of investment activity. To smooth investment activity fluctuations a mean value over the period 1993-2009 is used.

As indicators of innovativeness and R&D activities, we take per capita expenses for technological innovations of enterprises and per capita expenditures for research and development also available from Regions of Kazakhstan (1993-2009a). Per capita R&D expenditures are considered means used to generate new knowledge and technologies. Since expenses for research and development have only been available since 1997 and vary from year to year, an average value across 1997-2009 is used. Total expenses for the technological innovations of enterprises are regarded as actual charges in money terms, connected with realization of various kinds of innovative activity, which are carried out on the scale of an enterprise. The data on the technological innovations of enterprises are available only for the period 2003-2009, so, an average is taken over these years.

Regional accessibility is approximated by the relative distance from the centre of a region to the two main economic poles of Kazakhstan, namely Almaty and Astana. Relative distance measures access to the main markets. The index is calculated in this way:

$$\frac{\text{The distance from Almaty to Astana}}{\text{The distance from region's centre to Almaty} + \text{The distance from region's centre to Astana}}$$

Astana is the capital of Kazakhstan; Almaty, the former capital, is now the financial centre of the country. Both cities are main nodes in economic life of the Republic of Kazakhstan. This indicator is equal to the unit for both Almaty and Astana, while for other regions it is less than the unit.

An infrastructure variable is approximated by the density of the transport system of a region. It is calculated as a ratio of the total length of rail and automobile roads of a region to its area averaged over 2000-2009.

Having ascertained the numerical measures of growth factors, which are displayed in Table 6.1, the next step is to cluster Kazakhstan regions into homogeneous groups according to these measures.

Due to data availability and to avoid the disfiguring of the results of cluster analysis, we exclude from consideration the cities of Astana and Almaty, best considered as separate clusters for future study. In addition, prior to the onset of cluster analysis, we check for correlations among our variables. The recommendation is to exclude variables with a coefficient of correlation higher than 0.8-0.9 which could potentially distort the results (Kronthaler 2005). The calculation of the correlation coefficients presented in Table 6.2 demonstrates that none of the chosen variables correlate to each other to this extent.

In order to avoid the misrepresentation of results due to different unit scales of chosen variables, they are z-transformed to the dimensionless values of the uniform range [-3;+3] using equation (30).

Table 6.1 . Data for cluster analysis

	Real per capita investments in fixed assets (thousand tenge, 1993-2009 average)	Per capita expenses for technological innovations of enterprises (thousand tenge, 2003-2009 average)	Per capita expenditures for research and development (thousand tenge, 1999-2009 average)	Regional accessibility	Infrastructure
Regions/ Oblasts	**RealPerCapitaInvInFixedAssets**	**PerCapita_Exp_Tech_Innov**	**PerCapitaRD_Exp**	**Distance**	**AverDensTranspSyst**
Akmola	0.25	1.20	0.40	0.84	65.00
Aktobe	0.84	8.10	0.30	0.40	25.00
Almaty oblast	0.21	0.40	0.20	0.70	48.00
Atyrau	4.05	2.00	3.20	0.29	30.00
West Kazakhstan	1.07	1.20	0.30	0.29	41.00
Zhambyl	0.15	1.30	0.30	0.73	39.00
Karaganda	0.40	9.30	0.60	0.84	25.00
Kostanay	0.24	2.00	0.10	0.50	54.00
Kyzyl-Orda	0.42	0.20	0.10	0.57	16.00
Mangistau	1.49	13.60	4.30	0.27	21.00
South Kazakhstan	0.13	0.70	0.10	0.63	52.00
Pavlodar	0.42	16.30	0.20	0.70	49.00
North Kazakhstan	0.18	3.40	0.10	0.55	93.00
East Kazakhstan	0.24	8.70	2.90	0.58	45.00

Source: Regions of Kazakhstan (1993-2009), author's calculation

Table 6.2: Matrix of Correlations

		RealPerCapitaInvInFixedAssets	PerCapita_Exp_Tech_Innov	PerCapitaRD_Exp	Distance	AverDensTranspSyst
RealPerCapitaInvInFixedAssets	Pearson Correlation	1	0.023	0.620*	-0.642*	-0.366
	Sig. (2-tailed)		0.938	.018	.013	.198
PerCapita_Exp_Tech_Innov	Pearson Correlation	0.023	1	0.403	-0.059	-0.225
	Sig. (2-tailed)	0.938		0.153	0.841	0.440
PerCapitaRD_Exp	Pearson Correlation	0.620*	0.403	1	-0.520	-0.362
	Sig. (2-tailed)	0.018	0.153		0.056	0.203
Distance	Pearson Correlation	-0.642*	-0.059	-0.520	1	0.285
	Sig. (2-tailed)	0.013	0.841	0.056		0.323
AverDensTranspSyst	Pearson Correlation	-0.366	-0.225	-0.362	0.285	1
	Sig. (2-tailed)	0.198	0.440	0.203	0.323	

6.2.3 Results

The results of the cluster analysis of Kazakhstan regions according to chosen growth factors are presented by:

1. Proximity Matrix;
2. Table of Agglomeration Schedule;
3. Table of Cluster Membership;
4. Horizontal Icicle
5. Table of Clusters Profiles

The proximity matrix is obtained by processing the source data using SPSS as shown in Table 6.3. It gives information on similarities and differences in the growth factors of the Kazakhstan regions. The less the value of the table cell, the greater the similarity of corresponding regions or clusters of regions, and vice versa; the more the corresponding value in the cell of the proximity matrix, the more the difference between two regions.

The process of unification is shown in Table 6.4 by the agglomeration schedule, which show the sequence of construction of clusters, and their optimum amount. In the two columns located under the common heading Cluster Combined (Association in clusters), it is evident that, at the first step, cases three and 11 (Almaty and South Kazakhstan oblasts) have been joined. These two regions are similar to each other as much as possible, and remote from each other at a very small distance. These two cases comprise the cluster with the number three, while cluster 11 in the survey table does not now appear. At the following step, there is an association between cases three and six (Cluster 3 and Zhambyl oblast), then three and eight (Cluster 3 and Kostanay oblast). At the fourth stage, cases two and five (Aktobe and West Kazakhstan oblasts) are unified into cluster number two. In the fifth stage case one (Akmola oblast) is unified with Cluster 3 forming cluster number one. This process can continue until all units are unified into a single cluster. Therefore, it is necessary to stop the process when the number of clusters is optimal.

The issue of determining of what number of clusters constitutes optimal was discussed in Section 4.5.2. In our case, the parameter under the heading "coefficient" of Table 6.4 has crucial importance. This coefficient signifies the distance between two clusters, determined according to a chosen remote measure given the specified transformation of values. In our case, it is a square Euclidean distance (see equation (31)), measured with the use of standardized values according to equation (30). The process of cluster unification is brought to a halt at the stage when the measure of distance between two clusters increases abruptly, otherwise the clusters being at a rather big distance from each other would be consolidated (Everitt 1980).

In the case of the Kazakhstan regions, there are three abrupt jumps of the coefficient: the first is a jump from 9.488 up to 11.749 after the 10th stage; the second is a jump from 11.749 up to 14.547 after the 11th stage; and the third is a jump from 14.547 up to 18.972 after the 12th stage. A quantity of clusters is considered optimal if it is equal to the difference between the number of observations (here: 14) and the number of steps after which the factor increases abruptly (here: 10, 11, and 12). This means that after the formation of two, three, or four clusters we should not make any more subsequent associations, and that the results with these numbers of clusters are optimum.

The choice of the optimum number of clusters from these three possibilities is rather intuitive. From the economical point of view, the result with four clusters is the most interesting because subsequent clustering just unifies rather different groups of regions (Table 6.5 and Figure 6.1).

The last three columns of Table 6.4 reflecting the order of agglomeration also require an explanation. As an example, we consider a line corresponding to the 11th stage. Here, clusters 2 and 7 are unified. Previously, Cluster 2 has already participated last time in association at stage seven. Cluster 7 has participated last time in association of clusters at step eight. The new Cluster 2 then takes part in the association of clusters at step 12 (the column: Next Stage).

Table 6.5 contains information on the cluster membership at each step of the process. In Figure 6.1, the process of the unification in clusters of the whole set of Kazakhstan regions is represented. It is called Horizontal Icicle and shows clearly how regions are grouped in clusters according to the chosen set of growth factors.

Table 6.6 exhibits clusters' profiles in the case of four-cluster decision. Table 6.7 contains average growth rates of real per capita GRP over the period 1994-2009 of Kazakhstan regions in conformity with their cluster affiliation.

Table 6.3: Proximity matrix

No	Case	Euclidean Distance													
		Akmola	Aktobe	Almaty oblast	Atyrau	West Kazakhstan	Zhambyl	Karaganda	Kostanay	Kyzyl-Orda	Mangistau	South Kazakhstan	Pavlodar	North Kazakhstan	East Kazakhstan
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Akmola	0.000	3.311	1.106	5.313	3.144	1.396	2.505	1.841	2.807	5.278	1.287	3.032	2.068	2.801
2	Aktobe	3.311	0.000	2.487	3.937	1.632	2.346	2.335	1.995	1.828	3.168	2.355	2.518	3.627	2.365
3	Almaty oblast	1.106	2.487	0.000	4.857	2.304	.511	2.171	1.137	1.740	4.792	.459	2.992	2.426	2.553
4	Atyrau	5.313	3.937	4.857	0.000	3.579	4.876	5.077	4.567	4.443	3.417	4.826	5.410	5.509	4.226
5	West Kazakhstan	3.144	1.632	2.304	3.579	0.000	2.444	3.380	1.491	2.006	3.826	2.023	3.607	3.058	2.876
6	Zhambyl	1.396	2.346	.511	4.876	2.444	0.000	1.774	1.438	1.464	4.653	.871	2.877	2.864	2.461
7	Karaganda	2.505	2.335	2.171	5.077	3.380	1.774	0.000	2.687	2.283	4.182	2.413	1.936	3.868	2.344
8	Kostanay	1.841	1.995	1.137	4.567	1.491	1.438	2.687	0.000	1.954	4.378	.714	2.896	1.970	2.431
9	Kyzyl-Orda	2.807	1.828	1.740	4.443	2.006	1.464	2.283	1.954	0.000	4.334	1.829	3.502	3.868	2.931
10	Mangistau	5.278	3.168	4.792	3.417	3.826	4.653	4.182	4.378	4.334	0.000	4.716	4.088	5.388	2.703
11	South Kazakhstan	1.287	2.355	.459	4.826	2.023	.871	2.413	.714	1.829	4.716	0.000	2.971	2.127	2.528
12	Pavlodar	3.032	2.518	2.992	5.410	3.607	2.877	1.936	2.896	3.502	4.088	2.971	0.000	3.354	2.482
13	North Kazakhstan	2.068	3.627	2.426	5.509	3.058	2.864	3.868	1.970	3.868	5.388	2.127	3.354	0.000	3.258
14	East Kazakhstan	2.801	2.365	2.553	4.226	2.876	2.461	2.344	2.431	2.931	2.703	2.528	2.482	3.258	0.000

Table 6.4: Agglomeration schedule

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	3	11	.230	0	0	2
2	3	6	.614	1	0	3
3	3	8	1.282	2	0	5
4	2	5	2.099	0	0	7
5	1	3	2.968	0	3	9
6	7	12	3.936	0	0	8
7	2	9	4.942	4	0	11
8	7	14	6.228	6	0	11
9	1	13	7.779	5	0	12
10	4	10	9.488	0	0	13
11	2	7	11.749	7	8	12
12	1	2	14.547	9	11	13
13	1	4	18.972	12	10	0

Table 6.5: Cluster membership

Case	13 Clusters	12 Clusters	11 Clusters	10 Clusters	9 Clusters	8 Clusters	7 Clusters	6 Clusters	5 Clusters	4 Clusters	3 Clusters	2 Clusters
1:Akmola	1	1	1	1	1	1	1	1	1	1	1	1
2:Aktobe	2	2	2	2	2	2	2	2	2	2	2	1
3:Almaty oblast	3	3	3	3	1	1	1	1	1	1	1	1
4:Atyrau	4	4	4	4	3	3	3	3	3	3	3	2
5:West Kazakhstan	5	5	5	2	2	2	2	2	2	2	2	1
6:Zhambyl	6	3	3	3	1	1	1	1	1	1	1	1
7:Karaganda	7	6	6	5	4	4	4	4	4	4	2	1
8:Kostanay	8	7	3	3	1	1	1	1	1	1	1	1
9:Kyzyl-Orda	9	8	7	6	5	5	2	2	2	2	2	1
10:Mangistau	10	9	8	7	6	6	5	5	5	3	3	2
11:South Kazakhstan	3	3	3	3	1	1	1	1	1	1	1	1
12:Pavlodar	11	10	9	8	7	4	4	4	4	4	2	1
13:North Kazakhstan	12	11	10	9	8	7	6	6	1	1	1	1
14:East Kazakhstan	13	12	11	10	9	8	7	4	4	4	2	1

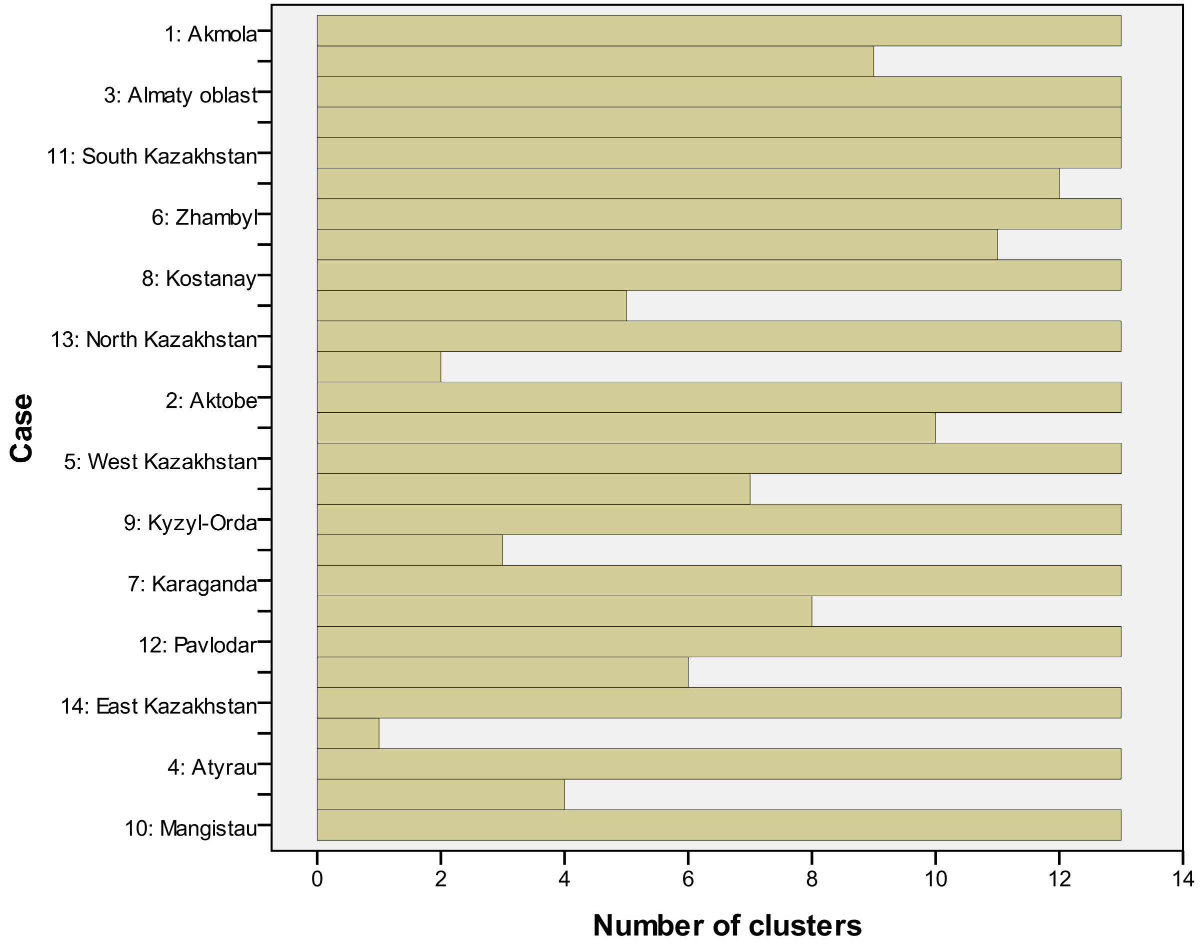

Figure 6.1: Horizontal icicle

Table 6.6: Clusters profiles

Ward Method		RealPerCapitaInvInFixedAssets	PerCapita_Exp_Tech_Innov	PerCapitaRD_Exp	Distance	AverDensTranspSyst
1	N	6	6	6	6	6
	Grouped Median	0.196	1.250	0.175	0.664	53.000
2	N	3	3	3	3	3
	Grouped Median	0.839	1.200	0.233	0.400	25.000
3	N	2	2	2	2	2
	Grouped Median	2.770	7.800	3.750	.279	25.500
4	N	3	3	3	3	3
	Grouped Median	0.396	9.300	0.600	0.700	45.000
Total	N	14	14	14	14	14
	Grouped Median	0.324	2.000	0.280	0.575	43.000

Notes: Four cluster decision

Table 6.7: The conformity of cluster affiliation with the average growth rates of real per capita GRP

Cluster	No	Region	Average growth rates of of real per capita GRP over the period of 1994-2009	Average growth rates across cluster
1	1	Kostanay	0.91	2.93
	2	Akmola	2.05	
	3	Zhambyl	3.20	
	4	North Kazakhstan	3.65	
	5	Almaty oblast	3.67	
	6	South Kazakhstan	4.08	
4	1	East Kazakhstan	3.34	3.85
	2	Pavlodar	3.59	
	3	Karaganda	4.64	
2	1	Aktobe	5.23	7.88
	2	West Kazakhstan	9.10	
	3	Kyzyl-Orda	9.30	
5	1	Almaty city	10.74	13.42
	2	Astana city	16.10	
3	1	Atyrau	16.99	20.22
	2	Mangistau	23.45	

Source: Regions of Kazakhstan (1993-2009), author's calculation

The most numerous in these tables is Cluster 1, which consists of six regions: South Kazakhstan, Zhambyl, Almaty, North Kazakhstan, Kostanay, and Akmola oblasts. These regions demonstrate low average growth rates of real per capita GRP lying in the range of 0.91% per year for Kostanay oblast to 4.08% per year for South Kazakhstan oblast. An average growth rate across this cluster is equal to 2.93% per year. Cluster 1 has lowest average values of such growth factors as real per capita investments in fixed assets, per capita expenditures in technological innovations, and per capita RD expenses. The average real per capita investment in fixed assets, in this cluster, is equal to 0.196 thousand tenge, while the average across the country is equal to 0.324 thousand tenge. The per capita expenditure in technological innovation averaged across this cluster is equal to 1.25 thousand tenge, while the average across all regions is equal to 2.0 thousand tenge. The average per capita R&D expenses in this cluster is equal to 0.175 thousand tenge, while the mean across the country is equal to 0.28 thousand tenge. However, this cluster has the highest level of the average density of transport system, which is equal to 53.0, while the average across the whole country is equal to 43.0. An average value of the relative distance of the regions included in this cluster is equal to 0.664, while the mean across all regions is equal to 0.575. The Akmola, Kostanay and North Kazakhstan regions are specializing in the agricultural sector or, more precisely, in crop production. The South Kazakhstan, Zhambyl, and Almaty oblasts are characterized by the prevalence of agriculture as well. In addition, they have high population density.

Cluster 2 - which consists of three regions: the Aktobe, West Kazakhstan, and Kyzyl-Orda oblasts - is characterized by higher average levels of investment activity. Real per capita investments in fixed assets are 0.839 thousand tenge, almost 2.6 times higher than the average across the country. However, the regions included in this cluster have lower values of indexes reflecting innovativeness. Average per capita expenditures in technological innovations amounts to 1.2 thousand tenge, which is less than the average across the country by 1.7 times. The average per capita R&D expense of this cluster of 0.233 thousand tenge is less than the country's average, equal to 0.28 thousand tenge. Due to the remoteness of regions included in this cluster from the centre of the country, the average value of the factor reflecting regional accessibility is equal to 0.4 while the highest value across clusters is 0.7. The average density of the transport system in this cluster is equal to 25.0 which is lower than the average across the country by 1.72 times. Three regions belonging to Cluster 2 have average annual growth rates of real per capita GRP, over the period of 1994-2009, ranging from 5.23% of the Aktobe to 9.3% of the Kyzyl-Orda oblasts. The average growth rate across this cluster is equal to 7.88% per year. Oblasts belonging to Cluster 2 are oil and gas producing regions with low population density (Aktobe – 2.3; West Kazakhstan – 4; Kyzyl-Orda – 2.8 people per one square kilometre). The factor which permits these regions to achieve relatively high growth rate is investment. Its influence outweighs other factors such as innovativeness, regional accessibility and infrastructure, which in these regions are characterized by low values.

Cluster 3 includes two oil rich regions: the Atyrau and Mangistau oblasts. It has the highest average level of such indexes as real per capita investment in fixed assets (14.1 times higher than in Cluster 1 and 8.5 times higher than the average across all regions) and per capita R&D expenses (21.4 times higher than in Cluster 1 and 13.4 times higher than an average across all regions). This cluster also has high average levels of per capita expenditure in technological innovations (3.9 times higher than an average across the whole country). Two growth disadvantages of the regions included in this cluster are regional accessibility described by relative distance from the main markets and the average density of the transport system. The former is equal to 0.279, while the mean across all the regions is equal to 0.575. The latter is equal to 25.5, which is lower than an average across the whole country by 1.7 times. Two regions of Cluster 3 exhibit the highest average growth rates of real per capita GRP over the period of 1994-2009, equal to 16.99% and 23.45% per year respectively. These are two oil and gas producing regions with low population density (2.4 people per one square kilometre in Mangistau, and 4.1 people per one square kilometre in Atyrau, while the average population density for the whole country is 6.18). The highest per capita GRP growth rates are achieved due to the high values of per capita investments and levels of innovative activity.

All the regions of Cluster 2 and Cluster 3 which demonstrate the highest average growth rates of real per capita GRP are oil and gas producing regions. Their explosive growth is explained by the huge investments made by foreign and domestic companies in the oil industry (See Figure 6.2 and Figure 6.3). It is not a surprise because we include an investment variable in the set of growth factors according to which cluster analysis has been done.

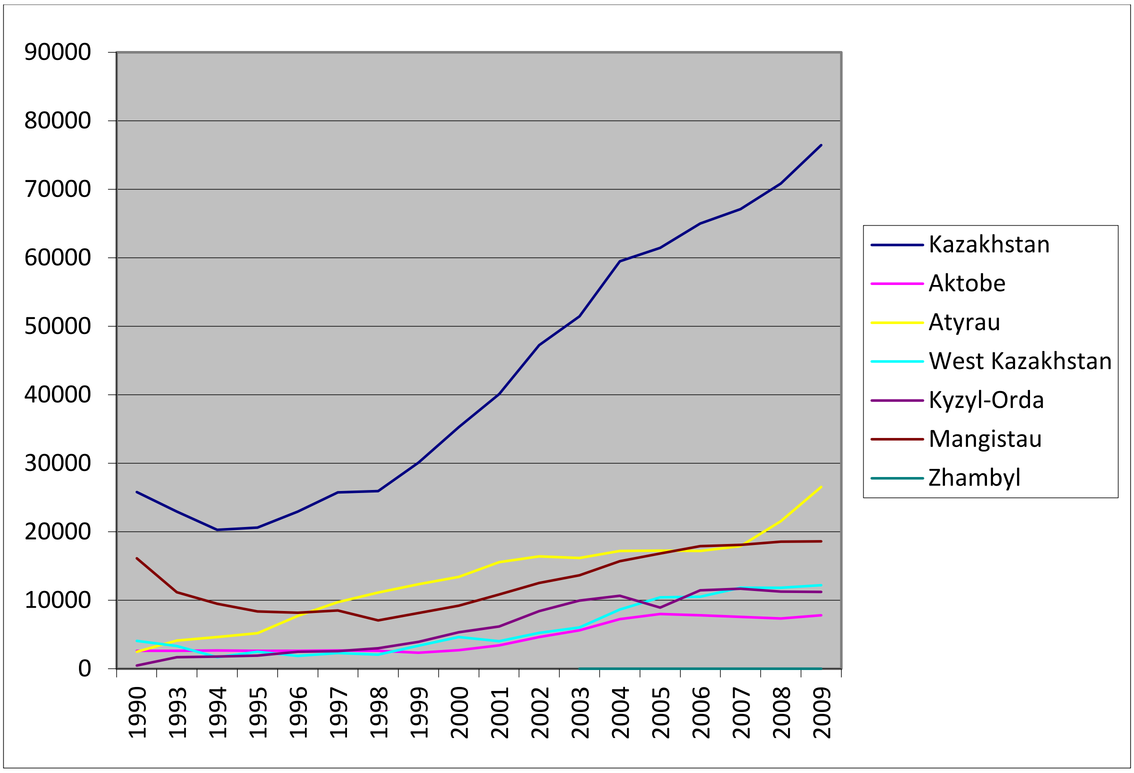

Figure 6.2: Oil production by Kazakhstan regions over the period 1990-2009 (thousand ton)

Source: Regions of Kazakhstan (1993-2009)

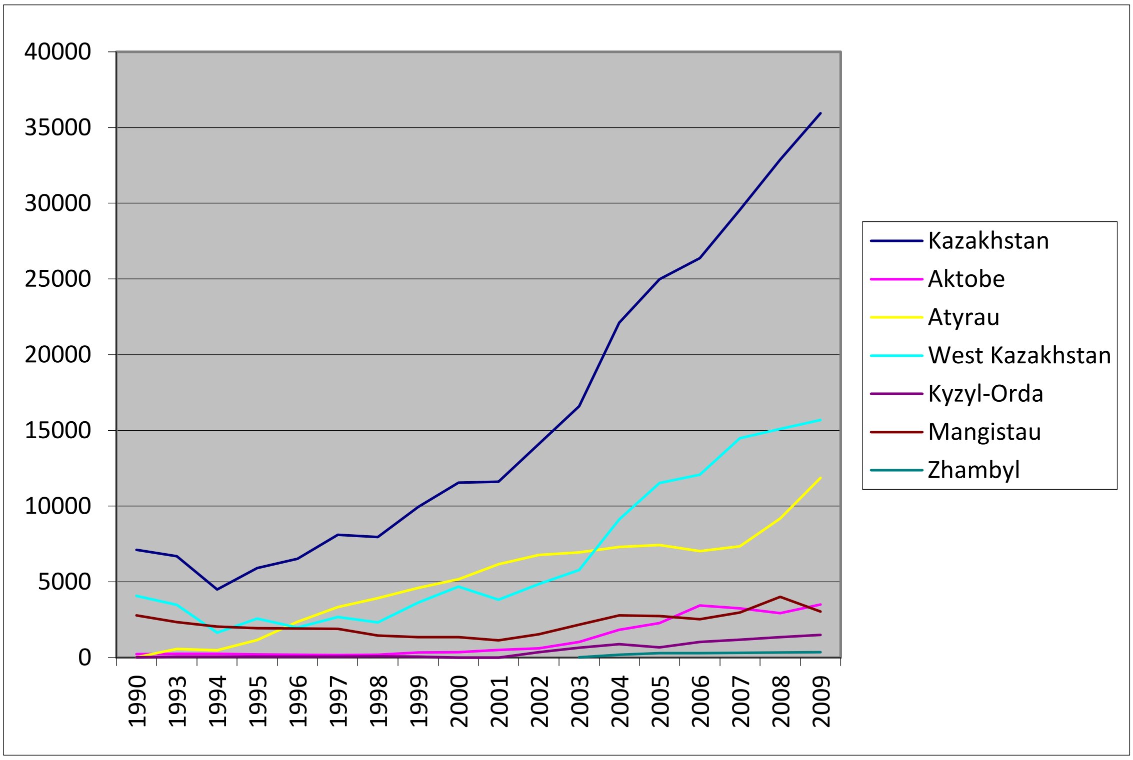

Figure 6.3: Gas production by Kazakhstan regions over the period 1990-2009 (million cubic meters)

Source: Regions of Kazakhstan (1993-2009)

Cluster 4 consists of three regions: Karaganda, Pavlodar, and East Kazakhstan oblasts. The distinctive feature of this cluster is the high levels of the innovativeness indicators. The per capita expenditures in technological innovations are 9.3 thousand tenge: that is 4.65 times higher than the average across all regions and the highest level in the country. The average value of the per capita R&D expenses is 0.6 thousand tenge, 2.1 times higher than the average across all regions. This cluster has a high value of geographic variable (relative distance is equal to 0.7, while an average across the country is equal to 0.575). The values of such indexes as the real per capita investments in fixed assets and the average density of the transport system are close to mean values across the country. Regions of Cluster 4 have the average growth rate of 3.85% per year over the period of 1994-2009. Three oblasts included in this cluster are regions with a highly developed metal mining industry. Higher values of innovativeness growth factors have provided moderate average growth rates of real per capita GRP over the past 15 years (East Kazakhstan - 3.34%, Pavlodar – 3.59%, Karaganda – 4.64% per year). These regions are industrially developed, and have powerful industrial potential with large enterprises dominating.

Finally, two cities, Astana and Almaty, which have been excluded from the cluster analysis because of incomplete data and the likelihood of their distorting the results of the clustering, form the fifth cluster, and settle together with average growth rates of 10.74% per year (Almaty) and 16.1% per year (Astana). Data on Astana city has only been available since 1997 when it became the capital of the country.

The completed cluster analysis aids the conclusion that even geographically closely situated regions can strongly differ from each other in the development of growth factors and therefore cannot be considered as belonging in the same economic cluster. The results of clustering of the Kazakhstan regions according to chosen growth factors really reflect existing distinctions in their economic development, which are expressed in differences in average growth rates of real per capita gross regional product over the period from 1994 to 2009. This provides good ground to consider clusters as candidates for convergence clubs. This is a new approach to identify convergence clubs. It does not mean, however, that regions included in a cluster would automatically demonstrate various types of convergence. These clusters are only “candidates” to convergence clubs. In the next section, the convergence of regions included in those clusters is studied.

6.3 Club Convergence across Kazakhstan Regions

In the clusters described in the previous section, we consider only two types of convergence: σ-convergence and unconditional β-convergence - because it is supposed that regions in each convergence club should have similar steady state positions and technology levels. Therefore, it is assumed that they should demonstrate those types of convergence which have not been fully observed when regions of the whole country were considered.

6.3.1 σ- Club Convergence across Kazakhstan Regions.

Figure 6.4 exhibits the evolution of the standard deviation of the logarithm of real per capita GRP across regions included in corresponding clusters over the period of 1993-2009. The values of standard deviations are presented in Table 6.8.

The regions of Cluster 1, which consists of South Kazakhstan, Zhambyl, Almaty oblast, North Kazakhstan, Kostanay, and Akmola, do demonstrate σ-convergence over the period of 1993-2009. The standard deviation of the logarithm of the real per capita GRP across these regions diminishes from 0.509 in 1993 to 0.328 in 2009. Therefore, this cluster can be regarded as a convergence club in terms of σ-convergence. However, there are several sub periods, when the standard deviation across regions included in Club 1 increases. Those are 1993-1995, 1996-1997, 1998-1999, and 2003-2008.

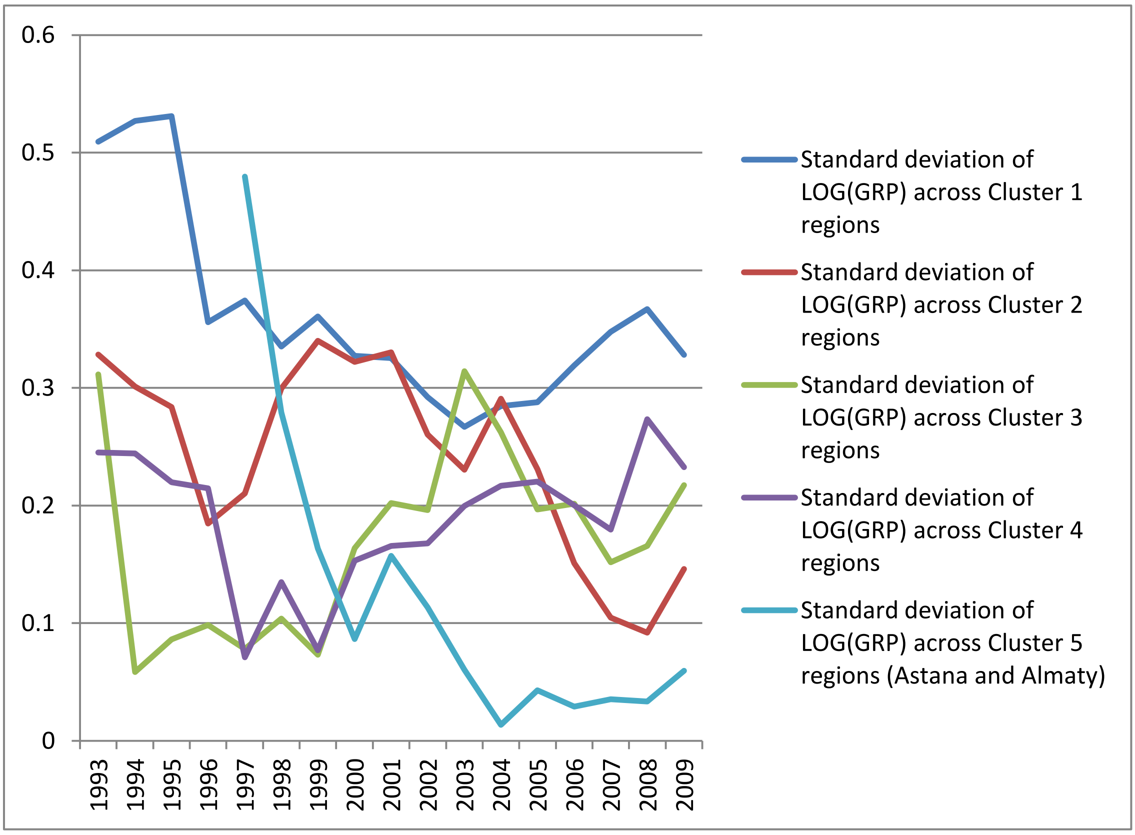

Figure 6.4: σ- club convergence across Kazakhstan regions over the period of 1993-2009.

Cluster 2 (Aktobe, West Kazakhstan, and Kyzyl-Orda oblasts) can also be considered a σ-convergence club over the period of 1993-2009, because the standard deviation of the logarithm of the real per capita GRP across these regions decreases from 0.328 in 1993 to 0.145 in 2009. However, there are also several sub periods of σ-divergence within this period, namely: 1996-1999, 2000-2001, 2003-2004, and 2008-2009.

The standard deviation of the logarithm of the real per capita GRP across the two oblasts forming Cluster 3 (Atyrau and Mangistau), decreased from 0.312 in 1993 to 0.217 in 2009.

Therefore, this cluster also can be regarded as a convergence club in terms of σ-convergence over the period of 1993-2009. Nevertheless, there are also sub periods of σ-divergence across these regions. The divergence takes place over the periods of 1994-1996, 1997-1998, 1999-2001, 2002-2003, 2005-2006, and 2007-2009.

Three regions of Cluster 4 (Karaganda, Pavlodar, and East Kazakhstan oblasts) also form a convergence club in terms of σ-convergence over the period of 1993-2009 because the standard deviation of the logarithm of the real per capita GRP falls from 0.245 in 1993 to 0.233 in 2009. However, again there exist sub periods of σ-divergence within the 1993-2009 time span, namely: 1997-1998, 1999-2005, and 2007-2008.

The graph of the standard deviation of the logarithm of real per capita GRP across the cities of Almaty and Astana, which form Cluster 5 (depicted in Figure 6.4) shows four short periods of increase: 2000-2001, 2004-2005, 2006-2007, and 2008-2009. However, these two cities demonstrate σ-convergence over the period of 1993-2009 because the standard deviation of the logarithm of real per capita GRP decreased from 0.48 in 1997 to 0.059 in 2009. That is, this cluster is also σ-convergence club.

Thus, all the clusters refined in the previous section could be considered convergence clubs in terms of σ-convergence over the period of 1993-2009, in spite of some periods of σ-divergence within this time span in each cluster. The next step is to test unconditional β-convergence across regions of these convergence clubs in order to determine the speed of convergence.

Table 6.8: Standard deviations of logarithm of real per capita GRP across clusters of Kazakhstan regions

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Standard deviation of LOG(GRP) across regions of Cluster 1	0.509	0.527	0.531	0.356	0.374	0.335	0.361	0.327	0.325	0.292	0.267	0.285	0.288	0.319	0.348	0.367	0.328
Standard deviation of LOG(GRP) across regions of Cluster 2	0.328	0.301	0.284	0.185	0.210	0.300	0.340	0.322	0.330	0.260	0.231	0.291	0.231	0.151	0.105	0.092	0.146
Standard deviation of LOG(GRP) across regions of Cluster 3	0.312	0.059	0.086	0.098	0.078	0.104	0.073	0.164	0.202	0.196	0.314	0.262	0.197	0.202	0.152	0.166	0.217
Standard deviation of LOG(GRP) across regions of Cluster 4	0.245	0.244	0.220	0.215	0.071	0.135	0.077	0.153	0.166	0.168	0.200	0.217	0.220	0.200	0.180	0.273	0.233
Standard deviation of LOG(GRP) across regions of Cluster 5 (Astana and Almaty)					0.480	0.279	0.163	0.087	0.157	0.113	0.060	0.014	0.043	0.029	0.035	0.034	0.059

Source: Regions of Kazakhstan (1993-2009), author's calculation

6.3.2 Unconditional β Club Convergence across Kazakhstan Regions.

Table 6.9 contains results of the linear least squares regressions in the form of equation (38) for the six regions belonging to Cluster 1. Again, the rate of convergence β is computed using equation (39).

Table 6.9: Absolute convergence across regions of Cluster 1

Sample	A				B				Rate of convergence β	Adj R^2
	Estimate	St. error	t-value	Sig.	Estimate	Standard error	t-value	Sig.		
Cluster 1 1993-2009	-.024	.006	-3.877	.018	.191	.045	4.190	.014	.03	.737
Cluster 1 1993-2000	-.061	.021	-2.941	.042	.376	.150	2.502	.067	.08	.605
Cluster 1 2000-2009	-.009	.022	-.391	.715	.135	.149	.909	.415	.009	-.204

The results show that regions belonging to Cluster 1 demonstrate unconditional β-convergence in terms of average growth rates of the logarithm of the real per capita GRP over two sample periods - 1993-2009, 1993-2000 - because, in these regressions, the logarithm of initial GRP enters significantly with negative signs. The speed of convergence varies from period to period. Over the whole period of 1993-2009, it is equal to 3% per year, which is close to 2% per year observed in the literature for regions of a country (Barro and Sala-i-Martin 2003). Over the period of 1993-2000, the convergence speed is equal to 8% per year. However, over the period of 2000-2009 the logarithm of initial GRP enters insignificantly, although with a negative sign.

Figure 6.5-Figure 6.7 plot the 1993-2009, 1993-2000, and 2000-2009 average growth rates of the logarithm of the real per capita GRP across the regions included in Cluster 1 against the logarithm of the initial 1993 and 2000 levels of this variable. The points of all three graphs form negative relationships, and the dots show negatively sloping patterns. That is, all three graphs show that initially poor regions tend to grow faster than rich ones. This means that Cluster 1, which includes six Kazakhstan regions is a convergence club in terms of unconditional β-convergence over the periods of 1993-2009, 1993-2000, and 2000-2009.

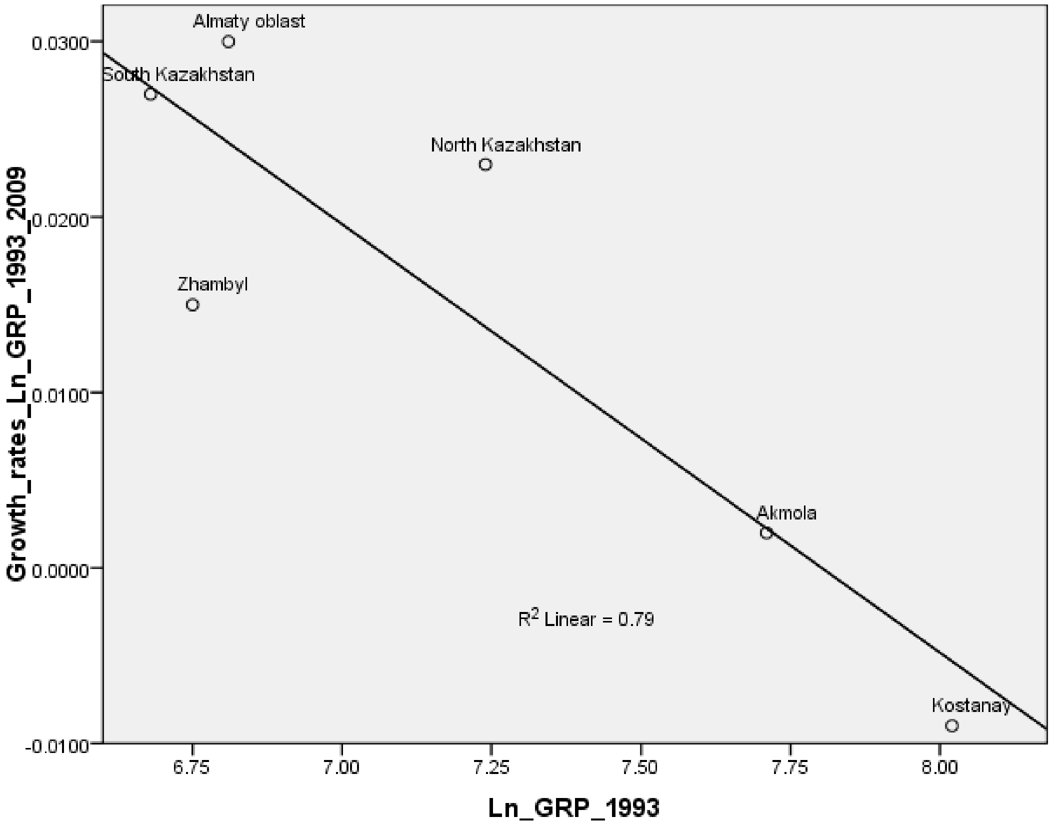

Figure 6.5: Absolute convergence across regions belonging to Club 1 over the period of 1993-2009

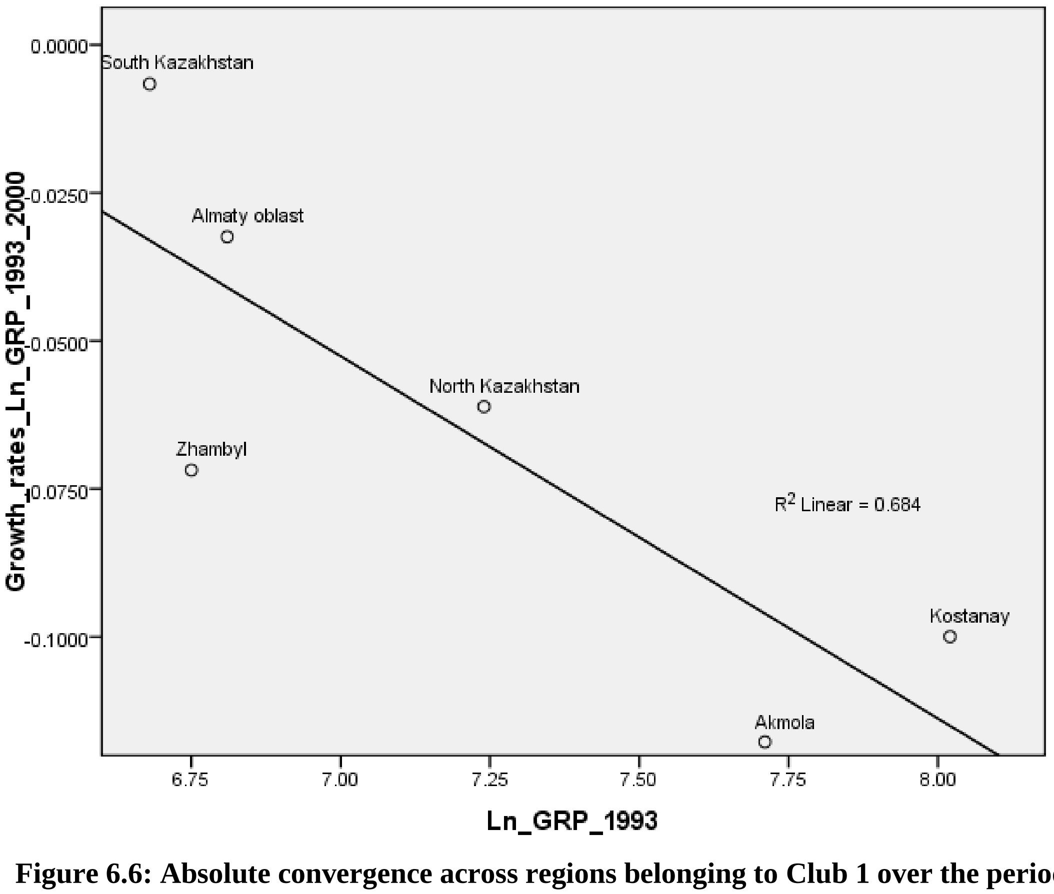

Figure 6.6: Absolute convergence across regions belonging to Club 1 over the period of 1993-2000

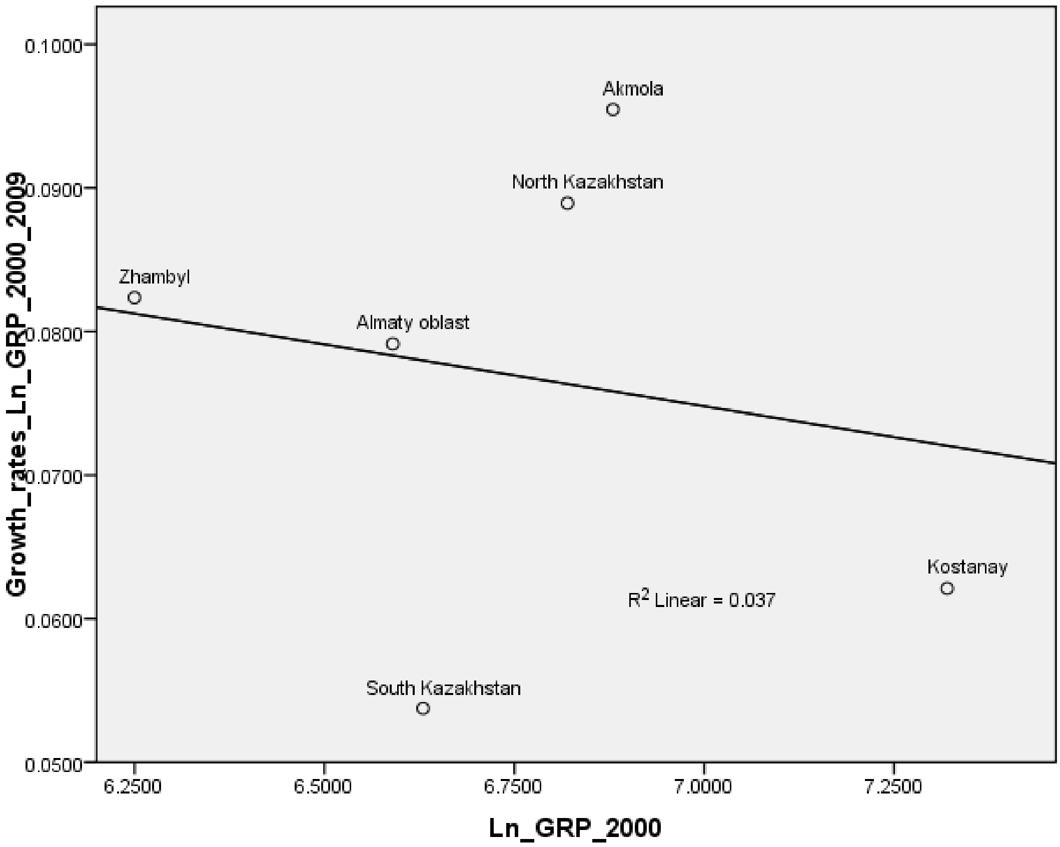

Figure 6.7: Absolute convergence across regions belonging to Club 1 over the period of 2000-2009

Table 6.10 presents regression results of equation (38) across regions of Cluster 2 including Aktobe, West Kazakhstan, and Kyzyl-Orda oblasts. As we have only three observations, most computed estimates are insignificant. The logarithm of initial GRP enters negatively in regression equations over all three considered sub-periods. In spite of their insignificance, we use them to compute convergence speeds. For the period of 1993-2009, the speed of convergence is equal to 7% per year. For the period of 1993-2000, it equals 3.2% per year, and for the period of 2000-2009 it equals 8.8% per year.

Table 6.10: Absolute convergence across regions of Cluster 2

Sample	A				B				Rate of convergence *θ*	Adj R^2
	Estimate	St. error	t-value	Sig.	Estimate	Standard error	t-value	Sig.		
Cluster 2 1993-2009	-.042	.019	-2.240	.267	.367	.135	2.719	.224	.07	.668

Cluster 2 1993-2000	-.029	.082	-.329	.786	.215	.591	.363	.778	.032	-.783
Cluster 2 2000-2009	-.061	.006	-9.604	.066	.547	.046	11.968	.053	.088	.979

The graphs of the average growth rates of the logarithm of the real per capita GRP over three periods (1993-2009, 1993-2000, 2000-2009) plotted against their initial values form negatively sloping patterns, also confirming the hypothesis of unconditional β-convergence across regions included in Cluster 2 (Figure 6.8-Figure 6.10). Therefore, Cluster 2 can also be regarded as a convergence club in terms of unconditional β-convergence over the periods of 1993-2009, 1993-2000, and 2000-2009.

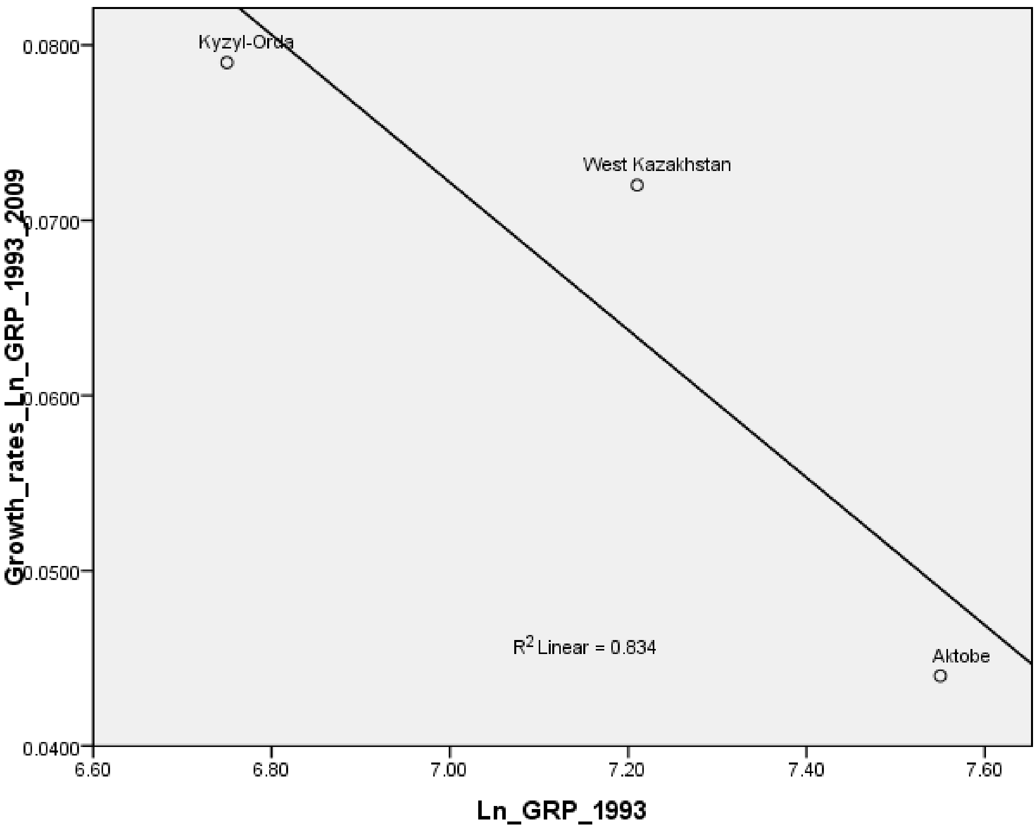

Figure 6.8: Absolute convergence across regions belonging to Club 2 over the period 1993-2009

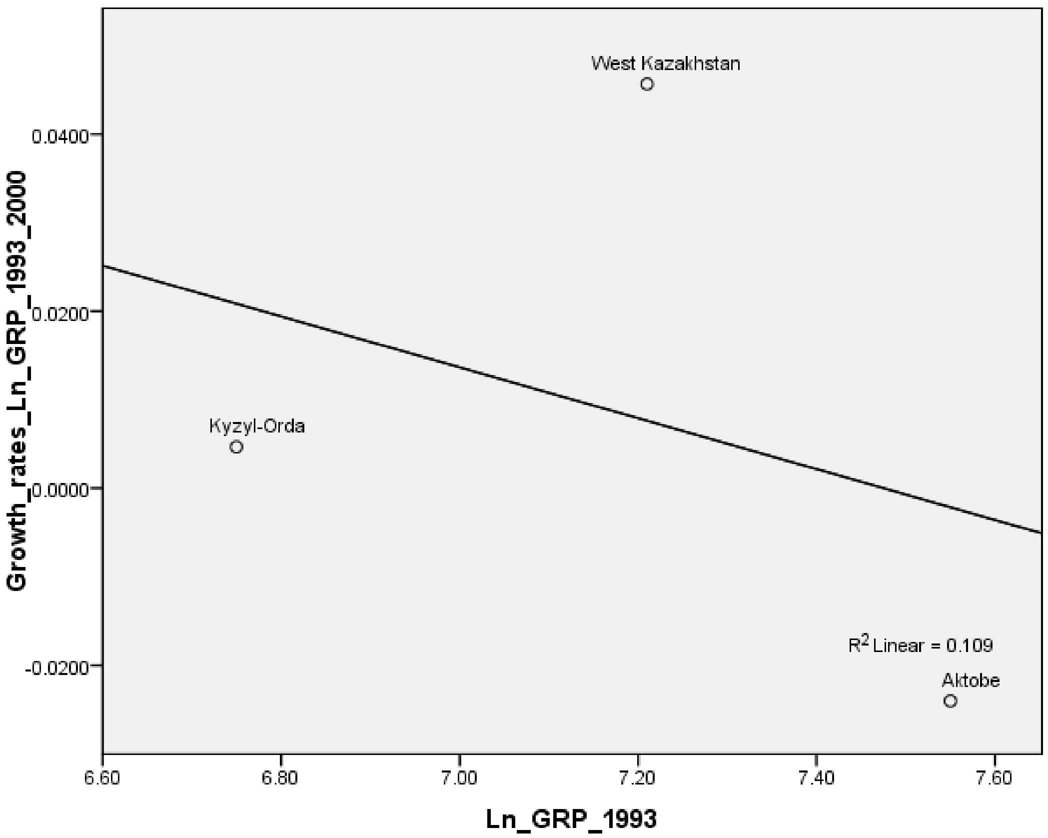

Figure 6.9: Absolute convergence across regions belonging to Club 2 over the period 1993-2000

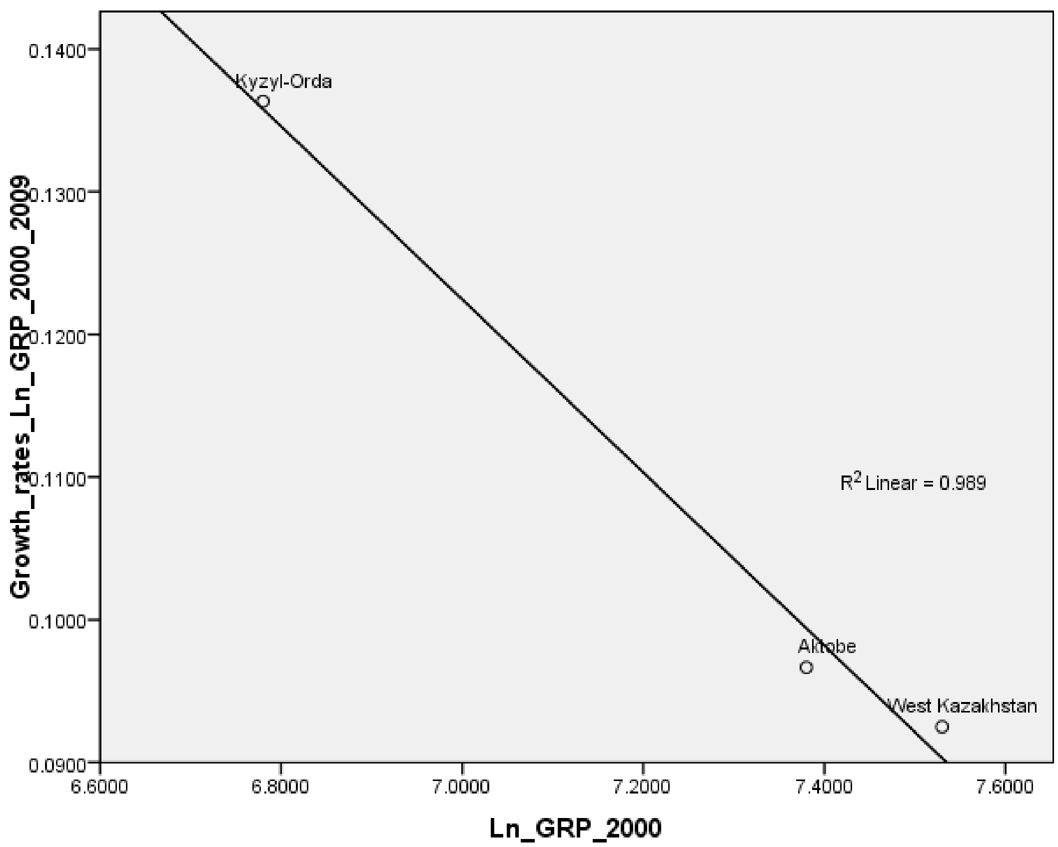

Figure 6.10: Absolute convergence across regions belonging to Club 2 over the period 2000-2009

Table 6.11 contains regression results of equation (38) across the regions included in Cluster 4, which consists of Karaganda, Pavlodar, and East Kazakhstan oblasts. Again, as the number of observations is only three, all the estimates are insignificant. However, over the periods of 1993-2009 and 1993-2000 the logarithm of initial GRP enters with a negative sign. Nevertheless, we use these estimates to calculate the speeds of convergence over these sub-periods, 1% and 8.3% per year over the sub-periods of 1993-2009 and 1993-2000 respectively. The last row of this table shows that the logarithm of the initial level of the real per capita GRP enters into the regression equation with a positive sign, which means that regions of this cluster diverge over the period of 2000-2009.

Table 6.11: Absolute convergence across regions of Cluster 4

Sample	A				B				Rate of convergence *β*	Adj R^2
	Estimate	St. error	t-value	Sig.	Estimate	Standard error	t-value	Sig.		
Cluster 4 1993-2009	-.009	.024	-.366	.777	.096	.178	.540	.685	.01	-.764
Cluster 4 1993-2000	-.063	.041	-1.553	.364	.467	.306	1.525	.370	.083	.414
Cluster 4 2000-2009	.058	.007	7.951	.080	-.376	.055	-6.838	.092	-	.969

Figure 6.11 - Figure 6.13 present the absolute convergence patterns across the three oblasts included into Cluster 4. Negatively sloping graphs of Figure 6.11 and Figure 6.12 indicate the unconditional β-convergence over the periods of 1993-2009 and 1993-2000. However, in Figure 6.13 the graph is positively sloping, which evidences absolute divergence across these regions over the period of 2000-2009. Nevertheless, Cluster 4 can be regarded as a convergence club in terms of β-convergence over the period of 1993-2009.

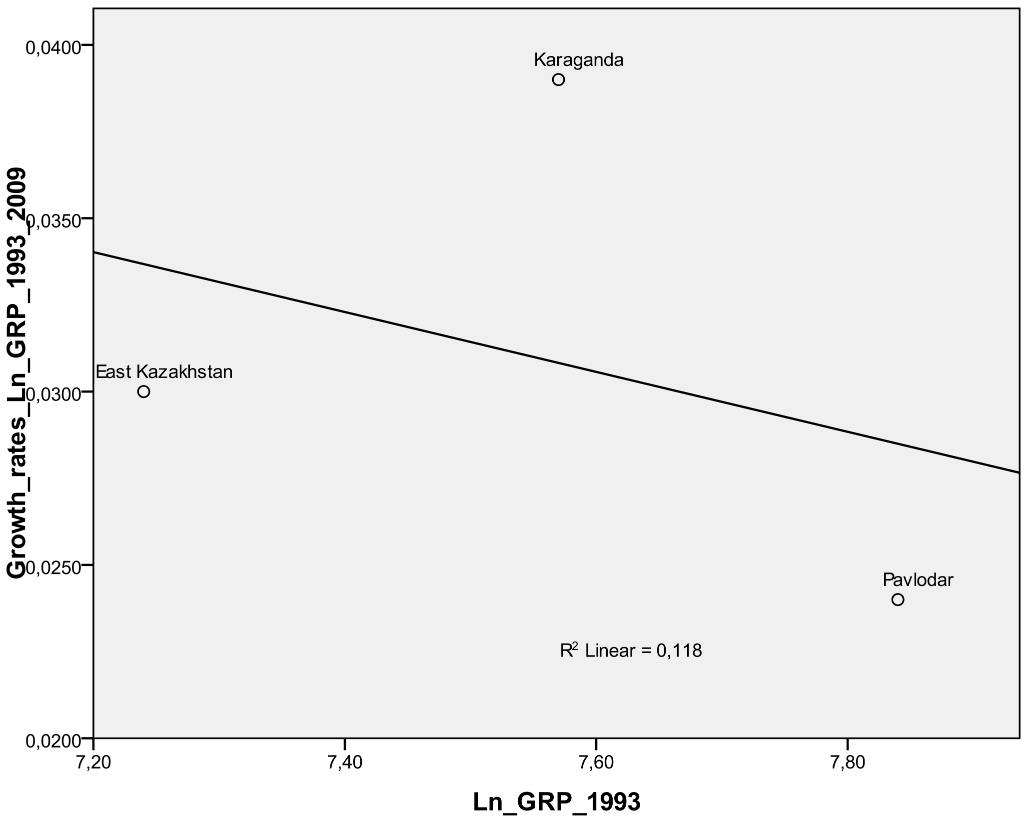

Figure 6.11: Absolute convergence across regions belonging to Club 4 over the period of 1993-2009

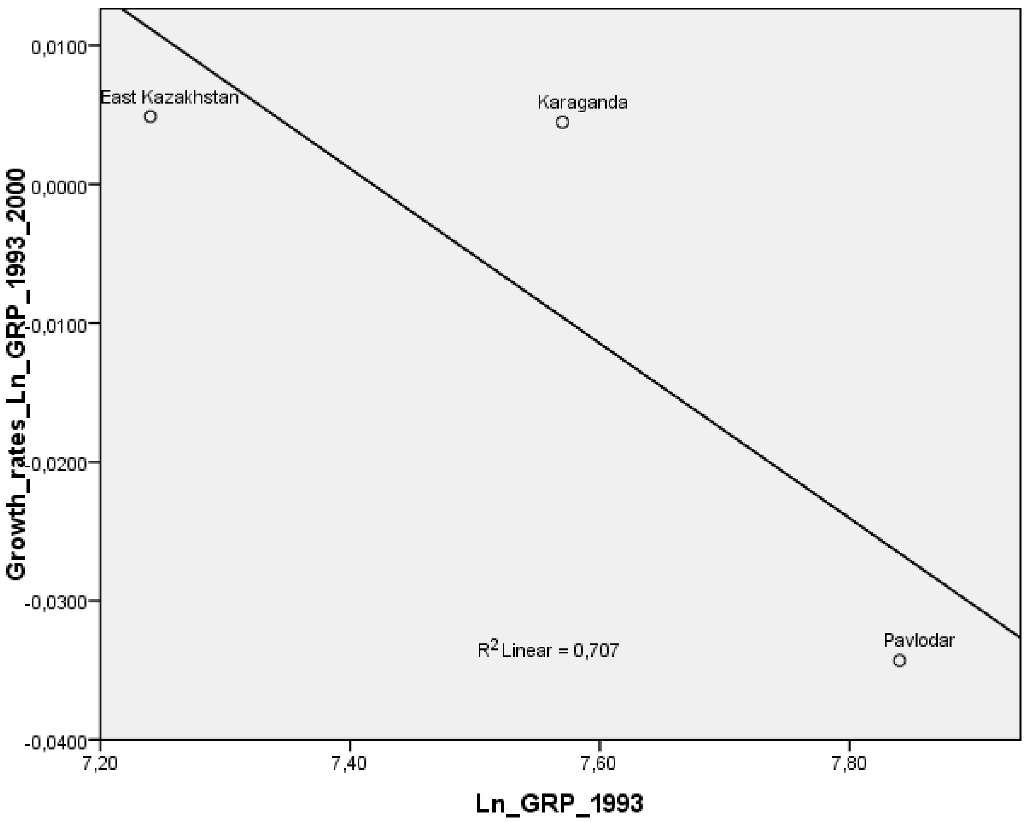

Figure 6.12: Absolute convergence across regions belonging to Club 4 over the period of 1993-2000

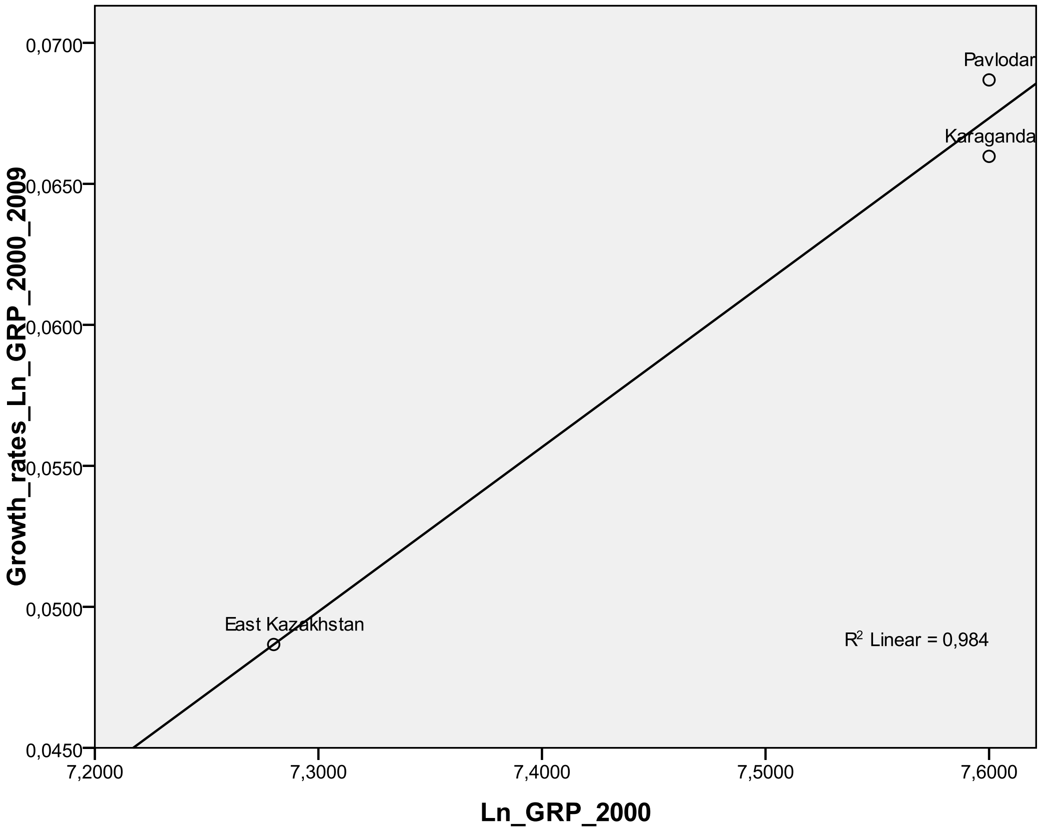

Figure 6.13: Absolute divergence across regions belonging to Club 4 over the period of 2000-2009

As Cluster 3 consists only of two regions (Atyrau and Mangistau oblasts), the linear regression models are exact and coincide with the lines plotted through two corresponding points. The speed of convergence can be calculated from the corresponding coefficient A using equation (39). Table 6.12 shows that two regions of Cluster 3 converge over the periods of 1993-2009 and 1993-2000, and they diverge over the period of 2000-2009. The speed of convergence is 2.3% per year over the whole period of 1993-2009 and 9% per year over the period of 1993-2000.

Table 6.12: Regression results on the absolute convergence across regions of Cluster 3

Sample	A	B	β (rate of convergence)	R^2
Cluster 3 1993-2009	-0.019	0.275	0.023	1
Cluster 3 1993-2000	-0.067	0.681	0.09	1

Cluster 3 2000-2009	0.036	-0.220		1

Figure 6.14 - Figure 6.16 plot average growth rates of the logarithm of the real per capita GRP against the logarithm of the initial (1993, 2000) levels of this variable over the periods of 1993-2009, 1993-2000, and 2000-2009. The points of the first and second graphs form negative relationships, and the dots show negatively sloping patterns. The points of the third graph form positively sloping pattern evidencing divergence. Nevertheless, Cluster 3 also can be considered unconditional β-convergence club.

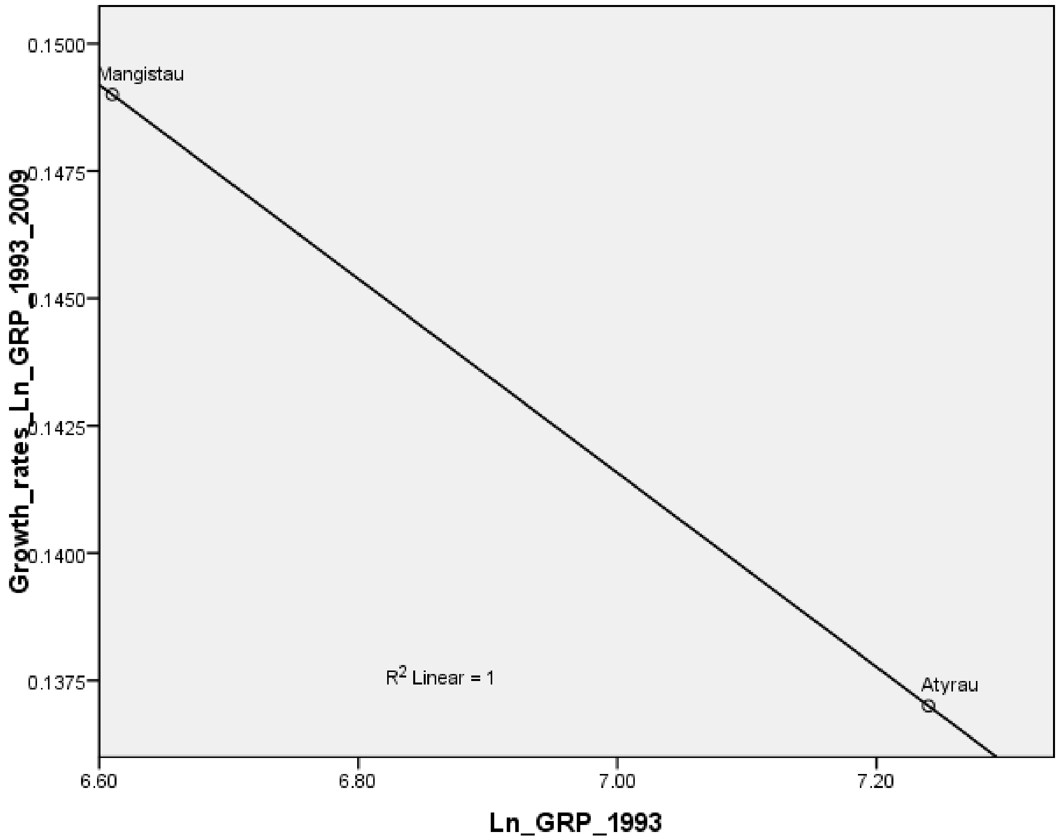

Figure 6.14: Absolute convergence across regions belonging to the third club over the period of 1993-2009

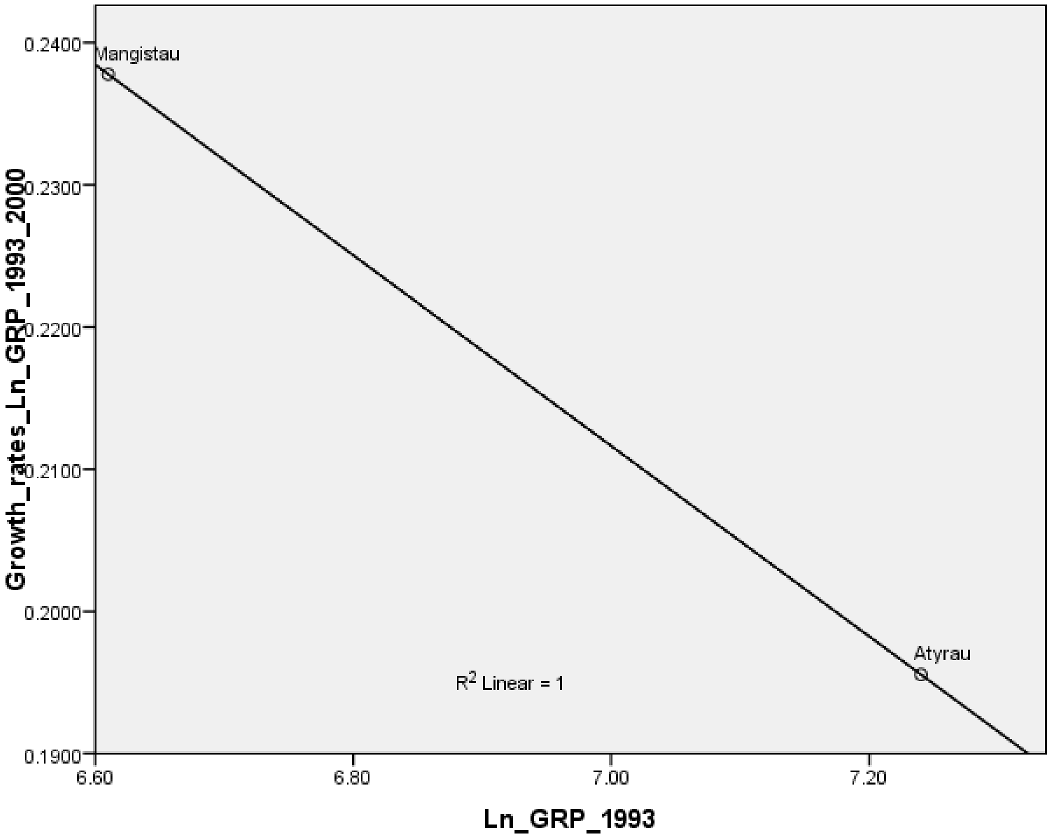

Figure 6.15: Absolute convergence across regions belonging to the third club over the period of 1993-2000

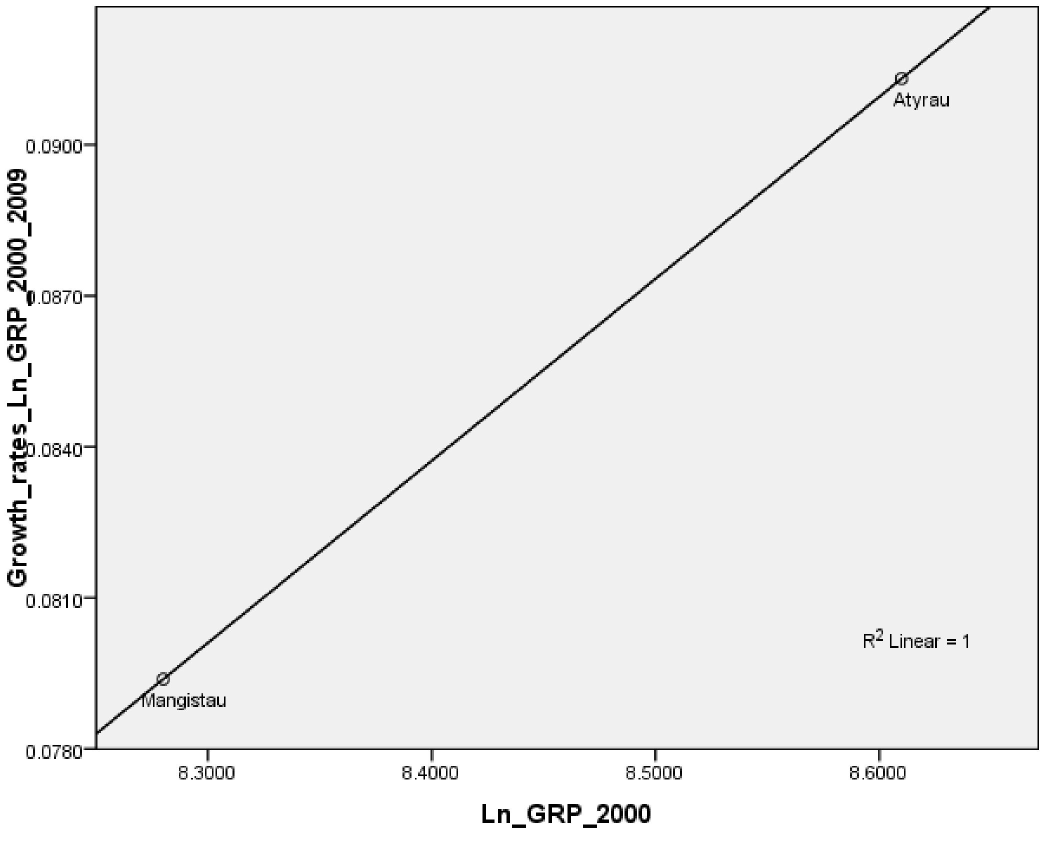

Figure 6.16: Absolute divergence across regions belonging to the third club over the period of 2000-2009

Table 6.13 and Figure 6.17 display the absolute convergence pattern across Astana and Almaty cities. We consider only the 1997-2009 time span because data on Astana city has been available only since 1997. The negatively sloping graph indicates unconditional β-convergence within this period. The speed of convergence is equal to 17.4% per year. Therefore, these two cities also can be considered a separate convergence club in terms of unconditional β-convergence.

Table 6.13: Absolute convergence across regions of Cluster 5

Sample	A	B	β (rate of convergence)	R^2
Cluster 5 1997-2009	-0.073	0.659	0.174	1

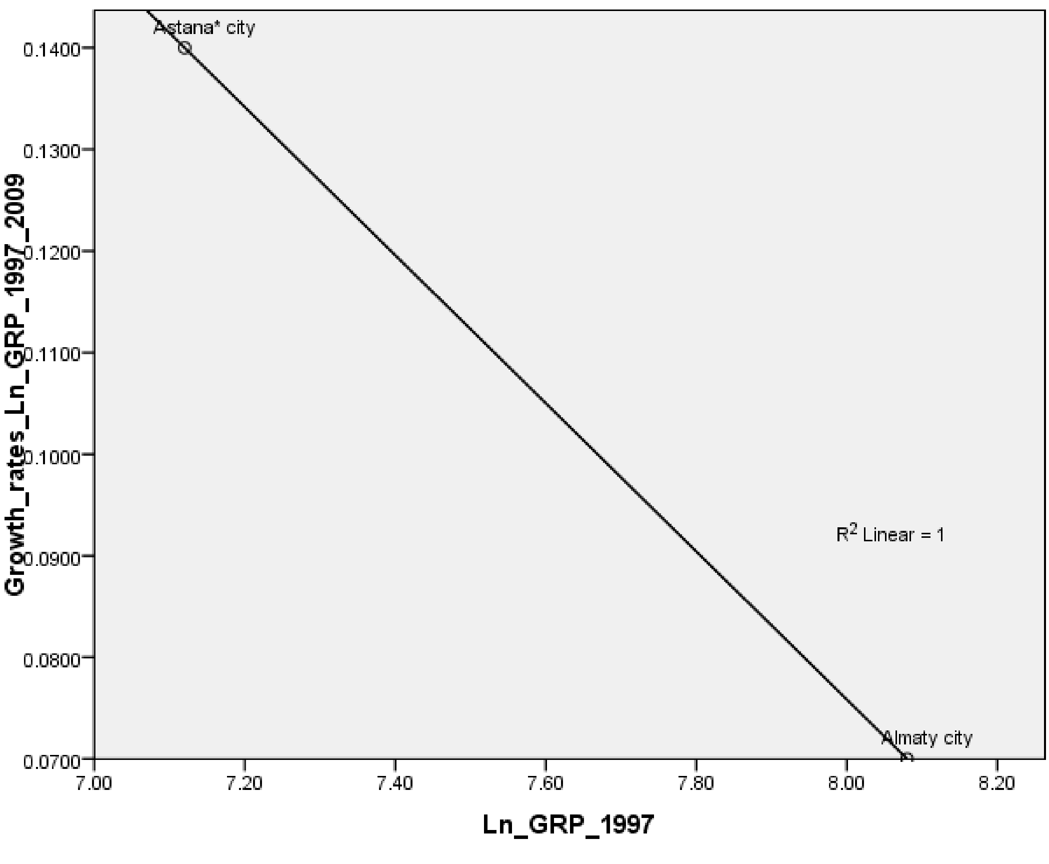

Figure 6.17: Unconditional beta convergence across cities Astana and Almaty over the period of 1997-2009

6.4 Conclusion

Club convergence testing across the Kazakhstan regions using the method of cluster analysis revealed that all five clusters are convergence clubs in terms of σ- and unconditional β- types of convergence. It confirms that the proposed method of identifying convergence clubs is reliable:

clustering of regions has been made according to growth factors, which are incontrovertibly linked with the convergence behaviour of the economies under consideration.

However, this approach to determine convergence clubs has several drawbacks. Firstly, it depends heavily on the quantity and the composition of clustering variables. For example, if we drop any of the chosen variables or add another growth factor into consideration, then the results of cluster analysis might change significantly, specifically in the quantity and the composition of clusters.

Secondly, as previously mentioned, the choice of the optimal number of clusters depends on the abrupt change of the variable reflecting the distance between clusters. As there could be several abrupt changes of this variable, the choice of the optimal number of clusters depends on intuition rather than science.

Thirdly, clustering results depend on the chosen distance measure, clustering technique, agglomerative method, and method of adjustment of data to the common scale.

Fourthly, they rely on the considered time period and the statistical data for the approximation of chosen growth factors.

Fifthly, this method is rather static and does not take into account possible shifts of region from one cluster to another.

Nevertheless, the above-mentioned drawbacks of the method do not mean that it is not helpful. These just mean that the proposed method of studying club-convergence is rather complicated and involves large number of cycles of clustering and testing of convergence hypothesis within the obtained clusters. If the clusters obtained are not convergence clubs, then we add or remove growth factors in order to change the composition of clusters, and then check the convergence hypothesis again.

CHAPTER 7.
TFP CONVERGENCE ACROSS KAZAKHSTAN REGIONS

7.1 Introduction

In this chapter, we study convergence across the Kazakhstan regions in terms of TFP. The σ- and β- types of convergence tested in Chapters 5 and 6 deal with the levels and growth rates of per capita GRP of Kazakhstan regions. The previous discussion has determined two main processes leading to these types of convergence: 1) attaining identical capital intensity levels, and 2) reaching equal technology levels. The effect of the first convergence mechanism approximated by the saving rate was studied in Chapter 5 in the framework of conditional β-convergence. It was based upon the neoclassical assumption that identical technology was available for all regions of the country and without cost. However, some researchers (Islam 1995, Durlauf and Johnson 1995, Jorgenson 1995a, 1995b) notice that this assumption may not hold. Moreover, due to the development of new growth theories, partly as an answer to this abstraction, the issue of technology production and transfer has been brought to the foreground of economic research (Islam 2001 11). Therefore, the next step of this research is to study convergence across the Kazakhstan regions in terms of the second convergence mechanism, namely, technical progress, which is usually approximated by total factor productivity (Lipsey and Carlaw 2004). The difference between TFP-convergence and β- or σ- convergence was discussed in section 3.3.3.

In addition, in this chapter, we test TFP convergence within the clusters of the Kazakhstan regions discovered in the previous chapter and found to be convergence clubs in terms of σ- and absolute β- types of convergence. We propose to determine whether they are convergence clubs in terms of TFP convergence.

From the policy perspective, the study of TFP-convergence helps us reveal whether or not TFP, as most important growth factor, converge. If not, there is a necessity to pursue a policy towards its convergence.

7.2 The Model and Methodology.

The main issue in studying TFP convergence is the calculation of TFP series, which is a panel of the values of TFP across regions and over some period of time. In this research, we use the growth accounting methodology discussed in Section 4.6, to compute TFP series of Kazakhstan regions. Byrne, Fazio and Piacentino (2009, p.6) point out such “... evident limitations of this approach as the choice of a particular functional form, the assumption of constant returns to scale, perfect competition, and constant factor shares, and time invariability of the production technology”.

Notwithstanding these drawbacks, there are several reasons to choose growth accounting to calculate the TFP series of the Kazakhstan regions. Firstly, this methodology permits one to obtain TFP series of each region over the sample period. It means that after applying the growth accounting methodology, the panel data set is available for further consideration. The second reason relates to the scarce regional data, particularly concerning the calculation of the sectoral level capital stocks for regions: their availability would allow much more accurate estimates of the series of TFP.

In order to use the growth accounting methodology, we assume that regional economies submit to the Cobb-Douglas production function with constant returns to scale with labour augmenting technical progress. Then, equation (3) rewritten for the region i at the time t takes the form:

$$Y_{it} = K_{it}^{\alpha_{it}}(A_{it}L_{it})^{1-\alpha_{it}} \quad (47)$$

where A_{it} represents labour-augmenting technical progress, which serves as a measure of TFP. Equation (21) for the values of regional TFP series for region i at time t looks as follows:

$$A_{it} = TFP_{it} = \left(\frac{Y_{it}}{L_{it}}\right) / \left(\frac{K_{it}}{Y_{it}}\right)^{\frac{\alpha_{it}}{1-\alpha_{it}}} \quad (48)$$

Having the panel of TFP series, in order to study TFP convergence across Kazakhstan regions, we apply the panel unit root tests, described in Section 4.6.2, to equation (33) for the series of the distances between the logarithm of TFP of each region and the cross-sectional averages.

7.3 Data Issues and Sources.

To use growth accounting procedure in calculating TFP series it is necessary to have data on output, labour, and capital. In practice, these inputs are measured in stocks instead of flows of current services, on the assumption that variation in capacity utilization can be neglected over the long-term.

In order to estimate capital stocks of Kazakhstan regions, we apply the perpetual inventory method described in Section 3.3.3. Equation (23) for the region i at the time t takes the form:

$$K_{it} = (1-\delta)K_{i,t-1} + I_{it} \quad (49)$$

where K_{it} is the capital stock of i-th region at time t, I_{it} is the real investment in fixed assets, δ is the depreciation rate, assumed to be 5% (Miyamoto and Liu 2005).

We deflate gross investment in fixed assets available in Regions of Kazakhstan (1993-2009a) and calculate real investment flows I_{it}. There are some controversies regarding the deflator used for deflating investment series (Islam, Dai and Sakamoto 2006). For example, Ezaki and Sun (1999, p.44) use the “price index of investment in fixed assets,” which is the weighted average of the "producer price index of machine building industry" and the "total output price index of construction" at the country level. The weights 1/3 and 2/3 are taken quite arbitrary. Another approach is to use the official deflator for the formation of gross fixed capital, but the data on this deflator has only been available since 1996. Therefore, we take the GDP deflator, available in the Statistical Yearbook of Kazakhstan (1993-2009b), to deflate investment series. The year 1993 is taken as the benchmark for the deflator.

As an initial stock of capital the balance (book) cost of fixed assets as of 1993, available in Regions of Kazakhstan (1993-2009a), is taken. In order to diminish the influence of the initial capital stock on the calculated series, the capital stock is computed from 1993 to 2009, even though in the model, these data are used from 1994 to 2009.
The results of the capital stock construction exercise are presented in Table 7.1 - Table 7.3. They begin with the gross investment in fixed assets in current prices shown in Table 7.1. Using the GDP deflator shown in the last line of Table 7.1 these data are then brought to constant 1993 prices. Table 7.2 shows total investment in fixed assets in constant 1993 prices. These investment series are then used to compute the capital stock of Kazakhstan regions from equation (49) of the perpetual inventory method with the 5% depreciation rate. Table 7.3 presents the results of these calculations.

It can be seen from this table that three regions out of 16 experienced very high growth rates of capital stock in 1994 (Atyrau oblast – 146.8%, Karaganda oblast – 54.3%, Almaty city 67%). This is explained by large investment in fixed assets in these regions in 1994 with respect to their existing capital stocks (Table 7.2). These three regions accumulated almost half (49%) of the country's investment in fixed assets in 1994. In Atyrau oblast investment was mainly directed into the oil industry, in Karaganda oblast – into the metallurgy and coal industries, in Almaty city – into the financial sector and infrastructure.

Another important variable in calculating TFP series of the Kazakhstan regions is labour input. According to the discussion in Section 3.3.3, in this research, we approximate the labour input by the total number of employees. These data are available from the issue Regions of Kazakhstan for the period of 1993-2009 (Table 7.4). This approach is similar to (Sarel 1997, Miyamoto and Liu 2005), and others, who assume that "... any unmeasured improvement in labour quality will show up in the residual in TFP growth" (Miyamoto and Liu 2005, p.525). However, this approach differs from that of Young (1995) who takes into account labour force heterogeneity, especially due to education.

In growth accounting methodology, one of the main problems is to choose a reasonable value for the input share of the labour force, $1-\alpha$. Some researchers assume it to be fixed over time and across regions and close to 0.7. However, this approach does not take into account "... the possibility of different regional economic structures" (Byrne, Fazio and Piacentino 2009, p.68).

Assuming a perfect competition of factor markets, the marginal product of each input is equal to factor price. Hence, the labour share coefficient can be found according to the equation:

$$1 - \alpha_{it} = \frac{w_{it} L_{it}}{\tilde{Y}_{it}} \quad (50)$$

where w_{it} is the rate of wage per employed worker, and $\tilde{Y}_{it}$ is an output at current prices (Barro and Sala-i-Martin 2003). Table 7.5 contains labour income shares $(1 - \alpha_{it})$ that vary over time and across regions. Since equation (50) for labour shares includes output in current prices, these variations can be explained by volatility in prices of oil and other commodities and the dependence of the regional economies on them.

Substituting the calculated values of K_{it}, L_{it}, and α_{it} into equation (48), we receive the time series of regional TFP, which are presented in Table 7.6. The TFP series are calculated for the time span 1994-2009 because of the availability of data on employed population. The values of the TFP of the city of Astana in 1994-1996 are taken as equal to the values of the Akmola oblast because in that period, the former was part of the latter. Table 7.6 shows wild fluctuations and declining of TFP in many regions that is explained by fluctuations in labour shares discussed above, disproportional increase of capital stocks in some regions, and declining of real output in first years of independence in some regions.

Table 7.1: Gross investment in fixed assets in current prices (mln.tenge)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Akmola	356	2700	5100	4400	20000	2646	1069	3293	11710	14494	15809	24428	38189	44059	103070	142549	149532
Aktobe	283	4000	8300	9700	8100	16531	21162	41095	61921	82651	115842	130987	184130	187090	225176	287212	312523
Almaty oblast	339	2700	3900	4100	6400	8963	9120	9986	17549	30294	49020	56687	99501	112414	142636	236717	314673
Atyrau	199	17500	27300	15900	33200	47180	68382	119348	231586	244494	338521	447424	713681	727635	764403	826373	1094394
West Kazakhstan	161	2000	3700	3900	5200	18694	59802	131403	167220	198290	125093	89018	91860	106626	186264	225963	244842
Zhambyl	185	2100	2500	3600	2000	2190	2406	2338	5242	9350	32675	18062	22182	25553	29940	123726	222800
Karaganda	867	12700	29200	17100	9200	22080	23876	33192	55153	62584	67157	96650	153438	134157	151887	210247	214076
Kostanay	409	4200	9800	5900	5100	6941	7123	9946	17377	19601	29279	42582	56074	63831	96419	108694	122204
Kyzyl-Orda	235	1400	3400	5700	4800	14095	14188	9973	16411	32434	53093	42900	61471	66455	102934	172339	171034
Mangistau	285	3700	7600	9400	13400	16101	11501	36979	56756	59933	75384	100518	143108	229755	251416	383199	314724
South Kazakhstan	260	3000	6600	4200	3300	6446	3929	15624	26361	23804	31221	45231	64939	84542	127175	203213	319043
Pavlodar	535	6700	14800	9700	5500	14987	18242	24559	26861	20597	33473	41213	64072	120020	129981	148435	165788
North Kazakhstan	457	3700	6300	3900	1900	2877	4225	7399	6222	8546	12353	18186	37229	34328	37288	41279	49505
East Kazakhstan	593	5000	8700	6500	9400	16811	21930	37629	38748	36904	44840	50748	82197	116054	126537	161376	139228
Astana city	0	0	0	0	19300	40823	51920	58991	89518	102615	137863	220560	274746	354583	424245	454488	368248
Almaty city	353	9500	11400	15000	12300	26839	50209	53909	114763	153395	166241	278490	334159	417421	492751	485068	382684

Source: Regions of Kazakhstan (1993-2009)

Table 7.2: Gross investment in fixed assets in constant 1993 prices (mln.tenge)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Akmola	356	164	119	74	289	36	13	34	109	128	125	166	220	209	423	483	484
Aktobe	283	243	193	163	117	226	255	422	577	728	913	889	1060	887	924	974	1012
Almaty oblast	339	164	91	69	92	122	110	103	164	267	386	385	573	533	585	803	1019
Atyrau	199	1063	635	266	479	644	824	1225	2159	2153	2668	3038	4110	3449	3137	2803	3545
West Kazakhstan	161	121	86	65	75	255	721	1349	1559	1746	986	604	529	505	764	766	793
Zhambyl	185	128	58	60	29	30	29	24	49	82	258	123	128	121	123	420	722
Karaganda	867	771	680	287	133	302	288	341	514	551	529	656	884	636	623	713	693
Kostanay	409	255	228	99	74	95	86	102	162	173	231	289	323	303	396	369	396
Kyzyl-Orda	235	85	79	96	69	192	171	102	153	286	419	291	354	315	422	584	554
Mangistau	285	225	177	158	193	220	139	380	529	528	594	682	824	1089	1032	1300	1019
South Kazakhstan	260	182	154	70	48	88	47	160	246	210	246	307	374	401	522	689	1033
Pavlodar	535	407	344	163	79	205	220	252	250	181	264	280	369	569	533	503	537
North Kazakhstan	457	225	147	65	27	39	51	76	58	75	97	123	214	163	153	140	160
East Kazakhstan	593	304	203	109	136	230	264	386	361	325	353	345	473	550	519	547	451
Astana city	0	0	0	0	279	557	626	606	835	904	1087	1497	1582	1681	1741	1541	1193
Almaty city	353	577	265	251	178	367	605	553	1070	1351	1310	1891	1924	1978	2022	1645	1240

Source: Regions of Kazakhstan (1993-2009), Statistical Yearbook of Kazakhstan (1993-2009b), author's calculation

Table 7.3: Capital stock of the Kazakhstan regions in constant 1993 prices (mln tenge)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Akmola	900	1019	1087	1106	1339	1309	1256	1227	1275	1339	1396	1493	1638	1765	2099	2478	2838
Aktobe	500	718	875	994	1061	1234	1427	1778	2266	2881	3650	4357	5199	5826	6459	7110	7767
Almaty oblast	800	924	969	989	1032	1103	1157	1202	1306	1507	1818	2112	2579	2983	3419	4051	4868
Atyrau	700	1728	2277	2429	2787	3292	3952	4979	6890	8698	10931	13423	16861	19467	21630	23351	25729
West Kazakhstan	400	501	563	600	645	868	1545	2817	4235	5769	6467	6748	6940	7098	7507	7898	8297
Zhambyl	600	698	721	745	737	730	722	710	724	770	989	1062	1137	1201	1264	1620	2261
Karaganda	1300	2006	2586	2743	2739	2903	3046	3234	3587	3958	4290	4732	5379	5746	6082	6490	6859
Kostanay	1800	1965	2095	2089	2058	2050	2033	2034	2094	2162	2285	2460	2660	2829	3083	3298	3529
Kyzyl-Orda	400	465	521	590	630	791	923	979	1083	1314	1667	1875	2135	2343	2649	3101	3500
Mangistau	500	700	842	957	1103	1267	1343	1655	2102	2524	2992	3525	4173	5053	5832	6840	7518
South Kazakhstan	600	752	868	895	898	941	941	1055	1248	1395	1571	1800	2084	2380	2783	3333	4200
Pavlodar	2600	2877	3078	3086	3011	3065	3132	3227	3317	3332	3429	3538	3730	4112	4440	4721	5022
North Kazakhstan	900	1080	1172	1179	1148	1129	1124	1144	1145	1163	1202	1265	1416	1508	1586	1646	1725
East Kazakhstan	1000	1254	1393	1433	1497	1651	1833	2128	2383	2589	2813	3017	3339	3722	4055	4400	4631
Astana city					279	822	1407	1942	2680	3449	4363	5643	6943	8276	9603	10664	11324
Almaty city	800	1337	1535	1710	1802	2078	2580	3004	3924	5078	6135	7719	9257	10773	12256	13289	13864

Source: Regions of Kazakhstan (1993-2009), Statistical Yearbook of Kazakhstan (1993-2009), author's calculation

Table 7.4: The total number of employees (thousand people)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Akmola	459.1	425.6	433.2	401.6	348.1	336.4	362.2	388	358.1	372.8	378.6	380.7	385.8	393.2	406.1	405.6
Aktobe	294.4	290	289.8	292.1	274.9	278.9	282.4	322.8	300.8	314.3	331.3	338.6	348.2	358.5	368.7	373.3
Almaty oblast	623.9	575.9	603.6	611.7	585.3	565.9	573.5	658.3	690.8	721.7	736.4	745.1	758.3	778.2	799.5	807
Atyrau	160.8	169.8	173.7	177.3	168.4	167.2	176.2	175.5	184	193.2	205.3	209.5	215.2	227.5	240.9	242.1
West Kazakhstan	266.1	264.4	252.9	268	270.1	269.6	273.5	285.5	271.6	285.1	290.4	290.9	293.7	302	308.5	313
Zhambyl	355.1	371.8	380.4	386.8	371.3	371.1	368.5	417.8	423.4	462.1	442.4	447.9	463.9	506.2	530.1	539.2
Karaganda	752.2	718.7	686.7	689.2	619.9	599.8	618.8	654.1	664.6	671.5	676	685.9	689.6	694.8	699	695.2
Kostanay	507.5	520.7	512.8	476.4	408.4	402.6	429.5	506.4	483.2	494.1	506.2	511.9	513.2	518.4	517.4	510.5
Kyzyl-Orda	220	203.3	215.7	203.1	206.6	213.7	220.1	223.9	240.8	254.7	267.1	272.5	271.2	282.6	283.9	287
Mangistau	129.6	134.2	140.1	143	133.6	129.2	132.7	130.6	133.2	141.4	164.4	170.2	172	177.8	187.9	194.1
South Kazakhstan	631.7	691	686.6	717.9	692.1	725.7	708.1	747.5	812.2	870.8	927	937.6	974.3	1006.5	1044.6	1057.6
Pavlodar	401	414.7	416.4	395.5	361	355.9	357.3	408.5	372.7	376.8	375.8	371.7	378.7	390	404.3	405.9
North Kazakhstan	394.6	355.2	324.2	307	301.8	302.4	308.9	400.8	375.2	372.5	367.2	364.3	366.1	366.7	365.1	358.4
East Kazakhstan	729.2	685.9	672.1	729	696.4	677.9	683	704.8	670.4	689.4	697.6	698.1	704.4	713.7	715.9	715.1
Astana city	144.9	142.9	141.4	140.4	142.8	148.9	156.9	178.1	218.7	239	266.6	269	278.5	290.8	331.7	347.2
Almaty city	511.7	587.4	589.3	533.3	546.9	560.2	549.4	496.1	509.3	525.7	549.4	566.9	590.5	624.3	653.6	652.2

Source: Regions of Kazakhstan (1993-2009)

Table 7.5: Labour income shares

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Akmola	0.29	0.37	0.46	0.68	0.57	0.43	0.51	0.51	0.53	0.57	0.57	0.60	0.50	0.42	0.43	0.44
Aktobe	0.29	0.38	0.49	0.44	0.42	0.53	0.49	0.54	0.48	0.45	0.43	0.37	0.33	0.32	0.28	0.32
Almaty oblast	0.38	0.43	0.38	0.41	0.50	0.57	0.58	0.65	0.74	0.73	0.77	0.75	0.66	0.67	0.63	0.62
Atyrau	0.20	0.22	0.21	0.25	0.31	0.35	0.27	0.26	0.25	0.22	0.22	0.22	0.18	0.21	0.18	0.19
West Kazakhstan	0.34	0.46	0.54	0.44	0.49	0.50	0.42	0.49	0.53	0.51	0.34	0.34	0.28	0.29	0.27	0.32
Zhambyl	0.48	0.73	0.50	0.61	0.74	0.82	0.77	0.93	0.99	0.86	0.83	0.80	0.77	0.77	0.74	0.82
Karaganda	0.39	0.36	0.47	0.46	0.43	0.41	0.41	0.42	0.44	0.42	0.43	0.38	0.31	0.32	0.31	0.32
Kostanay	0.24	0.47	0.52	0.35	0.36	0.38	0.41	0.50	0.50	0.50	0.51	0.51	0.47	0.42	0.39	0.42
Kyzyl-Orda	0.41	0.48	0.60	0.56	0.69	0.74	0.60	0.59	0.54	0.51	0.52	0.46	0.32	0.32	0.27	0.32
Mangistau	0.40	0.34	0.33	0.47	0.50	0.41	0.38	0.40	0.33	0.36	0.39	0.32	0.25	0.23	0.20	0.24
South Kazakhstan	0.43	0.64	0.44	0.48	0.57	0.60	0.51	0.51	0.63	0.65	0.77	0.80	0.76	0.72	0.71	0.67
Pavlodar	0.27	0.34	0.38	0.48	0.37	0.51	0.43	0.46	0.46	0.41	0.40	0.40	0.36	0.37	0.29	0.32
North Kazakhstan	0.28	0.24	0.23	0.30	0.47	0.47	0.59	0.63	0.68	0.65	0.62	0.61	0.50	0.47	0.43	0.49
East Kazakhstan	0.34	0.36	0.46	0.54	0.52	0.56	0.59	0.57	0.59	0.57	0.57	0.55	0.45	0.45	0.47	0.47
Astana city				0.49	0.48	0.38	0.32	0.31	0.35	0.33	0.32	0.26	0.22	0.24	0.28	0.30
Almaty city	0.43	0.55	0.31	0.28	0.31	0.33	0.35	0.29	0.29	0.28	0.27	0.25	0.18	0.22	0.24	0.23

Source: Regions of Kazakhstan (1993-2009), author's calculation

Table 7.6: TFP series of the Kazakhstan regions

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Akmola	20.41	4.35	2.68	1.46	1.07	1.58	1.30	1.54	1.69	1.80	1.98	1.89	2.15	3.10	2.26	2.20
Aktobe	19.02	5.55	2.71	3.89	3.68	2.70	2.27	2.19	2.11	1.80	1.79	1.50	1.22	1.29	0.88	0.80
Almaty oblast	3.84	2.27	3.95	3.35	2.24	1.87	1.88	2.02	1.98	1.91	1.96	1.95	2.05	2.37	2.05	2.07
Atyrau	1.66	1.10	1.19	1.50	0.92	1.57	1.91	1.04	0.90	0.60	0.29	0.16	0.05	0.09	0.05	0.07
West Kazakhstan	6.35	2.30	1.79	3.54	2.37	1.79	1.15	1.36	1.61	1.43	0.88	0.75	0.50	0.62	0.52	0.74
Zhambyl	1.73	1.09	1.95	1.50	1.41	1.31	1.24	1.26	1.43	1.55	1.79	1.81	1.81	2.07	1.81	1.79
Karaganda	10.63	8.52	2.94	3.37	3.01	3.32	3.49	3.11	2.86	2.73	2.72	2.64	3.46	3.92	3.87	3.44
Kostanay	16.22	2.09	1.82	3.22	2.37	2.23	2.08	1.96	1.99	2.21	2.29	2.13	2.18	2.94	2.77	2.59
Kyzyl-Orda	2.74	2.11	2.45	2.49	1.84	1.50	1.61	1.79	2.17	2.12	2.55	2.52	3.34	4.19	3.68	2.43
Mangistau	6.24	13.79	15.18	5.75	3.34	4.40	6.03	5.08	5.32	4.02	4.15	4.00	2.84	2.15	1.81	1.72
South Kazakhstan	3.81	1.39	3.30	2.94	2.13	2.26	3.19	3.74	2.67	2.53	2.09	1.92	1.95	2.40	2.11	2.39
Pavlodar	4.22	3.18	2.10	1.47	1.80	1.61	1.66	2.02	2.05	2.13	2.46	2.12	1.91	2.19	2.29	1.94
North Kazakhstan	8.29	9.39	12.48	3.70	1.71	1.77	1.39	1.75	1.78	1.80	2.06	2.01	2.29	2.91	2.93	2.73
East Kazakhstan	14.32	10.73	5.02	4.33	4.75	4.10	3.23	3.21	3.10	2.86	2.88	2.66	3.09	3.56	2.74	2.91
Astana city	20.41	4.35	2.68	3.57	3.29	3.26	2.62	2.09	2.59	2.50	2.49	2.22	1.93	1.69	1.28	1.45
Almaty city	5.58	3.31	19.54	41.54	27.17	15.67	9.29	13.20	11.51	10.10	8.18	7.88	18.23	11.87	6.23	5.95

Source: Regions of Kazakhstan (1993-2009), author's calculation

7.4 Results

As the first method to study TFP convergence across Kazakhstan regions, we use the Levin et al. test. As mentioned above, this test allows for constant over time heterogeneity across regions, but does not allow for differences in the speed of convergence. Nevertheless, it permits to make conclusions on the process of convergence at the average. We calculate the values of the lags separately for each region according to the sequential t-test of Ng and Perron (1995) (Table 7.10). Considering the whole sample of Kazakhstan regions, the test of Levin et al. rejects the null hypothesis of non-stationarity in the TFP series showing the TFP convergence among Kazakhstan regions (Table 7.7).

Table 7.7: Levin et al. panel unit root test of TFP convergence across Kazakhstan regions

Lags	coefficient	t-value	t-star	P > t	Conclusion
Are taken separately for each region according to the sequential t-test of Ng and Perron (1995)	-0.338	-8.194	-3.218	0.001	The null hypothesis of unit root can be rejected (convergence)

As to the Im et al. panel unit root test applied to the whole set of Kazakhstan regions, it also rejects the null hypothesis of non-stationarity with the 1% critical value for the same values of lags, confirming the rejection of the null-hypothesis of divergence (Table 7.8). The only distinction from the previous result is that the rejection of the null means that there is a subset of the regions that demonstrate TFP convergence.

Table 7.8: Im et al. panel unit root test of TFP convergence across Kazakhstan regions

Lags	t-bar	cv10	cv5	cv1	W[t-bar]	P-value	Conclusion
Are taken separately for each region according to the sequential t-test of Ng and Perron (1995)	-2.111	-1.780	-1.860	-2.000	-2.576	0.005	The null hypothesis of unit root can be rejected (convergence)

Next, we apply the Maddala and Wu test to the TFP series of Kazakhstan regions. The results presented in Table 7.9 show that for the values of lags 0-2 the null hypothesis of non-stationarity can also be rejected and the inferences of the TFP convergence across a subset of Kazakhstan regions are valid.

Table 7.9: Maddala and Wu tests of TFP convergence across Kazakhstan regions

Lags	chi2(32)	Prob > chi2	Conclusion
0	112.569	0.000	Reject H_0 (convergence)

1	145.927	0.000	Reject H_0 (convergence)
2	67.404	0.001	Reject H_0 (convergence)

Karlsson and Löthgren (2000) emphasize the issue that the rejection of the null-hypothesis of non-stationarity in the tests of Levin et al., Im et al., and Maddala and Wu cannot be regarded as a decisive proof of full convergence. In order to better interpret the results of the panel tests we also investigate the univariate behaviour of each of the Kazakhstan regional TFP series using the unit root test of Elliot, Rothenberg and Stock (1996), which is similar to the ADF test, but has best overall performance in terms of small size and power. The optimal lag lengths for each regional series are calculated using a sequential t-test of Ng and Perron (1995). Table 7.10 contains the results of these tests.

Table 7.10: The results of the Elliot et al. univariate unit root tests of TFP convergence across Kazakhstan regions

Region	T-statistic	Optimal lag	Conclusion
Akmola	-2.099*	0	Stationarity (Convergence)
Aktobe	-1.910	0	Non-stationarity (Divergence)
Almaty city	-2.363*	0	Stationarity (Convergence)
Almaty oblast	-1.925	0	Non-stationarity (Divergence)
Astana city	-3.239	0	Stationarity (Convergence)
Atyrau	-0.379	0	Non-stationarity (Divergence)
East Kazakhstan	-2.647*	0	Stationarity (Convergence)
Karaganda	-2.395*	0	Stationarity (Convergence)
Kostanay	-2.354*	3	Stationarity (Convergence)
Kyzyl-Orda	-2.951*	2	Stationarity (Convergence)
Mangistau	-2.439*	0	Stationarity (Convergence)
North Kazakhstan	-1.618	0	Non-stationarity (Divergence)
Pavlodar	-1.571	0	Non-stationarity (Divergence)
South Kazakhstan	-1.920	0	Non-stationarity (Divergence)
West Kazakhstan	-1.715	0	Non-stationarity (Divergence)
Zhambyl	-0.617	1	Non-stationarity (Divergence)

Notes: 1) The 1%, 5%, and 10% critical values are –2.660, –1.950, and –1.600, respectively. 2) The samples with the rejection of the null hypothesis of a unit root at 5% critical level are marked with an asterisk (*).

It can be seen that at the 5% confidence level, the logarithm of TFP of only eight regions from sixteen tend to converge to the average value. However, if we reduce the level of confidence of the test to 10% level (-1.600), the number of converging regions goes to 13.

Next, we test TFP convergence within the clusters of the Kazakhstan regions described in the previous chapter. These clusters were found to be convergence clubs in terms of σ- and absolute β- types of convergence. The intention now is to test whether they are convergence clubs in terms of TFP convergence. The type of convergence across regions within these clusters may differ from β- and σ- convergence behaviour because the set of growth factors according to which the clustering was made includes such factor as capital accumulation that does not directly influence TFP. Therefore, we need to check TFP-convergence within these clusters.

Remember that Cluster 1 consists of six oblasts: Akmola, Kostanay, North Kazakhstan, Almaty, South Kazakhstan, and Zhambyl. The results of the application of various panel unit root tests are presented in Table 7.11- Table 7.13.

Table 7.11: Levin et al. panel unit root test of TFP convergence across regions of Cluster 1

Lags	Coefficient	t-value	t-star	P > t	Conclusion
Are taken separately for each region according to the sequential t-test of Ng and Perron (1995)	-0.602	-9.849	-2.076	0.019	The null hypothesis of unit root can be rejected (convergence)

Notes: Cluster 1 consists of Akmola, Kostanay, North Kazakhstan, Almaty, South Kazakhstan, and Zhambyl oblasts.

Table 7.12: Im et al. panel unit root test of TFP convergence across regions of Cluster 1

Lags	t-bar	Cv10	cv5	Cv1	W[t-bar]	P-value	Conclusion
Are taken separately for each region according to the sequential t-test of Ng and Perron (1995)	-3.790	-1.960	-2.090	-2.330	-5.883	0.000	The null hypothesis of unit root can be rejected (convergence)

Notes: Cluster 1 consists of Akmola, Kostanay, North Kazakhstan, Almaty, South Kazakhstan, and Zhambyl oblasts.

Table 7.13: Maddala and Wu tests of TFP convergence across regions of Cluster 1

Lags	chi2(12)	Prob > chi2	Conclusion
0	74.129	0.000	Reject H_0
1	180.120	0.000	Reject H_0
2	120.256	0.000	Reject H_0

Notes: Cluster 1 consists of Akmola, Kostanay, North Kazakhstan, Almaty, South Kazakhstan, and Zhambyl oblasts.

As the number of regions in this cluster is 6, and the time dimension is 17, the multivariate ADF test of Sarno and Taylor (1998) can be applied to this sample. The result of this test is presented in Table 7.14 and confirms the conclusion of TFP convergence across regions included in Cluster 1.

Table 7.14: Sarno and Taylor tests of TFP convergence across regions of Cluster 1

Obs	Lags	MADF	Approx 5% CV	Conclusion
16	1	121.266	62.766	Convergence
15	2	196.211	72.726	Convergence

Notes: Cluster 1 consists of Akmola, Kostanay, North Kazakhstan, Almaty, South Kazakhstan, and Zhambyl oblasts.

All these panel unit root tests confirm that TFP of regions included in Cluster 1 converge to the average of the group.

The results of the Elliot, Rothenberg and Stock univariate unit root test are presented in Table 7.15.

Table 7.15: The results of univariate unit root tests of TFP convergence across regions of Cluster 1

Region	Optimal lag	T-statistic	Conclusion
Akmola	6	-5.553*	Stationarity (Convergence)
Almaty oblast	0	-2.642*	Stationarity (Convergence)
Kostanay	2	-0.634	Non-stationarity (Divergence)
North Kazakhstan	0	-1.753	Non-stationarity (Divergence)
South Kazakhstan	2	-6.390*	Stationarity (Convergence)
Zhambyl	0	-2.732*	Stationarity (Convergence)

Notes: 1.Cluster 1 consists of Akmola, Kostanay, North Kazakhstan, Almaty, South Kazakhstan, and Zhambyl oblasts.2.The 5% critical value is –1.950 and samples with the rejection of the null hypothesis of unit root are marked with an asterisk (*).

Summing up, the panel unit root tests confirm that, in spite of the result of the univariate unit root test indicating that the logarithm of TFP of two regions from six diverge from the group average, Cluster 1 can be considered a convergence club in terms of TFP convergence.

The second cluster consists of three oblasts: Aktobe, Kyzyl-Orda, and West-Kazakhstan. We also apply the panel unit root tests discussed above to this sample and the results presented in Table 7.16 - Table 7.19 show that Levin et al., Im et al., Maddala and Wu, and Sarno and Taylor panel unit root tests support the null hypothesis of non-stationarity and confirm the TFP divergence across regions of Cluster 2.

Table 7.16: Levin et al. panel unit root test of TFP convergence across regions of Cluster 2

Lags	coefficient	t-value	t-star	P > t	Conclusion
Are taken separately for each region according to the sequential t-test of Ng and Perron (1995	-0.195	-2.616	-1.246	0.107	The null hypothesis of a unit root cannot be rejected (Divergence)

Notes: Cluster 2 consists of Aktobe, Kyzyl-Orda, and West-Kazakhstan oblasts.

Table 7.17: Im et al. panel unit root test of TFP convergence across regions of Cluster 2

Lags	t-bar	Cv10	cv5	Cv1	W[t-bar]	P-value	Conclusion
Are taken separately for each region according to the sequential t-test of Ng and Perron (1995)	-1.402	-2.040	-2.190	-2.500	0.162	0.564	The null hypothesis of a unit root cannot be rejected (Divergence)

Notes: Cluster 2 consists of Aktobe, Kyzyl-Orda, and West-Kazakhstan oblasts.

Table 7.18: Maddala and Wu tests of TFP for Cluster 2

Lags	chi2(6)	Prob > chi2	Conclusion
0	17.653	0.0072	The null hypothesis of unit root can be rejected (Convergence)
1	5.262	0.5107	The null hypothesis of a unit root cannot be rejected

			(Divergence)
2	3.019	0.807	The null hypothesis of a unit root cannot be rejected (Divergence)

Notes: Cluster 2 consists of Aktobe, Kyzyl-Orda, and West-Kazakhstan oblasts

Table 7.19: Sarno and Taylor tests of TFP convergence across regions of Cluster 2

Obs	Lags	MADF	Approx 5%	Conclusion
15	1	10.718	62.766	The null hypothesis of a unit root cannot be rejected (Divergence)
14	2	5.986	72.726	The null hypothesis of a unit root cannot be rejected (Divergence)

Notes: Cluster 2 consists of Aktobe, Kyzyl-Orda, and West-Kazakhstan oblasts.

Table 7.20: The results of univariate unit root tests of TFP convergence across regions of Cluster 2

Region	Optimal lag	T-statistic	Conclusion
Aktobe	0	-1.687	Non-stationarity (Divergence)
Kyzyl-Orda	2	-2.399*	Stationarity (Convergence)
West Kazakhstan	0	-1.428	Non-stationarity (Divergence)

Notes: Cluster 2 consists of Aktobe, Kyzyl-Orda, and West-Kazakhstan oblasts. The 5% critical value is –1.950 and samples with the rejection of the null hypothesis of unit root are marked with an asterisk (*).

Table 7.20 presents the results of the univariate unit root tests of TFP convergence across regions of Cluster 2. These results show that two of the three regions of the cluster diverge from the group average. The only region, which demonstrates convergence, is Kyzyl-Orda. In other words, Cluster 2 cannot be regarded as a convergence club in terms of TFP convergence.

Cluster 4 consists of three oblasts: Karaganda, Pavlodar, and East Kazakhstan. Table 7.21 - Table 7.25 present the results of the Levin et al., Im et al., Maddala and Wu, Sarno and Taylor panel unit root tests and univariate unit root tests applied to the panel of demeaned series of the log of TFP of the regions of Cluster 4.

Table 7.21: Levin et al. panel unit root test of TFP convergence across regions of Cluster 4

Lags	coefficient	t-value	t-star	P > t	Conclusion
Are taken separately for each region according to the sequential t-test of Ng and Perron (1995)	-0.276	-3.052	-1.972	0.024	The null hypothesis of a unit root can be rejected (Convergence)

Notes: Cluster 4 consists of Karaganda, Pavlodar, and East Kazakhstan oblasts.

Table 7.22: Im et al. panel unit root test of TFP convergence across regions of Cluster 4

Lags	t-bar	Cv10	cv5	Cv1	W[t-bar]	P-value	Conclusion
Are taken separately for each region according to the sequential t-test of Ng and Perron (1995)	-2.151	-2.040	-2.190	-2.500	-1.182	0.119	The null hypothesis of a unit root cannot be rejected (Divergence)

Notes: Cluster 4 consists of Karaganda, Pavlodar, and East Kazakhstan oblasts.

Table 7.23: Maddala and Wu tests of TFP convergence across regions of Cluster 4

Lags	chi2(6)	Prob > chi2	Conclusion

0	14.844	0.022	The null hypothesis of unit root can be rejected (Convergence)
1	5.160	0.524	The null hypothesis of a unit root cannot be rejected (Divergence)
2	8.608	0.197	The null hypothesis of a unit root cannot be rejected (Divergence)

Notes: Cluster 4 consists of Karaganda, Pavlodar, and East Kazakhstan oblasts.

Table 7.24: Sarno and Taylor tests of TFP convergence across regions of Cluster 4

Obs	Lags	MADF	Approx 5%	Conclusion
15	1	9.317	62.766	The null hypothesis of a unit root cannot be rejected (Divergence)
14	2	6.359	72.726	The null hypothesis of a unit root cannot be rejected (Divergence)

Notes: Cluster 4 consists of Karaganda, Pavlodar, and East Kazakhstan oblasts.

Table 7.25: The results of the univariate unit root tests of TFP convergence across regions of Cluster 4

Region	Optimal lag	T-statistic	Conclusion
Karaganda	0	-3.199*	Stationarity (Convergence)
Pavlodar	0	-1.827	Non-stationarity (Divergence)
East Kazakhstan	0	-1.072	Non-stationarity (Divergence)

Notes:1. Cluster 4 consists of Karaganda, Pavlodar, and East Kazakhstan oblasts. 2. The 5% critical value is –1.950 and samples with the rejection of the null hypothesis of unit root are marked with an asterisk (*).

These results show that Cluster 4 cannot be considered a convergence club in terms of TFP convergence because the logarithms of TFP of two from three regions diverge from the average across the cluster.

Clusters 3, 5 consist of two regions each in the following order: Cluster 3 – Atyrau and Mangistau oblasts; Cluster 5 – the cities of Almaty and Astana. The issue of TFP convergence among regions included in these clusters can be adjusted to the study of the time behaviour of absolute differences of the logarithm of TFP between each the two regions inside the clusters.

Figure 7.1 shows the behaviour of the absolute difference of TFP between regions of Cluster 3 (Atyrau and Mangistau). It can be seen from the graph that, over the considered time span 1994-2009, the TFP of regions of Cluster 3 converge. Nevertheless, there are three sub-periods of divergence 1994-1996, 1998-2002, and 2003-2005.

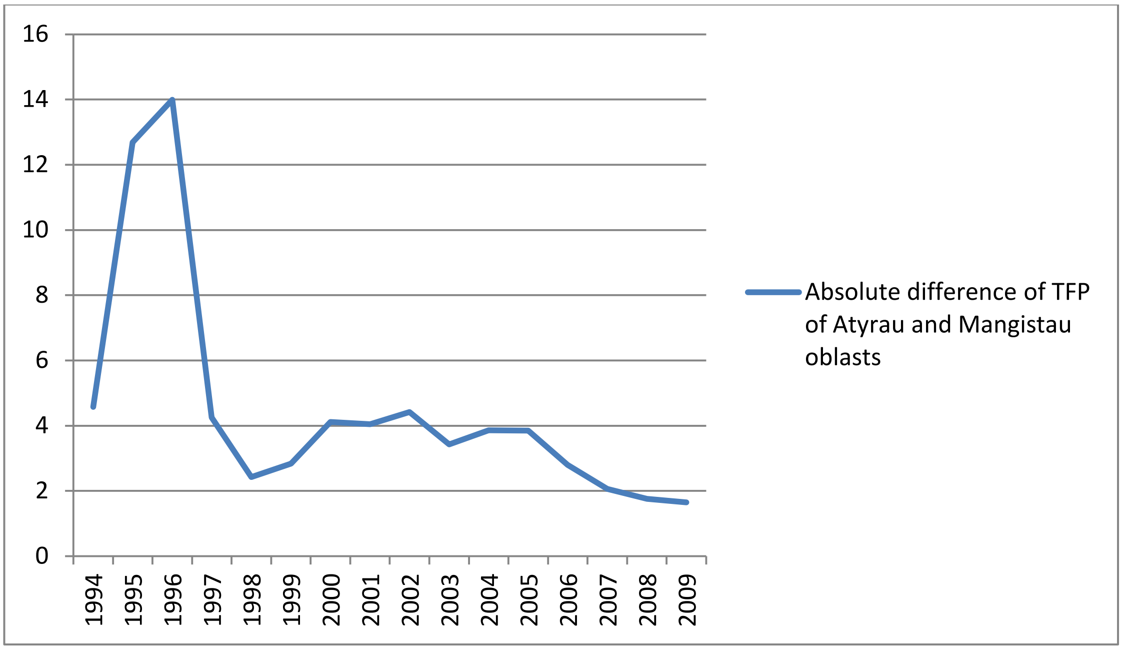

Figure 7.1: Time path of the absolute difference of TFP between regions of Cluster 3 (Atyrau and Mangistau)

As to the two cities of Astana and Almaty, the absolute difference of TFP has fallen from 37.97 in 1997 to 4.5 in 2009 (Figure 7.2): evidence of TFP convergence. However, there are two sub-periods of TFP divergence, namely 2000-2001 and 2005-2006, which are represented by upward inclined sections of the graph on Figure 7.2.

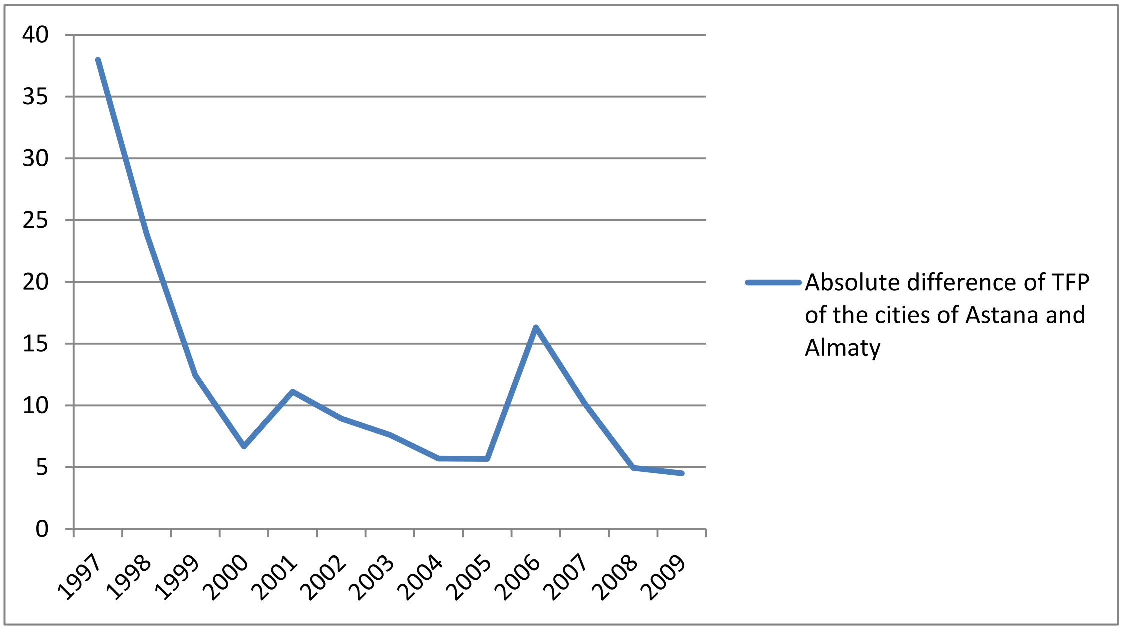

Figure 7.2: Time path of the absolute difference of TFP between regions of Cluster 5 (the cities of Astana and Almaty)

7.5 Conclusion

The distinction of TFP-convergence from considered earlier β- and σ- convergence, lies in the economic indicator, which behaviour is studied. While β- and σ- convergence study output or income, the TFP-convergence studies total factor productivity, which is considered the best approximation of technical progress. In its turn, technical progress is considered as one of two main mechanisms promoting convergence in terms of output or income growth rates and\or levels.

A sequence of panel unit root tests applied to the panel of TFP series of the Kazakhstan regions revealed that the null hypothesis of TFP divergence is rejected. However, it does not mean a conclusion of TFP convergence across the whole set of Kazakhstan regions. We found that TFP convergence takes place across some sub-groups of oblasts. In particular, Cluster1, Cluster 3, and Cluster 5, identified in CHAPTER 6, are convergence clubs in terms of TFP convergence, while Clusters 2 and 4 are not. The reason for this lies in the growth factors chosen to order the clustering of Kazakhstan regions. For example, such factors as investments in fixed assets did not contribute to the TFP directly, rather it influenced the physical capital input.

CHAPTER 8.
SECTOR DECOMPOSITION OF CONVERGENCE ACROSS THE KAZAKHSTAN REGIONS

8.1 Introduction

In this chapter, we look at the convergence issue from another point of view. Using the sector decomposition approach we estimate an input of each sector of Kazakhstan economy into the process of convergence across Kazakhstan regions. This allows us to reveal economic sectors that promote either convergence or divergence among regions of the country. In addition, the method of sector decomposition determines whether structural shifts in the economy of regions promote convergence among them.

From the policy perspective, this will make possible to determine sectors which could serve as targets of investments, in order to promote convergence across regions of the country.

8.2 Method and Data

The method of sector decomposition described in Section 4.7 consists of two stages. At the first one, a dependent variable (rate of growth of per worker GRP) is decomposed into components according to equation (34). These are rates of growth in sectors, structural shifts, and their covariance. At the second stage, each of these components is regressed on the logarithm of real per worker GRP at the initial moment of time.

We employ data on gross value added (GVA) and the number of employed people of five sectors over the period of 2000-2009, available from the Regions of Kazakhstan statistical issue. According to the availability of data, the following sectors of the Kazakhstan economy were considered: industry, construction, transport and communication, agriculture, trade and other services. Sometimes, for the simplicity, we will refer to the sector of transport and communication as transport sector, and to the sector of trade and other services as service sector.

We measure employment share as the ratio of the number of sector employment to the total employment. The labour productivity is measured as value added per worker. The output share is measured as a sector's total value added to the economy's total value added. All the gross values added are denominated to the prices of 1993, using series of GDP deflator available from the Statistical Yearbook of Kazakhstan (1993-2009b). Table 8.1 and Source: Regions *of Kazakhstan (1993-2009), Statistical Yearbook of Kazakhstan (1993-2009), author's calculation*

Table 8.2 show the output shares by regions and sectors for the initial (2000) and final (2009) years of the considered period, respectively.

Industry was one of the dominant sectors of the Kazakhstan economy producing 37% of total output in 2000 and 31% in 2009. During the period under consideration, the share of industry has fallen significantly in such regions as Akmola (from 20% to 13%), Almaty oblast (from 31% to 20%), Zhambyl (from 22% to 17%), Karaganda (from 59% to 50%), Kostanay (from 34% to 22%), South Kazakhstan (from 37% to 21%), Pavlodar (from 48% to 40%), North Kazakhstan (from 17% to 10%), East Kazakhstan (from 40% to 29%), and the city of Almaty (from 13% to 6%). However, some regions increased the share of industry in their economies. These regions are three oil producing oblasts: West Kazakhstan (from 26% to 52%), Kyzyl-Orda (from 44% to 50%), and Mangistau (from 55% to 61%).

Another dominant sector of Kazakhstan economy is service, including trade and other services. Its share in the economy of Kazakhstan has increased from 35% in 2000 to 44% in 2009. The share of the service sector has increased in almost all regions of the country except West Kazakhstan, Atyrau, and Kyzyl-Orda oblasts, where this share decreased insignificantly. The most considerable increase of the share of the service sector was observed in Almaty oblast (from 24% in 2000 to 42% in 2009), Kostanay oblast (from 26% to 38%), South Kazakhstan (from 28% to 51%), and Pavlodar oblast (from 17% to 32%).

The sector of transport and communications is the third largest sector in Kazakhstan, although its share in the economy of the country has fallen from 13% in 2000 to 11% in 2009. Accordingly, the share of this sector in the outputs of almost all regions has decreased as well. Exceptions are the cities of Almaty and Astana, where the share of the transport and communications sector has increased by 2.64 and 1.25 times respectively.

Although the share of the construction sector in the economy of Kazakhstan increased insignificantly from 6% in 2000 to 8% in 2009, there are considerable distinctions in the dynamics of this indicator across regions of the country. Some regions increased considerably the share of construction in their economies: Akmola oblast (from 1% to 13%), Aktobe oblast (from 3% to 8%), Almaty oblast (from 3% to 11%), Atyrau oblast (from 5% to 12%), Zhambyl oblast (from 1% to 9%), Karaganda oblast (from 1% to 4%), Kyzyl-Orda oblast (from 3% to 7%), Mangistau oblast (from 4% to 9%), South Kazakhstan oblast (from 5% to 10%), North Kazakhstan oblast (from 1% to 3%), the city of Almaty (from 2% to 5%). On the other hand, the share of construction decreased significantly in the economies of such regions as West Kazakhstan (from 22% to 6%), East Kazakhstan (from 6% to 4%), and the city of Astana (from 37% to 16%).

As to the sector of agriculture, its share in the economy of the country decreased from 9% in 2000 to 6% in 2009. This decrease took place in all regions except Kostanay, Pavlodar, North Kazakhstan and East Kazakhstan oblasts, where the share of agriculture increased slightly.

Table 8.1: Output shares of sectors in 2000

	Industry	Construction	Transport and communication	Agriculture	Trade and services
Kazakhstan	0.37	0.06	0.13	0.09	0.35
Akmola	0.20	0.01	0.16	0.29	0.34
Aktobe	0.44	0.03	0.12	0.09	0.33
Almaty oblast	0.31	0.03	0.14	0.29	0.24
Atyrau	0.58	0.05	0.08	0.02	0.27
West Kazakhstan	0.26	0.22	0.13	0.07	0.32
Zhambyl	0.22	0.01	0.18	0.21	0.37
Karaganda	0.59	0.01	0.10	0.04	0.26
Kostanay	0.34	0.03	0.15	0.23	0.26
Kyzyl-Orda	0.44	0.03	0.12	0.09	0.32
Mangistau	0.55	0.04	0.19	0.01	0.21
South Kazakhstan	0.37	0.05	0.13	0.18	0.28
Pavlodar	0.48	0.05	0.25	0.05	0.17
North Kazakhstan	0.17	0.01	0.13	0.33	0.36
East Kazakhstan	0.40	0.06	0.10	0.10	0.34
Astana city	0.09	0.37	0.07	0.00	0.48
Almaty city	0.13	0.02	0.13	0.00	0.71

Source: Regions of Kazakhstan (1993-2009), Statistical Yearbook of Kazakhstan (1993-2009), author's calculation

Table 8.2: Output shares of sectors in 2009

	Industry	Construction	Transport and communication	Agriculture	Trade and services
Kazakhstan	0.31	0.08	0.11	0.06	0.44
Akmola	0.13	0.13	0.09	0.24	0.41
Aktobe	0.43	0.08	0.10	0.06	0.34
Almaty oblast	0.20	0.11	0.09	0.19	0.42
Atyrau	0.56	0.12	0.06	0.01	0.24
West Kazakhstan	0.52	0.06	0.06	0.04	0.31
Zhambyl	0.17	0.09	0.10	0.13	0.51
Karaganda	0.50	0.04	0.08	0.04	0.34
Kostanay	0.22	0.04	0.13	0.23	0.38
Kyzyl-Orda	0.50	0.07	0.09	0.04	0.30
Mangistau	0.61	0.09	0.08	0.00	0.22
South Kazakhstan	0.21	0.10	0.08	0.09	0.51
Pavlodar	0.40	0.04	0.19	0.06	0.32
North Kazakhstan	0.10	0.03	0.08	0.35	0.44
East Kazakhstan	0.29	0.04	0.08	0.10	0.48
Astana city	0.04	0.16	0.17	0.00	0.63
Almaty city	0.06	0.05	0.16	0.00	0.73

Source: Regions of Kazakhstan (1993-2009), Statistical Yearbook of Kazakhstan (1993-2009), author's calculation

Table 8.3 presents the shift-share decomposition of the per worker output growth across Kazakhstan regions over the period of 2000-2009 using equation (34). It can be seen that the share of the growth effect made up the major part of the growth of labour productivity of Kazakhstan regions. The shift effect was small in the majority of the regions except Atyrau (-0.09), West Kazakhstan (0.15), Kyzyl-Orda (0.09), and Mangistau oblasts (0.13). All these regions are oil-producing areas, and there were considerable sector allocations in their economies during the period of 2000-2009. The total interaction effect was also small (-0.02). However, there were regions where this effect was rather considerable (Atyrau: -0.15, West Kazakhstan: -0.11, Mangistau: 0.15, Pavlodar: -0.11, and the city of Almaty: -0.16).

The per worker output of the country grew by 82% for the ten years. These 82 percentage points were summed up by 85 per cent of the per worker growth of sectors, -1 per cent – of the reallocation of employment among sectors, and -2 per cent – of the covariance of growth effect and shift effect.

The aggregate growth effect was positive in all regions, meaning that the growth of labour productivity across sectors contributed significantly to the total growth of labour productivity. The total shift effect was positive in eight regions and negative in the same quantity of regions, counting as negative value for the whole country. The positive values in some regions mean that employment growth of those regions was positive either in the majority of sectors or in those sectors with the highest initial output shares. The negative values mean that the employment growth of these regions was mostly negative.

The total interaction effect was positive in four regions and negative in twelve regions. The negative value means that the employment shares of the sectors, in which per worker output were increasing more rapidly than average, were decreasing.

Table 8.3: Shift share decomposition of the per worker output growth across Kazakhstan regions over the period of 2000-2009

	Growth effect	Shift effect	Interaction effect	Total growth
Kazakhstan	0.85	-0.01	-0.02	0.82
Akmola	0.98	-0.04	0.06	1.00
Aktobe	0.98	-0.02	-0.03	0.94
Almaty oblast	0.58	0.01	-0.01	0.58
Atyrau	1.16	-0.09	-0.15	0.92
West Kazakhstan	1.04	0.15	-0.11	1.08
Zhambyl	0.52	-0.05	0.05	0.52
Karaganda	0.55	0.02	0.02	0.60
Kostanay	0.43	-0.06	-0.01	0.36
Kyzyl-Orda	1.92	0.09	0.00	2.01
Mangistau	0.67	0.13	0.15	0.95
South Kazakhstan	0.30	-0.01	0.00	0.29
Pavlodar	0.68	0.02	-0.11	0.59
North Kazakhstan	0.82	-0.02	-0.04	0.76
East Kazakhstan	0.43	0.01	-0.05	0.40
Astana city	0.70	0.04	-0.04	0.70
Almaty city	1.60	-0.04	-0.16	1.40

Table 8.4: Decomposition of total growth effect

	Growth effect	Industry	Construction	Transport and communication	Agriculture	Trade and services
Kazakhstan	0.85	0.28	0.02	0.11	0.03	0.42
Akmola	0.98	0.09	0.13	0.07	0.15	0.54
Aktobe	0.98	0.44	0.09	0.16	0.03	0.26
Almaty oblast	0.58	0.02	0.04	-0.01	-0.01	0.53
Atyrau	1.16	0.88	0.08	0.03	0.01	0.17
West Kazakhstan	1.04	0.93	-0.14	0.01	0.04	0.20
Zhambyl	0.52	0.15	0.04	-0.03	0.00	0.36
Karaganda	0.55	0.23	0.03	0.06	0.05	0.18
Kostanay	0.43	0.02	0.02	0.09	0.06	0.24
Kyzyl-Orda	1.92	1.17	0.06	0.02	0.09	0.58
Mangistau	0.67	0.42	0.08	0.00	0.01	0.16
South Kazakhstan	0.30	0.05	0.00	-0.04	-0.04	0.33
Pavlodar	0.68	0.10	-0.02	0.16	0.02	0.42
North Kazakhstan	0.82	0.07	0.06	-0.01	0.23	0.47
East Kazakhstan	0.43	0.08	-0.03	0.08	0.05	0.25
Astana city	0.70	0.02	-0.13	0.31	0.00	0.49
Almaty city	1.60	0.01	0.03	0.47	0.00	1.08

Table 8.4 presents the decomposition of the total growth effect into the growth of per worker output due to each sector, weighted by the initial share of each sector in total output. It evidences that out of 85% of the total growth effect of the country 42% were provided by the labour productivity growth in the service sector, 28% - by the growth in industry, 11% - in the sector of transport and communications, 3% - in agriculture, and 2% - in construction[1].

However, this pattern of sector decomposition varies across the Kazakhstan regions according to their economic specialization. In oil-producing regions, the total growth effect is provided mainly by the output per worker growth in industry (Aktobe oblast: 44% out of 98%; Atyrau oblast: 88% out of 116%; West Kazakhstan oblast: 93% out of 104%; Kyzyl-Orda oblast: 117% out of 192%; and Mangistau oblasts: 42% out of 67%). In the rest of the regions, during the considered period of 2000-2009, the growth of labour productivity in the service sector was significantly higher than in other sectors. It is particularly significant for the agrarian regions and the cities of Almaty and Astana (Akmola oblast: 54% growth of service sector out of 98% of the total growth effect; Almaty oblast: 53% out of 58%; Zhambyl oblast: 36% out of 52%; South Kazakhstan oblast: 33% out of 30%; North Kazakhstan oblast: 47% out of 82%; the city of Almaty: 108% out of 160%; the city of Astana: 49% out of 70%).

Some sectors of the economy of the country had negative growth in some regions. For example, the labour productivity in the construction sector has decreased in the West Kazakhstan oblast (-14%), Pavlodar oblast (-2%), East Kazakhstan oblast (-3%), and the city of Astana (-13%). The labour productivity in the transport and communications sector fell in such regions as Almaty oblast (-1%), Zhambyl oblast (-3%), South Kazakhstan oblast (-4%), and North Kazakhstan oblast (-1%). The labour productivity in the agriculture sector has decreased in two regions: Almaty oblast (-1%) and South Kazakhstan oblast (-4%).

8.3 Results of Sector Decomposition

First, we perform the series of cross-section regressions over the period of 2000-2009, in which the logarithm of the real per worker GRP of 2000 is taken as an independent variable, while the respective growth rates of the sector decomposition are taken as dependent variables. The results presented in Table 8.5 show that all the convergence coefficients are insignificant, meaning that the logarithm of the initial (2000) GRP does not influence the growth rates of labour productivity in all the considered sectors, as well as the growth effect, the shift effect and the interaction effect. This means an absence of absolute β-convergence both as a whole and by sectors.

[1] Due to the rounding some values may not sum up

Table 8.5: Sector decomposition of absolute β-convergence across the Kazakhstan regions over the period of 2000-2009 (cross-section regression)

Sector	Convergence coefficient	Standard error	Significance level	R^2
Industry	0.151	0.153	0.341	0.065
Construction	-0.016	0.03	0.595	0.021
Transport and communication	0.091	0.052	0.101	0.18
Agriculture	-0.032	0.027	0.249	0.094
Trade and services	-0.049	0.097	0.619	0.018
Total growth effect	0.144	0.181	0.438	0.043
Total shift effect	0.014	0.028	0.638	0.016
Total interaction effect	-0.042	0.032	0.201	0.114
Aggregate convergence	0.115	0.181	0.533	0.28

However, we suspect that the insignificance of regression coefficient is caused by the small number of observations. Therefore, next we perform the panel and yearly cross-section regressions over the period of 2001-2009.

Before running panel regressions we address the possible problem of cointegration. Using panel unit root tests of Levin et al., Im et al., and Maddala and Wu, described in Section 4.6.2, we check whether the considered panel variables are stationary or they have unit roots. The results of this check are presented in Table 8.6 and indicate that all the tests reject the null hypothesis of non-stationarity (I(1) behaviour) in the considered series. This means that the series, which take part in panel regressions are stationary and the problem of cointegration does not arise. The possible reason of stationarity is that the series consist of growth rates of labour productivities in respective sectors, which are calculated using first differences. These differences allow to eliminate possible non-stationarity.

Table 8.6: Panel unit root tests of stationarity in the series corresponding to growth rates in various sectors, shift effect, interaction effect and logarithm of initial GRP

	Levin et al. test	Im et al. test	Maddala and Wu test
	P>t		
Industry	0.000	0.000	0.000
Construction	0.000	0.000	0.000
Transport and communication	0.000	0.000	0.000
Agriculture	0.000	0.000	0.000
Trade and services	0.000	0.000	0.000
Growth effect	0.000	0.000	0.000
Shift effect	0.000	0.000	0.000
Interaction effect	0.000	0.000	0.000
Total growth	0.000	0.000	0.000
Log Initial GRP	0.000	0.029	0.012

Note: H_0 - the series are non stationary

The results of panel and yearly cross-section regressions are presented in Table 8.7.

Table 8.7: Sector decomposition of absolute β-convergence across the Kazakhstan regions over the period of 2001-2009 (panel regression and yearly cross-section regressions)

Time period	Total growth	Growth effect	Industry	Construction	Transport	Agriculture	Service	Shift-effect	Interaction effect
2001-2009, fe	-0.153*** (0.036)	-0.205*** (0.034833)	-0.076*** (0.022)	-0.024** (0.011)	-0.035*** (0.010)	0.010 (0.007)	-0.081*** (0.027)	0.026** (0.012)	0.026*** (0.006)
2001	0.065 (0.048)	-0.003 (0.0497749)	-0.077** (0.027)	0.003 (0.014)	0.020 (0.019)	-0.002 (0.013)	0.053 (0.040)	0.033 (0.022)	0.035*** (0.011)
2002	0.052 (0.035)	0.031 (0.034)	0.004 (0.020)	-0.001 (0.017)	-0.007 (0.015)	0.003 (0.008)	0.032* (0.016)	0.016 (0.018)	0.005 (0.004)
2003	0.016 (0.023)	0.017 (0.029)	0.006 (0.011)	-0.013 (0.016)	0.0004 (0.016)	-0.002 (0.003)	0.025* (0.014)	0.003 (0.010)	-0.004 (0.003)
2004	-0.019 (0.039)	0.001 (0.035)	0.027 (0.021)	0.005 (0.012)	-0.002 (0.005)	-0.004 (0.006)	-0.025 (0.022)	-0.021** (0.009)	0.002 (0.004)
2005	0.063 (0.031)	0.071** (0.030)	0.060** (0.028)	-0.006 (0.005)	0.020 (0.012)	-0.00005 (0.003)	-0.003 (0.034)	-0.008 (0.007)	0.0004 (0.002)
2006	0.052 (0.030	0.043 (0.030)	0.008 (0.024)	0.015** (0.006)	0.005 (0.004)	0.006 (0.004)	0.010 (0.015)	0.011 (0.006)	-0.001 (0.001)
2007	-0.104*** (0.023)	-0.101*** (0.022)	-0.005 (0.008)	-0.010 (0.009)	0.017*** (0.004)	-0.008 (0.006)	-0.096*** (0.013)	-0.003 (0.009)	-0.00003 (0.002)
2008	0.020 (0.036)	0.032 (0.037)	0.045* (0.025)	-0.015* (0.008)	0.003 (0.003)	0.006 (0.006)	-0.007 (0.010)	-0.010** (0.004)	-0.002 (0.002)
2009	-0.046* (0.024)	-0.040 (0.027)	-0.010 (0.024)	-0.008* (0.004)	-0.004 (0.006)	-0.014 (0.009)	-0.002 (0.011)	-0.006 (0.007)	0.0002 (0.002)

*Notes:.1. The asterisks *, **, and *** mean the level of significance at the 10%, 5%, and 1% respectively ,2. Robust standard errors are in the parentheses.*

In each of these regressions, the logarithm of the initial per worker GRP is taken as an independent variable, while a respective term of the sector decomposition is taken as a dependent variable. In the table, we present only the estimates of the regression coefficient of the dependent variables including standard errors in parentheses. The second column of the table corresponds to the regression with the total growth taken as a dependent variable. In the third column, the dependent variable is growth effect. In the columns from fourth to eighth, a dependent variable is the growth rate of per worker value added in respective sectors. In the ninth and tenth columns, the dependent variables are shift effect and interaction effect, respectively.

In the second row of Table 8.7, the results of panel regression with fixed effects are presented. Regressions produce highly significant negative estimates of the convergence coefficient of all terms of sector decomposition excepting the sector of agriculture. This evidences that four from five sectors were engines of convergence across Kazakhstan regions over the considered period. The positive and insignificant estimate of the convergence coefficient in the regression for the sector of agriculture means that the initial per worker GRP did not influence consequent labour productivity growth in this sector, evidencing that this sector was not one of the sources of convergence. The basic engines of convergence were service sector and industry with the values of convergence coefficients equal to -0.081 and -0.076, respectively. The inputs of construction and transport sectors were considerably lesser: -0.024 and -0.035, respectively. On the other hand, shift effect and interaction effect terms of sector decomposition were engines of divergence with the positive and significant estimates of convergence coefficients. This was because the reallocation of productive structure was more intensive in the richer oil producing regions and the cities of Astana and Almaty.

Further, the sector decomposition is analysed separately for each year. In the analysis of the given type of models (cross-section regressions), the quantity of significant coefficients reduces, and not all sectors influence the process of convergence. The convergence of per worker GRP has significant negative coefficients only in 2007 and 2009. Firstly, this can be explained by the decrease of rates of growth in fast developing oil-producing regions due to a fall in the prices of raw materials. Secondly, the growth of prices of agricultural production and high yields resulted in high growth rates in poorer agrarian regions. For example, in 2007 and 2009, the growth rates of real per worker GRP in Aktobe oblast were +10% and -8%, respectively; in Atyrau oblast, -8% and +4%, respectively; in West Kazakhstan oblast, +2% and -6%, respectively; in Kyzyl-Orda oblast, +14% and -12%, respectively; in Mangistau oblast, +7% and -6%, respectively (Table 8.8).

Table 8.8: Yearly growth rates of real per worker GRP in prices of 1993 (tenge)

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Kazakhstan	0,05	0,10	0,06	0,08	0,08	0,20	0,06	0,003	0,01
Akmola	0,07	0,10	0,00	0,08	-0,01	0,18	0,36	-0,06	0,05
Aktobe	-0,02	0,24	0,09	0,10	0,16	0,10	0,10	0,03	-0,08
Almaty oblast	0,02	0,01	0,01	0,04	0,05	0,14	0,14	-0,01	0,08
Atyrau	0,12	0,16	0,17	-0,05	0,05	0,17	-0,08	0,14	0,04
West Kazakhstan	0,13	0,17	0,03	0,39	-0,05	0,13	0,02	0,08	-0,06
Zhambyl	-0,06	0,11	0,13	0,16	0,03	0,01	0,10	-0,04	0,01
Karaganda	-0,02	0,00	0,03	0,04	0,12	0,22	0,07	0,05	-0,01
Kostanay	-0,16	0,04	0,08	0,03	-0,01	0,09	0,24	0,04	-0,01
Kyzyl-Orda	0,12	0,22	0,11	0,13	0,12	0,37	0,14	0,13	-0,12
Mangistau	0,07	0,23	-0,07	-0,02	0,20	0,20	0,07	0,13	-0,06
South Kazakhstan	0,14	-0,10	-0,01	-0,08	-0,04	0,04	0,21	-0,05	0,19
Pavlodar	-0,02	0,07	0,09	0,11	-0,02	0,07	0,08	0,16	-0,05
North Kazakhstan	0,01	0,02	0,04	0,14	0,04	0,18	0,17	0,04	-0,02
East Kazakhstan	0,03	0,03	-0,02	0,03	0,01	0,20	0,11	-0,08	0,06
Astana city	0,07	0,04	0,13	0,12	0,29	0,18	-0,02	-0,17	-0,03
Almaty city	0,39	0,14	0,08	0,09	0,12	0,34	-0,04	-0,13	0,03

Notes: In prices of 1993
Source: Regions of Kazakhstan (1993-2009), author's calculation

At the same time, in 2007 and 2009, the agrarian oblasts had high growth rates: Akmola oblast, +36% and +5%; Almaty oblast, +14% and +8%; South Kazakhstan oblast, +21% and +19%, respectively. Average developing regions began to approach the leaders because they were quick to adapt to new economic conditions and found their market niche.

An analysis of the yearly absolute β-convergence by sectors has yielded the following results (Table 8.7). In 2001, the only engine of convergence was the industry sector, having the value of convergence coefficient equal to -0.077. At the same time, an interaction effect promoted divergence with the value of convergence coefficient equal to 0.035. The estimates of the convergence coefficient of other sectors and structural shifts were insignificant. The influence of industry on convergence is explained by the high growth rates of the per worker value added of this sector in such backward regions as Akmola oblast (62%), Almaty oblast (41%), Zhambyl oblast (68%), South Kazakhstan oblast (38%), North Kazakhstan oblast (32%), and low growth rates in such leading regions as Atyrau oblast (6%), West Kazakhstan oblast (0%), Mangistau oblast (-9%) (Table 8.9).

Table 8.9: Yearly growth rates of real per worker GRP in industry

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Kazakhstan	0,10	0,06	0,04	0,09	0,09	0,08	0,02	0,16	-0,04
Akmola	0,62	0,45	-0,15	-0,10	-0,01	0,07	0,19	-0,15	-0,25
Aktobe	0,38	0,19	0,02	0,18	0,20	-0,05	0,02	0,04	-0,16
Almaty oblast	0,41	-0,04	0,07	-0,10	-0,07	-0,02	-0,08	0,00	-0,01
Atyrau	0,06	0,10	0,06	0,10	0,16	-0,03	-0,02	0,43	0,16
West Kazakhstan	0,00	0,07	0,18	0,76	0,74	0,08	-0,03	0,24	-0,09
Zhambyl	0,68	0,04	0,02	0,25	-0,15	-0,07	0,01	0,13	-0,17
Karaganda	-0,10	0,00	0,05	0,01	0,19	0,16	0,03	0,08	-0,06
Kostanay	-0,11	-0,05	0,04	0,22	-0,19	-0,14	0,14	0,24	0,00
Kyzyl-Orda	0,38	0,38	0,20	0,23	0,24	0,39	-0,10	0,18	-0,28
Mangistau	-0,09	0,06	-0,02	0,19	0,25	0,15	-0,03	0,21	-0,08
South Kazakhstan	0,38	-0,15	-0,07	-0,18	-0,23	-0,01	-0,04	0,01	0,73
Pavlodar	-0,07	0,07	0,10	0,09	-0,17	-0,09	0,09	0,53	-0,22
North Kazakhstan	0,32	-0,06	-0,01	0,02	-0,10	0,01	-0,02	0,10	0,17
East Kazakhstan	0,16	-0,03	0,00	-0,06	-0,09	0,25	0,07	-0,16	0,11
Astana city	0,17	-0,14	0,31	0,11	-0,14	0,00	0,26	-0,20	0,02
Almaty city	0,22	0,07	-0,04	0,00	0,03	-0,03	0,08	-0,18	-0,01

Notes: In prices of 1993
Source: Regions of Kazakhstan (1993-2009), author's calculation

In 2002 and 2003, due to the positive and significant convergence coefficient, the service sector promoted divergence across Kazakhstan regions. This effect is explained by high growth rates of this sector in such richer regions as Atyrau oblast (51% in 2003), West Kazakhstan oblast (8% in 2002, 18% in 2003), Mangistau oblast (28% in 2002), Astana city (23% in 2002), Almaty city (17% in 2002, 10% in 2003), and low growth rates in such poorer regions as Zhambyl oblast (4% in 2002, 5% in 2003), South Kazakhstan oblast (-9% in 2002, -6% in 2003), North Kazakhstan oblast (3% in 2002, 0.03% in 2003) (Table 8.10).

Table 8.10: Yearly growth rates of real per worker GRP in service sector

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Kazakhstan	0,14	0,11	0,08	0,10	0,03	0,34	0,10	-0,05	0,01
Akmola	-0,15	0,21	0,07	0,33	-0,03	0,45	0,41	-0,05	-0,05
Aktobe	0,08	0,01	0,02	0,04	0,00	0,38	0,20	0,00	-0,06
Almaty oblast	0,27	-0,14	0,00	0,14	0,05	0,59	0,48	-0,04	0,10
Atyrau	0,13	-0,02	0,51	-0,08	-0,07	0,34	-0,07	-0,10	0,02

West Kazakhstan	0,40	0,08	0,18	0,49	-0,55	0,31	0,07	-0,03	0,00
Zhambyl	-0,29	0,04	0,05	0,40	0,07	0,27	0,39	-0,07	0,03
Karaganda	-0,08	-0,02	0,06	0,08	-0,01	0,46	0,13	0,04	-0,03
Kostanay	-0,32	0,15	0,07	0,06	0,28	0,33	0,34	-0,03	-0,02
Kyzyl-Orda	0,08	-0,01	0,17	0,25	-0,13	0,47	0,47	0,05	-0,08
Mangistau	0,04	0,28	-0,06	-0,21	-0,03	0,53	0,28	0,04	-0,11
South Kazakhstan	0,34	-0,09	-0,06	-0,03	0,00	0,26	0,58	-0,06	0,04
Pavlodar	0,65	0,09	-0,02	0,08	0,20	0,37	0,14	-0,07	0,05
North Kazakhstan	0,35	0,03	0,0003	0,21	0,02	0,32	0,28	-0,03	-0,18
East Kazakhstan	-0,09	0,19	-0,07	0,08	0,02	0,30	0,21	-0,03	0,03
Astana city	0,27	0,23	-0,05	0,07	0,32	0,28	-0,08	-0,18	0,01
Almaty city	0,42	0,17	0,10	0,08	0,07	0,36	-0,07	-0,08	0,04

Notes: In prices of 1993
Source: Regions of Kazakhstan (1993-2009), author's calculation

In 2004, there was only one engine of convergence – the shift effect, with negative and significant convergence coefficient equal to -0.021 (Table 8.7). This resulted in a negative although insignificant convergence coefficient of the total growth. The convergence across the Kazakhstan regions caused by shift effect in this year is explained by the considerable distinctions in growth rates of employment shares both across regions and sectors. For example, the growth rates of employment shares in industry were high in poorer regions and low (even negative) in richer regions (Atyrau oblast: -7%, Mangistau oblast: -12%, the city of Astana: -6%, Almaty oblast: +5%, Noth Kazakhstan oblast: +5%). A similar situation was observed in the construction, transport, and agriculture sectors.

In 2005, there was divergence of growth effect across the Kazakhstan regions, caused by the divergence of labour productivity in industry, with positive and significant convergence coefficient equal to 0.060 (Table 8.7). It is explained by the high growth rates in richer, mainly oil-producing, regions (Aktobe oblast: 20%, West Kazakhstan: 74%, Atyrau oblast: 16%, Karaganda oblast: 19%, Kyzyl-Orda oblast: 24%, Mangistau oblast: 25%). These high growth rates were provided by high growth rates of prices of oil, gas, coal, and ferrous metals. At the same time, the growth rates of industry in poorer regions were mainly negative (Akmola oblast: -1%, Almaty oblast: -7%, Zhambyl oblast: -15%, South Kazakhstan oblast: -23%, North Kazakhstan oblast: -10%) (Table 8.9).

In 2006, the sector of construction was the engine of divergence with positive and significant convergence coefficient equal to 0.015 (Table 8.7). Again, this divergence pattern was caused by high growth rates of labour productivity of construction in richer regions (Atyrau oblast: 33%, Karaganda oblast: 32%, Pavlodar oblast: 32%, Almaty city: 76%), and low growth rates in poorer regions (Akmola oblast: -8%, South Kazakhstan oblast: -11%, North Kazakhstan oblast: 3%) (Table 8.11).

Table 8.11: Yearly growth rates of real per worker GRP in construction sector

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Kazakhstan	0,03	0,25	-0,16	-0,04	0,30	0,25	-0,07	-0,17	-0,02

Akmola	4,39	0,48	-0,22	-0,36	0,73	-0,08	2,16	-0,01	0,02
Aktobe	2,40	0,07	0,16	-0,13	0,09	-0,13	0,25	-0,08	0,02
Almaty oblast	0,16	-0,11	-0,19	0,48	0,60	0,15	-0,10	0,21	0,01
Atyrau	0,90	0,60	0,20	-0,32	0,02	0,33	-0,38	0,11	0,10
West Kazakhstan	-0,15	0,46	-0,52	-0,05	0,50	-0,21	-0,19	-0,22	-0,07
Zhambyl	-0,51	2,26	2,23	-0,40	0,33	-0,22	-0,29	0,23	0,51
Karaganda	1,42	0,06	-0,32	-0,34	0,88	0,32	-0,04	0,01	0,06
Kostanay	-0,41	0,37	0,91	-0,43	0,88	0,14	0,02	0,17	-0,16
Kyzyl-Orda	2,39	1,23	-0,02	-0,63	-0,18	-0,04	-0,01	0,33	-0,01
Mangistau	0,63	0,20	-0,17	-0,07	0,36	0,11	0,46	0,10	-0,08
South Kazakhstan	-0,34	-0,24	-0,28	0,21	0,66	-0,11	0,00	0,15	0,33
Pavlodar	-0,48	-0,31	0,15	0,10	0,62	0,32	-0,13	-0,07	-0,21
North Kazakhstan	0,65	1,51	0,18	-0,23	1,07	0,03	-0,09	-0,03	0,22
East Kazakhstan	-0,41	-0,26	-0,08	-0,13	0,49	0,34	-0,01	-0,19	-0,18
Astana city	-0,09	-0,24	-0,09	0,42	0,00	0,10	-0,04	-0,29	-0,02
Almaty city	0,23	0,80	-0,28	0,49	0,42	0,76	-0,05	-0,49	-0,18

Notes: In prices of 1993
Source: Regions of Kazakhstan (1993-2009), author's calculation

In 2007, the negative and highly significant convergence coefficient evidenced convergence across the Kazakhstan regions in terms of the growth rate of the total per worker GRP (Table 8.7). However, various sectors differently influenced this process. The sector of services was the only engine of convergence with negative and significant at 1% confidence level convergence coefficient (-0.096). At the same time, the sector of transport and communications promoted divergence having the value of the coefficient equal to 0.017, also significant at 1% confidence level. Other sectors including shift and interaction effects had insignificant estimates of the convergence coefficient. As a result, the total convergence was driven by service sector due to its higher share in total output (average 45%) and the absolute value of convergence coefficient. The convergence of the service sector is explained by higher growth rates in poorer regions (Akmola oblast: 41%, Almaty oblast: 48%, Zhambyl oblast: 39%, South Kazakhstan oblast: 58%, North Kazakhstan oblast: 28%) and lower growth rates in richer regions (Atyrau oblast: -7%, West Kazakhstan oblast: 7%, Karaganda oblast: 13%, the city of Astana: -8%, the city of Almaty: -7%) (Table 8.10).

The results of 2008 were influenced by the world economic crisis, which concerned Kazakhstan as well as many other countries. In this year, the growth rate of total per worker GRP of the country has made only 0.3%, against 20% in 2006 and 6% in 2007. As to the convergence issue, the sector of construction and the structural shifts promoted convergence, while the sector of industry favoured divergence. However, due to the high share of industry in total output (32%), and low shares of construction (8%) and the shift effect, the total convergence coefficient was insignificant and made up 0.002 (Table 8.7). The divergence in industry is explained by the higher rates of growth in richer regions (Atyrau oblast: 43%, West Kazakhstan: 24%, Pavlodar oblast: 53%) and lower growth rates in poorer regions (Akmola oblast: -15%, Almaty oblast: 0.2%, South Kazakhstan oblast: 1%). In addition, the decrease of the labour productivity in the construction sector was more essential in richer regions than in poorer ones (West Kazakhstan oblast: -22%, Astana city: -29%, the city of Almaty: -49%) (Table 8.11). The shift effect was also more essential in poorer regions than in richer ones.

In 2009, there was convergence of the total growth rate of the real per worker output with the negative and significant at 10% confidence level value of the convergence coefficient equal to -0.046 (Table 8.7). The convergence was promoted mainly by the construction sector, however, other sectors also had negative although insignificant values of the convergence coefficient. This is explained by the higher growth rates in poorer regions and lower growth rates in richer ones (Table 8.11-Table 8.13).

Table 8.12: Yearly growth rates of real per worker GRP in the sector of transport and communications

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Kazakhstan	0,20	0,15	0,17	0,01	0,08	0,06	0,06	-0,07	0,02
Akmola	0,47	0,05	0,01	-0,22	-0,10	0,07	0,22	0,03	-0,03
Aktobe	0,20	0,70	0,00	-0,01	0,29	0,06	-0,04	-0,08	-0,03
Almaty oblast	0,06	0,08	-0,09	-0,01	0,19	-0,09	0,00	-0,16	0,02
Atyrau	-0,07	0,33	0,30	0,02	-0,07	-0,13	0,54	-0,11	-0,26
West Kazakhstan	0,45	-0,60	1,44	-0,04	0,07	0,13	0,10	-0,24	-0,23
Zhambyl	-0,16	0,38	0,14	0,05	-0,07	-0,05	-0,19	-0,16	0,02
Karaganda	0,82	-0,03	-0,01	0,05	0,02	-0,08	0,04	-0,11	0,01
Kostanay	-0,13	0,20	0,39	0,02	-0,06	0,02	0,02	-0,01	0,12
Kyzyl-Orda	-0,27	0,09	0,51	0,16	-0,13	0,00	-0,04	-0,27	0,41
Mangistau	0,03	-0,05	-0,49	-0,10	0,01	0,21	0,10	0,04	0,57
South Kazakhstan	-0,17	-0,08	0,19	0,06	-0,15	0,02	-0,24	-0,17	0,32
Pavlodar	0,41	0,07	0,18	0,05	-0,11	0,05	-0,03	-0,06	0,03
North Kazakhstan	-0,18	0,08	0,20	0,05	-0,11	0,09	-0,13	-0,01	-0,03
East Kazakhstan	0,13	0,84	-0,01	0,21	-0,04	0,00	-0,03	-0,12	-0,09
Astana city	0,34	0,10	1,16	-0,07	0,76	-0,01	0,22	0,04	-0,13
Almaty city	0,68	0,26	0,14	0,05	0,30	0,27	0,10	-0,06	0,08

Notes: In prices of 1993
Source: Regions of Kazakhstan (1993-2009), author's calculation

Table 8.13: Yearly growth rates of real per worker GRP in the sector of agriculture

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Kazakhstan	0,00	0,01	0,04	0,02	0,00	-0,04	0,10	-0,03	0,19
Akmola	0,06	-0,06	-0,03	0,08	0,01	-0,01	0,13	-0,17	0,55
Aktobe	-0,31	0,16	0,20	-0,03	-0,06	-0,10	0,13	0,16	0,36
Almaty oblast	-0,22	0,12	0,01	0,01	-0,05	-0,07	0,08	-0,06	0,22
Atyrau	0,55	0,09	-0,31	0,01	0,19	0,19	0,00	-0,04	0,03
West Kazakhstan	0,18	0,24	0,08	-0,11	-0,18	0,06	0,03	0,35	-0,07
Zhambyl	0,25	0,05	0,02	0,04	-0,01	-0,16	-0,07	-0,12	0,02
Karaganda	-0,10	0,22	0,12	0,17	-0,16	0,04	0,16	0,09	0,43
Kostanay	0,33	-0,20	-0,01	-0,08	-0,05	0,06	0,32	0,01	0,00
Kyzyl-Orda	0,02	-0,15	-0,09	0,23	0,10	0,11	0,03	0,04	0,53
Mangistau	0,14	2,44	0,05	-0,22	0,43	-0,09	-0,08	-0,27	-0,13
South Kazakhstan	-0,02	0,11	0,11	-0,17	0,01	-0,12	0,01	-0,18	0,01
Pavlodar	-0,34	0,09	-0,02	0,24	0,12	-0,09	0,05	-0,03	0,55
North Kazakhstan	-0,06	-0,04	0,02	0,11	0,07	0,06	0,11	0,14	0,16
East Kazakhstan	0,14	-0,11	0,04	0,07	-0,01	-0,07	0,04	-0,06	0,48
Astana city	-0,60	-0,32	6,20	0,16	0,35	-0,65	2,17	0,05	-0,87
Almaty city	-0,85	-0,87	5,50	0,57	0,82	0,37	0,38	0,03	-0,79

Notes: In prices of 1993
Source: Regions of Kazakhstan (1993-2009), author's calculation

8.4 Conclusion

The analysis conducted above shows that sector decomposition allows not only splitting of the convergence process into component parts, but also estimating convergence in labour productivity by sectors. The results of panel estimation showed that all sectors except agriculture promoted convergence of labour productivity across the Kazakhstan regions over the period of 2001-2009. At the same time, shift and interaction effects favoured divergence. The agriculture sector was neither an engine of convergence nor an engine of divergence across the Kazakhstan regions over the period of 2001-2009. This can be explained by the strong dependence of this sector on weather conditions, due to the low technological level.

The yearly cross-section analysis showed that in the sectors of industry, construction, transport, and service in different years the convergence behaviour differed. For example, the labour productivity of industry diverged in 2005 and 2008, and converged in 2001 as a whole. The sector of construction was an engine of divergence in 2006, while in 2008-2009 it promoted convergence. The transport and communication sector favoured divergence in 2007, while in the rest of the period it had insignificant values of convergence coefficient. The sector of services was an engine of divergence in 2002-2003, while in 2007 it promoted convergence.

This does not mean that sector decomposition is not helpful. The possible interpretation of these seemingly contradictory results is that the yearly cross-section regressions pick up region variation in average growth rates, whereas the panel regressions mainly reflect variation in growth rates within each region over time. In addition, the panel estimations control region specific fixed effects, which are independent of time.

CHAPTER 9.
CONCLUSIONS AND DISCUSSION

Practical issues concerning the economic development of the Kazakhstan regions chiefly motivated this thesis. Namely, since obtaining of independence economic disparities across the Kazakhstan regions have been growing. The possible consequences of this could be the slowdown of the rates of economic growth, an increase of the levels of unemployment and crime rates in poorer regions, an increase of inflation pressure in richer regions, and an increase in general social dissatisfaction and tension. The possible increase of separatism in some regions is another important practical issue. Therefore, the purpose of this thesis is to contribute to the formation of regional policy in Kazakhstan by studying convergence across the Kazakhstan regions over the period of 1993-2009.

However, there was also a theoretical motivation to this thesis. It was a possibility to compare obtained empirical results with the implications of various growth theories concerning the issue of convergence, aiming to check the appropriateness of the neoclassical growth model in the case of Kazakhstan. In addition, it was necessary to check empirically the specific convergence pattern of Kazakhstan regions caused by the transition type of its economy.

Various notions of convergence reflect various aspects of economic development. These have different definitions and approaches to empirical testing. Moreover, different empirical methodologies exist for testing the same type of convergence, which may produce different results. Therefore, in this thesis, we have used various types of convergence and various empirical approaches without prejudice.

9.1 Summary of Main Results

The relevance of this dissertation consists in the analysis of the development of Kazakhstan regions from the convergence point of view. It gives a rather wide picture of various types of convergence across the Kazakhstan regions over the period of 1993-2009. The study showed that, regions of the country behaved differently with respect to various types of convergence. This gave a picture of the problems that had to be dealt by policy makers and indicated some of the difficulties of the task.

In general, the regions of Kazakhstan diverged over the period of 1993-2009 in the sense of σ-convergence and unconditional β-convergence, which are the strongest notions of convergence. However, they have demonstrated convergence in the sense of other types (conditional β-convergence, TFP-convergence, club-convergence) over various time spans within the 1993-2009 period.

The case of σ-convergence across the Kazakhstan regions conforms to what is mostly observed in the literature for the transition countries, in the sense that regions of these countries usually demonstrate σ-divergence. Over the period as a whole, across all 16 regions, the standard deviation of the logarithm of real per capita GRP grew approximately by 54%, indicating the σ-divergence. The exclusion from the consideration of the five oil-rich regions and two cities of Astana and Almaty changed the behaviour of the graph from an increasing to a decreasing gradient. However, the decrease of the standard deviation was only 12% over the past 16 years. It means that σ-divergence across the Kazakhstan regions was caused by the shocks associated with the oil prices and the development of two capitals: former capital, Almaty, and the present one, Astana.

These results are robust to the choice of the measure of inequality across Kazakhstan regions. When we used the coefficient of variation instead of standard deviation, the patterns of σ-convergence did not change significantly.

In addition, we revealed a positive and significant linear relationship between the growth rates of the country and levels of inequality expressed in terms of both standard deviation and the coefficient of variation. It means that high growth rates in the country were accompanied by a deepening of differentiation across the Kazakhstan regions.

As to the unconditional β-convergence, the analysis showed that the regions of Kazakhstan considered all together did not demonstrate the absolute β-convergence over the period of 1993-2009 and sub-periods of 1993-2000 and 2000-2009. This behaviour contradicts what is usually observed in the literature for such developed countries as USA, Japan, EU, when regions of these countries demonstrate absolute β-convergence. However, this divergence behaviour is similar to the behaviour of regions of such transition countries as Ukraine, Russia, Poland, Hungary, Romania and Bulgaria. The reason for this divergence pattern is that the Kazakhstan regions have considerable distinctions in their steady state positions to which they converge in accordance with neoclassical growth theory.

To capture these differences and to explain the absolute divergence patterns two methods were used. The first one controls some variables responsible for steady state disparities, i.e. it studies the conditional β-convergence across the Kazakhstan regions. The second one divides the regions into homogeneous groups according to growth factors and studies convergence within these groups, i.e. it tests the club-convergence hypothesis.

In order to study the conditional β-convergence and to control possible steady state differences that may affect the rates of growth of regions, three additional variables were considered. Firstly, the ratio of the real gross regional investments in fixed assets to the real gross regional product was taken as an approximation of saving rate and a potential variable to control the shocks in growth rates. Secondly, in order to control the population change influence on the rates of growth of per capita output, the population growth variable was included in the regression equation. Thirdly, the share of output produced by the agricultural sector over the considered periods was the variable selected to take into account the agricultural branch shocks.

Regression analysis with the three added variables, considered as additional control factors, confirmed conditional β-convergence across the Kazakhstan regions over the periods of 1993-2009, 1993-2000, and 2000-2009. In all three regression equations, the logarithm of the initial per capita GRP entered with negative and significant coefficients. This confirmed the fact that initially less prosperous regions tend to grow faster to their steady state positions than more developed ones. The speed of convergence over the period of 1993-2009 was 9.3% per year.

The panel approach to the convergence study across the regions of Kazakhstan also confirmed that conditional convergence did take place over the period of 1993-2009. The speed of convergence obtained using panel estimators was much higher than that obtained using cross-section regression. This result is due to the Omitted Variable Bias Problem (OVBP) of the cross-section approach, which is partially overcome by using the panel estimation. Higher rates of conditional convergence across Kazakhstan regions are consistent with the results of studies that used the panel data approach to estimate the fixed-effects convergence models for various regional samples. They also showed very rapid (at rates of up to 21% per year) convergence of regional economies towards very different steady state positions in contrast to the early works of Barro and Sala-i-Martin and other authors with slow (at rates of about 2% per year) convergence to a common income level.

As to club convergence across the Kazakhstan regions, in order to reveal groups of regions similar in the development of chosen growth factors, the cluster analysis was applied. The following factors and corresponding indicators were chosen to divide the regions into homogeneous groups.

The capital accumulation was approximated by the real per capita investments in fixed assets. As indicators of innovativeness, the per capita expenses for technological innovations of enterprises and per capita expenditures for research and development were taken. The regional accessibility was approximated by the relative distance between the centre of a region and two main economic poles of Kazakhstan: Almaty and Astana. The infrastructure variable was approximated by the density of the transport system of a region.

As a result of clustering using these growth factors, four clusters were identified, and the study of convergence within them showed that they all could be regarded as convergence clubs. The first is a club consisting of six regions, which demonstrate the σ- and unconditional β-convergence, over all the considered periods. The convergence speed is equal to 3% per year.

The second convergence club consists of three oil rich regions and demonstrates the σ- and unconditional β- convergence as well. The speed of convergence varies from 3.2% per year in 1993-2000 to 8.8% per year in 2000-2009.

The third is a club consisting of two oil rich regions: Atyrau and Mangistau. They also demonstrate the σ- and absolute β- convergence, over the periods of 1993-2009 and 1993-2000 with the speeds of absolute convergence 2.3% and 9% per year, respectively. However, they diverge within the time span of 2000-2009.

The fourth convergence club consisting of Karaganda, Pavlodar and East Kazakhstan oblasts also exhibited σ- and absolute β-convergence over the periods of 1993-2009 and 2000-2009, with the speeds of 1% and 8.3% per year, respectively. However, they exhibited divergence over the period of 2000-2009.

The fifth convergence club includes cities of Astana and Almaty. They demonstrated both σ-and unconditional β-convergence over the period of 1997-2009. The speed of convergence was equal to 17.4% per year.

CHAPTER 7 presents the study of convergence across Kazakhstan regions with the focus on the total factor productivity regarded as the long-term structural determinant of economic growth. The TFP-convergence across the Kazakhstan regions was studied using three panel unit root tests. For the whole set of Kazakhstan regions, all the three panel unit root tests rejected the null hypothesis of a unit root, i.e. of divergence, in favour of the alternative. However, we found that the evidences of TFP convergence across the Kazakhstan regions using the panel unit root tests represented convergence across a subset of regions and could not be considered as conclusive with respect to the whole country.

Therefore, as a next step, we studied the TFP convergence across regions of each of five clusters devised in the previous chapter. These clusters were identified according to such growth factors as innovativeness, investment, regional accessibility, and infrastructure. All these factors except investment have direct connection to the total factor productivity. Therefore, it was reasonable to suppose that regions belonging to the same cluster display TFP convergence. Four panel unit root tests (we also added the Sarno and Taylor (1998) PUR test, as the dimension of variables permitted it) were applied to the six regions panel of Cluster 1, the three regions panel of Cluster 2, and the three regions panel of Cluster 4. The tests applied to Cluster 1 rejected the null hypothesis of non-stationarity in favour of the alternative hypothesis of TFP convergence. The results of the univariate ADF tests showed that the TFP of four regions from six converged to the cluster's average. However, the results of PUR tests applied to the TFP panels of Clusters 2 and 4 reported in favour of the null hypothesis of the presence of unit roots, that is, of TFP divergence. This was confirmed by the univariate ADF tests that showed the TFP convergence to the cluster's average of only one region, and TFP divergence of the remaining two regions in each cluster. As clusters 3 and 5 consist of just two regions each, the convergence within them was studied by just looking at the time trend of the difference of the logarithm of TFP. According to it, regions within Clusters 3 and 5 converged over the periods of 1993-2009 and 1997-2009, respectively.

The analysis revealed that most of the TFP convergence across the Kazakhstan regions discovered by the panel unit root tests took place across the regions of Clusters 1, 3, and 5, while the regions of Clusters 2 and 4 did not display a tendency to TFP convergence. This suggests that the clustering of regions according to selected growth factors do not accurately reveal the convergence clubs in terms of TFP convergence. In particular, investment contributes directly to the physical capital input, and therefore it cannot be taken as a clustering factor. Besides, there could be other factors that contribute directly to the total factor productivity, for example, human capital, foreign direct investments, infrastructure, patent activity and so on. It means that if we want to determine convergence clubs with respect to TFP-convergence we should consider another set of clustering factors than we used with respect to σ- or β-convergence.

In CHAPTER 8 we analysed the convergence across Kazakhstan regions using the method of sector decomposition. This method is based on the decomposition of the growth of labour productivity of the whole economy into three parts: the part accounting for the growth of this indicator in various sectors of an economy, the part accounting for the structure reallocation of labour force, and the part accounting for the interaction of these two parts. According to the sector decomposition, we revealed that industry and service are two dominant sectors, which contribute about 75% to the total output of the Kazakhstan economy.

As to the convergence issue, initially, we tested absolute β-convergence across the Kazakhstan regions by sectors, using the cross-section regressions over the period of 2000-2009, in which the respective growth rates of the sector decomposition were taken as the dependent variables, and the logarithm of the initial (2000) real per worker GRP was taken as an independent variable. These regressions produced insignificant estimates of convergence coefficients across all sectors, including shift and interaction effects.

Therefore, we performed the panel and yearly cross-section regressions over the period of 2001-2009, taking the yearly growth rates of the sectors' labour productivities as the dependent variables, and the logarithm of the real per worker GRP in the previous year as the independent variable. In spite that yearly cross-section regressions revealed that convergence behaviour of various sectors could vary from year to year, we took the results of panel regressions as evidences of either convergence or divergence behaviour of sectors.

The panel regression with fixed effects produced highly significant estimates of convergence coefficients of all sectors except agriculture. The signs of these coefficients showed that sectors of industry, construction, transport and communication, and service were engines of convergence across the Kazakhstan regions over the period of 2001-2009, while the shift and interaction effects were engines of divergence. The insignificant estimates of the convergence coefficient of the sector of agriculture mean that it promotes neither convergence nor divergence of labour productivity across Kazakhstan regions.

9.2 Theoretical contribution

In order to put a theoretical base under empirical study, this dissertation reviewed several growth models with respect to the convergence/divergence issue and proposed a classification of growth theories according to their convergence predictions. This classification divided the growth models into three groups: models which predict convergence; models which predict divergence, and models which produce mixed convergence/divergence patterns. This classification differs from the earlier rather simplified point of view that neoclassical growth theory implies convergence, while endogenous growth theories imply divergence. The proposed grouping of growth theories takes into account two main convergence factors or mechanisms responsible for producing either divergence or convergence patterns, namely diminishing returns to capital and technical progress.

As the empirical part of this dissertation rests mainly upon the neoclassical growth theory, there are some theoretical implications that can be produced from the discussed above empirical work with respect to this model.

First, it can be concluded that convergence predictions of the neoclassical growth model were confirmed in the case of Kazakhstan regions. An absence of the absolute β-convergence revealed that the determinants of the steady-state positions differ considerably across Kazakhstan regions. However, when we controlled these differences by including conditioning variables into the regression equations, the Kazakhstan regions converged, as predicted by the neoclassical growth model.

Second, the absence of the absolute β-convergence and the speed of conditional β-convergence contradicted the results for developed countries described in the literature because regions of these countries usually differ insignificantly and converge absolutely with the average speed of 2% per year. This fact can be explained by the transition period from the non-market to the market-based economy through which Kazakhstan was passing. The similar results are observed for the regions of several transition countries (Russia, Ukraine, Poland, Hungary, Romania and Bulgaria) and confirm the peculiar convergence behaviour of transition economies.

Third, the revealed positive relationship between growth rates and inequality across Kazakhstan regions confirms a hypothesis of Petrakos, Rodríguez-Pose, et al. (2003) that along with the long-term convergence tendency predicted by the neoclassical growth model and realised by the diminishing returns of capital, there is a short-to-medium-term divergence tendency, caused by the agglomeration economies.

Fourth, the obtained estimates of the human capital investment term in the panel regression equation confirm the hypothesis of insignificant effect of human capital on growth and convergence of less developed countries.

Another theoretical contribution of this dissertation comes from the study of club-convergence across Kazakhstan regions. We proposed a new approach of revealing convergence clubs, which is based on the clustering of the regions according to the set of growth factors. This method helped reveal clubs in terms of σ- and β-convergence. However, the attempt to use the same set of clusters in the study of TFP convergence revealed that, in order to obtain accurate convergence clubs in terms of TFP-convergence, it is necessary to choose another set of clustering variables, which contribute directly to the development of TFP in Kazakhstan regions.

The study of TFP convergence and sectoral decomposition of convergence across the Kazakhstan regions can also be considered a theoretical contribution to the study of the development of the Kazakhstan regions.

9.3 Practical Relevance and Policy Implications

The empirical findings of the thesis can be used to estimate the effectiveness of the regional policy carried out by the government of the country, and indicate directions for its enhancement. This dissertation produces several important recommendations for policy makers in Kazakhstan.

Firstly, as there were no unconditional β-convergence and σ-convergence across Kazakhstan over the years of independence, it can be concluded that convergence in Kazakhstan is not per se a process that accompanies economic development. It demands an appropriate strong regional policy. This policy should be directed toward conditioning factors that determine convergence, aiming to equalize steady state positions of the regions of the country. In this research, we took such factors as saving rate, population growth, and the share of agriculture in total output. According to the signs of the estimates of these variables in the regression equations, we would make the following possible policy recommendations.

1) To increase investment in under-developed regions. These could be either direct state investments in the infrastructure of poor regions or the stimulation of private investment using fiscal and administrative mechanisms;

2) To promote migration from less prosperous regions to the rich ones. However, this policy can lead to the decrease of absolute values of GRP in under-developed regions.

3) To stimulate structural changes in the economies of regions aiming to decrease the share of agriculture in them. It should be mentioned that this recommendation is already in operation after the start of the State Program of the Forced Industrial Innovative Development in 2010-2014 .

Secondly, the positive and significant linear relationship between the growth rates of the real per capita GRP and the level of inequality across Kazakhstan regions, exposed in this thesis, poses a rather thorny problem for the Kazakhstan authorities. On the one hand, it is necessary to preserve high growth rates of the economy. On the other hand, it is necessary to reduce regional disparities.

Thirdly, the composition of convergence clubs as revealed in this thesis could be used in the drafting of a group-specific policy, directed at the reduction of regional disparities. For example, policy for the regions of the convergence club consisting of slowly-developing agrarian oblasts, should differ markedly from the policy for the regions of the convergence club consisting of fast developing oil-rich oblasts.

The study of TFP convergence across the Kazakhstan regions also suggests policy recommendations, directed at the equalization of TFP levels across Kazakhstan regions. Influencing the factors determining the TFP level in less prosperous regions could make it possible to affect the levels of TFP in them. And the first factor to which the authorities should attend to is human capital. The literature review on human capital (Appendix 3) revealed that human capital mainly influences the growth rate of TFP indirectly through the ability to imitate and implement new technologies. Therefore, investments in human capital could be long-term measures for the acceleration of the economic growth of Kazakhstan regions taking into account that the educational potential of the country in the form of universities and research centres is very rich.

Another set of policy recommendations is suggested by the sector decomposition of convergence across Kazakhstan regions. In order to equalize the level of the development of Kazakhstan regions it is necessary to try to equalize their production structures. At first glance, this may seem impossible, due to the various natural conditions of the regions of Kazakhstan. However, it is possible to elaborate policy which could, for example, promote the development of industry and services in agrarian regions, and develop the agrarian sector in industrialized or oil-rich regions. In addition, the results of the sector decomposition show that the sectors of industry, construction, transport and communication, and service promote convergence across the Kazakhstan regions. The stimulation of development of these sectors could accelerate the economic growth of regions, on the one hand, and lower regional disparities, on the other hand.

As to the sector of agriculture, it is necessary to modernize it in order to enhance its productivity and to make it less dependent on weather conditions.

9.4 Limitations and Directions for Future Research

Despite the theoretical and practical contributions, this thesis is necessarily limited due to time and space constraints. It does, however, provide pointers for further research. We hope to explore the issues it raises in future work.

To study σ-convergence using various social and economic indicators and measures of differentiation.

In studying σ-convergence across the Kazakhstan regions we used only one economic indicator, namely real per capita GRP. However, it is possible to study σ-convergence in terms of other important social and economic indicators, such as incomes, investments, levels of poverty or unemployment, etc. This would give a more complex picture of the comparative development of the regions of the country. Moreover, it could be interesting to study σ-convergence across Kazakhstan regions using other statistical measures of differentiation in addition to the standard deviation and coefficient of variation used in this thesis.

To study more carefully the relationship between growth rates and inequality across Kazakhstan regions.

Another direction for further research comes from the positive and significant linear relationship between the growth rates of real per capita GRP and the level of inequality across Kazakhstan regions. It is necessary to study this relationship in more detail and to find the optimal growth rate of the economy, which would go some way to reducing of regional disparities.

To consider more conditioning factors in studying conditional β-convergence.

In this thesis, we have considered only three conditioning factors: namely, investment rate, population growth, and the share of agriculture in the total output of the regions. However, the potential set of conditioning factors observed in the literature is much wider. The small number of observations (only fourteen oblasts and two cities) in the cross-section regressions caused this limitation. It can be overcome by observing smaller parts of the administrative division of Kazakhstan, namely rayons (districts), which are sub-areas of oblasts. Every Kazakhstan oblast is subdivided into several rayons (from five to 17), and it is reasonable to study convergence in Kazakhstan using these districts as focal points. This could produce higher levels of significance for the estimates of convergence coefficients and allow a wider set of conditioning variables for use. However, there are some problems of data availability in these territorial units.

To use other approximations of human capital.

In this research, we used education-based approach to measure human capital variable in studying convergence in terms of the augmented neoclassical model of Mankiw, Romer and Weil (1992). Namely, as an approximation of investment in human capital we took the ratio of the number of graduates of higher education institutions to the total working age population of a region. However, there are other approaches to measure human capital, both within education-based and other approaches. Thus, one direction of further research could be the study of the role of human capital in the convergence process.

To check the robustness of the club-convergence study with respect to the choice of method of discovering convergence clubs.

The approach to identify convergence clubs proposed in this dissertation is not free of drawbacks.

Firstly, the number and composition of obtained clubs depends heavily on the set of growth factors taken as clustering variables, the choice of which was rather arbitrary. There are no strict rules on what growth factors should be taken as clustering variables and by what empirical data they should be approximated. Moreover, the importance of the growth factors could differ both across countries and, in time, that could influence the composition of convergence clubs. Therefore clustering procedure would be more accurate if some weighting coefficients were used.

Secondly, the results of the clustering depend on used methodology, namely, distance measure, clustering technique, agglomerative method, the choice of optimal number of clusters, and variables scaling method.

Thirdly, this method does not take into account the dynamic behaviour of revealed convergence clubs in the sense that some regions could belong to different clubs in different periods.

Therefore, the method could be modified in order to overcome the drawbacks mentioned above. This could provide matter of further research.

To use other approaches of calculating of TFP series and studying TFP convergence across Kazakhstan regions.

As there are several approaches to calculate TFP series of countries and regions, apart from the growth accounting methodology used in this dissertation, it would be helpful to check the robustness of TFP convergence implications obtained in the thesis with respect to different approaches of calculating TFP series. In addition, it would be interesting to use other methodologies to study TFP-convergence across the Kazakhstan regions. For example, to study the dynamics of standard deviation or the coefficient of variations of TFP.

To use larger number of economic sectors in implementing method of sectoral decomposition of convergence.

Due to the availability of statistical data, we used only five economic sectors to carry out the sectoral decomposition of convergence across the Kazakhstan regions. However, this method allows to decompose convergence into a larger number of economic sectors. This could produce more accurate policy recommendations in order to diminish economic disparities across the regions of the country.

APPENDICES

Introduction

The notion of convergence is complex and the literature on it is enormous. There are a number of important approaches, arguments, factors etc that could not be directly integrated into the main line of the argument of this thesis without diverging from its main focus. Therefore, we have placed some important material in the appendices of this thesis. Even though they were not directly addressed in the main body of the thesis, these are important and bear indirectly on the arguments and understanding of the convergence process across Kazakhstan regions. We include three appendices to the thesis in the following order. The first appendix describes the structure of the economy of each Kazakhstan oblast and the cities of Almaty and Astana. This is important material for the understanding of the results of the club-convergence study. The second appendix presents a review of growth models that predict divergence and models that have mixed predictions on the convergence behaviour. These models are not used in the empirical part of the thesis, but they are important for the understanding of the convergence/divergence issue. The third appendix includes literature review on human capital, which is used in the augmented neoclassical growth model as one production factor along with physical capital and labour. We have included this material in the thesis because human capital is a complex issue and there are several approaches to its measurement and determining its role in economic growth and convergence.

Appendix I Short description of the economic potential of the Kazakhstan regions

Akmola oblast

The basic branches of specialization in the area are manufacture and the processing of agricultural products. The area’s share in the country’s volume of gross agricultural output is 13% (fourth place). The oblast has a high percentage of agricultural population – 54.8 %. Crop production prevails in the branch structure of agriculture of the oblast (76%), including grain manufacture which makes 56.8% of total agricultural output. Industry occupies 13.2% of the structure of GRP of the oblast and is represented by the extraction of uranium and gold ores, mechanical engineering, chemical and a pharmaceutical industry, manufacture of building materials. The presence of agricultural lands with high natural fertility of soils has determined grain specialization of the area which makes more than 1/5 republican volumes of grain, including almost 1/4 of high-quality wheat.

Aktobe oblast

The Aktobe oblast belongs to the group of industrially developed regions of the country. The relative density of the oblast in the republic's industrial production makes 7.6 % (fifth place).

The oblast has a diversified structure of economy. In the structure of region's GRP the industry makes 42.9% and is represented by the enterprises of the oil-extracting industry, ferrous metallurgy and mechanical engineering.

Almaty oblast.

In oblast's GRP, the shares of agriculture and industry are almost equal. The leader is an agrarian sector giving 14.0% of gross output of agriculture of the country. The agrarian orientation of the economy of the region is apparent due to the fact that 45.4% of the total amount of production of a manufacturing industry go to the manufacture of foodstuffs.

Atyrau oblast

The area is the leader in a share of industrial production: it takes first place in the country's volume (23.6%). In the structure of GRP of the region an industry occupies 56.2%, from which 92.3% is presented by the mining sector. The oblast's economic potential is determined mainly by the development of oil and gas extraction industry. The region also specializes in oil refining, fishing industry and the manufacture of construction materials. The distinctive feature of the region is that rapid economic growth is concentrated and limited only in one branch - oil and gas production, in which only 5.4% of the occupied population of the region works.

West Kazakhstan oblast

The oblast is an industrial region. Its relative density in the country's industrial production makes 9.0% (third place after Atyrau and Mangistau oblasts). The region's specialization is determined by the mining industry (extraction of natural gas and a gas condensate), which occupies 89% in the structure of the industry. The manufacturing industry is represented by mechanical engineering and food branches.

Zhambyl oblast

The oblast has industrial-agrarian economic specialization. In the structure of the GRP of the area, an industry occupies 17.0%, and agriculture – 12.8%. The industry is represented, basically, by the food and chemical enterprises (manufacture of phosphorus and phosphoric fertilizers). The oblast is characterized by the low level of the development of industrial production and the negative tendency of the decrease of its share in the country's volume from 6.5% in 1990 to 1.3% in 2009. The number of occupied in the manufacturing industry, in comparison with 1985, was reduced almost in three times and, in 2009, has made 23 thousand people.

Karaganda oblast

The oblast traditionally is an important industrial centre of the country. The region's share in the republic industrial production is also high at 8.9% (third place after Atyrau and Mangistau oblasts). In the economic structure of the area, a processing industry (81%) prevails. Leading sectors of the oblast are a mining and smelting complex (including extraction of ores of ferrous, non-ferrous, precious, and rare metals; both ferrous and nonferrous metallurgy, and metal working), the coal industry, mechanical engineering, chemical and pharmaceutical industry, manufacture of construction materials. However, a decrease in a role of industry as a sphere of application of the labour force is observed. For the past twenty years, employment of population by industry reduced by 45.8% from 248.3 thousand persons to 113.7 thousand persons, mainly at the expense of mechanical engineering and metal working.

Kostanay oblast.

The area belongs to the group of industrial-agrarian regions of the country, occupying first place of the share of agricultural production (15.8%) and tenth place in the share of an industrial output (3.4%) in the country. A relative density of agriculture in the region's structure of GRP makes 22.9%, while the industry's – 22.1%. The area is leader in the extraction of asbestos and iron ores.

Kyzyl-Orda oblast.

The area is included in the group of industrial regions of the country. Industry occupies 50% of the structure of the economy of the area. And, besides, an essential imbalance in the structure of manufacture is observed: the mining industry takes 93.3%, while the processing industry takes only 4.9% of total manufacture output. The oblast is the largest manufacturer and the supplier of table salt, quartz sand, fish products and rice. In total amount of manufacture of the country, the share of the oblast makes 90 % of rice and 70 % of table salt.

Mangistau oblast

The oblast belongs to the group of industrially developed regions. The region's share in the industrial production of the republic is high and makes 14.4% (second place after Atyrau oblast). In the structure of the economy of the area, the mining industry makes 91.9% and is represented by the extraction of oil and gas. The manufacturing industry is represented by metallurgy, manufacture of metal wares, mechanical engineering, and the chemical industry. Region's specialization mainly on the extraction of oil and gas demands attention to the social aspects of the development of the oblast.

South Kazakhstan oblast

The region belongs to the group of industrial-agrarian oblasts. In the structure of GRP, an industry occupies 21.2%, and agriculture – 9.3%. The relative density of the oblast in the republic industrial production is low – 2.8% (twelfth place). In the gross output of agriculture of the country, the region's share makes 9.7% (fifth place). In the structure of the industry of the oblast, processing prevails (68.4%). The mining industry (21.6%) is represented by uranium extraction.

Pavlodar oblast

The oblast is a large industrial region of the country. The greatest relative density in GRP is occupied by the industry (39.8%), while the share of agriculture is only 5.9%. The region's share in the republic manufacturing industry makes 11.9% (second place after Karaganda area). In industry, the manufacture of intermediate production (aluminium, alumina, coal, ferroalloys, and the electric power) prevails, whose relative density makes 90%.

The North Kazakhstan oblast.

The area is one of the leading agrarian regions of the country. According to the share of agricultural production in republican volume, it occupies second place (14.6%) after Kostanay oblast (15.8 %). The relative density of agriculture in the region's structure of GRP makes 34.6%, the industry's – 10.4 %. The industry is represented by food processing and mechanical engineering. Despite the increase of the absolute industrial output of the area, over the last ten years, its share in the republican industrial output was reduced from 6.9% in 1990 to 0.9% in 2009 that is the lowest indicator among regions of the country.

East Kazakhstan oblast

The oblast is the developed industrial-agrarian region of the country though the share in the republic industrial production is rather insignificant (5.4%, eighth place). At the same time, the area's share in the republic's processing industry is rather high (11.8%): dominant branch - nonferrous metallurgy, the region's industry is also represented by enterprises of mechanical engineering, power engineering, chemical, wood-processing, light, food-processing, and building materials industries.

The city of Astana

Such sectors as services (in the republic's volume of rendered services – 11.4%, second place after the city of Almaty), construction, and the industry of construction materials occupy a big relative density in the structure of the economy of Astana. There are no other long-term city-forming development factors in the city, excepting the service sector.

The city of Almaty

Now the city is in the lead in the relative dense of sector of services in the country - almost 30% (first place). In the structure of GRP of the city, the sector of services makes the largest share (73.0%) that indicates a gradual transition of the city's economy to the postindustrial stage of development. For the last decades, the role of industry and its potential in the city's economy has sharply decreased.

The following conclusions can be made from the above analysis of the economic potential of Kazakhstan regions:

1. Almost half of the economic potential (47.2%) of the country is concentrated in four regions (cities of Almaty and Astana, Atyrau and Karaganda oblasts), while the share of four agrarian regions (Zhambyl, North Kazakhstan, Akmola, and Kyzyl-Orda oblasts) makes only 11.3 % of the gross national product.

2. The disparities in social and economic development of regions in the country remain. For the last ten years, the lowest per capita GRP at the rate less than 70% from the country average level remains in Zhambyl, South Kazakhstan, Almaty, North Kazakhstan and Akmola oblasts. These regions have basically agricultural specialization. They occupy 27% of the territory of the country, and about 40% of the total population live there.

3. The economic potential of the regions of the country is determined mainly by the development of industry and agriculture. The sector of services, except for cities of Almaty and Astana, still does not play a considerable role. At the same time, taking into account a labour abundance of the agrarian sector, in the next years, there will be a further reduction of workplaces. In the future, the industrial and services sectors possess the best potential for the creation of new workplaces and maintenance of employment of the population.

4. The largest quantity (45%) of the industrial enterprises is concentrated in the power abundant Northern zone. In the less power provided Western power zone, 30% of enterprises is concentrated. In the power scarcest Southern zone, 25% of the industry is concentrated.

5. According to the key specialization, it is possible to classify Kazakhstan regions into following six groups:

Mono-raw, oil and gas regions, (Atyrau and Mangistau oblasts) with low populated territory;

Regions of oil and gas specialization (Aktobe, West Kazakhstan and Kyzyl-Orda oblasts) with agrarian sector of a grain orientation and non-uniformly populated territory;

Agrarian regions of grain specialization (Akmola and North Kazakhstan oblasts) with the decreasing population;

Multifunctional regions of industrially-agrarian (East Kazakhstan, Karaganda and Pavlodar oblasts) or agrarian-industrial (Kostanay oblast) specializations;

Densely populated, poorly urbanized agrarian regions (Almaty, Zhambyl and South Kazakhstan oblasts);

Big cities and the agglomerations connected with them (Astana, Almaty), having rather modernized economy and the developed sector of services.

6. As a whole, low innovative activity in the majority of regions of the country is observed. Among regions, the greatest volumes of innovative production and services comes from Pavlodar, Karaganda, East Kazakhstan oblasts, and the city of Almaty.

7. As world experience shows, territorial disparities are natural and objective. Forming conditions of an inter-regional competition, the territorial distinctions promote the increase of efficiency of placing of manufacture, optimize the structure of population and labour markets. At the same time, spontaneous, uncontrolled self-development of regions leads to undesirable territorial distinctions, whose consequences are social and economic non-uniformity, uncontrollable population migration, poor use of the existing potential of development and high ecological costs.

Appendix 2 Convergence predictions of some endogenous theories

1. Endogenous Models Predicting Convergence

In the early 80s, the main shortcoming of the neoclassical growth theory - exogenous technological progress - stimulated research on an alternative: to explain long-term growth in terms of parameters endogenous to the model. As a result, endogenous growth theories proliferated. In these models public and private investments, human capital, innovations, etc. are considered as means of long-term growth (Romer 1986, Aghion and Howitt 1998, Barro and Sala-i-Martin 2003, Lucas 1988).

Although in the literature endogenous growth models are usually opposed to neoclassical models, it does not necessarily mean that their convergence/divergence predictions are opposite. There are endogenous growth models which predict convergence across economies.

One possible example is the Model of Endogenous Growth with Transitional Dynamics. This model follows the trend of endogenous growth researchers to redefine the Cobb-Douglas form of the neoclassical production function (Rebelo 1991, King and Rebelo 1989, Jones and Manuelli 1990). They introduced the idea of holding the property of constant returns to capital in the long term, while keeping the property of convergence special to the neoclassical model. This model together with constant returns to scale exhibits positive and diminishing returns to capital and labour. It differs from the Solow model in that one of the Inada conditions is violated meaning that "... the tendency for diminishing returns to capital eventually ceases" (Barro and Sala-i-Martin 2003, p.42). This model predicts endogenous, steady-state growth keeping the property of conditional convergence, similar to the neoclassical model.

Another example is the model of Tamura (1991) who, motivated by the empirical evidence of convergence among developed countries or among regions of the USA or European Union, had elaborated an endogenous growth model with human capital that predicts convergence in both income growth rates and income per capita levels. The income convergence arises from human capital convergence, which in turn rises because below average human capital agents have a greater rate of return to human capital investment than agents with above average human capital. This means decreasing returns to human capital accumulation.

Another group of models considers convergence as a demonstration of technological catching up and is called the "catching-up" hypothesis (Capolupo 1998, Abramovitz 1986). This approach assumes that technologically backward economies are in a better position to imitate the technology from the advanced economies. The idea is that technological leaders will have to pay extra costs for the elaboration of new leading-edge technologies. This causes the reduction of the gap between technological leaders and outsiders. According to this view, the per capita income or productivity levels tend to converge in a long run.

2. Models which Predict Divergence

In the growth models which predict divergence, neither of the two above-mentioned convergence factors (diminishing returns to capital and technical progress) act. For example, in the case of endogenous models with constant returns, large endowments of inputs can determine the output level, but not the rate of growth. Therefore, two countries: poor and rich, will grow at the same constant rate, and the gap between them will persist if they have similar parameters of technology and preferences.

In the models with increasing returns, the countries largely endowed with physical and human capital tend to grow faster than the poorly endowed. This fact totally contradicts the conclusions of the neoclassical growth theory.

a. AK Model

The simplest example of the group of models, which does not demonstrate diminishing returns to capital are the AK-type models. These models are called AK because they use the following form of the production function:

$$Y(t) = AK(t)$$

where A is the constant positive parameter reflecting the level of the technology and K is the capital stock in a broad sense including both physical and human capital.

One of the first versions of the AK model is the Harrod-Domar model (Harrod 1939, Domar 1946), which assumes that labour input grows automatically proportional to the capital. Another case of the AK model uses the assumption that the factor that grows automatically with capital is technological knowledge regarded as disembodied capital goods (Frankel 1962).

In the AK-model, assuming that $sA > n + \delta$, all the per capita variables increase at the same positive constant rate. Therefore, an economy described by the AK model can grow per capita in the long run without any technical progress. Besides, the rate of growth per capita depends on the model's parameters, such as the saving rate s and the rate of growth of population (Barro and Sala-i-Martin 1995). Thus, the AK model does not predict convergence, either absolute or conditional that is the growth rate of output per capita does not correlate with an initial output level.

b. R&D Models

Another series of endogenous growth models concentrated their efforts on the sources of technological progress and innovations. This group of models called R&D models considers the production of innovations as a special production sector.

The first group of R&D models is called endogenous models with an expanse of the variety of intermediate products (Spence 1976, Dixit and Stiglitz 1977, Ethier 1982, Romer 1987, 1990a). The basis for endogenous growth in these models is provided by the property that technological progress in the form of continuing increases in the variety of intermediate products avoids the diminishing returns tendency. An increase of the number of intermediate goods N, needs a technological progress in the sense of an adaptation or an invention, which are supposed to be the result of research and development activities. The rate of growth depends on such characteristics of preferences and technology as willingness to save, the level of the production function, the R&D cost, and the scope of an economy (approximated by the quantity of a fixed factor, such as labour).

The second group of R&D models includes endogenous models with improvements in the quality of products (Grossman and Helpman 1991, Aghion and Howitt 1992). According to this approach, intermediate goods come in N variates, which are supposed to be fixed apart from the above model. Each type of intermediate goods has a quality ladder along which improvements can occur. These improvements are built on the best technologies available today and obtained from the efforts of researchers. This type of technological progress has similar predictions about determination of the growth rate as discussed above: the growth rate is higher if the rate of saving is greater, the technology level is higher, and the cost of R&D is lower. The model also predicts scale effects, represented by the quantity of fixed factors like raw labour.

The two groups of R&D models discussed above do not predict negative correlation between the rate of growth and the initial level of per capita income of different economies. Quite the contrary, if the total effect of technological progress is accounted for, then this correlation is predicted to be positive. This happens because the cost of innovations decreases with the accumulation of knowledge. Therefore, the growth rate of an economy tends to differ according to the rate of technological progress and innovation that neutralizes any inclinations to diminishing returns. Thus, these models predict divergence across economies.

c. Lucas Model

Lucas (1988) considers the accumulation of human capital taken as a measure of the knowledge state as an alternative significant source of spillovers. He regards human capital as a factor, which being accumulated increases the productivity of an economy and serves as a permanent source of growth. It grows at an endogenous rate, which depends on both the time passed in acquiring human capital and the efficiency of the accumulation of new skills. The human capital possesses special properties of generating positive externalities since more educated workers produce more auspicious environment for technological progress because R&D programs are more productive if they employ better-qualified labour force (Romer 1990b). The detailed description of this model will be given later in the appendix devoted to human capital.

Capolupo (1998) notices that in the Lucas model, human capital and technical progress have similar spillover effects on growth. However, the former possesses another specific quality that is appropriable from the same individuals. It means that technical progress, being a public good, fails to explain the distinctions in rates of growth and levels of per capita income. Neither can disparities in the capital marginal productivity because, in this case, the capital is predicted to move to higher marginal productivity economies. Lucas assigns the source of productivity differences across countries to the external effect of human capital, which, being embodied in individuals, means that the lack of international migration causes failure in equalization of human capital levels across countries. In terms of the complex transitional dynamics of the Lucas model, an economy which is initially better endowed with human capital, tends to grow faster because its capital-labour ratio lies below the steady-state position.

As to the convergence issue, the Lucas model rather predicts divergence because of the increasing returns on human capital accumulation. In contrast to neoclassical theory, the Lucas model postulates that as the rate of return on human and physical capital grows with increasing income, so income per capita may increase boundlessly. Both human and physical capital, according to Lucas (1988), tend to move to the higher return economy, where they can earn a larger profit due to the increasing returns to inputs in the better endowed country.

3. Models with Mixed Predictions on Convergence

a. Learning-by-Doing Model

One of the models exploiting an inherent link between technological progress and increasing returns to scale is the model of "learning by doing" (Arrow 1962). This model assumes that an earlier production experience raises future productivity. This is an endogenous model of technological progress brought into the economy by investment. According to Arrow's model, improvements in technologies depend upon the experience obtained during the process of production measured by accumulated investment.

Sheshinski (1967) proposes a model in which the knowledge level of the labour force depends on the stock of capital in a wide sense. The model differs from Arrow's approach in that the technical progress is treated in a disembodied way, while in the model of Arrow the technological progress is embodied in the latest capital's vintage.

Another interpretation of the Arrow-Sheshinski model was offered by Romer (1986). He considers input, K as the knowledge stock (rather than the tangible physical capital stock), which as a non-competing good, exhibits increasing returns. This knowledge can be produced either by other investment activities (Romer 1986) or through R&D activities in the research branch that utilizes inputs similar to sectors that produce tangible goods (Romer 1990a).

The model demonstrates the possibility of the existence of steady growth with a constant rate of increase based on technological progress, which arises from learning-by-doing of workers. The technical progress depends on the knowledge stock of workers obtained during the work (learning-by-doing), which in turn depends on the capital stock used for production.

As to the convergence/divergence issue, it depends on whether or not externalities from learning-by-doing are sufficient to offset the influence of diminishing returns. If the aggregate exponent of capital is greater than one, then the model exhibits increasing returns to capital accumulation and divergence in terms of growth rates and income levels. If it is less than one, the model exhibits decreasing returns and endogenous growth is impossible. In this case, long-term behaviour is similar to the neoclassical growth model and the model predicts convergence. If the aggregate exponent of capital is equal to one, as assumed by Romer (1986), then the model exhibits constant returns to the aggregate stock of capital. This means that given the other parameters of technology and equal preferences, poor and rich countries will grow at an equal constant rate, and the difference between them will persist.

b. De la Fuente Model

De la Fuente (2002a) proposes another model, which generates mixed predictions about the convergence/divergence behaviour in terms of inter-regional and international per capita income. These predictions depend on the values of some parameters, which are responsible for the determinants of the technological progress rate and the production technology properties. According to this model, two processes, namely capital accumulation and technical progress, influence the time path of the relative income of two economies: a ‘follower’ and a ‘leader’. The parameters that determine the evolution of these processes are the rates of investment in physical or human capital, R&D investments, and the speed of technological diffusion.

The dynamics of this model is described as follows (de la Fuente 2002a, p.7). If the measure of returns to scale in capital is greater than one, the technology exhibits increasing returns on capital and the rate of return on investments grows with the capital stock. As a result, the economy exhibits ‘explosive’ dynamics. In each given economy, growth accelerates over time, and income disparities across the countries and regions increase boundlessly. If the measure of returns to scale in capital is less than one, the system displays decreasing returns on investment, then per worker capital stocks and income level tend to converge over time across countries provided that other structural parameters and technologies are the same.

Similarly, if the speed of diffusion of new technologies across economies equals zero, there is no international technological diffusion, these countries will have higher rates of productivity growth, which invest more in R&D. If there is an effect of technological catch-up, then the differences in technologies between two economies are predicted to stabilize at a level at which a benefit from imitations becomes just sufficient to neutralize the scarcer investment in R&D of the backward economy.

Appendix 3 Literature Review on Human Capital

Importance of Human Capital

In trying to explain the growth and convergence pattern of Kazakhstan regions, the main role here belongs to the study of growth factors. However factors which influence economic growth and convergence across regions of a country are numerous, ranging from the geographical conditions to infrastructure development, from the availability of physical capital and labour force to their quality and structure. Moreover, there is no common approach to the growth factors that must be considered when convergence equations are estimated. Besides, it appears that growth factors influence more developed and less well developed countries in different ways. However, many growth theories emphasize the role of human capital as an engine of economic growth and an important conditioning factor in the growth equation to control the disparities in steady states and to explain the convergence patterns better.

In spite of diminishing returns from physical capital, which is considered a main growth factor in the neoclassical growth theory, many countries, including the United States and some European countries, have experienced continued growth for more than one hundred years. The commonly accepted explanation for this fact is "... the expansion of scientific and technical knowledge that raises the productivity of labour and other inputs in production" (Becker 1993, p.24). Denison (1985) calculated that a quarter of the US per capita income growth during 1929-1982 was caused by an increase in the stock of human capital. The impressive economic development of Japan, South Korea, Taiwan, Singapore, and other countries in recent years also illustrates the significance of human capital to economic growth. These countries grew rapidly relying only on their labour force without having natural resources, and investing huge money in human capital.

Conceptual Definitions of Human Capital.

The notion of human capital appears in the second half of the twentieth century due to the publications of Theodore Shultz and Gary Becker (Schultz 1961a, Becker 1964). For the creation of the fundamentals of human capital theory, they were awarded a Nobel Prize in Economics: Theodore Shultz in 1979 and Gary Becker in 1992.

According to them, human capital is determined by the aggregation of investments in activities that increase an individual productivity in the labour market, such as health, education, migration, and on-the-job training.

Shultz has contributed immensely to the formation, popularization and broad acceptance by the scientific community of the theory of human capital from the initial stage of its development. He was one of the first to enter the concept of human capital as a productive factor. He has done the most to promote the understanding of the role of human capital as the main engine and base of industrial and post-industrial economy. As the basic results of investments in a person, Schultz considers an accumulation of abilities of people to work, their effective creative activity in a society, health maintenance, etc. He believes that human capital possesses the necessary attributes of productive character, capable of being accumulated and reproduced. By Schultz's estimations, more than three quarters of an aggregate product produced in a society is used towards human capital accumulation.

Gary Becker is perhaps the first who transferred the concept of human capital on a micro level. He defines the human capital of an enterprise as a set of skills, knowledge and abilities of its workers. Becker considers the expenses of education and training as investments. He has estimated economic efficiency of education, first, for a worker. For example, the return from higher education is estimated at approximately 12-14% of annual profit. In addition, he emphasizes the value of special training, special knowledge and skills. He has proved to both politicians and businesspersons by using extensive statistical material that human capital formation is the base of increase in income of both hired workers and employers, and the state as a whole. As a result, politicians, financiers and businesspersons began to consider investments in the formation of human capital as perspective capital investments, which are bringing in the income. In his works, Becker considers the worker as a combination of a unit of a simple labour and known quantity of the "human" capital embodied in it. Its income is a combination of a market price of its simple labour and the income of the investments enclosed in a person. In addition, the basic part of the income of a worker, by Becker's estimations, and also calculations of other researchers, is brought by the human capital.

These definitions of human capital have been widened to include non-market activities (Jorgenson and Fraumeni 1989 5, Schultz 1994). For instance, Laroche, Mérette and Ruggeri (1999, p.89) give a broader definition of human capital: “Human capital is the aggregation of the innate abilities and the knowledge and skills that individuals acquire and develop throughout their lifetime.”

There are also many other definitions of human capital. For example, Korchagin (2005, p.21) gives a wider definition of human capital including an environment, in which human capital operates: “Human capital is an intensive complicated productive factor of the development of an economy and society, which includes labour resources, knowledge, instruments of intellectual and managerial labour, an environment of living and intellectual work, providing effective and rational operation of human capital as a productive factor of the development.”

Unlike the abstract process of knowledge accumulation, the concept of human capital assumes knowledge (qualification, abilities, etc.), personified in each concrete worker and embodied in him. This knowledge is the result of the investments in human capital and represents repayment.

Becker (1993, p.11) gives the following definition of investments in human capital: "Investments in human capital are the activities that influence future monetary and psychic income by increasing the resources in people. Many forms of such investments include schooling, on-the-job training, medical care, migration, and searching for information about prices and incomes. They differ in their effects on earnings and consumption, in the amounts typically invested, in the size of returns, and in the extent to which the connection between investment and return is perceived. But all these investments improve skills, knowledge, or health, and thereby raise money or psychic incomes."

In its ability to be a productive factor, human capital is similar to physical capital. However, there are significant differences between these notions, which are discussed in the following section.

Comparison between Human and Physical Capital.

Human capital is similar to any other goods: it has its own price formed in competition process and can be consumed. Human capital like physical one can be accumulated and can depreciate (due to death or disqualification). Therefore, human capital can be regarded as a factor of production, similar to other factors such as physical capital, labour and natural resources. The main distinction from physical capital is the fact that "...you cannot separate a person from his or her knowledge, skills, health, or values the way it is possible to move financial and physical assets while the owner stay put..." (Becker 1993, p.16).

Laroche, Mérette and Ruggeri (1999) highlight another set of the differences between these two types of capital. With respect to property rights and marketability, human capital, apart from physical one, is not marketable because it is inseparable from the human being in whom it is embodied. Only services that arise from the stock of human capital could be market goods.

Human and physical capitals also differ from each other with respect to accumulation, which is a difference between the new capital production and its existing stock depreciation in a given period.

Firstly, owners or managers typically make the decision about production and accumulation of physical capital, while the human capital accumulation involves decisions made by different people or institutions, e.g. parents, educators, peers, and authorities.

Secondly, the accumulation of human capital has a social aspect because it occurs through interactions of human beings. These interactions cause spillover effects and externalities, which could alter dramatically the accumulation process.

Thirdly, the mobility of human capital depends on the regulations on international labour markets and the capacity of owners to move and to conform to change.

Fourthly, both physical capital and human capital depreciate with time. Human capital also depreciates when it is unused, but this process can be partly reversed. Since a part of people's knowledge and experience could be transmitted to other generations, the death of individuals does not mean a total loss of human capital.

With respect to returns, human capital and physical capital also behave differently. Returns to physical capital depend on market conditions. The owners cannot influence the amount of returns. In the case of human capital, the younger investors have higher returns because of a longer horizon of receiving benefits from their investment and because early learning promotes further learning. Therefore, returns to human capital are more variable across investors than returns to physical capital

There are also distinctions between physical and human capital regarding financing and taxation. Since it is harder to obtain private investment for the acquiring of human capital, governments try to establish programs, which partly or fully subsidize the human capital investments, e.g. primary or secondary education, health care, and culture. All countries have different tax legislation concerning human and physical capital.

Another difference between human and physical capital is the way of their measurement. While the stock of physical capital is measured by its cost, the measurement of human capital is a rather ambiguous task.

Measurement of Human Capital

Since economists recognise human capital as one of the crucial economic growth factors, it is highly important to measure accurately its stock and influence on economic processes. The definition of human capital as a stock of knowledge, health, skills, experience, and culture embodied in individuals that are used for the maintenance of social, personal, and economic welfare assumes impossibility of developing of the uniform exact approach to measurement of the human capital. All possible estimates of human capital must be indirect because of the intangible nature of human capital. There are three main approaches to the measurement of the amount of human capital: "cost-based", "income-based", and "educational stock-based" (Le, Gibson and Oxley 2003).

Cost-Based Approach.

According to the cost-based approach, human capital stock is measured by the cost of investments in education, healthcare, culture, and other sectors relating to human capital. Le, Gibson and Oxley (2003) give a review of this approach assigning the origin of it to Engel (1883) who proposed to measure human capital according to the costs of child rearing for their parents. Schultz (1961a) and Machlup (1962) augmented Engel's approach estimating human capital under the assumption that the depreciated value of monetary means expended on human capital related items is equal to human capital stock.

Ketova and Rusyak (2008) present another example of the cost-based approach determining the average stock of human capital of demographic unit as a linear combination of three parts: educational, health and cultural components. To model the evolution of human capital components, they use the system of first order differential equations.

A comparatively easy accessibility of data on private and public expenditures on human capital items is the main reason of the popularity of the cost-based approach (Schultz 1961a, Ketova and Rusyak 2008, Kendrick 1976). Nevertheless, it is not free of some disadvantages.

Firstly, the quality of human capital does not directly depend on the investment in human capital. Sometimes an inverse relationship could exist. For example, the less capable student is more costly for his parents, or an unhealthier child is more expensive to raise. Secondly, there are difficulties in differentiating between investments in human capital and consumption because "... most expenditures on people have both consumption effects (satisfying consumer preferences) and investment effects (enhancing productivity)" (Le, Gibson and Oxley 2003, p.275). Thirdly, the cost-based approach often ignores the differences in depreciation patterns of physical and human capital. For example, Kendrick (1976) uses the double declining balance method for the estimation of depreciation of both human and physical capital. The depreciation of physical capital is faster in the early years of its life, so this method is appropriate for it. However, there is an empirical evidence that human capital can appreciate at early stages and depreciate at late stages of its development (Graham and Webb 1979). Fourthly, the cost-based estimates of expenditures in education fail to account for a long time lag between current educational investments and the emergence of human capital caused by them (Jorgenson and Fraumeni 1989 5). Finally, the cost-based approach neglects the cost of non-market activities such as development of personal capabilities, self-fulfilment. They can considerably enhance the human capital, but are not measured in monetary units (Jorgenson and Fraumeni 1989 5).

Income-Based Approach.

The income-based approach to the estimation of the stock of human capital is based on "... summing the total discounted values of all the future income streams that all individuals belonging to the population in question expect to earn throughout their lifetime" (Le, Gibson and Oxley 2003, p.280). Therefore, the fundamental suggestion of this approach is to evaluate the individuals' human capital according to the total earnings that could be gained in the labour market during their life period.

It is supposed that the labour market, forming the market prices of human capital, takes into account such factors as abilities, professional qualifications, education, experience that form the human capital of a worker. This methodology does not require an assumption of an arbitrary depreciation rate, as cost-based approach does because the depreciation is already integrated into the model. Therefore, if the necessary data are available, this approach provides more reliable results.

Le, Gibson and Oxley (2003) present very detailed analysis of the development and recent state of the income-based approach to the measuring of the stock of human capital. According to their survey, "... the first truly scientific procedure for estimating the monetary value of a human being, was that developed by Farr (1852)" (p.276). Other researchers also used this approach to human capital measuring (Jorgenson and Fraumeni 1989 5, Graham and Webb 1979, Weisbrod 1961, Mulligan and Sala-i-Martin 1995).

The most notable drawback of the income-based approach to the estimation of the stock of human capital is the postulate that wage differences truthfully reflect productivity disparities. In fact, earnings can be different for reasons other than productivity distinctions. In addition, the retirement age and the discount rate, which differ considerably in various countries and sometimes regions, considerably influence the measures of human capital. This could cause severe bias of results. There are also debates whether to deduct costs for maintenance, similar to physical capital. The choice of a researcher can influence the resulting human capital stock. Another disadvantage of the income-based approach is a poor availability of the data on labour incomes when compared with investment data.

Mixed Cost- and Income-Based Approach.

As has been shown above, any approach to human capital measuring is not free from drawbacks. Therefore, some researchers have combined various approaches in order to use their advantages and to avoid their disadvantages.

For example, Tao and Stinson (1997) propose an integrated method for evaluating of the human capital stock of the United States. The authors use data on investments in human capital and the wage rate of people entering labour market immediately after high school graduation to compute a rental rate for human capital using a basic earning equation, which reflects the link between human capital and earnings. The estimation of human capital stock for other cohorts is made using the rental rate under the assumption that it does not vary across cohorts, and labour income data for each population subgroup substituted in the basic earning equation. This approach avoids the above-mentioned drawbacks of both cost- and income-based approaches. Firstly, it does not need any assumptions about human capital depreciation or appreciation. Secondly, it evades the problem of determining how to calculate the total investment in human capital, considering only educational expenditures in base entrants as human capital investments and assuming that all other spending, such as medical, is already accounted in earnings.

Dagum and Slottje (2000) also propose a combined method to measure human capital. They compute a special value of the human capital stock using such variables as person's human capital, the size distribution of it, the mean level of it by age, and the mean population level of human capital. Their method "... combines the microeconomic estimation of human capital as a latent variable with the macroeconomic estimation of the average human capital of a population of economic unit" (p.81).

Educational Stock-Based Approach

As education is at the core of the human capital notion, the educational stock-based approach of its measuring is the most popular method among the researchers. There are several proxies within this framework, which are usually used to assess the human capital stock such as adult literacy rates, school enrolment ratios, educational attainment levels, and average years of schooling (Wößmann 2003).

The choice of adult literacy rates proxy of human capital stock reflects the availability of data covering a broad range of countries rather than its theoretical suitability and accuracy. Romer (1990b) and Azariadis and Drazen (1990) use in their studies as a human capital measure the adult literacy rate. Literacy is regarded as the capability to read and write. Although such defined adult literacy rates surely approximate an important part of human capital stock, they miss out the investments made on the upper level of the attainment of basic literacy – e.g., analytical and logical thinking, scientific and technological knowledge. These investments add directly to the labour force productivity, therefore, it is clear that adult literacy rates can only take proper account of a small part of the total human capital stock.

School enrolment ratios used in such studies as (Mankiw, Romer and Weil 1992, Barro 1991) are the further educational stock-based human capital proxies. According to this approach, school enrolment ratio is the relation of the quantity of students enrolled in a level of grade g to the aggregate number of people of respective age group. The main and may be the only advantage of this proxy of the of the stock of human capital is the easy availability of data provided by national statistical agencies in the case of a country and UNESCO Statistical Yearbooks for a broad range of countries. As the enrolment ratios reflect only the part of the population enrolled at present in schools, which does not yet participate in the process of output producing, it is an inaccurate proxy of the human capital stock participating in the current production process (Wößmann 2003). However, they can be considered approximations of the human capital investment flows. The inaccuracy of these proxies stems from the following sources: firstly, they fail to provide exact proxy of human capital of the labour force, which enters labour market this year; secondly, due to dropping out and grade repetition, a portion of current enrolment may be lost and some part of graduates may not take part in the process of production.

In the framework of educational stock-based approach, the most commonly used and popular proxy of the human capital stock is average schooling years and levels of educational attainment (Barro and Sala-i-Martin 1995, 2003, O'Neill 1995, Islam 1995, Benhabib and Spiegel 1992, 1994, Gundlach 1995, Temple 1999, Barro 1997, 2001, Krueger and Lindahl 2001).

The schooling average years quantify the accumulated educational investment embodied in the current labour force. It is really a stock variable, and it considers the formal educational attainment obtained by the labour force, which takes part in the current production process.

There exist three main methods to construct sets of data on the educational attainment years based on data on enrolment ratios (Wößmann 2003).

The first is a perpetual inventory method refined in (Nehru, Swanson and Dubey 1995). This method is similar to that of computing physical capital stocks and uses such variables as an aggregate enrolment at grade level g at time t; possible age of an individual in the labour force; the school entering age; the ratio of repeaters to enrolments in a grade level g; the rate of drop-out; the surviving probability of a person enrolled at a grade g at time t until the year T.

The second approach called an attainment census method is based upon the use of direct measures of educational attainment levels extracted from censuses and surveys (Psacharopoulos and Arriagada 1986, Barro and Lee 1993, 1996, de la Fuente and Doménech 2000, 2001).

The third method assumes that the link between lagged enrolment ratios and average schooling years in the labour force is constant across countries and regions and over time. This assumption allows to project average years of schooling available for some period and country for further years and countries using multiple regression. This method is called a projection method (Wößmann 2003). For example, Kyriacou (1991) projects data on average schooling years in the labour force in the middle of 1970s taken from (Psacharopoulos and Arriagada 1986), for further years and countries.

Described above the three methods used to construct data sets of educational attainment years based on the enrolment ratio data have two main disadvantages. Firstly, one schooling year does not contribute to the stock of human capital by an equal quantity because of diminishing returns to schooling (Psacharopoulos 1994), i.e. a schooling year should be weighted according to an individual's number of already accumulated years. Secondly, one schooling year increases the human capital differently according to the quality of the educational infrastructure, education system's efficiency, teaching methods, and curriculum (Wößmann 2003).

Summing up, all the approaches to measure human capital discussed above have their advantages and drawbacks. However, in this research, taking into account data availability and possible biases caused by these disadvantages, we use educational stock-based approach to measure human capital of Kazakhstan regions.

Human Capital and Economic Growth

The role of human capital in economic growth process has been extensively studied in the literature (Nelson and Phelps 1966, Lucas 1988, Romer 1990b, Azariadis and Drazen 1990, Freire-Serén 2001, Temple 2001a, 2001b, and others). These studies specify two channels through which human capital can influence growth.

Firstly, human capital can be treated as one of the factors of production (Mankiw, Romer and Weil 1992, Abu-Qarn and Abu-Bader 2007, Coulombe and Tremblay 2001, Vinod and Kaushik 2007). In this sense, the accumulation of human capital is assumed to generate directly the growth of the output.

Secondly, human capital can influence the growth through the total factor productivity, namely raising technical progress, since education eases the diffusion and adoption of new technologies (Nelson and Phelps 1966, Islam 1995, Benhabib and Spiegel 1994). The former mechanism is called 'level effect' and the latter 'rate effect'(Freire-Serén 2001).

On the other hand, there is no common opinion among researchers on the important question: "What is more significant for economic growth: the accumulation of human capital or its stock? In this regard, Aghion and Howitt (1998, p.327) distinguish two approaches to modelling and analysing the link between human capital and growth. "The first one was initiated by Lucas (1988) and inspired by Becker's theory of human capital. It describes the economic growth as being driven by the accumulation of human capital. So that the differences in growth rates across countries are mainly determined by the differences in accumulation of human capital over time of those countries.

The second approach, which stems from the work of Nelson and Phelps (1966) and finds its continuation in Schumpeterian growth literature is based on the idea that economic growth is driven by the stock of human capital , which is a decisive factor in a country's ability to innovate or catch up with more advanced economies."

Human Capital as a Factor of Production

A production factor approach to study of the contribution of human capital to economic growth has mainly been used in the convergence analysis in the tradition of Barro and Sala-i-Martin

(1992a) who use the neoclassical production function. However, due to the appearance of endogenous growth theories it is logically natural to study both neoclassical and endogenous production functions.

Neoclassical Production Function

In this context, the most cited work is that of Mankiw, Romer and Weil (1992) who incorporated an explicit process of human capital accumulation into the neoclassical growth model. This model was described in details in section 3.2.5. Another way to consider human capital as a production factor is to place it into one of endogenous growth models.

Endogenous Production Function.

One of the most influential and famous works on the role of human capital in endogenous growth is that of Lucas (1988), which in turn was inspired by the previous work of Uzawa (1965). In this model, the gross output depends on the human capital stock. The long-run steady growth is only possible if there is unbounded human capital growth.

The model of Robert Lucas supposes a possibility of constant endogenous growth on the base of accumulation of personified human capital, which is produced in a special sector – education. The education sector is an element of the economic system producing human capital according to certain productivity, the share of learning time in total time of each individual and the average level of current human capital. This average human capital level is also considered an external effect on the production function of the final goods sector, although it does not play a decisive role in the realization of endogenous growth.

In order to produce endogenous growth it is sufficient that the motive to invest in human capital (time spent in acquiring skills) does not decline over time. This takes place under the assumption of constant returns to human capital accumulation. The equation for the accumulation of human capital takes the form:

$$\dot{h} = h(t)\delta(1 - u)$$

where δ is the productivity coefficient of the education sector, which is supposed to be constant in the model that means an absence of accumulation of physical capital in the education sector; $(1 - u)$ is the time spent to accumulate human capital (Lucas 1988). Education time is a result of the individual choice of each representative consumer, who tries to maximize future income choosing the optimal proportion between learning and working time. As a whole, the optimization of the long-term level of consumption is realized in the model with an optimal saving of both types of capital according to the optimal share of time devoted by the consumer to each sector.

The whole level of human capital, H, is equal to the average level of human capital of representative agent, h, multiplied by the labour force, L, which is supposed to be constant in the model.

$$H = hL, \qquad L = const$$

Since human capital contributes to the economy's knowledge level, it produces an externality, and the production function takes the form:

$$y = Ak^{\beta}(uh)^{1-\beta}h_a^{\eta}$$

Where uh is human capital devoted to the production of the output, h_a is the mean level of human capital of all workers, and h_a^{η} is an externality. This external effect shifts the Cobb-Douglas production function upwards.

The Lucas model distinguishes human capital as an input, the accumulation of which on the base of individual decision on the stock of education can serve as a source of constant growth together with technical progress.

The main challenge of this model lies in the difficulty of the interpretation of Uzawa-Lucas' notion of human capital by means of quantitative variables, for example, years of schooling or literacy rates. As Temple (2001b, p.6) says: "Their use of term 'human capital' seems more closely related to knowledge rather than to skills acquired through education."

Bils and Klenow (1998) suggest linking the model of Uzawa-Lucas to the data by assuming the increase over time of the quality of education. According to their explanation, the human capital stock could increase in a way that provides growing output levels even in the condition of constant over time of an average educational attainment.

Another way to study the influence of human capital on economic growth is to consider it as a factor, which affects the total factor productivity of an economy.

Human Capital and Total Factor Productivity

Wolff (2000) points out three paradigms dominating the discussion of the role of human capital in economic growth through productivity improvement.

The first approach is based upon the theory of human capital, which considers education as an investment in abilities, and therefore, as a means to improve a productivity of workers (Schultz 1960, 1961a, 1961b, Becker1993). This approach brings to the models of growth accounting, where growth of output or productivity is considered depending on the change in human capital. One of the very often cited empirical results of this type is that of Griliches (1970). He estimates that the increased labour force educational attainment in the USA between 1940 and 1967 is responsible for one third of the portion of the growth of output, which could not be ascribed to the growth in such inputs as labour and capital, and is usually called the Solow residual. Some other authors also report similar results (Maddison 1987, Jorgenson and Fraumeni 1993).

Yet, there are several empirical works which report opposite conclusions. For example, Denison (1983) finds that whereas educational attainment in the USA between 1973 and 1981 was increasing, the growth of labour productivity was falling at the same time. The findings of Maddison (1982) resemble conclusions for OECD countries over the 1970-1979 years.

The second approach considers the significance of human capital in the scope of productivity convergence or the "catch-up" model. According to Wolff (2000), the productivity convergence process is related to the notion of the "advantages of backwardness". By this term, it is understood that the diffusion of technical knowledge from more developed to less developed economies is a key reason of the catch-up process. Due to the permanent transfer of knowledge and technologies, countries learn from each other, but the less developed have more to adopt from the more advanced and, therefore, they can be expected to experience higher rates of growth of productivity.

Nelson and Phelps (1966) explain that the stock of human capital drives economic growth, affecting the ability of a country to introduce innovations or to borrow novelties from more developed countries. According to their approach, a more educated labour force is expected to be more efficient in adopting and performing of new technologies both on an organization and at a country level. Several empirical studies confirm the views of Arrow and Nelson-Phelps concerning the interrelations between the level of education of the labour force and technological activity measures, like the intensity of R&D in a country or region (Welch 1970, Bartel and Lichtenberg 1987, Mincer and Higuchi 1988, Howell and Wolff 1992).

Yet, just being backward is not sufficient for an economy to catch up. Abramovitz (1986, 1994) has summarized the group of factors, called social capability, which must be present to allow a nation to use its "backwardness advantage". These are research and development activities, an educated and trained labour force, strong investment, a receptive political system, a low growth of population, developed trading links with technologically leading countries, and so on. In this context, the human capital, and education in particular, is considered an index of the ability of the labour force to adopt new knowledge. Therefore, it is possible to regard it as a "threshold effect" (Wolff 2000). This means that a certain labour force education level might be considered a necessary condition for borrowing new knowledge and technologies. Moreover, the level of sophistication involved in implementing technologies is determined by the level of educational attainment. The correct econometric formulation would then link the growth rate of productivity to the level of human capital.

Wolff (2000) referring to Baumol, Blackman and Wolf (1989, Chapter 9) reports the strong effect of education level on the growth of the per capita income across all levels of development.

The third paradigm pointed out by Wolff (2000) stems from the work of Arrow (1962) who instituted an idea of "learning-by-doing". This notion assumes that the process of the application of a technology in the production activity drives to improvements in labour productivity in an industry over time. It means that a more educated labour force "learns faster," and, as a result, increases efficiency faster than a less educated one.

The underlying assumption of an alternative class of models, which are based upon the study of research and development, is that a key role in the production of new ideas belongs to human capital. According to these models, notably the prominent contribution of Romer (1990a), steady-state rate of growth depends partly on the human capital level. In contrast to the Uzawa-Lucas approach, this assumes that even a one-off growth in the stock of human capital can increase the rate of growth indefinitely. Indeed, many models of endogenous growth assume existence of a threshold level of human capital, above which it should be for taking place of any innovation at all (Temple 2001a, 2001b).

In most R&D based models of endogenous growth the human capital stock is considered exogenously determined. However, in more recent papers (Redding 1996, Acemoglu 1997), this assumption has been relaxed. They consider the behaviour of individuals, which can prefer to invest in training or education, while firms invest in research and development. They found that multiple equilibriums are likely because the motives of firms to invest in R&D and individuals to invest in human capital are mutually dependent. These models propose that, as a whole, the higher level of education or training investments might raise the expenditures on research and development, and vice versa.

Temple (2001b) gives several reasons why these models are significant. Firstly, human capital is considered as one of the key inputs in the creation of new ideas: the main determinant of growth rates in this view. Secondly, in order to increase the welfare level, these models propose several options: namely, do not just invest in R&D, but also invest in certain types of education, particularly those that would enhance later R&D activities. Thirdly, they posit the conclusion that the laissez-faire results in growth that is slower than the socially optimal. In general, these models suggest that human capital is one of the first things to consider when searching for growth determinants.

The review of theoretical approaches, which model the relations between human capital and economic growth, shows that the former can influence growth either directly, as a production input, or indirectly, via total factor productivity. The empirical studies reviewed in the next section use these approaches.

Empirical Studies of the Role of Human Capital in Economic Growth

Production Function Approach

The specification of Mankiw, Romer and Weil (1992) gives the opportunity to study the direct effect of human capital as a production input. They used the flow data for both types of capital to analyse the participation of them in aggregate production. As a proxy of the rate of investment in human capital, they take the proportion of working age population that is still studying. The evidence of a direct effect of human capital on economic growth is obtained after running a single cross-country regression.

However, Nonneman and Vanhoudt (1996) obtain the opposite result of statistical insignificance of the estimated coefficients of human capital variable. They use the share of GDP invested in education as a proxy of human capital. Moreover, they introduce the accumulation of technological knowledge into the model of Mankiw, Romer and Weil (1992). Kyriacou (1991) and Benhabib and Spiegel (1992) report similar results. They analyse the contribution of human capital to economic growth considering it as one of the inputs entering in the Cobb-Douglas production function in differences. Their findings show that human capital enters into the regression equation with the estimated coefficients not significantly different from zero, and in some samples, these estimates are even negative.

On the other hand, Murthy and Chien (1997) take as a proxy of human capital a weighted average of the population enrolled in higher, secondary, and primary education. They conclude that human capital makes a significant impact on economic growth.

As to the panel data approach, Islam (1995) reports that the influence of human capital on the process of economic growth is non-significant if the average of schooling years in the total population over age 25 is taken as an approximation of the stock of human capital.

Thus, the empirical evidence of the significance of the level effect of human capital on economic growth is somewhat mixed. The sources for these different results lie in the use of different measures of human capital and different estimation approaches. In addition, it is necessary to take into account a possible reverse impact of growth on the accumulation of human capital. Some studies report that, on the one hand, the level of income has a positive and significant effect on the accumulation of human capital, and, on the other hand, a significant value of the level effect of education on economic growth (Freire-Serén 2001).

TFP Approach

As to the rate effect of human capital through total factor productivity, the empirical results are more unambiguous. Human capital does positively affect TFP, although the results of the assessment of this influence by various empirical studies are different depending on used proxies of human capital and statistical methods.

The most popular approach to study empirically the influence of human capital on economic growth through productivity improvements is the growth accounting methodology (Jorgenson, Gollop and Fraumeni 1987, Griliches 1996, Young 1995, Temple 2001b, Maddison 1987, Englander and Gurney 1994, Wang and Yao 2003).

The growth accounting methodology splits growth of output into a part generated by the growth of inputs, and a “residual”, which captures productivity change. The change in the input quantities is weighted by their marginal products, approximated by their market rewards. This approach allows the labour input to disaggregate into various types, weighted by the mean income of each type, if sufficiently detailed data are available. For example, the labour force can be disaggregated according to the schooling level. Changes in the quantity of workers at each level of this classification are weighted by their average incomes, which serve as proxies for their marginal products. This allows quantifying the share of growth of output that can be explained by educational attainment changes.

Jorgenson, Gollop and Fraumeni (1987) found that, for the period of 1948-1979, approximately one third of the aggregate value added growth in the USA is explained by growth in labour input, the measure of which considers both worked hours and labour quality. Changes in the composition of total worked hours by gender, age, education, occupation, and employment class are the basis for changes in their overall index of the quality of labour. They report that the improvement of the labour quality explains about one tenth of the value added growth, or about one fourth of the residual.

Griliches (1996) reports that, over the post-war period, the increase in educational attainment in the USA is responsible for about one third of the productivity residual.

Maddison (1987) studies the impact on the growth of educational attainment changes for six countries belonging to the OECD (Japan, France, the Netherlands, the UK, the USA, and West Germany). The labour force is disaggregated into those with primary, secondary and higher education, which are combined using weights, which are constant over time and across countries. His results suggest that, between 1950 and 1984, the improvements in the labour quality typically contributed from 0.1 to 0.5 percent of annual growth rates.

The survey of Englander and Gurney (1994), which draws together the conclusions of a number of studies for the countries of the G7 (although some of them are based upon regressions rather than growth accounting), concludes that the growth of labour quality typically is responsible for 10-20 percent of the total output growth over the period of 1960-1980.

Young (1995) studies and compares the growth patterns of four East Asian countries (Hong Kong, Singapore, South Korea, Taiwan). He finds that about one per cent of the rate of annual growth of effective labour input is explained by the increasing educational attainment of the labour force. However, Temple (2001b) points out that the dramatic expansion of the secondary and higher levels of educational attainment in South Korea from 27% to 75% of the working population does not transform into an adequate increase of the rate of growth.

However, the growth accounting results require careful interpretation because attained education may have other, oblique effect on output through investment, labour force participation, R&D, and the TFP growth. The growth accounting approach does not take account of these oblique effects, and says nothing about the general significance of education for the economic growth (Temple 2001b).

Mixed Approach

The Production Function and TFP approaches to the study of the importance of human capital for economic growth considered above can be applied to the same data sets of the same economy. This leads to the mixed approach to test the role of human capital in economic growth.

For example, Benhabib and Spiegel (1992) investigate the influence of human capital on economic growth from two points of view.

The first approach is to estimate a Cobb-Douglas type production function, in which factors of production are: labour (L_t), human capital (H_t), and physical capital (K_t):

$$Y_t = A_t K_t^{\alpha} L_t^{\beta} H_t^{\gamma} \varepsilon_t$$

where Y_t is output; $\alpha, \beta, \gamma > 0$. So, the human capital is considered a production factor.

The relationship for a long-term growth turns out after taking log differences:

$$(\log Y_T - \log Y_0) = (\log A_T - \log A_0) + \alpha(\log K_T - \log K_0) + \\ +\beta(\log L_T - \log L_0) + \gamma(\log H_T - \log H_0) + (\log \varepsilon_T - \log \varepsilon_0)$$

They estimate this equation within the framework of the standard growth accounting by regressing the differences of logarithms of income on the differences of logarithms of production factors. This methodology provides the estimates of the values of $\alpha, \beta,$ and γ.

The results of their estimates are as follows: while the differences of logarithms of physical capital and labour positively correlate with the differences of logarithms of income, the correlation between the latter and the difference of logarithm of human capital is very close to zero. That is, the difference of logarithms of human capital in various tests enters insignificantly and usually with negative coefficients. It means that if considered as one of the production factors in the Cobb-Douglas framework, the accumulation of human capital fails to influence significantly the economic growth, and even enters with a negative sign.

The second approach of Benhabib & Spiegel (1992) is to consider human capital as a pre-requisite for improving the total factor productivity: in other words, increasing the Solow residual. These improvements at the level of technology take place both through direct influence of human capital on the rate of domestically produced innovations in technology and the technological catch-up from abroad. This catch-up is expressed by the term proportional to the technological difference between the leading country and the country currently considered.

This approach is adopted from Nelson and Phelps (1966) who suggested that the country's technological growth is proportional to the difference between its level and the level of "theoretical knowledge," $T(t)$, which is given exogenously and grows exponentially.

Benhabib and Spiegel (1994) specify the growth rate of i-th country's TFP as follows:

$$\frac{\dot{A}_i(t)}{A_i(t)} = g(H_i) + c(H_i)\left[\frac{\max_j A_j(t) - A_i(t)}{A_i(t)}\right], \quad i = 1,2,\dots,n$$

Where $g(H_i)$ is the rate of endogenous growth, and $c(H_i)$ is the catch-up coefficient. These functions of the stock of human capital, H_i, are non-decreasing. Therefore, the level of human capital not only increases the capability of an economy to improve its own level of technology, but also its capability to accommodate technological innovations worked out in other countries.

The regressions with the introduced logarithm of human capital stock level into the growth accounting equation are more positive. They report that human capital variable enters with a positive sign and is significant. These results were obtained for both cross-country and regional US data.

Fleisher, Li and Zhao (2010) also study two possible channels of the influence of human capital upon output of China provinces. The first is a direct effect, in which educated employees have a higher marginal product than those who do not have even secondary education. The second is indirect, through the total factor productivity growth. This effect is based on technological spillovers from the regions with the highest levels of technology. It is assumed that regions having a relatively high share of educated labour force have more chances to use these new technologies.

To take into account the first channel, they propose to estimate the provincial aggregate production functions with production factors defined to contain two types of labour: educated and non-educated. The workers with at least a secondary education are included in the educated group. The non-educated group consists of workers who have attended up to high school without graduating or have not attended high school at all.

They found that the estimated elasticity of an educated labour force is much higher than that of non-educated workers, which is close to zero or even negative. This result is very robust to different estimation methods and the specifications of the production function.

Besides the level effect of human capital on output, it is supposed to influence the TFP growth through the adoption of technological innovations.

The direct effect of human capital on TFP is approximated by human capital terms at the right hand side of the TFP growth equation. The indirect effect of human capital on TFP is described through the interplay of human capital, output gap and the space variable, which reflects the distance from the centre:

$$\log TFP_{it} - \log TFP_{i,t-1} = \cdots + \alpha_i h_{i,t-1} [\frac{1}{d\_\max\ \_i} \left(\frac{y_{max,t-1} - y_{i,t-1}}{y_{i,t-1}} \right)]$$

Where h_{it} is the human capital measure, $d_{\max\ \_i}$ is the distance by railway between the capital city in the region with the highest per capita output and the capital city of each region.

It is assumed in this specification that an area which is closer to a more technologically developed region has better access to new technology than more distant regions, i.e. the technology-spillover process is confined by costs and frictions positively related to distance. The term in round brackets means that the rate of TFP growth depends on the output difference between the more developed region and the current one.

They found that human capital approximated by the share of employees with greater than junior high school education has a positive direct effect on the growth of TFP. The human capital's spillover effect on TFP growth is also positive and statistically significant.

Thus, the human capital impact on economic growth is studied from two points of view: as a factor of production and as a factor that improves TFP. In addition, there is a mixed approach, which combines the above-mentioned two approaches.

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