Convergence of Per Capita Income Levels Across Regions of Pakistan

By

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To My Mother who has always been loving and caring

And To My Father

Nazir Ahmed Sindeelah (May Allah rest his soul in peace) who esteemed piety and integrity.

In the name of Allah, the beneficent, the merciful

Preface

The selection of a topic for research is not an easy task when you have such a vast literature of economics, its disciplines and so many economic issues and problems the humanity is suffering from. One also needs requisite data sets for empirical research which are usually not available in Developing Countries. It was very difficult for me to decide to write on a subject on which a very few people endeavour to write. However, my interest in Growth Theory developed when I went through Barro, Robert J. and Xavier Sala-i-Martin (1992) and Mankiw, Romer and Weil (1992). I was very ambitious to study the regional convergence or otherwise by using district as primary economic unit for research but due to data and time constraints, I had to restrict my analysis to province level.

All acclamation is to Allah Almighty who very graciously empowered me to accomplish the research successfully and enabled me to contribute partially towards the diffusion of knowledge on the subject. At the outset I would express my deep respect and gratitude to Dr. Hafiz Muhammad Yasin for his kindness and sympathetic attitude throughout my research work. Although I had a few meetings with him yet these were very productive ones for me. He took keen interest in the study and provided valuable guidance to complete the dissertation. His suggestions and comments helped me to improve the contents and arguments of this study.

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made me feel fresh with his jolly remarks and humour. May Allah (SWT) reward them for their well wishing and cordial services to me.

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Indeed, it is a pleasure for me to acknowledge with thanks the help of library staff of the IIIE, IIU Islamabad and their assistance in locating books and other material needed for this study. Especially, I am highly grateful to Mr. Niaz-ur-Rehman[7] and Mr. Zulfiqar Ahmed[8] for extending generous help in locating crucial journals and articles. Finally, I am also indebted to Dr. Tariq Javed[9] for his immense encouraging comments and appreciation during the defence of my thesis.

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ABSTRACT

Growth theory regained momentum as an important analytical framework to understand the dimensions of regional economic growth and the issue of convergence. The regional economies are supposed to converge overtime to a common equilibrium level of income, even if they differ in the initial/start-up level, provided they are similar in other socio-economic conditions. However, if the differences among economies or regions in terms of the said conditions are significant, then each region is likely to follow an independent path and will converge only to its peculiar equilibrium. The objective of this study is to investigate empirically if there is any evidence of convergence across different regions of Pakistan. The study reviews various concepts of convergence and utilizes different analytical techniques to examine the phenomenon over the period 1979-2005. The data is drawn for the four provinces and disaggregated into rural and urban sectors. Due to presence of vast differences among the regions in terms of the growth determinants, no evidence of absolute convergence could be observed. In contrast, the income disparities across the regions exhibited a widening tendency during the reference period as shown by the 'sigma' convergence test. However, the data did support conditional convergence, which implies that different regions followed independent growth paths. The findings further indicate that the socio-economic conditions or the determinants of steady state of regional economies are crucial to explain the persistence of income disparities across the regions. It is beyond the scope of the present study to investigate as to why the determinants concerned differ so widely across provinces of Pakistan. As expected, the study concludes with some policy recommendations that may improve the situation.

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CHAPTER 1

INTRODUCTION

1.1 Growth and Development

Growth and development are closely related terms used in the literature that convey more or less the same message to the general reader. Although the borders of the two areas are overlapping, however, these can be distinguished from each other in scope and coverage. Where growth theory concentrates on the ingredients of gross and per capita income, the theory of development focuses on the overall socioeconomic structure and institutional set up that moves ahead with the passage of time. In this context, the relationship between growth and development resembles that of an engine and the carriage. Naturally the carriage has to move according to the potential of the engine. The growth rate of income is central to the process of development. Following the impetus of growth in income/ output, the entire social and institutional structure of an economy begins to move forward in all direction, and if the growth process is sustained overtime, this results into modernization, democratic attitude of masses and a broader outlook towards life along with more equity in distribution, reduction in poverty and general improvement in the standard of living. A strict line of demarcation cannot be drawn to separate the two areas. The growth and development theorists look at the same picture from different angles. Saving, investment and capital formation, growth of labour force and technological progress etc. are the central phenomena discussed in studies on growth. The development literature, on the other hand, takes into account the impact of growth on the overall socio-economic structure in a much wider sense. It deals

with questions, for instance, whether the benefits of GNP growth are uniformly transmitted to all sections of the society, how the standard of living can be measured and compared across countries and regions, what are the key (social, political and institutional) factors responsible for development besides growth in income, how the priority between high rate of growth and more equity in distribution can be determined, and so on and so forth. The borders of the two areas of the discipline come closer to each other when a researcher considers the question of equity in income distribution across different households and at the same time the question of convergence across different regions in the economy.

1.2 **The Issue of Convergence**

Literally, convergence means meeting of some things at some point. The term has been used to imply a narrowing down of the differences of income or output among regions overtime, and thereby a return to some common equilibrium level as the growth process moves forward. The concept of steady state equilibrium is fundamental in this regard. It refers to an ideal situation when the key economic variables like income/output and factors of production, particularly the capital stock and labour force, all grow at the same exponential rate so that there are neither deficiencies nor surpluses in the long run. Investment and capital formation along with technological progress play the crucial role in this context. However, all the countries on the globe are not likely to grow with the same rate. Naturally some may be the leaders in growth and innovations while majority of others may be imitators and followers. The question whether the per capita incomes of different countries are converging over time to a common steady

state level or otherwise has been one of the most widely debated issues in the growth literature since the early nineties. The very concept of convergence came to the surface when the newly industrial countries exhibited rapid and sustained growth rate (as compared to old industrial countries that showed relatively a slowing down). It was believed that countries which entered relatively later in the phase of economic growth (after the second world war) would grow at high rate due to easy access to modern technical know how. The evidence, both in favour and against, could now be traced in the vast literature on growth and convergence. Later on, the thesis also applied to different socio-economic regions within a country, since disparities in per capita income/output have been a major concern of regional policy in all parts of world. The socio-economic regions within a country are the crucial and appropriate units for research so far as formulation of economic policies and other political considerations are concerned. Therefore, regional growth is as important for a country as national growth on the grounds of both equity and political reasons.

In the context of Neoclassical Growth Model, the convergence hypothesis implies that the growth rate of income per capita is inversely related to the initial level of per capita income. In this connection, one has to differentiate between the concepts of absolute and conditional convergence. The absolute convergence is interpreted as convergence of all economies/regions (that differ only in the initial levels of income) to the same or a common steady state level of income per capita. This implies that relatively poor regions grow faster than their rich counterparts, provided that all regions are similar to one another in respect of technologies and preferences, that is, all regions have the same (or similar)

steady state growth paths and other socio-economic conditions. However, if the regions exhibit differences in structural characteristics (such as propensity to save, growth rate of population, level of technology and institutions etc), then they may not converge to the same steady states level. In other words, each region, distinguished by structural characteristics, will converge overtime to its own/specific steady state level. This is termed as conditional convergence. In this case, the growth rate of the economy/region concerned is positively related to the distance between its current level of income and its own steady state/equilibrium level, that is, the economy should move at a faster rate if it is farther from the steady state level. The primary source of convergence in the neoclassical growth models is the assumption of diminishing returns to reproducible capital. Diminishing returns to capital implies that the rate of return is negatively related to the stock of capital so that, other things being equal, poor economies with a low amount of capital, have high marginal products and thereby are expected to grow faster. Another important tool, which is often used to measure and analyze the regional disparities, is based on the hypothesis of sigma convergence. It deals with the dispersion of per capita income across regions. This kind of convergence holds if the dispersion or variability of real per capita income across regions decreases, in other words, if the regions are getting closer to one another with the passage of time. In contrast, the divergence of output/income (disparity) occurs, if the variables that determine the steady level of income are also diverging across regions.

1.3 **The Case of Pakistan**

The questions concerning the prevalence of poverty, the deepening gulf between rich and the poor and rising trend in other economic disparities across regions, sectors and classes, have always been the burning issues all over the world. These issues, irrespective of caused whether by structural or policy reasons or both, are of great importance and bear far reaching economic as well as political bearings. The federation of Pakistan displays complex regional diversity, i.e. the geographic regions differ not only in linguistic, cultural, and demographic terms but this diversity is also reflected in the level of social and economic development. Although the constitution of Pakistan provides equal rights for all provinces in national resources (according to population density) and equal opportunities of progress for every citizen irrespective of religion, creed and cast, yet the level of development is not uniform. During the past half a century, investment in physical and social sectors concentrated in selected parts of the country, particularly in big cities, and its distribution has been uneven. This practice has led to creation of regional economic disparities and a sense of deprivations among rural masses. The prevalence of these disparities over a long period of time has substantial impact on the standard of living of people. This situation is considered to be a serious impediment to the country's sustainable growth and development. Regional economic disparities have further aggravated the problems of poverty and inequalities, which in turn have led to weakening of federation, regional tensions, political instability and difficulty in consensus on issues of national interest (like the construction of Kalabagh dam, for instance). The depressed people of backward regions can be misguided so

as to engage in secessionist movements and terrorist activities. The recent political unrest in Balauchistan may be seen as an evident repercussion of this situation.

1.4 **Rationale and Objectives of the Study**

The research in regional dimension is useful and need of the time, considering the fact that policy implication need prior and up to date information about the socio-economic conditions prevailing in different regions, particularly about the pattern of income distribution and the extent of poverty. Whether per capita incomes of relatively poor regions are converging overtime to that of the advanced regions is of great importance for human welfare. The investigation of the regional (or provincial) disparities within a country and understanding its causes and impacts is essential to formulate appropriate policies and to bring about institutional changes so that the benefit of growth process could be evenly distributed across regions. There has been an increasing interest in analyzing trends of the regional disparities within the framework of the neoclassical growth model and it is emphasized to understand the regional dimension of economic growth, the causes and nature of the differences in growth rates across regions overtime. In this regard, the regional analysis of convergence provides useful information for the purpose of policy making and in the allocation of public resources. Examples of such attempts are numerous both for the developed and developing countries. Despite its importance, no serious attempt has been made so far in Pakistan.

It would be therefore interesting and useful to enquire if different socio-economic and political regions of Pakistan have experienced any kind of convergence overtime. The main purpose of the present study is to empirically investigate the hypothesis of convergence and to identify the various factors and impediments to convergence. This may lead to a better understanding of the trends in income inequality across the regions using data for Pakistan. Rather than to test a specific growth model or class of growth models that predict convergence, we intend to investigate the existence of convergence and to identify its nature. However, it is questionable whether the assumption that all regions share a common or same steady state level of per worker income can be applied to different regions of Pakistan. There is much diversity among the regions, which can be seen in number of indicators like literacy rate, rate of saving, population density, life expectancy, degree of urbanization, the rule of law, social and family structure etc. Furthermore, these disparities have been increasing over time. These very facts provide sufficient rationale to focus attention on the issue of growth and convergence using formal procedures. The present study is the first of its kinds to investigate the issue formally within Pakistan. It tries to attempt the question whether the overall disparity or income inequality across provinces of the country has been increasing or narrowing down while considering different time periods. In sigma convergence analysis, we examine income dispersions both in per worker and per capita terms in order to find any possible difference between both the terms.

Another co-objective of the study is to investigate whether variation in the growth rate of real income across regions can be explained by the determinants of the

steady state (such as per worker saving, working age population growth rate and human capital). In this connection, we investigate conditional convergence that is the convergence after controlling for the determinants of steady states. We review alternative theories on growth leading to contrasting implications for regional income dynamics. We also try to examine if the rural-urban differences are important components of overall regional disparities and to identify its relationship with the overall regional disparities.

1.5 **Methodology of Research**

The present study attempts to analyze empirically the issue of conditional convergence using the dynamic panel growth framework since it focuses on the importance of differences in the determinants of steady state responsible for regional income disparities. In addition, we highlight some econometric issues regarding estimation in the context of dynamic panel growth framework and review as to how the researchers have consistently estimated the dynamic growth models. How to control for the differences in steady states of the different regions is the most important issue that emerges from a study of growth literature. To account for the determinants of steady state, we have used per worker saving rate, the working age population growth rate and an index of human capital as important variables in our analysis. Moreover, dynamic panel growth framework provides natural specification to control for unobserved region specific effects like initial level of technology in convergence growth regression.

We review the alternative growth theories that often provide with contrasting evidence about convergence or otherwise and about the factors (both economic

and non-economic) responsible for convergence of income/output across regions or countries. This is because the theoretical models are based on different assumptions that have peculiar implications for convergence and income disparities across economies. We consider the familiar Neoclassical Growth Model (due to Solow or its variants) as the base of analysis and follow the dynamic panel growth regression to investigate the conditional convergence. We employ different estimation techniques in our analysis in a quest to arrive at the appropriate and plausible parameters. The basic units of analysis and comparison are the 'provinces' keeping in view the limitations that the data on more smaller units like 'districts' is not available so far as the nature of this study is concerned.

1.6 **Organization and Set-up**

The study is organized as under. The next chapter is devoted to a brief review of the concerned literature. The third chapter provides the basic framework of analysis where different models and estimation techniques are discussed. Next we deal with the available data to be used in the analysis and discuss the problems and limitations therein. The fifth chapter is central to our endeavour that provides the detailed results. As usual, the final chapter is devoted to conclusions and food for further research or proposals for policy making. At the end, we provide bibliographies and references. Hopefully, this exercise will be useful in improving our general understanding of the complex problem of economic disparities through different regions of our homeland and may provide some insights in getting the situation improved.

CHAPTER 2

LITERATURE REVIEW

2.1 Convergence in Historical Perspective

Should we expect that income disparities across economies are getting smaller over time? Is there any tendency for low income economies to grow faster than high income economies? The question whether economies with different start up conditions can converge over time to the same level in terms of per capita income, productivity and technology has attracted the attention of leading economists since the mid -1980s. However, the idea of convergence is supposed to be one of the oldest controversies in economics. Elmslie (1995) points out that the modern convergence-divergence debate is often believed to have started with Veblen's (1915) assertion that the transfer of technology from advanced to developing economies leads to convergence or catching up. Later on, this idea was modernized and popularized by Gerschenkron (1952). In parallel to the notion of "importance of being unimportant" in the theory of international trade, he introduced the "theory of relative backwardness" by emphasizing that there is an advantage of being technological backward. However, economic historians have cited that the origin of convergence hypothesis goes back to mid-18th century and that important insights can be found in the scholarly writings of David Hume in 1742 in favour and Josiah Tucker (1776) in opposition.

David Hume believed that during the process of economic growth, there is a natural tendency towards convergence across economies. He pinpointed and explained various factor responsible for the convergence process and suggested

that transfer of technology and know how across boundaries can better explain the tendency of poorer economies (regions or nations) to catch up over time with the rich economies. In contrast, Josiah Tucker was of the view that economic disparity (non-convergence) can persists indefinitely or permanently. He argued that relatively rich countries will not naturally converge merely on the basis of increasing or non-decreasing returns accruing to them in scientific and economic activities. This exchange of views between David Hume and Josiah Tucker is referred to as the "rich country - poor country debate" in the literature, which contributed to the adoption of the free trade policy in England in the 19th century and promotion of the laissez-faire doctrine. Many prominent economists were impressed by the idea of convergence of income levels across economies after the Hume-Tucker exchange of views. For instance, economists of the stature of John Stuart Mill and Karl Marx of the 19th century and economic historians like Alexander Gerschenkron of the early 20th century were optimistic about convergence of latecomers to development (De Long, 1988).

One of the basic ideas behind the notion of convergence is that for a backward region or nation that has developed to a certain threshold level or social capability, imitation is easier than innovation. Therefore, the growth rate of backward regions should be higher than that of the advanced regions. The relative decline of United States economy in 1980s is attributed to convergence of the productivity level across countries. Given identical or similar preferences and technologies across the world economies, convergence implies a long run tendency towards the equalization of per capita income and productivity as

pointed out by Abramovitz (1986). He tested the early hypothesis proposed by economic historians and noted that under certain circumstances, backward countries tend to grow faster (in the level of productivity) than their rich counterparts. He also noted that a necessary condition for catching up is the existence of "social capability" in backward economies, which allows successful exploitation of imported technologies. Social capability refers to fulfillment of certain conditions like the existence of adequate entrepreneurship (and sincere leadership), the availability of efficient managerial & technical staff and the prevalence/ speedy development of the required infrastructure and institutions like banks, insurance companies and other financial institutions as well as an effective and impartial judiciary. Social capability also depends on the level and standard of education and training, organization of firms, general cultural values, social structure, attitude towards work, wealth and the existence of macroeconomic and political environment conducive to investment and structural change. Without social capability, relatively backward economies will not be able to take advantage of flow of modern technology and know how. Abramovitz summarized the technological catch up hypothesis as under:

> "Countries that are technologically backward, have a potentiality for generating growth more rapid than that of more advanced countries provided their social capabilities are sufficiently developed to permit successful exploitation of technologies already employed by the technological leaders. The pace at which potential for catch up is actually realized in a particular period depends on factors limiting the diffusion of knowledge, the rate of structural change, the accumulation of capital, and the expansion of demand. The process of catching

up tends to self limiting, but the strength of the tendency may be weakened or overcome, at least for limited periods, by advantages connected with the convergence of production patterns as followers advanced towards leader or by endogenous enlargement of social capabilities." (p.390)

According to convergence hypothesis, countries starting with a low per capita income should grow at a higher rate. Thus, an inverse relationship between output growth and initial level of output is interpreted as evidence in support of the convergence hypothesis. William Baumol (1986) was one of the pioneer economists who provided statistical evidence of convergence among some countries and the absence of convergence among others. By using data in the analysis of long run growth, he found the evidence of convergence among 16 advanced economies. He put the argument in the same fashion as Abramovitz, that technology is a public good and its diffusion over time leads to catching up and convergence. However, DeLong (1988) showed that Baumol's finding of unconditional convergence (in the 16 country OECD sample) suffers from selection bias. Since the very appearance of this empirical work, there has been a tide of econometric studies using both cross-country and cross-regional data, attempting to test the existence of absolute (or unconditional) and conditional convergence, both in term of per capita incomes and overall productivity, and to confirm empirically the validity of the neoclassical models (based on the assumption of diminishing returns to reproducible capital). This assumption implies that output grows less than proportionally with the increase in capital stock that is the rate of return on capital is lower in regions with more capital per

worker. Therefore, economies with a lower stock of capital will enjoy higher marginal products/returns to capital, savings and investment as compared to economies with higher level of capital. This difference in marginal returns to capital leads to convergence and equalization over time across economies in terms of income, productivity and growth rates.

2.2 **Contemporary Debate on Convergence**

Although, economists have emphasized on the study of economic growth, however, the focus shifted to other areas in the late 1960s and afterwards. Research in this field got momentum again in the late 1980s after a dormancy period of about two decades. The new research began with models of the long run growth that is now known as Endogenous Growth Theory. Growth theory has resurged as an important topic of investigation and has awakened much of the debate on the nature of public policies and their impact on economic growth. The standard neoclassical growth models, which assumed technical progress as exogenous, have been criticized and challenged in literature on the basis of endogenous growth pioneered by Romer (1986) and Lucas (1988). However, the other side of the picture is also shining. Recent research has also supported the implications of the original neoclassical growth models, particularly in empirical analysis of convergence across different economies for instance, Mankiw et al (1992). Mankiw (1995) provides a defence of the neoclassical growth model. After noting some empirical problems associated with the neoclassical model, these studies propose a feasible solution by redefining the term "capital" to include human capital besides the physical capital as argument of the production

function. This innovation is shown to support the predictions of the original model. Regional studies have gained considerable importance in economic research since the early 1990s. The renewed popularity is linked partly to the strong comeback of growth theory, which increasingly is the preferred tool for evaluating economic policies.

The dealing with the issue of regional disparities has changed in recent times. The analysis of regional disparities in economic growth across countries and between different regions within the same country is now tackled via the growth models as compared to the 1970s, when it was based on the general equilibrium models, international trade theory, the hypothesis of constant returns to scales and the theory of comparative advantage as mentioned by Coulombe (1999). Economic theory identifies the forces, with contrasting implications for income dynamics, and it pinpoints a series of factors and mechanisms that generate either convergence or divergence of per capita income levels across countries or regions. Theoretical models based on different assumptions can have different, rather contrasting, predictions about the income disparities across economies. Hence, the existing models of growth can be classified into two groups so far as their convergence predictions are concerned.

According to the traditional neoclassical growth models (based on the assumption of diminishing returns to individual factors and constant returns to scales), the long run growth depends on the advancement of technology, which is exogenously given. If decreasing returns apply, capital accumulates faster in

regions where it is relatively low at the beginning. Thus, other things remaining same, the relatively poor economies with lower initial values of capital-labour ratios are likely to grow faster (than the already advanced economies) due to the higher rate of return to capital. Put differently, the relatively rich regions or economies where capital is relatively high, output grows less than proportionally with the stock of capital. This implies that marginal productivity of capital decreases with its accumulation and reducing the incentive to save (a necessary condition for growth) that cause the growth to slow down over time. In case all regions or economies have easy access to the same technology and if other structural characteristics and preferences are common, the per capita income of a relatively poor regions will converge to relatively advanced regions because the law of diminishing returns to capital implies that return to capital will be higher in the regions where the capital to labour ratio is low. Thus the dynamics of capital accumulation ultimately equalizes the capital-labour ratio and returns to capital in all regions. This mechanism predicts convergence across economies to the steady states over time.

However, it does not imply complete elimination of inequalities across different economies; rather it means that the distribution of relative income per capita across economies will tend to stabilize in the long run. In case the assumption of similarity in structural characteristics for all economies is not realistic or the determinants of steady state of different economies are not the same, then economies may converge to the individual steady state level of income. In other words, convergence is still predicted; although conditional. The individual

economy grows faster when the gap or distance between its initial level of income and steady state level is relatively greater because the growth rate of an economy is positively related to this gap. Thus the existence of diminishing return to capital is considered as the key factor responsible for convergence in the neoclassical models.

In contrast, the endogenous growth models predict an increase in disparities over time, i.e. economies may diverge permanently in terms of per capita income. This means that (already) rich economies grow faster (than the relatively poor) and they maintain their lead, which results into status quo or increase in inequalities. The endogenous growth models are based on the assumption of non-decreasing returns to capital. This means that an economy with a higher level of capital (and thus a higher level of output per worker) will maintain their lead over others because its ability to save and invest will never diminish. These models emphasize the endogeneity of technological progress which implies continuous growth. In fact, in the endogenous growth models, there is no steady state level equilibrium. The models, which are based on the assumption of increasing returns to capital, predict divergence i.e. the disparities of income across economies may increase over time or that rich will grow richer and poor will become poorer. In this case, the return to investment increases with accumulation of the stock of capital per worker, thus the rich economies will grow faster than poor ones. The key feature of these models is that the accumulation of physical and human capital, new ideas and scientific advancement is the main source of long run growth in per capita income and productivity. If the assumption

of constant returns to physical capital holds, then poor will stay poor relative to the rich. In the absence of the assumption of diminishing returns to physical capital, the notion of convergence disappears because an economy (particularly the leaders on the growth path) can grow without limits.

Romer (1986), Lucas (1988) and Romer (1990) present their models with focus on the possibility of non-decreasing returns to capital stock and endogeneity of technological progress. Romer (1994) identifies two origins of the endogenous growth theories. First is the failure of the (basic) neoclassical growth theories to generate the long term growth from within the model. Second is the failure of their prediction of convergence, which is not supported by empirical evidence in large sample of countries. The new (endogenous) growth theories try to resolve these problems by avoiding the assumption of diminishing returns somehow. As a result, these models do not have any sort of convergence implication; rather they predict endogenous growth in the long run. Thus the issue of convergence and the issue of validity of alternative growth theories can be linked together. The advocates of endogenous growth theories hold the view that assumptions of the basic neoclassical growth are implausible, for instance the assumption that technological opportunities are equally available everywhere, which guides to the misleading conclusions like that of convergence.

2.3 **Mechanics of Convergence in Growth Theory**

The sources of these contrasting predictions can be traced to the basic assumptions about the accumulation of capital, properties of the production function at a given point and the dynamics of technological progress. In addition to the assumption of diminishing returns to capital, the important factor worth considering regarding convergence/divergence debate of per capita income or productivity is the generation and diffusion of technology. If the economies differ in their ability to generate and/or adopt new technologies, their long run growth rates will be different. Although, technological progress could be an important factor of divergence but there are other forces that may push the economies in opposite direction as explained by Abramovitz (1986) and discussed under section 2.1. The idea of convergence is simple that the followers are in a better position to benefit from the technologies that already exist and can be adopted easily since the imitation and implementation of discoveries is cheaper than innovations. They can grow faster than the technological leaders who have to bear costs of new discoveries.

To explain the regional growth path in the neoclassical growth models, the main source of convergence across regions within a country is the mobility of factors of production that accelerates the working of the market mechanism. As the assumption of diminishing returns to individual factors of production (K and L) applies, factors movements promote the equilibrating tendencies towards convergence. For example, if wages are too high in the developed regions, labour will migrate from the less developed ones. Then, labour will become

scarce in the latter and abundant in the former and it leads to an up-ward or down-ward movement of wages. As the wages and the marginal product of capital are inversely correlated therefore capital will move to labour intensive regions where wages are low (less developed regional economies) so as to minimize the factor cost and to explore the high profit opportunities, this will reduce the trend for labour to migrate outwards. The process will continue until equilibrium is achieved in all regions. Thus labour and capital mobility follow the routes opposite to each other. This inflow of capital in poor regions will boost up the growth of output resulting into a tendency of income equalization. Hence, growth rate in poor regional economy is faster than the advanced ones. Thus the factors mobility contributes to convergence in per capita income. Factor mobility may include flows of technology as well as of labour and capital.

In the previous section, we have discussed briefly the two groups of theories on growth with contrasting implications for regional income dynamics. Now an important question is that how the researchers distinguish empirically between the two groups of models. In regression models on convergence, the depended variable is the growth rate of income per capita (per worker) and the most important explanatory variable is the initial value of per capita income or output. The natural starting point is to examine the sign of association between the growth rate of per capita income and its initial level. The relationship should be negative according to the standard neoclassical models whereas in the context of endogenous growth models, the expected sign should be positive. Thus, we can infer convergence in a given sample when we find a sign of negative correlation.

On the other hand, a zero or positive correlation will lead us to opposite conclusions. The empirical findings that support the convergence hypothesis are also considered as evidence in support of the neoclassical growth models and the absence of convergence is taken equivalent to support the endogenous growth models. Thus, the sign of the estimated coefficient enables us to discriminate between the alternative and contrasting hypotheses. In other words, estimation of a convergence equation is a natural way to determine as to which group of models gives a better explanation of the growth experience (De la Fuente, 2000).

In convergence analysis, the initial stock of capital is considered to be an important factor that determines the growth rates. The null and alternative hypotheses can be made on the basis of the relationship between the level of incomes and their growth rates, depending on whether the return to capital is assumed to be diminishing, constant or increasing. In case of diminishing returns to capital, as assumed by the neoclassical theorists, the relationship will be negative while in case of increasing returns, as assumed by endogenous growth theorists, the relationship will be positive. In the constant returns to capital, as assumed by Lucas (1988) and Rebelo (1991), the growth rate of per capita income is independent of the starting level. Whether the income levels in poor economies are converging over time to those of richer counterparts is certainly a question of great importance for human welfare. Another reason that evoked interest in the issue of convergence is the fact that it has been linked (willfully or accidentally) with the validity of alternative growth theories. Generally,

convergence is considered as an implication of the original neoclassical growth theory whereas the endogenous growth theories are devoid of this implication. However, there seems no consensus in growth literature that testing for convergence necessarily means testing for the validity of alternative growth theories.

2.4 **Empirical Studies – An Overview**

As mentioned above, the recent interest on testing whether the observed per capita income is converging (or otherwise) took a start with two pioneering studies by Abramovitz (1986) and Baumol (1986). The convergence hypothesis has been tested by many researchers using various methodologies, statistical techniques and data sources. The hypothesis appears to be rejected by some data sets and accepted by others. For large sample of countries (with different socio-economic structures), most of the empirical evidence fails to support absolute or unconditional convergence. However, the evidence on convergence is supported by smaller groups of countries (especially with similar structural characteristics) within specific geographic regions or communities (which may be called homogeneous groups). For example, Barro and Sala-i-Martin (1992), and Mankiw, Romer and Weil (1992) reject unconditional convergence for a diverse group of countries in the global context but do not reject its occurrence when focusing on homogeneous regions like OECD countries, where technologies, preferences and other social structures are likely to be the same. Mankiw et al. (1992) also focus on linking the empirical findings to the convergence properties of growth models. Barro (1991), Barro and Sala-i-Martin (1992), also elaborate

this linkage and find the evidence of conditional convergence across countries when they add conditional variables (determinants of steady state) to the regression. In general, these studies report in favor of conditional convergence[1]. The research exploring the impact of macroeconomic and political variables on disparities has attracted considerable attention in the literature. For instance, Barro (1991) included certain variables that account for political stability in the analysis on convergence and found that their impact on growth is significant. In addition, he included a proxy for price distortions and found it to be linked negatively to growth.

Mankiw et al. (1992) showed that the basic neoclassical growth model due to Solow (1956) is better supported by cross-country data when the model is augmented with human capital in addition to the physical capital and population growth rates. These authors also argued that the failure of evidence on the per capita incomes to converge (to the same steady state) in a cross country analysis does not contradict with the predictions of the model. They emphasize that the model predicts only conditional convergence, i.e. different countries have different steady states and each country converges over time towards its own peculiar steady state. The prediction attributed to the neoclassical model, that poor economies will grow faster than rich, can be true only if certain conditions are fulfilled. For instance in basic neoclassical model, the long run equilibrium or the level of income at the steady state depends on the rates of savings and

[1] Temple (1999) and Durlauf and Quah (1999) provide comprehensive surveys of the empirical literature on growth and convergence.

population growth, which may however, differ across economies. In case we do not take care of this element or do not control for the determinants of steady states, we in fact assume identical conditions to prevail and want to test the hypothesis that all economies converge to the same long run equilibrium (absolute convergence). Thus the rejection of this hypothesis has nothing to do with the validity of the basic neoclassical model, since the model makes no prediction for unconditional convergence[2]. Mankiw et al (1992) found that after controlling the determinants of steady-state (like saving rates and population growth rates etc); the countries generally converge to the steady states at the rate predicted by the model.

The framework of cross-section studies for the estimation of conditional convergence is criticized for econometric reasons. Mankiw et al (1992) used the cross-section approach and the differences in initial level of technologies across countries are assumed to be part of the error term. However, the initial level of technology may be correlated with other explanatory variables in convergence

[2] When the factor substitution is allowed in the neoclassical growth model, the economy could achieve stable dynamic equilibrium, instead of suffering from the inherent instability that characterized the Harrod-Domar growth model. In neoclassical growth model, the substitution possibility and diminishing returns force the economy to converge to the equilibrium and it is independent of whether the economy starts off from a per capita capital stock that is lower or higher than the equilibrium capital level. Hence, this is a convergence within the economy. However, the concept of convergence usually associated with neoclassical growth theory considered as cross-economy process.

analysis. Thus the results may have suffered from the omitted variable bias. Islam (1995) extended their analysis by employing a panel data framework and argued that it becomes possible to control for time invariant and individual specific characteristics of countries (like the initial level of technology) using fixed effect models. He used the fixed-effect panel data estimator such as least squares dummy variable (LSDV) to control for the country-specific effects and found the rates of convergence in panel model were higher (3-6 times) than in a single cross-section model. Other studies on convergence analysis in the panel data framework, using the least squares dummy variable (LSDV) or fixed effects estimation methods have found extremely fast convergence rates of up to 20 per cent. More recent studies used different estimation techniques than the LSDV estimator (or within-groups estimator for panel data).

However, the said estimator (within-groups) considers the set of explanatory variables as perfectly exogenous. The strong theoretical argument reveals that most of the explanatory variables in the context of growth regression models are expected to be endogenous. From within the different procedures suggested in the literature for dynamic panel data models, Caselli, Esquival, and Lefort (1996) propose to solve the problem of endogneity by employing the GMM estimator in first differences as suggested by Arellano and Bond (1991). Using this estimator, Caselli et al (1996) find the evidence of rapid convergence across countries toward very different steady states and concluded that the differences in the growth rates and the level of incomes per capita across different countries may

be due to permanent differences in the steady state levels rather than due to investment rates.

2.5 **Regional Convergence Analysis**

Many researchers have also tried to investigate convergence in different regions or states within a country by utilizing the same framework and tools that were originally developed for cross countries analysis. The interest in regional convergence seems to originate from the same base that provided a spur to investigate international convergence (Blanchard, 1991). The convergence analysis has been widely studied for developed countries and most evidences in support of unconditional convergence have come from within country studies (i.e. across states or regions of the same country). For example, Barro and Sala-i-Martin (1991, 1992, and 2004) and Sala-i-Martin (1996) find evidences of unconditional convergence in case of USA, Germany, United Kingdom, Japan and other developed countries. They investigate the trends of convergence, using both long periods (like 100 years for the states of USA and 60 years for Japanese prefectures) and much shorter sub-periods. Most studies found that the rate of convergence is around 2% per annum. Absolute or unconditional convergence is more likely to be observed at the regional level within a country than across countries because differences in preferences, technology, institutional and structural environment are expected to be relatively smaller in regions within a country. On the other hand, the evidence of absolute

convergence is not supported for developing countries where the differences in economic and other structural characteristic are more severe.

Various empirical studies that focus on regional convergence analysis within the neoclassical growth framework for developing countries can also be seen in the literature. The study by Jian, Sachs, and Warner (1996) examines the convergence of per capita incomes across provinces of China between 1952 and 1993. By using the cross sectional approach, they find a tendency towards convergence since 1978 (the reform period) but did not find any signs of convergence prior to this period. Gundlach (1997) also finds similar evidence of absolute convergence in output per worker across Chinese provinces during the period 1978-89. Likewise, Juan-Ramon and Rivera-Batiz (1996) analyze the states of Mexico over the period 1970-1993 and report convergence in income levels only during the period from 1970 to 1985 but no evidence thereafter. Recently, an empirical study by Hossain (2000) investigates convergence of per capita output levels across regions of Bangladesh, and finds the evidence of convergence over the years 1982 to 1991 but a trend of divergence thereafter.

Cashin and Sahay (1996) and Bajpai and Sachs (1996) have studied the issue of convergence for the states of India. Cashin and Sahay (1996) use a cross section regression and examine the period between 1961 and 1991. Although they observe that parameters of unconditional convergence have the expected signs but they are statistically insignificant. By dividing the whole time span of 30 years into sub-periods, they find the evidence of unconditional convergence

during 1960s only. They also introduce additional variables like the share of agriculture and manufacturing in total output to control for the shocks to these sectors. These additional variables are considered to be proxies for the structural factors responsible for differing steady states. After adding these variables, the rate of conditional convergence is found to be 1.5 % per year. Similarly Bajpai and Sachs (1996) examine the convergence hypothesis between 1961 and 1993 which is further sub divided into three sub-periods. They report the unconditional convergence only for the sub-period 1961-71, which they suggest could be the result of high agricultural productivity in India during the 1960s because of the 'green revolution'. Nagaraj, Varoudakis and Veganzones (2000) have analyzed the same phenomenon by using the dynamic panel framework. They report the evidence of conditional convergence at high rates across Indian states and emphasized on the importance of differences prevailing in social, economic and physical infrastructure across various states of India.

So far as the case of Pakistan is concerned, we observe significant differences in the living standards of masses across different regions. As far as our information is concerned, no thorough study has been conducted on the issue in the context of growth and convergence. It would be therefore interesting to find if different socio-economic and political regions of Pakistan have experienced any kind of convergence overtime. The purpose of this study is to evaluate the evidence and to identify the nature of convergence across the regions of Pakistan; rather than to test a specific growth model or class of growth models that predict

convergence. In the next chapter, we will elaborate on various empirical specifications and methodologies that are used in our endeavour to test the hypotheses of convergence across Pakistan. In addition, we will highlight some econometric issues regarding estimation in the context of dynamic panel growth framework, the advantages and limitations of using panel data technique and how the prominent researchers have consistently estimate the dynamic growth models.

CHAPTER 3

THE FRAMEWORK FOR EMPIRICAL ANALYSIS

3.1 Background

Modern growth theory emerged as an extension of the Keynes General Theory (1936) that was primarily concerned with the short run analysis of the problems of the Great Depression of 1930's. Roy F. Harrod (1939) extended the Keynesian argument into a long-run effect or growth. Investment, according to Harrod, plays a dual role in the economy. In the short run, it increases aggregate demand as emphasized by Keynes and in the long run, it enhances and strengthens the productive capacity of the economy. He introduced the concept of a steady state equilibrium, which referred to an ideal situation where all the key variables like income, capital stock and labour force or employment grow at the same exponential rate. To be specific, he identified three crucial parameters namely the aggregate saving rate (s=S/Y), the capital output ratio (υ=K/Y) and the growth rate of labour or population (denoted by 'n') for a balanced growth of the economy. The growth rate of population or labour force is given by natural forces. These parameters should be related to one another in a specific way such that $s/\upsilon = n$, and this is called the condition for steady state equilibrium[1]. Later on, a similar result was derived by Evsey Domer (1946) while using an independent route.

[1] If the behavior of the households is expressed in terms of aggregate saving function: S = s.Y (where s=MPS) and that of the business sector by the relation: K = υ.Y (where υ=K/Y= ΔK/ΔY is the ICOR) and further assuming that $\Delta K = I_{(t)} = S_{(t)}$, then the interaction of the multiplier and accelerator leads to the growth rate of output given by: $\Delta Y/Y = s/\upsilon$, which is called the desired or warranted growth rate.

The steady state equilibrium as presented in the Harrod model is said to have suffered from two major problems, referred to as the existence and stability problems in growth literature. Most of the growth literature revolved around the solution of these problems during the later half of the 20th century. The economists working in the area emphasized that the problems, particularly that of instability, arise due to certain un-realistic assumptions inherent in the Harrod model. It was claimed that all the crucial parameters are determined exogenously (in the model but not in the real world) and therefore all the economic agents, like the households and the business people, are supposed to behave independent of one another. Thus the economy is likely to deviate from the steady state path in case of any slight variation in any of the parameters and that there seemed no intrinsic mechanism in the model to bring the economy back to equilibrium. The researchers argued that allowing flexibility in any one of the three parameters should resolve the issue of instability. The neoclassical economists, pioneered by Robert Solow (1956) suggested that the capital-labour ratio and thereby the capital-output ratio is flexible whereas the Keynesians, pioneered by Nicholas Kaldor (1962) and Passinetti (1962) proposed that the saving rate is flexible in the real life of business. However, the neoclassical model gained moss in the growth literature. The neoclassical model utilized the familiar flexible-coefficient production function, while keeping all other structures of the Harrodian model in tact and tried to resolve the issue. The capital-labour ratio should keep on adjusting according to the market forces until equilibrium is restored. The equation of motion[2] ultimately reduces to the Harrodian condition of the

[2] This led to the fundamental equation of motion given by dk/dt = s. f(k) – nk, where y = f (k)

steady state but with a difference - that capital-output ratio υ=k/y is now flexible and therefore the steady state condition can be ensured anyhow.

The neoclassical growth model could successfully explain as to why certain countries on the globe are so rich and others so poor. At equilibrium, the growth rates of per capita income (the prime indicator of the standard of living) and capital intensity are closely inter-related. Let the production function assumes the specific Cobb-Douglas form, with constant returns to scales and depicting all other neoclassical properties; the function may also be expressed in the reduced form, where the variables are in per capita terms:

$$Y_{(t)} = K^{\alpha}_{(t)} [A_{(t)} L^{(1-\alpha)}_{(t)}] \quad \Rightarrow \quad y_{(t)} = A_{(t)} k^{\alpha}_{(t)} \qquad (1)$$

Total output (Y), the capital stock (K) and labour force (L) are liable to change over time. Technical progress is represented by (A), which is exogenously given and growing with a certain exponential rate and which may be neutral or equally augmenting labour and capital. Next utilizing the equation of motion, we get the capital intensity to depend directly on saving rate and inversely on the growth rate of population at steady state. This in turn leads to the relationship of per capita income with the same variables/parameters:

$$k^{*}_{(t)} = \{s/n\}^{1/(1-\alpha)} \Rightarrow \quad y^{*}_{(t)} = A_{(t)} k^{\alpha}_{(t)} = A_{(t)} . \{s/n\}^{\alpha/(1-\alpha)} = A_{(t)} . \{1/\nu\}^{\alpha/(1-\alpha)} \qquad (2)$$

The growth rate of per capita income is straight forward as given by the following relation. Other features like depreciation of capital stock and the specific version of technology may be easily incorporated in the model:

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indicates the per capita income (Y/L) and 'k' represents the capital intensity (K/L). At equilibrium, the capital-labour stops further adjustment, leading to the equality s. f(k) = nk.

$$\ln y_t = \ln A_t + \{\alpha/(1-\alpha)\} \ln s - \{\alpha/(1-\alpha)\} \ln n \quad (3)$$

The important result implied by the neoclassical model or the message conveyed can be stated easily: other things remaining the same, countries with high investment and saving rates will grow faster and those with high population growth rates will lag behind in the race (of development and growth). This is the crux of the model.

However, the proponents of endogenous growth argued that the original neoclassical model suffered from two shortcomings. First, the model assumed technical progress as exogenous and failed to explain the residual component in growth accounting. Solow attributed this factor to the 'measure of our ignorance'. Given the P.F. in the general format: $Y_{(t)} = A_{(t)} \cdot f(K_{(t)}, L_{(t),})$, the aggregate growth rate can be expressed as the weighted sum of the growth rates of its arguments, where the weights are the partial output elasticities due to factors and 'g' is the rate of technical progress

$$\hat{Y} = g + \varepsilon_{y,k} \cdot \hat{K} + \varepsilon_{y,l} \cdot \hat{L} \quad (4)$$

Much of the research work during 1960-70's was directed towards specification and measurement of this residual factor, which comprised about 40-60% of the overall growth of output in the advanced countries. The controversy revolved around the question whether the technology could be considered as embodied or disembodied and whether it is exogenous or endogenous. Solow himself presented revised models and emphasized that technology is always embodied in the new capital equipment. Further research during the 1990's led to the introduction of endogenous growth

models that emphasized the role of human capital (through research) in development and growth. The pioneers in this area are Paul Romer (1989, 1990) and Robert Barro (1990, 1991).

Secondly, the model predicted convergence of economies to the steady state level overtime. It is argued that the growth rate of per capita income tends to be inversely related to the starting level of per capita income in the economy concerned. In other words, relatively poor economies are expected to grow quickly as compared to rich over time. However, the cross-country empirical evidence failed to support this prediction of catching-up. Rich economies that save more will grow faster indefinitely due to technological advancement. In fact and as emphasized by the endogenous growth models, there is no steady state level equilibrium since investment in human capital leads to increasing returns, where human capital is a public good[3]. Thus the growth rates of per capita incomes across economies are uncorrelated with the starting levels of per capita income[4]. Subsequent sections discuss the theory relevant to our empirical work.

[3] The ordinary production function with constant returns to scales: $Y=K^{a}L^{(1-a)}$, when augmented with human capital K^{B}, turns out to exhibit increasing returns to scales.

[4] Barro (1991) reports absence of unconditional convergence in a large sample of 98 countries and interprets this as supportive of the endogenous growth models such as Lucas (1988) and Rebelo (1991) that assume constant returns to a broad concept of reproducible capital, which includes human capital. In these models the growth rate of per capita product is independent of the starting level of per capita product. (p. 408)

3.2 **The Convergence Debate**

This chapter illustrates different concepts of convergence, the crucial differences and relationship among these and the neoclassical arguments for explaining regional growth. The neoclassical prediction of convergence is empirically tested by two different hypotheses. First is the hypothesis of beta (β) convergence, which predicts a negative relationship between growth rate of per capita income (or per worker income) and the initial level of income over a given period of time across different economies[5]. The concept of β-convergence can be further bifurcated into absolute (unconditional) and conditional convergence. The absolute convergence is interpreted as convergence of all economies to the same or common steady state level of income per capita[6]. This sort of convergence applies if poor economies tend to grow faster than rich ones, given that all of them have the same or similar steady state growth path and other socio-economic conditions. However, if the economies concerned have different structural characteristics (such as propensity to save, growth rate of population, level of technology and institutions etc), then they may not converge to the same steady states level. Conditional convergence is expected only after controlling for variables that determines the steady state level of income or output. In growth empiric terminology, there exists a conditional beta convergence if the coefficient of initial level of income (being the explanatory variable) bears a negative sign in

[5] This study uses the term economy to refer to any macroeconomic unit such as state, province, region, country, etc.

[6] For instance see Barro and Sala-i-Martin (1991)

the regression. In simple words, conditional convergence refers to a situation where different economies are converging overtime to their own steady state. In contrast, the absolute convergence implies that all economies (which differ only in the initial levels of income) are converging over time to a common steady state. Second is the hypothesis of sigma (σ) convergence. It deals with cross-sectional dispersion of per capita income across regions. This kind of convergence holds if the dispersion or variability of real per capita income across economies decreases with the passage of time.

The starting point for the analysis of convergence debate is the traditional neoclassical growth model due to Solow (1956), Swan (1956) and others, which pinpoints the key variable of the growth process and provides some testable predictions[7]. It is interesting to note that the basic neoclassical model does not predict absolute convergence of income per capita across economies[8]; rather it predicts that an individual economy will converge,

[7] Mankiw (1995) stated the predictions of Solow's model as under:

1. In the long run, the economy approaches a steady state that is independent of initial conditions.
2. The steady-state level of income depends on the rates of saving and population growth. The higher the rate of saving, the higher the steady state level of income per person. The higher the rate of population growth, the lower the steady-state level of income per person.
3. The steady-state rate of growth of income per person depends only on the rate of technological progress; it does not depend on the rates of saving and population growth.
4. In the steady-state, the capital grows at the same rate as income, so the capital-to-income ratio is constant.
5. In the steady-state, the marginal product of capital is constant, whereas the marginal product of labour grows at the rate of technological progress. (p.277)

sooner or later, to the steady state or equilibrium peculiar to the economy concerned, i.e. it predicts conditional convergence only. As discussed above, the economy can be described the usual production function with capital and labour inputs and supported by all the standard neoclassical assumptions. The steady state level of income is determined by the rate of saving, the rate of population growth and technology. The primary source of convergence, within the context of the said growth models, is the assumption of diminishing returns to reproducible capital. Diminishing returns to capital implies that the rate of return is negatively related to the stock of capital so that, other things being equal, economies with a low amount of capital are expected to grow faster. Along with diminishing returns to capital, another channel by which convergence can be explained is the diffusion of technology. The main idea behind this phenomenon is that followers tend to catch-up overtime with the technological leaders since imitation and implementation of discoveries is comparatively cheaper than innovations and discoveries itself and so the technical progress is rapid in the follower economies[9].

3.2.1 The Absolute Convergence

In this section, we discuss briefly a general regression equation that is used for testing absolute β-convergence on the basis of the neoclassical framework. Later in the next section, we will focus on the estimation of the structural convergence equation derived from formal model. In classical

[8] See Mankiw, Romer and Weil (1992)

[9] See Barro and Sala-i-Martin (2004)

literature, convergence is generally measured in the way as suggested by Barro and Sala-i-Martin (1991, 1992) gives the following equation[10].

$$\ln \hat{y}(t) = e^{-\beta t} \ln \hat{y}(0) + (1 - e^{-\beta t}) \ln \hat{y}^* \qquad (5)$$

In the above equation, lower case letters with a hat (^) represent quantities per unit of effective worker, Le^{gt}, and the asterisk subscript denotes steady state values[11]. The term 'e^{gt}' represents the effect of exogenous labor-augmenting technological progress and L is the labor force. $\hat{y}(t)$ is output or income per effective unit of worker, $\hat{y}(0)$ represents the initial value and $\hat{y}^*$ is the steady state level such that $\hat{y}(t)$ converges to equilibrium value ($\hat{y}^*$) in the limit as t $\rightarrow\infty$. The parameter β represents the rate of convergence or the speed of adjustment to the steady state which is determined by technology and preferences. Rewriting some of the variables in equation (5) and rearranging the terms, we get an expression for the average growth rate of per worker output or income over any given interval between t-r and t as[12]

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[10] Log linearization of the differential equation of the standard closed economy Ramsey model with labour augmenting technical progress around the steady state gives equation (5); see for example Barro and Sala-i-Martin (2004), Chapter 2.

[11] Steady state refers to a situation where the capital stock, per capita output and consumption grow at the same constant rate of technical progress. Once at the steady state, the economy grows at the constant rate including the zero rate of growth.

[12] We may rewrite the variables in per capita units since income expressed in efficiency units is not directly observable. As the income per effective worker is denoted by $\hat{y} = Y/Le^{gt}$, taking the logarithm, we get: $\ln \hat{y} = \ln (Y/L) - gt = \ln y - gt$. For any given point in time (t-r and t), the equation(5) can also be written as

$$\ln \hat{y}(t) - \ln \hat{y}(t-r) = -(1-e^{-\beta r}) \ln \hat{y}(t-r) + (1-e^{-\beta r}) \ln \hat{y}^*$$

$$\Rightarrow \ln [y(t)/y(t-r)] = gr + (1-e^{-\beta r}) \ln [\hat{y}^*/\hat{y}(t-r)]$$

Now, dividing the above expression through 'r' yields equation (6).

$$r^{-1} \ln [y(t) / y(t-r)] = g + r^{-1}(1 - e^{-\beta r}) \ln [\hat{y}^* / \hat{y}(t-r)] \qquad (6)$$

Where 'r' is the length of the observation interval i.e. [t–(t-r)] = r. Given g and $\hat{y}^*$, the average per capita income growth rate is inversely related to the initial level of per capita income 'y(t-r)' i.e. there is conditional β-convergence. This means that it is affected by the level of per capita income of each economy relative to its own steady state ($\hat{y}^*$) and the steady state growth rate (g) which may differ across economies. Thus for given values of g and $\hat{y}^*$, the per capita income growth rate would be higher, the lower the initial level of per capita income. Therefore, in order to determine absolute β-convergence (i.e. convergence to the same steady state income), it is necessary to hold constant the differences in steady state values across economies. One approach to control for the differences in steady states is to restrict the analysis to those economies for which the assumption of common steady state is feasible (Sala-i-Martin, 1996). In other words, unconditional convergence may be expected where it is not unrealistic to believe that the economies concerned differ only slightly in preferences of economic agents, technological and institutional set up. In case there are significant differences in technologies, tastes and institutional framework beside the initial (starting) level of per capita income, then unconditional or absolute convergence is not likely to hold.

We may consider a discrete period version of equation (8) with a one period time interval (r=1) that applies to economy i and includes the disturbance term to derive the statistical model,

$$\ln [y_{i,t} / y_{i,t-1}] = \alpha_i - (1 - e^{-\beta}) [\ln\ y_{i,t-1} - g_i(t-1)] + u_{i,t} \qquad (7)$$

Where 'i' indexes the economy or region and $\alpha_i = g_i + (1- e^{-\beta}) \ln \hat{y}_i^*$. The assumption for absolute convergence that all economies under consideration are equal with respect to technology and preferences implies that β is same across economies. The statistical model that is used for testing absolute β-convergence is implied by equation (6) and (7). The average growth rate of per worker income for the region i between two points of time (t-r and t), is given by:

$$(1/r) \ln [y_{i,t} / y_{i,t-r}] = C_i - (1 - e^{-\beta r}) (1/r)[\ln\ y_{i,t-r}] + \varepsilon_{i,t} \qquad (8)$$

In the above relation $C_i = g_i + (1- e^{-\beta r})/r [(\ln \hat{y}_i^* + g_i(t-r)]$. The intercept term ($C_i = C$) is assumed to be common or same across different regions for the test of unconditional convergence. If all economies under consideration have the same steady state levels and growth rates (i.e. $\hat{y}_i^* = \hat{y}^*$ and $g_i = g$), then C_i would equal C and equation (7) would imply absolute convergence. The slope parameter is important for the analysis concerned and captures the convergence co-efficient 'β' imply the speed at which economies are approaching to a common or same steady state level of income. The random error term ($\varepsilon_{i,t,}$) has the usual properties, i.e. independently distributed with zero mean and constant variance. Now, under the said assumptions, the equation (8) can be estimated for absolute convergence where $y_{i,t}$ is the level of per worker income in the region concerned at time t and $y_{i,t-r}$ is the level of per worker income at the beginning of the interval.

A positive value of the coefficient ($\beta>0$) implies that the economies with comparatively lower initial income per worker will catch up overtime with the rich economies, in other words they will experience beta convergence. Since the source of convergence in these models is the assumed diminishing returns to capital, the economies with lower values of capital intensity at the beginning will have higher marginal products of capital and therefore, they will tend to grow at higher rates. If the ratio of capital to effective labour rises, the marginal productivity of capital decreases. If the economies differ only in the initial levels of capital, then the model predicts that poor economies, with relatively low capital intensity at the beginning, will grow faster than rich economies having larger initial capital stock. In the steady state, all the economies will have the same level of per capita income (Sala-i-Martin, 1996). Absolute convergence across economies will occur if different economies have the same steady state level and growth path. With a common steady state the initially poor economies with relatively low level of capital are far away from their steady state. Thus for a given population growth rate, the level of technology, the saving behaviour and other attributes that determine the steady state, the greater is the gap between its initial per capita income level and steady state level, the faster it will grow.

3.2.2 The Conditional Convergence

The assumption that different economies/regions are similar in characteristics other than is very strong. In fact, there are significant differences in socio-economic attributes across the real world economies and therefore, one can expect only the conditional convergence which is predicted by the neoclassical model. In other words, economies are converging towards their

own steady state and not to a common steady state level (Mankiw, Romer, and Weil 1992). The case where differences in technologies and tastes across economies are significant and cannot be ignored, it is necessary to introduce a number of conditioning variables to control for differences in steady state when estimating dynamic growth regression[13]. Again, a positive value of β in equation (8), when it is estimated after introducing the requisite modifications, implies that there is conditional convergence i.e. in the long run each economy is converging towards its own steady state level at a speed given by the parameter of convergence.

In cross-sectional analysis for absolute convergence, the intercept in equation (8) is assumed to be identical across all economies. This common intercept constrains all the economies to have the same steady state level of per capita income and therefore implies similarity in structural parameters across regions This is a highly restrictive assumption that may induce heterogeneity bias in the estimators if the differences in structural parameters (preferences, technical progress, saving behaviour, population growth, human and physical capital, natural endowments and institutions etc.) are significant. Therefore, only the initial level of per capita income/output might not be sufficient to explain differences in the growth rates of the economies concerned. As economies can have different steady state level of income, introduction of additional (conditional) variables is needed to account for the differences stated above. Generally, such conditioning variables include proxies for accumulation of human capital (schooling, as used by Mankiw, et al -1992)

[13] Conditional variables are the variables used besides the initial level of income per worker in convergence analysis in order to control for the differences in steady state.

and physical capital, variables that affect the population growth rates, differences in industrial structure and certain dummies to control for other differences across the economies. Another variable of interest used in the models of convergence is the net migration rate of labour.

A more general model used for empirical analysis of conditional convergence is an equation of the form

$$g_{i,t} = \delta\, x_{i,t} - \beta\, y_{i,t-1} + \varepsilon_{i,t} \qquad (9)$$

In the above relation, $y_{i,t-1}$ is the initial level of real income per capita of economy i, $g_{i,t}$ is the growth rate of real income per capita over the period, $\varepsilon_{i,t}$ is the usual random variable and $x_{i,t}$ is the variable/ set of conditioning variables that are used to control for the differences in the steady state of economy. The general specification in equation (11) allows us to control for variables which might influence the steady state level of income other than the variables included explicitly in the standard neoclassical growth model due to Solow (1956). The saving rate and population growth are the two conditional variables included in convergence regression of Solow growth model. However, most empirical studies are based on the informal specification such as equation (11) and include many other socio economic variables[14]. One of the limitations of informal specification for conditional convergence is that no information regarding the values of structural parameter could be obtained since it is based on reduced form equation. In contrast, in formal model based specification one can estimates the structural parameters of the model under consideration.

[14] The researchers have used up to 50 different conditioning variables in convergence analysis following Barro (1991).

3.3 **Convergence Analysis – A Formal Specification**

In earlier studies, the conditional β-convergence was not formally derived from theoretical models. Many empirical studies on growth and convergence have used specifications similar to equation (11). However, researchers have increased their focus on the estimation of 'structural' convergence equations derived explicitly from formal models. Barro and Sala-i-Martin (1992) and Mankiw, Romer, and Weil (MRW, 1992) presents the formal, model-based specification of convergence regressions derived from the neoclassical growth models [15]. The specification derived by MRW (1992) is based on the assumption that the rate of technical progress is exogenous and common to all economies and the fundamental assumption of diminishing returns to reproducible capital that generates convergence. We reproduce the basic steps to introduce the notations and basic concepts of the augmented neoclassical growth model, the details can be seen in the literature[16]. The production function is slightly modified so as to capture the impact of human capital accumulation. As usual, it may also be written in the following form:

$$Y_t = f(K_t, H_t, A_t L_t) \qquad (10)$$

The production function is well behaved in the sense that it exhibits all the familiar neoclassical assumptions like constant returns to scales and diminishing marginal returns to individual factors. The symbols bear their usual meanings except that the symbol 'H' represents the stocks of human

[15] Barro and Sala-i-Martin (1992) use the Cass-Koopmans' optimal savings version of the neoclassical growth model and Mankiw, Romer, and Weil (1992) derive the formal regression specification from Solow-Swan model.

[16] See for example, Barro and Sala-i-Martin (2004), and Mankiw (1995)

capital. The labour force (measured in physical units) is assumed to be growing at constant rate (n) whereas the technical progress (which is labour-augmenting) is growing at constant exponential rate (g)[17]. Thus AL denotes labour measured in efficiency units, thereby growing at the composite rate (n+g). Defining $\hat{y} = Y/AL$, $\hat{k} = K/AL$ and $\hat{h} = H/AL$ as quantities per effective unit of worker. Given the aggregate saving function (S = s Y), the model assumes that the fraction of income invested in physical and human capital is represented by the given proportions s_k and s_h respectively, such that $s_k + s_h = s$. The rate of depreciation is denoted by δ. With these manipulations, the accumulation of physical and human capital or the familiar equations of motion are given as under.

$$\frac{d\hat{k}_t}{dt} = s_k \hat{y}_t - (n+g+\delta)\hat{k}_t \quad and \quad \frac{d\hat{h}_t}{dt} = s_h \hat{y}_t - (n+g+\delta)\hat{h}_t \qquad (11, 12)$$

The production function may assume a Cobb-Douglas specification as under, where the coefficients α and β measure the partial output elasticities with respect to factor inputs:

$$Y_t = K_t^{\alpha} H_t^{\beta} (A_t L_t)^{1-\alpha-\beta} \quad \Rightarrow \quad \hat{y}_t = \hat{k}_t^{\alpha} \hat{h}_t^{\beta} \qquad (13)$$

Now equations (11, 12) becomes

$$\frac{d\hat{k}_t}{dt} = s_k \hat{k}_t^{\alpha} \hat{h}_t^{\beta} - (n+g+\delta)\hat{k}_t \quad and \quad \frac{d\hat{h}_t}{dt} = s_h \hat{k}_t^{\alpha} \hat{h}_t^{\beta} - (n+g+\delta)\hat{h}_t \qquad (11', 12')$$

The assumption of diminishing returns implies that the economy will reach the steady state values overtime. The steady state equilibrium is assumed to

[17] Labour and technology are assumed to grow according to the functions: $L_t = L_0 e^{nt}$ and $A_t = A_0 e^{gt}$.

occur in the long run where the levels of physical and human capital per effective worker are constant as steady state refers to a situation in which various quantities grow at constant rate. Thus the further change in the stock of physical and human capital ceases or the time derivatives ($d\hat{k}/dt$ and $d\hat{h}/dt$) are zero at equilibrium. Hence the left hand sides of both equations (11′ and 12′) are equal to zero. Solving the resultant equations at equilibrium, one gets the steady state values as[18]

$$\hat{k}^* = \left(\frac{s_k^{1-\beta} s_h^{\beta}}{n+g+\delta} \right)^{\frac{1}{1-\alpha-\beta}} \quad and \quad \hat{h}^* = \left(\frac{s_k^{\alpha} s_h^{1-\alpha}}{n+g+\delta} \right)^{\frac{1}{1-\alpha-\beta}} \qquad (14, 15)$$

If all the parameters in equations (14,15) like saving rates, population growth rates and rates of technical progress etc. are similar for the any two economies (i and j), then the steady state values will be the same, i.e. $\hat{k}_i^* = \hat{k}_j^*, \quad \hat{h}_i^* = \hat{h}_j^* \quad and \quad thus \quad \hat{y}_i^* = \hat{y}_j^*$; in other words they will converge to the same equilibrium overtime. This provides the essence of convergence in the neoclassical growth model. Note that these final values grow at constant rate (including the zero rates). However, before reaching the steady state, the economies may grow at different rates. If the actual values of k and h (and y) for a particular economy are comparatively far from the steady state values k* and h* (and y*), the economy concerned will grow faster; an effect that can be

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[18] As stated above, in the steady state

$s_k \hat{k}_t^{\alpha} \hat{h}_t^{\beta} - (n+g+\delta)\hat{k}_t = 0 \quad and \quad s_h \hat{k}_t^{\alpha} \hat{h}_t^{\beta} - (n+g+\delta)\hat{h}_t = 0$

Taking logarithms and rearranging terms we have the log-linear values

$(\alpha-1)\ln\hat{k} + \beta \ln\hat{h} = \ln(n+g+\delta) - \ln s_k \quad and \quad \alpha \ln\hat{k} + (\beta-1)\ln\hat{h} = \ln(n+g+\delta) - \ln s_h$

Simultaneously solving for $\ln\hat{k}$, $\ln\hat{h}$ and then reverting to $\hat{k}$ and $\hat{h}$, we get the above equilibrium values of $\hat{k}^*$ and $\hat{h}^*$.

rationalized on the basis of diminishing marginal returns characteristic. Since the economies with lower initial values of capital have high marginal products of capital, they tend to grow faster.

3.3.1 Conditional versus Unconditional convergence

The distinction between conditional and unconditional (absolute) convergence is very important and useful as it effects the interpretation and implications of convergence. To explain the distinction, we substitute equation (14 and 15) into the production function and taking natural logs to get the steady state level (16).

$$\ln y^* = \ln[Y_t/L_t] = \ln A_{(0)} + gt + (\tfrac{\alpha}{1-\alpha-\beta})\ln s_k + (\tfrac{\beta}{1-\alpha-\beta})\ln s_h - (\tfrac{\alpha+\beta}{1-\alpha-\beta})\ln(n+g+\delta)$$

The above equation (16) clearly shows that the steady state income per worker of a region or economy depends on the elements: A, s_k, s_h, n, g, δ, α and β. Unconditional convergence implies that all these elements (determinants of steady state) are same for all economies under consideration. Therefore no other variables are included on the right hand side except initial level of per worker income in the absolute convergence regression. On the other hand, the concept of conditional convergence emphasizes possible differences in the steady state. Hence, appropriate variables are required to be included on the right hand side of convergence regression equation in order to control for these differences. Now this is an important issue in the growth literature as to which of the different elements should be allowed to vary and how, and which should assumed constant across economies; since this consideration does affect the results and interpretation of convergence. For instance, the panel data framework make it

possible to allow the initial level of technology to vary across regions/economies by treating '$A_{(0)}$' as the region specific effect while the cross section regression specification for convergence analysis may not be able to control for level of technology so one has to assume same level of technology across economies.

One can conclude from the equation (16) that the steady state level of income may differ across regions because of different rates of population growth, physical and human capital accumulation and technology in different economies. For conditional convergence analysis, the conditional variable that we used in the present study to account for differences in the steady state are per worker savings, working age population growth rate and human capital. Moreover, we will use the dynamic panel growth framework which allows difference in initial technology '$A_{(0)}$' across different economies in the form of unobserved region specific effect of each economy. This formulation will be explained in this chapter.

3.3.2 Specification for Conditional Convergence

Conditional convergence means that the growth rate of an economy is positively related to the distance between its current level of income and its own steady state. To examine dynamics of regional economies along transition to their steady states, the speed of conditional convergence can be expressed as[19]

$$d\ln\hat{y}_t / dt = \lambda\,[\ln\hat{y}^* - \ln\hat{y}_t] \qquad (17)$$

[19] See Mankiw, Romer and Weil (1992).

Where $\lambda = (1-\alpha-\beta)(n+g+\delta)$. The parameter '$\lambda$' shows how fast the income per effective worker reaches its steady state; in other words, 'λ' indicates the speed with which the gap between the steady state and current level of income is narrowed down. Equation (19) shows that for $\lambda > 0$, the growth rate of income per worker is decreasing in $\hat{y}$ for given $\hat{y}^*$ and rising in $\hat{y}^*$ for given $\hat{y}$. In other words, for given level of per worker income an increase in steady state level raises the per worker growth rate while for given steady state, a higher starting level of per worker income gives a lower growth rate of income per worker. One can get an expression for convergence regression by integrating equation (17) from period $t-\tau$ to period t or solving this differential equation:

$$\ln \hat{y}_t = e^{-\lambda\tau}[\ln \hat{y}_{t-\tau}] + (1 - e^{-\lambda\tau})[\ln \hat{y}^*] \qquad (18)$$

In this relation, $\hat{y}_{t-\tau}$ is the initial value of income per effective worker and $\tau = [t-(t-\tau)]$. Substituting for $\ln \hat{y}^*$ from equation (16), we get:

$$\begin{aligned} \ln \hat{y}_t &= e^{-\lambda\tau}(\ln \hat{y}_{t-\tau}) + (1 - e^{-\lambda\tau})\left(\tfrac{\alpha}{1-\alpha-\beta}\right)\ln s_k \\ &+ (1 - e^{-\lambda\tau})\left(\tfrac{\beta}{1-\alpha-\beta}\right)\ln s_h - (1 - e^{-\lambda\tau})\left(\tfrac{\alpha+\beta}{1-\alpha-\beta}\right)\ln(n+g+\delta) \end{aligned} \qquad (19)$$

We need an expression in terms of income per worker rather than income per effective worker for the purpose of estimation. Therefore, we reformulate equation (19) by rewriting variables in terms of income per worker. Finally, rearranging the terms provides us with an expression of per worker income growth as the left hand variable:

$$\ln y_t - \ln y_{t-\tau} = -(1-e^{-\lambda\tau})\ln y_{t-\tau} + (1-e^{-\lambda\tau})(\tfrac{\alpha}{1-\alpha-\beta})\ln s_k$$
$$+(1-e^{-\lambda\tau})(\tfrac{\beta}{1-\alpha-\beta})\ln s_h - (1-e^{-\lambda\tau})(\tfrac{\alpha+\beta}{1-\alpha-\beta})\ln(n+g+\delta) \qquad (20)$$
$$+[(1-e^{-\lambda\tau})gt + e^{-\lambda\tau}g\tau] + (1-e^{-\lambda\tau})\ln A_0$$

The above equation (20) provides a useful specification for our empirical study. This equation shows that the growth rate of income also depends on the initial level of income besides other determinants of steady state. Therefore, it describes the effects of physical and human capital, population growth as well as initial level of per worker income on the growth process. If speed of convergence 'λ' is positive, α >0, β>0 and α+β < 1 as assumed by the model, the signs of the coefficients in equation (21) can be predicted.

The first coefficient indicates that the growth rate of income is negatively related to the initial level of per worker output if other determinants of the steady state are held constant. This implies that a regional economy will grow faster if it is far below the steady state level. The second and third coefficients indicate, the growth rate of income per worker is positively related to both physical and human capital. This means that the more an economy saves and invests in physical and human capital, the faster it grows. The fourth coefficient indicates that for given values of technical progress (g) and depreciate rate (δ), the rate of income growth is negatively related to the growth of labour force. The fourth term represents the presence of time specific effect on growth. The last term contains A_0 which represents all the unobserved elements that determine the efficiency with which factors of production and the available technology are used to produce output, the greater is such efficiency, the higher the growth rate of economy. These

factors include resource endowment, economic structures, institutions, climates and so on. These factors are likely to differ across regional economies. Therefore last term suggests the presence of unobserved individual region-specific effect, which may be correlated with the other explanatory variables considered in the model. So this term should be controlled for before estimating the growth regression equation. Equation (21) predicts not only the sign of each coefficient but also the size or magnitude. In particular, the sum of coefficients associated with ln s_k , ln s_h and to ln $(n+g+\delta)$ equals zero.

We intend to investigate the hypothesis of conditional convergence not only by using the augmented neoclassical model as given above but also by using the basic neoclassical growth model that ignores human capital as a factor of production. Equation (20) is much simplified if the factor of human capital is eliminated. We rewrite equation (20) without human capital i.e. it represents the textbook version of the Solow model where the determinants of growth include the technological level and the observable variables like saving rates, initial level of income per worker and population growth rates.

$$\ln y_t - \ln y_{t-\tau} = -(1-e^{-\lambda\tau})\ln y_{t-\tau} + (1-e^{-\lambda\tau})(\tfrac{\alpha}{1-\alpha})\ln s$$
$$-(1-e^{-\lambda\tau})(\tfrac{\alpha}{1-\alpha})\ln(n+g+\delta) + [(1-e^{-\lambda\tau})gt + e^{-\lambda\tau}g\tau] + (1-e^{-\lambda\tau})\ln A_0 \qquad (21)$$

The speed of convergence to the steady state is given by the parameter 'λ'. The model predicts that a high saving rates affects growth positively whereas a high population growth rate affects growth of output per worker negatively. As such, the growth of income per worker is higher in regional economies with lower growth rate of population and higher savings or investment rates. The

model predicts not only the sign of each coefficient but also the magnitude. Equation (22) indicates that the coefficients associated with ln (s) and ln (n+g+δ) are equal in magnitude but opposite in sign. Hence, the sum of both coefficients is equal to zero.

3.4 Regional Convergence Analysis

The above specifications have not only been used to identify convergence in the cross-country samples but also for different regions within a country. The methodology and tools of analysis developed originally for the analysis of international convergence have also been applied in regional studies. However, there are some theoretical issues with this approach. The models are based on the assumption of closed economy in the sense that the flow of both labour and capital across borders is physically constrained. Obviously this particular assumption is difficult to be justified when one deals with different regions within a country. On the other hand, if one assumes unconstrained capital flows across regions as in the case of an open economy model with perfect capital mobility, then the model predicts infinite speed of convergence, which is never observed in reality (see Barro and Sala-i-Martin, 2004). However, Barro, Mankiw, and Sala-i-Martin (1995) have shown that in the presence of imperfections in capital market, the aggregate income shows behaviour very similar to that predicted by a closed economy model. Therefore, the speed of convergence will not be infinite but only slightly higher than that observed in the closed economy models. The greater is the mobility of capital, faster is the rate of convergence. Hence the speed of convergence towards the steady state predicted by open economy version of the

neoclassical growth model is faster than in the case of closed economy version of the model.

The mobility of factors of production across regions (but within a country) accelerates the working of the market mechanism and promotes the equilibrating tendencies towards convergence because of the very characteristics of decreasing returns to factors (K and L). Factor mobility may include the flow of technology and know how besides physical transfer of labour and capital. Empirical research shows that the probability of convergence is higher when regional economies have open trade and factor mobility. In other words, a free movement of capital and labour along with unconstrained diffusion of technology are the key factors for convergence in both inter-regional and inter-national economies. Examples of the empirical literature on regional growth who examine convergence across different regions within a country are given in literature review. In such studies, it is conventional to argue that conditional convergence may be approximated by absolute convergence with the assumption of a common steady state across regions within a country. Barro and Sala-i-Martin (2004) argue that differences with respect to preferences, culture and technology across regions within a country are smaller than across the countries and there also exists a common central authority and similar institutional arrangements such that there are no barriers to the flow of capital or labour across regions. Thus we can safely assume that all regions have similar level of real per worker income in the steady state. This homogeneity implies that absolute (unconditional) convergence is expected more across regions within a country than across different countries/nations.

However, it is questionable whether the assumption that all regions share a common or same steady state level of per worker income can be applied to different regions of Pakistan because significant natural, social and historical differences among them makes it less likely that they would tend towards same steady state. This diversity can be seen in number of indicators including literacy rate, rate of saving, population density, life expectancy, economic infrastructure, degree of urbanization, the rule of law, social and family structure. Furthermore, these disparities have been increasing over time. In this context, regional convergence analysis for the country is a question of particular interest.

3.5 **Sigma (σ) Convergence**

The sigma (σ) shows the dispersion of real per capita income across a group of regions over time. Therefore, if the dispersion (measured by the variance or standard deviation) of income per capita decreases over time, there exists sigma convergence among the economies. The presence of sigma convergence suggests a tendency to equalization of per capita income levels across economies or regions. If σ^2_{yt} is defined as the cross economy variance of per capita income at time t, then the dynamic equation for per capita income dispersion can be written as follows (Barro and Sala-i-Martin, 2004):

$$\sigma^2_{y,t} = e^{-2\beta}\ \sigma^2_{y,t-1} + \sigma^2_{\mu,t} \qquad (22)$$

In case the term $\sigma^2_{\mu t}$ remains constant over time, the steady state solution to this first order difference equation is given by:

$$\sigma^2_{y,t} = \sigma^2_{\mu} /(1-e^{-2\beta}) + [\sigma^2_0 - \sigma^2_{\mu} /(1-e^{-2\beta})]\, e^{-2\beta t} \qquad (23)$$

Where σ^2_0 is the variance of per capita income at the initial point. Dispersion in the levels of income across regions may fluctuate over time depending on whether the initial dispersion is below or above the steady dispersion σ^2_y. As $t \rightarrow \infty$, the income approaches the steady level or equilibrium. The value of dispersion at the steady state is given by:

$$\sigma^2_y = \sigma^2{}_{\mu} /(1-e^{-2\beta}) \qquad (24)$$

The steady state dispersion increases with the variance of shocks '$\sigma^2_{\mu t}$' and decreases with the speed of convergence co-efficient 'β'. Thus the dispersion may rise over time if the initial dispersion 'σ^2_0' is below the steady state dispersion even though β may be greater than zero. Both Barro and Sala-i-Martin (1992) and Sala-i-Martin (1996) derive the relationship between sigma (σ) convergence and beta (β) convergence. It is shown that beta convergence is a necessary but not sufficient condition for sigma convergence. This relationship shows that an empirical finding of increasing dispersion or variability is not incompatible with beta convergence. Other things remaining same, beta convergence may lead to sigma convergence. However, if other things are not equal because of structural disturbances among regions, then beta convergence does not imply a reduction in the dispersion of income across regions. Hence, conditional convergence, as implied by the neoclassical model, is compatible with increase in income dispersion (i.e. σ-divergence).

Quah (1993) and Friedman (1992) both favour sigma convergence as it concerns directly with the distribution of income across regions or economies. The concept of sigma convergence does not relate directly to the growth rate of economies; rather it focuses on the dispersion of per capita/per worker income across economies at each point of time. Hence, sigma convergence measures the inter-regional inequality of income at a given point of time.

3.6 **Econometric Issues**

Income convergence may be the result of three different mechanisms, convergence due to capital accumulation, convergence due to technological diffusion and convergence due to both. The steady state income level given by equation (16) shows the presence of technology parameters ($A_{(0)}$ & g) alongside the parameters governing the capital accumulation process. It is therefore necessary to take account of both these processes while testing for income convergence. However, it is difficult in the cross-section approach since the researcher has to rely on the assumption of same or identical technologies across economies or that production structures are similar. Although Mankiw et.al, (1992) recognize the importance of $A_{(0)}$ term, however it is included in the error term under the assumption that it is not correlated with other explanatory variables like savings and population growth rate. This is very strong assumption that may not be easily supported. The parameter concerned that represents the technology level at the beginning or "the efficiency with which inputs are transformed into output" cannot be stay independent of explanatory variables relevant to growth process. Therefore, it is difficult to argue that $A_{(0)}$ is uncorrelated with explanatory variable used in convergence regression equation. In cross section regression, it is included in

error term because it is difficult to observe efficiency function and there are no good measures of $A_{(0)}$. The failure of the cross-sectional approach to convergence analysis to control for the unobservable factors thereby leads to the omitted variable bias.

Another econometric issue of conditional convergence analysis concerns with the problem of endogeneity bias i.e. some of the explanatory variables appearing at the right hand of equation (20) like saving/ investment might be endogenous to the model. The output and investment etc in a particular period are likely to be jointly determined and this causes the possibility of endogeneity bias in growth regressions.

Therefore, the cross section regression model for conditional convergence analysis may not be appropriate as it suffers from the problem of omitted variable and endogeneity bias. The estimate of speed of convergence may be biased and inconsistence as a result of these problems. Moreover, reducing the time series to a single cross section means that not all the available information is being used. The panel data framework can overcome these problems to some extent. By combining the cross section and time series data, the panel framework gives a natural and efficient way to control for the error term and to take account of unobservable factors. Moreover, the panel technique increases the sample size and thereby the degrees of freedom, which is particularly useful in the present study as we have only four cross sectional units. Now, we focus attention on the dynamic panel data framework.

3.7 **The Dynamic Panel Framework**

The interpretation of equation (20) suggests a natural specification for the dynamic panel growth framework. As discussed above, the panel data approach can correct the omitted variable bias by allowing for the technological differences across different regions in the form individual region specific effects. Islam (1995) reformulated the neoclassical growth model by using a dynamic panel framework and interpreting the term: $(1-e^{-\lambda\tau})\ln A_{(0)}$ as the time-invariant region-specific effect. Using the notation of panel data approach, we can rewrite equation (20) for a given region i:

$$y_{i,t} = \gamma\ y_{i,t-1} + \sum_{j=1}^{3} \theta_j\ x_{i,t}^{j} + V_t + \mu_i + \varepsilon_{i,t} \qquad (25)$$

$$where\ y_{i,t} = \ln y_t,\ y_{i,t-1} = \ln y_{t-\tau}, \gamma = e^{-\lambda\tau}, \theta_1 = (1-e^{-\lambda\tau})(\tfrac{\alpha}{1-\alpha-\beta}),$$
$$\theta_2 = (1-e^{-\lambda\tau})(\tfrac{\beta}{1-\alpha-\beta}), \theta_3 = -(1-e^{-\lambda\tau})(\tfrac{\alpha+\beta}{1-\alpha-\beta}), x_{i,t}^{1} = \ln s_k, x_{i,t}^{2} = \ln s_h,$$
$$x_{i,t}^{3} = \ln(n+g+\delta), V_t = [(1-e^{-\lambda\tau})gt + e^{-\lambda\tau} g\tau], \mu_i = (1-e^{-\lambda\tau})\ln A_0.$$

The above modified equation (25) shows that it equivalent to estimating a dynamic equation with lagged dependent variable on the right hand side. Here 'y' denotes real per worker income and 't' stands for the time period. The set of conditioning variables denoted by $x_{i,t}$ capture the differences in the steady states. The 'v_t' term signifies the time specific effects, which includes the rate of technological change assumed to remain constant across the regions. The next term 'μ_i' is region-specific factor that represents the combined effect of institutions, resource endowment, location, climate and customs together with the initial level of technology. This time invariant component varies across regions and it will pick up the effect of any omitted variable that does not vary over time in a panel. Finally, 'τ' is the time interval of four/five year period and

'ε_{it}' represents the usual error term that varies across regions and time period and has mean equal zero.

3.7.1 Panel Estimation of the Convergence Model

The modified equation (25) indicates that the region-specific effects (μ_i) capture the term $A_{(0)}$. One issue that arises while using the panel data framework is whether the individual region-specific effect is considered to be fixed or random. Thus, there are different ways to model and deal with μ_i. However, within the growth framework, $A_{(0)}$ is often correlated with other explanatory variable (s_k,s_h, and n) as mentioned earlier. This implies that the random effect specification of μ_i is not appropriate since it assumes that the individual specific effects are uncorrelated with explanatory variables included in the model while the fixed effect formulation does not rely on this assumption. Therefore, the fixed effect specification may be an appropriate choice. The dynamic panel growth model with fixed effect allows us to control for the unobserved differences among the steady states of regions in addition to the observed differences, the later captured by the set of conditioning variables.

Researchers have to deal with several other econometric issues while utilizing the panel data framework. As discussed above, one of the issues concerns with endogeneity bias. Whereas the fixed effect specification of μ_i successfully handles the problem of omitted variable bias, it fails to account for the other i.e. the endogeneity of the explanatory variables. Caselli, Esquivel and Lefort (1996) point out this issue and try to solve both the problems (endogeneity and omitted variable bias) simultaneously by estimating the model via the first

difference GMM procedure as suggested by Arellano and Bond (1991). Most of the studies that used panel data framework have found the high rates of conditional convergence (Goddard and Wilson, 2001).

3.7.2 Estimation Issues

One of the important issues discussed in recent empirical growth studies is how to estimate consistently the parameters of convergence growth regression. As discussed above, the empirical work based on single cross-section regression can suffer from two inconsistencies, i.e. omitted variable bias and endogeneity bias. First, the omitted variable bias may arise when region-specific effects, which represent differences in technology and other unobservable factors, are assumed to be virtually uncorrelated with the other explanatory variables. Caselli, et.al. (1996) show that this assumption is violated due to the dynamic nature of convergence regression. Second, there is strong theoretical basis for a number of explanatory variables to be endogenous and a failure to control for endogeneity will lead to bias the results[20]. Since the single cross-section convergence regression suffers from these problems, Islam (1995) has used a fixed effect specification (least square dummy variable estimation technique) to estimate the panel data model so as to address the limitation and problems of cross-section approach. However, simply pooling of the cross section and time series data and using the least square (OLS) model does not take care of both the problems. Caselli, et.al. (1996) has suggested to use the first difference GMM approach to deal successfully with both the issues.

[20] For details, see Caselli, Esquivel and Lefort (1996) and Durlauf and Quah (1999).

The above discussion highlights that three panel data estimators are commonly used in the literature i.e. the simple pooled least square, the fixed effect or within groups estimator and the first difference GMM estimator[21]. Durlauf, Johnson, and Temple (2004) point out that omitted unobserved region-specific effects in dynamic panel model cause the least square estimators to be biased and inconsistent. The lagged dependent variable '$y_{i,t-1}$' is positively correlated with region-specific effect 'μ_i', and therefore, the least squares estimate of the lagged dependent variable in growth/convergence regression is likely to be biased upward. The fixed effect or within groups estimator, which takes into account the unobserved region-specific effects, also provides biased and inconsistent estimates. This is due the fact that the lagged dependent variable '$y_{i,t-1}$' is correlated with the mean of individual errors. In contrast to OLS, the within groups estimate of the coefficient of the lagged variable is likely to be biased downward. As suggested by Bond, Hoeffler and Temple (2001) and Durlauf, Johnson, and Temple (2004), the least square estimate can be regarded as the (approximate) upper bound on this coefficient and the estimate obtained from within groups can be regarded as the (approximate) lower bound. Therefore, a consistent estimate should lie between the two bounds. In the present study, we intend to apply and compare these three estimation techniques so as to find consistent estimates for conditional convergence as far as possible.

[21] The within groups estimator takes deviations from the individual means to control for μ_i. The first difference GMM procedure eliminates μ_i by first differencing and then using the lagged values of $y_{i,t}$ and of $x_{i,t}$ as instruments to address both the issues. Arellano and Bond (1991) use Sargan statistics to test the validity of instruments used in the first difference GMM approach.

CHAPTER 4

DATA DESCRIPTION

4.1 Introduction

The availability of reliable, appropriate and disaggregated data set is crucial for empirical research. The availability of data pose constraints to test various economic models and its quality affects the results. For the purpose of economic growth and convergence analysis, one needs long series of disaggregated data at least over twenty to thirty years. In order to test the hypothesis of income convergence across different regions of Pakistan over time, the appropriate economic unit would be district, or even tehsil/ta'luqa. However, so far as our information is concerned, the requisite published data sets at district level in Pakistan are not available. Anyhow some information is available at province level but that needs further massaging. Therefore the data set we used in the present study covers the four provinces, i.e. Punjab, Sindh, N.W.F.P and Baluchistan. The federally administrative tribal areas, the mountainous northern areas and Azad Kashmir are not included in the present study because of the data constraints and significant differences in economic structure from the rest of the country. The four provinces account for major share in population and income of the country and therefore provide sufficient information for our purpose.

The data used in the present study covers the period between 1979 and 2005. The main economic variable required for our analysis is the region-wise income per capita or income per worker. We have developed the concerned data sets by

using the sample survey information on household budgets and other economic characteristics. The sample survey data sets in Pakistan have been available on a more regular basis since the mid 1980s. The household income and expenditure survey (HIES) is a comprehensive and representative survey of household economic behaviour in Pakistan. It is based on a very large sample size that covers more than 90 percent of the total population of the country. This survey also provides data in rural and urban categorization, which is quite useful and important for the analysis of regional income dynamics for both rural and urban economies separately.

A common objection raised against the large sample surveys is the sample selection bias. It is argued that these surveys tend to underestimate inequality in distribution because of biased sampling. However, the presence of sample bias that leads to underestimate inequality may not pose serious problems to our analysis in case the said biases, if any, affect the estimates for all regions in the same way, since our objective is to find the evidence of convergence across the regions. However, if the nature of biases differs for different regions, which is least expected, the validity of results can then be questioned.

Other important data sets used in the analysis comprise the following variables for four provinces: savings rates, literacy rates, combined enrollment ratios, dependency ratios, population growth rates, crude birth rates and infant mortality rates. The important sources of the published data used in the present study are:

1. The Household Income and Expenditure Survey (HIES), renamed as the Household Integrated Expenditure Survey" in 1990-91, which is published by the Federal Bureau of Statistics, Government of Pakistan. All issues of this survey since 1979 are used.

2. The Pakistan Demographic Survey, published by the Federal Bureau of Statistics, Government of Pakistan. Various issues are used.

3. The Education Statistics of the Provincial Governments, prepared by the Provincial Bureaus of Statistics. All available issues are used.

4. The Development Statistics of the Provincial Governments, prepared by the Provincial Bureaus of Statistics. All available issues are used.

5. The Pakistan Labor Force Survey, published by the Federal Bureau of Statistics, Government of Pakistan. Various issues are used.

4.2 **Construction of Data Sets**

The required sets of variables used in estimation are derived from data given in the above mentioned sources. We discuss the variables used in the present study in some detail as under.

4.2.1 Income Levels

To calculate the per capita and per worker income at provincial level, we have used the average monthly income per household. The household income includes income from all sources like wages and salaries, crop farming, live stock

raising, property rent, owner occupied houses, social insurance & benefits, gifts, financial assistance, foreign remittances and other economic activities. Income per capita is calculated by dividing the total average income of the household by the average number of household members. On the other hand, income per worker is calculated by dividing the household total income by the number of employed persons per household. Household members are all such persons or group of persons in a household who normally live and eat together. All economically active persons are considered as employed persons by definition[1]. As the data of household income, members and employed persons are also available in rural and urban breakdown, so the same procedure is repeated in order to find the income per capita and income per worker in case of rural and urban regions separately. As expected, the urban per worker income is higher than the rural per worker income in all provinces across Pakistan. This is shown in Table (5.2 & 5.3).

4.2.2 Consumption and Saving

Consumption per capita and consumption per worker is calculated in the same way as income per capita, i.e. by dividing the total consumption expenditure of the household by the number of members and the number of employed persons per household respectively. To find the regional per capita saving rates, we subtract per capita consumption from per capita income levels. In the same way, per worker saving rates of all the regions is calculated by subtracting per worker

[1] More comprehensive definitions of household income, members and employed persons can be seen in HIES (1998-99).

consumption from per worker income levels. All the nominal figures of income and savings are deflated by the overall consumer price indices in order to obtain the real per capita and real per worker income and saving rates[2]. Annualized income growth rates are calculated by taking log differences of the real per capita or per worker income divided by the intervening years.

4.2.3 Working Age Population

Working age population is calculated from the dependency ratios of the regions under consideration. These indicators show the ratio of the dependent population (those under 15 and over 64) to the working age population (aged 15 to 64). For example, if the dependency ratio is 86.9, then the proportion of working age population (15 to 64 years) is 53.5% of the total population. The average working age population growth rates are computed as the differences between the natural logarithms of total working age population at the end and beginning of each period and dividing this difference by the number of years. The relevant data sets used for present study are shown in Table (5.1, 5.2, 5.3, 5.4 and 5.5) at the end of this chapter.

4.3 **Human Capital**

Human capital is an important factor that determines economic growth and convergence besides physical capital and labour force. It has been considered in many empirical studies and found to have positive impacts on growth (Barro and Sala-i-Martin, 2004). Human capital, inculcated through education training and

[2]The data for overall consumer prices index at constant prices of 1995 is taken from the World Development Indicators available on CD-ROM, World Bank.

experience, influences the capacity of both discovering the efficient methods of production as well as adopting new technologies developed elsewhere. In other words, human capital contributes to the catch up process among regions. Mankiw, Romer and Weil (1992) have used the ratio of secondary school enrollment to the working age population as proxy for human capital, noting however that this is an imperfect representation of human capital. Sala-i-Martin (1997) has used life expectancy at birth as proxy for non-educational human capital and school enrollment rate for educational human capital. The expenditure on health and education, both private and public, can be a better proxy for human capital. However, due to severe data problems, this option might not be feasible to work with.

Human capital is difficult to measure. It is a very vast concept that includes the elements of health and educational indicators. There are many attributes of human capital that need to be taken into account such as primary education, higher education, technical/vocational training, informal occupational experience, condition of health and physique, expenditure on social and cultural activities and last but not the least, the job opportunities. Despite the fact that these indicators are useful in analyzing the impact of human capital on income growth, it is not feasible to treat them simultaneously as explanatory variables since our sample size is small and their inclusion will lead to the loss of degrees of freedom. Moreover, the formal augmented neoclassical growth framework allows only human capital as a single composite variable that combines the effect of these

indicators. Therefore, it would be better to construct a composite index to be used as proxy for human capital in the analysis.

4.3.1 Index for Human Capital

In order to construct the requisite index, we intend to use two main indicators, namely, the composite indicator of educational attainment and indicator of health status. The educational attainment index includes the effects of both literacy rate and combined enrollment rate whereas the health index captures the effects of both infant survival rate and crude birth rate so as to account for life expectancy at birth. Following the procedure used in Human development in south Asia (1997) to construct the educational attainment index and health index, we try to construct the human capital index for regions of Pakistan as under.

(i) Education Attainment Index

Education Attainment Index is calculated by using 100 percent as a maximum level and zero as a minimum level of education attainment. It gives two-third weight to percentage of literates in labor force (denoted by a_1) and one-third weight to combined enrollment rates (denoted by a_2). It is given by the following statistics:

$$EA = \frac{[(2/3\,a_1)+(1/3\,a_2)]}{100}$$

(ii) Health Status Index

The Health Status Index gives sixty percent weight to infant survival rate (denoted by b_1) and forty percent weight to crude birth rate (denoted by b_2). The

infant survival rates are derived from the infant mortality rates. These two health indicators are used as proxy for life expectancy at birth since no data is available on this indicator at the provincial level in Pakistan. The maximum expected life is 85 years and the minimum is 25 years. Health index is given by the following statistics:

$$HS = \frac{[(0.60\, b_1) + (0.40\, b_2)] - 25}{85 - 25}$$

(iii) Human Capital Index

The Human Capital Index is simply the average of education attainment and health status indices.

$$HCI = \frac{[\, EA + HS \,]}{2}$$

Since some of the variables used in the above index are available for provinces either at four or five year's intervals. Therefore, we have to assume that the variables concerned are growing at constant rates through the time intervals and this is obviously a limitation. However, keeping in view the data constraints, this is the best measure one can construct. Moreover, we only require five or four year's interval data for panel data framework which is explained in the next section.

4.4 **Panel Data Set**

Panel data estimation is made possible by dividing the available period-wise information for each region into several shorter time spans. The question 'as to what should be the appropriate length of time interval (τ)' needs further consideration. Using a shorter time span like one or two years has the disadvantage that it may influence the short term disturbances. In fact, the economy of Pakistan reveals fluctuations from year to year in the gross real income (and per capita income). Therefore, it has been argued that short time spans may not be appropriate for studying growth and convergence (Islam, 1995). On the other hand, using variable averages over long period would risk a loss of information on changes in the steady state that have occurred during the long period. In order to balance these two concerns, the present study uses a panel of four/five-year time intervals for each of the region depending on the available data. This is also the standard practice followed in panel data empirical research work on growth and convergence.

Dividing the total time period (1979-2005) into shorter time spans, we obtain a total of six data (time) points for each of the province. The constructed four/five-year time interval spans are 1979-1984, 1984-1988, 1988-1993, 1993-1997, 1997-2001, 2001-2005. In dynamic panel framework, the dependent variable is the natural logarithm of per capita (per worker) income by the end point of each four/five-year span while lagged dependent variable is the natural logarithm of same variable at the beginning of the each span for each province. For example, considering the span (1979-1984), when t=1984, the t-τ is 1979 and the other

explanatory variables used such as saving rates per worker, working age population growth rates and human capital are averaged over that time span for each province. So we have six time observations for each province. For the purpose of clarity, the variables under consideration are explained in somewhat detail.

In the present study, we use real growth rate of income per worker as dependent variable, which is computed as the difference in the natural logarithm of income available at the end and beginning of the time span. Thus we get six observations for each province, i.e. ln (y_i, 1984) – ln (y_i, 1979), ..., ln (y_i, 2005) – ln (y_i, 2001). The first explanatory variable is the natural logarithm of lagged dependent variable. Therefore, the six observations for each province are given by: ln (y_i, 1979), ..., ln (y_i, 2001). The second explanatory is the natural logarithm of the averages of per worker saving rates. These averages are taken over the (previous) five or four year interval. Thus, we have six observations of this variable for each province, that is, ln (s_i, 1984), ..., ln (s_i, 2005). The third explanatory variable is the natural logarithm of three indices; working age population average growth rate plus rate of technical progress plus rate of depreciation of physical capital ($n+g+\delta$). The actual values of technological growth rate 'g' and depreciation rate 'δ' could not be directly estimated. So we assume the value of ($g+\delta$) to remain constant i.e. same for all regions and time. The average of the working age population growth rate is also taken over the four/five year's interval. Thus we have six observations for each province, that is, ln (n_i, 1984), ..., ln (n_i, 2005). The fourth explanatory variable is a proxy for

the fraction of income invested in human capital (i.e. investment in activities that enhance human capital like expenditure on education and health care). We use human capital index as a proxy for human capital that includes both educational and health indicators. For each province, we have six observations, that is, ln (h_i, 1984), ..., ln (h_i, 2005).

This provides us with panel data sets for the study of conditional convergence and economic growth in dynamic framework across regions of Pakistan. Combining the cross section and time series data has advantages over the single cross section framework discussed earlier. The single cross section regression analysis reduces the time series to a single observation, which leads to the slackness that all available information is not utilized. The panel data framework not only increases the sample size but also handles the issues that the cross sectional approach fails to address. As discussed earlier, this formulation can control for the region-specific effects efficiently. The potential advantage of panel data technique, however, depends on the estimators used in the analysis and on the availability of feasible instruments in case of endogeneity correction.

TABLE 4.1: Data for All Areas

YEARS	Punjab		Sind		N.W.F.P		Balochistan	
variables	***per worker income***	***per worker savings***	***per worker income***	***per worker savings***	***per worker income***	***per worker savings***	***per worker income***	***per worker savings***
1979	1874.332	120.574	2199.583	171.100	2516.826	309.009	2111.074	215.342
1984-85	2514.894	166.209	2740.671	128.283	2909.014	333.329	2821.229	267.279
1985-86	2530.313	175.041	2745.617	131.513	2707.367	106.696	2879.986	397.897
1986-87	2479.757	90.340	2949.209	111.780	2965.514	1543.842	2858.786	444.371
1987-88	2505.830	107.355	2767.865	157.027	2881.511	87.907	2726.233	308.525
1992-93	2712.647	125.496	2991.242	53.882	2408.123	-150.208	2540.554	218.288
1993-94	2611.812	104.366	3122.696	-34.738	2514.380	-8.426	2632.404	101.279
1995-96	2728.197	288.768	3028.511	-70.402	2148.692	-215.449	2961.951	220.250
1996-97	2859.112	394.294	3251.701	187.808	2598.384	46.184	2695.574	239.359
1998-99	2345.012	178.417	2622.899	112.745	2646.209	-108.382	3120.743	240.712
2001-02	2326.693	208.527	2269.651	46.754	2693.318	44.387	2605.296	278.496
2004-05	2961.949	196.985	3268.005	125.536	3319.289	237.067	2691.269	101.580
variables	Growth rate of Working age Population	Human capital index	Growth rate of Working age Population	Human capital index	Growth rate of Working age Population	Human capital index	Growth rate of Working age Population	Human capital index
1979-84	0.0290	0.5067	0.0326	0.5488	0.0317	0.4943	0.0387	0.2692
1984-88	0.0245	0.5157	0.0295	0.5188	0.0321	0.5147	0.0202	0.2739
1988-93	0.0284	0.5350	0.0289	0.5313	0.0238	0.5233	0.0186	0.2794
1993-97	0.0251	0.5445	0.0273	0.5762	0.0256	0.5445	0.0337	0.2850
1997-01	0.0369	0.5648	0.0263	0.5632	0.0371	0.5462	0.0208	0.3010
2001-05	0.0207	0.5638	0.0225	0.5815	0.0260	0.5377	0.0296	0.2949

TABLE 4.2: Data for Rural Areas

YEARS	Punjab		Sind		N.W.F.P		Balochistan	
variables	*per worker income*	*per worker savings*	*per worker income*	*per worker savings*	*per worker income*	*per worker savings*	*per worker income*	*per worker savings*
1979	1623.302	78.631	1233.126	11.938	2052.282	47.710	1494.258	66.297
1984-85	2249.037	124.738	1943.859	48.377	2691.325	223.793	2738.977	259.209
1985-86	2288.102	171.079	1936.731	69.409	2593.766	74.158	2714.687	376.120
1986-87	2134.051	62.554	2157.318	51.679	2899.979	103.474	2771.634	443.313
1987-88	2209.531	70.566	1895.179	18.927	2838.146	62.223	2589.859	279.046
1992-93	2388.260	52.844	2089.867	-146.252	2235.672	-206.502	2402.067	187.151
1993-94	2216.342	61.042	1980.408	-136.828	2313.995	-34.936	2383.988	48.737
1995-96	2346.550	250.944	2119.893	-152.042	2019.700	-251.621	2752.292	179.723
1996-97	2619.938	461.435	2537.918	307.002	2498.295	37.023	2439.251	191.747
1998-99	1872.938	123.351	1796.083	70.360	2395.199	-161.849	3039.474	221.362
2001-02	1940.623	129.529	1478.362	18.916	2500.845	-41.481	2369.282	194.486
2004-05	2378.339	73.378	2202.829	15.340	2990.826	133.105	2342.457	32.290

SOURCES (TABLE 4.1 & 4.2): 1- Household Integrated Expenditure Survey (HIES), Federal Bureau of Statistics, Government of Pakistan, Islamabad.
2- Education and Development Statistics of the Provincial Governments, Provincial Bureaus of Statistics.
3- The Pakistan Demographic Survey and The Pakistan Labor Force Survey Federal Bureau of Statistics, Government of Pakistan.

TABLE 4.3: Data for Urban Areas

YEARS	Punjab		Sind		N.W.F.P		Balochistan	
variables	*per worker income*	*per worker savings*	*per worker income*	*per worker savings*	*per worker income*	*per worker savings*	*per worker income*	*per worker savings*
1979	2659.540	229.259	3234.100	342.102	3325.799	825.541	2807.728	405.040
1984-85	3158.329	243.134	3778.958	231.336	4224.064	981.863	3409.766	325.536
1985-86	3258.874	188.567	3863.985	217.387	3386.115	305.330	3956.330	540.391
1986-87	3362.155	97.123	3999.915	185.033	3358.219	160.721	3306.115	448.457
1987-88	3340.429	212.234	3975.446	344.829	3027.920	-367.562	3573.759	491.103
1992-93	3694.792	345.617	4254.167	332.248	3612.086	274.592	3696.507	475.302
1993-94	3757.489	229.632	4595.583	103.356	3735.805	162.186	3957.327	535.608
1995-96	3807.720	391.060	3991.991	18.601	3234.207	65.504	4286.940	475.138
1996-97	3578.243	203.368	3969.526	57.953	3302.693	105.471	3761.562	441.175
1998-99	3732.026	341.912	3945.540	179.784	4153.526	209.515	3714.783	379.644
2001-02	3455.286	437.812	3777.458	99.808	3838.295	542.829	3876.094	734.380
2004-05	4383.862	501.685	4841.552	288.188	5283.394	823.782	4486.290	456.544

SOURCE: Household Integrated Expenditure Survey (HIES), Federal Bureau of Statistics, Government of Pakistan, Islamabad.

TABLE 4.4: DATA FOR PER CAPITA INCOME

	Punjab			Sindh		
variables	***per capita income***			***per capita income***		
YEARS	all areas	rural areas	urban areas	all areas	rural areas	urban areas
1979	593.5385	522.7583	729.2286	687.3696	469.7623	845.8415
1984-85	640.7374	585.1152	775.3127	743.8332	571.5278	928.97
1985-86	661.1463	606.8937	955.3894	742.0588	577.0293	925.1794
1986-87	664.1504	589.5358	841.8066	782.3535	624.9241	956.9996
1987-88	656.868	587.0207	850.4774	747.0214	545.4418	980.5706
1992-93	704.0459	637.8584	893.7254	764.1178	553.6965	1030.356
1993-94	701.7428	622.4467	896.5198	764.3314	505.6361	1145.079
1995-96	752.4544	683.6104	919.3094	780.8704	560.6964	1006.328
1996-97	792.9021	754.7503	886.148	825.3891	676.1607	965.5604
1998-99	735.9729	618.5321	1027.163	817.2238	606.5374	1289.207
2001-02	715.0846	620.9994	948.5098	731.4659	512.8245	1072.414
2004-05	854.6693	714.2267	1159.646	915.6259	644.1022	1280.716
	N.W.F.P			Balochistan		
variables	***per capita income***			***per capita income***		
YEARS	all areas	rural areas	urban areas	all areas	rural areas	urban areas
1979	679.1434	571.9474	893.4983	603.164	489.4982	721.9872
1984-85	721.5452	667.4486	1045.619	651.0528	634.8969	804.7895
1985-86	632.2593	608.4623	778.3603	696.0386	660.4606	886.6581
1986-87	660.9357	638.2525	777.1476	749.1674	737.282	807.4183
1987-88	632.8355	613.8806	724.8783	702.3515	674.4426	859.774
1992-93	535.8922	500.939	790.5044	627.5125	606.8826	769.2451
1993-94	573.078	530.7624	773.3007	618.2871	583.1336	807.3856
1995-96	521.2624	499.9257	666.6611	652.9033	619.5196	827.4186
1996-97	566.455	542.805	712.6346	640.4868	598.0651	797.7305
1998-99	586.9155	531.5876	903.6505	790.5882	777.2544	941.0784
2001-02	608.282	564.0758	869.3356	689.7376	642.4641	915.4593
2004-05	718.9639	652.5437	1053.906	661.7316	693.4223	1010.648

SOURCE: Household Integrated Expenditure Survey (HIES), Federal Bureau of Statistics, Government of Pakistan, Islamabad.

TABLE 4.5: DATA FOR DEPENDENCY RATIOS

	Punjab			**N.W.F.P**		
variables	dependency ratios			dependency ratios		
YEARS	all areas	rural areas	urban areas	all areas	rural areas	urban areas
1976	98	98	96	106	108	94
1979	99	100	96	112	115	100
1981	95	96	89	103	105	87
1985	98	101	94	105	110	99
1990	95	98	89	109	113	90
1992	93	97	85	109	114	86
1993	96	100	86	110	115	86
1994	94	99	84	108	113	85
1996	95	97	91	110	114	91
1998	87	93	77	86	86	82
2000	82	91	73	96	105	81
2001	82	88	72	93	96	79
	Sindh			**Baluchistan**		
variables	dependency ratios			dependency ratios		
YEARS	all areas	rural areas	urban areas	all areas	rural areas	urban areas
1976	93	97	87	90	91	86
1979	92	98	84	94	95	92
1981	94	99	87	107	109	93
1985	96	103	91	1078	109	105
1990	95	103	87	113	115	103
1992	95	105	86	108	110	100
1993	94	105	86	106	107	100
1994	92	103	83	96	108	107
1996	93	99	87	108	108	109
2000	88	100	79	102	106	96
2001	88	98	77	98	100	92

SOURCE: The Pakistan Demographic Survey, Federal Bureau of Statistics, Government of Pakistan.

CHAPTER 5

EMPIRICAL ANALYSIS AND RESULTS

5.1 The Absolute Convergence

To examine the presence or absence of unconditional (absolute) convergence, the regression model is given by equation (8) showing the growth rate of real per worker income as the dependent variable and the lagged value of income per capita as the explanatory variable. The equation is reproduced for ready reference and with slight modification as under:

$$(1/r)\ln[y_{i,t}/y_{i,t-r}] = C_i - (1-e^{-\beta r})(1/r)[\ln y_{i,t-r}] + \varepsilon_{i,t}$$
$$\Rightarrow \ln[y_{i,t}/y_{i,t-r}] = C + \alpha \ln y_{i,t-r} + \varepsilon_{i,t}$$

As mentioned earlier, the $y_{i,t-r}$ is the initial level of log real per capita or worker income and the intercept term C represents steady state per capita growth rate which is assumed to be common or same across regions under consideration for unconditional convergence. The slope parameter $\alpha = -(1- e^{-\beta r})$ is important for our analysis, where 'r' is the length of the observation interval. For example, when analyzing the absolute convergence over the period from 1979 to 2005 in case of Pakistan, the dependent variable is the growth rate of real per worker income for the region i over the period t=2005 and t-r=1979 and the only explanatory variable is the level of per worker income in region concerned at the beginning of the time interval ($y_{i,1979}$). The same process is repeated for the analysis of other sub periods. Note that the above equation does not control for any determinant of the steady state, so a negative and statistically significant

value of the coefficient on initial level of real per capita (per worker) income would imply unconditional (absolute) convergence to the common or same steady state. In other words, this would imply that the growth rate depends only on the initial level of per capita/worker income. This suggests further that other conditions remaining identical, the regions with lower initial income levels should grow faster than economies with higher initial income so as to catch up with the later over time.

A non-negative value of the slope parameter ($\alpha \geq 0$) is a signal for the absence of absolute convergence. It may even exhibit an absolute β-divergence if strictly positive, which means that disparities in income per capita increase across regions over time. By implication, a zero value of the parameter indicates no convergence or divergence. The value of the parameter 'β' measures the speed of convergence or the rate at which regions converge to the common steady state. Hence, it can be concluded that a value of the slope parameter in the range of $-1 < \alpha < 0$ would be an evidence of absolute beta convergence i.e. the nearer the value to -1, the higher the speed of convergence and the nearer its value to zero, the lower the speed. After this brief introduction, we focus on the analysis.

5.1.1 Aggregate Analysis

As discussed earlier, we have data set on income per worker for the four provinces, both in the rural and urban format as well as in combined form. We begin with testing the hypothesis of absolute convergence by using the data in the combined (aggregated) form. Table 5.1 reports the cross-section regression results, which cover a period of twenty six years (1979 - 2005) and correspond to income per worker[1]. We have divided this time span into three sub-periods, (1979-1988), (1988-1998) and (1998-2005) in order to find the evidence of convergence separately. Another reason for this division into sub-periods is to test whether the political and macroeconomic stability (instability) bears any implications for absolute β-convergence[2].

Column (1) reports the unconditional convergence estimates for the entire period (1979-2005). The regression coefficient for the explanatory variable (initial level of per worker income) is negative but statistically insignificant. Thus, the overall data do not provide any conclusive evidence in favour of β-convergence which implies that the poor regions do not tend to grow faster than rich regions in terms

[1] Results in per capita terms are not reported here because all estimated coefficients on absolute beta convergence growth regression are statistically insignificant.

[2] The first and third sub-periods represent the military-guided, semi-democratic regimes of General Zia-ul-Haq and General Pervez Musharaf respectively. The second sub-period shows the so called democratic regime. Although the country was ruled by publicly elected representatives during this period but it was politically unstable. Four elections were held within this period of 10/11 years but no elected government could complete its tenure.

Table 5.1: Absolute Convergence Regressions (Rural +Urban)

	Dependent variable ln (y_t / y_{t-1})			
	(Overall)	(.....Period-wise .....)		
PERIODS	(1979-2005)	(1979-1988)	(1988-1998)	(1998-2005)
CONSTANT	**4.349**	**4.318****	**0.123**	**- 2.288**
standard error	3.488	0.668	9.764	5.351
T- value	1.247	6.461	0.013	- 0.428
P- value	0.339	0.023	0.991	0.711
Ln (y_{t-1})	**- 0.522**	**- 0.533****	**- 0.018**	**0.317**
standard error	0.454	0.087	1.235	0.684
T- value	- 1.149	- 6.121	- 0.014	0.464
P- value	0.370	0.026	0.990	0.688
ß=Implied speed	**0.028**	**0.074**	**0.002**	**N/A**
R^2	0.397	0.924	0.060	0.503

NOTE: All regressions are for the four provinces of Pakistan.
** Significant at 5% level

of per worker income levels in Pakistan. For the sub-period (1979-1988), there is negative association between growth and initial level of income, which is statistically significant, implying convergence. The corresponding implied speed of convergence is 7.4% per annum. In other words, the hypothesis of convergence cannot be rejected for the period under reference. However, this trend of convergence could not be sustained during the second sub-period (1988-1998), where the sign is correct (negative) but the coefficient is close to zero and it is statistically insignificant. Further, the regression is poor fit. During the third sub-period (1998-2005), the results are just in the opposite direction. The concerned coefficient bears a positive sign, however it is statistically insignificant. This implies that there is no indication of convergence; rather there is a signal (although weak) of divergence. The results support the claims of increase in income disparities across Pakistan during the recent past. To sum up, there are no signs of convergence when the entire time span is considered.

However, the signs of regional income convergence could be seen during the sub-period (1979-1988) only but the trend could not continue afterwards; rather a slight divergence is suspected during the sub-period (1998-2005).

The signals of absolute convergence during the sub-period (1979-88) can be rationalized on the basis of certain ground realities. For instance, the overall economic performance was better relative to other developing countries around the globe; the growth rate was high and inflation rate was mild. The average annual real GDP growth rate of Pakistan was 6.15% and inflation rate was 6.74% during 1980s as compared to the average rates of developing countries: annual real GDP growth rate of 4.49% and inflation rate of 34.72% during the decade[3]. There was a sharp increase in worker's remittances during the era, which boosted up the living standard of masses. Nadeem-ul-Haq (1999) believes this to be the most important factor in reduction of poverty during 1980s. As discussed earlier (in literature review), various studies show that political and macroeconomic stability leads to income convergence across regions. Although, political stability during the period may be questionable, the high GDP growth rate and lower inflation rate suggest some macroeconomic stability. The finding of convergence during the sub-period (1979-88) further supports the opinion that the military-led regime was economically more stable as compared to the succeeding periods despite the fact that the country faced acute political and social problems due to Afghan war. Further research is needed so as to go deep into this argument, which is however, not the objective of this study.

[3] The figures can be seen from International Financial Statistics.

The overall results of absolute β-convergence show that the single regressor (initial per worker income) might not be sufficient to explain the nature and causes of income growth rates across the regions in Pakistan. It is quite evident from the low values of R^2 for most of the cross-section regression results. The results suggest that there may be other important factors that need to be included for explaining the growth rate and the process of regional income convergence. It can also be concluded that the assumption of a common steady state level may not be appropriate. The said assumption implies that all the regions have similar saving and population growth rates and have equal access to technology. If the regions do not converge to a common steady state (as in the present case) then the model for estimation of absolute β-convergence may be misspecified. Therefore, conditional convergence would be a better alternative since it shows the regional income convergence after controlling for the differences in steady states. There is need to test for convergence by using the appropriate framework that includes the above mentioned variables as the determinants of the steady state. In section (5.2), we will proceed in that direction.

5.1.2 Disaggregate (Urban-Rural) Analysis

The data for income per worker is available in rural and urban breakdown as well and this can be utilized for convergence analyses in rural and urban areas separately. Although the income convergence in respect of rural and urban areas of different provinces is more difficult to imagine within existing administrative set up, however the available information allows us to see the dynamics of rural and

urban areas, which may lead to very useful insights. Anyhow, the rural and urban areas can be considered as separate regional economies due to the obvious difference in their socio-economic and political structure. Thus we try to repeat the exercise to test for absolute β-convergence in the rural and urban contexts. Table (5.2) and (5.3) present the results of cross-section regressions for absolute convergence in the four provinces of Pakistan.

Table-5.2 is concerned with rural areas. We follow the same methodology as for the aggregate analysis. It can be seen that the regression coefficient for the initial level of income per worker concerning the entire period (1979-2005) is negative, but significant only at 10% level of significance. However, when the time span is divided into three sub-periods, (1979-1988), (1988-1998) and (1998-2005), the coefficient for the initial level of per worker income alternates in sign but not significantly different from zero. The very base and the vital component of our

Table 5.2: Absolute Convergence Regressions (Rural Areas)

	Dependent variable $\ln(y_t / y_{t-1})$			
	(Overall)	(.....Period-wise .....)		
PERIODS	(1979-2005)	(1979-1988)	(1988-1998)	(1998-2005)
CONSTANT	**3.385***	**2.497**	**-0.530**	**2.013**
standard error	1.071	2.327	4.751	3.236
T- value	3.161	1.073	-0.112	0.622
P- value	0.087	0.396	0.921	0.597
Ln (y_{t-1})	**-0.399***	**-0.284**	**0.061**	**-0.241**
standard error	0.135	0.316	0.612	0.424
T- value	-2.947	-0.900	0.100	-0.567
P- value	0.098	0.463	0.930	0.628
ß=Implied speed	**0.020**	**0.033**	**N/A**	**0.039**
R^2	0.685	0.288	0.005	0.577

NOTE: All regressions are for the four provinces of Pakistan.
*Significant at 10% level of significance

rural economy is the agricultural output, which primarily depends on the forces of nature. Therefore, the results might have been affected by shocks to agricultural output as we divide the time span into small sub-periods. It means that results are sensitive to periods in which agriculture output is very high or low. The rural economies of Pakistan, especially in Punjab and Sindh provinces, perform better in the years when agricultural productivity is high.

Table 5.3: Absolute Convergence Regressions (Urban Areas)

	Dependent variable $\ln(y_t / y_{t-1})$			
	(Overall)	(.....Period-wise .....)		
PERIODS	(1979-2005)	(1979-1988)	(1988-1998)	(1998-2005)
CONSTANT	**4.351*** **	**8.427**	**9.673** **	**0.360**
standard error	0.107	5.986	2.456	2.253
T- value	40.555	1.408	3.938	0.160
P- value	0.001	0.294	0.059	0.888
Ln (y_{t-1})	**-0.489*** **	**-1.035**	**-1.173***	**-0.022**
standard error	0.013	0.748	0.301	0.273
T- value	-36.457	-1.384	-3.892	-0.080
P- value	0.001	0.301	0.060	0.944
ß=Implied speed	**0.026**	**N/A**	**N/A**	**0.003**
R^2	0.998	0.489	0.825	0.003

NOTE: All regressions are for the four provinces of Pakistan.
Levels of statistical significance are indicated by asterisks.
*** Significant at 1% level of significance
** Significant at 5% level of significance
* Significant at 10% level of significance

Similar results can be seen from table (5.3) for the urban regions, we find the evidence of unconditional convergence only for the entire period (1979-2005). The implied speed of convergence for the rural and urban economies works out to be 2% and 2.6% per year respectively, when we consider the entire period. These results indicate that rural and urban economies are not likely to converge to the common steady state; rather they are converging to their respective steady

states and following their own balanced growth paths. However, more tests are needed to explain the nature and causes of growth in rural and urban economies separately since the only variable (initial per worker income) does not seems to be sufficient to explain the process of growth and convergence.

5.2 **Conditional Convergence**

In the absence of satisfactory evidence on absolute convergence, the researchers have employed the standard neoclassical growth models to determine conditional convergence. The panel data framework is seems to be appropriate for the purpose when the sample size is small as in our case. As discussed earlier, in dynamic growth models, the region-specific effects are correlated with savings and population growth rates but cannot be controlled for in single cross-section regression. Other advantages of using the panel data framework have been discussed in the previous chapters. To estimate the dynamic panel growth models in the present analysis, we prefer to use the first difference generalized method of moments (GMM). To find the evidence for conditional convergence, we apply the estimation procedure to two different specifications of the neoclassical growth model. First is the original neoclassical model due to Solow (1956) and second is the modified version of the growth model due to Mankiw, Romer and Weil (1992) that augments the former with human capital.

5.2.1 Estimation via the Basic Neoclassical Model

We begin our analysis with the basic neoclassical growth without any provision for human capital. The empirical specification within the panel data framework is provided by equation (21), which is reproduced below but rewritten in a more general format:

$$\ln(y_{i,t}/y_{i,t-\tau}) = \gamma_0 \ln y_{i,t-\tau} + \gamma_1 \ln(s_{i,t}) + \gamma_2 \ln(n_{i,t} + g + \delta) + \mu_i + \varepsilon_{i,t}$$

Given that $\gamma_0 = -(1-e^{-\lambda\tau}), \gamma_1 = (1-e^{-\lambda\tau})(\frac{\alpha}{1-\alpha}), \gamma_2 = -(1-e^{-\lambda\tau})(\frac{\alpha}{1-\alpha}), \mu_i = (1-e^{-\lambda\tau})\ln A_0$.

As discussed earlier, μ_i represents the region-specific effects and $\gamma_0,\gamma_1,\gamma_2$ are parameters to be determined. The question whether to use the variables in per capita or per worker terms is the general issue while working on the neoclassical growth model. The model is based on the production function with capital and labour as arguments. Since every member of the household does not contribute directly to production, it seems appropriate to use the per worker variables i.e. per worker income and growth rate of the labour force etc[4]. The construction and sources of data in respect of the explanatory variables used in the panel estimation, has been explained in the chapter on data description.

The hypothesis of conditional convergence can be tested using the regression equation cited above. The interpretation of this equation depends on the

[4] Islam (1995) and Caselli, Esquivel and Lefort (1996) used per capita variables and the growth rate of whole population. In contrast, Mankiw, Romer and Weil (1992) used data in terms of per worker variables and the growth of working age population. Although the data is available to us both in terms of per capita and per worker, however we prefer to use the latter.

coefficient of lagged real per worker income 'γ_0'. A statistically significant value of the coefficient that bears a negative sign implies conditional convergence as predicted by the neoclassical model. In case the coefficient is not much different from zero ($\gamma_0 \approx 0$), then the data do not reveal convergence effect. In this case, other variables on the right hand side measure differences in the steady state levels. According to the neoclassical specification, we may expect a positive sign for the coefficient on real per worker savings and a negative sign for the coefficient on the working age population growth rate. Similarly, we expect that both the coefficients on saving and population growth rates are nearly equal in absolute value which is reflected in the sign and magnitude of the coefficients in the above equation.

To find consistent estimates for conditional convergence, we have tried three estimation techniques, namely the OLS estimators, the Fixed effect or within groups estimators and the GMM estimators within the panel data framework. Next we focus on interpretation of the results.

5.2.2 Panel Regression (Basic Model)

The results of testing conditional convergence hypothesis are presented in Table-5.4. The first column reports the ordinary least squares estimates which are obtained by applying least squares by simply pooling the time series and cross section data. The second column reports estimation through the fixed effects model or Within Groups (WG) estimators. The third column reports the results of first differenced Generalized Method of Moments (GMM) ala Arellano-

Bond (1991). As discussed in Chapter (3), it is well known that OLS estimate on lagged dependent variable is biased upward and WG estimator is biased downward in dynamic panel models. Bond, Hoeffler and Temple (2001) suggest that the OLS and WG estimators provide the approximate upper and lower bounds for consistent estimate, which should therefore lie somewhere in between the two bounds. The GMM estimators also suffer from certain limitations, although more advanced. In an attempt to find consistent estimates, we report results of all the three techniques.

A comparison of the estimated coefficient for the lagged dependent variable reveals that the OLS provides higher estimates than WG method. The signs in both are correct. The OLS estimates a value of (– 0.046) and WG provides a value of (–1.262) for the coefficient (the initial level of per worker income).

Table 5.4: Dynamic Panel Estimates for Conditional Convergence

(Estimation via the Basic Neoclassical Mode)

Dependent Variable $ln\ Y_{i,t} - ln\ Y_{i,t-\tau}$

Variables	Least squares	Fixed Effect (WG)	DIF-GMM
ln ($y_{I,t-\tau}$)	**- 0.046**	**-1.262****	**- 0.327*****
	(0.082)	(0.177)	(0.071)
ln ($s_{I,t}$)	**0.014**	**0.024***	**0.020***
	(0.019)	(0.013)	(0.012)
ln ($n_{I,t}$+g+δ)	**- 0.10**	**- 0.091**	**- 0.107**
	(0.181)	(0.104)	(0.095)
Implied λ	**0.009**	**N/A**	**0.080**
J-statistic			14.402
Instrument rank			16.000
Sargan Test(P-value)			**0.346**

NOTES: Data used for five and four year's intervals between 1979 and 2005 relates to the four provinces of Pakistan for all regressions. The symbol (λ) denotes the convergence rate. Standard errors given in parentheses. Three, two, and one asterisk denote statistical significance at 0.01, 0.05, and 0.10 levels respectively.
DIF-GMM is the first differenced generalized method of moments Arellano-Bond (1991) estimator. The figures reported for the Sargan test are the p-values of the null hypothesis, valid specification. J-statistic is simply the Sargan test of over-identifying restrictions.

Fortunately, the value given by the GMM estimator (- 0.327) falls between the upper and lower bound and therefore it is more likely to be unbiased and reliable. The validity of the instrumental variables set used for the first difference GMM estimation can be checked by Sargan test. The p-value (0.346) strongly suggests that the instrumental variables used in GMM technique are valid[5]. Thus, based on these results, the first difference GMM is the preferred estimation technique for convergence analysis within the dynamic panel framework.

Now we focus on the estimated results for conditional convergence from the first differenced GMM technique (last column Table-4). All estimated values are statistically significant except the working age population growth and the coefficients bear the expected signs. In particular, the coefficient on lagged per worker income is statistically significant and has the appropriate negative sign, which supports the hypothesis of conditional convergence across regions. The estimated coefficient on saving rates indicates that an increase by one percent in saving rate is associated with a small increase of 0.02 percent in growth rate of real income. Likewise, an increase by one percent in the growth rate of working age population is associated with a 0.11 percent decline in growth rate of real income.

[5] Under the null hypothesis (that over identifying restrictions are valid), the Sargan statistics is distributed as a χ^2(K-Y), where K is the number of coefficients and Y is the instrumental rank. The J-statistic is simply the Sargan statistic that is used to check the validity of instruments used. Given that J-statistic = 14.402, the p-value is computed by using "CHIDIST (14.402, 13)".

The speed of convergence 'λ' can be estimated from the coefficient on lagged dependent variable. The implied speed is 8 % per year. The half life of convergence is the time that an economy or region takes to move half way to its own steady state[6]. The estimated half life of convergence indicates that average time a region takes to cover half of the distance between its initial position and its steady state income level is about nine years. The results show that most of the regions are very near to their respective steady states level. The differences in per worker income levels across the regions can be explained by the differences in their steady state levels. In this regards, the factors that determine steady state are more important. These factors or determinants of the steady states comprise the set of conditioning variables and these might be different across the regions and also might be changing over time. Thus any change in the conditioning variables causes a shift in the steady state level. The finding of conditional convergence does not rule out persistence income dispersion due to the different steady state income levels of different regions. Therefore, the differences or disparities across regions can be attributed to differences or variations in their steady state.

5.2.3 Panel Regression (Augmented Model)

Human capital is another important variable that has been considered in empirical growth literature besides savings and population growth rates. We

[6] The half life of convergence process given by formula: $T = \ln(2)/\lambda$, where λ denotes speed of convergence and T is the number of years. Given that $\lambda = 0.08$, $T = 8.67$. The estimated half life of convergence is 8.67 years.

estimate an augmented version in which the production function also includes the stock of human capital. The panel data results are reported in Table-5.5 by estimating the growth equation (25) which includes human capital. We used human capital index as a proxy for human capital that includes both educational and health indicators.

For the first differenced GMM estimator, the estimate of the coefficient of lagged dependent variable is highly significant. It falls between the upper and lower bound given by the OLS and WG estimates and it is consistent with the results from application of the data to basic neoclassical model. The Sargan test with p-value (0.366) does not reject the validity of the instruments used in the analysis.

Table 5.5: Dynamic Panel Estimates for Conditional Convergence

(Estimation via the Augmented Neoclassical Mode)

Dependent Variable $\ln Y_{i,t} - \ln Y_{i,t-\tau}$

Variables	Least squares	Fixed Effect(WG)	DIF-GMM
ln ($y_{i,t-\tau}$)	**- 0.051**	**- 1.313*** **	**- 0.356*** **
	(0.090)	(0.177)	(0.025)
ln ($s_{i,t}$)	**0.012**	**0.031** **	**0.027***
	(0.021)	(0.014)	(0.014)
ln ($n_{i,t}$+g+δ)	**- 0.096**	**- 0.088**	**- 0.102**
	(0.185)	(0.102)	(0.085)
ln ($h_{i,t}$)	**- 0.081**	**0.727**	**0.662** **
	(0.515)	(0.540)	(0.332)
Implied λ	**0.010**	**N/A**	**0.088**
J-statistic			14.106
Instrument rank			17.000
Sargan Test(P-value)			**0.366**

Notes: Standard errors given in parentheses, (λ) denote the annual convergence rate.
* Significance at 10% level, ** Significance at 5% level, *** Significance at 1% level.

The coefficients on the savings and working age population growth have the expected signs; however the coefficient of working age population growth is not

statistically significant. The speed of convergence 'λ' is slightly higher when the basic neoclassical model is augmented with human capital. As evident, the coefficient of human capital is positive and statistically significant which indicates its importance for growth. The results also indicate the positive effect of improvement of quality education and healthy condition on income per capita growth rate.

5.2.4 Panel Regression (Restricted Model)

In this sub-section, we consider the question whether the estimates obtained are consistent with the predictions and economic interpretation of the growth models or otherwise. The data is considered to support the models if the estimated coefficients have not only the predicted signs but also the expected magnitudes. The signs and magnitudes of the coefficients as predicted by the formal models shown by equation (20) and (21) make it convenient to test the models under restrictions. Restricted estimation is useful in the sense that the values of structural parameters, like the shares of physical capital (α) and human capital (β), can be estimated.

First, with reference to the basic neoclassical model, we examine the restriction that the coefficients of ln(s) and ln(n+g+δ) are equal in magnitude but opposite in sign (i.e. $\gamma_1 = -\gamma_2$ or $\gamma_1 + \gamma_2 = 0$). Although, the estimated values γ_2 and γ_3 reported in Table-4 do not seem to support this prediction. The formal test for restrictions (Wald test) gives the p-value (0.0861) for GMM technique clearly rejects the hypothesis ($\gamma_2 + \gamma_3 = 0$), which implies that our data do not support the predictions

of the neoclassical model. Secondly in order to obtain the implied value for the physical capital share 'α', we re-estimate the basic neoclassical model by imposing the restriction that savings and working age population growth rates enter the equation as a difference. The restricted form of equation (21) is as

$$\ln(y_{i,t}/y_{i,t-\tau}) = -(1-e^{-\lambda\tau})\ln y_{i,t-\tau} + (1-e^{-\lambda\tau})(\tfrac{\alpha}{1-\alpha})[\ln s_{i,t} - \ln(n_{i,t}+g+\delta)] + \mu_i + \varepsilon_{i,t} \quad (26)$$

The regression results, after incorporating the restriction, are reported in Table (5.6). The implied value of the share of physical capital estimated in GMM case is 0.066, which is very low.

Table 5.6: Dynamic Panel Estimates for Conditional Convergence
(Restricted Basic Neoclassical model)

Dependent Variable $\ln Y_{i,t} - \ln Y_{i,t-\tau}$

Variables	Least squares	Fixed Effect(WG)	DIF-GMM
$\ln(y_{i,t-\tau})$	**-0.008**	**-1.237*** **	**-0.292*** **
	(0.020)	(0.169)	(0.067)
$\ln(s_{i,t}) - \ln(n_{i,t}+g+\delta)$	**0.015**	**0.024***	**0.021**
	(0.019)	(0.013)	(0.014)
Implied λ	**0.001**	**N/A**	**0.07**
Implied α	**0.693**	**0.019**	**0.066**
Wald test: p-value	**0.199**	**0.131**	**0.086**

Notes: Standard errors in parentheses. Three asterisks, two asterisks, and one asterisk denote statistical significance at 0.01, 0.05, and 0.10 levels respectively.

Now, with reference to the augmented neoclassical model, we may examine the restrictions that the coefficient of ln(s), ln(n+g+δ) and ln(h) sum to zero (i.e. $\gamma_1+\gamma_2+\gamma_3 = 0$). The restriction implied by the augmented neoclassical model can not be rejected at the conventional levels of significance (i.e. with p-value 0.2545) the results are reported in last row of table (5.7). Similarly, to find the implied

values of physical and human capital shares from the augmented neoclassical growth model, the following is the restricted dynamic panel growth regression.

$$\ln(y_{i,t}/y_{i,t-\tau}) = -(1-e^{-\lambda\tau})\ln y_{i,t-\tau} + (1-e^{-\lambda\tau})(\tfrac{\alpha}{1-\alpha-\beta})[\ln s_{i,t} - \ln(n_{i,t}+g+\delta)] + (1-e^{-\lambda\tau})(\tfrac{\beta}{1-\alpha-\beta})[\ln h_{i,t} - \ln(n_{i,t}+g+\delta)] + \mu_i + \varepsilon_{i,t} \quad (27)$$

Where 'α' is the share of physical capital and 'β' is the share of human capital in per worker income. The estimated results from the above restricted regression are reported in Table-5.7 below.

Table 5.7: Dynamic Panel Estimates for Conditional Convergence
(Restricted Augmented Neoclassical Model)

Dependent variable $\ln(Y_{i,t}) - \ln(Y_{i,t-\tau})$

Variables	Least squares	Fixed Effect(WG)	DIF-GMM
ln ($y_{i,t-1}$)	**- 0.033**	**-1.276*****	**- 0.329*****
	(0.068)	(0.176)	(0.057)
ln ($s_{i,t}$) – ln ($n_{i,t}$+g+δ)	**0.015**	**0.024***	**0.022****
	(0.019)	(0.013)	(0.014)
ln ($h_{i,t}$) – ln ($n_{i,t}$+g+δ)	**0.067**	**0.087**	**0.104***
	(0.176)	(0.099)	(0.101)
Implied λ	**0.007**	**N/A**	**0.080**
Implied α	**0.129**	**0.018**	**0.050**
Implied β	**0.581**	**0.063**	**0.228**
Wald test: p-value	**0.27**	**0.41**	**0.2545**

Notes: Standard errors in parentheses. Three asterisks, two asterisks, and one asterisk denote statistical significance at 0.01, 0.05, and 0.10 levels respectively.

The results from first difference GMM show that the share of physical capital implied by the restricted augmented growth regression 0.050 which is very low and unrealistic value but the share of human capital is 0.23. The data support augmented Solow growth model as the test hypothesis that sum of the coefficient on ln(s), ln(n+g+δ) and ln(h) is equal to zero is not rejected. Also the share of

human capital is positive and quite reasonable and it turns out to be very important determinant of income growth. However, the share of physical capital is very low which does not support the model. So we can say that to some extent the data support the augmented Solow growth model's predictions and determinants of income growth rather than to support the Solow growth model. Moreover, on the other hand, we can observe that estimates of convergence coefficient are not effected by restricting both the models and remain almost same as before the results from unrestricted models shown in table (5.4) and (5.5). It shows that the convergence coefficients are consistent to this specification or modification, so the results for speed of convergence are robust. The implications of conditional convergence are discussed in the section (5.4).

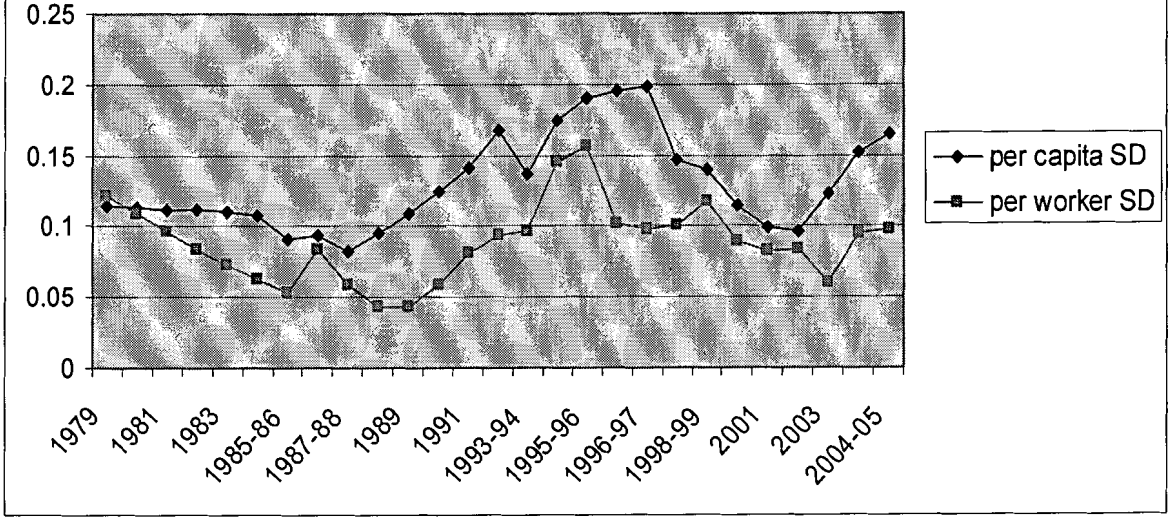
5.3 Sigma (σ) convergence

As we explained earlier, Sigma (σ) convergence means that cross-regional dispersion of per capita (worker) income measured as a standard deviation of the logarithm of real per capita income tends to decrease over time. On the other hand, the increase in interregional income inequality or variability is considered as σ-divergence meaning that the dispersion of real per capita income tends to increase over time. Friedman (1992) supports a measure of dispersion such as the standard deviation (σ) or coefficient of variation (CV) to see the disparities or inequalities in per capita incomes across different regions or economies. In convergence analysis, sigma convergence does not directly relate to the growth rates of economies but it focuses attention on the dispersion of per capita income over a cross section of economies at each point in time.

5.3.1- Overall analysis

The figure (5.1) shows the trend in the dispersion of both per capita and per worker incomes across all provinces or regions of Pakistan over the period from 1979 to 2005. Here we plot the standard deviation of log real per capita and per worker income. The trend in σ-estimates during the whole period (1979-2005) for the per capita income data shows that there is no evidence of Sigma (σ) convergence as regional income dispersion seems to rise. The standard deviation rose from (0.114) in 1979 to (0.165) in 2005 with the increase of 44 percent. If we analyze the trend in income dispersion between this period 1979-2005, apart from slight decrease in standard deviation in years 1988 and 2001-02 there is increase in regional income dispersion from 1979. However, much of the sharp increase in dispersion has taken place during the 1990s where the highest income per capita dispersion can be observed as reaching its maximum in 1996-97. Overall for entire period, the dispersion of per capita income across

Figure 5.1: Dispersion of real per capita/worker income(All Regions) (Sigma Convergence) 1979-2005



provinces has been widened or inter-provincial income disparities increases, so there is sign of σ-divergence.

Now, we turn to analysis in terms of per worker real income, the figure 4 shows overall slight decrease in dispersion from 0.12 in 1979 to 0.10 in 2005. However, there is a sign of Sigma (σ) convergence in 1980s as the clear declining trend in per worker real income dispersion is observed along with the temporary increase in year 1986-87. During 1990s, the standard deviation rose sharply indicating increase in regional disparities, thereafter no uniform trend appear to be exist but fluctuated up and down.

Three important results can be derived from Sigma (σ) convergence analysis across regions of Pakistan. First, comparison between per capita and per worker income turns out to be quite useful and important as when we observe the data in per capita terms, regional income disparities appear to be more increasing compared to the overall small decline of dispersion in per worker terms. The reason behind this result might be the fact that the majority of Pakistani population is not economically active and highly depends on active population (workers) as shown by high dependency ratios in data description chapter[7]. It can also be noted that all values of standard deviation for per worker real income lying below the standard deviation estimates for per capita real income showing less dispersion in terms of per worker data. It seems that the dependent and

[7] According to Population Census Report (1998), Economically Active Population is 29.4 millions out of total Population 132.4 millions. The report also indicates that only one third of the population 10 years and above in Pakistan is economically active which is very low.

inactive population increases disparities in real income because in terms of per worker income, there are less dispersions compared to the higher dispersions in terms of per capita income. Therefore, we can say that worker's income or output seem to be eaten up by dependent and inactive population. Second, during 1980s, per capita sigma estimates decrease slightly as compared to more decline in variability or dispersion in terms of per worker real income. This result is consistent with the finding of absolute convergence of per worker real income during period 1979-2005. Third observation is that there was sharp increase in dispersion in both per capita and per worker terms during the 1990s.

5.3.2- Rural- Urban Analysis

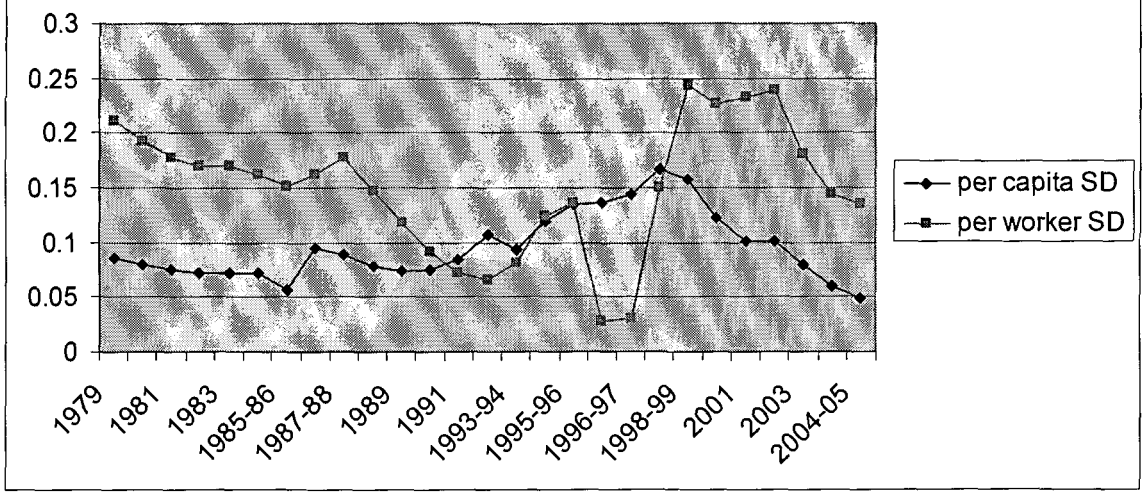
Sigma (σ) convergence for rural and urban economies or regions would be useful to understand the dispersion or inequalities of per capita/worker income across rural and urban areas separately. Figure (5.2) and (5.3) indicate the trends in dispersion of per capita and worker income across regions of Pakistan over the period from 1979 to 2005 for rural and urban areas respectively, measured by the standard deviation of log per capita and per worker income.

The Sigma (σ) measure of per capita real income for rural regions shows no significant change in dispersion for the entire period as the standard deviation slightly fall from 0.08 in 1979 to 0.05 in 2005 indicating by figure 5.2. However, there is consistent rising trend in dispersion from 1979 to 1998 apart from miner drop in one year 1986, showing clear sign of σ-divergence in rural areas in per capita terms. So this pattern shows increase in regional income disparities

across rural regions in this period. After the year 1998, there is decline in variability in per capita real income indicating some evidence of Sigma (σ) convergence in recent years in rural areas.

Regional income variations in rural areas are largely affected by agriculture production as agriculture output is one of the major components of the rural economy. Two main agrarian provinces, Punjab and Sindh which together account for 75 percent of the rural population, their income mostly depends on

Figure 5.2: Dispersion of real per capita/worker income (Rural Regions) (Sigma Convergence) 1979-2005



agriculture production. The rural economies performed better in years that show high productivity in agriculture and it seems that the sigma (σ) estimates are affected by agriculture output in several years. For example, the sharp rise in per worker income dispersion in years 1998-99 and 2001-02 is because of fall in agriculture output. The agriculture growth rate was 1.95 and -2.2 for the years 1998-99 and 2001-02 respectively falls from the higher growth rate of 11.74 in

1995-96[8]. After these periods, the agriculture production increases that lead to decrease in dispersion of per worker real income across rural regions as shown by figure 5.2. Thus, we can say that there is mix trend of rise and fall in standard deviation of log per worker income for the whole period and it mostly depends on agriculture production.

Figure 5.3: Dispersion of per capita/worker income(Urban Regions) (Sigma Convergence) 1979-2005

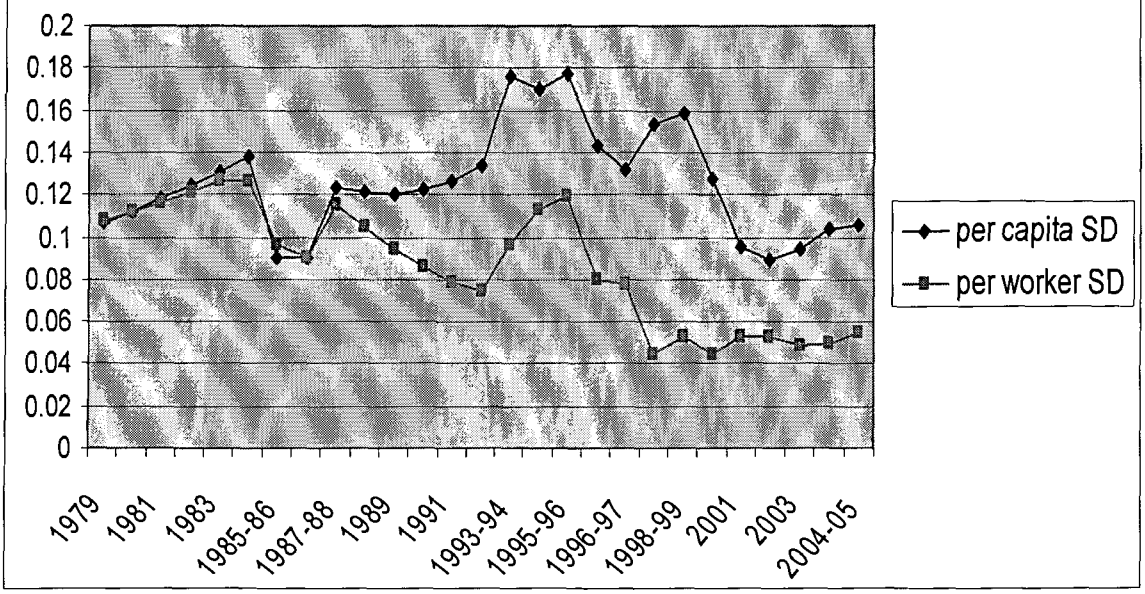


Figure (5.3) shows the dispersion of per capita and worker income for urban economies or regions for the entire period from 1979 to 2005. We find no significant change in trends in dynamics of urban income between per capita and per worker terms as the trends in dispersion of per capita and per worker income seem to be same almost for the entire period, although the overall dispersion in

[8] These figures can be seen from economic survey of Pakistan 2003-04, Government of Pakistan.

per worker income is less than per capita income. The dispersion in both per capita and per worker income starts from the same point and remains as till year 1988. However, the difference permanently increases or lying between per capita and per worker income dispersion but the trends in dispersion remains similar for the whole period apart from years 1988 to 1993-94 (i.e. per capita income dispersion seem to be rising while per worker declining).The overall separate analysis of Sigma (σ) estimates shows that there is sign of reduction in per worker real income dispersion across urban regions. The standard deviation falls from 0.108 in 1979 to 0.055 in 2005 with the decline of 49 percent, shows a significant fall. But between the entire period, income dispersion across urban regions fluctuate rather showing a clear decreasing or increasing trends as the rise can be seen in years 1984-85 and 1993 to 1995-96 followed by the sharp fall till 1998-99. It can also be revealed from the per worker SD curve that there is no significant change in real income disparities in the sub-period 1998-99 to 2005 across urban areas. But there is overall reduction in per worker income disparities for the entire period.

The data in terms of per capita income shows more variability and clear rise in regional income dispersion from 1979 to 1998-99 apart from temporary drop in 1985-86 and 1986-87 and 1996-97. There is fall in income dispersion for years after 1998-99 and then followed by rise till 2005. Therefore, overall Sigma (σ) estimates indicates no evidence for Sigma (σ) convergence in per capita income across urban economies rather it shows σ-divergence as the increase in income dispersion has been observed from 1979 to 1998-99. Hence, we can say that

regional disparities or inequalities appear to increase across urban areas in terms of per capita income compared to per worker income. The possible reason behind these results might be those described in section (5.2.1).

5.4 IMPLICATIONS OF CONVERGENCE

In conditional convergence, region converges to a steady state which is determined by parameters that are specific to that particular region. This steady state can be entirely different from the steady state of another region or economy with different set of parameters. The evidence of conditional convergence indicates that each regional economy converges towards to its own steady state. But, it does not tells about regional disparities or convergence process across different regions because different regions can have different (low or high) steady state level of income depends on the determinants of steady state (such as savings, population growth, human capital and technology). Hence, conditional convergence does not necessarily imply reduction in regional income disparities. There is crucial difference between conditional and absolute convergence, the latter implies regions are converging or catching up towards the same or common steady state. Therefore, studying dispersion or variability becomes important whether regions are, actually, converging or diverging. In other words, one needs to understand how dispersion or disparities across regions evolve over time i.e. the Sigma convergence analysis which is explained in section (5.3).

We find the absence of absolute convergence and Sigma (σ) convergence that is income disparities increase over time across different regions of Pakistan. The

evidence of conditional convergence does not contradicts with increasing disparities and this increasing variation or disparities is due to the variation in the steady states of regional economies because the findings of high rate of conditional convergence suggest that regional economies are very close to their steady states. Thus, the differences or disparities across regions can be explained by differences or variations in their steady state. These results strongly suggest that regional economies of Pakistan are converging to different steady states. Pakistan has been undergoing substantial structural changes in recent years, so the steady state determinants may have changing constantly[9]. The absence of absolute convergence also consistent with endogenous growth models that predict divergence or the increase in disparities over time across regions mentioned in literature review.

The welfare implication of conditional convergence finding is limited because it only means that poor regions are moving towards their own steady states and if these steady state income levels are themselves very low, the situation of poor is not going to improve without improving the steady state income level of poor. According to neoclassical growth models, growth rate of a region is affected by both the distance from the steady state (the more the distance from steady state, the faster the growth) and the change or shift in the steady state (balance growth path) itself[10]. There are some evidences that for many countries, the most

[9] These changes might be because of recent event of nine-eleven that have changed the geo-political environment in Asia especially in Pakistan and Afghanistan.

[10] See, for example, Romer (1996).

important part of growth process is not the process of convergence to the given steady state but the factors leading to changes in steady state (Islam, 1995). If any policy can increase the steady state level of income per worker or per capita, then the growth rate of that region should also rise because of the fact that the steady state is now further away. The above empirical findings and discussion shows that it is more important to focus on the determinant of steady state level.

CHAPTER 6

Summary and Conclusions

6.1 Summary of Analysis

The present study has examined the phenomenon of convergence of per capita (per worker) income levels across the four provinces of Pakistan over the period from 1979 to 2005. Different concepts on convergence, namely the beta-convergence (including both absolute and conditional concepts) and sigma-convergence have been reviewed and applied in the analysis. To this end, the neoclassical growth model provides the fundamental framework of analysis. We have used the available econometric techniques, right from the single cross-section regression to the more advanced dynamic panel data model by combining the time series and cross section data. To find the evidence of conditional convergence, we employed the dynamic panel framework because it provides natural specification to control for unobserved region specific effects like initial level of technology in convergence growth regression. We have used different estimators to find the consistent estimates of dynamic panel growth models and the first difference generalized method of moments (GMM) was the preferred estimation technique.

The hypothesis of absolute or unconditional beta-convergence assumes that all countries/regional economies within a country are similar in terms of the socio-economic condition but differ only in the initial levels of per capita incomes. As such, the relatively poorer regions/economies may grow faster than the richer and ultimately all the regions may converge overtime to the same/common

equilibrium (steady state) level of income. The hypothesis of conditional beta-convergence on the other hand takes care of the factual differences among the regions concerned that may occur in terms of the socio-economic condition or determinants of steady state growth. Therefore, the regional economies will follow independent growth paths and converge overtime to their own equilibrium levels, which may be different from one another. This concept can better explain the prevalence of income disparities across the regions even over the long run. The concept of sigma-convergence just looks at the regional dispersion of per capita income measured as a standard deviation and if the said dispersions are decreasing overtime, the per capita income gap between provinces is narrowing down. We investigated Sigma-convergence both in terms of per worker income and per capita income which showed how income dispersion or disparities across provinces evolves over time.

We could find no evidence of absolute convergence for the entire time span of 26 years from 1979 to 2005. However, when the data was divided into sub-periods (division based on different political regimes), the signs of regional income convergence could be observed for the period 1979-88. The trend could not continue thereafter, rather the symptoms of slight divergence or increasing income disparities were observed for the period 1998-2005. On the other hand, when the factors that affect the steady state equilibrium levels were controlled (differences in the determinants across the regions taken care of), we could observe a strong evidence of conditional convergence. The findings imply that

differences in the socio-economic conditions prevailing across the provinces are crucial and responsible for the persistence of economic disparities.

Some interesting results could also be derived by confronting the data to sigma-convergence analysis. By comparing the findings between per capita and per worker income, the regional disparities in terms of per capita incomes appeared to be more severe than that of per worker incomes. The finding implies that the number of dependent or inactive members of the population is responsible for higher dispersion of per capita income. This is in line with the conventional wisdom, since a higher dependency ratio means higher consumption or lower saving rates and thereby lower growth rates. An application of the model to rural and urban areas separately revealed that the intra-regional differences in the socio-economic conditions are as serious as the inter-regional differences. To sum up, the findings indicate that incomes per capita across the provinces are moving farther away from one another overtime and there is little tendency for reducing of disparities.

6.2 **Conclusions and Policy Recommendations**

The differences in social, cultural and political behaviors/outlook across the inhabitants of the four provinces of the federation are natural and easily understood. However, the prevalence of poverty and inequalities over the long run, both across the regions and within the regions in rural-urban bifurcation, are posing problems. This situation needs serious attention and calls for immediate remedial measures, failing which the dangerous sense of deprivation will

continue to develop and lead to political instability. Economic theory predicting convergences across regions subject to fulfillment of certain assumption can help in this regard. In other words, all the regions can converge to the same steady state equilibrium level of per capita income and thereby economic disparities removed if and only if the differences in the factors responsible for the steady state equilibrium levels of income across the respective regions could be minimized somehow via the appropriate public policies. Special efforts are therefore needed to enhance investment, not only in physical infrastructure but also in the social sector and human capital, to improve the conditions of living in parts of the country that were more or less ignored or remained lagging behind on the route to prosperity due to one reason or the other. In particular, special attention is needed to improve the efficiency of labour and to generate more employment opportunities in the relatively poorer regions. 'Regional development implies the overall economic development of the federation' can be considered as a simple rule of thumb. High GDP growth is meaningless if does not reduce the sufferings of masses. Further research is needed to identify the determinants of growth that are specific to the regions, keeping in view the socio-political circumstances prevailing over there. Since economic research relies heavily on data, therefore more efforts are required to generate complete and adequate data sets, disaggregated at least to the district level that are now the primary units of analysis and policy implementation after the devolution plan of present regime in 2002 and afterwards.

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