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Factors of Economic Growth in Latvia

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UNIVERSITY OF LATVIA
FACULTY OF ECONOMICS AND MANAGEMENT



OĻEGS KRASNOPJOROVŠ

**FACTORS OF ECONOMIC GROWTH IN
LATVIA**

SUMMARY OF DOCTORAL THESIS

Submitted for the degree of Doctor of Economics

Subfield: Econometrics

Riga, 2013

University of Latvia
Faculty of Economics and Management

Oļegs Krasnopjorovs

FACTORS OF ECONOMIC GROWTH IN LATVIA

Summary of Doctoral Thesis

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The doctoral thesis was carried out at the Chair of Mathematical Economics, Faculty of Economics and Management, University of Latvia, from 2008 to 2012.



LATVIJAS
UNIVERSITĀTE

European Social fund Project „Support for Doctoral Studies at the University of Latvia” Nr.2009/0138/ 1DP/1.1.2.1.2./ 09/IPIA/ VIAA/004.

The thesis contains the introduction, 4 chapters, reference list and 20 appendices.

Form of the thesis: dissertation in Economics, Econometrics subfield.

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- 3) Dr. oec., asoc. prof. Arnis Sauka, Ventspils University College.

The thesis will be defended at the public session of the Doctoral Committee of Economics, University of Latvia, at 12:00 on 22 March, 2013 in Riga, at Aspazijas blvd. 5, room 322.

The thesis is available at the Library of the University of Latvia, Kalpaka blvd. 4.

Chairman of the Doctoral Committee _____/prof. Ērika Šumilo

Secretary of the Doctoral Committee _____/asoc.prof. Anda Batraga

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Contents

Summary of the Doctoral Thesis	5
General Description of the Thesis.....	6
Approbation of the Thesis.....	13
The Main Tenets of the Thesis	17
1. Measuring the Factors of Long-term Economic Growth.....	17
2. Economic Growth Factors in Latvia.....	18
3. Factors of Average Labour Productivity Level in Latvia	22
4. Factors of Real Convergence Process in Latvia.....	25
The Main Conclusions and Proposals of the Doctoral Thesis.....	29

Summary of the Doctoral Thesis

Uneven economic growth during the recent years raise the question whether any factor of economic growth aside economic cycle fluctuations exists in Latvia. The objective of the Doctoral Thesis is, to assess the factors of economic growth in Latvia using econometric modelling techniques, and to solve various problems that arise when such techniques are used in Latvia's case.

The Doctoral Thesis has identified the main factor of economic growth in Latvia – fixed capital accumulation. Although every euro of public investments on average contributes to the GDP growth at least as much as the euro of private investments, fixed capital accumulation in the private sector is the primary source of economic growth owing to its larger amount and faster growth. The positive impact of fixed capital accumulation on the average labour productivity level in the country is both direct (increasing capital to labour ratio) and indirect (allowing to use more productive technologies). It is fixed capital accumulation that was the main factor that determined the convergences process of Latvia's average income and labour productivity level to the respective indicator in the EU-15 (countries that entered EU before 2004).

The Doctoral Thesis has identified the role of other factors of economic growth in Latvia as well as in other EU countries: labour, human capital and natural resource capacity in a country; changes of economic structure; world technical progress and country backwardness in respect to the world production frontier; regional aspects.

The Doctoral Thesis showed that results of the research depend crucially on selection of a particular method, statistical data source and assumptions. Therefore, a considerable part of the research is devoted to the methodological features of statistical data as well as to the check of result stability in respect to alternative methods and assumptions.

General Description of the Thesis

Topicality

Robert Lukas, Nobel Prize - 1995 winner in Economics recognized that economic growth concept has such a detrimental impact on human well-being that once a researcher begins to think about economic growth, it is hard to think about anything else. Thus, it is not surprising that economic growth field of study is one of the most popular ones within the economic science. For instance, from 51 thousand articles published in scientific journals within *Science Direct* database in 2012 containing the term "economics", more than 23 thousand contain the term "economic growth". Moreover, the share of scientific journal articles in Economics containing the term "economic growth" is rising over time.

The author of Doctoral Thesis began his research in the field of economic growth in 2003, being a second year student of Economics Bachelor's programme at the University of Latvia (LU). Since then, all author's term papers, as well bachelor's paper and master's paper were devoted to different questions related to the economic growth study field. Thus, this Doctoral Thesis should be regarded as a continuation of the previous research efforts.

Economic growth in Latvia during the past ten years was rather uneven. Three years in a row (2004, 2005 and 2006) Latvia's Gross Domestic Product (GDP) growth was the fastest among the European Union (EU) countries. This created a perception that Latvia's average income level could achieve the EU-15 level in just one generation. Latvia, Estonia and Lithuania were often named as "Baltic Tigers", based on the analogy with the "Asian Tigers" (South Korea and Singapore) and "Celtic Tiger" (Ireland), which were able to multiply the average income level during the living time of one generation.

The procyclical behavior of Latvian households (at the times of fast income growth, spending growth was even faster, and the households were borrowing money), procyclical expansive fiscal policy and real estate bubble resulted in a faster income rise than was augmented by the fundamental factors. While entrepreneurs were claiming on labour shortage, real wages were increasing faster than productivity in every sector of the economy, consumer price inflation increased and economic growth based on domestic demand was resulted

in unsustainably high current account deficits. Latvia's output gap exceeded 15% of GDP in 2007, which was the highest number in the EU.

After several years, a period of steep economic growth began to appear as merely a movement to the peak of the economic cycle – income growth that is not sustainable as it is not augmented with the fundamental factors. As the global financial crisis started, internal imbalances became visible to financial market participants; in its turn, global demand slump has deteriorated exporting possibilities. The mix of these factors has determined a deepness of economic slowdown: Latvia lost almost 25% of its GDP during 2008-2010, which was one of the deepest slowdowns in the world. Therefore, level of GDP in 2010 just returned to its value in 2004, creating the analogy to the Japanese "lost decade" during 1990-ties. From the one extreme, Latvia's society moved to the opposite extreme: income convergence topic in the media as well as in research paper headings was replaced by unemployment, social estrangement and financial crisis terms.

However, the question regarding the fundamental factors of economic growth never had been so topical before. In the long-term, economic growth is based on its fundamental factors. Fundamental factors of economic growth will determine whether GDP rise during the next few decades will exceed the respective indicator in the EU-15, i.e., whether the average income level in Latvia will fully or partly converge to the respective value in the EU-15.

During the recent years, among the policy priorities dominated the need to overcome the economic slowdown and its consequences, thus, various research papers were focusing on the assessment of the economic cycle fluctuations, analyzing and forecasting short-term economic growth. In its turn, fundamental factors of economic growth were rarely analyzed, and this defined the focus of this Doctoral Thesis. The impact of fundamental factors on economic growth may not be evident right now, but these factors are crucially important for the pace of Latvia's economic prosperity in the 21st century.

A number of scientists have assessed the fundamental factors of economic growth in Latvia using parametric methods. In its turn, the author of this Doctoral Thesis was the first to use non-parametric methods to assess the fundamental factors of economic growth in the case of Latvia. Furthermore, modelling of the real convergence process

is relatively rare. Therefore, this Doctoral Thesis is the first research project in which fundamental factors of economic growth in Latvia are assessed with various methods widely used in the international academic literature.

Research limitations

- Indicators of economic growth

According to the academic term database *AkadTerm*, economic development or growth is an upward shift of the national economy which is reflected in a rise of Gross National Product and other indicators during the specified period. In this Doctoral Thesis, real GDP and Gross Value Added (GVA) were used as main indicators of economic growth, based on the practice of other scientists (Gross National Product is relatively rarely used in assessing the factors of economic growth, both in Latvia and abroad). Real GDP is internationally recognized as the most important indicator of economic growth; in its turn, GVA is the most important GDP component from production and income sides.

According to the *AkadTerm*, economic growth is confirmed by the increase of investments and labour productivity as well as by rising real wages and general living standards. This definition has determined the selection of supplementary economic growth indicators – average level of labour productivity (GDP or GVA per employed or per working hour) and the average income level (GDP per capita). In its turn, investments, followed by the findings of the research literature, were analyzed as one of the possible economic growth factors; and real wage rise is reflected in a labour income share in GVA increase.

- Period of research

The period of research starts in Q1 1995 and ends at 2010 Q4. It is a longest period for which statistical data are available. In September 2011, Central Statistical Bureau of Latvia (CSB) has changed the methodology of GDP calculations for another time. Switching the sectoral classification from NACE 1.1. to NACE 2 changed not only the sector's share in GDP but also the total volume of GDP and GVA. CSB has recalculated real GDP figures according to the new methodology as from the beginning of 2001: 1995 – 2000 data are not available according to the new methodology whereas 2011 data are not available according to the old methodology. Research period of other growth

research papers that include Latvia or other EU-12 countries (countries that entered the EU in 2004 and 2007) commonly starts at 1995 as well.

The research object is economic growth in Latvia.

The research subject – factors of economic growth in Latvia.

The objective of the Thesis is to assess the factors of economic growth in Latvia using econometric modelling techniques, and to solve various problems that arise when such techniques are used in the case of Latvia.

For achieving the objective of the Thesis the following **tasks** have been set forth:

- to construct a theoretical and practical base for assessing the factors of economic growth in the case of Latvia;
- to study the research object and subject using dynamically structural analysis;
- to formulate and appropiate practically applicable methods for assessing the factors of economic growth in Latvia;
- to check the stability of results subject to the usage of alternative econometric modelling methods and statistical data sources;
- to summarize the problems regarding the usage of econometric modelling methods in the case of Latvia and the solutions thereof, as well as to present the proposals to improve the usage of these methods in the case of Latvia and other countries.

Research hypothesis: there exists at least one factor of economic growth in Latvia which is not related to the economic cycle fluctuations.

The Thesis includes the following **defendable theses:**

- Fixed capital accumulation is the main factor of economic growth in Latvia: it forms the base for GDP growth as well for the average income and average labour productivity convergence to the EU-15 level.
- Fixed capital formation promotes economic growth both by increasing the capital to labour ratio and allowing to use more productive technologies.
- Investments in the public sector in Latvia are at least as favorable for GDP growth as investments in the private sector.
- Income convergence in the EU is evident both in the country and regional level.

- Assumptions and statistical data sources used in the econometric modelling have large impact on results of the economic growth research.

Scientific contribution by the author. The following novelties have been designed in the Thesis:

- The author has developed the theoretical base to apply a number of economic growth research directions (non-parametric production function as well as conditional beta-convergence and club-convergence models) in the case of Latvia;

- It has been proved the usefulness of neoclassical growth model and appropriate technology model in studying the economic growth in the case of Latvia;

- It was studied the usefulness of decomposition of fixed capital and investments by institutional sectors (private capital and public capital) in the case of Latvia;

- It has been showed the usefulness of the non-parametric econometric research methods in modelling the economic growth in the case of the EU-12 countries.

- It has been studied the usefulness of the check of the stability of results in the economic growth research subject to assumptions and statistical data sources used.

Practical contribution by the author. The practical novelties specified below have been presented in the Thesis:

- The dynamically structural analysis of the labour income share in the GVA was performed, using Latvia's national accounts data;

- Fixed capital dynamics (in private and public sectors) estimation method that aims to maximize the descriptive power of the production function model was approbated in the case of Latvia;

- Flash correction of employment quarterly time series (CSB Labour Force Survey data) subject to the unreported migration (CSB plans to recalculate 2001-2010 data consistent with the 2011 population census in the second half of 2013) was performed;

- It has been performed the dynamically structural analysis of the convergence of the average income and labour productivity level in Latvia to the corresponding values in the EU-15 countries;

- It has been assessed the impact of two structural factors (employment structure by sectors and the intensity of natural resource usage) on the average labour productivity level in Latvia and in the other EU countries.

Research methods. In the course of work on the Thesis, generally accepted quantitative and qualitative methods of economic research were applied; including the analysis of monographs, grouping, comparison, generalization, graphic analysis, statistical and econometric analysis, as well as econometric modelling methods. Calculations were performed by using *Microsoft Excel*, *EViews* and *DEAP* software.

Substantiation of the content and structure of the Thesis. The structure of the Thesis has been determined by the tasks set forth for paper. The paper consists of the introduction, four sections, conclusions and proposals as well as list of references. The Thesis consists of 165 pages and includes 21 table, 58 figures, 92 formulas and 20 annexes. The list of references includes 201 source.

Section 1 constructs a theoretical base for the application of economic growth research methods in the case of Latvia. Founded on neoclassical growth model and its extensions, it analyzes the methods to assess the factors of GDP growth as well as average income and average labour productivity; the main findings of the scientific research literature published in Latvia and abroad were analyzed critically.

Section 2 is devoted to the assessment of the factors of GDP growth in Latvia. Section includes a critical analysis of the econometric modelling methods and assumptions that were used by other researchers. Latvia's production function was estimated both using regression approach and national accounts approach, assessing the possible sources of the differences in results. Various production function specifications were tested, particularly, splitting fixed capital stock into the private and public components. Emphasis was put on the check of the stability of results subject to the methods, assumptions and statistical data sources used.

In Section 3, factors determining labour productivity differences in the EU were analyzed using parametric and non-parametric methods. Furthermore, based on neoclassical growth model and appropriate technology model, world production frontier was constructed, as well as the backwardness of selected countries towards it was estimated. The

stability of results was checked subject to the assumptions regarding the fixed capital accumulation process as well as to the cross-country differences in employment sectoral composition and the intensity of natural resource usage.

Section 4 is devoted to the assessment of the real convergence process within the EU, using country and regional data and separating absolute beta-convergence, conditional beta-convergence, sigma-convergence and club-convergence concepts. The dynamically structural analysis of the convergence process of average income and labour productivity level in the case of Latvia was performed.

Finally, there were summarized the main conclusions and proposals to the Saeima, Cabinet of Ministers, Ministry of Economics, Ministry of Finance, Latvia's Municipalities Association, Central Statistical Bureau of the Republic of Latvia, Bank of Latvia, administration and academic personal of Latvia's universities as well as to scientists and researchers.

Research period. In the course of the research, 1995-2010 data were used. The selection of the period was determined by the data availability (see research limitations). Research was carried from 2008 to 2012. The Doctoral Thesis involves all available information (particularly, historical data corrections in statistical databases) as of June 2012. Statistical data corrections published after June 2012 (the time of the presentation of the Thesis on extended meeting of Mathematical Economics Department) is not assessed.

The theoretical and methodological basis of the Thesis. The theoretical and methodological basis of the Thesis is constituted by the relevant economic and econometric literature, research publications as well as discussion materials and monographs by Latvian and foreign scientists, materials of scientific conferences and seminars, regulatory enactments of the Republic of Latvia, statistical data and methodological materials of the Central Statistical Bureau of the Republic of Latvia, the Eurostat, the World Bank and other international organizations.

Approbation of the Thesis

- Job:

The author of the Thesis works as a Senior Economist in the Macroeconomic Analysis Division of the Monetary Policy Department of the Bank of Latvia (BoL MPD). The main results of the Thesis have been approbated in several analytical publications of the Bank of Latvia as well as unpublished research papers. The full list of the author's analytical publications (more than 80 publications during the last three years) could be found in the Internet: <http://www.makroekonomika.lv/olegs-krasnopjorovs>

- Participation in scientific projects:

1. In-depth study "*Product Space Analysis and the Scope for Structural Transformation: The Case of Latvia*" (co-authors: K.Beņkovskis, M.Bitāns) for the State Chancellery research project "*Elaboration of the State Competitiveness Assessment and Sustainable State Competitiveness Monitoring Model*", 2011.
2. Scientific Project of the University of Latvia No. 2008/ZP – 108 and No. 2009/ZP – 109 "*The role of Sectoral Composition of the Foreign Direct Investments in Economic Growth*" (co-authors: I.Revina, E.Brēķis, K.Vītola).

- Study process:

The author conducted quest lectures in the courses "*International Monetary Economics*", "*Applied Econometrics*" and „*Economic Modelling Methods*” at the Faculty of Economics and Management of the University of Latvia (LU EVF) over the period 2009 – 2012.

- Presentation and discussion of research results (excluding academic conferences):

1. Open meeting of the Latvian association of Econometricians "Modelling Real Convergence Process in the European Union Region". Riga, Latvia, held on 28 January 2013. (www.ekonometrija.lv)
2. LU Doctoral Committee on Economics meeting, held on 4 December, 2012.
3. Extended meeting of the Mathematical Economics Department of the LU EVF held on 14 June 2012.
4. Meeting of the Economics Doctoral Council of the University of Latvia held on 7 May 2012.

5. Meeting of the Mathematical Economics Department of the LU EVF held on 23 February 2012.
6. Study Center „Gerzensee” (Swiss National Bank) course "*Advanced Topics in Empirical Macroeconometrics*" (Switzerland, February 6-17, 2012). Report: "*Measuring the Sources of Economic Growth with Parametric and Non-parametric Methods*"
7. Scientific Seminar of the BoL MPD "*Private investment and public Investment Productivity Assessment: Production Function Approach*" held on 14 October 2011.
8. Scientific Seminar of the BoL MPD "*Labour Market Elasticity Assessment in Latvia as Compared to Other EU Countries*" held in September 2010 (co-author: A. Meļihovs)
9. Scientific Seminar of the BoL MPD "*Wage and Labour Productivity in Latvia: Economic Structure and Employment Composition Effects*" held in February, 2010.
10. Scientific Seminar of the BoL MPD "*Measuring Public Spending Efficiency in Latvia*" held in October 2009.

- Presentation and discussion of research results in academic conferences:

International Scientific Conferences:

1. "*Do Appropriate Technology View Holds in the EU: Explaining Cross-Country Labour Productivity Gaps Using DEA*": section "Integrated and Sustainable Development" in the 13th international scientific conference of the Latvian University of Agriculture "Economic Science for Rural Development"; Jelgava, Latvia, 2012.
2. "*Measuring the Sources of Economic Growth with Non-Parametric Methods: the Case of Baltic States*": section "International Relations and Economic Growth" (award for the best presentation) and plenary session in the international scientific conference for Doctoral Students "Current Issues in Economic and Management Sciences" at the University of Latvia in Riga (Latvia) held on 10 - 12 November 2011.
3. "*Private and public capital contribution to economic growth in Latvia*": in the 2nd international scientific conference „Sustainable Development and Competitiveness” at the University of National and World Economy, Sofia (Bulgaria) held on 25-26 September 2009.
4. "*An analysis of the impact of FDI in Latvia*" (co-authors: I.Revina, E.Brēķis): in the 2nd international scientific conference „Sustainable

Development and Competitiveness” at the University of National and World Economy, Sofia (Bulgaria) held on 25-26 September 2009.

particularly, annual International Scientific Conferences of the University of Latvia:

5. *"Measuring the Impact of Fixed Capital on Economic Growth in Latvia Using Parametric and Non-parametric Methods"*: LU 70th conference (2012).
6. *"Income Convergence of Latvia to the Average Level of EU-15 Countries"*: LU 69th conference (2011).
7. *"Wages and Labour Productivity in Latvia"*: LU 68th conference (2010).
8. *"Sectoral Composition of Foreign Direct Investments – its Role in Economic Growth"* (co-authors: I.Revina, E.Brēķis, K.Vītola): LU 68th conference (2010).
9. *"The Impact of Private and Public Capital on the Economic Growth in Latvia"*: LU 67th conference (2009).
10. *"Foreign Direct Investment Structure Role in Economic Growth"* (co-authors: I.Revina, E.Brēķis, K.Vītola): LU 67th conference (2009).
11. *"Measuring the public spending efficiency"*: LU 66th conference (2008).
12. *"Factors of Economic Growth"*: LU 65th conference (2007).
13. *"Economic Development of Latvia: analysis and forecasts"*: LU 64th conference (2006).
14. *"Money Supply and GDP"*: LU 62th conference (2004).

- Scientific Peer-Reviewed Publications:

1. Krasnopjorovs O. (2012) Do Appropriate Technology View Holds in the EU: Explaining Cross-Country Labour Productivity Gaps Using DEA // *Economic Science for Rural Development. Conference Proceedings #27 "Integrated and Sustainable Development"* (ISSN 1691-3078, ISBN 978-9934-8304-0-2, Agris, EBSCO) pp.132-138. Latvian University of Agriculture, Jelgava, Latvia; 289 p.
2. Krasnopjorovs O. (2012) Measuring the Sources of Economic Growth in the EU with Parametric and Non-parametric Methods // *Journal of Economics and Management Research* (University of Latvia), Vol.1. pp. 106-122.
3. Krasnopjorov O. (2012) Why the poor countries are developing faster: measuring the beta-convergence process in the European Union

- (in Russian) // Topical questions of the modern economic science. Lipeck, Russian Federation. Publishing house "Gravis", Vol. 9, pp.7-12.
4. Krasnopjorov O. (2012) Assessing the production function under the uncertainty of dynamics of the fixed capital (in Russian) // Topical questions of the modern economic science. Lipeck, Russian Federation. Publishing house "Gravis", Vol. 9, pp. 146 - 151.
 5. Krasnopjorovs O. (2011) Is public capital more productive than private capital? Evidence from Latvia 1995 – 2009 // *Economic Studies* (EconLit; IDEAS RePEc). Bulgarian Academy of Sciences, Economics Institute, Sofia, Bulgaria. Issue No. 3 / 2011. pp. 168-180.
 6. Krasnopjorovs O. (2010) Dynamics of Labour Income Share in Latvia and the EU // *Journal of Business Management* (EBSCO), Riga International School of Economics & Business Administration (RICEBA), Issue 3. pp. 48-56.
 7. Krasnopjorovs O. (2009) The Role of Private and Public Capital in the Economic Growth in Latvia (in Latvian) // *Scientific Papers of the University of Latvia*, Vol.744, Economics. pp.228-239.
 8. Krasnopjorovs O. (2009) Measuring the Efficiency of Public Spending in Latvia (in Latvian) // *Scientific Papers of the University of Latvia*, Vol.743, Economics. pp.117-128.
 9. Revina I., Brekis E., Krasnopjorovs O. (2009). An Analysis of Impact of Foreign Direct Investments in Latvia // *Sustainable Development and Competitiveness. Conference proceedings*. University of National and World Economy, Sofia, Bulgaria, pp.14-21.

- Other important publications (not peer-reviewed):

1. Krasnopjorovs O. (2010) What Does Productivity Tell on Economy – Income, Competitiveness, Growth Prospects? (in Latvian) // *Journal "Balance"*, Nr. 2 / 2010, pp. 16-17.
2. Krasnopjorovs O. (2009) Efficiency of Public Spending in Latvia (in Latvian) // *Bank of Latvia bulletin "Averss un Reverss"*, Nr. 3 / 2009, pp. 5-7.
3. Krasnopjorovs O. (2009) Labour Market During Economic Slowdown (in Latvian) // *Bank of Latvia bulletin "Averss un Reverss"*, Nr. 4 / 2009, pp. 1-4.
4. Krasnopjorovs O. (2008) The Share of Labour Income in GVA in Latvia and Other EU Countries (in Latvian) // *Bank of Latvia Monetary Review*, Nr. 3 / 2008, pp. 44 – 46

The Main Tenets of the Thesis

1.Measuring the Factors of Long-term Economic Growth

Neoclassical growth model is a theoretical base of economic growth research. Its main directions are summarized in Figure 1.

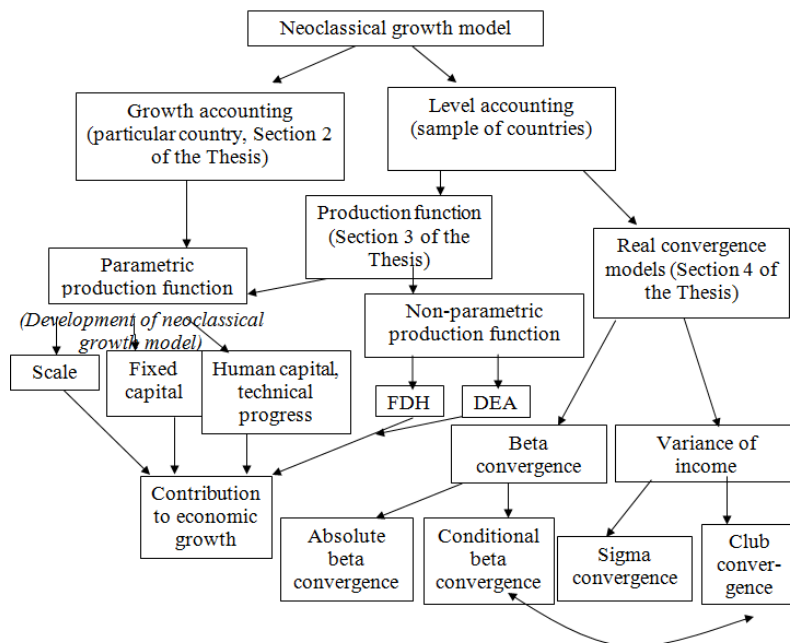


Figure 1. Classification of the Main Directions of the Long-term Economic Growth Research

Source: author's development

In the one country case, economic growth research is based on the production function in a parametric form. The main purpose of production function estimation is to assess the elasticity of GDP in respect to the fixed capital and labour. This exercise could be pursued using regression approach or national accounts approach. Neoclassical growth model has been developed over time. First, it was augmented with the conditions of scale effect presence. Second, fixed capital was splitted in various forms - subject to economy branches, institutional

sectors and asset types. Third, production function was augmented with the labour quality indicator (human capital) while technical progress was endogenized.

In a multy-country case, economic growth research is based either on the production function (in a parametric or non-parametric form) or on real convergence models. The purpose of non-parametric production function estimation is to assess the world production frontier as well as location of any particular country subject to this frontier. Research literature distinguishes two methods of non-parametrical analysis: FDH (Free Disposal Hull) and DEA (Data Envelopment Analysis), from which the latter method is more advanced and gives more feasible results. In its turn, real convergence process could be analyzed from the two aspects. The first mode is to check whether average income per capita level in poor countries rises faster than in rich ones (beta-convergence). The second mode is to assess the changes of cross-country income differentials: for instance, in the course of time, income variance in a country sample may decrease (sigma-convergence), while the countries may split by the several income groups or clusters (club-convergence).

2. Economic Growth Factors in Latvia

Fixed capital dynamics is the largest uncertainty when Latvia's production function is estimated using regression approach. Different researchers use various methods to estimate the fixed capital time series. Although the choose of the method has important impact on results, scientific literature rarely checks the stability of results subject to the methods, statistical data sources and assumptions used.

For instance, dependent on assumptions regarding fixed capital accumulation, estimated GDP elasticity in respect to the fixed capital could vary by several times. Latvia's production function was estimated for the period from the first quarter of 1995 to the fourth quarter of 2010, which is the longest time span for which GDP data are available without changes in methodology. Every curve in Figure 2 reflects the estimated GDP elasticity in respect to the fixed capital (left vertical axis) subject to the assumptions regarding fixed capital to GDP ratio in 1995 (horizontal axis) and fixed capital depreciation rate δ (which is showed with the corresponding curves).

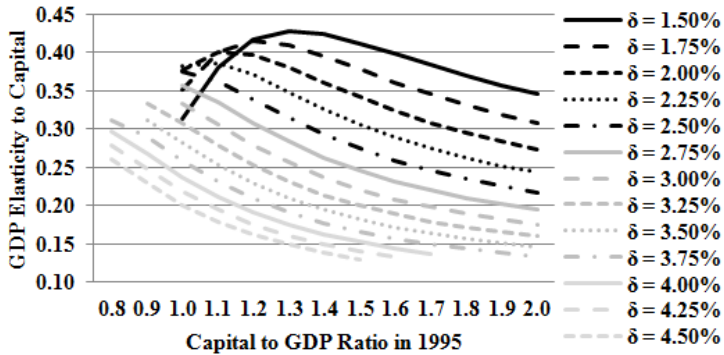


Figure 2. Estimated GDP Elasticity to Fixed Capital Subject to Assumptions on Fixed Capital Accumulation

Source: author's estimation based on CSB data

It was found such combination of assumptions that maximizes the descriptive power of the production function model (i.e., minimizes the value of regression Akaike criteria): fixed capital to GDP ratio in 1995 was 1.2, whereas fixed capital depreciation rate is equal to 2.5% per quarter, which is approximately 10% per year (see Figure 3). Trend stationarity of the total factor productivity (TFP) process allows interpreting the distance from its linear trend as data error.

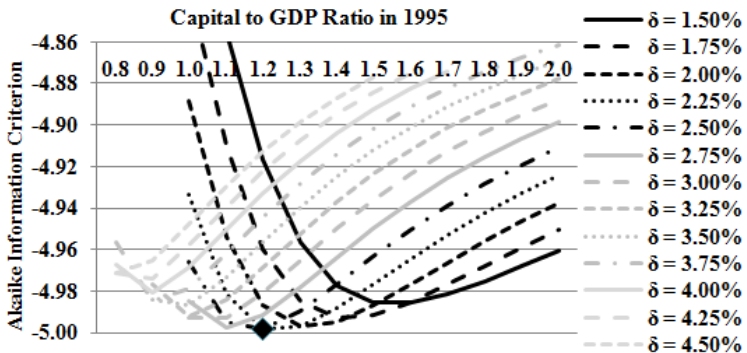


Figure 3. Akaike Information Criterion of the Latvia's Production Function Model Subject to Assumptions on Fixed Capital Accumulation

Source: author's estimation based on CSB data

Fixed capital split to private and public components allows assessing the relative productivity of these fixed capital types, i.e., in which institutional sector additional euro of investments is more important to the economic growth. It is the first time when such a split was made in the case of Latvia's production function. It was found that although public investments are more productive in promoting GDP growth, the productivity difference between the two investment types is statistically significant only if the share of public sector in fixed capital stock in the beginning of research period is assumed to exceed 40% (see Figure 4). At the same time, national accounts data on fixed capital and employment shows that the public sector share was likely to be smaller. Moreover, the descriptive power of the production function model is maximized when the share of public capital in fixed capital stock in 1995 is assumed to be 21%. Therefore, we can conclude that public investments are at least as much productive in promoting GDP growth as private investments.

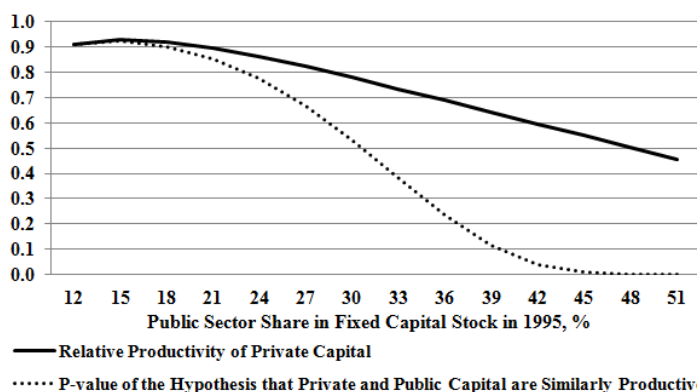


Figure 4. Relative Productivity of Private Capital and p-value of the Hypothesis that Private and Public Capital are Similarly Productive Subject to Assumptions on Public Sector Share in Fixed Capital Stock in 1995

Source: author's estimation based on CSB data

Latvia's production function estimation results are shown in Table 1. The increase of the fixed capital stock in the private sector by 1% raises GDP by 0.311%. In its turn, the increase of the fixed capital stock in the public sector by 1% raises GDP by 0.049%. Therefore, GDP elasticity in respect to the fixed capital is 0.360. Inclusion of the

dummies is necessary to overcome a structural break of the production function model evidenced during the period of economic downturn. All estimated coefficients are statistically significant at 99% confidence level and stable over time (change of the estimation period do not have a major impact on results) which increases the robustness of results.

Table 1.

Latvia's Production Function Estimation Results, Splitting Fixed Capital Stock by Institutional Sectors

		Constant	3.950*
GDP elasticity subject to	fixed capital in the	private sector	0.311*
		public sector	0.049*
	labour		<u>0.640</u>
Residual component of GDP growth (TFP)			0.0073*
Dummies	2008 Q1 – 2008 Q4		-0.111*
	2009 Q1 – 2010 Q4		-0.260*
Standard deviation			0.0192
Augmented coefficient of determination			0.9952
Durbin-Watson statistics			1.354
Akaike information criterion			-4.9806
Schwarz information criterion			-4.7782

*: coefficient is statistically significant at 99% confidence level.

Underlined coefficient: calculated indirectly from other coefficients.

Source: author's estimation based on CSB data

It was found that labour variable that maximizes the descriptive power of the production function model is working hours according to the national accounts data. The author of the Thesis made an attempt to adjust employment data on the unrecorded migration using passenger flow method (the difference between passenger arrivals and departures in Riga airport and seaport), but this adjustment did not improve the descriptive power of the production function. Considering the failure of other researchers to increase the descriptive power of Latvia's production function with the education indicators, human capital variable in the Thesis rely on employment composition among the economic branches. However, also this human capital approximation was not capable to raise the descriptive power of Latvia's production function. The same applies to the usage of alternative assumptions regarding scale effect and technical progress.

Assessing the role of supply factors in Latvia's GDP growth during the 2001 – 2010 period, fixed capital accumulation was found to be the main GDP growth driver. Furthermore, the primary role belongs to the fixed capital accumulation in the private sector which is determined by its largest amount and steeper rise. In its turn, fixed capital accumulation in the public sector accounted for about 13% of GDP growth, TFP impact was 9% and labour impact – 3%. Compared to the results of other researchers, the role of fixed capital accumulation in GDP growth is estimated to be higher and the role of TFP is lower.

3. Factors of Average Labour Productivity Level in Latvia

World production frontier Φ , estimated using a DEA method, and with fixed capital and average labour productivity data adjusted for the economic cycle, is shown in Figure 5.

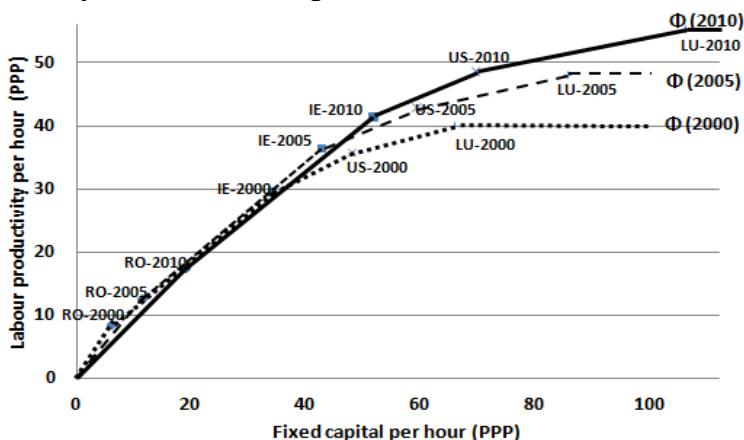


Figure 5. World Production Frontier in 2000, 2005 and 2010, Estimated by a DEA Method

Source: author's estimation based on Eurostat, Groningen Growth Accounting Database (GGAD) and World Bank data

Irrespective of the time period, world production frontier includes four countries – Romania, Ireland, USA and Luxembourg. Over time it moves up – technical progress allows achieving ever higher labour productivity with the same fixed capital endowment. However, this effect is present only in the case of sufficiently large fixed capital

endowment. At the contrary, if fixed capital endowment is low (this applies also for Latvia), given the unchanged production facilities, smaller value added could be produced today than 10 years ago. This finding reflects the capital-biased technical progress, which bear fruits primarily to the countries with large fixed capital endowment. According to the Basu and Weil (1998)¹ appropriate technology model, technical advances that are created in countries with large fixed capital endowment are not usable or at least are not so productive in a low capital to labour environment. Therefore fast fixed capital accumulation can raise the labour productivity level in poor countries both directly (increasing the capital to labour ratio) and indirectly – allowing to use more productive technologies.

This Thesis is the first attempt to use non-parametric growth accounting methods to the sample of countries that includes also EU-12 States. All three Baltic States are situated below the world production frontier, thus, average labour productivity level is lower than could be achieved with the current fixed capital endowment (see Figure 6).

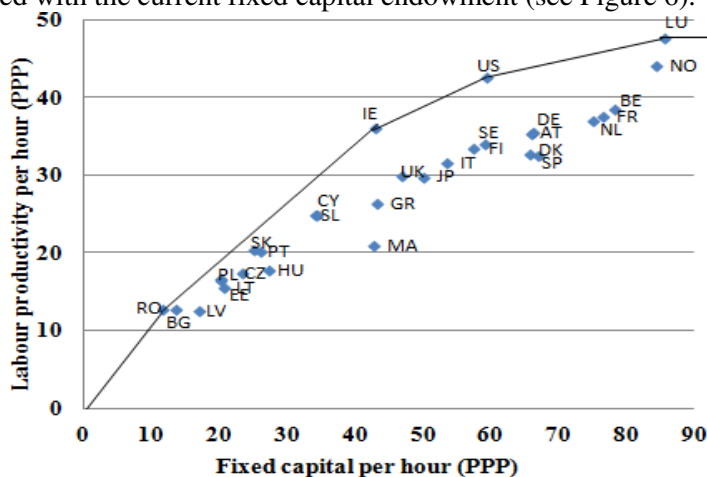


Figure 6. Assessment of the Backwardness Subject to the World Production Frontier for Different Countries During the 2000 – 2010

Source: author's estimation on Eurostat, GGAD and World Bank data

¹ Basu S., Weil D.N. Appropriate Technology and Growth. *The Quarterly Journal of Economics*. Volume 113, Issue 4, pp. 1025 – 1054. November 1998.

For instance, in Latvia, fixed capital stock per hour worked in 2000, adjusted for Purchasing Power Parity (PPP) was 10.1 euro. World production frontier reflects the highest labour productivity (GVA per hour worked) that could be achieved given the respective fixed capital endowment – 13.2 euro PPP. However, the actual level of average labour productivity in Latvia was only 8.9 euro PPP. Therefore, production process efficiency is estimated to be 0.675 (see Table 2). Over time, the average efficiency of the EU-12 countries converges to the respective indicator of EU-15 countries and USA: in just ten years, it increases from 0.733 to 0.814. However, in the Baltic States, particularly in Latvia, the increase of efficiency was much slower.

Table 2.

Assessment of the Production Process Efficiency in Selected Countries (in 2000 and 2010)

Year:	Variable:	Unit:	Latvia	EU-15 and USA average	EU-12 average
2000	Fixed capital	euro PPP per hour worked	10.1	50.1	18.1
	GVA		8.9	29.4	13.6
	GVA frontier		13.2	35.5	19.2
	Production process efficiency		0.675	0.829	0.733
2010	Fixed capital	euro PPP per hour worked	25.7	70.6	30.8
	GVA		16.5	38.8	21.8
	GVA frontier		23.5	47.3	27.2
	Production process efficiency		0.701	0.821	0.814

Source: author's estimation on Eurostat, GGAD and World Bank data

Combining parametric and non-parametric production function, it was found that both direct and indirect effects of fixed capital accumulation are important. Therefore, neoclassical growth model, by considering only the direct effect, underestimates the role of fixed capital accumulation in economic growth and overestimates the role of residual component TFP. Although neoclassical growth model assumes that fixed capital endowment does not have an impact on TFP, this is not confirmed by empirical data. For instance, the value of the coefficient of determination in the regression that put together fixed capital endowment and TFP is from 0.71 to 0.83 (depending on assumptions on fixed capital accumulation and whether the impact of

employment structure and natural resource use on labour productivity was taken into account). Therefore, cross-country differences in fixed capital endowment could explain 71-83% of TFP cross-country differentials.

In the case of Latvia, the main factor of labour productivity rise is fixed capital accumulation (see Figure 7), and similar result is obtained also for the other EU-12 countries. Fixed capital accumulation allows not only increasing the capital to labour ratio, but also to use more productive technologies.

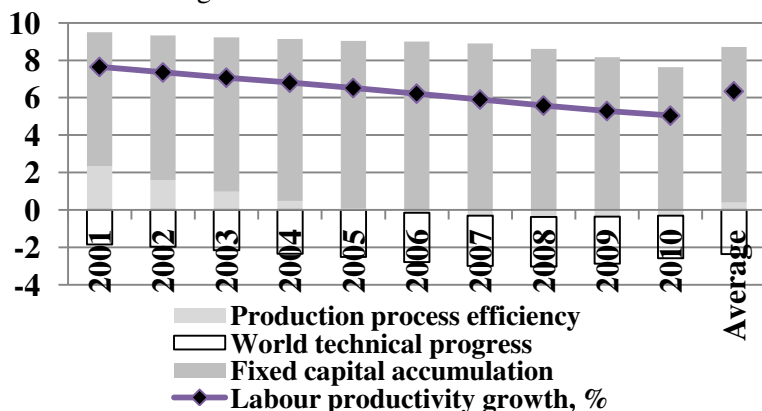


Figure 7. Factors of Labour Productivity Growth in Latvia During 2001-2010, Estimated by the DEA Method (percentage points)

Source: author's estimation on Eurostat, GGAD and World Bank data

4. Factors of Real Convergence Process in Latvia

When estimated on empirical data, the speed of beta-convergence process is much smaller than calculated theoretically within the neoclassical growth framework. Annual speed of income convergence during the 1995-2009 period among the EU countries was estimated to be 2.6%. This result is similar to Barro and Sala-i-Martin (2004)² long-term income convergence estimations for another regions and time periods. In the course of the Thesis, it was found that income convergence process is statistically significant in all time periods except

² Barro R., Sala-i-Martin X. *Economic Growth*. London, 2004. – 672 pages.

for the 1995-2000 when labour productivity convergence was compensated by the divergence of employment levels. In a regional breakdown, income beta-convergence process takes place slower than in a country breakdown. Annual speed of income convergence during 1995-2009 using data of NUTS-1, NUTS-2 and NUTS-3 regional breakdown (EU is splitted to 113, 271 and 1303 regions respectively) is 2.2%, 2.0% and 1.7% respectively. The lower was average income level in 1995 (y_{1995}), the faster income growth was recorded during the following 14 years (y_{2009} / y_{1995} ; see Figure 8).

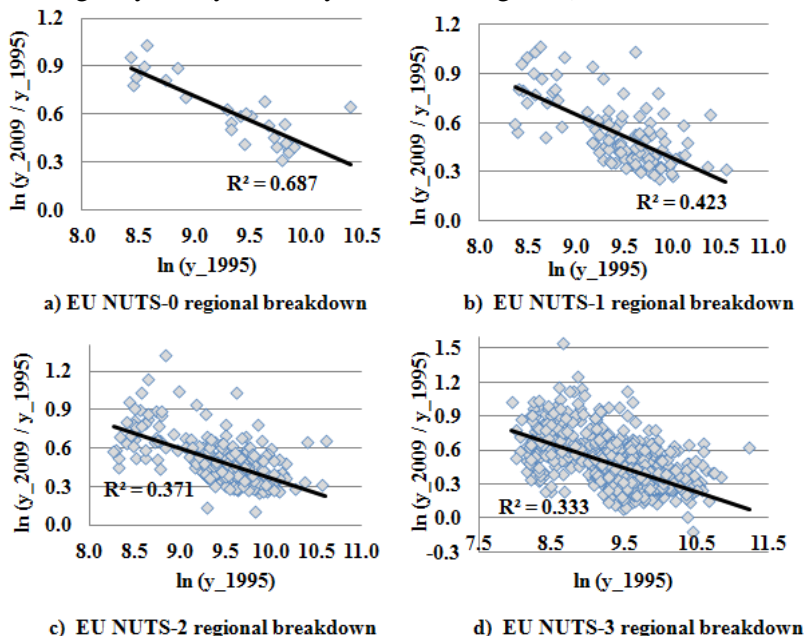


Figure 8. Income Growth in the EU During 1995-2009 in Respect to the Income Level in 1995

Source: author's estimation on Eurostat data

In the course of the research, it was found that country borders and the region's belonging to the EU-15 or EU-12 country group do not have a major impact on income convergence dynamics. For instance, income convergence within the EU-15 and EU-12 is much slower than in the EU as a whole. Therefore, income convergence primarily takes place between rather than within EU-15 and EU-12.

However, the convergence speed depends on how developed is a particular region compared to a country it belongs to. When the most developed regions were selected from each EU country, income convergence between them was found to be faster than among the whole EU and also faster than in the group of not so developed regions.

In Latvia, labour productivity is a main factor of average income growth. Although the role of participation and employment rate changes, as well as the dynamics of the average working week length was significant in some years, in the middle term these factors neutralize each other (see Figure 9). Similar picture is obtained when assessing factors of Latvia's per capital income convergence to the respective value of the EU-15.

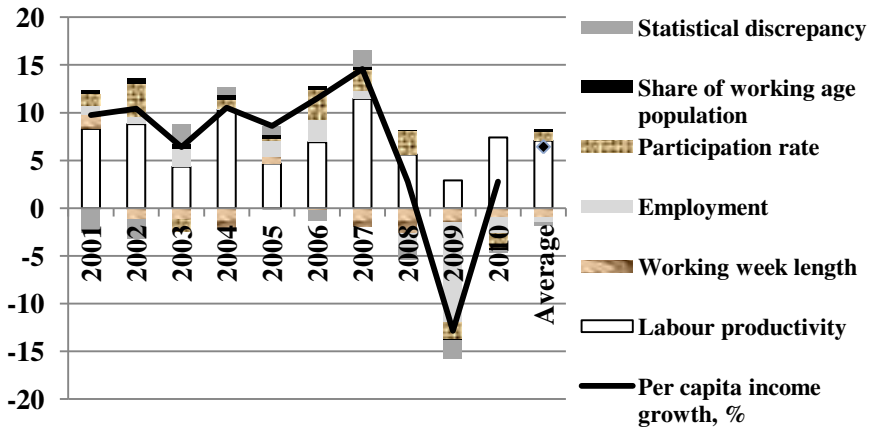


Figure 9. Factors of Average Income Level Rise in Latvia During 2001-2010 (contribution; percentage points)

Source: author's calculations based on Eurostat data

The rise of average labour productivity level in Latvia was determined not only by the labour productivity growth in each of the sectors of the economy, but also by the economy structural changes – over time, sectors with high labour productivity increased their share in total employment structure. However, compared to the EU-15 countries, the share of hours worked in sectors with high average labour productivity is still low, particularly in manufacturing.

Income beta-convergence process in the EU is accompanied with the sigma-convergence process. During the 1995-2010 period, the coefficient of variation of the average income level decreased by 42%.

In its turn, no evidence was found in favor of club-convergence process in the EU. Kernel density function of the average income level of the EU regions is shown in Figure 10. The natural logarithm of the per capita income level ($\ln(y)$) is shown in the horizontal axis while the vertical axis reflects the kernel density or the number of regions with the respective income level.

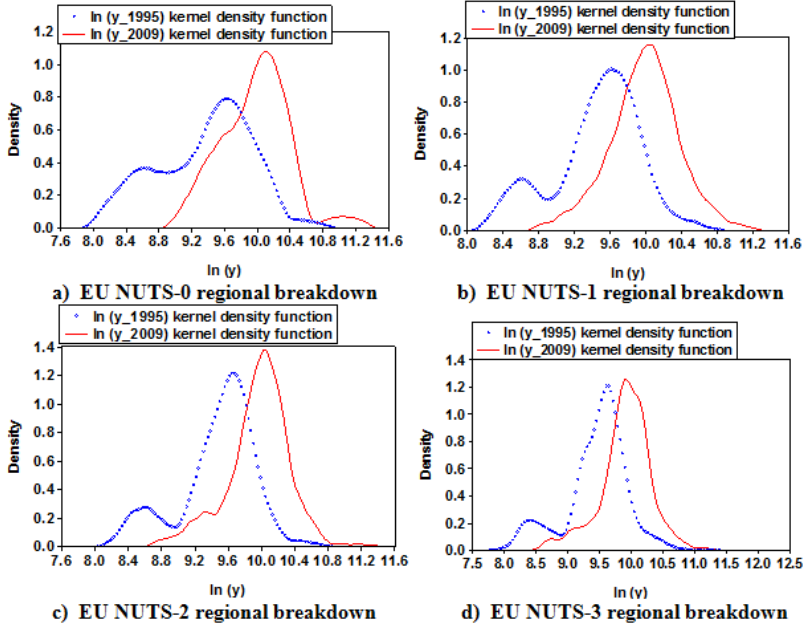


Figure 10. Income Kernel Density Function Estimation in the EU Regions

Source: author's estimation based on Eurostat data

Bimodal income distribution in 1995 gradually transforms to the unimodal distribution. Moreover, if in 1995 income distribution was left-tailed, during the subsequent years it tended to approach normal distribution. Various statistical tests that examine the equality of variance among the samples prove that the decrease of income variance across EU regions is statistically significant.

The Main Conclusions and Proposals of the Doctoral Thesis

During the elaboration of the Thesis the author has come to the following **main results and conclusions**:

Neoclassical growth model is a base for measuring the factors of long-term economic growth. In the case of Latvia, the list of practically attributable economic growth research methods includes the estimation of the production function (using either total fixed capital stock or splitting it by institutional sectors - private capital and public capital), parametric and non-parametric methods to analyze the average labour productivity level and its changes as well as modelling the real convergence process using beta-convergence and sigma-convergence concepts. Methods, statistical data sources and assumptions used in the course of the research have a crucial impact on its results. This finding is at odds with the usual acknowledgement in the research literature that the usage of alternative assumptions would not have a significant impact on results. In the EU-12 countries, particularly in Latvia, the largest uncertainty is related to the modelling of the fixed capital accumulation process.

When estimating production function for Latvia, various researchers have remarked high TFP role in GDP growth. However, the Thesis shows that this result could be a consequence of imprecise modelling of the fixed capital accumulation process. Therefore, the role of TFP in the previous papers may be overestimated. The usage of alternative method to estimate fixed capital time series allows decreasing the contribution of TFP in GDP growth from 49% to 15%. Splitting the fixed capital to private and public components allows to decrease the contribution of TFP to 11%. Furthermore, the usage of alternative labour indicators allows decreasing the contribution of TFP to 9%.

For the first time in the case of Latvia, the production function was estimated by splitting the fixed capital to private capital and public capital. It was found that public capital at least as much promote GDP growth as private capital (public capital is relatively more productive in all specifications of the production function, but only in some specifications the difference between public and private capital productivity is statistically significant). However, due to smaller volume

and slower growth of public capital, it is the private capital that could be regarded as the driving force of GDP growth during the recent decade.

Fixed capital accumulation increases labour productivity both directly (by raising the capital to labour ratio) and indirectly, allowing to use more productive technologies. This finding proves the usefulness of appropriate technology model and application of non-parametric research methods in the case of Latvia. Fixed capital accumulation was found to be the main driving force of the labour productivity rise during the recent decade in all EU-12 countries, particularly in Latvia. World technical progress (estimated using the data for all EU-27 countries, USA, Japan and Norway) is found to be capital-biased – it promotes labour productivity rise only in countries with relatively large fixed capital endowment. The efficiency of the production process in wealthy states on average is not higher than in the poorer states that could reflect the full technology transmission among the EU region. However, the Baltic States, particularly Latvia, have achieved little progress in raising the efficiency of the production process: Latvia's backwardness subject to the world production frontier in 2010 was similar as in 2000. Economic structure of the Baltic States gradually converges to the structure of EU-15 countries, and that had a positive impact on the dynamics of labour productivity. The average level of labour productivity in Latvia is further promoted by large forest endowment: Latvia holds the 1st place among the EU Member States subject to the share of forest rent in GDP and 8th place subject to the all natural resource rent in GDP.

Both beta-convergence (income growth in poorer countries and regions growing faster than in wealthier states) and sigma-convergence (decreasing variance of the average income level across states and regions) was evident in the EU as a whole during 1995-2009. In its turn, club-convergence hypothesis was not proved: the bimodal income distribution of the EU regions in 1995 was approaching the unimodal distribution over the next years.

Although absolute beta-convergence process is found to be statistically significant in whichever degree of regional detalization, income convergence between states takes place faster than between regions. Moreover, conditional convergence model has larger descriptive power than absolute convergence model. It was found that the convergence path of the respective region depends on how

developed is a particular region subject to the rest of the country. In its turn, country borders and region's belonging to the EU-15 or EU-12 country group are not significant factors of the convergence path. The non-existence of the income beta-convergence during 1995-2000 could be explained with the divergence of employment rates, whereas labour productivity convergence was statistically significant also during this period.

Based on the results, the author has come to a conclusion that **the hypothesis formulated in the Thesis is proved**: in the course of the Thesis, the main factor of economic growth in Latvia as well as income convergence to the average level of EU countries has been identified – **fixed capital accumulation**. Estimation of the Latvia's production function suggests that fixed capital accumulation in both the private and the public sectors explains about 88% of Latvia's GDP growth during 2001-2010. That includes the contribution of private capital accumulation as of 75% and the contribution of public capital accumulation (13%). The usage of non-parametric methods in economic growth research allowed identifying a direct impact of fixed capital accumulation on labour productivity (increasing the capital to labour ratio) as well as an indirect effect (allowing to use more productive technologies). Fixed capital accumulation was the main factor that determined a gradual convergence of Latvia's average income and labour productivity level to the respective level in EU-15 countries.

Moreover, other economic growth factors, unrelated to the economic cycle fluctuations, were founded in the course of the Thesis:

Labour. Although in Latvia GDP elasticity to labour is higher than in respect to the fixed capital, employment rise was relatively modest; thus, the contribution of labour to the GDP growth during 2001-2010 was only about 3%. Despite population actually decreased during the respective period, number of hours worked was higher in 2010 than in 2000, which is partly attributable to the increase of the share of working age population.

Human capital. Although the role of human capital in economic growth was unambiguously proved in the foreign research literature, in the case of Latvia this role still remains unquantified. First, short time series make it impossible to distinguish between the human capital long-run impact on economic growth and the human capital indicator fluctuations over the economic cycle. Second, the increase of human

capital to fixed capital ratio may promote investments growth, thus, the impact of human capital on economic growth may be partly assessed within a fixed capital impact.

Natural resources. Latvia holds the 1st place in the EU in respect to the impact of the forest resources to GDP. There are the forest resources that determine Latvia's 8th place in the EU in respect to the share of natural resource rent in GDP (0.9% on average during 2000-2008). Although forest resources have an impact on Latvia's GDP as well as on average income and labour productivity level, it have no major impact on the dynamics of these indicators since the share of natural resource rent in GDP is not increasing over time.

Economy structural changes. Economy structural changes in Latvia have a significant impact on the average labour productivity changes and thus, on per capita income dynamics. For instance, decreasing industry share had a negative impact while an increase of financial and other private services share had a positive impact. Overall, economy structural changes determined 13% of the increase of the average labour productivity level in Latvia and 16% of its convergence to the average level of the EU-15 during 2000-2010. However, the impact of economic structure on average labour productivity in Latvia still is negative since the share of sectors with the highest labour productivity (industry, financial services) is still below the average value of the EU-15.

Efficiency of the production process (or backwardness in respect to the world production frontier). Although the gap between EU-15 and EU-12 countries in terms of production process efficiency had almost disappeared during 2000-2010, Latvia still significantly lags behind the world production frontier. For instance, the average productivity level in Latvia and, thus, also GDP is 30% lower than could be achieved with the present fixed capital endowment.

World technical progress. Although fixed capital accumulation in Latvia during 2000-2010 was particularly fast, the level of fixed capital endowment is still lower than in the world research and development centers (for instance, USA, Germany). Therefore, world leading technologies, even if they were freely available to Latvia, often are not applicable or are not so productive owing to the insufficient fixed capital endowment. The impact of the world technical progress on the average labour productivity level in Latvia, which was estimated in

the course of the Thesis, is even negative. This means that given the same production facilities, smaller value added could be produced today than 10 years ago. Latvia has two ways how to obtain a positive impact from the world technical progress on the average productivity in the future. First possibility – to become one of the world's leading scientific centers and therefore to develop technologies that are appropriate for the current capital to labour ratio – may be considered only theoretically due to the insufficient country size. Second possibility is to promote fixed capital accumulation: when the capital to labour ratio will approach the respective values in the USA and Germany, technologies that are going to be invented in these countries will be appropriate also for Latvia.

Regional considerations. The geographical location of Latvia close to the developed EU-15 countries as well as the EU membership are factors that may promote faster economic growth. In the course of the Thesis, there were identified statistically significant beta-convergence and sigma-convergence processes within the EU: average income level differences smooth over time between countries, regions and even districts. However, income convergence is not automatic and this does not mean that income differences will completely disappear somewhen in the future. For instance, it was found that the fastest income convergence is evident between the regions of capital cities, at the contrary, other regions in the EU-12 countries are lagging behind the capital cities even more.

The author presents the following **proposals** based on the research conducted within the scope of the Thesis and the conclusions drawn:

To institutions engaged in structural politics in Latvia (including Ministry of Economics):

- Given that the share of sectors with the highest labour productivity (industry, private services) in Latvia is still lagging behind the average value of EU-15, and that partly determines relatively low labour productivity level in Latvia, it is necessary to find possibilities for priority development of high labour productivity sectors.

To institutions engaged in Latvia's regional politics (including Ministry of Economics, Latvian Association of Local and Regional Governments):

- Given that regional disparities of average income level in Latvia are not decreasing, it is necessary to create additional mechanisms for more balanced economic growth in a regional breakdown.

To institutions engaged in planning and administration of the EU structural funds that are available for Latvia (including Ministry of Finance, Ministry of Economics):

- Given that public investments promote GDP growth, to secure a successful absorption of EU structural funds attributable to the 2007 – 2013 planning period.

- As far as possible, to assure the larger scope of EU structural funds that are going to be available for Latvia during the 2014 – 2020 planning period as well as to increase the share of investments, which proved a positive impact on GDP and labour productivity, in the total EU funds financing.

To institutions engaged in planning and implementation of Latvia's state budget (including The Cabinet of Ministers, Ministry of Finance, Saeima, local and regional governments):

- Given that the increase of private investments share in the total investments structure during 2011 - 2012 may negatively affect economic growth, to contain further decrease of public investments share. As far as possible, to raise the share of investments in total spending of consolidated state budget.

To institutions engaged in elaboration of Latvia's tax system (including The Cabinet of Ministers, Ministry of Finance, Saeima) or influence the minimal wage level or personal income tax allowance (including Employers' Confederation of Latvia, Free Trade Union Confederation of Latvia):

- Given a high tax wedge on labour income in Latvia that decreases the labour income share in GVA below the labour contribution to the production process, to support a decrease of tax wedge on labour income. It could be pursued either by decreasing the personal income tax rate or social security contributions, or by decreasing the difference between minimal wage and personal income tax allowance.

To institutions and scientists engaged in research and analysis of the Latvian economic development (including the Bank of Latvia, the Ministry of Economics and the Ministry of Finance):

- To supplement the existing methods of analyzing Latvian economic development with the following models that were approbated to the case of Latvia in the course of the Thesis – non-parametric production function and appropriate technology model, as well as club-convergence model.

- To use the developed approaches for more extended research of Latvian economic development. For instance, by taking into account the impact of the employment structure by economic sectors and intensity of natural resource usage on average labour productivity dynamics.

- As soon as possible after the Labour Force Survey data correction for the unrecorded emigration (CSB plans to perform the respective correction at the second half of 2013), to adjust the estimate of Latvia's production function model.

To institutions and scientists engaged in the forecasting of Latvian economic development (including the Bank of Latvia, the Ministry of Economics, and the Ministry of Finance):

- In the forecasts of GDP, average income and labour productivity level, to take into account the expected changes in economic structure and the intensity of natural resource usage.

To the administration and academic staff of Latvia's universities:

- To promote the inclusion of the non-parametric research methods in the study process within the Economics Master and Economics Doctoral programs.

To the Central Statistical Bureau of the Republic of Latvia:

- To correct the Labour Force Survey time series subject to the underestimated emigration as soon as possible.

- To calculate and publish fixed capital stock (preferably not only annual, but also quarterly data) that includes not only the firm's assets but all fixed capital in the economy (including infrastructure). To the extent reasonably practical, to split the fixed capital by a regional breakdown according to the NUTS-3 methodology (Rīga, Pierīga, Vidzeme, Latgale, Zemgale, Kurzeme) which would allow to estimate the production function in a regional breakdown.