PROJEKTU UN KVALITĀTES VADĪBA

CROWDING OUT EFFECT AND PUBLIC CAPITAL ELASTICITY IN LATVIA FOR THE DEVELOPMENT OF THE EU FUNDS IMPACT ASSESSION METHODOLOGY

RESEARCH REPORT

IEGULDĪJUMS TAVĀ NĀKOTNĒ

ERAF EIROPAS REĢIONĀLĀS ATTĪSTĪBAS FONDS

ESF EIROPAS SOCIĀLAIS FONDS

KF KOHĒZIJAS FONDS

EIROPAS SAVIENĪBA

Rīga, 2013

Within the public procurement of the Ministry of Finance of the Republic of Latvia (public procurement Nr.FM2012/1-ESF/ERAF/KF/TP/HP) research report „CROWDING OUT EFFECT AND PUBLIC CAPITAL ELASTICITY IN LATVIA FOR THE DEVELOPMENT OF THE EU FUNDS IMPACT ASSESSION METHODOLOGY" was performed by the group of researchers from a limited liability company „Projektu un kvalitātes vadība".

The Research Report was developed by the following researchers:
Dr.oec. Oļegs Krasnopjorovs

Contribution: elaboration of the public capital elasticity section, scientific management of Research Report, formulation of summary amd recommendations.

Mg.math. Rita Freimane

Contribution: elaboration of the EU funds crowding out section.

Information used in the Research Report was obtained from CSB, Eurostat and AMECO databases. Moreover, Research Report uses data on financing from European Social Fund, European Regional Development Fund, Cohesion Fund, European Agricultural Fund for Rural Development, European Fishery Fund, EU pre-accession financial instrument's Phare and SAPARD, INTERREG, European Economic Zone and Norway government finacial instruments, as well as Swiss Collaboration Program.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

COE – crowding out of domestic investments owing to the EU fund inflows;

CPL – Convergence Program of Latvia 2013-2016 (April 2013);

CSB – Central Statistical Bureau of the Republic of Latvia;

EU – European Union;

FDI – foreign direct investments;

GDP – Gross Domestic Product;

GVA – gross value added;

LMF – Report of the Ministry of Economics on the labour market midterm and longterm forecasts (2013 June);

New EU countries – countries that entered the EU since 2004;

OECD – Organization for Economic Co-operation and Development;

PCE – public capital elasticity;

TFP – total factor productivity;

VIS – EU funds management information system.

SUMMARY

The Research Report provides a retrospective assessment of public capital elasticity (PCE) and the crowding out effect of EU funds (COE) using econometric methods, as well as the forecast of these indicators until 2020 subject to the various economic development scenarios.

Econometric modeling results suggest that the average PCE value in Latvia between the 2000 Q1 and 2013 Q1 was 0.070. Therefore the increase of public capital by 1% rises the production volume by 0.07%. Although private capital elasticity exceeds PCE, it is determined by the greater amount of private capital, not the low productivity of public capital. One lat of public capital on average promotes the production volume more than one lat of private capital.

Testing the stability of results reveals that assumptions used in econometric modeling has no major impact on the PCE value, moreover, also the conclusion that one lat of public capital on average promotes production volume more than one lat of private capital holds irrespective of the combination of assumptions used.

On the one hand, the value of PCE is considerably lower than BICEPS (2008) assumed (0.80 during 2004-2006 period and 0.50 during 2007-2013 period) based on Ligthart (2002) results on OECD countries. Moreover, it is also lower than 0.30 assumed by SSER (2011), based on Bom un Ligthart (2008) results on other countries. On the other hand, the results of our study suggest that public capital in Latvia has positive and statistically significant impact on the production volume irrespective to the combination of assumptions used in econometric modeling and that this impact is not smaller than that of private capital.

PCE value tends to decrease over time: from 0.084 during the period until 2003 Q4 to 0.069 during the period between 2004 Q1 and 2010 Q2, followed by 0.052 since 2010 Q3. The availability of EU funds allowed to decrease the shortage of infrastructure, particularly observed before the EU entrance and that determined a gradual decline of PCE. It could support the hypothesis stated by BICEPS (2008) that the value of PCE may be higher during the periods of substantial infrastructural shortages.

The results of PCE forecasting suggest that if production volume will grow by 4% per year (base scenario), PCE value is likely to decrease further - to 0.045 during 2013-2020 period on average. However, even in this case one lat of public capital may promote production volume slightly more than one lat of private capital. Within the optimistic scenario (production volume rise by 6% annually) infrastructural shortages (comparing to private capital and labor endowments) may be more pronounced and the value of PCE is likely to increase until 0.069. In pessimistic scenario case (production volume rise by 2% annually), the amount of public infrastructure may remain close to its current level, but is going to grow subject both to the private capital used and the number of employed in full-time units. Therefore, in comparison with other production factors, public capital may be in surplus and that will determine a substantial decrease of PCE - till 0.028.

COE value for the period between 2001 Q1 and 2013 Q1 is estimated at 0.44 level. It means that every lat of EU funds has crowded out 44 santims of domestic (both public and private) investments. This result is somewhat higher than the value assumed by SSER (2011) (0.30 in a base scenario case, as well as 0.15 and 0.50 under the alternative scenarios), based on Ederveen et.al. (2003) results on other countries.

Full crowding out of the EU funds is not evident in any sector of the economy. COE estimates vary from 0.17 in private services to 0.96 in construction. Therefore a strong expansion of construction during the period of fast economic growth was likely to happen also without EU fund inflows, i.e.

based on domestic financing. At the contrary, a considerable part of investment projects in private services may not be implemented without EU financing. Relatively high crowding out is estimated in industry sector. However, it is likely that investments in water supply and sewerage system, energy efficiency and cogeneration as well as energy management would be substantially lower without the EU fund support (and without the EU regulations on reforming these sectors). EU fund crowding out effect is relatively high at public services, however, also in this case about one third of EU financing, for instance, in infrastructure and material base modernization of education institutions and healthcare centers or developing the family doctor's network may not be otherwise implemented.

According to the results of econometric modeling, the value of COE is likely to increase in the forthcoming years; however, in optimistic scenario case it will be lower than within the base and pessimistic scenario. If production volume will expand at an annual rate of 6%, there will be enough investment opportunities in the economy and EU funds may replace the relatively smaller amount of domestic financing. In its turn, since stagnation may reflect a lack of profitable investment projects, EU funds may primarily crowd out domestic financing.

Although PCE indicator is important from political planning and forecasting perspective, it could be hardly regarded as a one of public sector outcome indicators. From the microeconomic perspective, the aim to maximize PCE may force civil servants to enhance competition with the private sector for implementing the most profitable projects. From statistical and econometric directions, there is a risk to assess PCE using such statistical data sources, econometric models and assumptions which are not reliable, but maximize PCE value. Finally, from macroeconomic perspective, the aim to maximize PCE may result in unsustainable economic development.

In its turn, COE minimization is likely to increase the welfare of the society; therefore it may be regarded as one of the public sector outcome indicators. However, also here (similarly as in PCE case) political constraint is present: if EU funds will not compete with the domestic financing (accordingly, if public investments will not compete with private investments) for implementing the most profitable projects, it may be diverted to projects with relatively low profitability and this may cause public mood about low efficiency of EU funds (or public investments) and corruption prevalence.

Key words: public capital, public capital elasticity, production function, EU funds, crowding out

1. PUBLIC CAPITAL ELASTICITY CONCEPT AND THE KEY FINDINGS OF SCIENTIFIC LITERATURE

In the scientific literature, the assessment of public capital elasticity is based on production function approach. PCE value shows by how many percentages production volume can be increased, raising the amount of public capital by 1 percent. Production function reflects the relation between the production volume and aggregate supply factors (the amount of production factors in the economy, its utilization, technology), which is estimated with the econometric methods. On the basis of the neoclassical growth model and its extensions (Aschauer, 1989; Barro, 1991), fixed capital could be broken down by the institutional sector breakdown: fixed capital in the public sector (public capital) and fixed capital in the private sector (private capital).

For the elaboration of recommendations it is important to determine which type of capital (public or private) is more conducive to the production volume. For example, if the public and private capital impact on production volume is similar, the current capital structure is optimal, and thus investment structure should be such to maintain the capital structure constant. On the other hand, if public capital is more productive in promoting production volume, it may be desirable to raise the share of public investment in the total investments. At the contrary, if the public capital impact on production volume is not statistically significant, obviously the amount of public capital may be exceeded the saturation point, thus, instead of new infrastructure projects the government should promote the amount of private investments.

Although many foreign researchers assessed the public capital elasticity already since the second half of the 1980s, the scientific literature so far not found a clear answer to the question whether public capital promotes economic growth more than private capital. There is no universal agreement even to whether the public capital affects the production volume at all (i.e., whether public capital elasticity is statistically significantly different from zero).

Depending on the shape of the production function, presence of the scale effect and data used, the various researchers came to the different conclusions. Aschauer (1989) used variables in levels and found that in the US public capital promotes private output more than the private capital. For instance, an increase of the public and private capital ratio by 1% raise total factor productivity (TFP) by 0.39%, and this impact is stable over time (period under consideration was 1949-1981). Among the various types of public capital, non-military infrastructure (roads, airports, power plants, public transportation) promotes production volume the most; in its turn, military capital does not have a statistically significant impact on the production volume. According to the Aschauer (1989), it is the slower public capital accumulation that was the main factor of slowing TFP growth in the US since the mid-1970s.

At the same time, Aschauer (2000) points that the fact that the public capital promotes production volume does not mean that the increase in government investment would always have positive impact on output. Given the amount of savings in the economy, more public investment means less private investment. So the impact of public investment on production volume depends on private and public capital relative productivity. In addition, it may also depend on the manner in which the public investments growth is financed. When public investments are financed from the tax increases, the negative impact of tax rise on production volume should be taken into account. Thus, the increase in public investment may have a positive impact on production volume only if its positive effect outweighs the negative effect of tax increases. On the basis of the empirical assessment of the 48 US states' data during the 1970-1990 period, Aschauer (2000) found that economic growth is maximized when the public and private capital ratio is in the range between 0.6 and 0.8. It corresponds to the public capital share in total fixed capital from 38% to 44%. The actual share of public capital was smaller in almost all US states. Thus, public capital growth acceleration should have raised production volume. In its turn, the rest public spending components in almost all US states were greater than the value that maximizes output. Therefore, economic growth may be accelerated by increasing public investments at the cost of decreasing non-investment part of public spending.

Since then these results were criticized in two main directions (see, e.g., Naqvi, 2003; Bom and Ligthart, 2008). First, regression may appear to be spurious if non-stationary variables with stochastic trends are used in levels. Second, the correlation between public capital and production volume does not mean that the public capital accumulation is the cause for increase in output. Reverse causality is also possible: faster economic growth increases tax revenues (and reduces social spending such as unemployment benefit expenditures), which, in turn, is being diverted to public investments.

Evans and Karras (1994) using similar data as Aschauer (data on 48 US states during the 1970 – 1986 period), but regressing first differences of the variables, not their levels, found that public capital has a statistically significant negative impact on output and that this result is stable depending on the specifications used. With a similar methodology (using the first differences of the variables) Holtz-Eakin (1994) concluded that public capital has no statistically significant impact on output.

Further study directions were determined by the development of Johansen cointegration framework, according to which non-stationary variables could be regressed in levels if they are cointegrated. However, stationarity and cointegration of the variables is rarely tested in empirical papers (also regarding the estimation of Latvia's production function, stacionarity and cointegration usually are not checked, for example, Vanags and Bems, 2005; Melihovs, 2007; Paula and Titarenko, 2009; Purmalis, 2011). Subsequent studies actually revived not only the past approach (e. g. Aschauer, 1989; 2000), but also conclusions of Aschauer, that public capital is an important factor of economic growth.

For example, Naqvi (2003) found that in Pakistan public capital is at least as productive as private capital under the assumption of exogenous technology and twice as productive as the private capital under the alternative assumption of endogenous technology. Khadharoo and Seetanah (2000) found that public capital accumulation process has a positive effect on private capital accumulation. Strong positive correlation between public capital and TFP, which may underestimate the role of public capital in economic growth if the technical progress is assumed to be exogenous, is also noted by Macdonald (2008). Kamps (2004) after assessing the public capital time series for several OECD countries and including them into production function, found that in 20 out of the 22 cases public capital elasticity is positive, moreover, in 12 cases it is statistically significant. At the same time, Henderson and Kumbhakar (2005) note that public capital elasticity may change with time. Gupta, etc. (2011) points out that the impact of public investment on output may depend on the effectiveness of public spending. Developing countries experience low levels of public capital and its efficiency, thus, marginal product of effective public investment is relatively high while the average impact of public capital on economic growth is relatively low.

Overall, it can be concluded that the studies that estimated the production function using variable levels (i.e., natural logarithm of the public capital, for example. Aschauer 1989; 2000; Naqvi, 2003;

Macdonald, 2008; Gupta, etc., 2011), found that public capital is an essential factor of economic growth and, in some cases, it is more productive than the private capital. On the other hand, studies in which production function was assessed using the first differences (i.e., natural logarithm of the public capital change; for example, Evans and Karras, 1994; Holtz-Eakin, 1994), found that public capital does not promote output – the value of public capital either is not statistically significant or it is even negative. However, the usage of first differences ignores the long term impact of public capital on the production volume, i.e., it is assumed that the past investments do not affect the current output. In this case, the positive impact of public capital on output may be underestimated more than that of private capital if its impact is more extended in time or public investments time series are more fluctuating. It should be noted that also in the case of Latvia's production function, if fixed capital is replaced with investments (which is almost similar to the use of the first differences of the fixed capital) the elasticity of output in respect to the fixed capital is assessed at a low level and, in many cases it is not statistically significant (for instance, see Dubra etc., 2007; Purmalis, 2011; critical analysis of this studies could be found in Krasnopjorovs, 2013). Therefore, the fact that some foreign studies assessed the public capital elasticity at a low level or even suggested it to be negative shows that incorrect research methods could bias results rather than that in some countries and periods public capital could not promote output. Bom and Ligthart (2008) examined 76 studies and concluded that the value of public capital elasticity, adjusted to the methodology differences, is within the range of 0.061 and 0.086.

It should be noted that even if public capital elasticity is found to be lower than the private capital elasticity, it still does not suggest yet that public capital accumulation is less important for economic growth. For example, if the amount of private capital significantly exceeds the amount of public capital, the impact from a 1% rise of private capital is likely to exceed the respective impact of the public capital, even if each lat of public capital on average promotes output more than one lat of private capital (see Krasnopjorovs, 2011; 2013). Therefore, the assessment of public capital promoting impact on output, in addition to public capital elasticity should also take into account the public to private capital ratio.

In the case of Latvia, pioneering studies to assess the value of PCE were performed by Krasnopjorovs (2009, 2011; 2013). His research results indicate that public capital in Latvia have a positive and statistically significant impact on output. Raising public capital by 1%, output increases by 0.05% (Krasnopjorovs, 2013). Further, the promoting impact of public capital on output exceeds the respective impact of private capital.

This study significantly develops the methods applied by Krasnopjorovs (2009, 2011; 2013) in 4 important ways:

1. production function model includes private capital in use, not the entire private capital stock in the economy. It makes possible to take into account the changes of the private capital unilization rate.

2. employment data in the course of the research are adjusted to the 2011 Population Census results. It increases the accuracy of the production function estimates and makes it possible to dispense with dummy variables (used by Krasnopjorovs, 2013), which reduces the amount of information that a model receives from the respective time periods.

3. the current study checks whether an impact of public capital on the production volume (compared with private capital impact) changes over time. This allows identifying the role of public capital during the different periods of economic development.

4. the current study involves public capital elasticity forecast up to 2020, which allow further developing of the methodology of assessment of the impact of EU funds on the economy.

2. THE ECONOMETRIC MODEL OF PUBLIC CAPITAL ELASTICITY ASSESSMENT

The standard approach of the scientific literature to incorporate public capital in the production function is to include it as a separate factor, which together with private capital, labor and technology raises the production volume. Therefore, the production function in its unrestricted form which could be used in the case of Latvia is:

$$\log(Y_t) = \hat{\beta}_0 + \hat{\beta}_1 t + \hat{\alpha}_{KP} \log\left(K_t^P \cdot U_t^K\right) + \hat{\alpha}_{KG} \log\left(K_t^G\right) + \hat{\alpha}_L \log\left(L_t \cdot U_t^L\right) \qquad (1)$$

Y – gross value added (GVA) in 2000 year prices (output; production volume);

K^P – fixed capital in the private sector in 2000 year prices (private capital);

K^G – fixed capital in the public sector in 2000 year prices (public capital);

L – number of persons employed (labor);

U^K – private capital utilization rate;

U^L – labor utilization rate (workload);

$\hat{\alpha}_{KP}$ – estimated GVA elasticity subject to capital in the private sector (private capital elasticity);

$\hat{\alpha}_{KG}$ – estimated GVA elasticity subject to capital in the public sector (public capital elasticity);

$\hat{\alpha}_L$ – estimated GVA elasticity subject to labor (labor elasticity);

$\hat{\beta}_0$ – estimated reference level of total factor productivity (TFP);

$\hat{\beta}_1$ – estimated TFP rise during the period of time;

t – time period.

In addition to the Hicks-neutral technical progress and unit substitution between the production factors, research literature usually assumes the fulfillment of a neoclassical growth model's postulate regarding the absence of a scale effect (rising private capital, public capital and labor by 1% altogether increases the production volume exactly by 1%):

$$\hat{\alpha}_{KP} + \hat{\alpha}_{KG} + \hat{\alpha}_L = 1 \qquad (2)$$

Therefore, the production function is often estimated in a restricted form, where the elasticity of one production factor is determined as the difference between unity and the sum of elasticities of all other factors of production. In this case, the equation (1) looks like:

$$\log(Y_t) = \hat{\beta}_0 + \hat{\beta}_1 t + \hat{\alpha}_{KP} \log\left(K_t^P \cdot U_t^K\right) + \hat{\alpha}_{KG} \log\left(K_t^G\right) + \left(1 - \hat{\alpha}_{KP} - \hat{\alpha}_{KG}\right) \log\left(L_t \cdot U_t^L\right) \qquad (3)$$

where $\left(1 - \hat{\alpha}_{KP} - \hat{\alpha}_{KG}\right)$ is labor elasticity.

Moreover, it is sometimes admitted in the scientific literature that the production function has constant returns to scale subject to the private factors of production (private capital and labor) only, while public capital is additional production factor, which provides a positive scale effect as a whole (for example, Aschauer, 1989; Holtz-Eakin, 1994; Macdonald, 2008):

; $$\hat{\alpha}_{KP} + \hat{\alpha}_L = 1 \quad \hat{\alpha}_{KP} + \hat{\alpha}_{KG} + \hat{\alpha}_L > 1 \qquad (4)$$

In this case, equation (1) could be shown as:

$$\log(Y_t) = \hat{\beta}_0 + \hat{\beta}_1 t + \hat{\alpha}_{KP} \log(K_t^P \cdot U_t^K) + \hat{\alpha}_{KG} \log(K_t^G) + (1 - \hat{\alpha}_{KP}) \log(L_t \cdot U_t^L) \quad (5)$$

Besides, the public capital dynamics may be closely correlated with the residual component of the production functions model (Hicks–neutral technical progress or TFP). In this case multicollinearity may exist between the factors of production so that public capital elasticity may be underestimated – the positive impact of public capital on the production volume may be undermined. To turn off this option, Macdonald (2008) excludes exogenous technical progress from the production function model. In this case, equation (1) transforms to:

$$\log(Y_t) = \hat{\beta}_0 + \hat{\alpha}_{KP} \log(K_t^P) + \hat{\alpha}_{KG} \log(K_t^G) + (1 - \hat{\alpha}_{KP} - \hat{\alpha}_{KG}) \log(L_t) \quad (6)$$

Most empirical research assume no scale effect presence by default, and explores a restricted form of the production function model (e.g., Stikuts, 2003; Cheng, 2003; Tahari etc., 2004; Vanags and Bems, 2005). Moreover, the major part of researchers testing the hypothesis regarding the absence of a scale effect, could not reject it (for example, Epstein and Macchiarelli, 2010; Melihovs, 2010; Gupta, etc., 2011). Just a few studies rejected the hypothesis on the absence of a scale effect, pointing to positive returns to scale. For instance, Park and Ryu (2006) found positive returns to scale in newly developed East Asian economies – Hong Kong, Korea, Singapore and Thailand during the period of 1960s and 1970s. Moreover, Beddies (1999) found a positive scale effect in the production function of Gambia during the 1964 – 1988 period. The scientific literature lacks any example when the economy performs under the statistically significant negative returns to scale. For example, although Fadejeva and Melihovs (2009) found that some sectors of the Latvian economy are characterized with a negative returns to scale, it was not mentioned in their study whether it was statistically significant (according to the personal communication with the authors, it was found that it was not statistically significant in many sectors). However, the possibility that the Latvian production function exhibits a scale effect is not exhausted, so the scale effect presence was tested during the course of the study (see Figure 1).

The next important step is to get in which institutional sector one lat of investments enhances the production volume to a larger extent:

$$\omega_{G/P} = \frac{\hat{\alpha}_{KG} / \hat{\alpha}_{KP}}{\overline{K}^G / (\overline{K}^P \cdot \overline{U}^K)} \quad (7)$$

where $\omega_{G/P}$ is relative productivity of public capital (in respect to the private capital);

$\hat{\alpha}_{KP}$ un $\hat{\alpha}_{KG}$ – private and public capital elasticity estimations respectively;

$\overline{K}^P \cdot \overline{U}^K$ – amount of private capital in use (period average);

$\overline{K}^G$ – amount of public capital stock (period average).

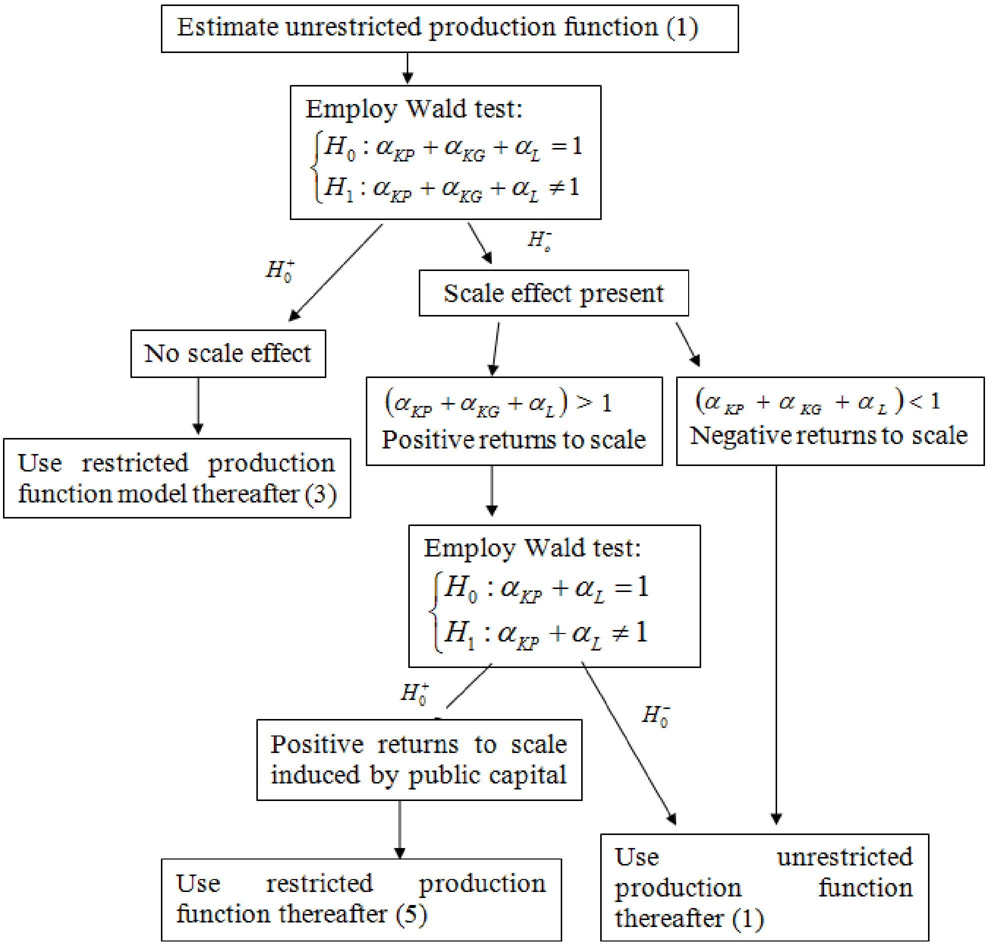


Figure 1. Figure 1. Determining the scale effect presence in the public capital elasticity assessment model[1]

For instance, if $\hat{\alpha}_{KP}$ is five times larger than $\hat{\alpha}_{KG}$ and $\left(\overline{K}^P \cdot \overline{U}^K\right)$ is 2.5 times greater than $\overline{K}_G$, $\omega_{G/P}$ is 0.5. It means that every lat of private capital on average is twice as productive (in raising the production volume) than one lat of public capital. Whether this difference is statistically significant (i.e., the relative productivity of public capital is statistically significantly different from unity), could be tested with the Wald test. Relative productivity of public capital is equal to one when:

$$\frac{\hat{\alpha}_{KG}}{\hat{\alpha}_{KP}} = \frac{\overline{K}^G}{\overline{K}^P \cdot \overline{U}^K} \qquad (8)$$

Since Wald test results are not invariant to the way in which nonlinear restriction is specified, before applying Wald test, equation (8) should be written in a linear form:

$$\hat{\alpha}_{KG} \cdot \left(\overline{K}^P \cdot \overline{U}^K\right) = \hat{\alpha}_{KP} \cdot \overline{K}^G \qquad (9)$$

In case there are no major differences between $\hat{\alpha}_{KP}/\hat{\alpha}_{KG}$ and $\overline{K}^P \cdot \overline{U}^K / \overline{K}^G$, than $\omega_{G/P}$ is not statistically significantly different from unity. Then it is not clear for sure whether one lat of public capital induces production volume more than one lat of private capital.

[1] Authors' development

3. RETROSPECTIVE ASSESSMENT OF PUBLIC CAPITAL ELASTICITY

The retrosoective assessment of PCE was performed based on research literature findings (see Section 1) and selecting the most appropriate econometric model for the case of Latvia (see Section 2). Data used for PCE retrospective assessment are revealed in subsection 3.1., while subsection 3.2. provides results of PCE econometric estimation.

3.1. DATA USED IN THE RETROSPECTIVE ASSESSMET OF PUBLIC CAPITAL ELASTICITY

The lack of reliable statistical data necessary for PCE study was the main difficulty in the course of the research, thus, the whole subsection is dedicated to methods used to solve this problem.

Production volume

Regarding the production volume, the present study uses gross value added (GVA) in 2000 prices downloaded from the CSB database IK041. Earlier estimations of Latvia's production function (for example, Stikuts, 2003; Vanags and Bems, 2005; Paula and Titarenko, 2009; Melihovs, 2010) employed real gross domestic product (GDP) instead; however, we believe that GVA may reflect the production volume more correctly since it does not include indirect taxes and subsidies. GVA and GDP dynamics are similar, and also results of production function assessment are similar, however, the usage of GVA somewhat increases the descriptive power of the production function model.

Number of persons employed

Employment data are available in CSB and Eurostat databases according to the various methodologies (Labor Force Survey (LFS; national concept); national accounts (domestic concept); survey of enterprises) and types (number of persons employed, number of jobs). Enterprise survey data are only available from the year 2005, as also does not include small businesses and the unofficial workers, thus may not be representative of the entire economy. Previous production function model assessments in Latvia's case usually included the number of employed according to the LFS data (e. g. Vanags and Bems, 2005; Melihovs, 2007; 2010; Paula and Titarenko, 2009). However, LFS and the national accounts data until the 2010 Q4 are based on outdated population data, which does not take into account the results of the 2011 Population Census. CSB intends to take the appropriate correction in the first half of 2014. This determined the necessity to assess the number of persons employed during the course of the study.

From the CSB database ISG06 (population by cohorts, annual data) we calculated working age (15-74) population at the beginning of the years 1995-2013 and then interpolated it quarterly. Economically active population was calculated by multiplying the working-age population with the participation rate. Eurostat database contains participation rate quarterly data since Q1 2002; in addition, we adjusted the data in line with the 2011 Population Census results. For the 1998–2001 period participation rate bi-annual data are available, which were interpolated by quarters. Number of persons employed was calculated by multiplying the number of economically active population with the employment level (the level of employment is inversely proportional to the unemployment rate):

$$L_t = P_t \cdot \gamma_t \cdot (1 - u_t) \tag{10}$$

where L – number of persons employed;

P – working age (15–74) population;

γ – participation rate (age 15–74);

u – unemployment rate (age 15–74);

t – period of time.

Unemployment rate data are available in the Eurostat database as from the first quarter of 1998 and it has already been adjusted to the 2011 Population Census results. Regarding the 1995–1997 period, the number of persons employed was calculated using the employment number in 1998 and the employment annual growth rates in 1996–1998 according to the national accounts official data. Figure 2 shows the estimated number of persons employed according to the equation 10, compared with CSB LFS official data. Two time lines are broadly similar in 2011 and 2012, but the LFS data for 2010 overstates the number of persons employed for 90 thousand.

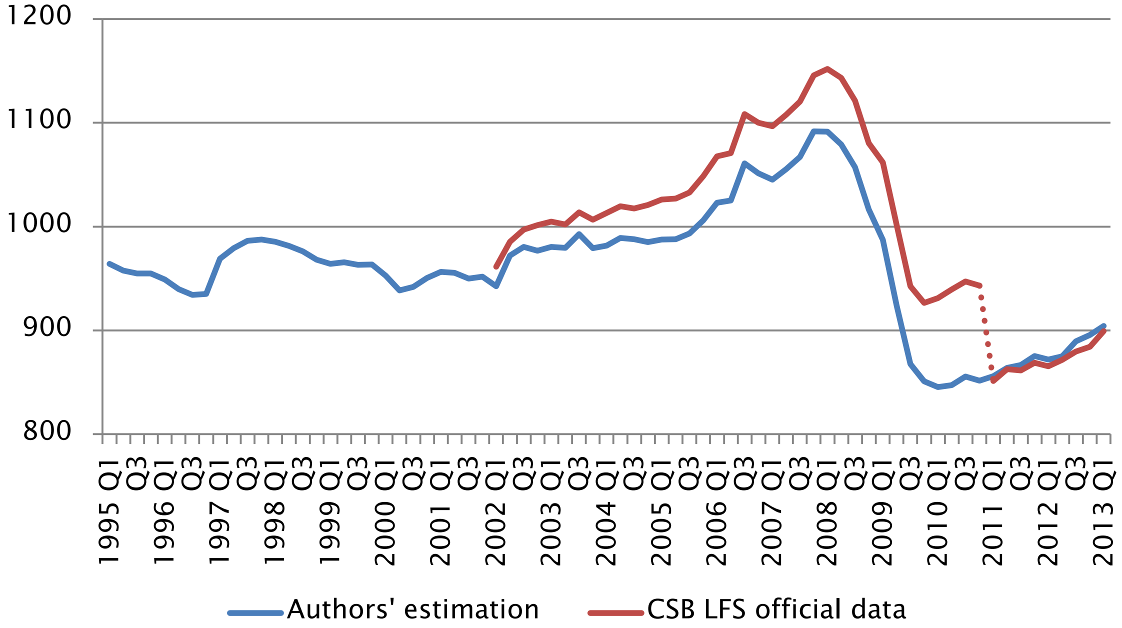


Figure 2. Number of persons employed in Latvia (ths.; seasonally adjusted data)[2]

Fixed capital

Latvia's national accounts compile the balance sheet data on fixed capital of the companies (at the beginning of the year and at the end of the year; the amount of fixed capital at the end of the year

2 Authors' calculations based on CSB and Eurostat data.

is equal to its amount in the beginning of the following year) in current prices. Therefore, to enter these data in the production function model, researchers should calculate the amount of fixed capital in base period prices and interpolate it in a quarterly basis. Interpolation is usually performed by using investment and investment deflator (price) data. However, national account data on fixed capital are rarely used in scientific literature both in Latvia and abroad. For example, in the case of Latvia, this data was used by Stikuts (2003) in assessing the production function model for the 1995-2001 period. However, this method is not applicable for the subsequent period, because, starting with the year 2002, CSB changed methodology of fixed capital compilation. Before fixed capital was assessed in accordance with the accounting rules (and their value was many times lower than the current market value), but, starting with the year 2002, CSB began to assess the fixed capital market value and prior period data were not recalculated according to the new methodology.

The vast majority of scientific studies estimate the fixed capital dynamics with a perpetual inventories method (PIM). According to the PIM, fixed capital in the current period is equal to the accumulated fixed capital minus depreciation plus the current period investments. After splitting the fixed capital to the private and public components, PIM may be shown as:

$$\begin{cases} K_t^P = K_{t-1}^P \cdot \left(1-\delta^P\right) + I_t^P \\ K_t^G = K_{t-1}^G \cdot \left(1-\delta^G\right) + I_t^G \end{cases} \quad (11)$$

where K is fixed capital;

I – investments (fixed capital formation; national accounts code P51);

δ – fixed capital depreciation rate (%) during one period;

P and G – private and public sector respectively;

t – period of time.

Total investments data were taken from CSB database IK07. Private investments were calculated as a difference between the total investments and public investments. Public investments at current prices starting from the year 1999 are available in the CSB database VF02. Public investments in base period prices were calculated using the investment deflator, which was obtained from the data published in CSB database IK07. Public investments for the 1995-1998 period were extrapolated with regard to the share of public investments in total investments during the subsequent years.

In order to estimate fixed capital dynamics according to the equation 11, assumptions are necessary on the amount of fixed capital stock (K_0) and share of public capital during the reference period, as well as regarding the fixed capital depreciation rate. In the case of Latvia, research literature generally uses 10% annual depreciation rate (Kazaks et.al., 2006; Melihovs and Davidsons, 2006; Melihovs, 2007; 2010; Titarenko, 2008; Paula and Titarenko, 2009), based on the national accounts data according to the old methodology. In its turn, there is no consensus in the scientific literature regarding the value of (K_0). For example, various researchers assume significantly different fixed capital to GDP ratios in Latvia for the year 1995: 75% (Room, 2001); 100% (Vetlov, 2003); 140% (Bems, Johnson, 2005); 200% (Denis, etc., 2006). Krasnopjorovs (2013) stresses that no method that used in the scientific literature to identify the fixed capital to GDP ratio should not be considered to be accurate. Fixed capital to GDP ratio used in current Research Report (190% in 1995) was obtained from the AMECO database. Unlike previous publications, the present study takes into account the capital utilization rate, that is why $K_0 \cdot U_0^K$ in 1995 was 110% of GDP, which is broadly similar to the average value used in the scientific literature in the case of Latvia.

In accordance with the national accounts data, the share of public capital in total fixed capital at the beginning of the 1995 was 23%. However, Vanags and Bems (2005) pointed that national accounts data may underestimate the full amount of fixed capital due to shadow economy prevalence. Assuming that the amount of public capital in national accounts is reflected correctly, but the amount of private capital – underestimated due to the shadow economy prevalence, given $(K/Y)_0 = 1.9$, the share of public capital in total fixed capital would be 13%. Research Report uses the average of these values (the share of public capital in the total fixed capital was 18% in 1995; see Figure 3) as a base specification. In its turn, the stability of results subject to the usage of alternative assumptions is tested in Section 4.

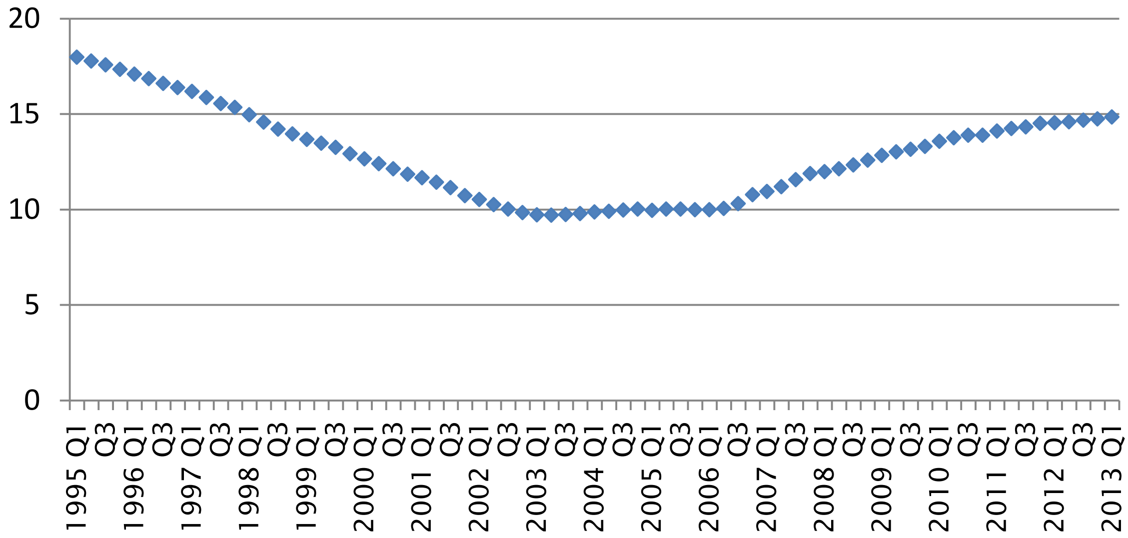


Figure 3. Share of public capital in the total fixed capital in Latvia (%; seasonally adjusted data)[3]

Thus, at the beginning of 2013 fixed capital accounted for 16.8 billion LVL in 2000 year prices, or approximately 220% of country's GDP; of which 15% was public capital (see Figure 4).

3 Authors' estimation based on CSB data.

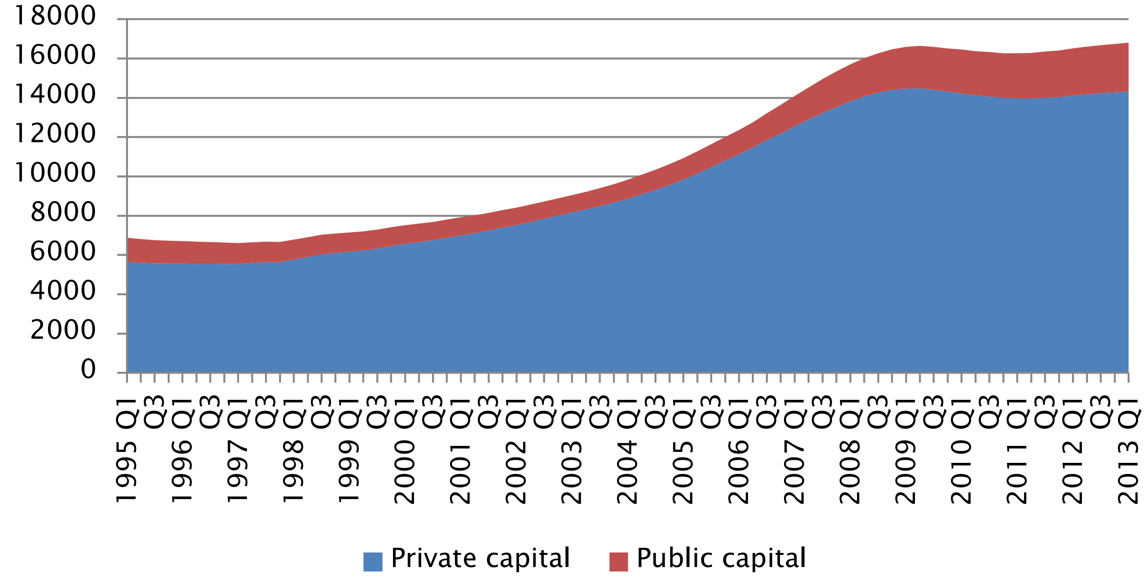


Figure 4. Private and public capital stock in Latvia (mill. LVL; seasonally adjusted data)[4]

Production factors utilization

This study is the first attempt to estimate Latvia's economy production function, counting for the variable factor utilization (although Fadejeva and Melihovs (2009) also took into account variable production function utilization, it was assessed in a sectoral breakdown). During the economic slowdown of 2008 – 2009, both capital and labor utilization fell significantly, and if ignored, it may bias the results of production function assessment.

As a labor utilization rate, Research Report uses the average weekly working time compared with the statutory normal weekly working time as defined in "The Labor Law" – 40 hours:

$$U_t^L = \frac{h_t}{40} \quad (12)$$

where U^L – labor utilization rate;

h – average number of actual weekly hours worked in total;

t – period of time.

Data on the average number of actual weekly hours in total are not available; however, the Eurostat databases contain the respective data separately for the main job and secondary job. Thus, the average total working week length can be calculated on the basis of the number of hours worked for the main and secondary jobs:

$$h_t = l_t + \frac{\hat{S}_t}{\hat{L}_t} \cdot s_t \quad (13)$$

4 Authors' calculations based on CSB data.

where h – average number of actual weekly hours worked in total;

l – average number of actual weekly hours of work in main job;

s – Average number of actual weekly hours of work in the secondary job;

$\hat{S}$ – number of persons employed on the secondary job (official data);

$\hat{L}$ – total number of persons employed (official data);

t – period of time.

Although official LFS data on the number of persons employed could not reflect the actual situation, it is realistic to assume that the share of workers who have a secondary job is reflected correctly, thus, equation 13 gives realistic assessment on changes of the average working week duration. The number of persons employed in full-time work units compared with the number of persons employed estimated on the course of the study, is shown in Figure 5. Workload decreased considerably during the economic downturn and has not changed significantly since then.

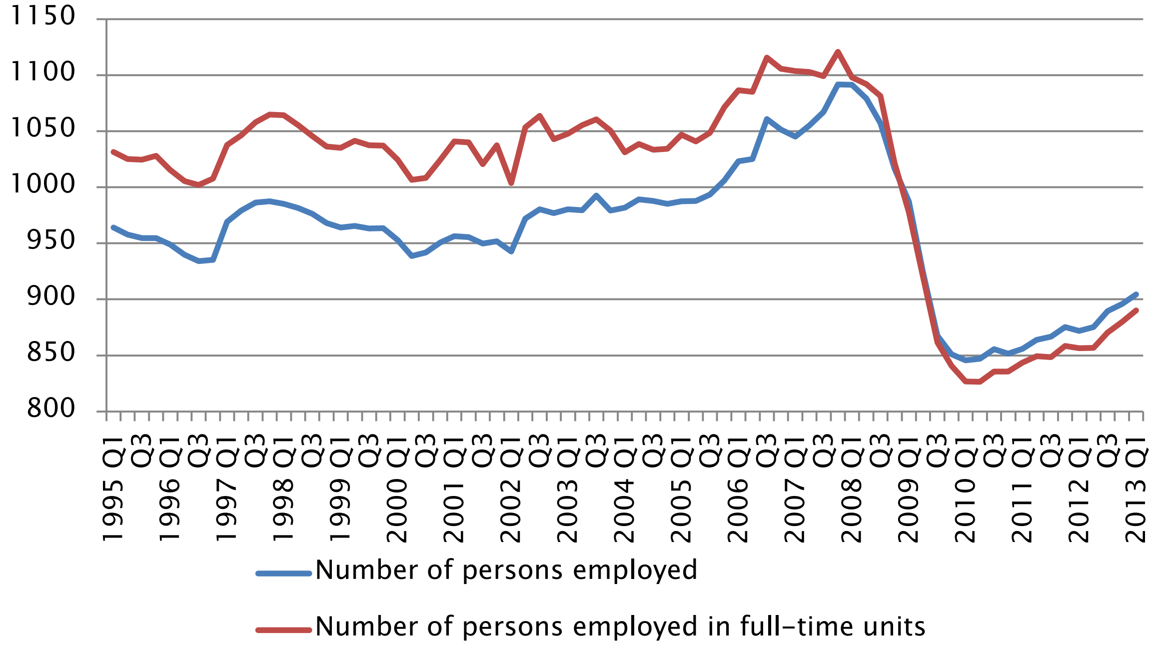


Figure 5. Actual number of persons employed and employment in full-time units in Latvia (ths.; seasonally adjusted data)[5]

Regarding the fixed capital utilization, there is only one indicator available in the case of Latvia – business tendency survey data on the production capacity utilization in manufacturing (CSB database KR 52; prior period data are available in the European Commission databases). Although the capacity utilization in manufacturing could be inaccurate to reflect the developments of the whole economy, the adjustment of the private capital concept with this variable significantly improves the descriptive power of the production function model in the case of Latvia. It should also be noted that the study assumes that the public capital stock is used fully. First, the level of capacity utilization in manufacturing has little to do with the infrastructure utilization (besides, adjusting public capital concept with this variable does not improve the descriptive power of the production function). Second, when interpreting results of the research, policy makers may be

5 Authors' calculations based on CSB and Eurostat data.

interested in the conclusions relating to the variables, which are in their hands; while the usage intensity of infrastructural objects is out of government control.

Private and public capital stocks, as well as amount of private capital in use, are shown in Figure 6. Although the private capital utilization significantly decreased during the recession, now it is back to pre-crisis level.

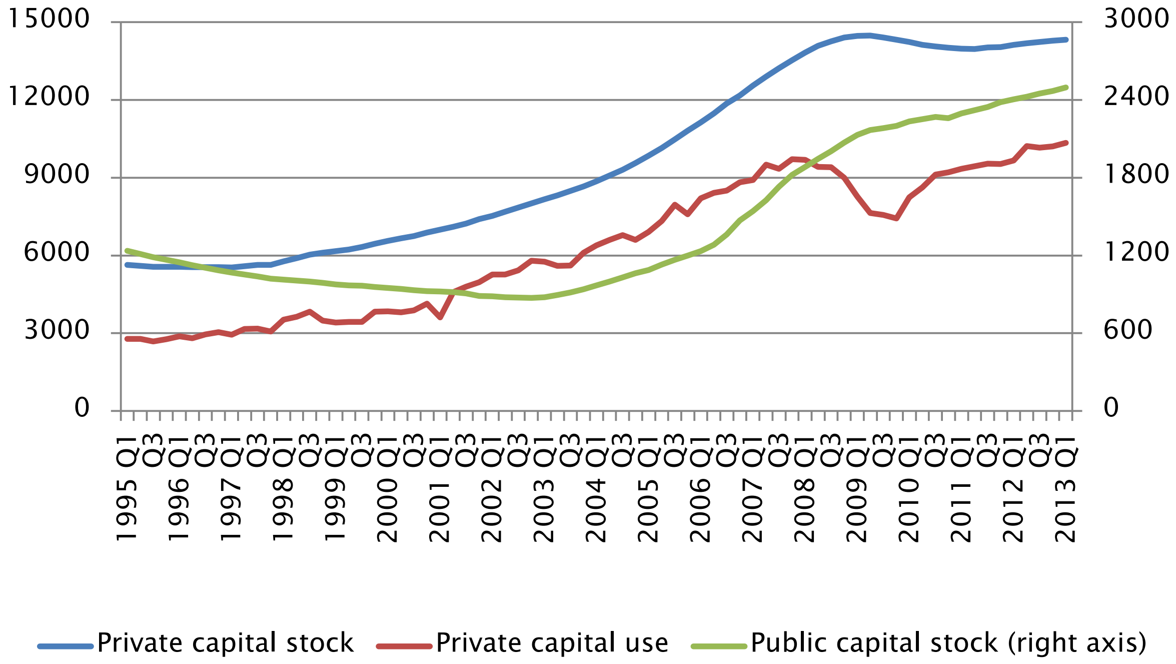


Figure 6. Private capital stock and use in Latvia (mill. LVL; seasonally adjusted data)[6].

Technical progress

On the basis of the scientific literature, assuming constant speed TFP process, the values of the production function coefficients during 2008 – 2010 period change significantly and become unrealistic. In addition, Andrews-Quandt test indicates a structural break in the fourth quarter of 2007, and the value of the TFP coefficient decreases significantly thereafter and becomes statistically insignificant. It might be an indication of TFP growth termination during the crisis period. Maximizing the predictive power of Latvia's production function model, it can be specified that TFP resumed growth in the third quarter 2011. Thus, this study uses calibrated TFP process, which although is based on the exogenous and constant TFP.

Another alternative – an endogenous TFP was not used in the course of the study since in the developing countries this assumption is very rare. For example, one of the notable exceptions is Room (2001), who modeled TFP process in Estonia as a function of foreign direct investment (FDI) inflows; however, Vanags and Bems (2005) challenge this approach for two reasons. First, TFP dynamics in the Baltic countries is similar, though Estonia after the restoration of independence has accumulated two times higher FDI per capita than Latvia and Lithuania. Second, although Czech Republic is Eastern European leader regarding FDI inflows, it experiences relatively slow TFP growth.

---

6 Authors' calculations based on CSB data.

3.2. RESULTS OF PUBLIC CAPITAL ELASTICITY RETROSPECTIVE ASSESSMENT

The most appropriate econometric model for PCE retrospective assessment in the case of Latvia was chosen on the basis of Figure 1. Results of unrestricted production function model evaluation (according to equation 1) are shown in Appendix 1. All coefficients of the production function (except constant) are statistically significant at 99% confidence level and their values are in line with the scientific literature findings. Even though Latvia's production function shows weakly positive returns to scale $(\hat{\alpha}_{KP} + \hat{\alpha}_{KG} + \hat{\alpha}_L = 1.021)$, Wald test suggests that it is not statistically significant (see Appendix 2). It should be noted that the exclusion of TFP variable from the production function model (according to equation 6) significantly reduces the descriptive power of the production function model and does not increase the value of PCE (see Appendix 3). This proves the conclusion of Krasnopjorovs (2011) that in the case of Latvia positive externalities may exist from the private capital accumulation, but not public capital. Thus, Latvia's production function should be assessed in a restricted form according to equation 3.

PCE average value during the period between Q1 2001 and Q1 2013 is assessed at 0.070 level (see table 1) which is similar to Bom and Ligthart (2008) conclusion related to the other countries and time periods. Raising the public capital stock by 1% increases production volume by 0.07%. This is three times less than the private capital elasticity: the rise of used private capital by 1% increases production volume by 0.21%. The value of the coefficient of determination is high, specifying that the production function model explains 99.65% of GVA dynamics. Durbin-Watson statistics is quite high (1.434) and also higher than in the previous assessments of the Latvia's production function, which results were considered to be satisfactory despite the presence of positive serial correlation (for instance, 0.90 (Grundiza et.al., 2005); 0.848 (Melihovs, 2007); 0.312 (Paula and Titarenko, 2009)).

Table 1. Results of PCE retrospective assessment with the restricted-form model[7]

Period:	1995 Q1 - 2013 Q1		
$\hat{\beta}_0$	-0,496***	Standard error of regression	0,017088
$\hat{\alpha}_{KP}$	0,214***	R-squared	0,996451
$\hat{\alpha}_{KG}$	0,070***	Adjusted R-squared	0,996296
$\hat{\alpha}_L$	<u>0,718</u>	Durbin-Watson statistics	1,434
$\hat{\beta}_1$	0,0107***	Akaike info criterion	-5,248

***, **, *: coefficient is statistically significant at 99%, 95% and 90% confidence level.
Coefficients, obtained from the assessment of other coefficients, are underlined.

Public capital and GVA time series are cointegrated (see Appendix 4), in its turn, the case of reverse causality in Latvia is not considered since public capital accumulation was considerably affected by (exogenous) EU fund inflows. Various tests confirm model's stability. Model's recursive residuals are located within the 2 standard deviations except for random fluctuations and short period when the economic slowdown began (see Appendix 5a). Stability of recursive residuals is further revealed

7 Authors' development.

with the CUSUM and CUSUM of Squares tests (see Appendix 5b and 5c). Model's recursive estimates are stable and converging to their true values. Only the confidence interval of the private capital elasticity coefficient remains somewhat wider, possibly reflecting the uncertainty regarding to the private capital utilization rate fluctuations (see Appendix 5d). Correlogram of residuals does not reflect a significant autocorrelation, moreover, in the correlogram of residuals squared autocorrelation is not seen at all (see Appendix 5e and 5f). The low value of Jarque-Bera statistics reveals that the distribution of model errors is close to the normal distribution (see Appendix 5g). Detailed autocorrelation tests confirm that correlation of model residuals is not significant. For instance, although Breusch-Godfrey autocorrelation test results are ambiguous for the small number of lags (under 3), autocorrelation presence is strongly rejected for the higher number of lags (see Appendix 5h). Similarly, model does not suffer from heteroskedasticity: although White test results are not clear-cut, ARCH, Glejser, Harvey as well as Breusch-Pagan-Godfrey tests strongly reject the heteroskedasticity presence (see Appendix 5i).

The amount of private capital in use considerably exceeds the public capital stock, thus, the relative productivity of public capital (see equation 7) is greater than unity: every lat of public capital on average promotes production volume more than one lat of private capital. However, Wald test results (see equation 9 and Appendix 6) reveal that the difference between the public and private capital impact on the production volume is not statistically significant.

Differences of PCE assessment between the various economic development cycles are not essential. Results of econometrical modeling suggest that it was 0.071 during the 1995 -2000 period (not shown in Research Report). The amount of public capital decreased during this period because public investments in infrastructure were not sufficient to fully offset depreciation. The most pronounced infrastructure deficit was present during the 2001-2003 period. During this period the amount of public capital was at its lowest level, both in absolute terms and relative to the private capital, and PCE value was the highest (0.84; see Table 2), which may reflect high degree of infrastructure utilization.

Table 2. Public capital elasticity retrospective assessment by economic development periods[8]

Period:	2001 Q1 – 2003 Q4	2004 Q1 – 2010 Q2	2013 Q3 – 2013 Q1
Public capital elasticity	0.070		
	0.084	0.069	0.052

10-15 years long period of infrastructure stagnation ended with Latvia joining the European Union in 2004 (for instance, Latvia has lowest public investments share in GDP among the EU countries during 1997-2003 and the biggest rise of the respective indicator in 2004-2012, compared to the previous period). The availability of EU funds allowed decreasing a large shortage of infrastructure (the amount of public capital increased both relatively to the private capital and per employed in full-time units), and this determined a moderate decrease of PCE value over time (till 0.069 during 2004-2010 and 0.052 in 2010-2013).

8 Authors' development.

4. TESTING THE STABILITY OF PUBLIC CAPITAL ELASTICITY EX-POST ASSESSMENT

The base specification of PCE retrospective assessment model uses several assumptions regarding the fixed capital dynamics in Latvia. For instance, that fixed capital to GDP ratio in 1995 $(K/Y)_0$ was 1.9, the share of public capital in the total capital stock $(K_g/K)_0$ was 18% and capital depreciation rate is 2.5% per quarter. There is no consensus in the scientific literature regarding these values (see Section 3.1) and the best method for identifying the most reliable assumption could hardly be specified (see Krasnopjorovs, 2013). Therefore, Section 4 tests either the usage of alternative assumptions has a major impact on PCE assessment.

Based on scientific literature findings and the authors' expert judgment, the following values of the respective indicators were used in the stability evaluation of PCE retrosoective assessment:

- $(K/Y)_0$: from 1.2 to 2.0;
- δ: from 2% to 3%;
- $(K_g/K)_0$: from 15% to 24%.

Subject to the values of these indicators, the volatility of PCE retrospective assessment is not large – from 0.06 to 0.09 (see Figure 7). Therefore assumptions regarding the fixed capital accumulation have no major impact on the value of PCE.

Figure 7 also shows that the value of PCE obtained in the base specification (0.07) is not a result of using such a combination that maximizes or minimizes its value; and this increases the reliability of PCE assessment. For instance, assuming both higher initial public capital share in fixed capital stock and slower capital depreciation would result in a higher PCE value. However, in our view, the most reliable assumptions are those used in a base specification.

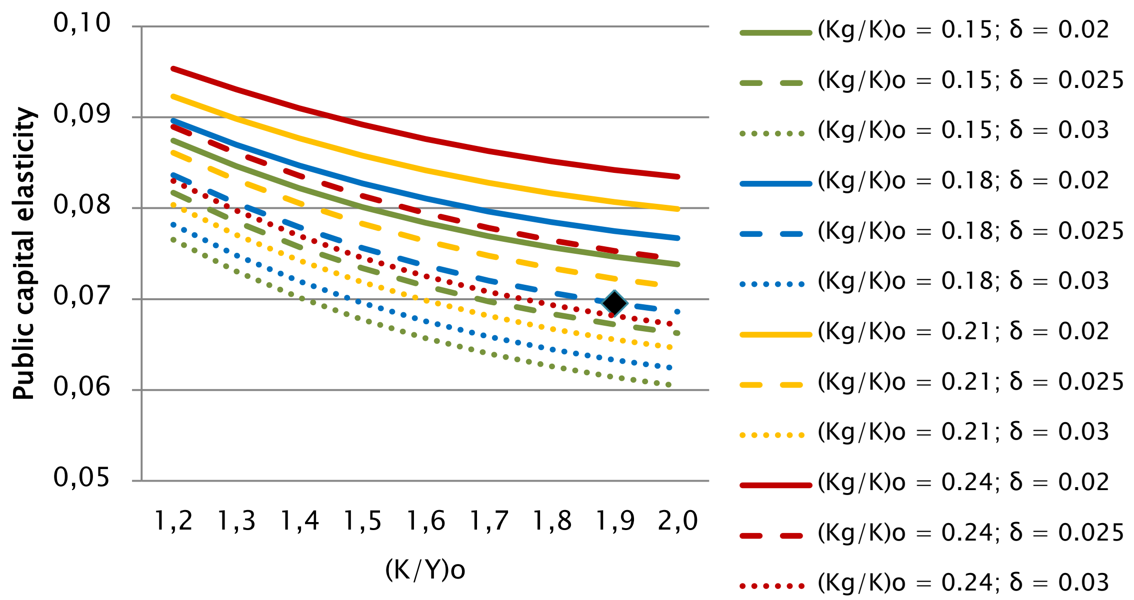


Figure 7. Public capital elasticity subject to the assumptions used in econometric modeling (1995 Q1 – 2013 Q1 average value)[9]

Private capital elasticity exceeds PCE at all possible combinations of assumptions – it changes between 0.16 and 0.22 (see Figure 8). In this case it is not clear how the particular assumption regarding the fixed capital accumulation may influence the result – it depends to the combination of the three assumptions altogether.

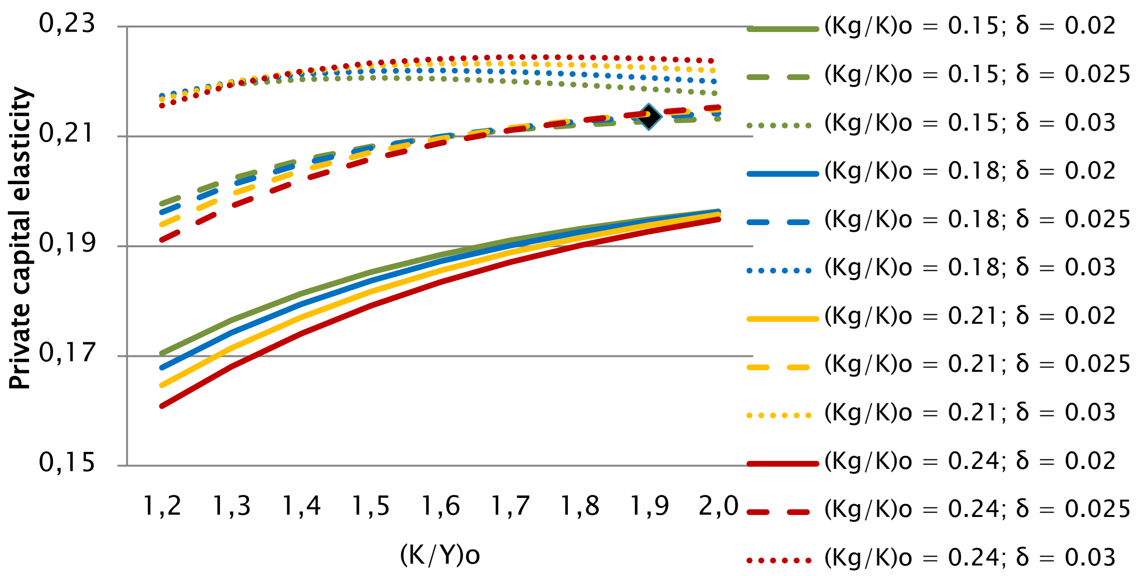


Figure 8. Private capital elasticity subject to the assumptions used in econometric modeling (1995 Q1 – 2013 Q1 average value)[10]

9 Authors' estimations.
10 Authors' estimations.

The elasticity of production volume in respect to the total fixed capital, depending on the assumptions used in econometric modeling is between 0.25 and 0.30 (see Figure 9).

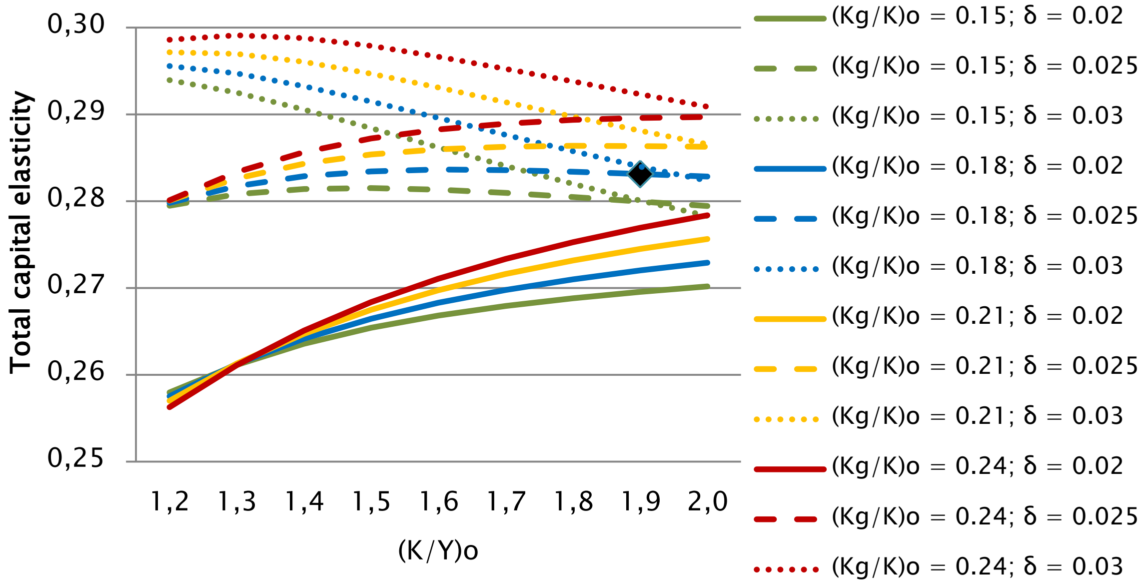


Figure 9. Total capital elasticity subject to the assumptions used in econometric modeling (1995 Q1 – 2013 Q1 average value)[11]

It is broadly in line with the results of previous production function assessments for Latvia. For instance, Grundiza et.al. (2005) obtained capital elasticity at 0.286 level, in its turn, Melihovs and Davidsons (2006) – at 0.303, while Krasnopjorovs (2011) – at 0.295. However, some papers have estimated total capital elasticity to be higher or lower – the differences in results should be attributed both to the different research period and data used (for example, previous papers disregarded the utilization rate of capital and labor as well as used outdated employment data which were not adjusted to the 2011 Population Census results).

Krasnopjorovs (2013) chose such a combination of assumptions regarding the fixed capital accumulation that minimizes the model's error or the value of Akaike information criterion. Method was justified by the proposition that in the case of deterministic TFP process, part of model errors may reflect an inaccuracy of statistical data. However, in the current research, the choice of combination of assumptions that maximizes the descriptive power of the production function is not straightforward: curves in Figure 10 are parallel and almost horizontal in a rather wide range. However, it should be pointed out that the value of Akaike information criterion in the base specification (–5.248) is lower than the average value of all alternative specifications considered (–5.218), thus, combination of assumptions used in a base specification could be regarded as one of those which maximizes the descriptive power of the production function in the case of Latvia.

11 Authors' estimations.

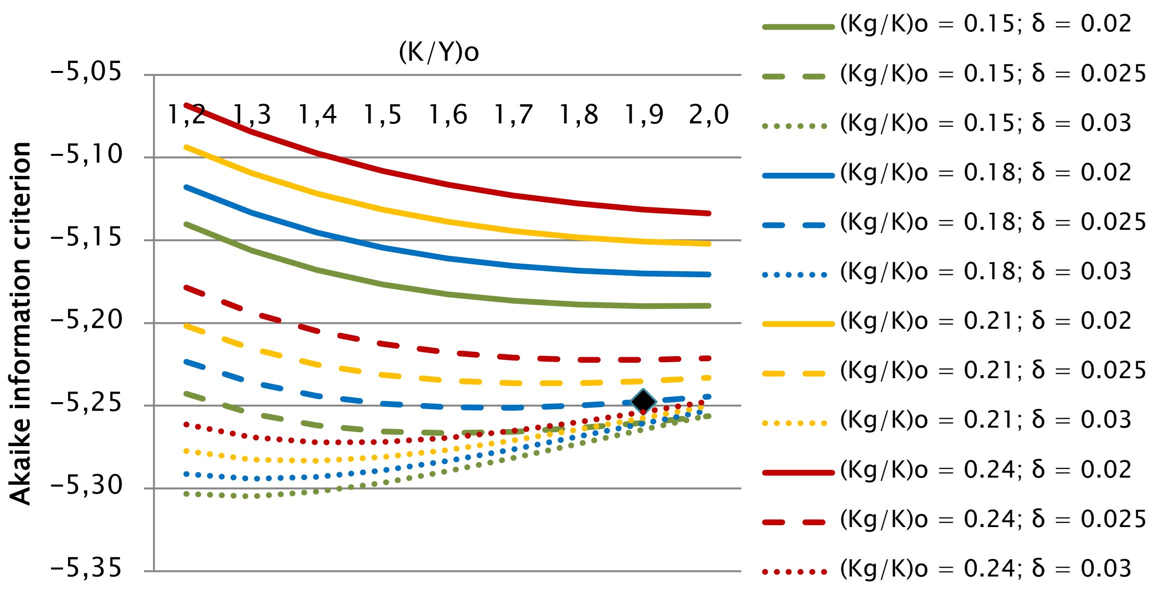


Figure 10. Value of Akaike information criterion subject to the assumptions used in econometric modeling (1995 Q1 – 2013 Q1 average)[12]

The relative productivity of public capital exceeds unity in all cases pointing that every lat of public capital on average promotes production volume more than the lat of private capital. The greater dominance of public capital productivity may be obtained assuming slower fixed capital depreciation and lower initial share of public capital in fixed capital stock, yet in authors' view, these assumptions are not reliable in the case of Latvia (see Figure 11).

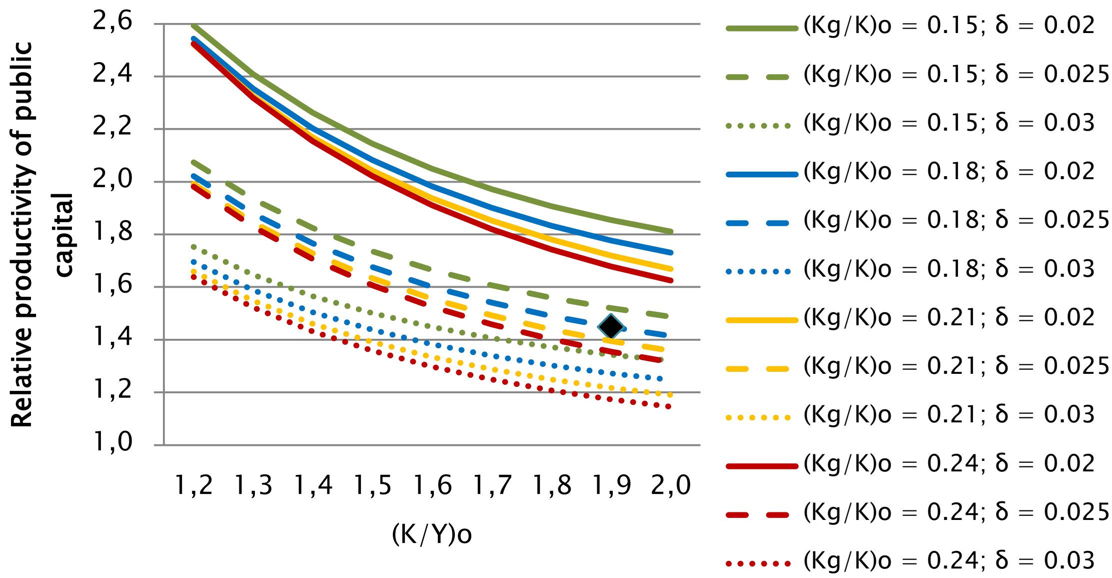


Figure 11. Relative productivity of public capital subject to the assumptions used in econometric modeling (1995 Q1 – 2013 Q1 average value)[13]

12 Authors' development.

13 Authors' development.

The conclusion on whether the difference of positive impact on production volume between the two capital types is statistically significant, is not straightforward – it depends on a combination of assumptions used in econometric modeling (see Figure 12). However, also in this case one cannot say that assumptions used in a base specification maximizes or minimizes the probability that public capital and private capital are equally productive.

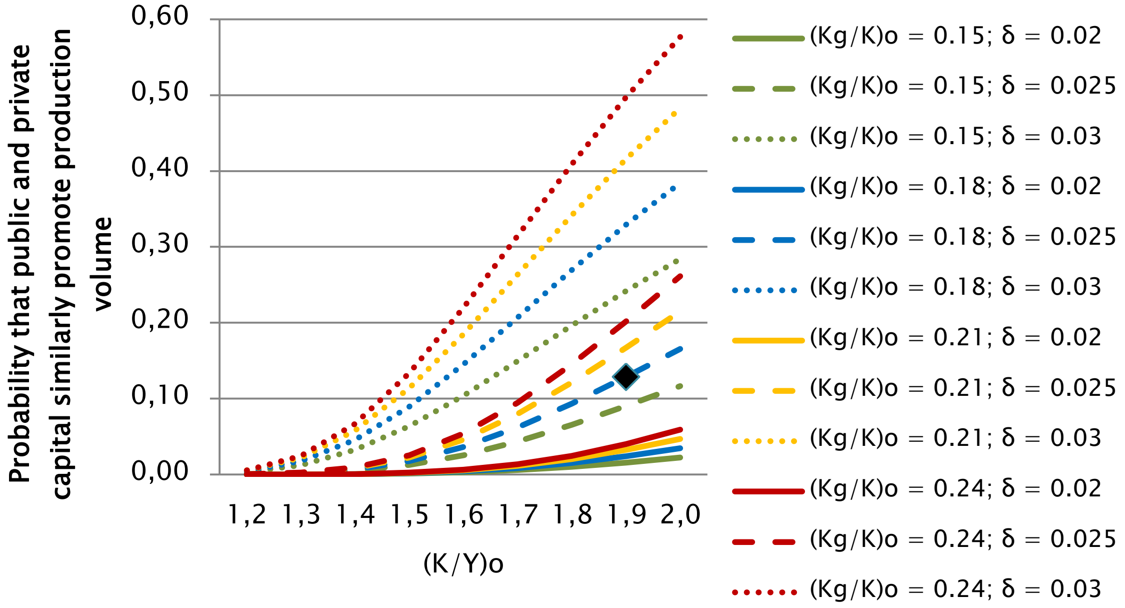


Figure 12. Probability that public and private capital promote production volume similarly, subject to the assumptions used in econometric modeling (1995 Q1 – 2013 Q1 average value)[14]

Concluding, although (in line with Krasnopjorovs, 2013), the assumptions used in econometrical modeling could substantially alter the results of production function assessment, these assumptions have no major impact on PCE value or the conclusion that one lat of public capital on average promotes production volume more than one lat of private capital.

On the one hand, the value of PCE is considerably lower than BICEPS (2008) assumed (0.80 during 2004-2006 period and 0.50 during 2007-2013 period)[15] based on Ligthart (2002) results on OECD countries. Moreover, it is also lower than 0.30 assumed by SSER (2011)[16], based on Bom un Ligthart (2008) results on other countries. On the other hand, the results of our study suggest that public capital in Latvia has positive and statistically significant impact on the production volume (irrespective of the combination of assumptions regarding fixed capital accumulation, the probability that public capital is not significant factor is zero) and that this impact is not smaller than that of private capital. Moreover, the results of the current research may confirm the hypothesis of BICEPS (2008)[17] that PCE value was higher during 2004-2006 period than afterwards owing to the greater public infrastructure shortage during the former period.

---

14 Authors' development.
15 BICEPS (2008): Second deliverable, page 10.
16 SSER (2011): First deliverable, page 12.
17 BICEPS (2008): Swcond deliverable, page 9.

5. PUBLIC CAPITAL ELASTICITY FORECAST UNTIL 2020

The forecast of PCE value until 2020 was performed using econometric methods and based on restricted production function model (see equation 3). PCE forecast involve the forecast of macroeconomic indicators used in an econometric model of PCE assessment and extension of the model until Q4 2020.

5.1. DATA USED IN PUBLIC CAPITAL ELASTICITY FORECAST

The forecasts of macroeconomic data involved in the econometric model of PCE assessment are based on Convergence Programme of Latvia 2013-2016 (hereinafter referred to as CPL) which was ratified at the Cabinet of Ministers of the Republic of Latvia meeting on April 29, 2013. Regarding the indicators which were not included in CPL, forecasts are based on the document "Information Report on Labor Market Mid-term and Long-term forecasts", developed by the Ministry of Economics of the Republic of Latvia and presented at the Cabinet of Ministers of the Republic of Latvia meeting on July 9, 2013 (hereinafter referred to as LMF). Besides, in some cases the forecasts made by the authors of the current research were used.

As from Q2 2013, quarterly growth rates g_{cet} were calculated from the forecasted annual growth rates g_{gads} according to the formula:

$$g_{cet} = \left(g_{gads}\right)^{1/4} \cdot 100 - 100 \qquad (14)$$

The forecasted value of macroeconomic indicator X in time period t was obtained as:

$$X_t = X_{t-1} \cdot (1 + g_{cet}) \qquad (15)$$

Production volume

Production volume growth rate forecasts during 2013-2016 period are based on CPL. CPL base scenario expects the annual rate of GDP growth to be 4%[18], optimistic scenario – 6%[19], whereas pessimistic scenario – 2%[20]. As CPL predicts GDP annual growth rate to remain constant during the 2013-2016 period, we assume that it will remain constant also during 2016-2020. Moreover, it was assumed that GVA and GDP growth rates will be identical (see Figure 13).

[18] Convergence Programme of Latvia 2013-2016, page 82.
[19] Convergence Programme of Latvia 2013-2016, page 51.
[20] Convergence Programme of Latvia 2013-2016, page 52.

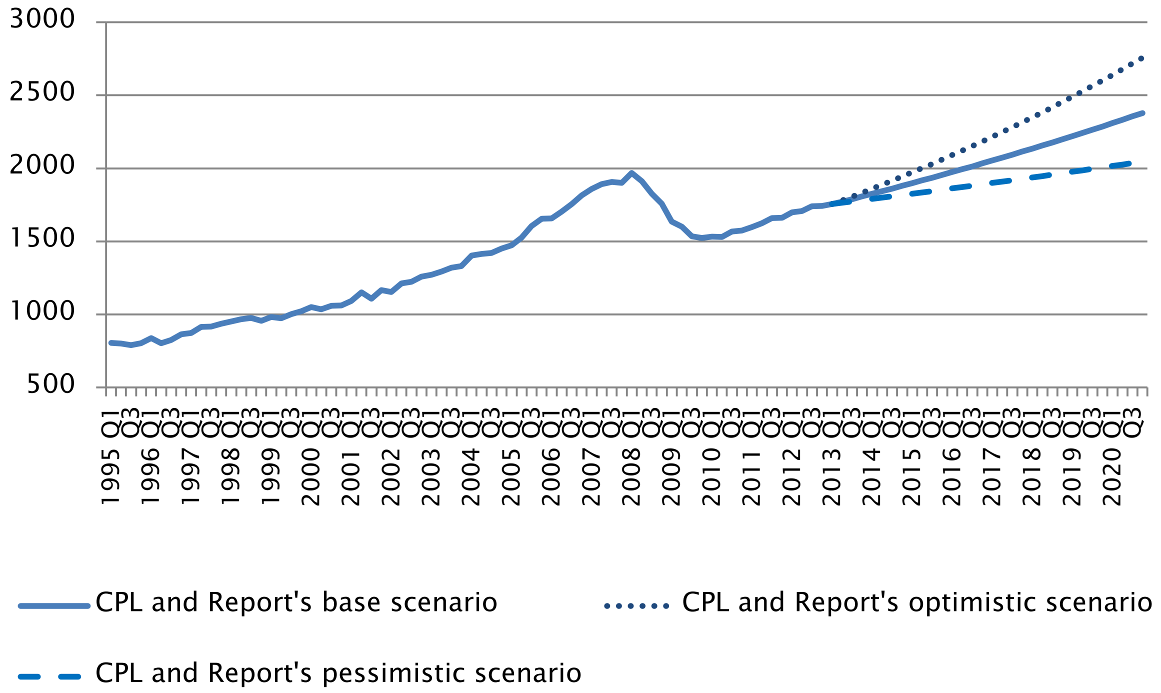


Figure 13. Production volume forecast in Latvia (mill. lats; seasonally adjusted data)[21]

Fixed capital

CPL base scenario expects investments to grow by 5.2% in 2013 and by 6% annually as from 2014[22]. In this case, investments share in GVA will increase continuously and in 2020 will achieve 31% of GVA. In our view, it is not enough justification to expect continuous rise of investments share in the medium term given the moderate speed of economic development (4% annually). Investments share in GVA, calculated from CPL data would be considerably higher than the respective indicator in countries with a similar level of development. That is why the authors of Research Report used more modest expectations regarding investments growth. According to the base scenario of this Report, investments share in GVA is likely to decrease gradually – to 24% in 2020 (it is similar to the 2010-2011 average level). It would increase somewhat according to the optimistic scenario – to 28%, and the decline is more rapid (to 20%) in pessimistic scenario (see Figure 14).

21 Authors' development, based on Convergence Programme of Latvia 2013 – 2016.

22 Convergence Programme of Latvia, page 82.

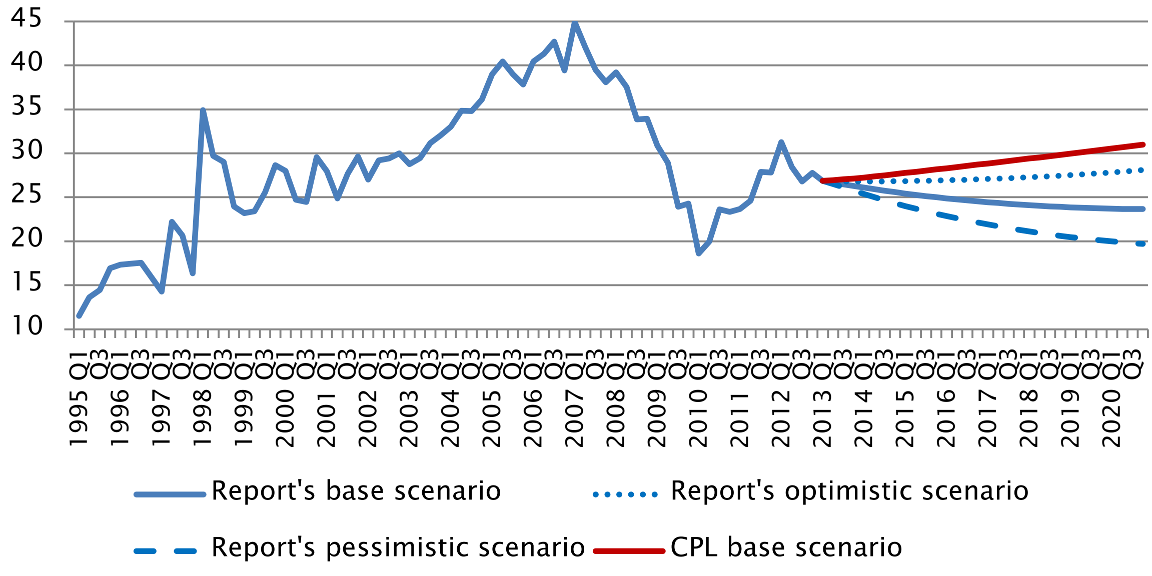


Figure 14. Fixed capital formation share in GVA forecast (%; seasonally adjusted data)[23]

According to the CPL base scenario, gross fixed capital formation in the public sector will be 3.5% of GDP in 2013 and then it will gradually decrease to 2.2% of GDP in 2016[24]. Even assuming that public investments will not decrease further and will remain at 2.2% level during the 2016-2020 period, it is not sufficient for maintaining the current amount of infrastructure. In this case, the amount of public capital is going to decrease already in 2014, and in 2020 public capital share in total fixed capital will decrease to 11%, which is close to record low level recorded in 2003. At the same time, public sector share in investments will decrease to 8% up to 2020, which is record low value since 2002. In our view, this scenario is not realistic, and that is why the Research Report assumes that the decline of public investments share in GDP is likely to be slower – till 3.0% in 2016 and 2.6% in 2020. In this case, public capital share in total fixed capital will decrease gradually, which, is base scenario is sufficient for maintaining of the public capital amount at least at the current level (see figures 15 and 16).

23 Authors' development, using Convergence Programme of Latvia 2013 – 2016.
24 Convergence Programme of Latvia 2013-2016, page 84.

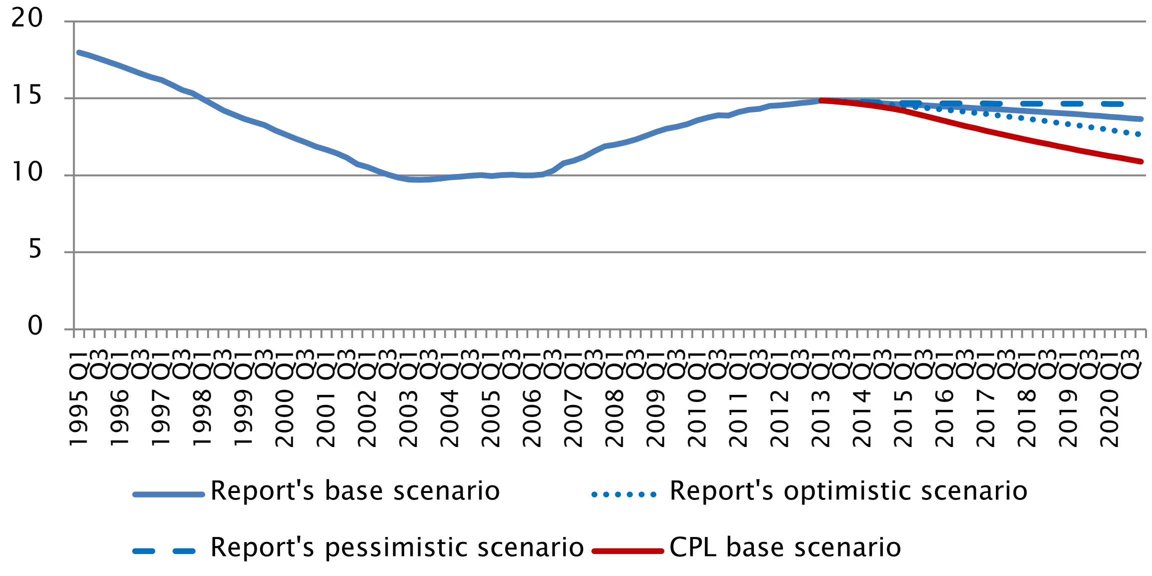


Figure 15. Public capital share in total fixed capital forecast (%; seasonally adjusted data)[25]

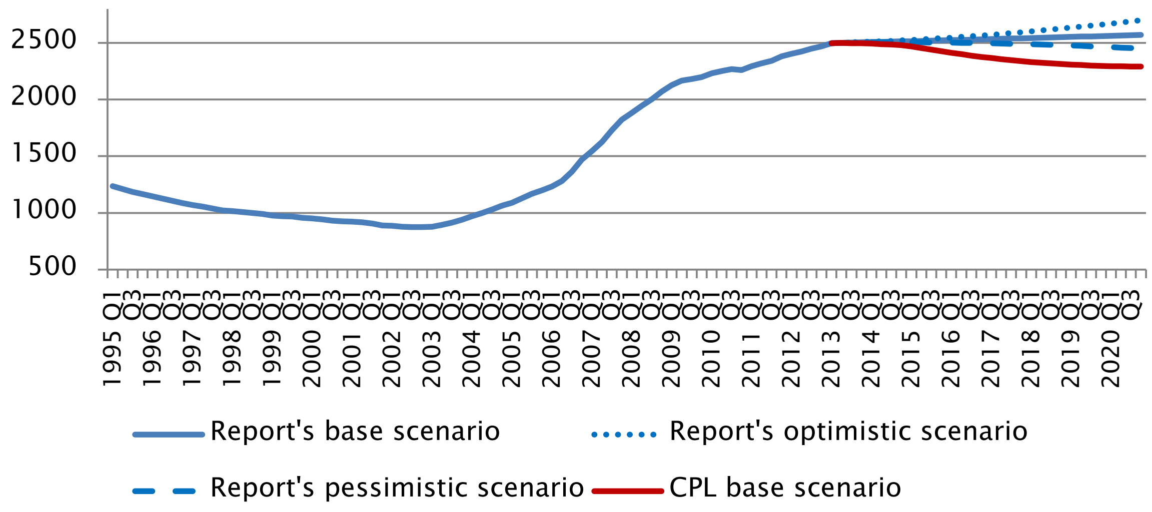


Figure 16. Public capital stock forecast (mill. LVL; seasonally adjusted data)[26]

Number of employed

According to the CPL base scenario, employment growth will be 1.4% in 2013, 1.2% in 2014 and 1.3% since 2015[27]. LMF employment forecast is more modest. It expects that in 2015 number of employed will exceed 2012 level by 3.4% and in 2020 – by 5.6% [28]. It means that employment annual growth during 2013-2015 is projected to be 1.1% whereas in 2016-2020 it is only 0.4%. Differences between CPL and LMF forecasts directed the authors of Research Report to make employment forecasts in the course of the research.

25 Authors' development, using Convergence Programme of Latvia 2013 – 2016.
26 Authors' development, using Convergence Programme of Latvia 2013 – 2016.
27 Convergence Programme of Latvia, page 82.
28 LMF Appendix, page 3.

Working age population was projected given the age and sex structure of Latvia's population in the beginning of 2013, as well as death and birth age-coefficients and LMF net migration forecasts[29]. LMF migration forecast expects positive net migration since 2017. Optimistic scenario of Research Report expects positive net migration already since 2014 whereas under pessimistic scenario net migration is likely to remain negative until 2020 (see Figure 17).

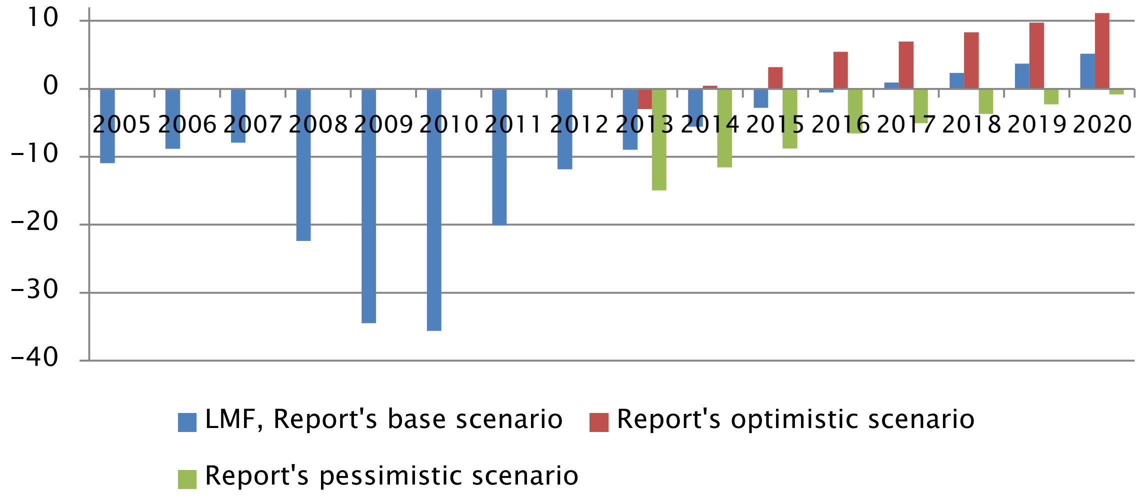


Figure 17. Net migration forecast (ths. persons)[30]

Number of employed was calculated according to equation 9, given the authors' expectations regarding changes in participation rate and unemployment and assuming that 80% migrants are in a working age. Base scenario of the current research expects further decrease in unemployment and rise in participation rate (see Appendix 12). Therefore in 2020 unemployment rate is expected to be lower than its historical average and participation rate – close to its record high value. However, employment will not change significantly in the medium term since unemployment drop and participation rise is going to be offset by the negative net migration, population natural decrease and declining of the working-age population to the total population ratio. Moderate employment growth is projected only within the optimistic scenario, reflecting higher net migration and participation rate as well steeper unemployment decline. In its turn, according to the pessimistic scenario, unemployment rate will not change significantly, the rise of participation rate is minor and the dominance of emigration over immigration is substantially larger: this will result in a gradual employment slowdown (see Figure 18).

29 LMF, page 37.
30 LMF, authors' development.

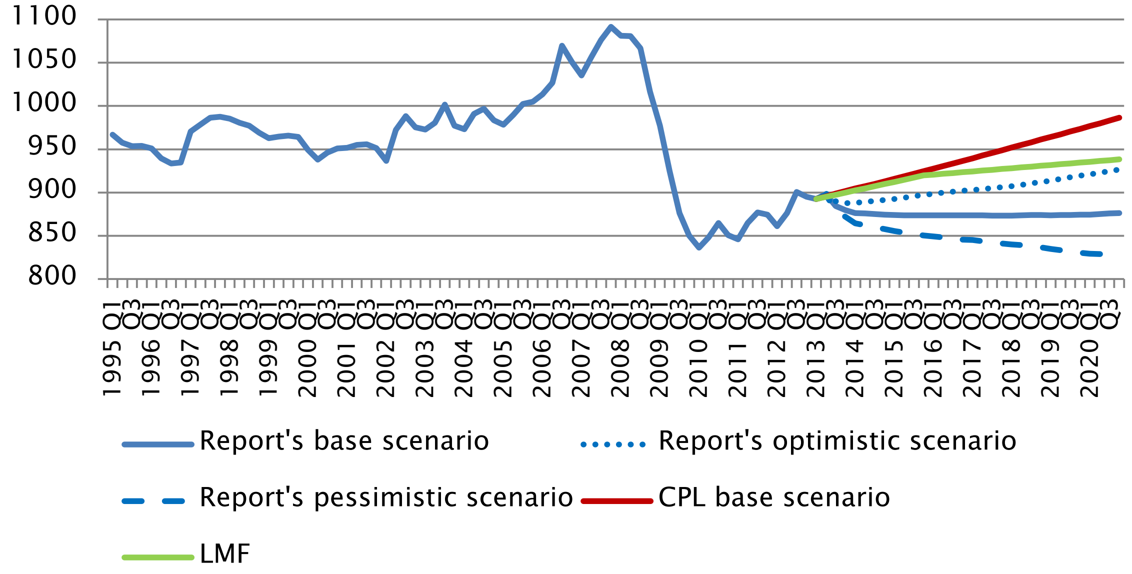


Figure 18. Number of persons employed forecast (ths.; seasonally adjusted data)[31]

Production factors utilization

Capacity utilization in manufacturing – indicator that approximates the private capital utilization rate in the course of the research, is not projected neither by PCL nor LMF. The authors of the Research Report consider that given its high rate and decreasing tendency over the last quarters, capacity utilization continues to decrease in the medium term in a base scenario case, however even in 2020 it will exceed its historical average level. In optimistic scenario case, capacity utilization in the medium term will hold close to historically high level whereas within the pessimistic scenario it will decrease substantially (see figure 19).

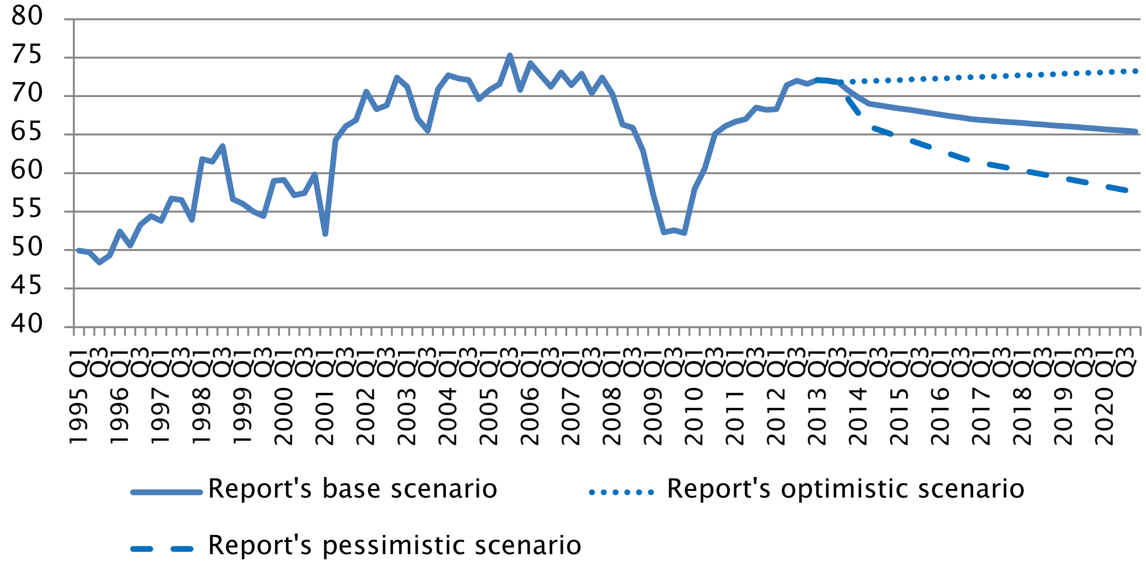


Figure 19. Capacity utilization rate forecast (%)[32]

31 Authors' development, using CPL and LMF.
32 Authors' development.

According to the CPL base scenario, number of hours worked in 2013 is going to rise by 3.1% and since 2014 – by 3.2% per year[33]. Given CPL employment forecast, labor utilization will rise continuously and in a few years will reach record high levels. We do not regard this assumption to be realistic given that a rise in production volume is only moderate (by 4% annually). In the medium term, labor utilization in Latvia tends to decrease – as average income level tends to increase over time, so does demand for leisure. If 10 years ago working week length in Latvia was one of the longest in Europe, currently the number of actual weekly hours worked per worker is below 40. Moreover, despite the rapid revival of output and labor market after the crisis, during the last three years labor utilization rate almost did not increase.

Our base scenario expects a moderate decrease of labor utilization in the future. The decline will be reflected in all labor utilization components (see equation 12): both the average working week length on the main job and the prevalence and working time in the secondary job. Pessimistic scenario assumes steeper labor utilization decline than optimistic scenario (see Figure 20). The decrease of labor utilization even within the optimistic scenario seems to be reliable since labor utilization rate did not rise even during 2006-2007 period, characterized by widespread labor shortage and 12% annual GDP growth.

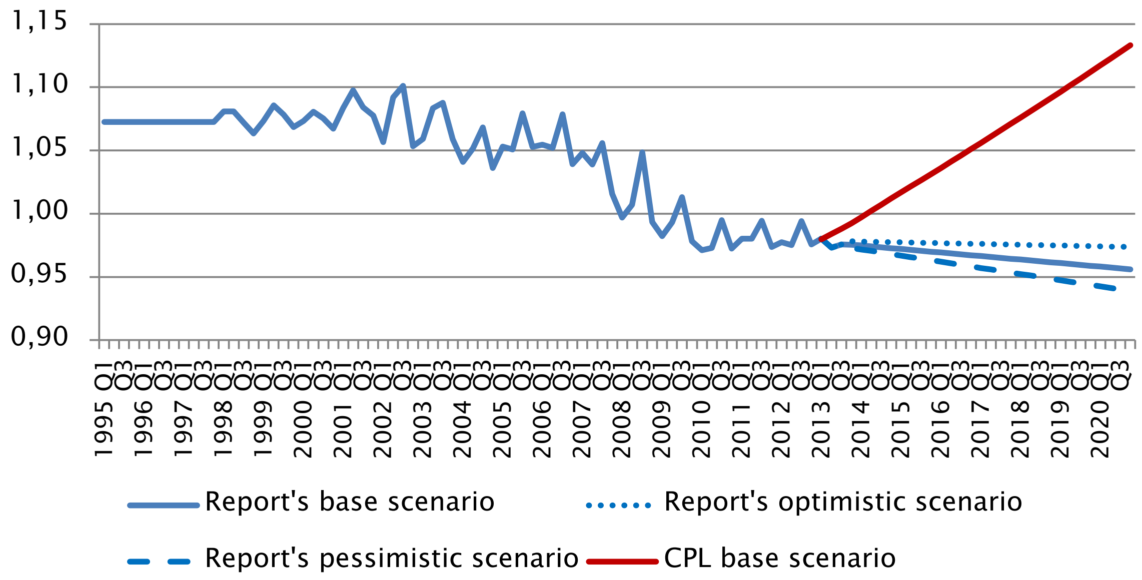


Figure 20. Labor utilization rate forecast (40-hour working week = 1; seasonally adjusted data)[34]

Technical progress

Technical progress or TFP process is modeled as exogenous and deterministic until 2020. The results of econometric modeling do not indicate on a possible structural break similar to one experienced during the 2008-2009 slowdown period.

[33] Convergence Programme of Latvia 2013-2016, page 82.

[34] Authors' development, using Convergence Programme of Latvia 2013 – 2016.

5.2. RESULTS OF PUBLIC CAPITAL ELASTICITY FORECAST

CPL base scenario forecasts are not suitable for the purpose of the current research. For instance, results of CUSUM test show that the mutual disjuncture of various macroeconomic indicators' forecasted values is evident already in 2013 and increases over time (see Appendix 7a). These results for the base scenario are considered to be unsatisfactory and this confirms the necessity to use of authors' own forecasts in the course of the research.

In our base scenario forecast case, value of CUSUM test is not statistically significant showing that the mutual disjuncture of various macroeconomic indicators' forecasted values is prevented (see Appendix 8A). Moreover, recursive residuals are close to zero during the whole forecast period (see Appendix 8B, for comparison – in the case CPL forecasts, recursive residuals exceeds the 95% confidence threshold for a long time and do not converge to zero even at the end of forecasting period, see Appendix 7B). Recursive estimates of model's coefficients are stable and its confidence interval narrows over time (see Appendix 8C).

Results of unrestricted PCE forecasting model assessment according to the three economic development scenarios are shown in Appendix 9. The value of PCE is positive and statistically significant in all cases. The results of the Wald test confirm that absence of a scale effect in Latvia's production function (see Appendix 10), thus according to the methodology of the current research (see Figure 1), preference should be given to the restricted PCE forecasting model, shown by equation 3 (results are shown in Appendix 11). In optimistic scenario case, PCE value will maintain close to the 2001-2013 average value and will somewhat exceed its current value. According to the base scenario, PCE value will decrease moderately. The decline is steeper under the pessimistic scenario (see Figure 21).

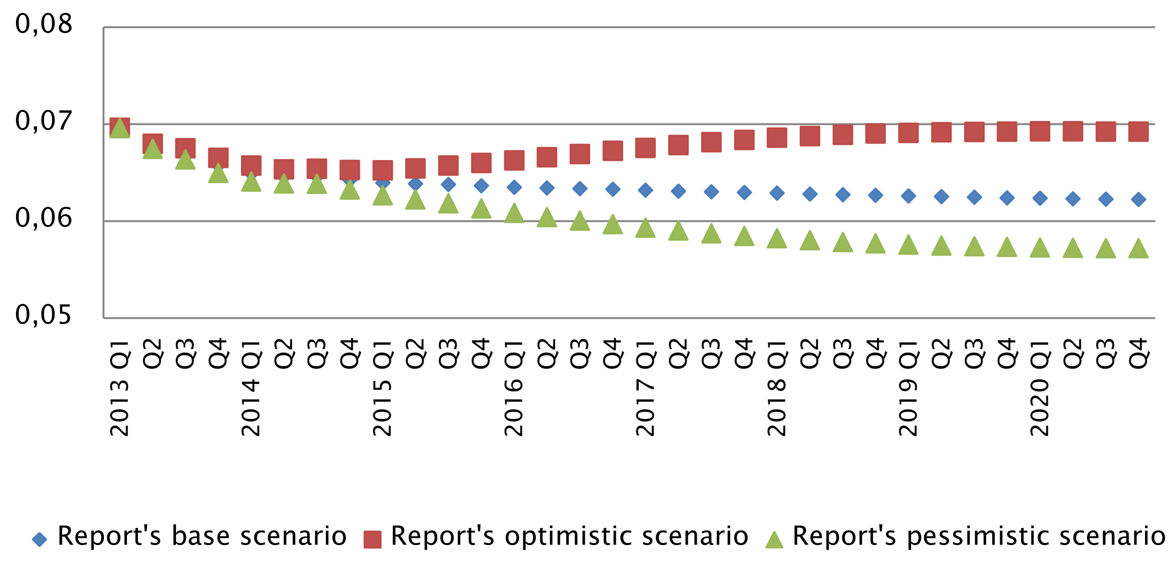


Figure 21. Recursive estimates of public capital elasticity forecasted values[35]

35 Authors' development.

In the base scenario case, the average value of PCE during the period between 2013 Q2 and 2020 Q4 will be 0.045. Moreover, according to the optimistic scenario it will be higher than under pessimistic one (0.068 and 0.028 respectively). Taking into account the flash economic development indicators in 2013, we regard that probability of optimistic scenario is higher than that of pessimistic scenario. It is expected that the probability of base scenario is 50%, probability of optimistic scenario is 30% and the probability of pessimistic scenario is 20%. Therefore weighted average forecast of PCE value during 2013-2020 is 0.049 (see table 3).

Table 3. Public capital elasticity forecast[36]

Scenario: / Period:	Optimistic scenario (30%)	Base scenario (50%)	Pessimistic scenario (20%)	Weighted average
2001Q1 - 2020 Q4	0.069	0.062	0.057	0.063
2013 Q2 - 2020 Q4	0.068	0.045	0.028	0.049

Irrespective of economic development scenario, private capital elasticity will exceed PCE over the whole forecasting period. Base scenario expects a moderate private capital elasticity rise, pessimistic - a steeper rise. In its turn, optimistic scenario expects a moderate decline of private capital elasticity (see Figure 22).

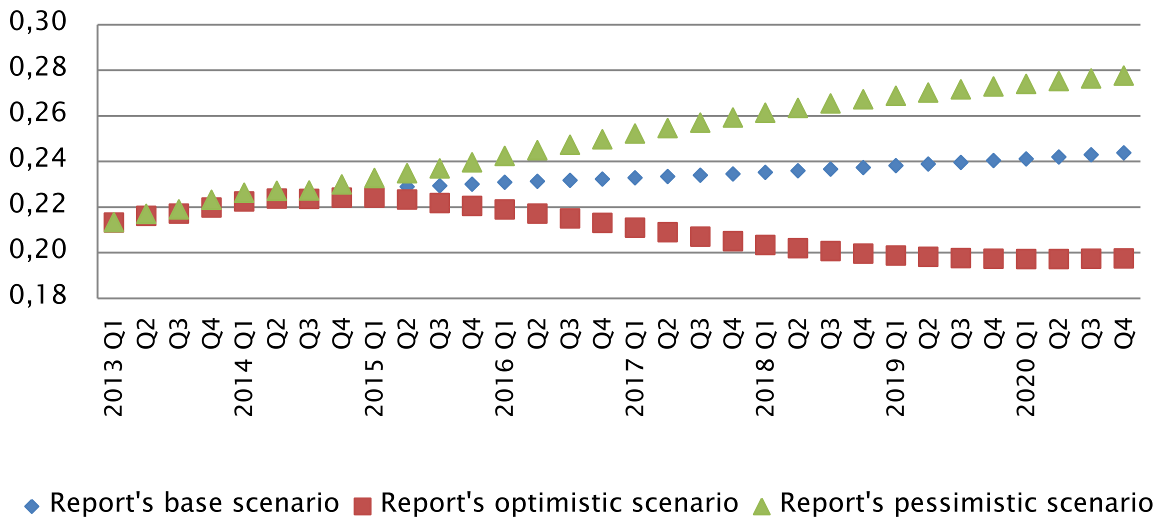


Figure 22. Recursive estimates of private capital elasticity forecast[37]

Irrepsective of the economic development scenarios, forecasted value of PCE is not likely to go beyond the limits encountered in the scientific literature: 0.26 - 0.34 (see Figure 23).

36 Authors' calculations.
37 Authors' development.

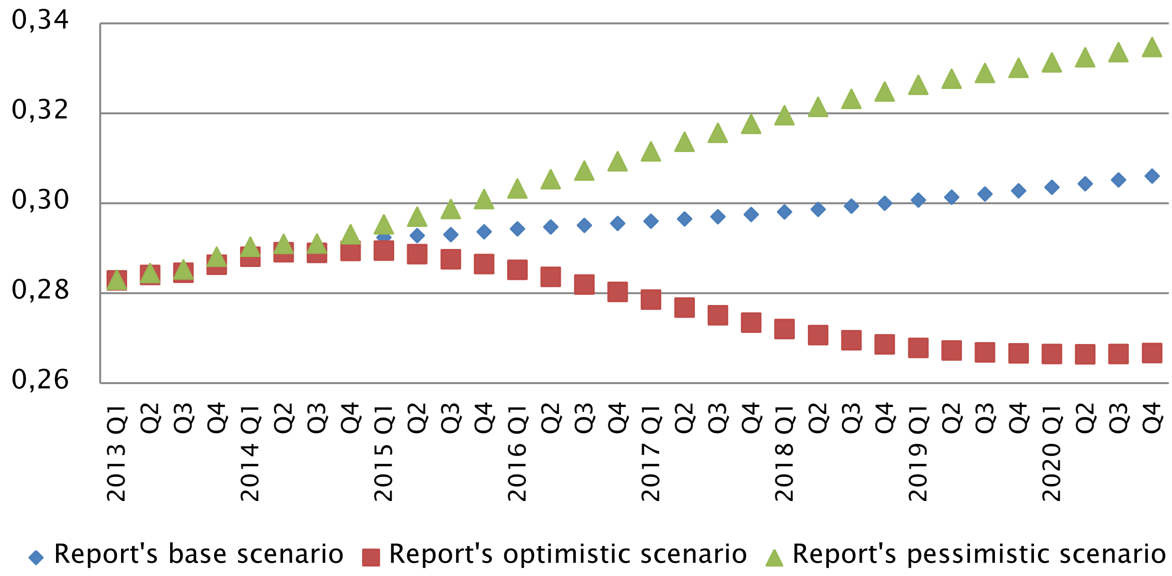


Figure 23. Recursive estimates of total capital elasticity forecast[38]

Base and optimistic scenarios suppose that the positive impact of one public capital lat on production volume will remain larger than that of private capital until the very end of forecasting period (see Figure 24).

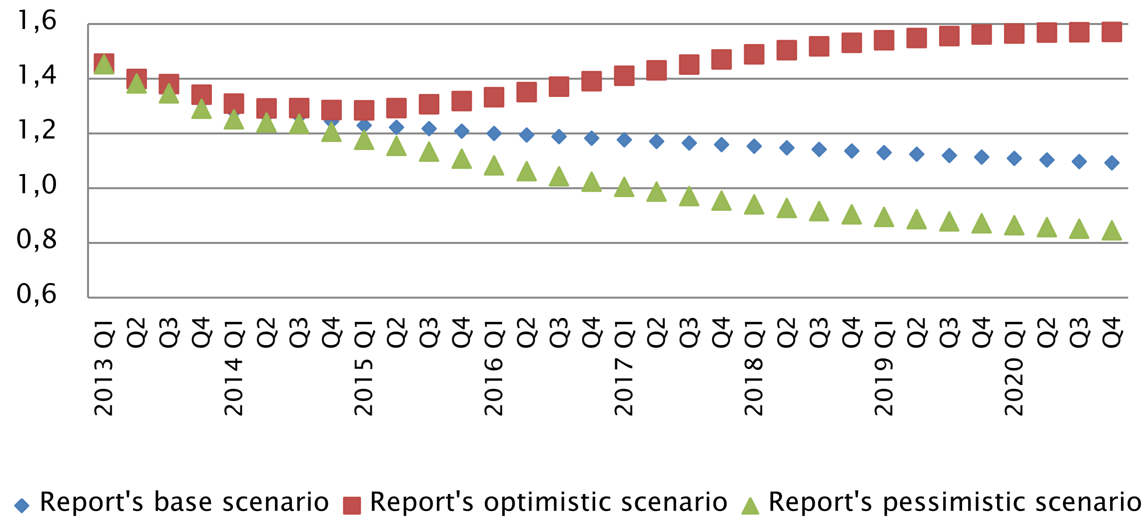


Figure 24. Recursive estimates of public capital relative productivity forecast[39]

Moreover, in the optimistic scenario, the difference regarding the promoting impact on production volume between the two capital types is statistically significant (see Figure 25). Although pessimistic scenario expects that over time one lat of private capital will become more important than one lat of public capital, the difference between two capital types still will not be statistically significant.

38 Authors' development.
39 Authors' development.

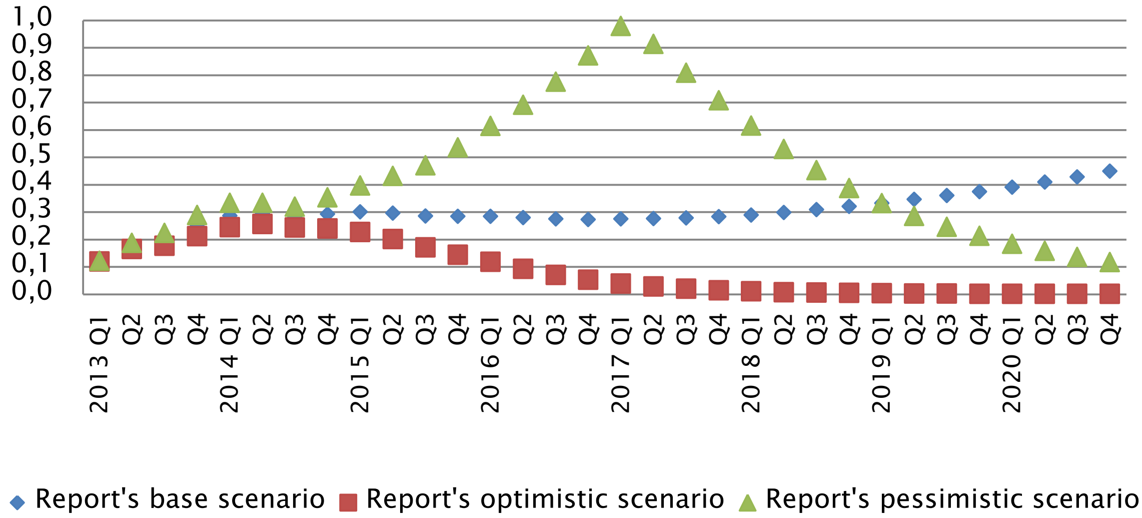


Figure 25. Recursive estimates of forecasted probability that private and public capital is equally productive[40]

It could be concluded that only in optimistic scenario case that supposes production volume growth at an annual rate of 6%, it is possible to maintain the PCE level close to the historical average level of 0.07. Although the infrastructural endowment of the economy will grow up, the shortage of infrastructure may become even more immense because private capital amount will rise considerably faster: amount of public capital subject to the one used lat of private capital, comparing to the beginning of 2013, is going to decrease by 18% (see Figure 26).

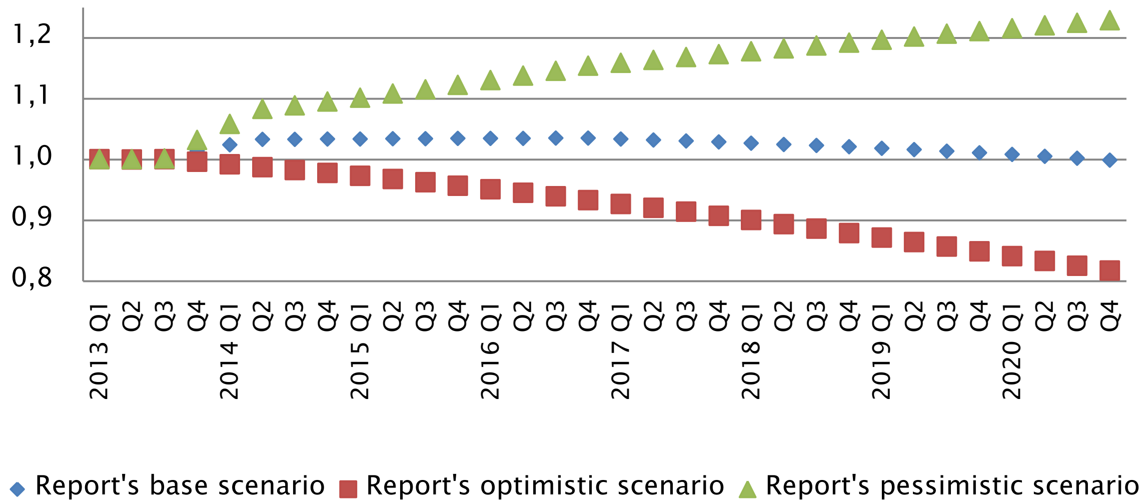


Figure 26. Public capital stock on one used private capital lat forecast (index; 2013 Q1 = 100)[41]

Base scenario assumes that production volume will grow at the annual rate of 4%: this is slower than during the 1995–2012 period on average. The infrastructural endowment will grow gradually, but relatively to the used private capital lat it will remain almost unchanged. A small decline of PCE

40 Authors' development.
41 Authors' development.

is attributed to the increase of the public capital amount subject to the number of employed in full-time units (see Figure 27; base scenario assumes a population decrease by 100 thousand during the following eight years).

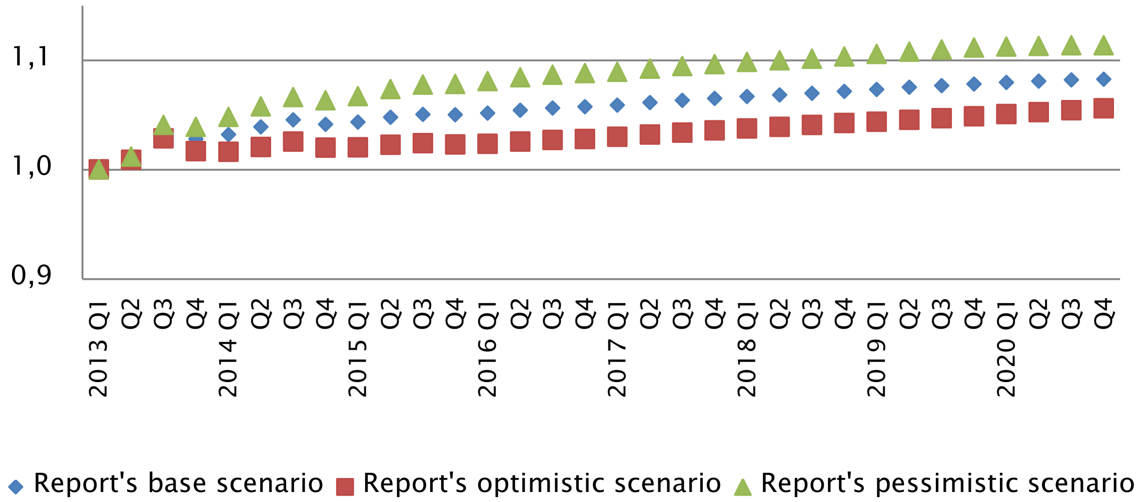


Figure 27. Public capital stock on one employed in full-time units forecast (index; 2013 Q1 = 100)[42]

In its turn, the pessimistic scenario supposes production volume growth by an annual rate of 2%, which, both from the Latvia's historical evidence and income convergence expectations would likely be seen as stagnation. The amount of public infrastructure would remain almost at the current level; however, it will increase significantly subject to the used private capital and employment in full-time units. Therefore, comparing to the other factors of production, public capital may be in redundancy and that will be reflected in a substantial decline of PCE.

42 Authors' development.

6. EU FUND CROWDING OUT CONCEPT AND MAIN FINDINGS OF THE SCIENTIFIC LITERATURE

Historically the crowding out effect is linked to the analysis of the effectiveness of fiscal policy: whether the government investments crowds out private investments, and what socio-economic factors determine this process. Assessing the role of the crowding out effect on economic development it is important to estimate the degree of crowding out (full or partial). In economics theory measurement of the degree of crowding out usually is based on the following definition: degree of crowding out is the ratio of change in private economic activity on related change in public economic activity (Buiter, 1975).

The objective of our analysis is evaluation of crowding out effect of domestic investments in respect to inflows of EU funding. The crowding out or investment substitution effect stems from the fact that in both the private and public sectors projects have and will be undertaken even if the funds had not been available. Thus, the funds partly *substitute* or *crowd out* domestic investment (both private and public). Thus, it is necessary to evaluate the degree of crowding out of domestic investments in respect to EU funding.

Theoretically the crowding out effect has been widely described in the scientific literature, but the empirical testing and quantitative measurement of the effect is not straightforward. This is evidenced by the fact that there are a small number of empirically obtained estimates of the degree of crowding out. This may be due to the availability of data and modeling problems.

The basic setup for empirical analysis of crowding out is to estimate the following equation[43]:

$$Y_{it} = \alpha + \beta \cdot X_{it} + Exog_{it} \cdot \delta + \varepsilon_{it} \quad (16)$$

where Y is dependent variable (e.g., local funding, private donations, private spending etc.) – it depends on the issue of the analysis. Domestic investments are used as dependent variable in application of the model in assessment of crowding out of EU funding;

X – explanatory variable that can be described as source of crowding out. In our study, EU fund inflows are used as X.

Exog – set of exogenous measures that help to identify Y variation;

ε – error term;

i – identifies the unit of observation (e.g., individual, state or municipality or project);

t – identifies the period the measure covers (e.g., year or quarter).

α, β,δ – coefficients or its vectors.

In the equation (16) crowding out is measured by the coefficient on the X, β. That shows the mean change in dependent variable as X increases by one unit, but other factors do not change. Consequently, difference $1-\beta$ shows the degree of crowding out.

Thus, the objective of the study is to evaluate the β. Under ideal circumstances, this coefficient is unbiased, representing a statistically accurate measurement of the average effect from a change in factor X on the dependent variable. However, the estimate of β can be biased because of endogeneity of X and/or omitted variables that are correlated with X. The potential omitted variable bias results from the limited information researchers use for their analyses.

[43] Payne, 2009; page 162.

Other problem in respect to estimation of an equation (16) is a specification problem of the econometric model – do we have linear or non-linear relationship. Evidence from empirical investigations (Payne, 2009; Bradley et al., 2005; Tron, 2009) shows that estimated values of crowding out can differ because of differences in model specification.

The issues of endogeneity and omitted-variable bias can be addressed by using measures that allow for the identification of exogenous part of X. The prominent statistical strategy is two-stage least squares (2SLS), that allows us to identify a set of measures that directly explain X but only indirectly affect the dependent variable. As X is predicted using a set of chosen instruments, then the predicted X value is used to measure the crowding out effect on the dependent variable (second stage equation). To be effective, the instruments should have a statistically significant impact on X. A researcher should emphasize F statistics for the significance of the instruments. In addition, the instruments should not have a direct effect on the dependent variable. Ensuring this is more difficult.

Other approach – a natural experiment. The strategy is to divide the regions in the sample into two groups: the observations in the control group do not receive cohesion support while observations in the treatment group receive a lot. The relation between national aid and the relative poverty of a region is estimated on the basis of control group only. In this manner one can have a crack at what regions in the treatment group should have received. Difference between these groups must be due to crowding out (Ederveen et.al., 2003).

Although the topicality of the impact of the EU support policy resulted in a large number of empirical papers analyzing COE, usually the value of COE is assumed in macroeconomic models. There are only some scientific publications in which the value of COE is evaluated quantitatively.
Garcia – Mila and Mc Guire (2001) paper uses the „differences-in-differences" method (change in cash flows) to conclude that in Spain the inflow of EU funds has resulted in a substantial decrease of domestic investments. Despite the presence of crowding out effect was proved, the paper still lacks its quantitative assessment.

Ederveen et.al. (2003) state that their research is the first attempt to obtain a quantitative evaluation of the COE value. They stress the link between the assumptions about COE value and the methodology for evaluation of the EU fund efficiency assessment. Simulation models assume that EU fund support directly transfers to the productive investments therefore crowding out is not present. At the contrary, case studies models show a substantial crowding out. Therefore, the truth might be somewhere in between and simulation models are argumented with the extra assumption that the COE effect is exogenous so that its lower and upper bounds could be determined. The drawback of this method – results are rather sensitive to these bounds (de La Fuente and Gives, 1995 and others).

Therefore Ederveen et.al. (2003) justified the necessity to obtain a quantitative estimate of COE using the econometric model. The estimated value of COE in their paper is between –0,95 and 0,75. It is very wide range since the one extreme value points to the almost perfect compliance with the European Commission request regarding the co-financing and the other one reflect almost full crowding out. On average, COE value is 0.17. It means that €1 of Cohesion support crowds out €0.17 of the national regional policy spending despite the request of co-financing. So that decreases the effectiveness of Cohesion policy.

Ederveen et.al. (2003) paper is one of the most cited items regarding the quantitative estimation of COE, but also one of the most criticized. For instance, in analyzing its drawbacks, Bradley and Untiedt (2008) point, that alternative assessment of EU fund impact would be macroeconometrical modeling combined with the microeconomic approach, that would allow to obtain much more accurate estimations, conclusions and political recommendations.

Therefore although Ederveen et.al. (2003) idea of COE quantitative assessment seems attractive, its implementation do not allow achieving the goal of our research. Bradley and Untiedt (2008) arguments are important, but their recommendations do not allow obtaining a quantitative assessment of crowding out. Quite the opposite – usually additional assumptions should be stated about the degree of crowding out.

Other relatively new but also extensively cited paper regarding the COE assessment is Alegre (2012). His paper is important contribution to the literature for the following reasons. First, the author augmented the neoclassical growth model with the several types of grants and assumption that might provide an opportunity to assess the efficient of the EU regional policy and state whether the EU funds has crowded public investments or not. The novelty of his paper is empirical as well. He stated the method for testing the stability of results and checked his model both in international and national (Spain regions) cases. Second, Alegre (2012) model shows the way how to quantitatively assess the value of PCE. He checked himself whether EU funds crowds out public investments in the Member States.

The main idea of Alegre (2012) is comparison of EU funds to inter-governmental grants that affect public spending. Transfers between different governments – usually from upper to lower levels of the public administration – became an often used tool with the purpose of enhancing public expenditure in pre-determined areas (education, infrastructure, etc.). These subsidies were usually given on the condition that they were invested in certain targeted policies or programs. However, as long as the subsidized government was free to administer the rest of its budget, these transfers could simply crowd out the resources previously allocated in the subsidized areas to other alternative uses or to reduce tax revenues. Such situation can be described with a neoclassical model of local government with fully informed agents and perfect political competition; alterations to private income are perfectly substitutable by equivalent alterations to public revenue.

Thus, Alegre (2012) stated that an effectiveness of EU Structural Funds can be estimated with the help of an extended version of the AK model in which they introduce public grants, which were conceived to push up public investments and expenditures in key areas for enhancing growth.

Alegre (2012) based his analysis on the following model:

$$I_{it} = \beta_1 s_{it} + \beta_2 c_{it} + \eta_i + u_{it} \tag{17}$$

where I_{it} – public investment,

s_{it} – EU Structural Funds allocated to the member country i in the current year t.

c_{it} – vector of other control variables (GDP, population, budget surplus, public consumption and private investment).

$\beta_1, \beta_2, \eta -$ vectors of estimated coefficients,

u – stochastic error term.

In evaluation of the equation (17) Alegre (2012) uses the annual data of 15 EU Member States during the time period from 1993 until 2005. The estimation is based on the standard fixed and random effects linear model with autocorrelated residuals and generalized method of moments' (GMM) model dynamic specification that takes into account the endogeneity of explanatory variables. The result obtained – full crowding out is not present, the increase of public investments in the Member States is about 60% from the increase in ES fund inflows. The rest 40% therefore are diverted to the alternative programs, for instance, public consumption. The stability of results is checked using data on Spanish regions.

There are discussions about potential degree of crowding out in different economic sectors in scientific literature. For instance, del Bo et al. (2011) have mentioned that transportation and communication sectors are those where they do not expect crowding out, but education and health may be spheres with high level of crowding out.

As stated in the BICEPS (2008) paper[44], although there are no empirical estimations of COE in the case of Latvia, there is evidence that EU fund financing partly crowded out domestic investments. Particularly, they mentioned an example that the State Employment Agency reduced expenditures on active labor market policy in the run up to 2004 in order to take maximum advantage of the European Social Fund. However, this might be attributable to the decrease of unemployment rate.

Moreover, EU funds may crowd out not only public but also private investments: part of the private sector investments would be implemented also without EU funds.

The main simulation scenario of SSER (2011) paper assumes 30% crowding out, given that the share of national financing (both private and public) is about 30%. Therefore, they pointed out that these resources would have been invested also in the absence of the EU funds[45].

BICEPS (2008) emphasized that it is clear that both in the private and public sectors there are projects that would have been implemented also without EU funds; therefore EU funds may partly crowd out domestic investments both in private and public sectors. Also they pointed out that this question is ambiguous since when modeling the crowding out, it should be taken into account that such information is not available on historical data, and especially for the future.

One more article about crowding out effect un context of EU structural funds is in't Veld (2007). He estimated the potential impact of Cohesion policy for the 2007-2013 period (simulation results) using the QUEST II model. Defining the crowding out as a gap between the Cohesion policy transfer and its impact on GDP, for Latvia the estimated gap is 3% in 2008, 66% in 2009 and 77% in 2010. From today's view, such estimation for the crisis period seems to be implausible. On the other hand, these estimates are forecasts that were obtained during the period of economic overheating, thus, in normal times forecasts might be more realistic.

Therefore, the main findings of the scientific literature regarding the crowding out effect presence are the following:

- COE assessment is not straightforward. It should be an opportunity to estimate how many projects would be implemented without the EU fund support.
- The econometric model for COE assessment should be parsimonious since it should be used as one of the instruments to assess the macroeconomic impact of EU funds. However, the simplest model could bias results if its assumptions are not realistic or model specification is wrong (both regarding the selection of variables and its measurement as well as to its endogeneity). Judging the trade-off between the most complete and parsimonious model, the priority might be given to country specific model rather than to the cross-country model which dominate in this kind of research.
- Although some publications (for instance, Tron, 2009) point out that in some sectors (for instance, in agriculture – owing to the special agriculture support program, and in industry – owing to the direct impact on productivity and GDP) the agent's reaction on the EU fund inflows may be different, currently empirical literature lacks example of assessment of the COE value in the sectoral breakdown. Difficulties might appear particularly to separate the interaction

[44] BICEPS (2008), Second deliverable.

[45] SSER (2011), Second deliverable, page 10.

between sectors (for instance, the impact of construction expansion on other sectors' development), as well as problems with the data availability by sectors.

- Scientific literature shows both theoretically and empirically that the value of COE might change subject to the economic cycle. Therefore, in the course of the research, several economic development periods are defined within the COE retrospective assessment.

7. ECONOMETRIC MODEL FOR RETROSPECTIVE ASSESSMENT OF THE EU FUND CROWDING OUT EFFECT

In the course of research the crowding out of the domestic investment as a result of EU fund inflows was evaluated in a sectoral breakdown and across several economic development periods. In defining periods of Latvia's economic development, the points of possible structural breaks were identified with the statistical tests. Then, dummy variables were used in assessing whether the COE value is statistically different across these periods.

Panel data cointegration analysis was selected for the modeling. Model includes a balanced panel for each of the sectors of the economy. The time period for the panel is from 2001 Q1 to 2013 Q1:

$$Inv_{it} = \beta_{oi} + \beta_{1i} EU_{it} + \beta_{2i} X_{it} + \delta EU_{it} D_t + \varepsilon_{it} \tag{18}$$

where Inv_{it} are domestic investments (gross fixed capital formation) in sector i and time t;

EU_{it} – inflow of EU funds and aid programs in sector i and time t;

X – vector of other explanatory factors;

D – vector of dummy variables;

ε – error.

Several factors that are likely to affect domestic investments are used as explanatory variables, which were selected based on Alegre (2012), Wostner (2009) and Tron (2009) empirical findings; as well as sector specific variables (consisted with the implementation of particular investment projects etc.).

The main explanatory variable in the equation (18) is EU fund inflows to the respective sector. Additionally, model may contain variables that reflect the increase of gross value added, employment and the availability of other resources (domestic credit to GPD ratio, interest rates) as well as composite factors and dummy variables to represent several periods of economic development. All variables enter the model in real terms, after being deflated with the one of the price indexes.

Based on results of equation (18) evaluation, the value of COE in each of the sectors can be calculated as $(1-\beta_{1i})$.

If estimated β_1 is not statistically different from 1, it is going to be interpreted as the absence of a crowding out effect, reflecting that the EU funds are directly transferred to productive investments. In its turn, if $0<(1-\beta_1)<1$, than partial crowding out is observed. In case of $(1-\beta_1)<0$ EU funds have positive impact on domestic investments, whereas if $(1-\beta_1)>1$, then full crowding out is observed.

8. RETROSPECTIVE ASSESSMENT OF EU FUND CROWDING OUT EFFECT

COE assessment was performed based on the global scientific literature findings (see Section 6) and the aim of research – to obtain COE assessment by economic sectors. Econometric model of COE assessment is based on equation (20). Data used in COE retrospective assessment are analyzed in Section 8.1., while Section 8.2. is devoted to the results of COE econometric assessment and its interpretation.

8.1. DATA USED IN EU FUND CROWDING OUT EFFECT RETROSPECTIVE ASSESSMENT

Papers devoted to empirical COE assessment often stress the data availability as a main problem. This subsection analyses the main problems the authors encountered to obtain the necessary data as well as shows the elaboration process of the EU fund database.

Investments

The dependent variable in the econometric model of COE retrospective assessment is quarterly domestic investments (gross fixed capital formation) by sectoral breakdown. Data availability problem arises due to the fact that such data are not available. CSB database contains quarterly data only in respect to the non-financial investments, which include only large private, state and municipal enterprises (more than 50 employees). Although dynamics of non-financial investments is similar to that of gross fixed capital formation, the cumulative sum of non-financial investments represents only about 60% of the latter indicator (see Figure 28).

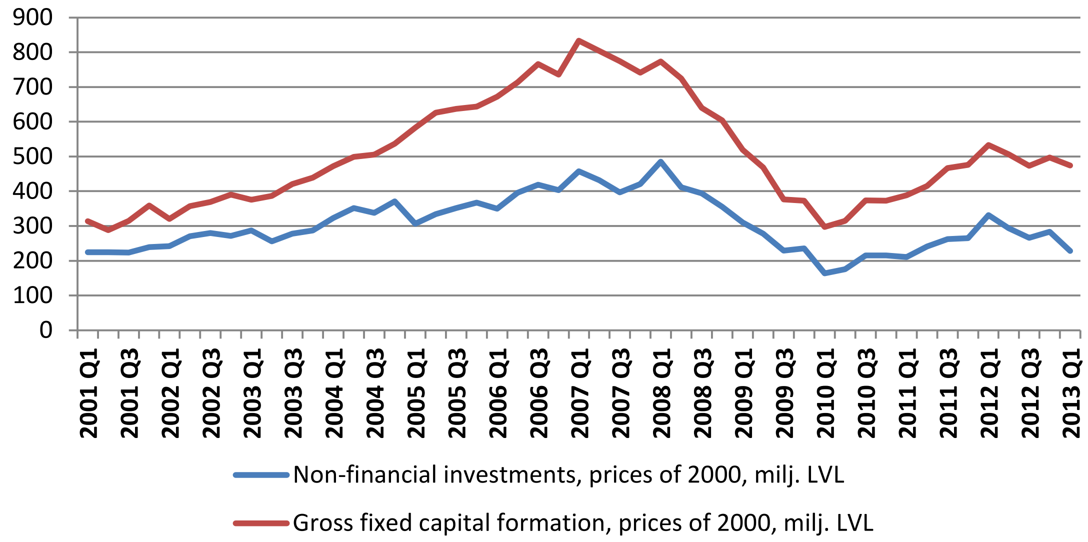


Figure 28. Gross fixed capital formation and non-financial investments in Latvia[46]

[46] CSB data.

When adjusting the NACE methodology, CSB has not recalculated non-financial investments by sectors, that is why necessary data were obtained through information request. Dynamics of non-financial investments in Latvia in five sectors separately is shown in Figure 29[47].

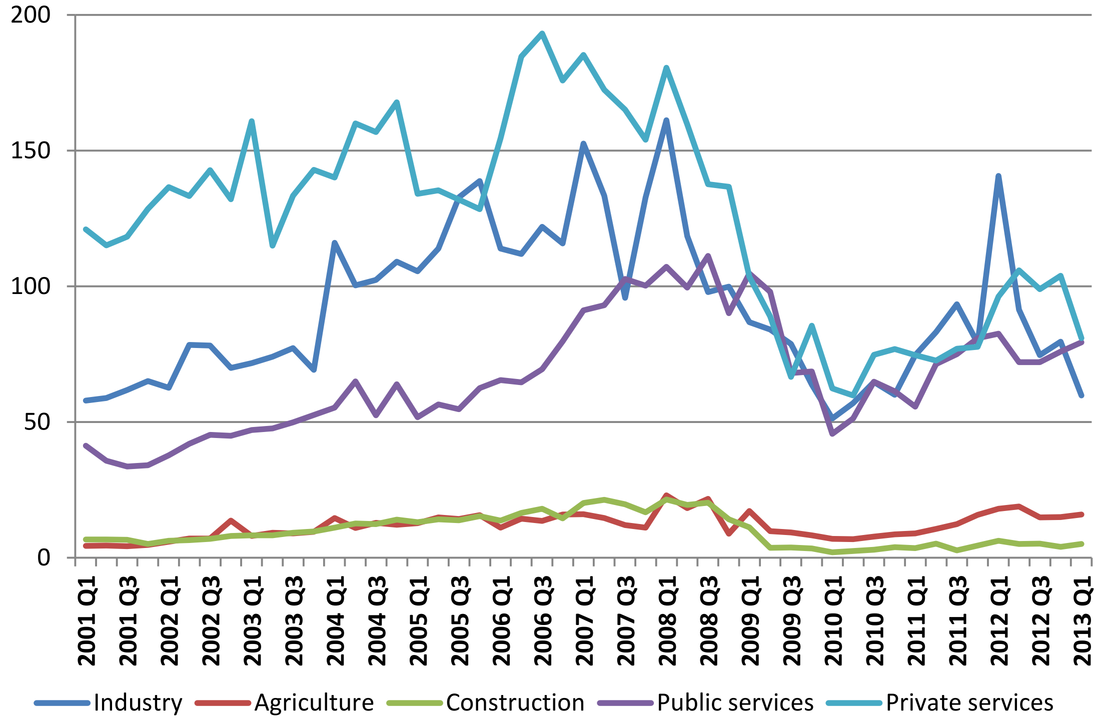


Figure 29. Non-financial investments in Latvia by sectors (mill. LVL; 2000 year prices)[48]

As shown in Figure 29, the dynamics of non-financial investments in Latvia differs substantially by sectors. The most important differences may be explained by the end of several large EU co-financed projects that were implemented during the previous years. For instance, the investment flows in industry were substantially affected by the large projects in energy subsector aimed, particularly, to the rise of the efficiency of heat supply networks, construction of biomass cogeneration power stations as well as the increase of energy efficiency of buildings. For instance, the increase during the 2011-2012 period is attributable to the second round of Riga cogeneration power station TEC-2 reconstruction. Currently the reconstruction of TEC-2 is almost complete, so the industry sector exhibits a large fall of non-financial investments despite in other industry branches the dynamics of non-financial investments was different. The substantial impact of EU co-financed projects on the dynamics of non-financial investments could be observed in other sectors as well.

However, the non-financial investments data are not sufficient for COE assessment since it is necessary to evaluate the whole change in gross fixed capital formation as a consequence of EU fund inflows in the economy. Therefore calculations were performed to obtain new variables to reflect the gross fixed capital formation by sectors. In this regard gross fixed capital formation annual data by sectors from the Eurostat were used. In order to get the necessary quarterly data it was assumed that the dynamics of gross fixed capital formation is similar to the changes of non-

[47] To assess the COE of EU funds, economic branches were grouped into five sectors according to the following NACE 1.1. codes: A-Agriculture (A-B), T-industry (C-E), N-private services (G-K), C-construction (F) and G-public services (L-P).

[48] CSB data.

financial investments. As a result, gross fixed capital time series in five sectors were obtained (see Figure 30).

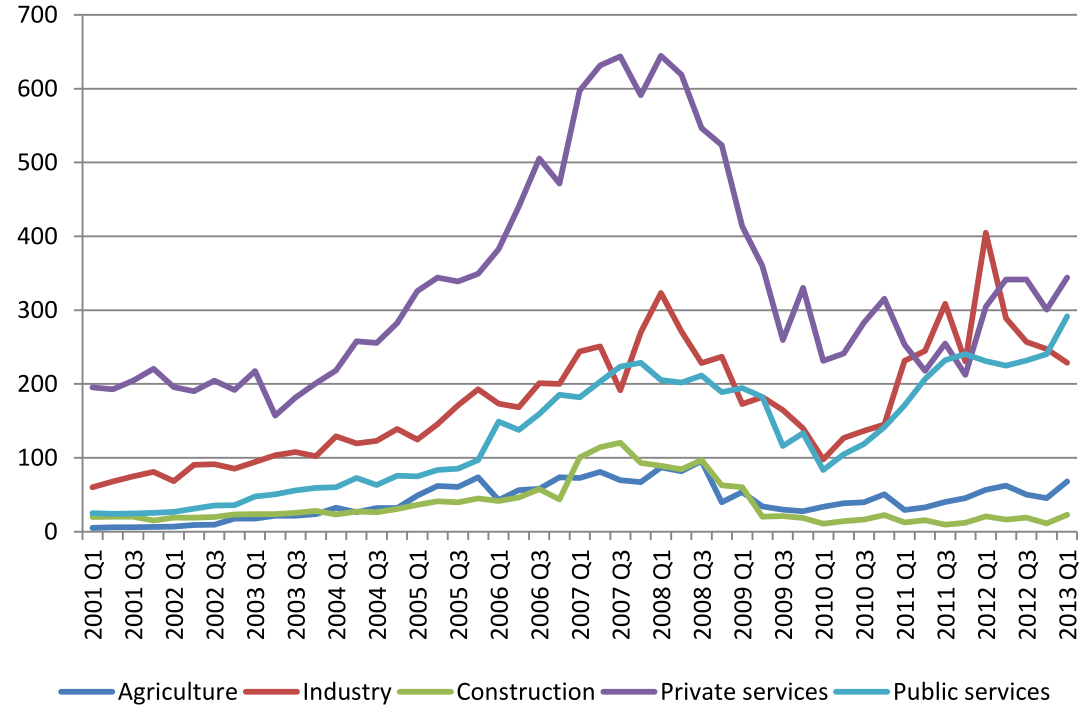


Figure 30. Gross fixed capital formation by sectors (mill. LVL in 2000 year prices)[49]

In order to obtain retrospective assessment of COE by sectors, authors used gross fixed capital formation time series expressed in 2000 year prices.

EU fund inflows were used as an important factor that has an impact on gross fixed capital formation in each of the sectors of the economy.

EU fund[50] inflows by sectors

One of the tasks of this research is to create a database of EU fund inflows, thus, obtaining time series of EU fund inflows in five sectors of the economy from 2001 Q1 to 2013 Q1.

These time series were obtained primarily based on disaggregated data by projects' breakdown. Projects were divided by six groups according to their NACE code (A, T, C, N, G, and those that could not be attributed to particular sector). Assuming that the investment decisions of project registrants are affected by the total amount of grant, not the sum of money received until the particular date, the amount of grant for each particular project was aligned during the whole period of project's duration, based on the data about the project's start date, project's duration and the total amount of grant. EU fund inflows aligned in such way, and in a sectoral breakdown, are shown in Figure 31.

[49] Authors' calculations.

[50] Research Report uses data on financing from European Social Fund, European Regional Development Fund, Cohesion Fund, European Agricultural Fund for Rural Development, European Fishery Fund, EU pre-accession financial instrument's Phare and SAPARD, INTERREG, European Economic Zone and Norway government finacial instruments, as well as Swiss Collaboration Program.

As a result, we obtained a database of EU fund inflows until 2013 Q1, as well as assigned (planned) financing which were adjusted given the actual acquisition of EU funds.

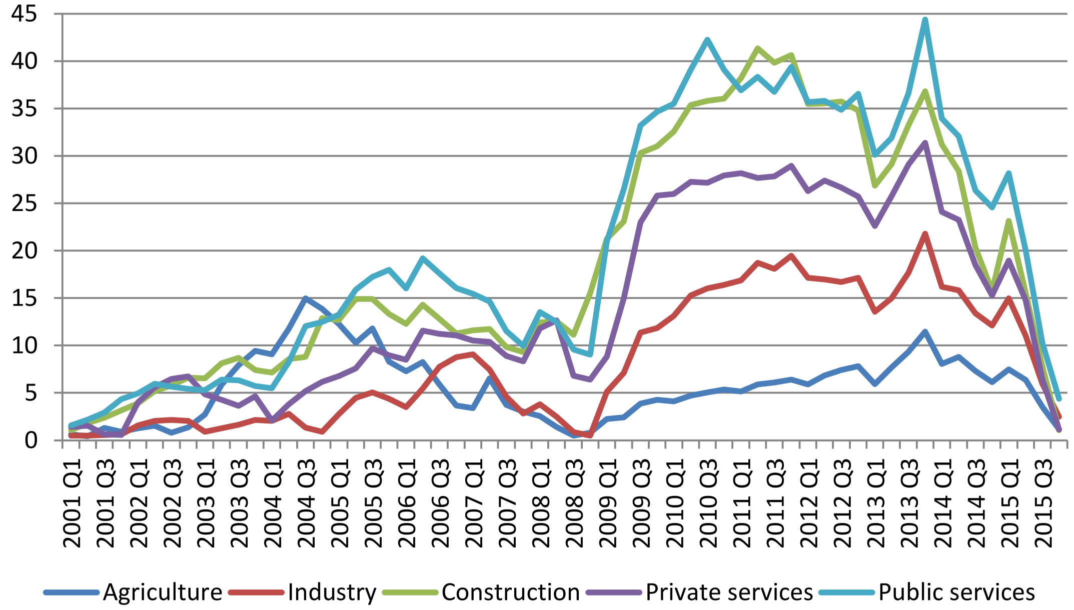


Figure 31. EU fund and aid scheme inflows by sectors during 2001 Q1 – 2015 Q4 (mill. LVL in 2000 year prices)[51]

Regarding the share of EU fund co-financed projects (in the overall European Commission, domestic public and domestic private financing) the first place is given to industry sector (about 30%), in its turn, it is slightly larger than 20% in construction, slightly lower than 20% in private services and about 10% in agriculture.

The differences between sectors arise regarding the total eligible costs of EU fund projects according to the source of financing. The largest share of EU co-financing is evident in agriculture (about 90%), while in industry it is only about 60% on average; in other sectors it is slightly larger than 80%. The largest part of EU financing (about 30%) from the total EU fund financing acquired was diverted to the public services (of which major part – in social infrastructure and technical support). Somewhat smaller amount of EU funds was diverted to construction. Private services sector acquired 17% of the total EU funds, industry – 18%, agriculture – 10%.

Taking into account the relative size of the sectors, the largest amount of EU financing to the one lat of value added was recorded in construction. In private services and public services it was considerably smaller.

[51] Authors' calculations.

Other explanatory factors

Factors that may have an impact on real gross fixed capital formation in various sectors were assumed to be similar. First, such factor is a value added of a respective sector. Moreover, the model includes factors that may affect investment decisions, for instance, real long term interest rate. Inflation was used as an indicator of uncertainty. Unemployment was included in a model assuming that fixed capital and labor are substitutes, so that high unemployment rate may hinder investments in fixed capital. Besides, other variables were used as well given its possible impact on investments, but only few of them appeared to be statistically insignificant. For instance, weighted average credit interest rate (in lats and euro) as well as EURIBOR interest rate in order to reflect the general availability of financing. The statistical insignificance of the respective coefficients might be attributed to the precaution for taking credit obligations during the post-crisis period. Moreover, although interest rates currently are relatively low, during the period of economic overheating was characterized by both high interest rates and fast credit expansion.

Moreover, dummy variables are used to assess the changes of COE during the several economic development periods.

8.2. RESULTS OF EU FUND CROWDING OUT EFFECT RETROSPECTIVE ASSESSMENT

COE assessment was performed using panel data regression with the period from 2001 Q1 to 2013 Q1 and separating five sectors of the economy: A, T, C, N and G[52]. Differences between sectors might raise the problem of heteroskedasticity therefore model's estimation is obtained using weighted least squares technique.

In order to assess the COE changes through the several economic development periods, panel data regression estimated with the fixed effects method, including the dummy variables that are multiplied with the EU fund variables.

Econometric modeling results reveal that during the whole period considered COE was not full in any of the sectors of the economy. It is not surprisingly given that the share of public investments in GDP during 1995-2003 was one of the lowest in the EU, whereas its increase during the following years was the most rapid among all EU Member states. Therefore it could be concluded that EU funds increased the total amount of investments rather than fully crowded out domestic financing.

Results of COE assessment for the whole retrospective period considered by sectoral breakdown are shown in table 4. Model was estimated using the generalized least squares method (see also Appendix 13).

[52] Given that gross fixed capital formation data are precise only in the annual breakdown, annual data were used in econometric modeling as well. However, the small number of observations did not allow to enter the dummy variables for assess the COE differences during the several economic development periods. Therefore these results are not included in Research Report.

Table 4. EU fund crowding out effect retrospective assessment by sectors[53]

Sector	A	C	N	G	T
Dependent variable: domestic investments					
Unemployment rate			-5.15***		
Constant	68.5	50.8	138.0	-297.0	147.0
EU funds	0.10***	0.04***	0.83***	0.33 ***	0.19
Value added	0.93***	-0.02**	-0.07	0.42**	0.33
Weighted average interest rate for short-term credits issued in LVL	-0.43*	0.75	0.45	1.03*	-0.06
Real long term interest rate	1.44***	1.67**	-6.07***	0.36	-1.47
EU fund crowding out effect	0.90	0.96	0.17	0.67	0.81

A – agriculture, C – construction, N – private services, G – public services, T – industry.
*, **, *** statistically significant with 90%, 95% and 99% confidence level respectively.
Underlined coefficients were estimated indirectly from other model coefficients.

The partial regression coefficients attributed to the EU fund inflows are statistically significant (excluding industry), positive and lower than one, therefore it could be concluded that full-crowding out is not evident in any sector. COE estimates vary from 0.17 in private services to 0.96 in construction. Therefore a strong expansion of construction during the period of fast economic growth was likely to happen also without EU fund inflows, i.e. it was based on domestic financing. At the contrary, a considerable part of investment projects in private services may not be implemented without EU financing. Relatively high crowding out is observed in industry sector (0.81). However, it is still likely that investments in water supply and sewerage system, energy efficiency and cogeneration as well as energy management would be lower without the EU fund support (and without the EU regulations on reforming these sectors). EU fund crowding out effect is relatively high also at public services, however, also in this case about one third of EU financing, for instance, in infrastructure and material base modernization of education institutions and healthcare centers or developing the family doctor's network may not be otherwise implemented.

COE average value for the total economy was calculated as a weighted average from the results in separate sectors. The average result for the period between 2001 Q1 and 2013 Q1 is estimated at 0.44 level. It means that every lat of EU funds has crowded out 44 santims of domestic (both public and private) investments.

In order to assess whether crowding out effect may have been different during the several periods of economic development, the following periods were justified: 1) 2001 Q1 – 2003 Q4, which is a period of EU pre-accession program implementation; 2) 2004 Q1 – 2008 Q2; 3) 2008 Q3 – 2009 Q4; 4) 2010 Q1 – 2013 Q1. The stability of results was checked by estimating the various model specifications. One period was deducted to be a base period and then in judging whether dummy variable is statistically significant, conclusion could be made whether COE differs among the economic development periods considered. Results are shown in table 5 (see also Appendix 14).

[53] Authors' calculations.

Table 5. EU fund crowing out effect estimations by sectors and economic development periods[54]

Sector:	2001 Q1 – 2003 Q4	2004. Q1 – 2008 Q2	2008 Q3 – 2009 Q4	2010 Q1 – 2013 Q1
A	0.79	0.81	0.70	0.68
C	0.92	0.66	0.70	0.54
T	0.34	0.32	0.34	0.46
N	0.73	0.64	0.50	0.54
G	0.87	0.82	0.37	0.48
Total economy	0.57	0.50	0.41	0.49

Analyzing the result for the total economy, it could be concluded that the highest EU fund crowding out was observed during the EU pre-accession period. During the period of strong economic growth (2004 Q1 – 2008 Q2) the average COE decreased and reached 0.41 during the crisis. Recovery after the crisis was not similar among the sectors of the economy which is reflected in the differences of COE dynamics; as a result, the total economy average COE since the beginning of 2010 is slightly higher than during the crisis and has reached 0.49. In should be noted that total economy average COE is calculated as a weighted average indicator, where weights are defined as a share of respective sector in gross value added during a respective period.

[54] Authors' calculations.

9. EU FUND CROWDING OUT FORECAST UNTIL 2020

COE forecast until 2020 is performed with econometric methods and is based on estimation of the investment equation (see equation 17) for the three different scenarios of economic development. COE forecasting involves the forecast of macroeconomic indicators included into the econometric model as well as projection of EU fund inflows and extension of the econometric model until Q4 2020.

9.1. DATA USED IN EU FUND CROWDING OUT EFFECT FORECAST

Similarly as in the PCE case, the macroeconomic projections included in the econometric model of COE forecasting, are based on CPL, LMF and authors' forecasts.

Just as in the PCE case, COE forecasts are provided for the same three macroeconomic development scenarios which are based on assumptions regarding GDP growth rates until 2020. To harmonize the two parts of Research Report, COE part uses the same forecasts for such indicators as gross fixed capital formation, gross value added and employment which were extensively analyzed in Section 5.1. Based on these time series, the respective macroeconomic indicators were divided by five sectors of the economy.

Regarding the EU fund inflows it should be noted that works on 2014-2020 planning period continues and currently the ministries' proposals are actualized, therefore the present time is hardly the best period to project future EU fund inflows. There is still a lack of information regarding both the total amount of planned financing and its breakdown by sectors. Therefore the recipient of Research Report may need to update our forecast in near future. Current projections on EU fund inflows are based on the following **assumptions**:

1) Similarly as in the informative report on the acquisition of EU funds (http://www.esfondi.lv/upload/Uzraudziba/Ceturksna_zinojumi/FMzino_070813_ES_fondi.pdf) it was assumed that acquisition rates during the 2014-2020 planning period would be similar to that during the 2007-2013 planning period and shall be equally attributed to the three economic development scenarios.
2) There will be no major changes in the EU fund distribution by sectors during the 2013-2020 planning period.
3) Supervision institutions will solve all the possible problems that might arise in 2014 to ensure the n+2/n+3 principle, and the continuity of EU fund inflows will be safeguarded.

According to the provisional agreement about EU financing, during the 2014-2020 Latvia is likely to receive about 2.6% of GDP from the Cohesion politics instruments that is somewhat less than in the preceding period (about 3.1% of GDP). EU fund forecasts are based on the informative report "About the priorities of EU fund investments in Latvia during the 2014-2020 planning period".[55]
At the start of the new planning period, when the administrative system is not completely developed yet, acquisition activity might be lower. However, EU funds are likely to remain the important factor of investment growth.

[55] http://esfondi.lv/page.php?id=1108

9.2. RESULTS OF EU FUND CROWDING OUT EFFECT FORECAST

COE forecasts are obtained using econometric modeling techniques by estimating the investments model (see equation 17) in the form of panel regression, differentiating 5 sectors of the economy and extending the time period to 2020 Q4. Results of COE forecasts are shown by the three models separately which reflects the three scenarios of economic development: base scenario, optimistic scenario and pessimistic scenario (details shown in Appendix 15). Based on the results of econometric models, COE forecast summary is shown in table 6.

Table 6. EU fund crowding out forecast for the period 2013 Q2 – 2020 Q4[56]

Scenario: / Sector	Optimistic scenario (30%)	Base scenario (50%)	Pessimistic scenario (20%)	Weighted average
Agriculture	0.08	0.60	0.81	**0.49**
Industry	0.92	0.92	0.98	**0.93**
Construction	0.72	0.89	0.55	**0.77**
Private services	0.83	0.74	0.54	**0.73**
Public services	0.39	0.39	0.68	**0.45**
Total economy average	**0.62**	**0.70**	**0.73**	**0.68**

According to the results of econometric modeling, the value of COE is likely to increase in the forthcoming years; however, in optimistic scenario case it will be lower than within the base and pessimistic scenario. If production volume will expand at an annual rate of 6%, there will be enough investment opportunities in the economy and EU funds may replace the relatively smaller amount of domestic financing. In its turn, since stagnation may reflect a lack of profitable investment projects, EU funds may primarily crowd out domestic financing.

56 Authors' calculations.

10. ANALYSIS OF THE FACTORS AFFECTING PUBLIC CAPITAL ELASTICITY AND CROWDING OUT EFFECT, CONCLUSIONS AND RECOMMENDATIONS FOR ITS REGULATION AND PRACTICAL IMPLEMENTATION OF PUBLIC CAPITAL ELASTICITY AND CROWDING OUT EFFECT ASSESSMENT

PCE and COE could be influenced by various macroeconomic and microeconomic factors. The current research focuses on macroeconometric assessment of these two indicators, and econometric modeling methods used allow identifying macroeconomic factors that may affect PCE and COE. In its turn, recommendations for the regulation of these factors are provided also from the microeconomic, econometric and statistical points of view.

The results of econometric modeling obtained in the course of the research allow identifying **the following macroeconomic factors that may affect PCE**:

Amount of public capital. Although the productivity of one public capital lat is larger than that of one private capital lat, PCE is lower than private capital elasticity since the public capital stock is several times smaller than the amount of private capital in use (see Section 3). Therefore greater amount of public capital may have increased the value of PCE.

Amount of private capital in use to one lat of public capital stock. Both PCE and relative productivity of public capital depend on infrastructural endowment of the economy relatively to the amount of private production factors in use. The greater is amount of private capital in use to one lat of public capital stock, the higher is productivity of infrastructure objects (see Section 5.2). It could reflect that public capital either supplements private capital or that rising amount of private capital in use increases the utilization of infrastructure. Therefore higher PCE value could be obtained by raising the private capital stock and its utilization rate.

Hours worked to one lat of public capital stock. Infrastructure does not promote production volume in a country with zero population or when people are not engaged in activities that create the value added. Results of econometric modeling suggest that the value of PCE is positively affected by the increase in the hours worked on one lat of public capital stock (see Section 5.2). Therefore PCE value could be enhanced with the greater population (including the higher net migration) as well as with the higher level of employment (higher participation rate and lower unemployment rate) and higher workload (hours worked in the main job, hours worked in the secondary job, secondary job prevalence).

Macroeconomic factors that may affect the value of COE are the following:

Domestic investments. The higher are domestic investments, the lower is crowding out of the EU funds (see Section 9.2). Higher domestic investments could reflect that there are plenty of profitable investment opportunities in the economy so that EU funds are going to replace a smaller part of domestic financing. At the contrary, if there is a shortage of profitable investment opportunities, EU funds would primarily crowd out domestic financing.

The structure of EU funds. The crowding out of the EU funds may depend also on economic sector. The application of econometric methods allowed determining that the lowest EU funds crowding out may be evidenced in private services, in its turn, the highest crowding out – in construction. Therefore smaller COE could be reached by changing the structure of EU funds for the benefit of the sectors with lower crowding out.

Recommendations for the regulation of the factors affecting PCE and COE is provided in four directions:

- econometric,
- statistical,
- macroeconomic and
- microeconomic.

Econometric direction

Authors are sure that at the time of the study the models used in the course of the research provide the most reliable retrospective assessment and forecast of PCE and COE in the case of Latvia. However, over time PCE and COE assessment models could be developed in the scientific literature. Therefore the augmentation of the models used may fine-tune the estimated values of PCE and COE.

One of the possible development directions of the PCE assession model is human capital inclusion. Currently time series of macroeconomic indicators in the case of Latvia are too short and mutilated with the large cyclical fluctuations and this does not allow assessing the long term impact of human capital on the production volume. Melihovs and Davidsons (2006) as well as Krasnopjorovs (2013) concluded that currently there is no such a human capital variable that could improve the descriptive power of the production function in the case of Latvia[57], however, there is a possibility that after 3 or 4 years it will be possible to identify such a human capital variable.

At the same time, not all econometric novelties should certainly be used in assessing the value of PCE in the case of Latvia. For instance, relaxing the constraint of scale effect unpresence in the production function even if scale effect is not statistically significant or the inclusion of endogenous TFP is not likely to provide reliable results in the case of Latvia owing to the short time series and strong economic cyclical fluctuations.

Regarding the COE assession it could be concluded that panel data regression is a good tool which allows taking into account the differences both between time periods and sectors. However, as statistical data on domestic investments are precise only in the annual (and not quarterly) breakdown, in the future with the longer time series, our advice is to use annual data.

Statistical direction

From a statistical direction, the value of PCE may change with the re-statement of the statistical data. For instance, at the time of the study employment data adjusted for the 2011 Population Census were not available yet. CSB plans to publish adjusted figures during the first half of 2014. In this case, the transition of employment data to the official statistical data source may slightly change the assessment of PCE value. Similarly the reflection of fixed capital in national accounts may improve over time that could change assumptions regarding the fixed capital dynamics that

[57] To find the variable was attempted in this research, but it was not included in this report.

were used in the course of the research. As statistical data quality improves, transition to the new indicators and statistical data sources is even preferable. However, the main reason for such a transition should be aim to include in the econometric model the most reliable and precise data, not the intention to manipulate with the estimation of PCE value. For instance, Section 4 shows that PCE retrospective assessment depends on assumptions regarding the fixed capital dynamics. It is not allowed to use such a combination of assumptions that, although does not seem to be the most realistic from the analytical point of view, maximizes (or minimizes) the estimated PCE value.

When updating the EU funds databases for the COE assessment, it is recommended to primarily use VIS database, which allows quickly and easily obtain information on a sufficiently detailed manner and in a single standardized format. EU fund planning for the 2014-2020 period continues and currently the ministries' proposals are actualized, therefore forecasted EU fund time series might be adjusted after the end of reconciliation process.

Macroeconomic direction

PCE and COE forecasts suggest that stronger economic growth may promote higher PCE and lower COE values. Therefore economic growth acceleration over the optimistic scenario case (GDP annual growth by 6%) is able not only maintain the value of PCE at the current level, but even increase it. In its turn, the value of COE may decrease under its historical average level. However, good intention to accelerate the speed of economic growth may harm the economy in the long term if economic growth will not be balanced, e.g., internal and external imbalances (wage growth in excess of labor productivity developments, unsustainably high current account deficit and credit expansion) are likely to emerge. Therefore economic growth acceleration in the short term may harm long term economic growth. Instead the acceleration in potential economic growth is necessary, which should be done not only attracting new units of production factors, but more intensively using the available resources.

For instance, Latvia still has large potential to raise capital utilization rate since although it's current level is close to historical maximum, it is well behind the EU average indicator. Large potential exists also in decreasing the natural unemployment rate (i.e., the structural unemployment component) which historically considerably exceeded the EU average level. Furthermore, although participation rate currently is higher than Latvia's historically average level, it is still behind the EU average level and considerably lower than that in the Northern region EU countries.

Microeconomic direction

Microeconomic direction of PCE and COE regulation involves the selection of a particular investment projects. It is obvious that both higher society's welfare and higher PCE could be achieved with the uncorrupted and transparent selection and implementation of the projects that are important for society. However, there are situations when PCE maximization goal is at odds with the society's welfare maximization goal and in this case priority should be given to the latter.

Warner (2013) suggests that optimal government action would be to select the projects with the higher social return among those that could not be implemented by the private sector. Social return here should be understood as an internal rate of return from a society's point of view – interest rate on which the net present value of all future utility flows is zero. It is precisely such a government's action that maximizes welfare of a society.

However, in real life we can expect a positive correlation between the private and social returns of particular projects, i.e. the more important the project is for society, the higher probability that it will be profitable for the private sector to undertake it. That is why the government, comparing to its optimal action, can increase the value of PCE by competing with the private sector on implementing the most profitable projects. Moreover, it is likely to decrease elasticity of private capital as well, therefore, may substantially increase the relative productivity of public capital. But such action would decrease welfare of the society since in this case public investments crowd out (and not complement) private ones, despite society would be better if a particular project would be implemented with private financing (because, for instance, public investments are financed by taxes that mutilate private initiatives).

Therefore, the optimal government's action from the microeconomic point of view would be to deliberately not choosing the most profitable projects if may be implemented by the private sector. This action may be politically constrained, however. For instance, in this case both PCE value and relative productivity of public capital would be low. Even in the absence of unambiguous PCE assessment models this may lead to society's mood about the low efficiency of public investments and indignation that the most profitable projects are not implemented owing to the large corruption prevalence.

Similarly, the optimal action would be to divert EU funds only to those projects that could not be implemented with domestic (private and public) resources only. Therefore the aim to minimize COE may increase the welfare of the society. However, also this action may be constrained politically since if EU funds would not compete with the domestic financing for implementing the most profitable projects it could raise the public mood regarding the poor selection process of EU funded projects.

Concluding, although PCE indicator is important from political planning and forecasting perspective, it could be hardly regarded as a one of public sector outcome indicators. From the microeconomic perspective, the aim to maximize PCE may force civil servants to enhance competition with the private sector for implementing the most profitable projects. From statistical and econometric sides, there is a risk to assess PCE using such statistical data sources, econometric models and assumptions which are not reliable, but maximizes PCE value. Finally, from macroeconomic perspective, the aim to maximize PCE may result in unsustainable economic development.

In its turn, COE minimization is likely to increase the welfare of the society; therefore it may be regarded as one of the public sector outcome indicators. However, also here (similarly as in PCE case) political constraint is present: if EU funds will not compete with the domestic financing (accordingly, if public investments will not compete with private investments) for implementing the most profitable projects, it may be diverted to projects with relatively low profitability and this may cause public mood about low efficiency of EU funds (or public investments) and corruption prevalence.

Based on the results of the study, the authors propose the following **recommendations for the practical implementation of PCE and COE assessment**:

1. To update the retrospective assessment of PCE after CSB's correction of the employment data subject to the results of 2011 Population Census. In this case, the variable $L \cdot U^L$ (see equation (3)) should be replaced with the number of hours worked according to the national accounts data.

2. The updates of PCE and COE retrospective assessment and forecast should be regular. The authors regard that these updates may be done once during each two years. For instance, it may be comfortable to accomplish this exercise during April since public investments data on previous year are usually available at the end of March.

REFERENCES

Laws, macroeconomic policy planning documents, strategies, informative reports:

Labour law. Available at the Internet: *http://likumi.lv/doc.php?id=26019* [accessed 26.08.2013]

Convergence Program of the Republic of Latvia 2013-2016. Ministry of Finance of the Republic of Latvia, April 2013. Available at the Internet: *http://ec.europa.eu/europe2020/pdf/nd/cp2013_latvia_lv.pdf* [accessed 26.08.2013]

Informative Report on Labpur Market Midterm and Longterm Forecasts. Ministry of Economics of the Republic of Latvia, June 2013. Available at the Internet: *http://www.em.gov.lv/images/modules/items/tsdep/darba_tirgus/EMZino_260612_full.pdf* [accessed 26.08.2013]

Literature:

- **Alegre, J.G.**, 2012. An evaluation of EU regional policy: Do Structural Actions crowd out Public Spending? *Public Choice*, Vol.151-1, p. 1-21
- **Aschauer D.A.** Do states optimize? Public capital and economic growth. *Annals of Regional Science.* Volume 34 (2000), p. 343-363.
- **Aschauer D.A.** Is Public Expenditure Productive? *Journal of Monetary Economics*. Volume 23 (1989), p.177-200.
- **Baltijas Starptautiskais Ekonomikas Politikas Studiju Centrs (BICEPS),** 2008. „EU Funds Macroeconomic Impact Assessment. Second Stage report", Contract No. FM 2007/ERAF - 5.2.3. - 2, *http://www.esfondi.lv/upload/Petijumi_un_izvertejumi/Phase_2_report_final_020708.pdf*
- **Banarjee, B.H., Marcellino, M.**, Osbat, C., 2005. Testing for PPP: should we use panel methods? *Empirical Economics,* Vol. 30, p. 77-91.
- **Barro R.** Government spending in a simple model of endogenous growth. *National Bureau of Economic Research (NBER) working paper #2588*, 1991. 39 pages. Pieejams internetā: *http://papers.ssrn.com/sol3/papers.cfm?abstract_id=273578* [accessed 29.04.2013]
- **Beddies C.H.** Investment, Capital Accumulation and Growth: Some Evidence from the Gambia 1964-98. *International Monetary Fund Working Paper* # 99 / 117, 32 pages; 1999.
- **Bems R., Johnson K.** Trade Deficits in the Baltic States: How Long Will the Party Last? *Sveriges Riksbank Working Paper* No. 186. (2005). 43 pages.
- **Bom P.R.D., Ligthart J.E.** *How Productive is Public Capital? A Meta-Analysis*. CESifo Working Paper No. 2206 (2008).

- **Bradley, J., Kearney, I. Morgenroth, E.,** 2000. Ex-ante Analysis of the Economic Impact of Pre-accession Structural Funds: A Model-based Methodology for Latvia, *The Economic and Social Research Institute* (ESRI), Dublin.
- **Bradley, J., Untiedt, G.**, 2008. EU Cohesion Policy and "Conditional" Effectiveness: What do cross - section regressions tell us? GEFRA WP-2008/4, p. 20 *http://www.gefra-muenster.org/downloads/doc/GEFRA-WP-4-2008.pdf*
- **Buiter, W.H.**, 1977. "Crowding out" and the Effectiveness of Fiscal Policy, *Journal of Public Economics*, Vol.7-3, June, pp. 309-328
- **Cheng K.C.** Growth and Recovery in Mongolia During Transition. *International Monetary Fund Working Paper* # 03 / 217, 26 pages; 2003.
- **De la Fuente, A., Vives, X., Dolado, R., Faini, R.,** 1995. Infrastructure and education as instruments of regional policy, evidence of Spain. *Economic Policy*, Vol. 10, No. 20, pp. 13-51
- **Del Bo, C., Florio, M., Sirtori, E., Vignetti, S.**, 2011. Additionality and Regional Development: are EU Structural Funds Complements od Substitutes of National Public Finance?, *Centre of Industrial Studies* WP.N.01/2011, p. 28 *http://www.csilmilano.com/docs/WP2011_01.pdf*
- **Denis C., Grenouilleau D., Mc.Morrow K., Roger W.** Calculating Potential Growth Rates and Output Gaps. *European Commission Economic Paper # 247*, 2006. 107 pages.
- **Dubra E., Purmalis K., Junga E., Kasalis E., Piņķe G., Milča N., Šmatkova I., Kristaps G., Popova A., Vanags I., Zvidriņš P., Bērziņš A., Lešinskis K., Roba R., Mūkina I., Pļevako T., Revina I., Gulbe M., Tkačevs O., Meļihovs A.** Detalizēts darbaspēka un darba tirgus pētījums tautsaimniecības sektoros. Eiropas Savienības Struktūrfondu Nacionālā Programma "Darba tirgus pētījumi", projekts "Labklājības Ministrijas Pētījumi", Nr. VPD1/ESF/NVA/04/NP/3.1.5.1/0001/0003. Latvijas Universitāte, 2007. lpp. 224. Pieejams internetā:*http://www.lm.gov.lv/upload/darba_tirgus/darba_tirgus/petijumi/darbaspeka_darba_tirgus.pdf* [accessed 29.04.2013]
- **Ederveen, S, Gorter, J, de Mooij, R and Nahuis, R**, 2003. Funds and Games: the Economics of EU Cohesion Policy, *European Network of Economic Policy Research Institutes, Occasional Paper No.* 3/October 2003 *http://aei.pitt.edu/1965/1/ENEPRI_OP3.pdf*
- **Epstein N., Macchiarelli C.** Estimating Poland's Potential Output: a Production Function Approach. *International Monetary Fund Working Paper* #10/15, 20 pages; 2010.
- **Evans P., Karras G.** Are Government Activities Productive? Evidence From a Panel of U.S. States. *The Review of Economics and Statistics.* Vol. 76 (1994), Issue 1, pp. 1 - 11.
- **Fadejeva L., Meļihovs A.** Latvijas tautsaimniecības nozaru kopējās produktivitātes un faktoru izmantošanas novērtējums. *Latvijas Bankas pētījums* #3 / 2009. lpp. 39.
- **Garcia - Mila, T., McGuire, T.,** 2001. Do Interregional Transfers Improve the Economic Performance of Poor Regions? The Case of Spain, *International Tax and Public Finance,* Springer, vol. 8(3), pp. 281-296.
- **Gupta S., Kangur A., Papageorgiou C., Wane A.** Efficiency-Adjusted Public Capital and Growth. *International Monetary Fund Working Paper # 11/217*, 35 pages; 2011.

- **Hassan, S., Othman, Z., Karim, M.Z.A.**, 2011. Private and Public Investment in Malaysia: A Panel Tome - Series Analysis. *International Journal of Economics and Financial Issues,* Vol. 1, No.4, 2011, pp.199-210

- **Henderson, D. J., Kumbhakar, S. C.** Public and Private Capital Productivity Puzzle: A Nonparametric Approach. *State University of New York at Binghamton*, 2005. 25 p.

- **Holtz-Eakin, D.** Public-sector Capital and the Productivity Puzzle*. Review of Economics and Statistics*, Vol. 76 (1994), Issue 1, pp. 12-21.

- **in't Veld, J.,** 2007. The Potential Impact of the Fiscal Transfers under the EU Cohesion Policy programme. *European Economy:* Economic Papers no. 283, p. 29

- **Kamps C.** New Estimates of Government Net Capital Stocks for 22 OECD Countries 1960-2001, *International Monetary Fund Working Paper # 04/67*, 39 pages; 2004.

- **Kazāks M., Kūle L., Strašuna L.** Vai Latvijai ir nepieciešama darbaspēka imigrācija? *Hansabankas analītiskās diskusijas materiāli* (June 15, 2006); 19 pages.

- **Khadharoo, J., Seetanah, B.** New evidences on the link between public capital and economic growth from a small island economy. *University of Mauritus*, 2000. 22 pages

- **Krasnopjorovs O.** Is private capital more productive than public capital? Evidence from Latvia 1995 - 2009. *Economic Studies*. Issue No. 3 / 2011. pp. 168-180. 2011.

- **Krasnopjorovs O.** Latvijas ekonomikas izaugsmi noteicošie faktori. *Promocijas darbs tautsaimniecības doktora (Dr.oec.) grāda iegūšanai*. Zinātniskais vadītājs: prof. I. Revina. Latvijas Universitāte, 2013.

- **Krasnopjorovs O.** Privātā un sabiedriskā kapitāla nozīme Latvijas ekonomikas izaugsmē. *Latvijas Universitātes zinātniskie raksti No.744. Ekonomika*. lpp.228-239. 2009. gads

- **Ligthart, J. E.** Public Capital and Output Growth in Portugal: An Empirical Analysis. *European Review of Economics and Finance*, Vol. 1, pp. 3-30. 2002. gads.

- **Lolos, S. E. G.** 2001. The Macroeconomic Effect of EU Structural Transfers on the Cohesion Countries and Lessons for the CEECs, IIASA, *Interim Report* IR-01-044/October.

- **Lolos, S. E. G.** 2001. The Macroeconomic Effect of EU Structural Transfers on the Cohesion Countries and Lessons for the CEECs, IIASA, *Interim Report* IR-01-044/October.

- **Macdonald, R.** An Examination of Public Capital's Role in Production. *Statistics Canada - Catalogue No. 11F0027Mn no. 050*, 2008. 49 p.

- **Meļihovs A.** Latvijas IKP īstermiņa ekonometriskā prognozēšana. *Promocijas darbs tautsaimniecības doktora (Dr.oec.) grāda iegūšanai*. Zinātniskais vadītājs: prof. I. Revina. Latvijas Universitāte, 2010.

- **Meļihovs A.** Tehnoloģiskais progress Latvijā: Koba-Duglasa ražošanas funkcijas lineārā un nelineārā modelēšana. *Latvijas Universitātes Raksti*, 2007. 718. sēj. Ekonomika VI, 269. - 274. lpp.

- **Meļihovs, A., Dāvidsons, G.** Ražošanas progresa un cilvēkkapitāla nozīme Latvijas tautsaimniecības izaugsmes nodrošināšanā. *Latvijas Bankas pētījums*, 1 / 2006. 31 lpp.

- **Naqvi N.** Is Public Capital More Productive than Private Capital? Macroeconomic Evidence from Pakistan, 1965-2000. *University of Durham*, 2003. 23 pages. Pieejams internetā: *http://cosmic.rrz.uni-hamburg.de/webcat/hwwa/edok04/f10398g/wp0303.pdf* [skatīts 29.04.2013]

- **Park J., Ryu H.K.** Accumulation, technical change, and increasing returns in the economic growth of East Asia*. Journal of Productivity Analysis*, Volume 25 (2006), pp. 243 - 255.

- **Paula D., Titarenko D.** Latvijas ekonomikas konkurētspēja un investīciju nozīme tās vecināšanā. *Latvijas Universitātes Ekonomikas un Vadības Fakultātes monogrāfija* profesores E. Dubras redakcijā. 166 lapas. Latvijas Universitāte, 2009.

- **Payne, A.A.**, 2009. Does Government Funding Change Behaviour? An Empirical Analysis of Crowd-Out, NBER „*Tax Policy and the Economy*", Vol. 23, pp. 159-184. *http://www.nber.org/chapters/c10574*

- **Purmalis K.** Latvijas darba tirgus analīze un tā attīstības perspektīvas. *Promocijas darbs tautsaimniecības doktora (Dr.oec.) grāda iegūšanai*. Zinātniskais vadītājs: prof. R. Škapars. Latvijas Universitāte, 2011.

- **Room (Hinnosaar) M.** Potential output estimates for Central and East European countries using production function method. Igaunijas Centrālās Bankas pētījums # 2 / 2001. 23 pages.

- **Stikuts, D.** Latvijas faktiskā un potenciālā ražošanas apjoma starpības: aprēķins un lietojums. *Latvijas Bankas pētījums*, 2 / 2003. 24 lpp.

- **Tahari A., Ghura D., Akitoby B., Brou Aka E.** Sources of Growth in Sub-Saharan Africa. *International Monetary Fund Working Paper* # 04 / 176, 30 pages; 2004.

- **Titarenko D.** Investīcijas kā Latvijas ekonomikas izaugsmes faktors. *Promocijas darbs tautsaimniecības doktora (Dr.oec.) grāda iegūšanai*. Zinātniskais vadītājs: prof. E. Dubra. Latvijas Universitāte, 2008.

- **Tron, Z.**, 2009. Examining the Impact of European Regional Policy, Institute for World Economics Hungarian Academy of Sciences WP 188, p. 21 *http://pdc.ceu.hu/archive/00005895/01/wp-188.pdf*

- **Vanags A., Bems R.** The Baltic Growth Acceleration: Is It Sustainable? *Baltic International Center for Economic Policy Studies (BICEPS) Working Paper* (2005). 35 pages.

- **Varga J., in't Veld, J.**, 2011. A Model Based Analysis of the Impact of Cohesion Policy Expenditure 2000-06: Simulations with the Quest III Endogenous R&D Model. *Economic Modelling Vol. 28, p.* 647 -663

- **Vetlov I.** Economic Growth Accounting in the Baltics. *Lietuvas Bankas pētījums* #3 / 2003.

- **Warner A.**M. A Framework for Efficient Government Investment. *International Monetary Fund Working Paper* # 13 / 58, 21 pages; 2013.

- **Wostner, P., Šlander, S.,** 2009. The Effectiveness of EU Cohesion Policy Revised: Are EU Funds Really Additional? EPRC nr.69, p. 26 *http://www.eprc.strath.ac.uk/eprc/documents/PDF_files/EPRP_69_The_Effectiveness_of_EU_Cohesion_Policy_Revisited.pdf*

APPENDIXES

Results of PCE retrospective assessment with the unrestricted model

Table: APP1_UNRESTRICTED_MODEL   Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 1: unrestricted model

Dependent Variable: KPV_SA
Method: Least Squares
Date: 08/27/13   Time: 12:05
Sample: 1995Q1 2013Q1
Included observations: 73
KPV_SA=C(1)+C(2)*K_PRIV_USE_SA+C(3)*K_PUB_STOCK_SA+C(4)
*L_SA+C(5)*TFP_CALIBRATED

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.793421	0.579818	-1.368396	0.1757
C(2)	0.218817	0.031727	6.896912	0.0000
C(3)	0.072778	0.010721	6.788342	0.0000
C(4)	0.729612	0.035291	20.67391	0.0000
C(5)	0.010522	0.000815	12.90682	0.0000

R-squared	0.996464	Mean dependent var	14.07649
Adjusted R-squared	0.996256	S.D. dependent var	0.280780
S.E. of regression	0.017180	Akaike info criterion	-5.224153
Sum squared resid	0.020069	Schwarz criterion	-5.067272
Log likelihood	195.6816	Hannan-Quinn criter.	-5.161633
F-statistic	4791.144	Durbin-Watson stat	1.453876
Prob(F-statistic)	0.000000		

Testing the scale effect presence in PCE retrospective accession model

Table: APP2_WALD_SCALE_EFFECT Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 2: Wald test on scale effect presence

Wald Test:
Equation: EQ_UNRESTRICTED

Test Statistic	Value	df	Probability
t-statistic	0.513938	68	0.6090
F-statistic	0.264132	(1, 68)	0.6090
Chi-square	0.264132	1	0.6073

Null Hypothesis: C(2)+C(3)+C(4)=1
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
-1 + C(2) + C(3) + C(4)	0.021207	0.041263

Restrictions are linear in coefficients.

Appendix 3

Results of PCE retrospective assessment using a model without TFP process

Table: APP3_NO_TFP Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 3: no TFP unrestricted equation

Dependent Variable: KPV_SA
Method: Least Squares
Date: 08/27/13 Time: 11:58
Sample: 1995Q1 2013Q1
Included observations: 73
KPV_SA=C(1)+C(2)*K_PRIV_USE_SA+C(3)*K_PUB_STOCK_SA+C(4)
*L_SA

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-3.920754	0.971275	-4.036710	0.0001
C(2)	0.619027	0.012385	49.98374	0.0000
C(3)	0.048290	0.019456	2.481993	0.0155
C(4)	0.555934	0.060156	9.241481	0.0000

R-squared	0.987803	Mean dependent var	14.07649
Adjusted R-squared	0.987272	S.D. dependent var	0.280780
S.E. of regression	0.031677	Akaike info criterion	-4.013236
Sum squared resid	0.069235	Schwarz criterion	-3.887731
Log likelihood	150.4831	Hannan-Quinn criter.	-3.963220
F-statistic	1862.660	Durbin-Watson stat	1.057018
Prob(F-statistic)	0.000000		

Appendix 4

Testing GVA and public capital cointegration

Table: APP4_JOHANSEN   Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

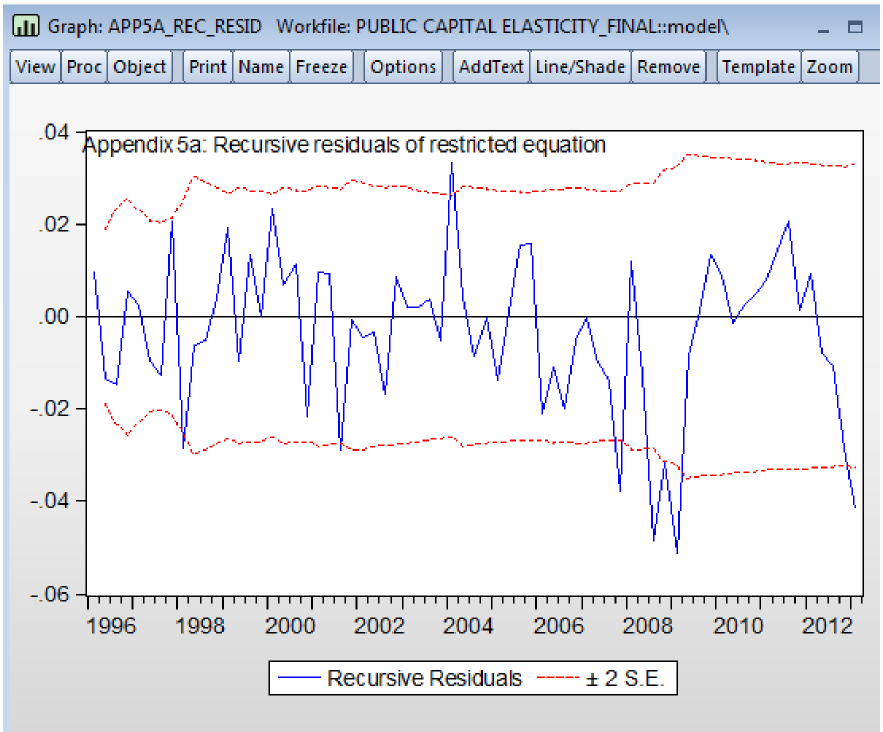
View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

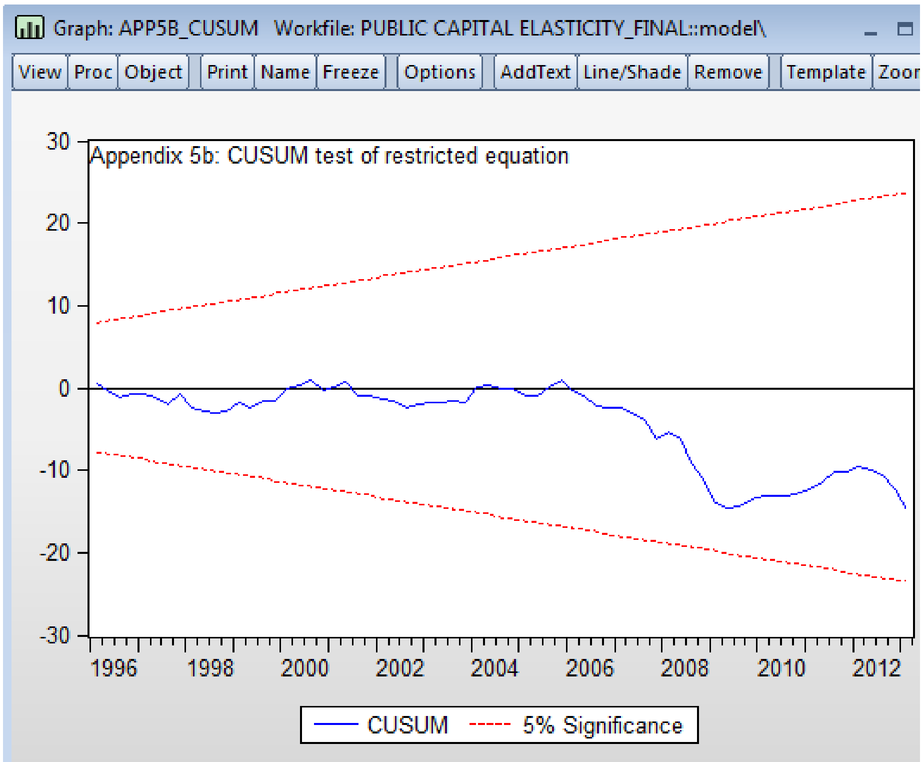
Appendix 4: Johansen cointegration test (gross value added; public capital)

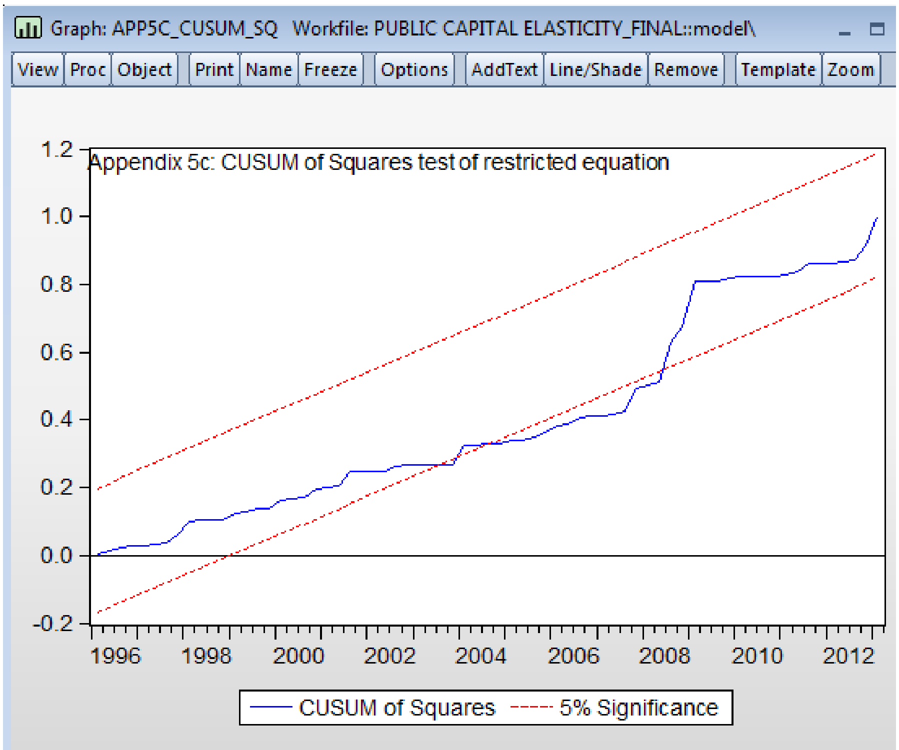
	A	B	C	D	E
1	Date: 08/27/13 Time: 12:03				
2	Sample (adjusted): 1995Q4 2013Q1				
3	Included observations: 70 after adjustments				
4	Trend assumption: Linear deterministic trend (restricted)				
5	Series: KPV_SA K_PUB_STOCK_SA				
6	Lags interval (in first differences): 1 to 2				
7					
8	Unrestricted Cointegration Rank Test (Trace)				
9					
10	Hypothesized		Trace	0.05	
11	No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
12					
13	None *	0.284570	29.10599	25.87211	0.0191
14	At most 1	0.077740	5.664961	12.51798	0.5040
15					
16	Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
17	* denotes rejection of the hypothesis at the 0.05 level				
18	**MacKinnon-Haug-Michelis (1999) p-values				
19					
20	Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
21					
22	Hypothesized		Max-Eigen	0.05	
23	No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
24					
25	None *	0.284570	23.44102	19.38704	0.0122
26	At most 1	0.077740	5.664961	12.51798	0.5040
27					
28	Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				
29	* denotes rejection of the hypothesis at the 0.05 level				
30	**MacKinnon-Haug-Michelis (1999) p-values				

Appendix 5

Description of PCE retrospective assessment restricted model






Graph: APP5C_CUSUM_SQ Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\
View Proc Object Print Name Freeze Options AddText Line/Shade Remove Template Zoom
Appendix 5c: CUSUM of Squares test of restricted equation
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
1996 1998 2000 2002 2004 2006 2008 2010 2012
CUSUM of Squares
5% Significance

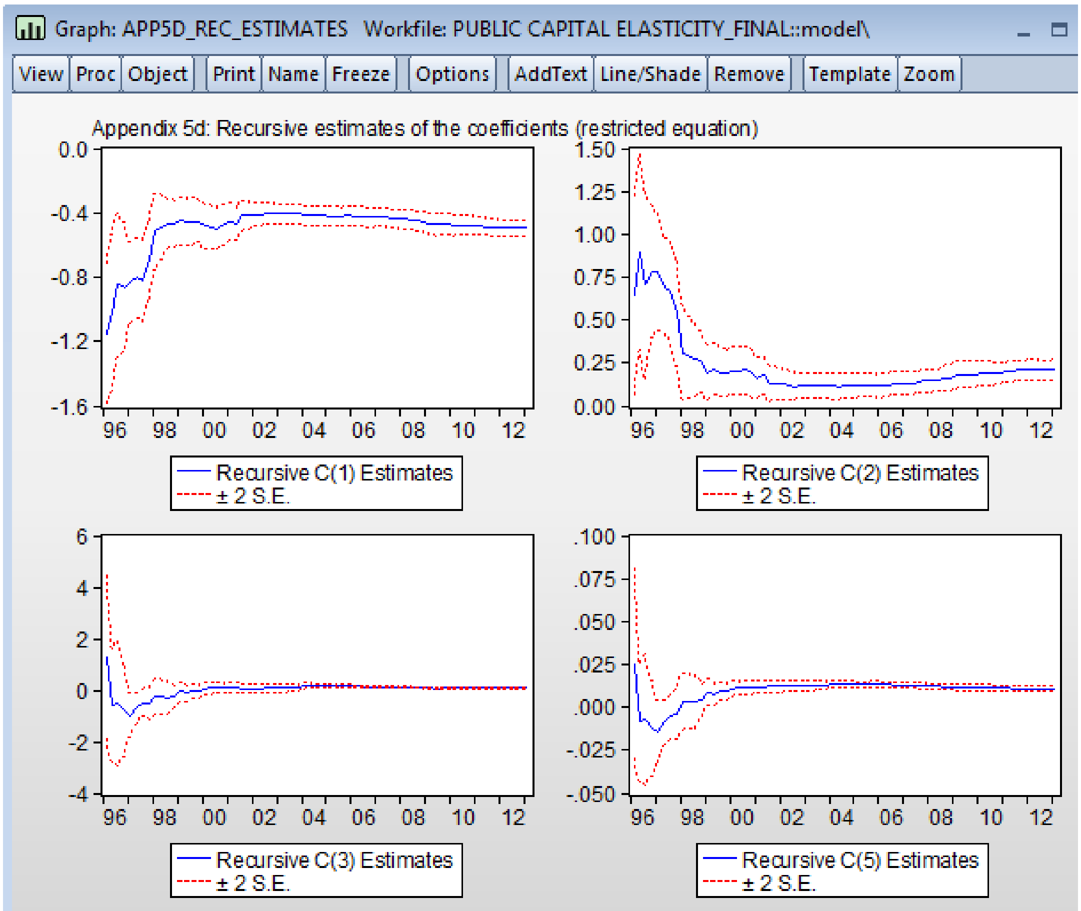

Graph: APP5D_REC_ESTIMATES Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\
View Proc Object Print Name Freeze Options AddText Line/Shade Remove Template Zoom
Appendix 5d: Recursive estimates of the coefficients (restricted equation)
Recursive C(1) Estimates
± 2 S.E.
Recursive C(2) Estimates
± 2 S.E.
Recursive C(3) Estimates
± 2 S.E.
Recursive C(5) Estimates
± 2 S.E.
96 98 00 02 04 06 08 10 12

Table: APP5E_COR_RESID   Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 5e: correlogram of residuals (restricted equation)

Date: 08/20/13   Time: 13:06
Sample: 1995Q1 2013Q1
Included observations: 73

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.238	0.238	4.3003	0.038
		2	0.200	0.152	7.3716	0.025
		3	0.067	-0.010	7.7273	0.052
		4	-0.027	-0.075	7.7867	0.100
		5	0.019	0.033	7.8147	0.167
		6	-0.150	-0.154	9.6594	0.140
		7	-0.017	0.044	9.6844	0.207
		8	-0.277	-0.263	16.155	0.040
		9	-0.021	0.121	16.192	0.063
		10	-0.185	-0.178	19.150	0.038
		11	-0.065	0.055	19.525	0.052
		12	-0.135	-0.194	21.166	0.048
		13	-0.189	-0.057	24.431	0.027
		14	-0.051	-0.093	24.673	0.038
		15	-0.048	0.108	24.891	0.051
		16	0.208	0.092	29.036	0.024
		17	-0.041	-0.088	29.197	0.033
		18	0.054	-0.090	29.488	0.043
		19	-0.229	-0.316	34.815	0.015
		20	-0.115	-0.061	36.173	0.015
		21	0.088	0.135	36.986	0.017
		22	-0.117	-0.133	38.464	0.016
		23	0.081	0.038	39.187	0.019
		24	0.010	0.051	39.199	0.026
		25	0.144	-0.010	41.567	0.020
		26	0.038	-0.042	41.738	0.026
		27	0.128	-0.011	43.681	0.022
		28	0.122	0.095	45.502	0.020
		29	-0.055	-0.098	45.874	0.024
		30	-0.001	-0.109	45.874	0.032
		31	-0.098	-0.103	47.115	0.032
		32	0.042	-0.062	47.355	0.039

Table: APP5F_COR_RESID_SQ Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 5f: correlogram of squared residuals (restricted equation)

Date: 08/20/13 Time: 13:09
Sample: 1995Q1 2013Q1
Included observations: 73

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.042	0.042	0.1355	0.713
		2	0.094	0.092	0.8162	0.665
		3	-0.140	-0.149	2.3538	0.502
		4	0.146	0.155	4.0393	0.401
		5	-0.062	-0.056	4.3478	0.501
		6	0.041	0.002	4.4859	0.611
		7	-0.059	-0.008	4.7716	0.688
		8	-0.086	-0.132	5.3957	0.715
		9	-0.059	-0.013	5.6948	0.770
		10	-0.103	-0.110	6.6237	0.760
		11	-0.126	-0.134	8.0165	0.712
		12	-0.063	-0.013	8.3693	0.756
		13	0.134	0.135	10.000	0.694
		14	-0.141	-0.178	11.840	0.619
		15	-0.098	-0.099	12.748	0.622
		16	0.146	0.255	14.798	0.539
		17	0.058	-0.079	15.126	0.586
		18	-0.003	-0.048	15.126	0.653
		19	-0.016	0.042	15.152	0.713
		20	0.102	0.035	16.234	0.702
		21	0.000	-0.010	16.234	0.756
		22	-0.006	-0.093	16.238	0.804
		23	0.025	0.073	16.304	0.842
		24	0.087	0.139	17.149	0.842
		25	-0.041	-0.150	17.344	0.869
		26	0.141	0.147	19.662	0.807
		27	-0.104	0.020	20.955	0.788
		28	0.071	0.045	21.575	0.801
		29	0.091	0.081	22.614	0.794
		30	0.165	0.157	26.101	0.670
		31	-0.061	0.045	26.592	0.692
		32	-0.003	-0.095	26.594	0.737

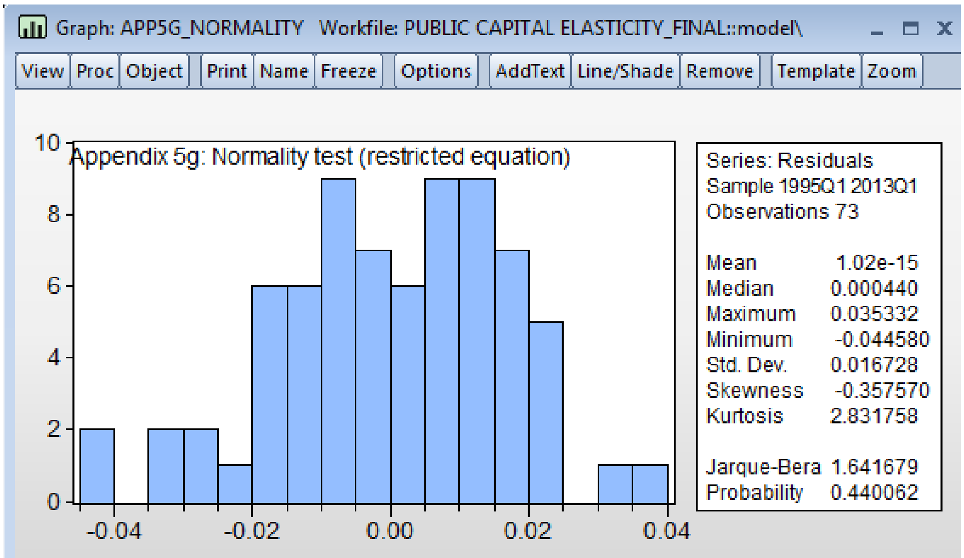


Table: APP5H_LAG1 Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 5h_lag1: Breusch-Godfrey Serial Correlation LM Test (Restricted Equation) with 1 lag

	A	B	C	D	E	F
1	Breusch-Godfrey Serial Correlation LM Test:					
2						
3	F-statistic	4.538133	Prob. F(1,68)		0.0368	
4	Obs*R-squared	4.567028	Prob. Chi-Square(1)		0.0326	
5						

Table: APP5H_LAG2 Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 5h_lag2: Breusch-Godfrey Serial Correlation LM Test (Restricted Equation) with 2 lags

	A	B	C	D	E	F
1	Breusch-Godfrey Serial Correlation LM Test:					
2						
3	F-statistic	3.324548	Prob. F(2,67)		0.0420	
4	Obs*R-squared	6.590494	Prob. Chi-Square(2)		0.0371	
5						

Table: APP5H_LAG3 Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 5h_lag3: Breusch-Godfrey Serial Correlation LM Test (Restricted Equation) with 3 lags

	A	B	C	D	E	F
1	Breusch-Godfrey Serial Correlation LM Test:					
2						
3	F-statistic	2.183305	Prob. F(3,66)		0.0983	
4	Obs*R-squared	6.590550	Prob. Chi-Square(3)		0.0862	
5						

Table: APP5H_LAG4 Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 5h_lag4: Breusch-Godfrey Serial Correlation LM Test (Restricted Equation) with 4 lags

	A	B	C	D	E	F
1	Breusch-Godfrey Serial Correlation LM Test:					
2						
3	F-statistic	1.741334	Prob. F(4,65)		0.1516	
4	Obs*R-squared	7.065480	Prob. Chi-Square(4)		0.1325	
5						

Table: APP5I_ARCH_LAG1 Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 5i: ARCH Heteroskedasticity test (restricted equation) with 1 lag

	A	B	C	D	E
1	Heteroskedasticity Test: ARCH				
2					
3	F-statistic	0.154653	Prob. F(1,70)		0.6953
4	Obs*R-squared	0.158721	Prob. Chi-Square(1)		0.6903
5					

Table: APP5I_ARCH_LAG2 Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 5i: ARCH Heteroskedasticity test (restricted equation) with 2 lags

	A	B	C	D	E
1	Heteroskedasticity Test: ARCH				
2					
3	F-statistic	0.463612	Prob. F(2,68)		0.6310
4	Obs*R-squared	0.955107	Prob. Chi-Square(2)		0.6203
5					

Table: APP5I_BPG Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 5i: Breusch-Pagan-Godfrey Heteroskedasticity test (restricted equation)

	A	B	C	D	E
1	Heteroskedasticity Test: Breusch-Pagan-Godfrey				
2					
3	F-statistic	1.846754	Prob. F(4,68)		0.1300
4	Obs*R-squared	7.153118	Prob. Chi-Square(4)		0.1280
5	Scaled explained SS	5.853100	Prob. Chi-Square(4)		0.2104
6					

Table: APP5I_GLEJSER Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 5i: Glejser Heteroskedasticity test (restricted equation)

	A	B	C	D	E
1	Heteroskedasticity Test: Glejser				
2					
3	F-statistic	1.488107	Prob. F(4,68)		0.2155
4	Obs*R-squared	5.875768	Prob. Chi-Square(4)		0.2086
5	Scaled explained SS	5.128685	Prob. Chi-Square(4)		0.2743
6					

Table: APP5I_HARVEY Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 5i: Harvey Heteroskedasticity test (restricted equation)

	A	B	C	D	E
1	Heteroskedasticity Test: Harvey				
2					
3	F-statistic	1.024894	Prob. F(4,68)		0.4008
4	Obs*R-squared	4.150773	Prob. Chi-Square(4)		0.3860
5	Scaled explained SS	4.070211	Prob. Chi-Square(4)		0.3966
6					

Table: APP5I_WHITE_CROSS Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 5i: White Heteroskedasticity test (restricted equation) with cross terms

	A	B	C	D	E
1	Heteroskedasticity Test: White				
2					
3	F-statistic	2.025286	Prob. F(13,59)		0.0340
4	Obs*R-squared	22.52462	Prob. Chi-Square(13)		0.0477
5	Scaled explained SS	18.43096	Prob. Chi-Square(13)		0.1418
6					

Table: APP5I_WHITE_NOCROSS Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 5i: White Heteroskedasticity test (restricted equation) without cross terms

	A	B	C	D	E	F
1	Heteroskedasticity Test: White					
2						
3	F-statistic	2.191805	Prob. F(4,68)		0.0791	
4	Obs*R-squared	8.336985	Prob. Chi-Square(4)		0.0800	
5	Scaled explained SS	6.821809	Prob. Chi-Square(4)		0.1456	
6						

Testing whether publicē and private capital positive impact on production volume is similar

Table: APP6_WALD Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::model\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 6: Wald test on the difference of public and private capital productivity (restricted equation)

Wald Test:
Equation: EQ_RESTRICTED

Test Statistic	Value	df	Probability
t-statistic	1.537560	69	0.1287
F-statistic	2.364092	(1, 69)	0.1287
Chi-square	2.364092	1	0.1242

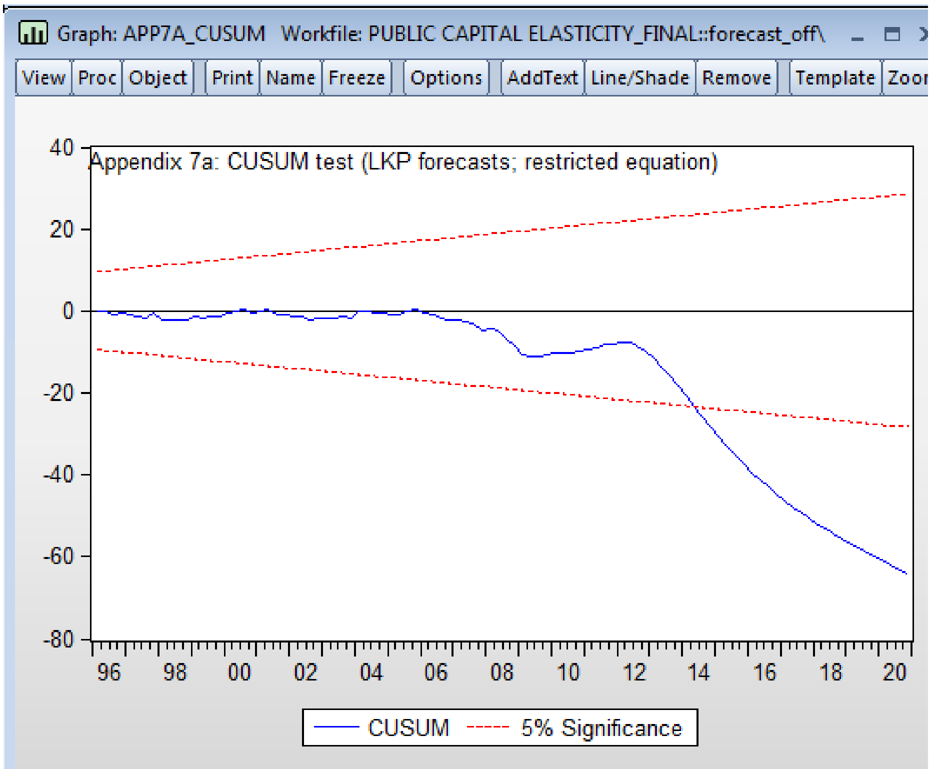
Null Hypothesis: C(3)*6324151=C(2)*1421056
Null Hypothesis Summary:

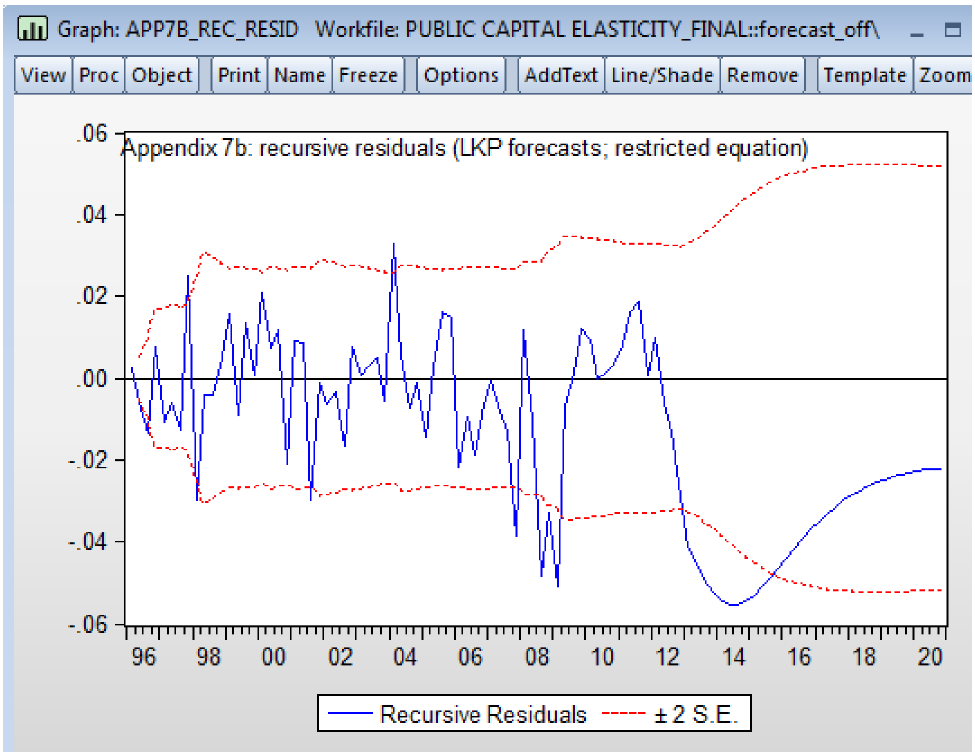
Normalized Restriction (= 0)	Value	Std. Err.
-1421056*C(2) + 6324151*C(3)	136238.3	88606.81

Restrictions are linear in coefficients.

Appendix 7

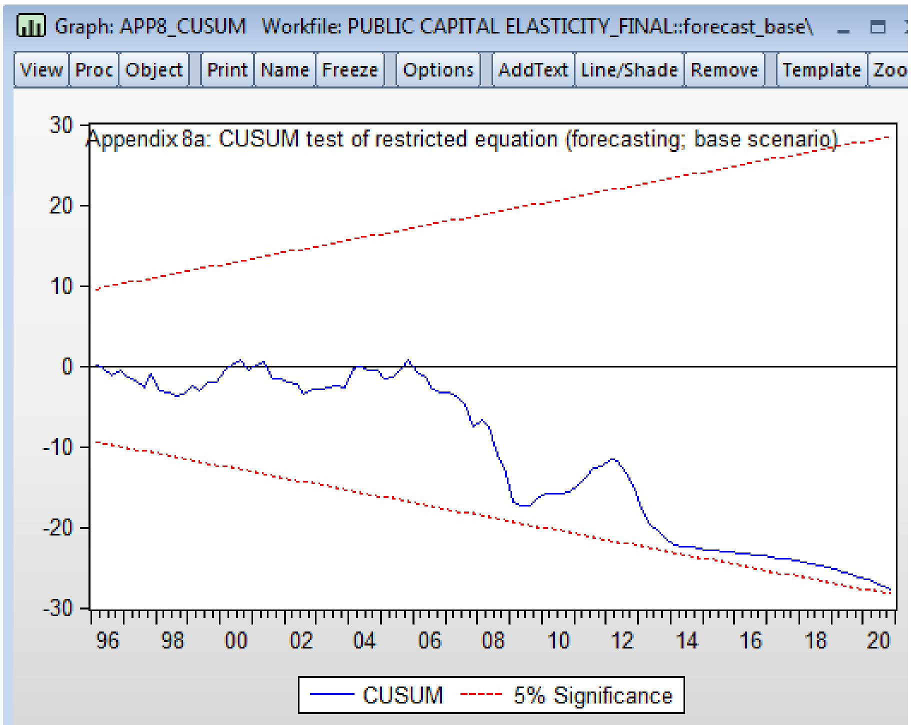
Description of PCE forecasting restricted model (CPL base scenario)

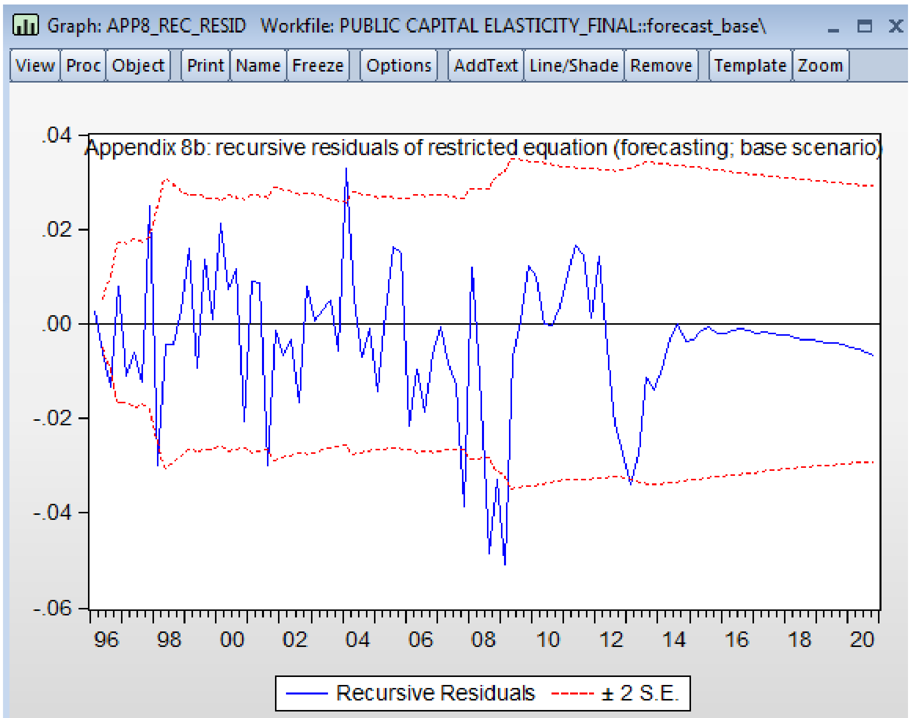


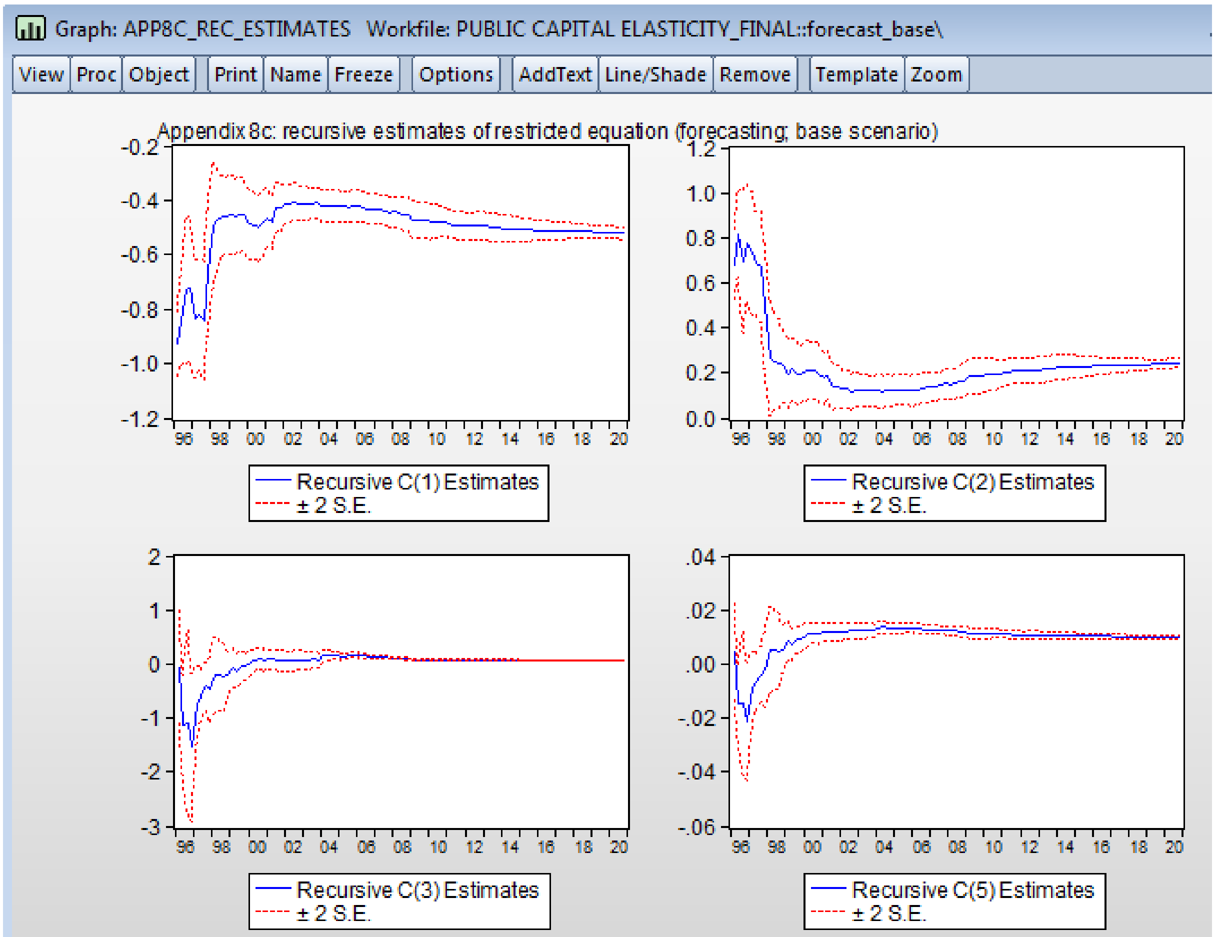


Appendix 8

Description of PCE forecasting restricted model (base scenario)






Graph: APP8C_REC_ESTIMATES Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::forecast_base\
View
Proc
Object
Print
Name
Freeze
Options
AddText
Line/Shade
Remove
Template
Zoom
Appendix 8c: recursive estimates of restricted equation (forecasting; base scenario)
Recursive C(1) Estimates
± 2 S.E.
Recursive C(2) Estimates
± 2 S.E.
Recursive C(3) Estimates
± 2 S.E.
Recursive C(5) Estimates
± 2 S.E.

Results of PCE forecasting with unrestricted model

Table: APP9A_UNRESTRICTED_EQ Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::forecast_base\

Appendix 9a: unrestricted equation (forecasting; base scenario)

	A	B	C	D	E
1	Dependent Variable: KPV_SA				
2	Method: Least Squares				
3	Date: 08/28/13 Time: 18:21				
4	Sample: 1995Q1 2020Q4				
5	Included observations: 104				
6	KPV_SA=C(1)+C(2)*K_PRIV_USE_SA+C(3)*K_PUB_STOCK_SA+C(4)				
7	*L_SA+C(5)*TFP_CALIBRATED				
8					
9		Coefficient	Std. Error	t-Statistic	Prob.
10					
11	C(1)	-1.026384	0.428075	-2.397673	0.0184
12	C(2)	0.241078	0.009924	24.29239	0.0000
13	C(3)	0.070314	0.008850	7.945402	0.0000
14	C(4)	0.725327	0.028050	25.85808	0.0000
15	C(5)	0.009930	0.000201	49.43896	0.0000
16					
17	R-squared	0.998024	Mean dependent var		14.21314
18	Adjusted R-squared	0.997945	S.D. dependent var		0.319096
19	S.E. of regression	0.014467	Akaike info criterion		-5.587072
20	Sum squared resid	0.020719	Schwarz criterion		-5.459938
21	Log likelihood	295.5278	Hannan-Quinn criter.		-5.535566
22	F-statistic	12503.49	Durbin-Watson stat		1.428415
23	Prob(F-statistic)	0.000000			
24					

Table: APP9B_UNRESTRICTED_EQ Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::forecast_opt\

Appendix 9b: unrestricted equation (forecasing; optimistic scenario)

	A	B	C	D	E
1	Dependent Variable: KPV_SA				
2	Method: Least Squares				
3	Date: 08/28/13 Time: 18:25				
4	Sample: 1995Q1 2020Q4				
5	Included observations: 104				
6	KPV_SA=C(1)+C(2)*K_PRIV_USE_SA+C(3)*K_PUB_STOCK_SA+C(4)				
7	*L_SA+C(5)*TFP_CALIBRATED				
8					
9		Coefficient	Std. Error	t-Statistic	Prob.
10					
11	C(1)	-0.727745	0.450828	-1.614241	0.1097
12	C(2)	0.197787	0.012134	16.30082	0.0000
13	C(3)	0.072798	0.008791	8.281351	0.0000
14	C(4)	0.747120	0.027533	27.13530	0.0000
15	C(5)	0.011078	0.000257	43.09154	0.0000
16					
17	R-squared	0.998322	Mean dependent var		14.23585
18	Adjusted R-squared	0.998254	S.D. dependent var		0.347277
19	S.E. of regression	0.014509	Akaike info criterion		-5.581175
20	Sum squared resid	0.020841	Schwarz criterion		-5.454041
21	Log likelihood	295.2211	Hannan-Quinn criter.		-5.529669
22	F-statistic	14726.83	Durbin-Watson stat		1.368266
23	Prob(F-statistic)	0.000000			
24					

Table: APP9C_UNRESTRICTED_EQ Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::forecast_pes\

Appendix 9c: unrestricted equation (forecasting; pessimistic scenario)

	A	B	C	D	E
1	Dependent Variable: KPV_SA				
2	Method: Least Squares				
3	Date: 08/28/13 Time: 18:27				
4	Sample: 1995Q1 2020Q4				
5	Included observations: 104				
6	KPV_SA=C(1)+C(2)*K_PRIV_USE_SA+C(3)*K_PUB_STOCK_SA+C(4)				
7	*L_SA+C(5)*TFP_CALIBRATED				
8					
9		Coefficient	Std. Error	t-Statistic	Prob.
10					
11	C(1)	-1.278015	0.425964	-3.000288	0.0034
12	C(2)	0.270246	0.009226	29.29166	0.0000
13	C(3)	0.069614	0.009186	7.578354	0.0000
14	C(4)	0.713280	0.029234	24.39899	0.0000
15	C(5)	0.009169	0.000187	49.00031	0.0000
16					
17	R-squared	0.997515	Mean dependent var		14.18998
18	Adjusted R-squared	0.997415	S.D. dependent var		0.293815
19	S.E. of regression	0.014939	Akaike info criterion		-5.522863
20	Sum squared resid	0.022093	Schwarz criterion		-5.395729
21	Log likelihood	292.1889	Hannan-Quinn criter.		-5.471358
22	F-statistic	9936.412	Durbin-Watson stat		1.396862
23	Prob(F-statistic)	0.000000			
24					

Appendix 10

Testing the scale effect presence in PCE forecasting model

Table: APP10A_WALD Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::forecast_base\

Appendix 10a: Wald test on scale effect presence (forecasting; base scenario)

Wald Test:
Equation: EQ_UNRESTRICTED

Test Statistic	Value	df	Probability
t-statistic	1.181665	99	0.2402
F-statistic	1.396333	(1, 99)	0.2402
Chi-square	1.396333	1	0.2373

Null Hypothesis: C(2)+C(3)+C(4)=1
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
-1 + C(2) + C(3) + C(4)	0.036720	0.031074

Restrictions are linear in coefficients.

Table: APP10B_WALD Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::forecast_opt\

Appendix 10b: Wald test on scale effect presence (forecasting; optimistic scenario)

Wald Test:
Equation: EQ_UNRESTRICTED

Test Statistic	Value	df	Probability
t-statistic	0.544214	99	0.5875
F-statistic	0.296169	(1, 99)	0.5875
Chi-square	0.296169	1	0.5863

Null Hypothesis: C(2)+C(3)+C(4)=1
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
-1 + C(2) + C(3) + C(4)	0.017706	0.032534

Restrictions are linear in coefficients.

Table: APP10C_WALD Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::forecast_pes\

Appendix 10c: Wald test on scale effect presence (forecasting; pessimistic scenario)

Wald Test:
Equation: EQ_UNRESTRICTED

Test Statistic	Value	df	Probability
t-statistic	1.711648	99	0.0901
F-statistic	2.929739	(1, 99)	0.0901
Chi-square	2.929739	1	0.0870

Null Hypothesis: C(2)+C(3)+C(4)=1
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
-1 + C(2) + C(3) + C(4)	0.053139	0.031046

Restrictions are linear in coefficients.

Results of PCE forecasting restricted model

Table: APP11A_RESTRICTED_EQ Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::forecast_base\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 11a: restricted equation (forecasting; base scenario)

	A	B	C	D	E
1	Dependent Variable: KPV_SA				
2	Method: Least Squares				
3	Date: 08/28/13 Time: 18:34				
4	Sample: 1995Q1 2020Q4				
5	Included observations: 104				
6	KPV_SA=C(1)+C(2)*K_PRIV_USE_SA+C(3)*K_PUB_STOCK_SA+(1-C(2)				
7	-C(3))*L_SA+C(5)*TFP_CALIBRATED				
8					
9		Coefficient	Std. Error	t-Statistic	Prob.
10					
11	C(1)	-0.520706	0.010914	-47.71058	0.0000
12	C(2)	0.243816	0.009669	25.21660	0.0000
13	C(3)	0.062240	0.005635	11.04452	0.0000
14	C(5)	0.009900	0.000200	49.57315	0.0000
15					
16	R-squared	0.997997	Mean dependent var		14.21314
17	Adjusted R-squared	0.997936	S.D. dependent var		0.319096
18	S.E. of regression	0.014495	Akaike info criterion		-5.592297
19	Sum squared resid	0.021011	Schwarz criterion		-5.490590
20	Log likelihood	294.7995	Hannan-Quinn criter.		-5.551093
21	F-statistic	16605.05	Durbin-Watson stat		1.399024
22	Prob(F-statistic)	0.000000			
23					

Table: APP11B_RESTRICTED_EQ Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::forecast_opt\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 11b: restricted equation (forecasting; optimistic scenario)

	A	B	C	D	E
1	Dependent Variable: KPV_SA				
2	Method: Least Squares				
3	Date: 08/28/13 Time: 18:36				
4	Sample: 1995Q1 2013Q1				
5	Included observations: 73				
6	KPV_SA=C(1)+C(2)*K_PRIV_USE_SA+C(3)*K_PUB_STOCK_SA+(1-C(2)				
7	-C(3))*L_SA+C(5)*TFP_CALIBRATED				
8					
9		Coefficient	Std. Error	t-Statistic	Prob.
10					
11	C(1)	-0.495621	0.025840	-19.18052	0.0000
12	C(2)	0.213198	0.029407	7.249838	0.0000
13	C(3)	0.069632	0.008500	8.191714	0.0000
14	C(5)	0.010697	0.000738	14.50204	0.0000
15					
16	R-squared	0.996561	Mean dependent var		14.07649
17	Adjusted R-squared	0.996411	S.D. dependent var		0.280780
18	S.E. of regression	0.016821	Akaike info criterion		-5.279133
19	Sum squared resid	0.019523	Schwarz criterion		-5.153628
20	Log likelihood	196.6884	Hannan-Quinn criter.		-5.229117
21	F-statistic	6664.063	Durbin-Watson stat		1.443238
22	Prob(F-statistic)	0.000000			
23					

Table: APP11C_RESTRICTED_EQ Workfile: PUBLIC CAPITAL ELASTICITY_FINAL::forecast_pes\

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Appendix 11c: restricted equation (forecasting; pessimistic scenario)

	A	B	C	D	E
1	Dependent Variable: KPV_SA				
2	Method: Least Squares				
3	Date: 08/28/13 Time: 18:37				
4	Sample: 1995Q1 2013Q1				
5	Included observations: 73				
6	KPV_SA=C(1)+C(2)*K_PRIV_USE_SA+C(3)*K_PUB_STOCK_SA+(1-C(2)				
7	-C(3))*L_SA+C(5)*TFP_CALIBRATED				
8					
9		Coefficient	Std. Error	t-Statistic	Prob.
10					
11	C(1)	-0.495753	0.025862	-19.16917	0.0000
12	C(2)	0.213357	0.029432	7.249114	0.0000
13	C(3)	0.069585	0.008508	8.179043	0.0000
14	C(5)	0.010693	0.000738	14.48432	0.0000
15					
16	R-squared	0.996554	Mean dependent var		14.07649
17	Adjusted R-squared	0.996404	S.D. dependent var		0.280780
18	S.E. of regression	0.016837	Akaike info criterion		-5.277230
19	Sum squared resid	0.019561	Schwarz criterion		-5.151726
20	Log likelihood	196.6189	Hannan-Quinn criter.		-5.227215
21	F-statistic	6651.352	Durbin-Watson stat		1.440855
22	Prob(F-statistic)	0.000000			
23					

Appendix 12

Forecast of labour market indicators

Base scenario (annual average)

	Working age (15-74) population	Participation rate	Unemployment rate	Employed persons	Weekly hours on the main job	Share of employed with a secondary job	Weekly hours on the secondary job
	L	Y	u	L	l	S/L	s
2013	1548571	65.3	12.1	888664	38.3	4.6	17.3
2014	1525676	65.0	11.7	875476	38.1	4.6	17.8
2015	1506700	65.4	11.3	873852	38.0	4.5	17.7
2016	1490572	65.8	10.9	873710	37.9	4.5	17.6
2017	1476402	66.1	10.5	873586	37.8	4.5	17.5
2018	1465797	66.3	10.1	873702	37.7	4.4	17.4
2019	1458152	66.5	9.8	874071	37.6	4.4	17.3
2020	1452886	66.7	9.6	875473	37.5	4.3	17.2

Optimistic scenario (annual average)

	Working age (15-74) population	Participation rate	Unemployment rate	Employed persons	Weekly hours on the main job	Share of employed with a secondary job	Weekly hours on the secondary job
	L	Y	u	L	l	S/L	s
2013	1550371	65.3	11.9	892171	38.3	4.6	17.3
2014	1532276	65.3	11.0	889824	38.3	4.6	17.9
2015	1518100	65.7	10.2	894972	38.3	4.6	17.8
2016	1506772	66.1	9.5	900424	38.2	4.6	17.8
2017	1497402	66.3	8.9	904511	38.2	4.5	17.7
2018	1491597	66.5	8.3	909677	38.2	4.5	17.7
2019	1488752	66.7	7.7	916633	38.2	4.5	17.7
2020	1488286	66.9	7.3	923824	38.2	4.5	17.6

Pessimistic scenario (annual average)

	Working age (15-74) population	Participation rate	Unemployment rate	Employed persons	Weekly hours on the main job	Share of employed with a secondary job	Weekly hours on the secondary job
	L	Y	u	L	l	S/L	s
2013	1546771	65.3	12.3	885171	38.2	4.6	17.3
2014	1519076	64.7	12.3	861280	38.0	4.5	17.8
2015	1495300	65.1	12.3	853046	37.8	4.5	17.7
2016	1474372	65.5	12.2	847484	37.6	4.4	17.6
2017	1455402	65.8	12.0	843292	37.4	4.4	17.5
2018	1439997	66.0	11.8	838566	37.3	4.3	17.4
2019	1427552	66.2	11.9	832657	37.1	4.2	17.3
2020	1417486	66.4	12.0	828576	36.9	4.2	17.2

Results of COE retrospective assessment in a sectoral breakdown

P Pool: POOL_1_LABAKS Workfile: IIE_RETROSPECTIVE_FINAL_01_10::Retros...

View | Proc | Object | Print | Name | Freeze | Estimate | Define | PoolGenr | Sheet

Dependent Variable: RGFCFSA?
Method: Pooled EGLS (Cross-section SUR)

Sample: 2001Q1 2013Q1
Included observations: 49
Cross-sections included: 5
Total pool (balanced) observations: 245
Linear estimation after one-step weighting matrix
White cross-section standard errors & covariance (no d.f. correction)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNEMPL	-5.154712	0.523059	-9.854928	0.0000
C	21.47457	38.55963	0.556918	0.5782
_A--REUSA_A	0.104888	0.025256	4.153072	0.0000
_T--REUSA_T	0.190336	0.135544	1.404237	0.1617
_C--REUSA_C	0.038345	0.012472	3.074366	0.0024
_N--REUSA_N	0.830833	0.165998	5.005072	0.0000
_G--REUSA_G	0.331250	0.018103	18.29777	0.0000
_A--RINTL	1.437456	0.384048	3.742910	0.0002
_T--RINTL	-1.469874	0.845949	-1.737545	0.0837
_C--RINTL	1.673663	0.535004	3.128318	0.0020
_N--RINTL	-6.074870	1.078865	-5.630798	0.0000
_G--RINTL	0.359703	0.811852	0.443064	0.6582
_A--RGVASA_A	0.929462	0.284678	3.264958	0.0013
_T--RGVASA_T	0.325415	0.240559	1.352744	0.1776
_C--RGVASA_C	-0.022510	0.082181	-0.273905	0.7844
_N--RGVASA_N	-0.073487	0.060230	-1.220100	0.2238
_G--RGVASA_G	0.416307	0.168705	2.467667	0.0144
_A--LSA_A	-0.327098	0.061532	-5.315947	0.0000
_T--LSA_T	-0.338979	0.327515	-1.035002	0.3018
_C--LSA_C	0.343760	0.175336	1.960571	0.0512
_N--LSA_N	0.477396	0.421523	1.132549	0.2587
_G--LSA_G	1.225506	0.406079	3.017899	0.0029
_A--INTRATE_SHORTCREDIT	-0.426208	0.230983	-1.845194	0.0664
_T--INTRATE_SHORTCREDIT	-0.062977	1.103279	-0.057082	0.9545
_C--INTRATE_SHORTCRE...	0.747217	0.539146	1.385927	0.1672
_N--INTRATE_SHORTCRE...	0.448563	1.602273	0.279954	0.7798
_G--INTRATE_SHORTCRE...	1.034806	0.504588	2.050793	0.0415
Fixed Effects (Cross)				
_A--C	47.06986			
_T--C	125.5112			
_C--C	29.32303			
_N--C	116.5750			
_G--C	-318.4791			

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.958998	Mean dependent var	5.620272
Adjusted R-squared	0.953250	S.D. dependent var	3.816729
S.E. of regression	1.012325	Sum squared resid	219.3074
F-statistic	166.8425	Durbin-Watson stat	1.446685

Appendix 14

Results of COE retrospective assessment in selected economic development periods and sectoral breakdown

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments+/-

Dependent Variable: RGFCFSA?
Method: Pooled EGLS (Cross-section SUR)

Sample: 2001Q1 2013Q1
Included observations: 49
Cross-sections included: 5
Total pool (balanced) observations: 245
Linear estimation after one-step weighting matrix

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	108.5886	13.98155	7.766559	0.0000
UNEMPL	-7.010941	0.485079	-14.45320	0.0000
_A--REUSA_A	0.296339	0.298938	0.991306	0.3227
_C--REUSA_C	0.299312	0.194713	1.537199	0.1258
_N--REUSA_N	0.658238	0.320788	2.051941	0.0414
_G--REUSA_G	0.497098	0.047324	10.50420	0.0000
_T--REUSA_T	0.633867	0.412924	1.535070	0.1263
_A--REUSA_A*D1	-0.089223	0.285314	-0.312719	0.7548
_C--REUSA_C*D1	-0.219699	0.109043	-2.014796	0.0452
_N--REUSA_N*D1	-0.246370	0.329985	-0.746610	0.4561
_G--REUSA_G*D1	-0.228013	0.059319	-3.843839	0.0002
_T--REUSA_T*D1	-0.499501	0.994069	-0.502482	0.6159
_A--REUSA_A*D2	-0.103113	0.271618	-0.379625	0.7046
_C--REUSA_C*D2	0.040647	0.039446	1.030461	0.3040
_N--REUSA_N*D2	0.023372	0.004688	4.985901	0.0000
_G--REUSA_G*D2	-0.135047	0.017219	-7.843033	0.0000
_T--REUSA_T*D2	-0.450650	0.257458	-1.750380	0.0815
_A--REUSA_A*D4	0.028280	0.022452	1.259604	0.2092
_C--REUSA_C*D4	0.157912	0.211669	0.746033	0.4565
_N--REUSA_N*D4	-0.122980	0.047291	-2.600510	0.0100
_G--REUSA_G*D4	-0.037860	0.007509	-5.041731	0.0000
_T--REUSA_T*D4	-0.109389	0.057216	-1.911862	0.0573
_A--RINTL	5.440072	1.100979	4.941122	0.0000
_C--RINTL	5.529606	0.813953	6.793523	0.0000
_N--RINTL	2.664127	2.682664	0.993090	0.3218
_G--RINTL	-6.224543	1.036967	-6.002644	0.0000
_T--RINTL	-3.442023	1.812795	-1.898738	0.0590
_A--RGVASA_A/L_A	21543.22	15444.38	1.394890	0.1645
_C--RGVASA_C/L_C	-2581.913	7014.466	-0.368084	0.7132
_N--RGVASA_N/L_N	-1388.976	15198.57	-0.091389	0.9273
_G--RGVASA_G/L_G	145987.6	29625.22	4.927815	0.0000
_T--RGVASA_T/L_T	71700.71	25241.88	2.840546	0.0049
Fixed Effects (Cross)				
_A--C	-53.47311			
_C--C	-39.24835			
_N--C	159.4840			
_G--C	-75.51104			
_T--C	8.748460			

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics

R-squared	0.971869	Mean dependent var	5.972351
Adjusted R-squared	0.967158	S.D. dependent var	4.239105
S.E. of regression	1.042315	Sum squared resid	227.0618
F-statistic	206.2992	Durbin-Watson stat	1.505069

Results of COE forecast

BASE SCENARIO

EViews - [Table: TABLE01 Workfile: IIE_FORECASTS::Baseline\]

File Edit Object View Proc Quick Options Window Help

View Proc Object Print Name Edit+/- CellFmt Grid+/- Title Comments+/-

Method: Pooled EGLS (Cross-section SUR)

Sample: 2013Q1 2020Q4
Included observations: 32
Cross-sections included: 5
Total pool (balanced) observations: 160
Linear estimation after one-step weighting matrix

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.365939	0.250406	-9.448420	0.0000
_A--RGVASA_A	0.108701	0.015159	7.170685	0.0000
_C--RGVASA_C	0.006748	0.001022	6.602696	0.0000
_N--RGVASA_N	0.129605	0.016432	7.887193	0.0000
_T--RGVASA_T	0.150336	0.024612	6.108175	0.0000
_G--RGVASA_G	0.140032	0.014652	9.557183	0.0000
_A--REUSA_A	0.396442	0.014840	26.71479	0.0000
_C--REUSA_C	0.083040	0.002422	34.28993	0.0000
_N--REUSA_N	0.107406	0.003540	30.33656	0.0000
_T--REUSA_T	0.259180	0.010093	25.68000	0.0000
_G--REUSA_G	0.608712	0.018095	33.63914	0.0000
_A--L_A	5.25E-05	3.54E-05	1.480363	0.1410
_C--L_C	1.80E-05	1.31E-05	1.374824	0.1714
_N--L_N	6.23E-05	2.61E-05	2.387345	0.0183
_T--L_T	0.000173	5.68E-05	3.044513	0.0028
_G--L_G	-5.67E-06	5.46E-05	-0.103861	0.9174
_A--UNEMPL	0.318381	0.133764	2.380167	0.0187
_C--UNEMPL	0.105321	0.038399	2.742804	0.0069
_N--UNEMPL	1.602984	0.529233	3.028882	0.0029
_T--UNEMPL	1.164186	0.441185	2.638770	0.0093
_G--UNEMPL	1.429687	0.604606	2.364657	0.0194

Weighted Statistics

R-squared	0.999974	Mean dependent var	65.71161
Adjusted R-squared	0.999970	S.D. dependent var	143.8068
S.E. of regression	0.857127	Sum squared resid	102.1186
F-statistic	264740.6	Durbin-Watson stat	0.924138
Prob(F-statistic)	0.000000		

OPTIMISTIC SCENARIO

P Pool: POOL_2 Workfile: IIE_FORECASTS::optimistic\

View | Proc | Object | Print | Name | Freeze | Estimate | Define | PoolGenr | Sheet

Dependent Variable: RGFCFSA?
Method: Pooled EGLS (Cross-section SUR)
Date: 10/03/13 Time: 17:42
Sample: 2013Q1 2020Q4
Included observations: 32
Cross-sections included: 5
Total pool (balanced) observations: 160
Linear estimation after one-step weighting matrix

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-69.19107	4.117590	-16.80378	0.0000
UNEMPL	0.813269	0.171881	4.731572	0.0000
L?	-0.000118	3.25E-06	-36.19488	0.0000
RGDP	0.065202	0.001285	50.74112	0.0000
_A--REUSA_A	0.921743	0.094718	9.731487	0.0000
_C--REUSA_C	0.002779	0.009840	0.282411	0.7780
_N--REUSA_N	0.284299	0.021427	13.26811	0.0000
_T--REUSA_T	0.167800	0.023122	7.257261	0.0000
_G--REUSA_G	0.014425	0.018302	0.788183	0.4319
_A--RGVASA_A	-0.501133	0.012775	-39.22691	0.0000
_C--RGVASA_C	-0.414916	0.005309	-78.15083	0.0000
_N--RGVASA_N	0.124889	0.001055	118.4312	0.0000
_T--RGVASA_T	0.223456	0.002304	97.00111	0.0000
_G--RGVASA_G	0.505415	0.003765	134.2511	0.0000

Weighted Statistics

R-squared	0.999973	Mean dependent var	82.66267
Adjusted R-squared	0.999970	S.D. dependent var	152.5212
S.E. of regression	0.907265	Sum squared resid	120.1770
F-statistic	410530.8	Durbin-Watson stat	0.635552
Prob(F-statistic)	0.000000		

PESSIMISTIC SCENARIO

EViews - [Pool: POOL01 Workfile: IIE_FORECASTS::Pessimistic\]

File Edit Object View Proc Quick Options Window Help

View | Proc | Object | Print | Name | Freeze | Estimate | Define | PoolGenr | Sheet

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	116.6855	42.14230	2.768846	0.0064
CPI	0.091423	0.119161	0.767224	0.4443
_A--L_A	0.000332	0.000107	3.099976	0.0024
_C--L_C	8.36E-05	8.08E-05	1.033632	0.3032
_N--L_N	7.35E-05	0.000105	0.699721	0.4853
_T--L_T	0.000427	0.000269	1.584789	0.1154
_G--L_G	0.000194	0.000125	1.552564	0.1229
_A--UNEMPL	0.503020	0.221556	2.270396	0.0248
_C--UNEMPL	0.236837	0.169930	1.393733	0.1657
_N--UNEMPL	1.962874	0.814883	2.408781	0.0174
_T--UNEMPL	1.387906	0.754867	1.838610	0.0682
_G--UNEMPL	1.667240	0.644433	2.587143	0.0107
_A--REUSA_A	0.190889	0.057749	3.305478	0.0012
_C--REUSA_C	0.017287	0.006906	2.503385	0.0135
_N--REUSA_N	0.448681	0.080314	5.586615	0.0000
_T--REUSA_T	0.462034	0.119881	3.854096	0.0002
_G--REUSA_G	0.315585	0.050378	6.264344	0.0000
_A--RGVASA_A	-0.828644	0.595250	-1.392096	0.1662
_C--RGVASA_C	-0.057717	0.095579	-0.603871	0.5470
_N--RGVASA_N	-0.051162	0.017716	-2.887971	0.0045
_T--RGVASA_T	-0.127537	0.062886	-2.028050	0.0445
_G--RGVASA_G	-1.389639	0.337023	-4.123271	0.0001
Fixed Effects (Cross)				
_A--C	-80.80030			
_C--C	-125.1031			
_N--C	16.05297			
_T--C	-64.24373			
_G--C	254.0942			

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.999826	Mean dependent var	84.89485
Adjusted R-squared	0.999793	S.D. dependent var	56.28060
S.E. of regression	0.809370	Akaike info criterion	2.562545
Sum squared resid	87.78070	Schwarz criterion	3.062261
Log likelihood	-179.0036	Hannan-Quinn criter.	2.765462
F-statistic	30747.14	Durbin-Watson stat	0.729509
Prob(F-statistic)	0.000000		