ANTICIPATING THE REGIONAL EFFECTS OF AN AGEING POPULATION: A DYNAMIC CGE ANALYSIS FOR FINLAND*

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Abstract:

Coping with the effects of an ageing population is among the foremost fiscal challenges in most industrialised countries. Among the European economies, Finland provides an interesting case, as the large post-war baby-boomer generations are some years older than in other European counties, and the country is thus already coping with the effects of ageing. We evaluate the regional effects of ageing using the VERM model, a dynamic, regional CGE model for Finnish Economy. The model bases on the well-known TERM model, but has been extended in several aspects. Our dynamic extension uses MONASH-type dynamics. To study the effects of ageing, we introduce an econometric approach whereby we use econometric results for the parameter values determining the population-driven demand for public services, taking into account changes in the number and in the structure of population. Secondly, we combine CGE analysis to study fiscal pressure on public sector finances. The public sector is divided in tree sub-sectors, namely, the central government, municipalities and social security funds. The study is related to an on-going evaluation of the financial relations especially between the central government and local authorities.

KEYWORDS: Computable general equilibrium; ageing; government expenditure; Fiscal policies; regional; Finland.

* This study is part of long-run, on-going process to develop Finnish general equilibrium models at the Government institute of Economic Search for different kinds of policy analyses. For further questions please contact to authors. E-mail: firstname.lastname@vatt.fi

1 Background

Coping with the effects of an ageing population is among the foremost current fiscal challenges in most industrialised countries. Europe is facing the simultaneous problems of a decreasing working-age population and increased old age-related expenditure in the very near future. Among the European economies, Finland provides an interesting case, as the large baby-boomer generations are some years older than in other European countries, and the country is thus already coping with the effects of ageing.

As one of the main challenges for the future, effects of ageing on government expenditure have been intensively investigated in recent years[1]. In Finland there have been also several studies. For example: Kautto et al (2005) Häkkinen et al (2007) and Hujanen et al (2004) has studied health care expenditures; Volk & Nivalainen (2009), Kauppinen (2005), Huovari & Kiander & Volk (2006) and Parkkinen (2008) has studied ageing from regional point of view. There is also tradition of modelling effects of ageing in economy. Commonly studies have been made with overlapping generations (OLS) models, see for example Kilponen & Kinnunen & Ripatti, (2006) and Lassila & Valkonen (2008).

The brunt of the service-related costs of ageing is borne by municipalities, whereas the central government faces increased pension costs and other transfers. The division of the costs is currently under debate. This study considers two extreme policies for dealing with the cost pressures in the municipal economies. In one of the policies, central government taxes are used to finance increased transfers from the central government to the municipalities, in the other, municipalities have to deal with the budgetary pressure by increasing municipal taxes.

We evaluate the regional effects of the policies with VERM model, which is a dynamic, regional, CGE model for Finnish economy. The model bases on the well-known TERM model (Horridge & Madden & Wittwer 2005), but has been extended to include MONASH-type dynamics (Dixon & Rimmer 2002). The model also uses a very comprehensive data base of transactions in and between the public sectors.

The remainder of the paper is organized as follows: Section 2 deals with the description of the data used, especially in the government accounting. Section 3 presents the econometric models used and their results. Section 4 presents the results of the regional CGE analysis. Section 5 concludes.

[1] For further readings, see for example: Weil (1997; 2006), Sapozhnikov (2007).

2 Data

There are several data sources which have been used in database formation. The most important data sources are National and Regional Accounts, but also some micro-level datasets that include individual observations are used. Little effort is put on describing MONASH- and TERM-type input-output structure, capital formation and balance of payment information which are available elsewhere (Dixon & Rimmer 2002; Horridge & Madden & Wittwer 2005, Honkatukia, 2009). Finally, data for econometric analysis is described.

In Finland, national supply and use tables are constructed annually (last for year 2005). The number of commodities depends of the reference year. Supply and use tables for used year 2004 include 950 commodities and 175 industries. The industry classification uses the national TOL 2002, basing on NACE 2002[2] and ISIC Rev. 3.1[3], to classify industries. The commodities use national KTTL classification, basing on CPA[4] and CPC[5] classifications. Commodity classifications are designed to match with industries. For example national TOL 2002 corresponds with national KTTL classification. Regional classification bases on NUTS[6] classification at the third level which divides Finland in 20 regions. Latest regional input-output tables are available from year 2002.

Other important statistics for building TERM- and MONASH databases are capital stocks (both national and regional), financial accounts, balance of payments, data on imports by place of frontier crossing point, as well as a sample from income distribution statistics and Finnish Linked Employer-Employee Data (FLEED).

The data used for the econometric analysis are derived from Statistics Finland Regional Accounts database. For econometric studies LAU1 sub-regional classification is used. The LAU1 sub-regions can be interpreted as the fourth level of the NUTS classification. The amount of LAU1 sub-regions has been changed in recent years. In Finland, during 2005 to 2008 there were 77 LAU1 sub-regions, but from 2009 onwards their number reduces to only 72.

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[2] NACE (Nomenclature Générale des Activités Economiques dans les Communanautés Européennes) is statistical industry classification used in European Union.
[3] ISIC (International Standard Industrial Classification of All Economic Activities) is a statistical industry classification confirmed by United Nations.
[4] CPA (The Classification of Products by Activity) is used by the European Union in national and regional accounts for input-output analysis.
[5] CPC (Central product classification) is a statistical product classification confirmed by United Nations.
[6] NUTS (The Nomenclature of Territorial Units for Statistics) is statistical region classification used in European Union

Necessary data for government consumption by commodity, general government sub-sector, and by region are available only for the year 2002, derived from regional input-output tables. For econometric analysis, time-series data are needed. As best approximations for dependent variables, data from sub-regional output by industry and general government sub-sector have been used (Table 1). However, public consumption and production are very closely related. Price indices from National accounts database are used to convert data into fixed prices, from which follows that the price changes are the same in every region. As an independent variable, data from Statistics Finland population statistics[7] are used in various forms. The econometric analysis uses time-series from 1975 to 2006, consisting of sub-regional output and population projection data. The parameter values obtained from econometric study are incorporated with the population projection is used to create a forecast from 2006 onwards. Price data from National accounts are used to transform output data in fixed price form.

3 Empirical model for econometric forecast

All estimated models in this study are based on the assumption that changes in regional population size and structure as well as an industry-specific trend are the driving forces for the regional public consumption. There are 12 different commodities (Table 1) in the model involved in the government consumption based on the standard KTTL classification. All trends are estimated using industry specific output data as dependent variables. Hausman test results for the comparison of fixed and random effects models turn out to be significant for every estimated model, which indicates that fixed effect models should be used. The trend is assumed to be deterministic and for our analysis purposes, a least squares dummy variable (LSDV) approach is used. Dummy variables are created for every K-1 regions for two different time periods, which indicates that the intercept is our estimate for variable K. Also two time-specific dummy variables are included. From this follows that all estimated models can be written in the form

$$\ln y_{ik,t} = \alpha + \beta t + \chi t_1 + \gamma_k \sum_{j \neq Uusimaa}^{k} t * D_j + \delta_k \sum_{j \neq Uusimaa}^{k} t_1 * D_j + \varphi \ln POP_{ik,t} + \varepsilon_{ik,t} \text{, where} \quad (1)$$

y = output for a gov sub-sector and industry

[7] For more information on population projection, see http://www.tilastokeskus.fi/til/vaenn/index_en.html.

i = LAU1 sub-regions (NUTS4)

j,k = province (NUTS3)

t = time

t_1 = time before year 1992

$\sum t*D_j$ = province-specific time dummies for others than Uusimaa (capital city region)

$POP_{ik,t}$ = population of sub-region i (within province k) at time t

$\alpha, \beta, \chi, \gamma_k, \delta_k, \varphi$ = constants are parameters to be estimated

$\varepsilon_{ik,t}$ = error term.

The logarithmic model specification allows us to interpret the estimated multipliers (φ_i) as population elasticises for government consumption. For example, if the multiplier is between one and zero, an increase by one percent in population has less than one percent effect on government consumption.

For education, health and social services, as the independent population variable we use an average population indicator which incorporates differences in unit costs between age groups. Unit prices for cost shares are based on studies of age dependency of public sector costs in year 2002 (see Hujanen et al., 2004). These data are nation-wide. Thus, we use information concerning the dependent from one year to come around the problem of not having a time series on age-group-specific public consumption/production data. The indicator can be written as

(2) $POP_i = \prod_g POP_{gi}^{C_g}$, where

i = sub-region

g = age groups (0-6, 7-15, 16-64, 65-74, 75-84, 85+)

C = age group's cost share

POP_{gi} = population size by age group and sub-region

Table 1. Dependent variable, independent variable and method by commodities and sectors.

Commodities	**Central government**	**Local government**	**Social security funds**
C_17_9 Textiles and wearing			Public administration and social security output, Changes in population size, fixed regional effect model
C_24 Chemicals and chemical products			Public administration and social security output, Changes in population size, fixed regional effect model
C_4501 Buildings and building construction works		Construction output, Changes in population size, fixed regional effect model	
C_4502 Other construction works		Construction output, changes in population size, fixed regional effect model	
C_60 Land transport services			Public administration and social security output, changes in population size, fixed regional effect model
C_63 Warehousing and support services for transportation	Transport, storage and communication output, changes in population size, fixed regional effect model	Transport, storage and communication output, changes in population size, fixed regional effect model	
C_70_4 Real estate services	Real estate services output, changes in population size, fixed regional effect model	Public administration and social security output, Changes in population size, fixed regional effect model	
C_75 Public administration and defence services; compulsory social security services	Public administration and social security output, Changes in population size, fixed regional effect model	Public administration and social security output, Changes in population size, fixed regional effect model	Public administration and social security output, changes in population size, fixed regional effect model
C_80 Education services	Education output, Changes in population size, fixed regional effect model	Education output, education unit price dependent Cobb-Douglas function, fixed regional effect model	
C_85 Human health and social work services	Health and social work output, changes in population size, fixed regional effect model	Health and social work output, health care unit price dependent Cobb-Douglas function, fixed regional effect model	Public administration and social security output, changes in population size, fixed regional effect model
C_92_5 Other services	Other services output, changes in population size, fixed regional effect model	Other services output, changes in population size, fixed regional effect model	

Dependent variable, independent variable, used method.

First, we analyse goodness of fit statistics (Appendix 2). Education, health and social care costs for local government are the models estimated using Cobb-Douglas indicator. The use of this kind of indicator is not possible for the rest of the models because lack of data. For these two models, goodness of fits statistics are the highest ($R^2 > 0.98$). Explanatory power is also higher compared to models that are estimated only by using changes in total population as the independent variable. This indicates that use of the indicators increases the explanatory power of the model. For the rest of models, explaining consumption of local government and social security funds, goodness of fit statistics are also significantly high ($R^2 > 0.90$). Models for the general government administration (NACE 75) have the lowest explanatory power. This can be rational. For example when thinking about education, if region has university, then it could be assumed that government consumption in these regions is higher.

The parameter estimates for all the models are presented in Appendix 2. The results can be illustrated by considering two very different regions. Uusimaa, the capital region, is clearly the largest and richest region in Finland. In contrast, Kainuu is one of the smallest and poorest. In 2006, the regional GDP in Uusimaa was 58.5 billion euro, which is over 35 percent of total GDP of Finland. In Kainuu, regional GDP was only 1.1 billion euro. The population of Kainuu is only 83 thousand, in contrast with Uusimaa's 1.4 million. The total population in Finland is 5.3 million.

In Appendix 2, the headings (S1311, S1313 and S1314) refer to the sector: central government, municipalities and social security funds, respectively. The dummy variables for different time periods (TIME, P1TIME) are referred to as t and $t_{1,}$ as in previously specified model. The first dummy variable set (TMK2-21) refers to the term ($\sum_{j=1}^{k-1} t * D_j$) used in the model, and the second term ($\sum_{j=1}^{k-1} t_1 * D_j$) refers to variables P1TMK2-21. The terms LNVPOP (general government), KOUPOP (education) and TERPOP (health care) refer to independent population variables.

Uusimaa is treated as a K:th variable in model specified earlier. Variable TIME, which refers to time after the year 1992, subscribes the growth trend of Uusimaa's output compared to increase in population indicator variable. To study Kainuu's situation, the variable TMK18 must be added. For example, changes in government administration outputs have statistically significant population-independent trend at Uusimaa (1.2%) and in Kainuu (3.1% (1.2%+1.9%)). Population elasticities are presented in the LNVPOP, KOUPOP and TERPOP rows. For example, one percent growth in population increases educational costs by 1.42 percent. One of the reasons could be that educational cost has decreasing trend in every region, which increases excess capacity. In contrast, one percent change in growth in age-specific population indicator increases municipal health and social work costs by 0.83 percent.

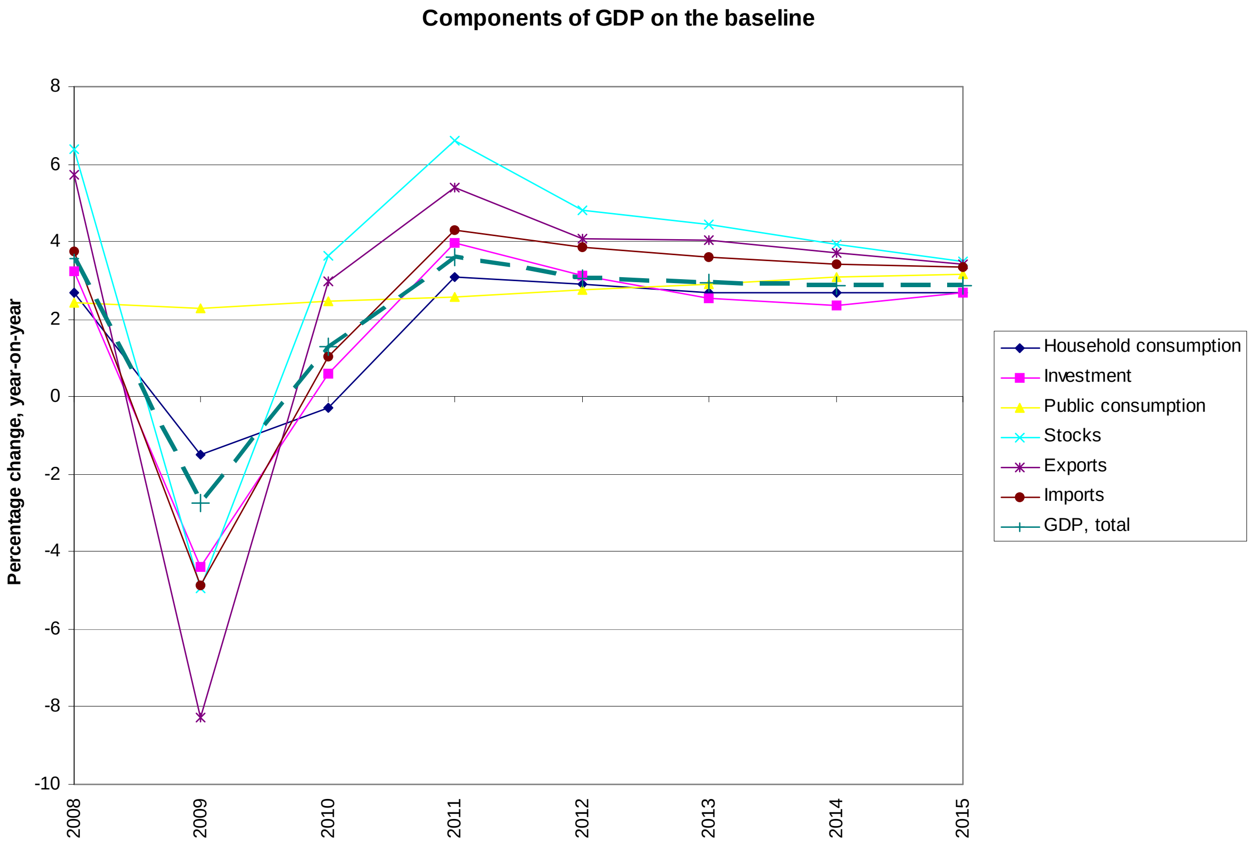
4 Regional Equilibrium Effects

4.1 The effects of ageing in the baseline

We base our analyses on the medium term economic forecast of the Ministry of finance. This forecast is regionalized using the simulation model by fixing nationwide expenditure aggregates and letting the model use inputs on productivity growth, labor supply and so on to determine regional economic development that is consistent with the national aggregates. We use a fairly recent forecast, stemming from February 2009.

The national aggregates are summarized in figure 1. GDP is forecast to fall by 2.7 per cent in 2009, but in the consecutive years, growth picks up fairly rapidly. The fall is caused mostly by the fall of exports and investment. In fact, the 8.2 per cent fall in exports alone would be sufficient to cause the drop in GDP in 2009. However, several other expenditure aggregates are contributing to GDP growth. Public sector consumption, in particular, continues to grow. And while household demand is also falling, it is actually sustaining GDP in 2009.

Figure 1. Components of GDP on the baseline



There are considerable regional differences in economic development. Figure 2 shows regional GDP in 2009. The fall in GDP is largest in Uusimaa, Satakunta and Pohjanmaa, all of which are large regions and contain almost a third of the population.

Figure 3 shows the contribution of expenditure aggregates on regional GDP. The figure shows that exports and investment account for much of the fall in GDP in regions, where export industries stand for a large part of the regional GDP. The regions Kymenlaakso, Etelä-Karjala, Pirkanmaa, Päijät-Häme, Kanta-Häme, Pohjanmaa and Satakunta are all home to heavy, export industry, whose share in value added is more than a third in some of them. In other regions, such as Uusimaa, Pirkanmaa and Satakunta, household consumption falls and contributes to the fall of GDP, but in most regions, household consumption sustains GDP growth. Public consumption contributes to GDP in all regions.

Figure 2. Change in regional GDP

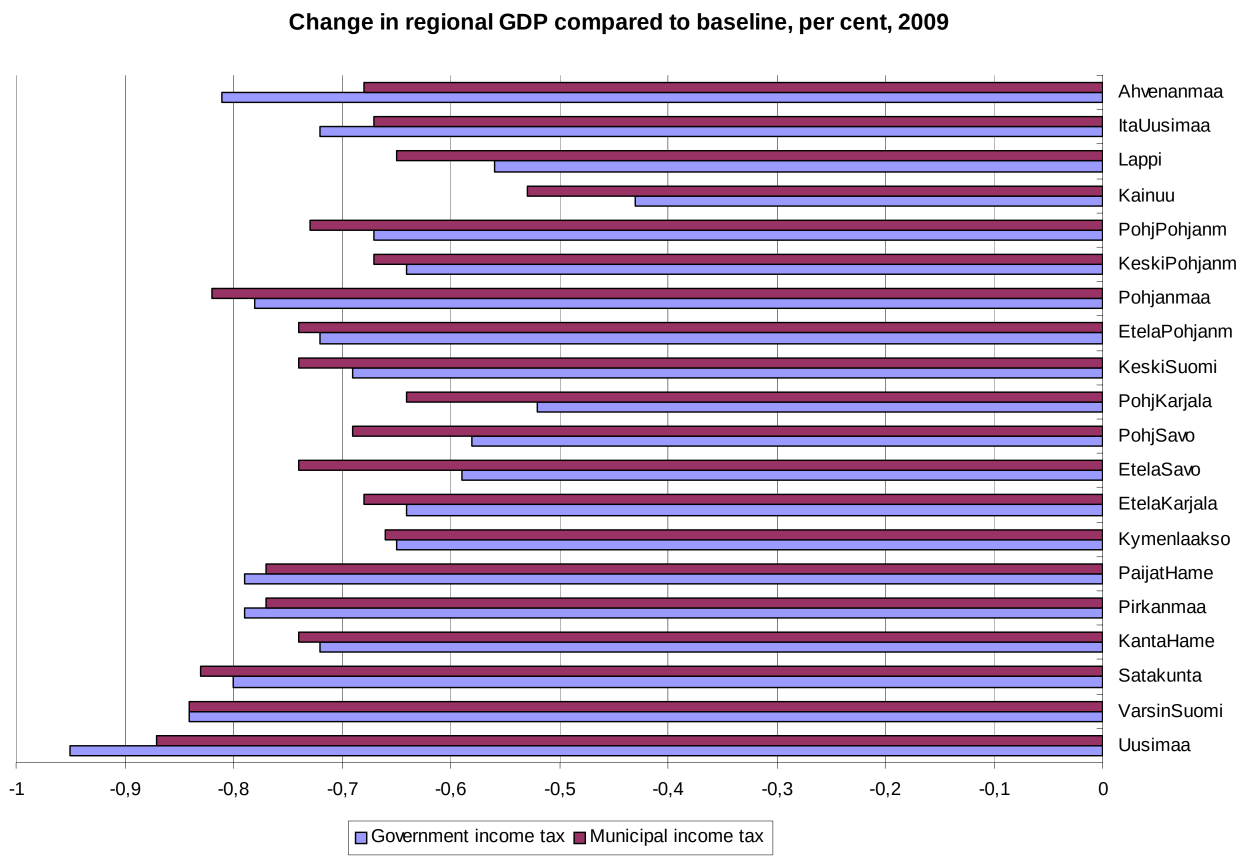
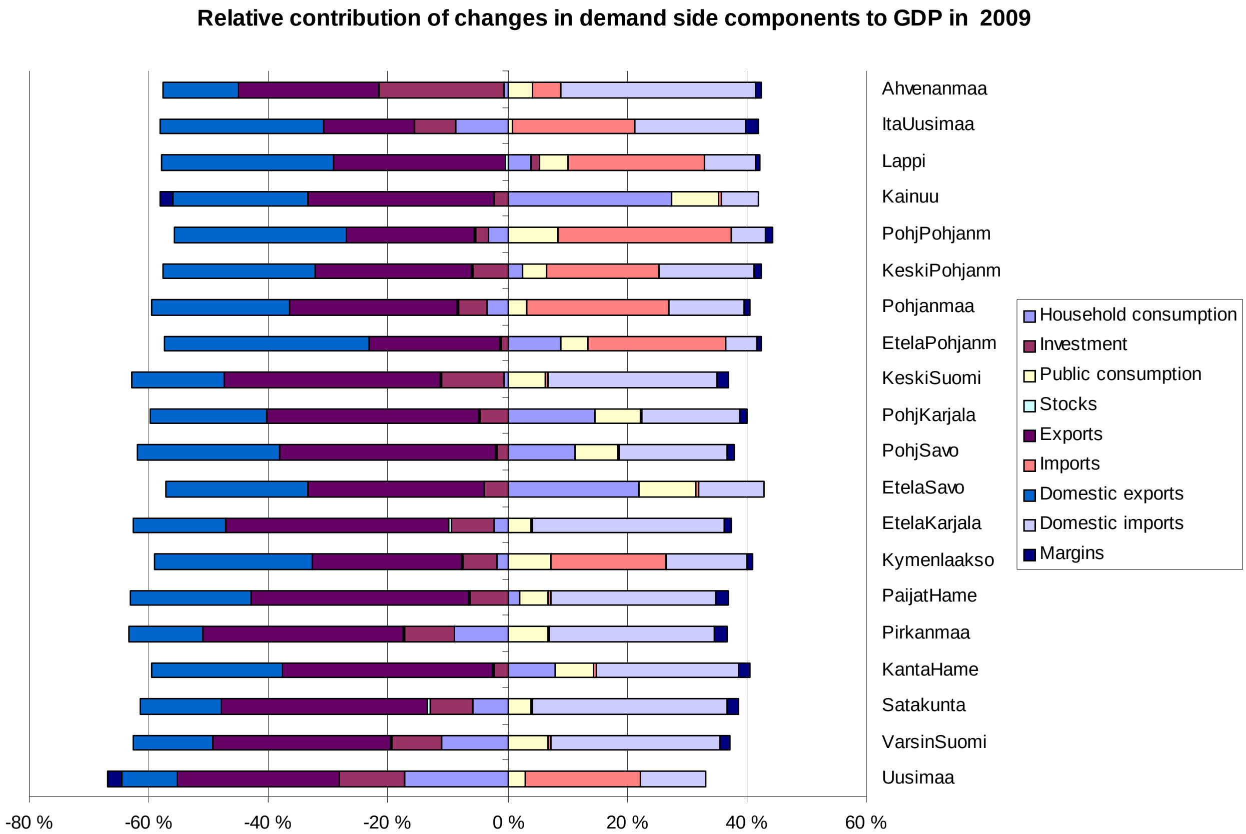


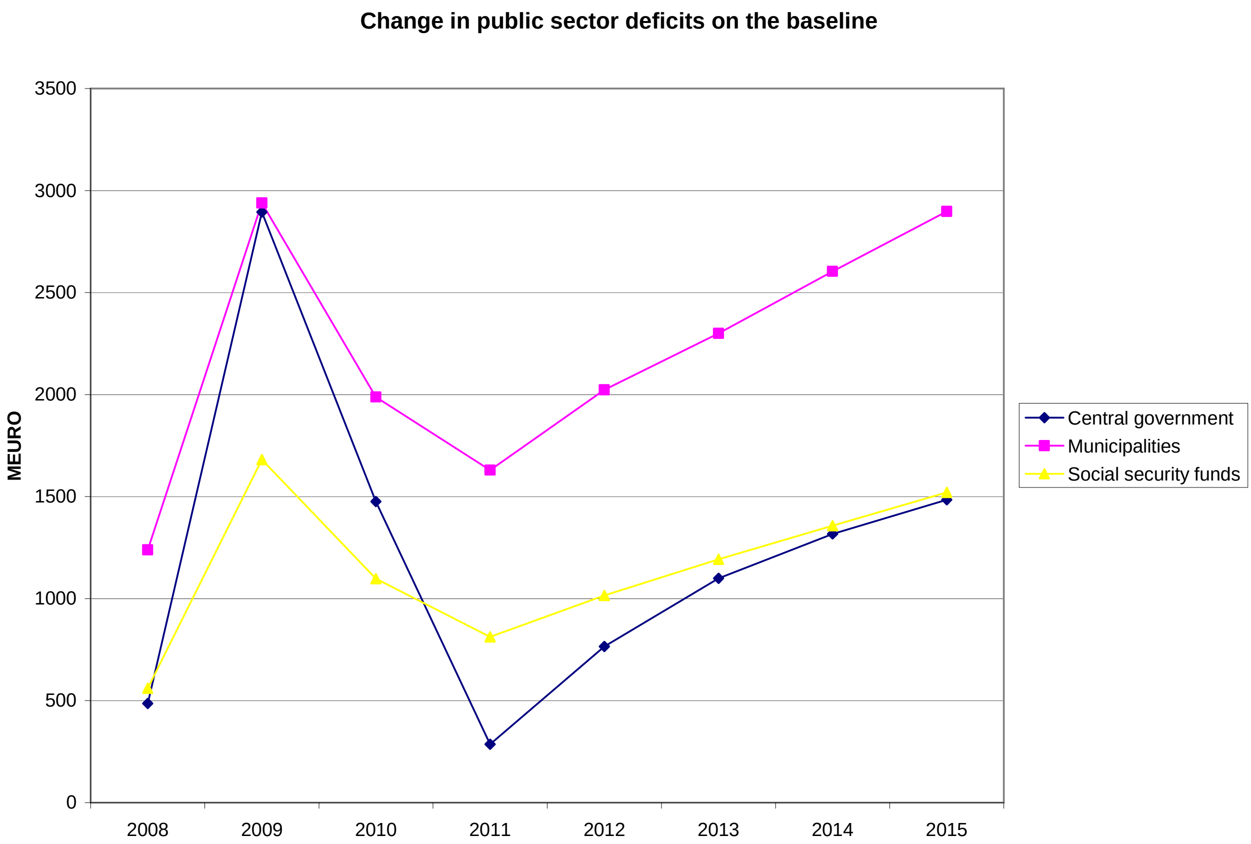
Figure 3. Contribution of demand components to regional GDP in 2009



Our baseline forecast utilizes the econometric public consumption forecasts described in the previous section. Public investment, on the other hand, is assumed to follow private investment. The baseline does not take into account counter-cyclical policy measures, such as tax cuts that are already being implemented. Consequently, our baseline is characterized by rapid growth in public expenditures, both from structural reasons and because of the economic down-turn, and also a deterioration of government revenues in the short run.

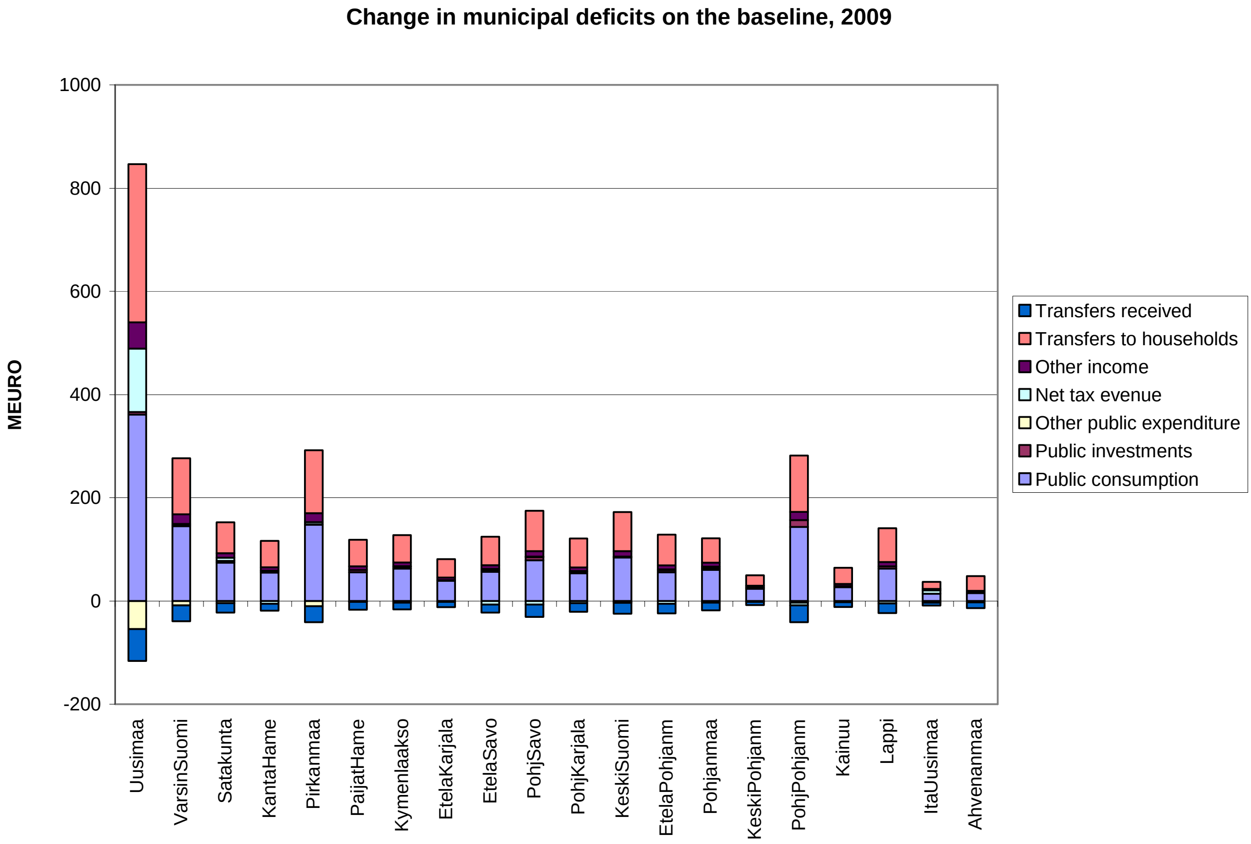
Figure 4 shows the change in public sector deficits on the baseline. The figure shows that central government and municipal deficits grow rapidly in 2009, but already in 2010, their growth would decelerate. The overall municipal deficit growth for 2009 is about three billion euro, and about two billion in 2010. Since the deficits grow in the following decade as well, there is clearly cause for concern about the sustainability of public sector finances.

Figure 4. Change in public sector deficits in the baseline



Since economic development on our baseline is improving already in 2010, we take that year's deficit forecast as a benchmark. However, it is difficult to assess how much of the deficits are due to structural reasons. In figure 5, we show the contributions of all municipal expenditures on the growth of the 2009 deficit. It is fairly clear that a large part of the deficit stems from increased transfer outlays on households. Public consumption, on the other hand, contributes around 1.6 billion Euros. By using 2010 deficit as a benchmark, we are in effect assuming that roughly two thirds of the deficit stem from structural change in municipal spending.

Figure 5. Change in municipal sector deficits in the baseline in 2009



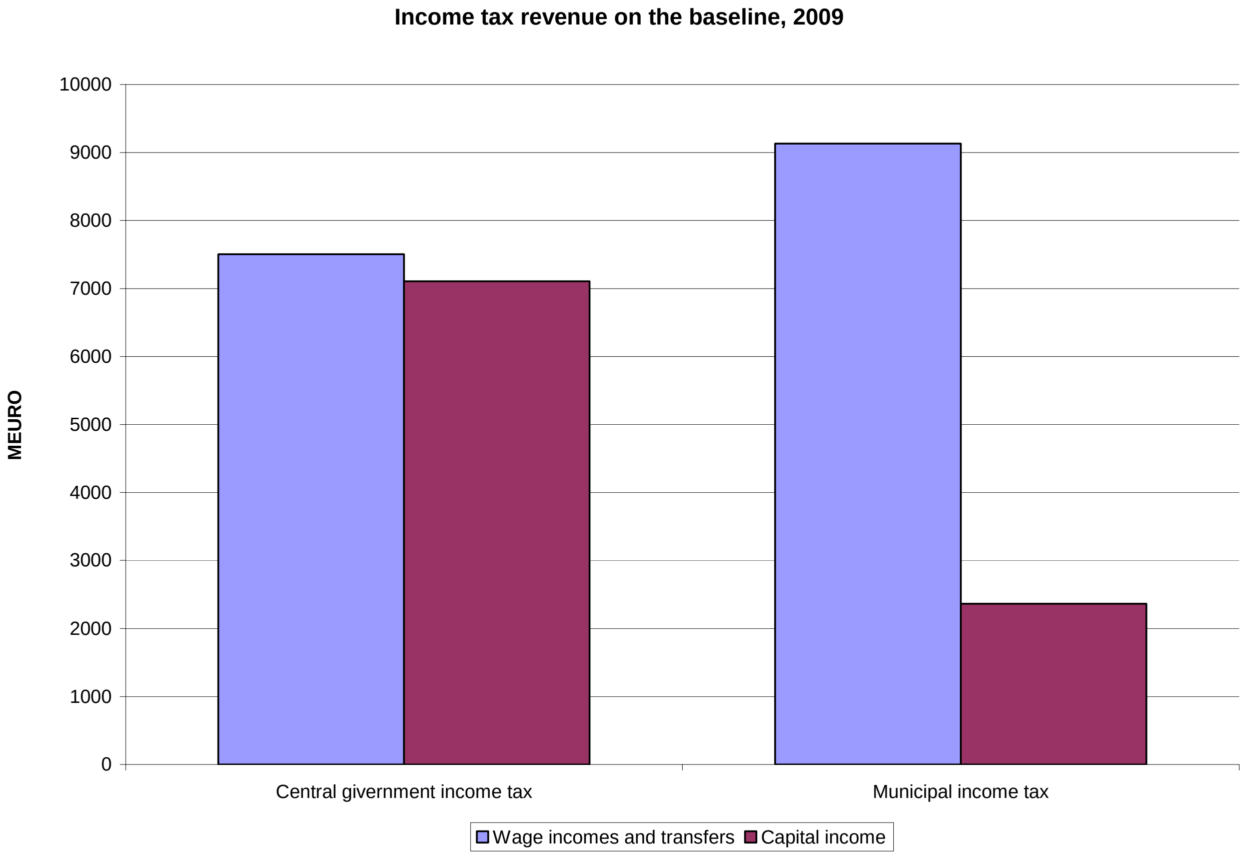
5.2 Policies to curb the deficit

We study two alternative policies for dealing with the cost pressures in the municipal economies. In one of the policies, central government taxes are used to finance increased transfers from the central government to the municipalities, in the other, municipalities have to deal with the budgetary pressure by increasing municipal taxes. We assume that taxes are used to limit the growth in 2009 deficits to a level that corresponds with the 2010 forecast. In effect, we are cutting a billion from the 2009 deficit growth. We also assume that the tax changes remain in place after 2010. Finally, we assume that the policy only concerns taxes on labour income and social security benefits, not capital income.

It is clear that these alternative policies will not have equal effects. There are many reasons for this. First, the thresholds for levying central government and municipal income taxes differ considerably, with the municipal tax concerning lower incomes than the central government tax. Secondly, the central government tax is progressive, while the municipal tax has a flat rate. Thirdly, regions differ very much in their ability to generate tax revenue.

Figure 6 shows the revenues from central government and municipal income taxes in 2009. The revenue from labor income is larger for the municipal sector than the central government, whereas capital income is taxed more heavily under the central government tax.

Figure 6. Income tax revenues in the baseline in 2009



5.2.1 Cutting deficit growth with government taxes

Figure 7 shows the increase in central government income tax revenue from all the regions in Finland in the case where government income taxes are raised to finance transfers to the regions to keep in check the growth of municipal deficits. Central government income tax revenue would grow by almost 2.5 billion euros, and the transfers by 1.9 billion. The required tax increase would by fairly high, the average income tax rate would have to be raised by 6.2 percentage points. There would also be marked regional differences, with, for example, Lapland and Kainuu, which are sparsely populated, facing relatively smaller changes in taxes than Uusimaa and Pirkanmaa, which are population rich economic centers.

Figure 7.Change in central government income tax revenue

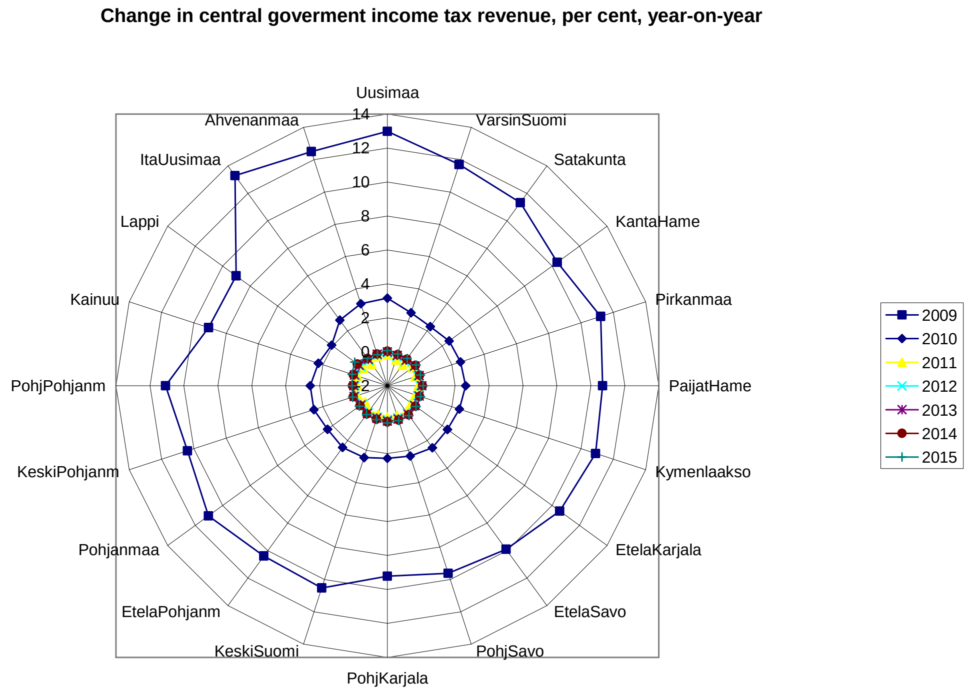
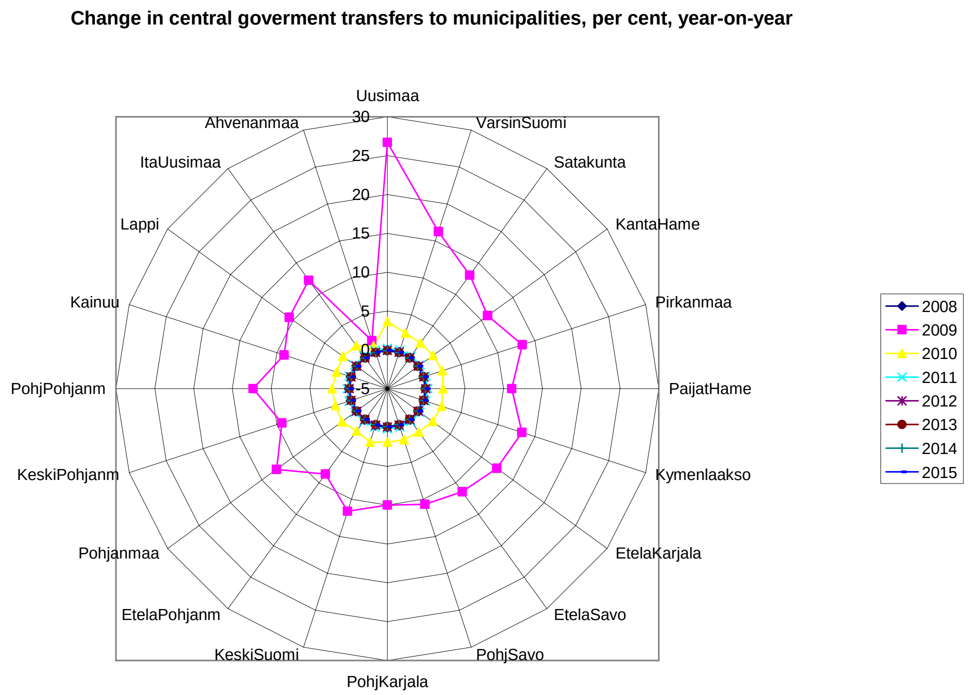


Figure 8 shows the changes in transfers to the municipalities. Here, the pattern is less clear, since it is reflecting not only the tax policies but also the level of transfers prior to the policies.

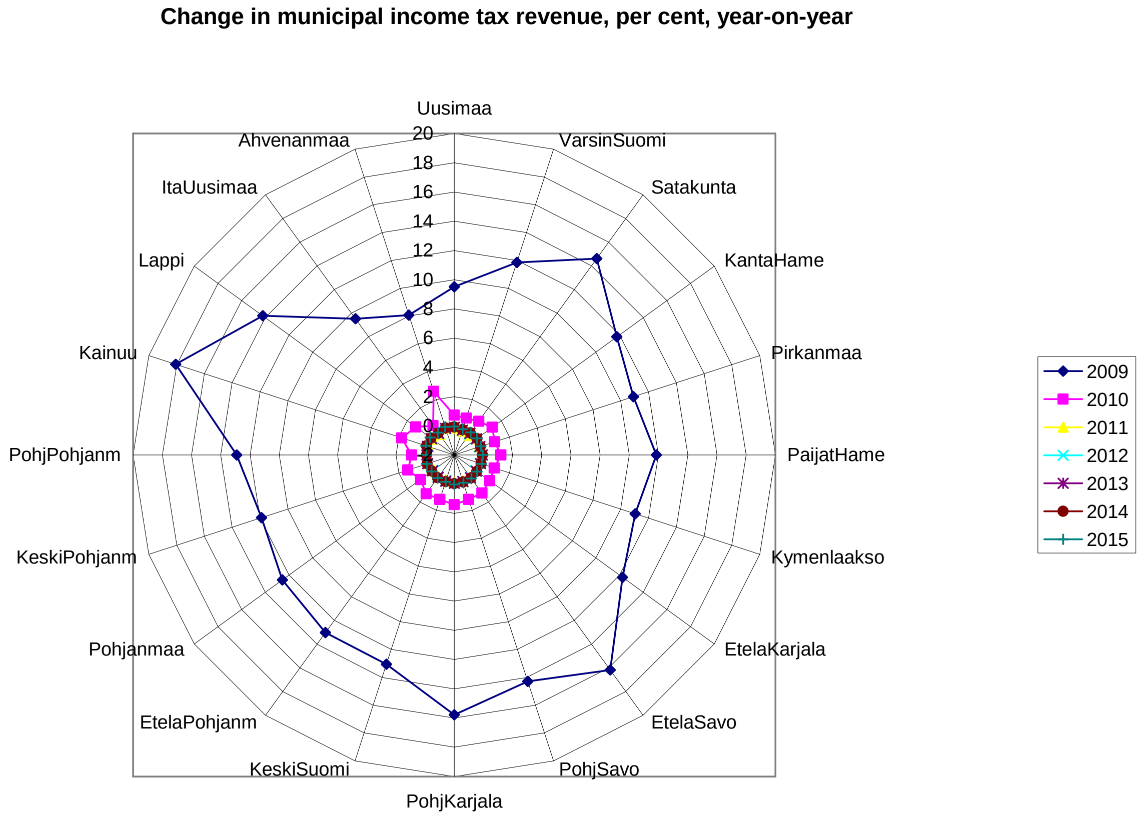
Figure 8. Change in central government transfers to municipalities



5.2.2 Cutting deficit growth with municipal taxes

If municipal income taxes were used to curb the growth in deficits, the average income tax rates would have to be raised by 5.8 per cent. Figure 10 shows the changes in municipal tax revenues. It is clear that the regional effects differ markedly from the government tax case. Here, the raises are directly linked to the regional deficits, which would place a relatively larger burden on regions like Kainuu and Lapland, and a smaller one on the likes of Uusimaa and Pirkanmaa.

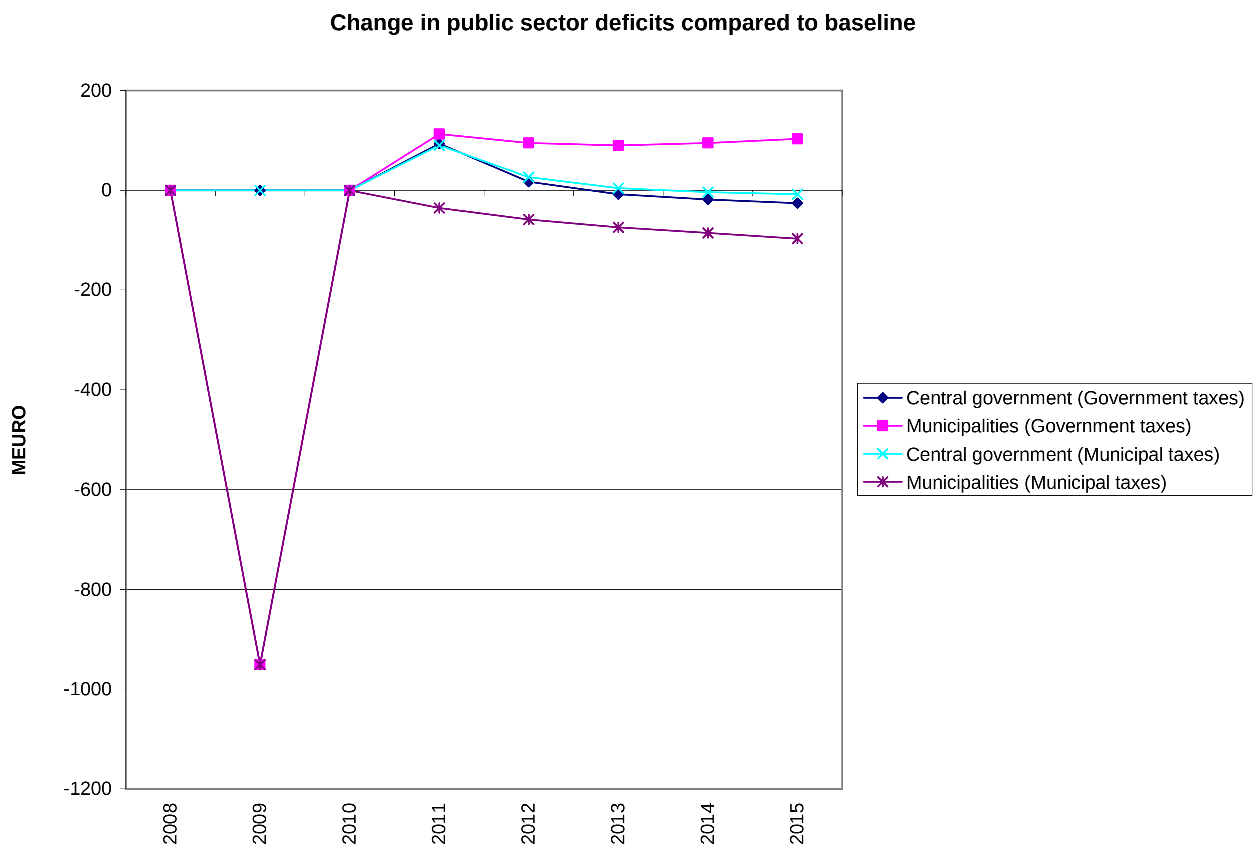
Figure 10. Change in municipal income tax revenue



5.3 A comparison of the policies

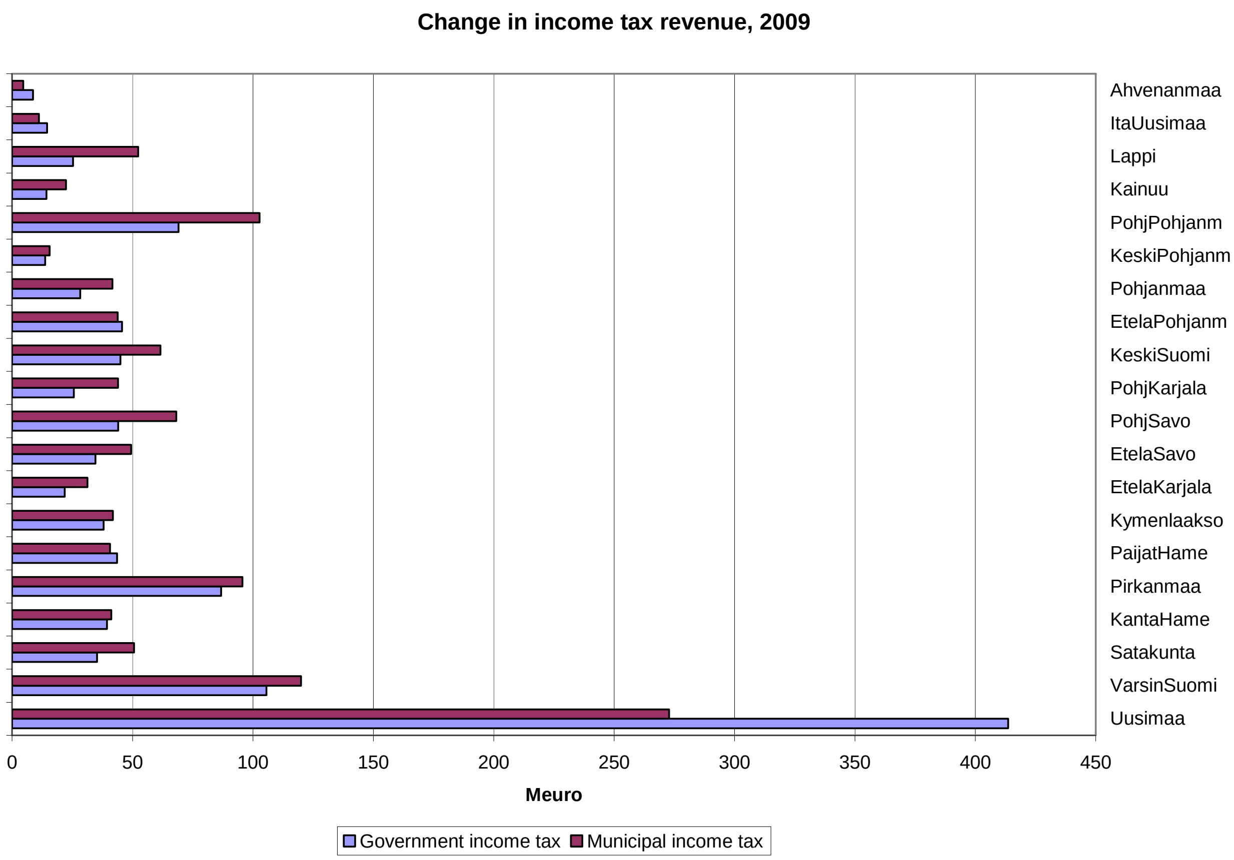
Figure 11 shows how the public sector deficits evolve under the policies, compared to the baseline. Interestingly, only the municipal tax –alternative curbs deficit growth in the medium term. In the government tax case, deficit growth would continue at about 100 million euro a year. Thus it appears the latter policy would not induce as much structural adjustment as the former.

Figure 11. Central government and municipal deficits



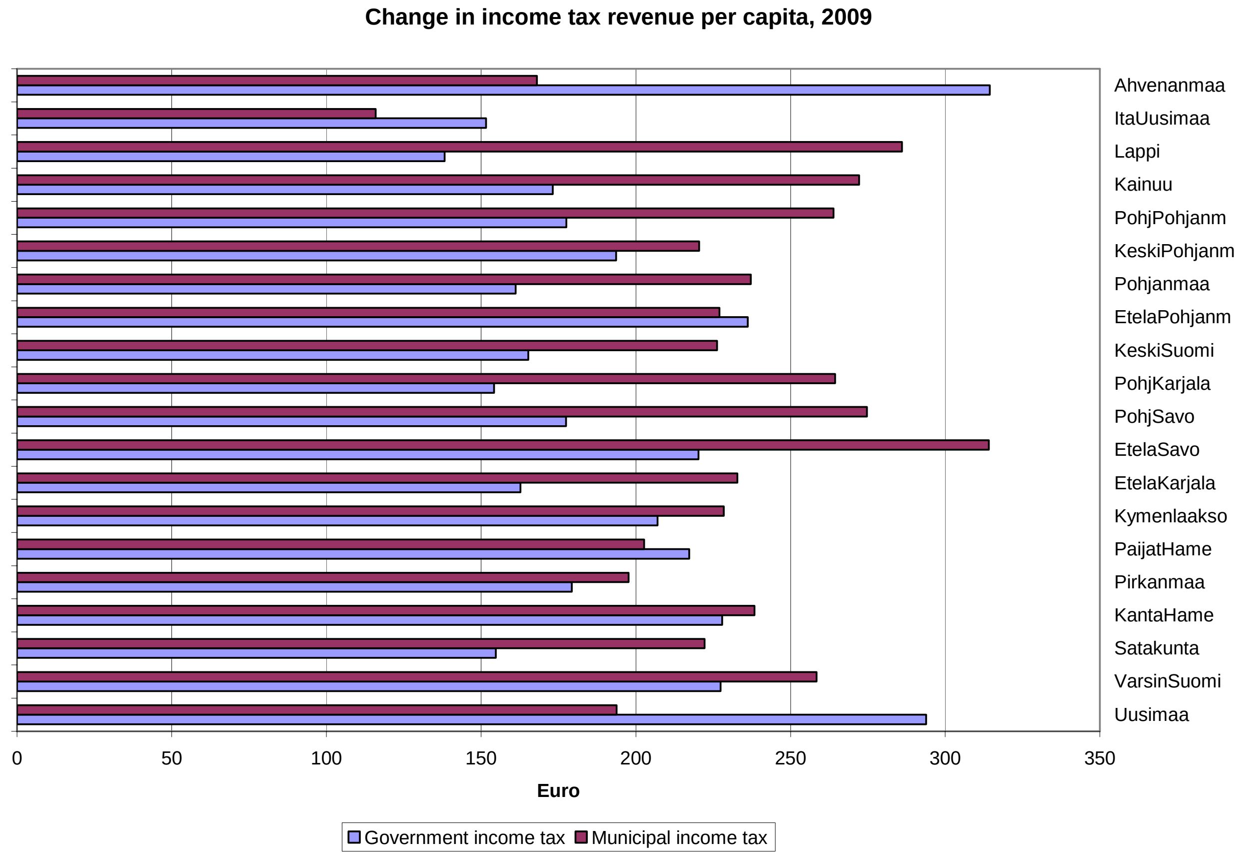
The burden of the policies can be illustrated also with the change in taxes collected from different regions. Figure 12 depicts the change in revenues in euro in 2009. It is apparent that larger, richer regions contribute more in the government tax alternative and, in effect, finance the transfers to the other regions, since the necessary revenue change in these regions would have to be larger if they were to reduce the deficits on their own.

Figure 12 Income tax revenues in 2009



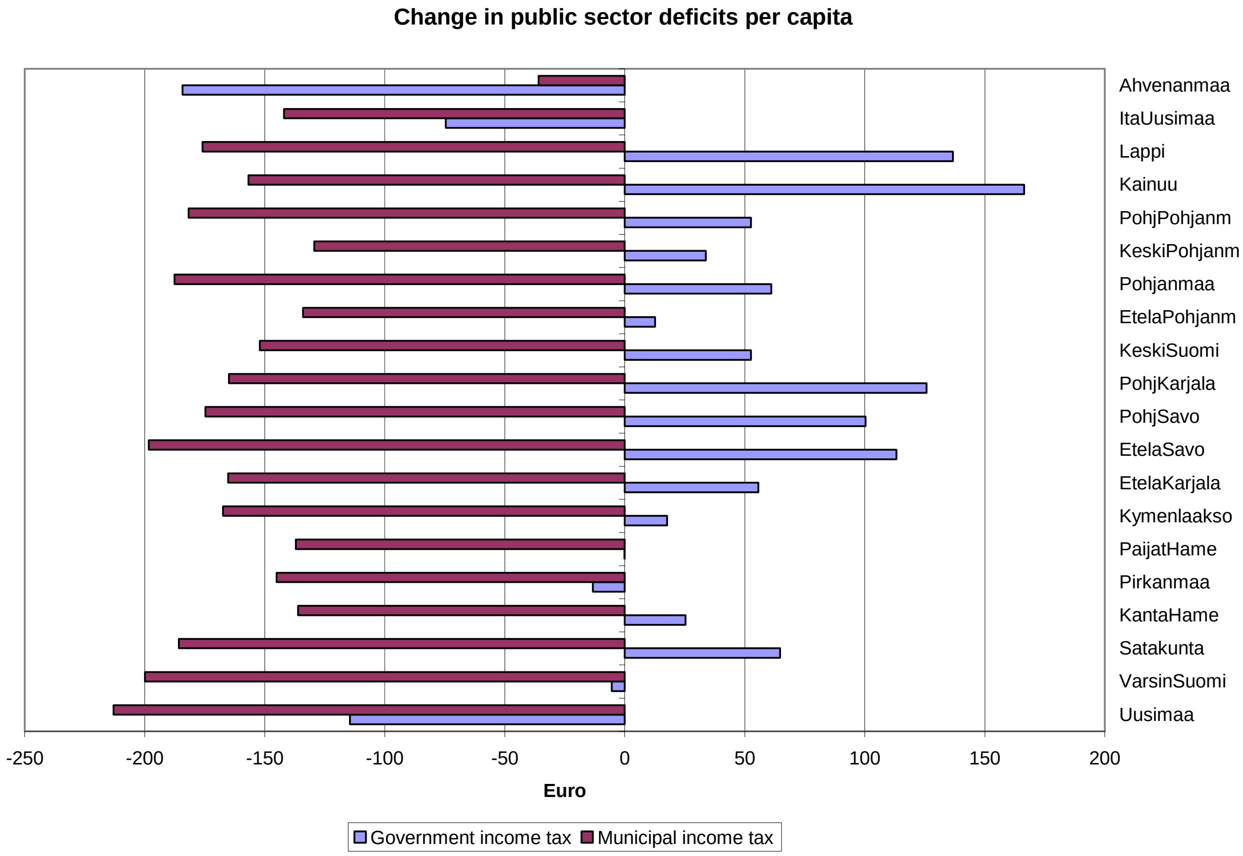
The regional differences are also apparent when tax revenues are considered per capita. This is done in figure 13. For example, Uusimaa, the capital region, contributes almost a half more in the government tax case than its own deficits would merit, whereas Lappi and Kainuu clearly are recipients in the government tax case. Ahvenanmaa, the autonomous archipelago region, stands out in the results but the reason for this probably is that the transfers to Ahvenanmaa follow a much more complicated pattern than we have assumed here. In reality, such a contribution to central government coffers would be very unlikely.

Figure 13. Income tax revenue per capita in 2009



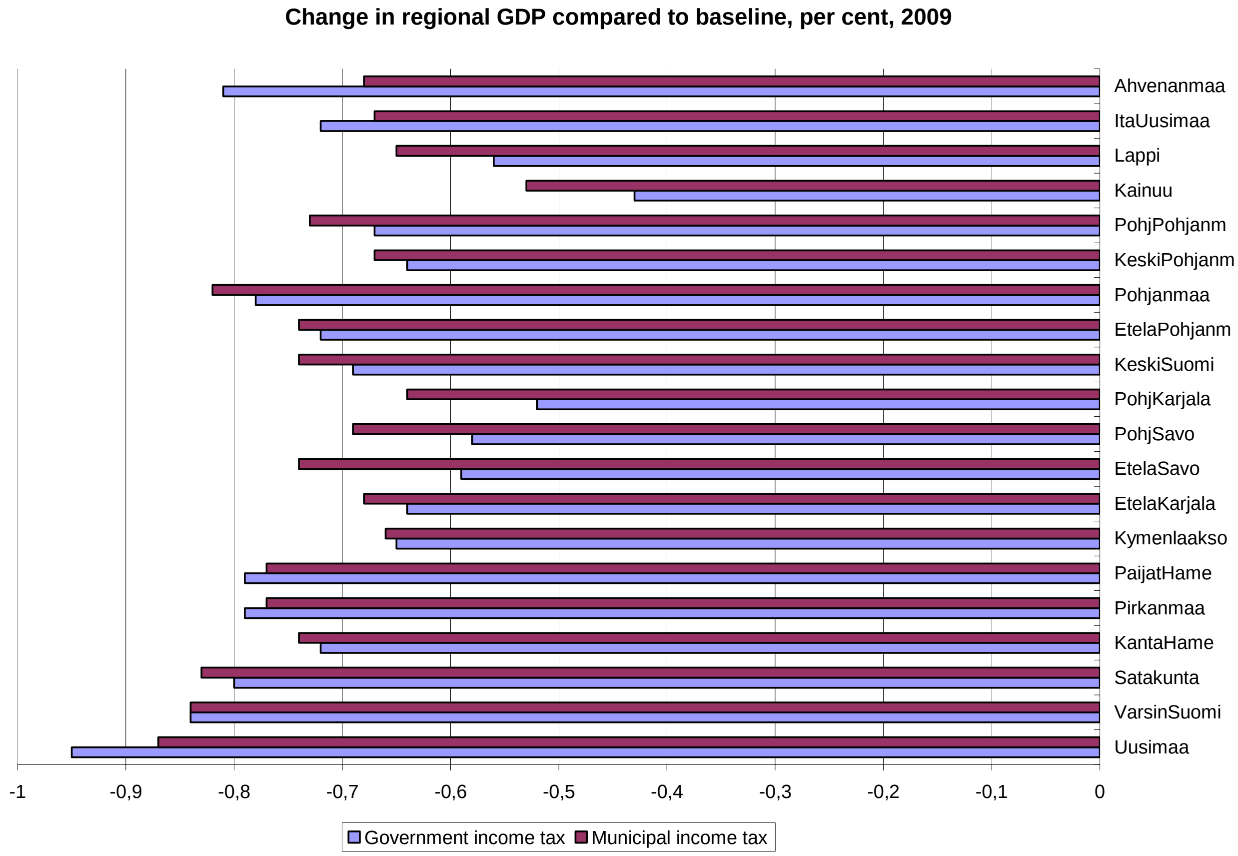
The regional differences are even more apparent when we consider the change in central government deficits regionally. In other words, we compare the change in the difference of government outlays and incomes in each region. The result of this exercise is illustrated in figure 14. The figure shows that in the municipal tax case, deficits are curbed in all regions. Under the central government case, the deficits are decreasing in the regions that in effect finance the policy, whereas those regions that are net recipients of government transfers, the deficits are growing. The figure also shows that Lappi and Kainuu are the largets recipients on a per capita basis, whereas Uusimaa, Pirkanmaa (and Ahvenanmaa) are paying more than they receive.

Figure 14. Change in central government and municipal deficits in 2009



It is clear that the fairly large tax hikes would have macroeconomic effects. Figure 15 shows the effects on regional GDP in 2009. The results are large in all regions, but Uusimaa stands out in the negative end of the scale, whereas Lappi and Kainuu fare relatively better.

Figure 15. Change in regional GDP in 2009



The curbing of deficit growth appears to be a fairly costly policy in the short run. In the longer run, the issue might be different, however, since a large part of deficit growth stems from changes in the population. In figures 16 and 17, we show the changes in regional GDP in the medium term. Picking two examples at the extreme ends, it is clear that Kainuu fairs better under the government tax case than under the municipal, whereas the opposite is true for Uusimaa. Interestingly, the policies are not different enough to affect the ranking of these two regions. However, for some other regions even this may be the case.

Figure 16. GDP change (Government taxes)

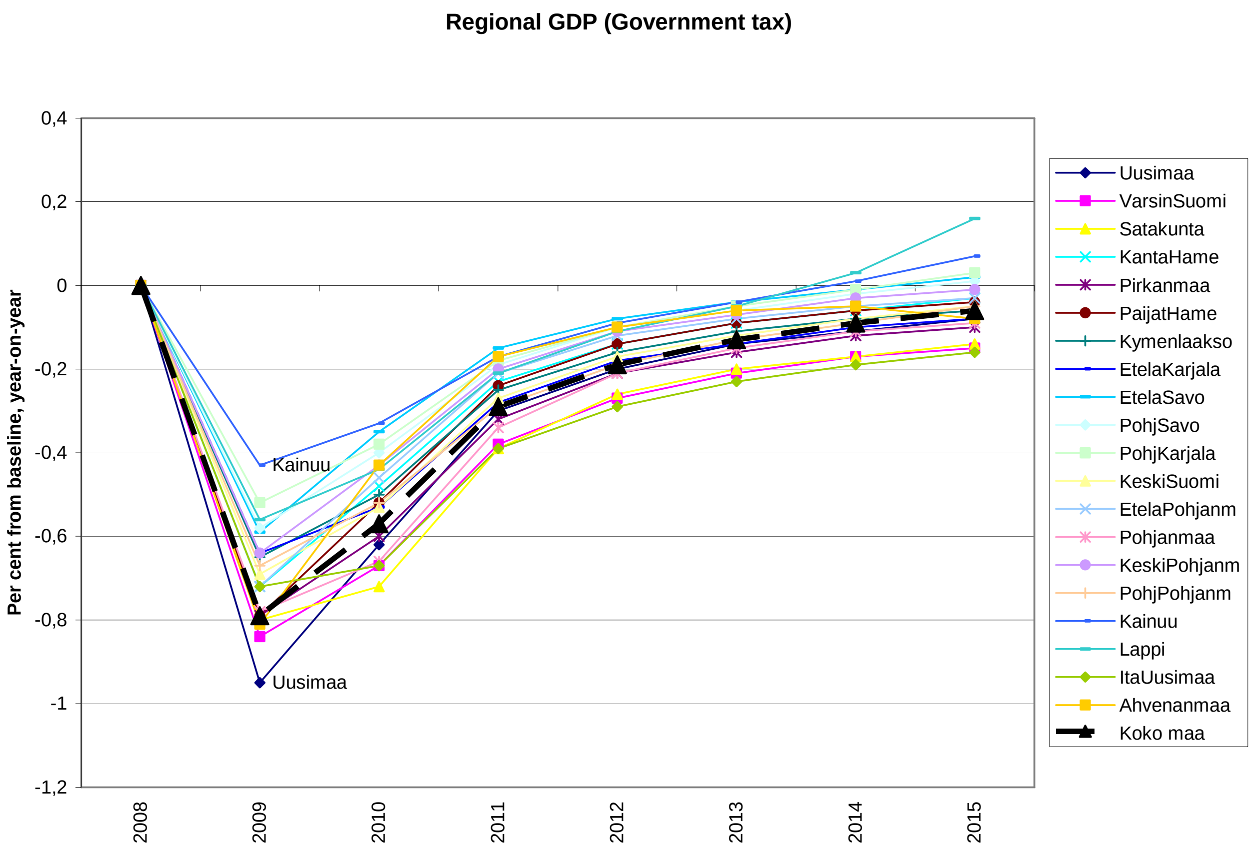
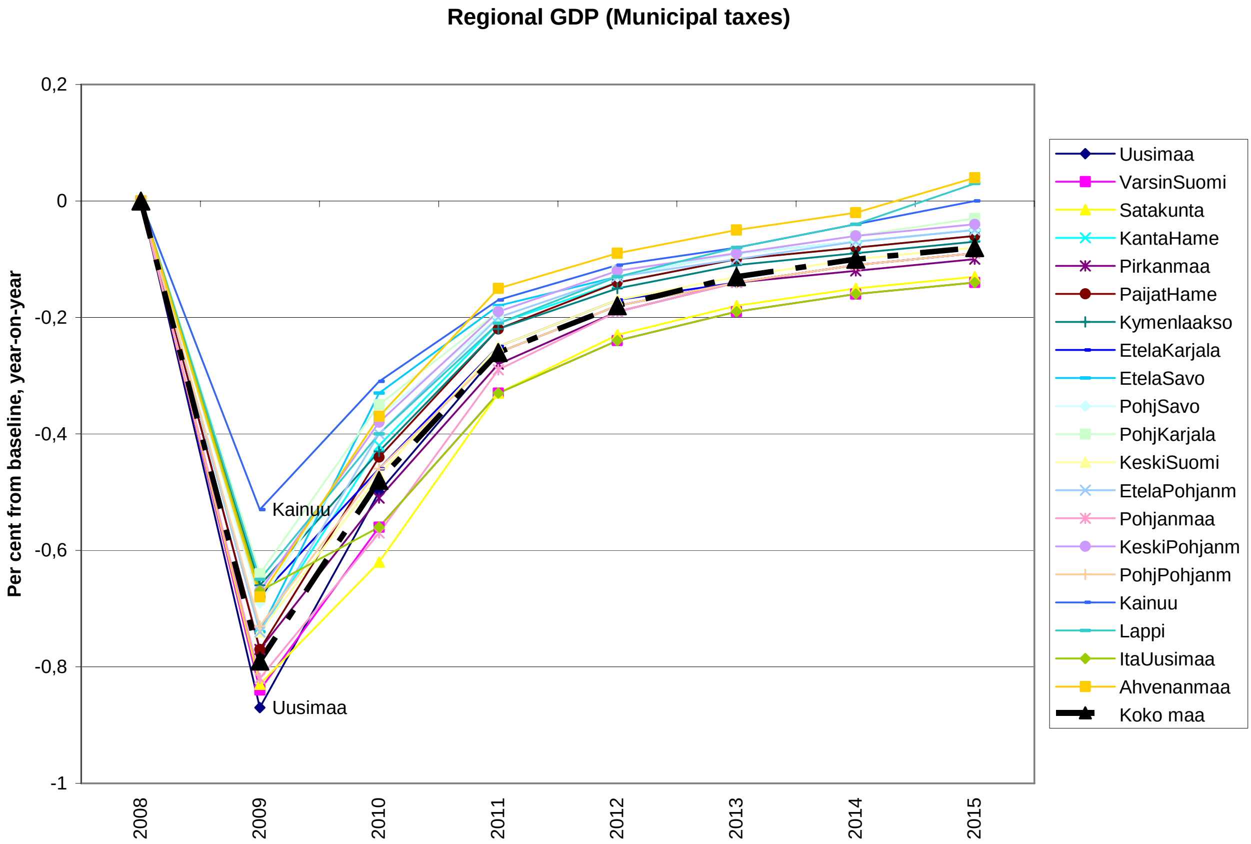


Figure 17. GDP change (Municipal taxes)



5 Conclusions

This study has evaluated the effects of ageing on regional economies with the help of an econometric forecast and a regional AGE model. We find that the population growth is the greatest determinant of public expenditures. We also find that the growth rate of public expenditures is fairly rapid, which leads to a pressure on public finances in the longer run.

We have evaluated two policies for curbing the growth in municipal sector deficits. Both policies imply a need to raise income taxes by roughly 6 percentage points. The macroeconomic effects of such a policy would be non-trivial.

The policies we have considered differ markedly in their regional implications. A policy that aims at levelling the effect of regional ability to raise taxes places a burden on the relatively richer regions compared to a policy, where each regions would have to take care of its own finances. While the policies put the population in unequal footing in terms of taxation, the difference in the policies is not very large in terms of economic growth.

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Appendix 1. Goodness of Fit Statistics.

Public Sector	Output				
Central Government	Transport, storage and communication output	Sum of Squared Errors (SSE)	1617.5044	Degree of freedom in Error (DFE)	1639
		Mean Squared Error (MSE)	0.9869	Root Mean Squared Error (RMSE)	0.9934
		R-squared (R^2)	0.7567		
	Real estate services output	Sum of Squared Errors (SSE)	581.5977	Degree of freedom in Error (DFE)	2216
		Mean Squared Error (MSE)	0.2625	Root Mean Squared Error (RMSE)	0.5123
		R-squared (R^2)	0.9099		
	Public administration and social security output	Sum of Squared Errors (SSE)	105.4767	Degree of freedom in Error (DFE)	2346
		Mean Squared Error (MSE)	0.0450	Root Mean Squared Error (RMSE)	0.2120
		R-squared (R^2)	0.9800		
	Education output	Sum of Squared Errors (SSE)	561.8237	Degree of freedom in Error (DFE)	1678
		Mean Squared Error (MSE)	0.3348	Root Mean Squared Error (RMSE)	0.5786
		R-squared (R^2)	0.9195		
	Health and social work output	Sum of Squared Errors (SSE)	158.4210	Degree of freedom in Error (DFE)	549
		Mean Squared Error (MSE)	0.2886	Root Mean Squared Error (RMSE)	0.5372
		R-squared (R^2)	0.9047		
	Other services output	Sum of Squared Errors (SSE)	96.8703	Degree of freedom in Error (DFE)	459
		Mean Squared Error (MSE)	0.2110	Root Mean Squared Error (RMSE)	0.4594
		R-squared (R^2)	0.9159		
Local Government	Construction output	Sum of Squared Errors (SSE)	179.3404	Degree of freedom in Error (DFE)	2300
		Mean Squared Error (MSE)	0.0780	Root Mean Squared Error (RMSE)	0.2792
		R-squared (R^2)	0.9504		
	Transport, storage and communication output	Sum of Squared Errors (SSE)	90.4453	Degree of freedom in Error (DFE)	2316
		Mean Squared Error (MSE)	0.0391	Root Mean Squared Error (RMSE)	0.1976
		R-squared (R^2)	0.9610		
	Public administration and social security output	Sum of Squared Errors (SSE)	44.1282	Degree of freedom in Error (DFE)	2346
		Mean Squared Error (MSE)	0.0188	Root Mean Squared Error (RMSE)	0.1371
		R-squared (R^2)	0.9807		
	Education output	Sum of Squared Errors (SSE)	22.1210	Degree of freedom in Error (DFE)	2346
		Mean Squared Error (MSE)	0.0094	Root Mean Squared Error (RMSE)	0.0971
		R-squared (R^2)	0.9885		
	Health and social work output	Sum of Squared Errors (SSE)	45.6658	Degree of freedom in Error (DFE)	2346
		Mean Squared Error (MSE)	0.0195	Root Mean Squared Error (RMSE)	0.1395
		R-squared (R^2)	0.9839		
	Other services output	Sum of Squared Errors (SSE)	66.3720	Degree of freedom in Error (DFE)	2344
		Mean Squared Error (MSE)	0.0283	Root Mean Squared Error (RMSE)	0.1683
		R-squared (R^2)	0.9785		
Social Security Funds	Public administration and social security output	Sum of Squared Errors (SSE)	39.5351	Degree of freedom in Error (DFE)	2283
		Mean Squared Error (MSE)	0.0173	Root Mean Squared Error (RMSE)	0.1316
		R-squared (R^2)	0.9833		

Appendix 2. Parameter estimates.

Variable	S1311TRANS	S1311ESTATE	S1311ADMIN	S1311EDUC	S1311HEALTH	S1311OTHER
TIME	-0.024 (-1.79)	0.035(5.33***)	0.012 (4.54***)	-0.045(-5.91***)	0.003 (0.19)	0.054 (4.61***)
TMK2	0.033 (1.95)	0.002 (0.29)	-0.007 (-2*)	0.03 (3.01**)	-0.006 (-0.44)	0.009 (0.74)
TMK4	0.003 (0.13)	0.03 (3.28**)	0.018 (4.84***)	0.073 (6.64***)	-0.006 (-0.07)	-0.136(-4.87***)
TMK5	0.016 (0.77)	0.018 (1.98*)	0.012 (3.14**)	-0.045 (-4.1***)	-0.053 (-3.23**)	-0.056(-3.94***)
TMK6	0.037 (2.11*)	-0.008 (-1.02)	0.002 (0.55)	0.011 (1.06)	0.006 (0.19)	-0.009 (-0.67)
TMK7	0.011 (0.53)	0.001 (0.13)	0.012 (2.87**)	0.046 (3.99***)	-0.185(-8.01***)	-0.085(-5.67***)
TMK8	0.085 (4.17***)	0.032 (3.11**)	0.019 (4.55***)	0.012 (1.04)	0.031 (1.55)	-0.062 (-2.73**)
TMK9	0.104 (5.09***)	-0.02 (-2.01*)	-0.006 (-1.53)	0.084 (7.11***)	0.01 (0.55)	-0.06 (-0.72)
TMK10	0.02 (1.07)	-0.002 (-0.28)	0.004 (1.21)	0.059 (5.49***)	0.032 (1.7)	-0.061 (-2.95**)
TMK11	0.049 (2.76**)	-0.016 (-1.88)	0.001 (0.25)	0.028 (2.76**)	0.119 (8.19***)	0.023 (0.88)
TMK12	-0.014 (-0.67)	0.009 (1.01)	0.011 (2.82**)	0.073 (6.15***)	0.002 (0.04)	-0.057 (-2.08*)
TMK13	0.095 (4.74***)	-0.008 (-0.96)	0.005 (1.47)	0.009 (0.81)	-0.1 (-6.49***)	-0.075(-5.52***)
TMK14	0.091 (4.85***)	-0.013 (-1.68)	0.007 (2.07*)	0.04 (3.99***)	-0.113(-5.34***)	-0.031 (-1.02)
TMK15	0.02 (1.08)	0.002 (0.2)	0.004 (1.07)	0.075 (5.86***)	0.115 (7.47***)	-0.153 (-5.8***)
TMK16	0.031 (1.16)	-0.059(-5.86***)	-0.005 (-1.11)	0.063 (4.44***)	0.007 (0.05)	-0.09 (-1.08)
TMK17	0.073 (4.36***)	-0.024 (-3.09**)	-0.007 (-2.08*)	0.03 (3.27**)	-0.046(-3.46***)	-0.009 (-0.7)
TMK18	0.041 (1.67)	-0.025 (-2.37*)	0.019 (4.5***)	0.061 (4.99***)	-0.005 (-0.05)	0.035 (0.43)
TMK19	0.085 (4.37***)	-0.007 (-0.82)	0.004 (1.14)	0.064 (6.71***)	0.122 (1.52)	-0.076(-5.83***)
TMK20	-0.025 (-1.19)	0.022 (2.07*)	-0.01 (-2.38*)	-0.064(-3.59***)	-0.008 (-0.26)	0.005 (0.04)
TMK21	-0.05 (-2.6**)	-0.065(-5.51***)	-0.033(-8.82***)	-0.04 (-2.91**)	0 (.***)	-0.043 (-1.33)
P1TIME	-0.061 (-3.01**)	0.018 (1.77)	0.003 (0.81)	-0.017 (-1.44)	0.004 (0.3)	-0.014 (-1.3)
P1TMK2	0.012 (0.48)	-0.023 (-1.75)	0.007 (1.35)	0.041 (2.74**)	0.053(3.13**)	0.094 (4.93***)
P1TMK4	0.064 (2.04*)	0.002 (0.14)	0.006 (0.98)	0.021 (1.22)	-0.004 (-0.12)	0.025 (1.05)
P1TMK5	0.013 (0.41)	0.009 (0.61)	0.011 (1.82)	0.026 (1.58)	0.008 (0.4)	0.017 (0.94)
P1TMK6	0.018 (0.64)	-0.014 (-1.09)	0.006 (1.07)	0.035 (2.32*)	-0.021 (-0.87)	0.107 (5.6***)
P1TMK7	0.035 (1.11)	-0.005 (-0.28)	0.003 (0.41)	-0.01 (-0.54)	-0.023 (-0.95)	0.04 (1.97*)
P1TMK8	0.064 (2.02*)	0.005 (0.31)	0.007 (0.99)	0.078 (4.31***)	0.015 (0.68)	0.02 (0.97)
P1TMK9	0.004 (0.12)	-0.013 (-0.88)	0.013 (2.15*)	0.038 (2.22*)	-0.037 (-1.78)	0.025 (0.78)
P1TMK10	0.078 (2.89**)	-0.007 (-0.54)	0.01 (1.72)	0.019 (1.24)	0.021 (1.11)	0.035 (1.78)
P1TMK11	-0.024 (-0.9)	-0.002 (-0.14)	0.003 (0.6)	0.041 (2.78**)	0.006 (0.27)	0.041 (1.64)
P1TMK12	0.013 (0.42)	0.004 (0.27)	0.006 (1.05)	0.05 (2.96**)	-0.013 (-0.45)	-0.012 (-0.5)
P1TMK13	-0.007 (-0.24)	-0.015 (-1.16)	-0.008 (-1.48)	0.042 (2.74**)	0.076(3.26**)	0.063 (3.11**)
P1TMK14	0.074 (2.48*)	-0.023 (-1.89)	-0.001 (-0.23)	0.052 (3.45***)	0.054 (2.19*)	0.03 (1.08)
P1TMK15	0.019 (0.69)	-0.006 (-0.46)	0.02 (3.52***)	0.036 (1.99*)	0.051(2.74**)	0.009 (0.37)
P1TMK16	0.023 (0.59)	-0.018 (-1.12)	-0.008 (-1.25)	0.05 (2.52*)	-0.004 (-0.1)	0.031 (0.97)
P1TMK17	0.009 (0.34)	-0.013 (-1.09)	0.005 (1.01)	0.044 (3.11**)	-0.036 (-1.61)	0.085 (4.7***)
P1TMK18	0.054 (1.47)	-0.023 (-1.47)	0.014 (2.15*)	0.061 (3.31***)	-0.004 (-0.11)	0.051 (1.6)
P1TMK19	0.022 (0.79)	-0.016 (-1.27)	0.013 (2.55*)	0.071 (4.85***)	0.025 (0.84)	0.043 (2.74**)
P1TMK20	0.005 (0.17)	0.042 (2.53*)	0.013 (1.97*)	-0.015 (-0.69)	0.026 (0.98)	-0.023 (-0.63)
P1TMK21	0.079 (2.58**)	-0.056 (-3.02**)	0.023 (3.96***)	-0.027 (-0.9)	0 (.***)	0.015 (0.61)
LNWPOP	1.585 (2.9**)	1.85 (8.11***)	1.781 (19.58***)	6.277 (20.08***)	-2.09 (-1.75)	-2.588 (-2.94**)
KOUPOP						
TERPOP						
Intercept	-13.231(-3.11**)	-17.647(-8.3***)	-13.2(-18.7***)	-59.05(-20.3***)	20.953 (1.76)	21.443 (2.66**)

Variable	S1313CONS	S1313TRANS	S1313ADMIN	S1313EDUC	S1313HEALTH	S1313OTHER	S1314ADMIN
TIME	0.016 (4.52***)	0.036 (14.32***)	0.021 (11.98***)	0.015 (12.05***)	0.007 (3.87***)	0.021 (9.93***)	0.006 (3.68***)
TMK2	0.02 (4.59***)	-0.006 (-2.07*)	0.011 (4.88***)	-0.001 (-0.57)	0.012 (5.41***)	0.006 (2.35*)	0.014 (6.9***)
TMK4	0.012 (2.49*)	0.007 (1.94)	0.013 (5.14***)	0.002 (1.4)	0.027 (10.59***)	0.01 (3.2**)	0.007 (3.14**)
TMK5	0.024 (4.98***)	0.002 (0.71)	0.009 (3.6***)	-0.001 (-0.74)	0.019 (7.84***)	0.01 (3.43***)	0.003 (1.35)
TMK6	0.028 (6.27***)	0.012 (3.76***)	0.008 (3.65***)	-0.002 (-1.57)	0.017 (7.8***)	0.015 (5.95***)	0.004 (2.1*)
TMK7	0.007 (1.27)	0.005 (1.2)	0.012 (4.58***)	-0.005 (-2.57*)	0.023 (8.39***)	0.009 (2.67**)	0.005 (2.03*)
TMK8	0.006 (1.09)	0.002 (0.51)	0.009 (3.35***)	-0.006 (-3.14**)	0.026 (9.44***)	-0.002 (-0.68)	0.008 (3.01**)
TMK9	0.022 (4.21***)	0.005 (1.45)	0.006 (2.51*)	-0.001 (-0.47)	0.018 (7.24***)	0.006 (1.91)	0.006 (2.39*)
TMK10	0.024 (5.05***)	0.006 (1.78)	0.014 (5.89***)	-0.003 (-1.74)	0.021 (8.76***)	0.016 (5.54***)	0.007 (3.05**)
TMK11	0.008 (1.8)	-0.007 (-2.03*)	0.01 (4.47***)	-0.007 (-4.1***)	0.022 (9.8***)	0.007 (2.7**)	0.007 (3.39***)
TMK12	0.018 (3.53***)	-0.006 (-1.8)	0.016 (6.38***)	-0.007 (-3.94***)	0.022 (8.53***)	0.016 (5.23***)	0.004 (1.68)
TMK13	0.041 (9.16***)	0.006 (1.93)	0.014 (6.56***)	-0.005 (-3.11**)	0.019 (8.48***)	0.017 (6.42***)	0.011 (5.27***)
TMK14	0.03 (6.97***)	-0.002 (-0.62)	0.016 (7.45***)	-0.002 (-1.63)	0.019 (8.56***)	0.009 (3.54***)	0.006 (3.04**)
TMK15	0.026 (5.42***)	-0.007 (-2.27*)	0.008 (3.74***)	0.002 (1.14)	0.02 (8.73***)	0.004 (1.59)	0.009 (4.08***)
TMK16	0.02 (3.51***)	-0.017 (-4.46***)	0.017 (6.22***)	-0.002 (-1.27)	0.033 (12.05***)	-0.002 (-0.73)	0.008 (3.21**)
TMK17	0.042 (9.96***)	-0.007 (-2.35*)	0.019 (9.53***)	-0.009 (-6.44***)	0.022 (10.55***)	0.015 (5.86***)	0.005 (2.51*)
TMK18	0.042 (7.45***)	0.001 (0.37)	0.017 (6.26***)	-0.008 (-4.23***)	0.024 (8.44***)	0.021 (6.07***)	0.009 (3.24**)
TMK19	0.031 (6.79***)	0.001 (0.2)	0.014 (6.59***)	-0.011 (-7.13***)	0.019 (8.75***)	0.013 (4.79***)	0.01 (4.74***)
TMK20	-0.002 (-0.41)	-0.003 (-0.85)	0.008 (3.17**)	-0.005 (-2.45*)	0.013 (4.73***)	0.002 (0.51)	-0.001 (-0.2)
TMK21	0.052 (10***)	0.014 (3.57***)	0.022 (9.14***)	0.015 (8.71***)	0.029 (12.03***)	0.008 (2.52*)	0.017 (5.25***)
P1TIME	0.001 (0.17)	0.003 (0.82)	0.005 (1.92)	0.014 (7.52***)	0.029 (10.44***)	0.028 (8.31***)	0.009 (3.55***)
P1TMK2	-0.001 (-0.17)	-0.004 (-0.74)	0.008 (2.45*)	-0.007 (-2.7**)	-0.007 (-1.99*)	-0.002 (-0.42)	-0.004 (-1.23)
P1TMK4	0.002 (0.2)	0.002 (0.35)	0.005 (1.27)	-0.005 (-1.87)	-0.008 (-1.97*)	0.005 (1.02)	0.006 (1.66)
P1TMK5	0.018 (2.27*)	0.003 (0.49)	0.006 (1.68)	-0.01 (-3.52***)	-0.01 (-2.48*)	0.007 (1.53)	0.003 (0.77)
P1TMK6	0.019 (2.73**)	-0.004 (-0.8)	0.009 (2.64**)	-0.007 (-2.8**)	-0.009 (-2.54*)	0.006 (1.52)	0.009 (2.89**)
P1TMK7	0.009 (1)	-0.002 (-0.32)	0.005 (1.19)	-0.004 (-1.38)	-0.01 (-2.32*)	0.003 (0.66)	0.002 (0.37)
P1TMK8	0.008 (0.88)	0.004 (0.63)	0.002 (0.49)	-0.006 (-2.08*)	-0.01 (-2.32*)	-0.003 (-0.55)	0.003 (0.7)
P1TMK9	0.001 (0.12)	-0.008 (-1.37)	0.012 (3.18**)	-0.01 (-3.71***)	-0.011 (-2.73**)	0.002 (0.45)	0.008 (2.11*)
P1TMK10	0.003 (0.37)	0 (0.09)	0.012 (3.46***)	-0.013 (-4.99***)	-0.013(-3.46***)	0.004 (1.02)	0.003 (0.88)
P1TMK11	-0.008 (-1.21)	0.007 (1.46)	0.014 (3.97***)	-0.009 (-3.54***)	-0.01 (-2.96**)	-0.002 (-0.37)	0.005 (1.51)
P1TMK12	0.001 (0.11)	0.016 (2.86**)	0.018 (4.59***)	-0.01 (-3.63***)	-0.008 (-2.1*)	0.023 (4.9***)	0.007 (2.01*)
P1TMK13	0.017 (2.43*)	0.004 (0.93)	0.016 (4.68***)	-0.008 (-3.41***)	-0.014(-4.09***)	0.002 (0.44)	0.001 (0.37)
P1TMK14	0.009 (1.31)	-0.002 (-0.42)	0.018 (5.53***)	-0.01 (-4.29***)	-0.014(-4.21***)	0.006 (1.38)	0.003 (0.86)
P1TMK15	0.01 (1.33)	0.004 (0.84)	0.007 (1.83)	-0.012 (-4.54***)	-0.008 (-2.24*)	-0.004 (-0.89)	0.003 (0.97)
P1TMK16	0.016 (1.79)	0.021 (3.46***)	0.009 (2.17*)	-0.009 (-3.12**)	-0.018(-4.23***)	-0.006 (-1.09)	0.001 (0.24)
P1TMK17	0.013 (1.91)	0.002 (0.41)	0.016 (4.95***)	-0.011 (-4.64***)	-0.019(-5.82***)	0.01 (2.44*)	0.004 (1.22)
P1TMK18	0.014 (1.59)	0 (-0.02)	0.019 (4.37***)	-0.011 (-3.63***)	-0.006 (-1.33)	0.02 (3.76***)	0.005 (1.3)
P1TMK19	-0.014(-2.02*)	0.001 (0.19)	0.007 (2*)	-0.006 (-2.67**)	-0.008 (-2.33*)	0.003 (0.8)	0.004 (1.39)
P1TMK20	-0.006 (-0.71)	-0.012 (-2*)	0.002 (0.45)	-0.003 (-0.9)	-0.005 (-1.25)	0.011 (2.01*)	-0.004 (-1.06)
P1TMK21	0.014 (1.79)	-0.005 (-0.96)	0.001 (0.25)	-0.014 (-5.29***)	-0.021(-5.27***)	-0.021(-4.44***)	0.028 (5.39***)
LNWPOP	0.92(7.56***)	1.048 (12.18***)	0.959 (16.3***)			0.843 (11.65***)	1.288 (22.45***)
KOUPOP				1.423 (40.09***)			
TERPOP					0.838 (16.03***)		
Intercept	-9.25(-9.85***)	-10.17(-15.34***)	-7.472(-16.3***)	-7.843(-37.04***)	-4.10(-13.37***)	-7.962(-14.22***)	-12.3(-23.32***)

Headings: (S1311, S1313 and S1314) refer to the sectors; central government, municipalities and Social Security Funds respectively. Rows: TIME, P1TIME, TMK2-TMK21, P1TIME2-TIME21 = time dummy variables, LNVPOP= Locaritm of population, KOUPOP = education indicator, TERPOP = health care indicator