Documents 6/2011

Olga Kerimova

A study of Norwegian local government behaviour in a dynamic context

Statistisk sentralbyrå • Statistics Norway
Oslo–Kongsvinger

Documents In this series, documentation, method descriptions, model descriptions and standards are published.

ISBN 978-82-537-8041-2 Printed version
ISBN 978-82-537-8042-9 Electronic version
ISSN 1891-5906
Subject: 12.90

Print: Statistics Norway

Symbols in tables	**Symbol**
Category not applicable	.
Data not available	..
Data not yet available	…
Not for publication	:
Nil	-
Less than 0.5 of unit employed	0
Less than 0.05 of unit employed	0.0
Provisional or preliminary figure	*
Break in the homogeneity of a vertical series	—
Break in the homogeneity of a horizontal series	|
Decimal punctuation mark	.

Preface

This document is a revised version of a Master thesis submitted for the degree of Master in Philosophy in Environmental and Development Economics (May 2010).

A special thank you to my supervisors, Audun Langørgen and Rolf Aaberge, for the challenging topic, many helpful comments and ideas, stimulating discussions, tireless guidance and patience. I am also grateful for the opportunity to have been a part of the Local Public Finance research group at Statistics Norway, where this thesis was written as part of a paid engagement

Abstract

Using previous work on the subject as a foundation, Norwegian local government spending behaviour is analysed in a dynamic framework facilitated by a panel dataset, combining municipality data for the years 2001 to 2008. Local governments are assumed to be utility maximising agents and therefore choose the best combination of budget surplus or deficit and output of public services, subject to the budget constraint that total spending does not exceed total income, which consists of grants from the central government and local taxes. The analysis is conducted in a simultaneous framework using a structural Linear Expenditure System model where government expenditure in each service sector is endogenous and dependent on the expenditures in the other sectors. Extending existing research on the subject, this study analyses changes over time in local government spending behaviour, exploiting both cross-section and time-series variation in the data to account for any unobserved municipality or time heterogeneity. Panel data methods such as fixed effects are found to be well suited to the analysis with unobserved time and municipality heterogeneity playing an important role in the changes in spending patterns. Moreover, the observed sluggishness of spending adjustment over time suggests that a combination of fixed and/or time effects with a dynamic partial adjustment model is a promising specification for future research.

Contents

1. Introduction

The current research builds on existing work of examining the behaviour of local governments in Norway by Aaberge and Langørgen (2003), Aaberge and Langørgen (2006), Langørgen, Galloway, Mogstad and Aaberge (2005) among others. Using previous work on the subject as a foundation, the key purpose of this paper is to analyse local government spending behaviour in a dynamic framework facilitated by a panel dataset, combining municipality data for the years 2001 to 2008. A local government is represented by a dominant party or coalition and has preferences, given by a Stone-Geary utility function, over the budget surplus (sector zero) and output in 12 service sectors. Since local governments are assumed to be utility maximising agents, they choose the best combination of budget surplus or deficit and output of public services, subject to the budget constraint that total spending (spending and budget surplus) does not exceed total income, which consists of grants from the central government and local taxes. Furthermore, local government spending is analysed in a simultaneous framework, that is using a structural model where government expenditure in each service sector is endogenous and dependent on the expenditures in the other sectors, since allocating a larger share of income to one sector will reduce the share of income in other sectors.

Local government expenditure in each sector is modeled to consist of two components: the minimum required expenditure, that is expenditure required to meet the public service mandates dictated by the central government or the expert opinion consensus among local government, and the discretionary income – the remaining income after the minimum required expenditure has been covered – which is divided between the sectors according to local priorities. The share of discretionary income allocated to a sector is the marginal budget share for that sector.

Since data on public service prices are not available, this paper uses the method employed by Aaberge and Langørgen (2003, 2006), namely using information on municipality characteristics that capture variation in costs and capacity to produce local public services in order to estimate the expenditure for each sector. Minimum required expenditure (sector-specific subsistence spending) and minimum fiscal surplus are assumed to depend on central government regulations and technological constraints, represented by factors that include demographic variables (residents in specific age groups, civil status, employment status etc.), settlement pattern within a municipality, economies of scale, climatic conditions (e.g. amount of snowfall), sewage purification regulations. Marginal budget shares are assumed to vary with local population's average education level, settlement density and the political party composition of the local council.

The independent contribution of this study is to extend the existing research on Norwegian local governments' behaviour, which uses cross-sectional data, by combining the cross-sections for the 8 available years (2001 – 2008). This will allow for a quasi-dynamic study and long-term analysis of local government behaviour, also allowing one to account for any municipality or time heterogeneity not captured by the included explanatory variables. This study is quasi-dynamic because it contains both static and dynamic elements. It is static in a sense that it is not based on intertemporal optimisation. That is local governments' preferences are observed at a point in time with no explicit relationship between preferences across time periods. Moreover, local governments are assumed to be subject to a static budget constraint; that is a budget condition that is not specified to include linkages between different time periods. However, this study analyses changes over time in local government spending behaviour, exploiting both cross-section and time-series variation in the data, and is therefore referred to as quasi-dynamic. Panel data is well-suited to analysing the dynamics of change as well as to controlling for the unobserved heterogeneity. Thus, a panel study allows for a richer analysis of how local government behaviour changes over time in the presence of unobserved municipality and time effects.

Well-known panel data methods such as fixed effects estimation are adapted to estimating a system of equations. Models with both municipality and time effects are developed and estimated using the Full Information Maximum Likelihood technique. All empirical analysis, including model estimations, is conducted using the SAS software[1].

Models with municipality fixed effects and/ or time effects are found to perform better than the benchmark model which accounts for increasing minimum required expenditures only through income growth. When unobserved time and municipality heterogeneity are not taken into account, the effects on the minimum required expenditures are usually biased. The municipality heterogeneity is modeled in two ways: by introducing municipality-specific dummy variables or dummy variables for labour market regions into which all municipalities are grouped. Many of the region effects are found significantly different from the Oslo region, which is chosen as the reference, particularly when region effects are included together with the time effects. Finally a dynamic model is estimated to analyse the dynamics of adjustment of municipality spending over time, where spending is modeled as a weighted average of optimal long-run spending and the spending in the previous period. The weight measures the speed of adjustment to equilibrium and is estimated to be relatively low, suggesting sluggishness in the municipalities' spending behaviour over time.

The rest of the paper is organised as follows. Section 2 contains a literature review of selected studies of local government behaviour and the different models used. Section 3 discusses some well-known panel data methods such as fixed effects and random effects regression as well as their application to balanced and unbalanced data sets. Section 4 presents the benchmark model used and comments on some of the issues that may arise in applying the model to a panel data set. Section 5 suggests some possible model variants that extend the benchmark model to account for unobserved heterogeneity. Section 6 outlines the data used and provides a discussion of the results obtained by estimating the models in Section 5. A discussion of the change in the parameters of interest between different model formulations is also provided. Section 7 concludes.

2. Literature review

A number of studies have already been conducted on various aspects of economic behaviour of local governments. Both the expenditure and the revenue sides of the local governments' budgets have been discussed, using models appropriate to the particular question under investigation. Some studies are based on cross-section data, while others make use of panel data to capture any possible unobserved heterogeneity.

Borge (1995) focuses on the revenue aspect and analyses determinants of fee income for Norwegian municipalities, using a representative voter model where the utility function of the pivotal voter is maximised subject to the relevant resource constraint (disposable income is spent on private consumption and user fees). A separable utility function is assumed. Its arguments are per capita service production of free services, services subject to user fees and the level of private consumption, as well as sociodemographic variables such as share of children, youth and the elderly in a municipality's population. Two additional variables are included to capture structural differences across local governments: population size and settlement pattern (average traveling distance to the center of the municipality). The estimation is conducted using panel data of 414 municipalities for the years

[1] Program code is available on request.

1980 – 1990; time dummies are included additively allowing the intercept to shift from year to year. These dummy variables capture the shift in the functional responsibility between the counties and the municipalities, and the effects of any left-out variables that vary over time. A municipality-specific term is also included, which is assumed constant, fixed or random depending on the specification. Borge (1995) finds among other things that higher private income and higher compulsory expenditures contribute to an increase in fee income.

Other studies focus extensively on the expenditure side of the budgets, analysing how a fixed total budget is allocated among different service sectors. In a dynamics-centred analysis Borge, Rattsø and Sørensen (1995) develop a partial adjustment model with endogenous speed of adjustment to analyse how pressure from interest groups and mass media influence the adjustment process of local governments' spending. Based on a combined cross-section and time-series data set for Norwegian local governments, the sluggishness of the adjustment process is estimated for 6 service sectors[2], with pressure groups related to primary education explaining an important part of the sluggishness observed. Pressure groups promoting kindergartens and health care or care for the elderly are found to stimulate budget reallocations. Similarly to Borge (1995), the desired allocation is influenced by the share of youth, the share of the elderly and the share of children. Additional variables are population density, population growth and the inverse of the population size. As in Borge (1995), the intercepts are allowed to vary over time for the available years 1984 – 1990.

The reduced form of the partial adjustment model is estimated.

(2.1)

$$A_{it} = \frac{1}{1+h(\mathbf{POL})}\left(\alpha_{i0} + \alpha_{i1}\log Y_t + \alpha_{i2}\log I_t + \alpha_{i3}\mathbf{Z}_t + \alpha_{i4}\mathbf{POL}\right) + \left(1 - \frac{1}{1+h(\mathbf{POL})}\right)A_{it-1}$$

where A_{it} is local government spending share in sector i in year t, Y_t is total local government spending per capita, I_t is per capita private consumption and $\mathbf{Z}_t$ is a vector of sociodemographic characteristics. The budget constraint is satisfied with the spending shares adding up to 1 for all 6 sectors.

The adjustment coefficient $\frac{1}{1+h(\mathbf{POL})}$ for each local government measures the share of the desired change which is implemented in the first year and **POL** is a vector of interest group variables. In the benchmark model a constant speed of adjustment is assumed with the **POL** vector empty.

The two extensions of the benchmark model are based on a non-constant speed of adjustment $\frac{1}{1+\mu_t}$ where $\mu_t = h(\mathbf{POL})$ and **POL** includes variables that capture the pressure form special interest groups and pressure from the mass media.

All versions of the model are estimated in reduced form by a system technique. Borge, Rattsø and Sørensen (1995) cite three key reasons for analysing the sector expenditure shares simultaneously. First, the error terms of the demand equations are correlated due to the budget constraint and should therefore be estimated as a system instead of equation by equation to obtain efficient estimates. Second, a system technique is required to capture restrictions on the model's parameters. Third, since the demand equations are non-linear in the parameters in two of the model's specifications, a non-linear estimation method is needed. In estimating these models the Fixed Information Maximum Likelihood method is used, a system technique that handles non-linear restrictions. The benchmark constant speed of adjustment model is linear in the parameters, and is estimated by the SUR method (Borge, Rattsø and Sørensen, 1995). To avoid a singular covariance matrix, one of

[2] The service sectors are: administration, education, health, kindergartens, culture and infrastructure.

the equations is omitted from the estimation. The demand equation of this sector is determined by the budget restriction and the estimated coefficients for the other sectors. Borge, Rattsø and Sørensen (1995) chose cultural services as the residual sector.

Conclusions derived by Borge, Rattsø and Sørensen (1995) are mostly reasonable and in line with expectations. An increase in the share of youths contributes to a significantly higher expenditure share for primary education, while the share of elderly has a similar effect on resources allocated towards health care or care for the elderly. However, spending on kindergartens is not significantly related to the share of children in the community. As expected based on the budget constraint, higher expenditures in one sector are financed by cutbacks in other sectors. Borge, Rattsø and Sørensen (1995) report a negative effect of the share of elderly on the expenditure on primary education, kindergartens and cultural services, and similarly a negative effect of the share of youth (7-15 years) on kindergartens, cultural services and infrastructure. Evidence of economies of scale is found in the administration and primary education sectors. Although the current study is related to the Borge, Rattsø and Sørensen (1995) paper both in its goals, type of data used and the factors proposed to explain spending behaviour variation in different service sectors, some important differences must be highlighted. The key methodological difference between Borge, Rattsø and Sørensen (1995) and the present study is that the former estimates a simultaneous reduced form Almost Ideal Linear Demand System, while this paper follows the methodology of Aaberge and Langørgen (2003, 2006) in estimating a structural simultaneous Linear Expenditure System. By estimating the model in its structural form, we are able to derive the structural parameters directly, which facilitates the analysis of parameters of interest (the effects of service target groups and other sector-specific factors on the minimum required expenditures and marginal budget shares in different service sectors). Moreover, Borge, Rattsø and Sørensen (1995) are not able to include price effects in their model as prices of the local government services are not observed. Following Langørgen and Aaberge (2003), the present study incorporates prices into the model through the minimum required expenditure parameters.

In Aaberge and Langørgen (2003, 2006) variations in spending per capita in various service sectors are analysed by specifying the expenditure in each service sector to consist of two components: the minimum required expenditure according to the service provision standards set by the central government, and the additional expenditure in each sector after the minimum requirement has been met (the share of the discretionary income allocated to each service sector according to local priorities). Each municipality's operating expenses by service sector (indexed by i) are decomposed as follows:

$$u_i = \alpha_i + \beta_i \left(y - \sum_{i=0}^{12} \alpha_i \right) \quad i = 0,...,12 \qquad (2.2)$$

where u_i is the per capita expenditure in service sector i, α_i is the minimum required expenditure and β_i is the marginal budget share in service sector i; y is total income.

The minimum required expenditure, marginal budget shares and discretionary income vary between municipalities as functions of observable characteristics. A detailed description of the way minimum required expenditures and marginal budget shares are modeled, as well as the derivation of the Linear Expenditure System, is provided in Section 4.2.

Allers and Elhorst (2007) investigate fiscal policy interaction, testing for interdependent behavior among Dutch municipalities with respect to taxation and spending in 9 public service sectors using a structural form simultaneous equation framework. The expenditure in a particular service sector is assumed to depend on the price or cost variables of other service sectors. A linear expenditure system (LES) is developed following the logic of Aaberge and Langørgen (2003, 2006) with some notational differences. However, Allers and Elhorst (2007) develop two extended versions of the model: the first includes a spatially lagged dependent variable and the second – a spatial autoregressive process in the error term of each equation.

The spatial lag model posits that a municipality's fiscal policy depends on the fiscal policy in neighbouring municipalities and on a set of observed local characteristics. Allers and Elhorst (2007) formulate the spatial lag by making minimum required expenditure dependent on the expenditure of neighboring municipalities. Using the notation of Aaberge and Langørgen (2003, 2006) described above and including an error term ε_i , the spacial lag model is given by:

(2.3)
$$u_i = \delta_i \mathbf{W} u_i + \alpha_i + \beta_i \left(y - \sum_{i=1}^{9} \alpha_i \right) + \varepsilon_i$$
$$i = 1,...,9$$

where $\mathbf{W}u_i$ is the dependent variable observed in neighboring municipalities according to a spatial weights matrix $\mathbf{W}$ describing the spatial arrangement of the municipalities in the sample, δ_i is the spatial autoregressive coefficient and α_i and β_i are a function of exogenous variables determining the cost of reaching the minimum standard for public service sector i and exogenous variables determining the share of discretionary income spent on service i, respectively.

The spatial error model, on the other hand, posits that a municipality's fiscal policy depends on a set of observed local characteristics and that the error terms are correlated across space, resulting in the following version of the LES:

(2.4)
$$u_i = \alpha_i + \beta_i \left(y - \sum_{i=1}^{9} \alpha_i \right) + \phi_i$$
$$i = 1,...,9 \text{ , } \phi_i = \lambda_i \mathbf{W} \phi_i + \varepsilon_i$$

where φ_i is the spatially autocorrelated error term, $\mathbf{W}$ is a spatial weights matrix describing the spatial arrangement of the municipalities in the sample and λ_i is the spatial autocorrelation coefficient. The spatial error model is consistent with a situation where determinants of fiscal policy omitted from the model are spatially autocorrelated, and with a situation where unobserved shocks follow a spatial pattern (Allers and Elhorst, 2007).

To estimate the spatial LES Allers and Elhorst (2007) use cross-sectional data from 496 Dutch municipalities in 2002. However, the authors acknowledge that a panel data study would offer an opportunity to control for non-observed local characteristics, which do not vary over time. Thus, the estimation may be further extended by adding spatial fixed or random effects to each equation within LES to account for these characteristics.

Similarly to Allers and Elhorst (2007), the current paper closely follows the methodology and arguments of Aaberge and Langørgen (2003, 2006), which are outlined in Section 4.2. However, while the simple benchmark model is the same in all of these papers, the current research focuses on fixed effects estimation, extending the work of Langørgen and Aaberge (2003, 2006) in the context of panel data, rather than employing the spacial lag or spacial error models of Allers and Elhorst (2007). While these models certainly yield insight into possible interaction elements in the behaviour of local municipalities, this issue is not the primary focus of this paper. Rather, the objective is to analyse the dynamics of municipalities' spending behaviour, comparing the estimated effects on the minimum required expenditures and budget shares with those based on cross-sectional estimations and a chosen baseline model.

3. Theoretical foundations and methods

3.1. Advantages and limitations of panel data

Advantages and limitations of panel data are discussed in, among others, Hsiao (1985), Baltagi (2005), Wooldridge (2002a) and Gujarati (2003). Panel data allows one to look at dynamic relationships and is better suited to analysis of dynamics of change or adjustment. Panel data also makes it possible to control for unobserved cross section heterogeneity (i.e. take into account unobserved individual or time effects by including them in the model) (Wooldridge, 2002a). Having access to a panel data set also significantly increases the number of observations, provides a more informative data set, less collinearity among variables, more variability and more degrees of freedom (Gujarati, 2003). Limitations include panel surveys design and data collection problems, measurement errors, self-selectivity, non-response and attrition (Baltagi, 2005). Some of these are less relevant for this study. However, an important and relevant problem associated with the short time-series panels is the incidental parameters problem.

3.1.1. Incidental parameters problem

A characteristic feature of a typical panel data set is a large number of cross-sectional units combined with a small time dimension (each unit observed only a few times). This feature causes a so-called incidental parameters problem, whereby the number of parameters increases with the sample size leading to a loss in consistency of these parameters (Beck, 2004). For example, when a fixed effects model is estimated, cross-sectional unit-specific intercepts are added to the regression in the form of dummy variables. Treating these parameters as parameters to be estimated leads to the incidental parameter problem as discussed by Neyman and Scott (1948) and Chamberlain (1980).

Whether the inconsistency in estimating the fixed effects will give rise to inconsistency for estimators of the structural parameters of interest, say $\tilde{\theta}$, depends on whether the estimators of $\tilde{\theta}$ satisfy the Neyman-Scott principle. That is, if there exist functions $\psi_{Nj}\left(\tilde{y}_1,....,\tilde{y}_N \mid \tilde{\theta}\right), j = 1,....,m$ of observables $\tilde{y}_i = \left(y_{i1},.....,y_{iT}\right)'$ which are independent of the incidental parameters such that when $\tilde{\theta}$ are the true values, $\psi_{Nj}\left(\tilde{y}_1,....,\tilde{y}_N \mid \tilde{\theta}\right)$ converge to zero in probability as N tends to infinity, then an estimator $\hat{\tilde{\theta}}$ derived by solving $\psi_{Nj}\left(\tilde{y}_1,....,\tilde{y}_N \mid \hat{\tilde{\theta}}\right) = 0,\ j = 1,...,m$, is consistent under suitable regularity conditions (Hsiao, 1985:136).

Green (2001) provides an accessible discussion of the problem. In a single linear equation case with fixed individual effects, the parameters can be estimated by the Least Squares Dummy Variable (LSDV) or 'within groups' estimator, denoted $\mathbf{b}_{\mathbf{LSDV}}$. This is computed by least squares regression of the dependent variable, from which its mean over all time periods (T) is subtracted, on the same transformation of the explanatory variables. The slope parameters can also be estimated using first differences. Under the assumptions, $\mathbf{b}_{\mathbf{LSDV}}$ is a consistent estimator of the parameters associated with the explanatory variables. However, the individual fixed effects are each estimated with the $T(i)$ individual specific observations for each cross-sectional unit i. Since $T(i)$ is typically small, and is fixed, the LSDV estimator of the fixed effects is inconsistent. However this inconsistency is not transmitted to the LSDV estimator $\mathbf{b}_{\mathbf{LSDV}}$ because it is not a function of the fixed effects estimator (Green, 2001:2). That is the Neyman-Scott principle is satisfied.

The incidental parameter problem disappears if the effects are treated as random since they are assumed to possess a probability density function characterized by a finite number of parameters. However, making specific distributional assumptions imposes a degree of restrictiveness, whose severity depends on the type of the model being investigated (Hsiao,1985:136).

3.2. Fixed effects

In a panel data set, the same unit (for example an individual, firm or municipality) is followed over a number of time periods. In this framework there may be effects that are not captured by the vector of explanatory variables. Wooldridge (2002a) represents these effects as an omitted random variable "c", called an unobserved effect. In the context of the local government expenditure model, this is a municipality effect c_k where k is a municipality index. The population regression function is then given by:

(3.1) $$E[y_{kt} \mid \mathbf{x_{kt}}, c_k] = b_0 + \mathbf{x_{kt}}\mathbf{b} + c_k \qquad t = 1,2,...,T \qquad k = 1,2,...,K$$

where

(3.2) $$\mathbf{x_{kt}}\mathbf{b} = b_1 x_{1kt} + ... + b_J x_{Jkt}$$

and x_{jkt} indicates variable j at time t and municipality k, b_1 ... , b_J are slope parameters and b_0 is the intercept.

Hsiao (1985) offers a classification of variables used in panel data analyses, which is particularly useful in the discussion of fixed effects estimation that follows. Economic variables are divided into three types: individual time-invariant, period individual-invariant, and individual-time varying variables. The individual time-invariant variables are the same for a given cross-sectional unit through time but vary across cross-sectional units. Examples include ability, sex, and socio-economic background. The period individual-invariant variables are the same for all cross-sectional units at a given point in time but vary through time. Examples of these are prices, interest rates and widespread optimism or pessimism. The individual-time varying variables are variables that vary across cross-sectional units at a point in time and also exhibit variations through time, for example firm profits, sales, and capital stock (Hsiao, 1985:130).

In equation (3.1) c_k is assumed to be of the first type (time-invariant or time-constant), i.e. c_k has the same effect on the mean response in each time period (Wooldridge, 2002a). If the unit of observation is a municipality, c_k contains unobserved municipality characteristics—such as administrative structure and efficiency—that can be viewed as being roughly constant over the period in question. Allers (2007) also suggests work ethos as an unobserved effect, which influences local government efficiency. In a model of municipality expenditures where the observed explanatory variables are factors affecting minimum required expenditures and the factors affecting the share of the discretionary income used on various sectors, an unobserved effect represents all factors affecting municipality expenditures that are constant (or roughly constant) over time. Geographical position for example is constant over time (except in cases where municipalities merge, in which case it is still approximately constant over the period of interest). Whether a municipality is located on relatively flat land or in a mountainous region may have an effect on some of the expenditures, such as road infrastructure, as it is more difficult and costly to build roads on mountainous terrain. Also, a mountainous area may be more suitable for skiing such that a municipality may spend more on sporting activities and skiing infrastructure in the culture and recreation sector.

In most applications, the main reason for collecting panel data is to allow for the unobserved effect to be correlated with the explanatory variables, i.e.

$$\text{(3.3)} \qquad E[\mathbf{x}'_{kt}, c_k] \neq \mathbf{0}$$

where **x** is a vector of explanatory variables, c_k is the fixed effect and **o** is a vector of zeros.

In this situation, a fixed effects model may be appropriate (Wooldridge,2002b). For example, in modeling municipality expenditures we may allow the unmeasured municipality factors to be correlated with some of the explanatory variables – for example geographic location may be correlated with population density and amount of snowfall.

A method commonly applied in the literature to model these time-constant unobserved effects is Least Squares Dummy Variable regression. Typically a dummy variable for each cross-sectional unit (here: municipality) is added, omitting a base category municipality to avoid the so-called dummy variable trap of perfect collinearity. However, when the number of cross-sectional units is very large (300 – 400 municipalities) and the time period is small (here: 8 years), the estimation may be difficult as there may not be enough degrees of freedom. The incidental parameters problem is also applicable in this situation.

We may also have unobserved effects that are constant across municipalities but not time (what Hsiao (1985) calls period individual-invariant effects, or more simply time effects). There may be omitted variables that capture effects or characteristics that at a given time are common to all municipalities. For example, central government legislation that affects spending behaviour of all municipalities in a given year is one such unobserved effect.

A potential pitfall of this type of model is that when we include a full set of year dummies—that is, year dummies for all years but the base—we cannot estimate the effect of any variable whose change is constant over time. This is a consequence of the fixed effects taking up the between unit variation in the variables, making it impossible to estimate the impacts of any variables that do not vary over time (Beck, 2004). On first examination, however, this does not seem to be relevant to the expenditure model for local governments; however, population size does appear to be roughly constant over time.

Moreover, the parameters of time-invariant variables cannot be estimated in the fixed effect model. This is a consequence of the fixed effects taking up the between unit variation in the variables, making it impossible to estimate the impacts of any variables that do not vary over time (Beck, 2004). For example Allers (2007) discusses soil condition as a time-invariant explanatory variable, which impacts road and sanitation costs. This variable is effectively removed (its effect cannot be estimated) when fixed effects for municipalities are introduced. Similarly, if we have variables that change very slowly over time (such as institutional measures), then the fixed effects approach will essentially wipe them out (Beck, 2004).

However, the time-invariant variables can be interacted with variables that change over time and, in particular, with year dummy variables. For example, in a wage equation where education is constant over time for each individual, we can interact education with each year dummy to see how the return to education has changed over time. Even though fixed effects cannot be used to estimate the return to education in the base period – and hence in any period – we can see how the return to education in each year differs from that in the base period (Wooldridge, 2002b:444).

3.2.1. Interactive fixed effects

In the standard fixed effects models, fixed and time effects are typically introduced separately, either additively or multiplicatively depending on the model's assumption. However, it is also possible to introduce these effects in a way that links the time and cross-sectional heterogeneity. Arellano and Honoré (2000) discuss an example of a model where individual effects are interacted with the time effects. The model is formulated in the following way:

(3.4) $$y_{kt} = \mathbf{b}\mathbf{x}_{kt} + \delta_t \eta_k + \upsilon_{kt}$$

where **b** is a vector of parameters, $\mathbf{x}_{kt}$ is a vector of explanatory variables, k represents a cross-sectional unit such as municipality and t is the time index.

In this specification the time effects could represent an aggregate shock, which is allowed to have individual-specific fixed effects on y_{kt}, measured by η_k. In this case we clearly cannot simply first difference away the fixed effects. The authors then go on to suggest a transformation first derived by Chamberlain (1984), which provides a solution (Arellano and Honoré, 2000:25). Generalising the previous specification to

(3.5) $$f_{kt} = g_{kt}\eta_k + \upsilon_{kt}$$

where $E(\upsilon_{kt} \mid x_k) = 0$, x_k are some predetermined variables and g_{kt} is a function of predetermined variables and unknown parameters. Dividing by g_{kt} and first differencing, they obtain

(3.6) $$f_{k(t-1)} - (g_{kt}^{-1} g_{k(t-1)}) f_{kt} = v_{k(t-1)} - (g_{kt}^{-1} g_{k(t-1)}) v_{kt} = v_{kt}^{+}$$

Hübler (2006) suggests a similar model, specifying a time-varying individual effect where the effect varies e.g. with cyclical ups and downs, although individual characteristics stay the same. He argues that one cannot expect that unobserved individual effects to have the same effects in different situations, such as different time periods (Hübler, 2006).

3.2.2. Partial adjustment model

A dynamic variant of the fixed effects model can be specified as a partial adjustment model, which includes a lagged dependent variable as well as possibly lagged explanatory variables in addition to the fixed and time effects. Arellano and Honoré (2000) discuss a model of this type:

(3.7) $$y_{kt} = \alpha y_{k(t-1)} + \beta_0 x_{kt} + \beta_1 x_{k(t-1)} + \delta_t + \eta_k + \upsilon_{kt}, \quad k = 1,...,K, \quad t = 2,...,T$$

(3.8.) $$E(\upsilon_{kt} \mid x_k^T) = 0$$

By construction $y_{k(t-1)}$ is correlated with the fixed effect η_k and may also be correlated with the past, present and future values of the residuals υ_{kt} since these may be autocorrelated.

A more general version of the partial adjustment model, however, is the specification employed by Borge, Rattsø and Sørensen (1995):

(3.9) $$y_{kt} = \lambda y_{kt}^{*} + (1-\lambda) y_{kt-1} + \upsilon_{kt}$$

or equivalently

(3.10) $$y_{kt} = y_{kt-1} + \lambda\left(y_{kt}^{*} - y_{kt-1}\right) + \upsilon_{kt}$$

where λ is the speed of adjustment parameter, which shows how fast the dependent variable y_t adjusts to its equilibrium value y^{*}_{kt}. The desired allocation y^{*}_{kt} may be specified as a function of explanatory variables x_{kt} as well as time and/or fixed effects δ_t and η_k respectively. This model is adapted to analyse the adjustment of the local government expenditures and is presented in Section 5, while the results are discussed in Section 6.

3.3. Random effects

If the unobserved effect c_k in equation (3.1) is assumed uncorrelated with each explanatory variable in all time periods,

(3.11) $\mathrm{Cov}(x_{jkt}, c_k) = 0,\ \ t = 1,2,\ldots,T\ \ j = 1,2,\ldots,J\ \ k=1,2,...,K$

where t represents time period, j is a subscript on an explanatory variable and k represents observation, then using a fixed effects model results in inefficient estimators and the random effects method is preferable. However, if the c_k are correlated with some explanatory variables, the fixed effects method is needed; if random effects is used, then the estimators are generally inconsistent (Wooldridge, 2002b:453).

A random effects model assumes c_k to be a component in the composite error ($v_{kt}=c_k+u_{kt}$) in each time period; the v_{kt} are serially correlated across time. Generalised Least Squares (GLS) may be used to solve the serial correlation problem. In order for the procedure to have good properties, it must have a large cross-sectional dimension and relatively small time dimension (Wooldridge, 2002b).

A random effects model allows for explanatory variables that are constant over time, which is an advantage of random effects over fixed effects. This is possible because the unobserved effect is assumed to be uncorrelated with all explanatory variables, whether they are fixed over time or not (Wooldridge, 2002b:450).

3.4. A comparison of fixed and random effects

In the fixed effects approach one is typically interested in measuring the effect of regressors holding unobserved heterogeneity constant, while in the random effects approach the parameters of interest are those characterising the distribution of the error components (Arellano and Honoré, 2000:1).

The fixed effect model involves making inferences conditional on the effects that are in the sample. The random effect model is one where inference is unconditional or marginal with respect to the population of all effects. Thus, whether the conditional likelihood function or the marginal likelihood function is used depends on the context of data and the manner in which they were gathered (Hsiao, 1985). Hsiao (1985) provides an illustrative example where several technicians care for machines. If one wants to assess differences between specific technicians, then the fixed effect model is more appropriate. However, if the technicians are randomly sampled from all employees, the effects of technicians may be assumed random. Similarly, if an experiment involves hundreds of individuals that are considered a random sample from some larger population, random effects are more appropriate. But if one is interested in analyzing just a few individuals, then fixed individual effects would be more relevant.

When individual units in the sample are of interest, the effects are more appropriately considered fixed. When inferences will be made about the characteristics of a population from which those in the data are considered to be a random sample, then the effects should be considered random (Hsiao, 1985:132).

Hence, a fixed effect specification appears to be more appropriate to analysing the behaviour of local governments, which are viewed as the units of interest rather than a random sample of a larger population.

3.5. Random Coefficient Model

Beck (2006) suggests an alternative to the fixed and random effects models, namely a version of a random coefficient model (RCM). This model allows for cross-sectional unit heterogeneity, but also assumes that the various unit level coefficients are draws from a common (normal) distribution. Thus the RCM may be described by as

(3.12) $$y_{kt} = \mathbf{x}_{kt}\boldsymbol{\beta}_k + \varepsilon_{kt}, \quad \boldsymbol{\beta}_k = \boldsymbol{\alpha} + \mathbf{z}_k\boldsymbol{\chi} + \boldsymbol{\mu}_k$$

where $\boldsymbol{\beta}_k$ is a vector of parameters, which are assumed to be random, composed of a vector of constants $\boldsymbol{\alpha}$, a vector of some exogenous variables z_k ($\boldsymbol{\chi}$ is the vector of corresponding parameters) and a random effect $\boldsymbol{\mu}_k$ which has a normal distribution; *k* indexes the cross-sectional units and *t* indexes time.

A feature of the above specification is that one can model the variation of the unit coefficients as a function of unit level variables (**z**). This allows us to move from saying for example that the effect of some variable is different in country A and country B to this impact differs because of some institutional difference between the two nations (Beck, 2006:9). While this model is often estimated by Bayesian methods, it is also feasible to estimate it via standard maximum likelihood as has been implemented by Pinheiro and Bates (2000).

In a classic paper, Hsiao (1975) discusses the estimation of a Random Coefficient Model, in which the random component is decomposed into a time and a cross-sectional random effect. The coefficients of the explanatory variables are assumed to have common means, as well as some random components associated with the time and/or cross-section units. The model is specified in the following way:

(3.13) $$y_{kt} = \sum_{j=1}^{J} \beta_{jkt} x_{jkt} + \varepsilon_{kt}$$
$$\beta_{jkt} = \beta_j + \delta_{jk} + \gamma_{jt}, \quad k = 1,...,K, \quad t = 1,...,T$$

where k indexes the individual units, for example municipalities, j represents an index of an explanatory variable such that x_{jkt} is an exogenous variable j for municipality k for year t. And each exogenous variable x_{jkt} is assumed to have a random parameter β_{jkt}, which consists of three components: a constant parameter β_j for each x_j, a cross-sectional random effect δ_{jk} and a time random effect γ_{jt}. The error term ε_{kt} and both of the random effects are assumed to have zero means and constant variances. The random effects are also assumed to be uncorrelated with one another, or with the error term.

It may be noted that the Random Effects model is a special case of the RCM. The RCM is reduced to Random Effects if it is only the intercept, which is a random parameter, that is:

(3.14) $$\beta_{jkt} = \begin{cases} \beta_j + \delta_{jk} + \gamma_{jt} & x_{jkt} = 1 \\ \beta_j & otherwise \end{cases}$$

Hsiao and Pesaran (2004) discuss a simplified variant of the above model, where in vector notation

(3.15) $$\boldsymbol{\beta}_{kt} = \beta + \boldsymbol{\delta}_k, \quad \boldsymbol{\delta}_k \sim N(\mathbf{0}, \Delta)$$

In other words, there are only individual-specific effects; these stay constant over time and are independently normally distributed over k with mean zero and covariance $\boldsymbol{\Delta}$.The error term has mean zero and a covariance matrix **C**. If the errors and $\boldsymbol{\delta}_k$ are normally distributed and the errors are independently distributed across k and over t, i.e.

(3.16) $$E\left(\varepsilon_{kt}^2\right) = \sigma_k^2$$

where σ^2_k is the variance of the errors,
then the GLS estimator of β is the maximum likelihood estimator of β conditional on $\boldsymbol{\Delta}$ and σ^2_k. Without knowledge of $\boldsymbol{\Delta}$ and σ^2_k, we can estimate β, $\boldsymbol{\Delta}$ and σ^2_k for k

= 1, ... ,K simultaneously by the maximum likelihood method, although computationally it can be tedious (Hsiao and Pesaran, 2004:9).

3.6. Balanced vs. unbalanced panel

Wooldridge (2002a:250) defines a balanced panel as a panel where we have the same time periods, denoted t = 1, ... ,T for each cross sectional observation, i.e. the same time periods are available for all cross sectional units. Some panel data sets have missing years for at least some cross-sectional units in the sample. This is referred to as an unbalanced panel. The dummy variable fixed effects regression goes through in the same way as with a balanced panel. In the local government expenditure model, some of the municipalities have merged over the period 2001 to 2008. Provided that the reason the municipality leaves the sample is uncorrelated with the error term, the estimators will remain unbiased. This seems likely to hold in most cases of municipality mergers. However, a closer examination may be warranted (Wooldridge, 2002b:448).

Greene (2003) suggests that if a time effects estimation is theoretically justified and is performed (i.e. a full set of time dummies are added using the union of the dates represented in the full data set even though some of the dates have missing observations), then any missing data in any time period is accounted by a dummy variable for that time period. Thus the dummy variable regression with time effects automatically takes care of the unbalanced data set.

4. Model

4.1. Norwegian local government fiscal responsibilities and financing

In Norway municipalities play an important role in provision of public services. The services offered range from almost pure collective services such as administration, to 'quasi private goods' such as care for the elderly. The differences in central government control over these services, varying from a regulated primary education sector to an almost unregulated infrastructure sector, are the result of a compromise between the wish for local democracy and the requirement of national standards. This is partly reflected in the variation in per capita spending between municipalities. The variation is less in the more heavily regulated sectors, such as primary schools, and much higher in other sectors. It is of interest to examine if this variation in spending is a reflection of preferences (Rongen, 1995:254-255).

Municipalities' resources are largely concentrated on production of national welfare services. Child care, primary schools and social services (including care for the elderly) account for about 70 percent of the municipalities' gross operating expenses. Municipalities also have a local responsibility in water supply and sanitation, culture, economic development, planning and community development (NOU, 2005/18:66).

The revenues of Norwegian municipalities consist primarily of:
- Fee income (user fees), which includes sales and rental income
- Interest income, which includes interest on bank deposits and other receivables
- Tax revenue, consisting of taxes on income and wealth, property and other production taxes, as well as licensing fees
- Transfers from the state (general grants and earmarked grants) (NOU, 2005/18:68).

4.2. Baseline model description and specification

The model of municipality expenditures, referred to as KOMMODE, explains variations in spending per capita in various service sectors in which local governments have a responsibility to provide services to their constituencies. The model is designed such that the accounting relationships between revenues, expenses and net operating surplus are always maintained. The supply of funds is always equal to their use. For example, if a municipality receives 1 krone extra in income, this will be exactly offset by changes in expenditures and net operating surplus (Langørgen, Pedersen and Aaberge, 2010).

The present research will consider an extended version of KOMMODE, which consists of 12 service sectors:

1. Administration
2. Primary schools
3. Other education
4. Child care
5. Health care
6. Social services
7. Child protection
8. Care for the elderly and disabled
9. Culture
10. Municipal roads
11. Water supply and sanitation
12. Other infrastructure

The analysis is conducted to determine how the minimum required expenditure (subsistence requirement) varies within the different sectors between municipalities based in part on demographic, social and geographic factors. Hypotheses about the variables that give rise to minimum required expenditures can be derived from knowledge of statutory responsibilities, minimum standards, production conditions and other conditions for municipalities.

Discretionary income shows economic freedom as measured by the revenues that the municipalities have at their disposal after the minimum required expenditures for all sectors are covered. The marginal budget shares show how the discretionary income is distributed among sectors, depending on local priorities. The marginal budget shares are assumed to vary from municipality to municipality depending on the local population's educational level, settlement density, and the political party composition of the council.

Based on these concepts, each municipality's operating expenses by service sectors (sector i) may be decomposed as follows:

(4.1) Expenditure(i) = Minimum required expenditure(i) + Marginal budget share(i) * Discretionary income

where the minimum required expenditure, marginal budget shares and discretionary income vary between municipalities as functions of observable characteristics.

There are thus three types of explanatory factors for municipality expenditures included in the model:

- Local income basis (given by tax rates, tax bases and transfers)
- Factors that explain variations in minimum required expenditures
- Factors affecting local government priorities over and above the minimum required expenditures

4.2.1. Outline of model derivation

In Aaberge and Langørgen (2003) and Pedersen (2008) a linear expenditure system is derived by constrained utility maximisation. The production function for sector i is assumed to be

(4.2) $$q_i = f_i\left(\mathbf{x}_i, \mathbf{z}_i\right), i = 1,...,12$$

where $\mathbf{x}_i$ is a vector of factor inputs and $\mathbf{z}_i$ is a vector of community characteristics that affect production opportunities.

Under constant returns to scale and cost minimisation, the cost function is given by

(4.3) $$C_i\left(q_i, \mathbf{w}_i, \mathbf{z}_i\right) = p_i\left(\mathbf{w}_i, \mathbf{z}_i\right) q_i$$

where $\mathbf{w}_i$ is a vector of factor prices and p_i is unit cost in sector i.

Local governments (municipalities) are treated as utility maximising agents. A Stone-Geary utility function is given by

(4.4) $$W\left(u_0, q_1, q_2, ..., q_{12}\right) = \left(u_0 - \alpha_0\right)^{\beta_0} \prod_{i=1}^{12}\left(q_i - \gamma_i\right)^{\beta_i}$$

where

(4.5) $$\sum_{i=0}^{12}\beta_i = 1$$

and $0 \le \beta_i \le 1 \forall i$, $\gamma_i \le q_i$, $\alpha_0 \le u_0$ are assumed satisfied.

Equation (4.5) is the restriction which says that the marginal budget shares in all sectors must sum to 1.

The utility function (4.4) is maximised subject to a budget constraint

(4.6) $$y = u_0 + \sum_{i=1}^{12} p_i q_i$$

where y is exogenous income inclusive of user fees, u_0 is budget surplus, p_i and q_i are price and quantity in service sector i and $u_i = p_i q_i$, $i \neq 0$ is the expenditure on service sector i (Aaberge and Langørgen, 2003).

As Allers and Elhorst (2007) note, the Stone-Geary utility function presupposes that all public services are normal and all pairs of public services are net substitutes. These conditions are likely to be satisfied as long as local public services are categorised into a limited number of broad groups, as is indeed the case in KOMMODE.

The resulting linear expenditure system is of the following form:

(4.7) $$u_i = \alpha_i + \beta_i\left(y - \sum_{i=0}^{12}\alpha_i\right)$$
$$i = 0,1,...,12$$

where price variation is included in the $\alpha_i = p_i\gamma_i, i \neq 0$

(4.8) $$\sum_{i=0}^{12}\alpha_i = \alpha_0 + \sum_{i=1}^{12}\alpha_i = \alpha_0 + \alpha$$

and α is the minimum required expenditure on all services while α_0 is the minimum savings parameter.

The following heterogeneity in the parameters is introduced by translating the demand system in the sense described by Pollak and Wales (1981), whereby "translating can sometimes be interpreted as allowing 'necessary' or 'subsistence' parameters of a demand system to depend on the demographic variables" (Pollak and Wales, 1981:1534-1535).

(4.9) $$\alpha_i = \alpha_{i0} + \sum_{j=1}^{k} \alpha_{ij} z_j$$

(4.10) $$\beta_i = \beta_{i0} + \sum_{j=1}^{m} \beta_{ij} v_j$$

Equation (4.9) insures that the minimum required expenditures per capita depend on production technology and cost structure captured by exogenous variables z_1, z_2, ... , z_k, while (4.10) says that the marginal budget share parameters depend on local taste variables v_1, ..., v_m that affect the allocation of discretionary income $(y – \alpha)$ between sectors.

Two additional restrictions are imposed such that (4.5) holds.

(4.11) $$\sum_{i=0}^{12} \beta_{ij} = 0$$

$$j = 1,2,...,m$$

(4.12) $$\sum_{i=0}^{12} \beta_{i0} = 1$$

4.3. Practical issues

In creating a panel data set, data are available for the years 2001 – 2008. However, the number of municipalities under observation differs slightly from year to year due to mergers of municipalities. This problem may be dealt with by selecting only those municipalities common to all the years. However, by taking all the municipalities in all the years, we are free to exclude the municipalities with missing data when performing the estimation, and hence both balanced and unbalanced panel estimation is possible.

4.3.1. Outlier municipalities

In the previous estimations of KOMMODE certain municipalities were considered outliers and excluded from the estimation. An outlier is defined in Langørgen, Pedersen and Aaberge (2010) as a municipality that does not fit into the model. If such municipalities are included in the model estimation, the estimates may be distorted. Thus, these outliers are excluded from estimation.

Several grounds for exclusion are used. First, municipalities that have special characteristics are considered outliers. Oslo municipality is excluded from estimation because it is both a municipality and a county government, and it is therefore not possible to distinguish completely between municipal and county expenditures in its accounts. If Oslo were included in the estimation, total expenditure would be overestimated. Other outliers in this category are: rich municipalities (Bykle, Eidfjord and Modalen), little municipalities (Utsira), very poor municipalities (Haram in 2002, Bø in 2006). Second, the municipalities that have particularly large residuals on initial estimation are excluded from the final model estimation. Third, Langørgen, Pedersen and Aaberge (2010) suggest that it is possible to determine which municipalities have an independent effect on the estimation results, that is whether there is a significant difference in the estimated coefficients with and without a particular municipality. If a significant difference is observed, that municipality is considered an outlier and omitted from the model.

Finally, municipalities that have negative or large positive per capita expenditures as well as large net operating surpluses are excluded from estimation.

The outlier municipalities differ somewhat from year to year and hence need to be combined in a meaningful way for the panel model. It is reasonable to exclude municipalities that are outliers in at least 1 year or in at least 2 years. Both formulations may be used to estimate different versions of the model. Table A.1 in Appendix A shows these municipalities as well as the total number of outliers in each year.

4.4. Price and income indices

In order to remove the effect of inflation and make the coefficients comparable over the time period of consideration, the income and expenditure variables in the model may be adjusted by a price index such that all of these variables are measured at the base of a selected year, for example 2008. The price growth (ΔP) values are taken from the Ministry of Local Government and Regional Development (2009) report. The standard formula is used to calculate the price indices (PI), normalising 2008 to 1,

(4.13)
$$PI_t = \frac{PI_{t+1}}{1 + \Delta P_{t+1}}$$

Thus the price indices are calculated recursively from 2008 back to 2001.

As an alternative deflator, an income index measure may be used. As one of the key reasons for increasing minimum expenditures is the income growth over time, deflating the income and expenditure variables by the average income growth is the method employed in this paper. Adjusting the expenditures and income in this way accounts for the part of time heterogeneity in the minimum required expenditures that is due to the fact that municipality incomes are growing over time and ensures that the estimates are comparable over time. While the price index may be more suitable in other contexts and may be used in further studies on the subject, the income index has a better theoretical basis in the present context, as we expect the change in the minimum required expenditures to result primarily from growing incomes rather than prices.

The income index R_t is determined as the mean per capita income over all municipalities[3] in each period as a fraction of the mean per capita income in the base year 2008. Thus, R_t=1 in 2008.

(4.14)
$$R_t = \frac{\bar{y}_t}{\bar{y}_8}$$

where

(4.15)
$$\bar{y}_t = \frac{1}{K_t}\sum_{k=1}^{K_t} y_{kt}$$

$$k = 1,...,K_t, \quad t = 1,...,8.$$

$\bar{y}_t$ is the mean per capita income in year t and K_t is the number of municipalities included in the estimation for a particular year. Calculations are shown in Tables A.2 – A.5 in Appendix A.

3 The index is calculated for municipalities included in the estimation; hence different indices are used for different versions of the model.

Table 4.1. Price and income indices

year	2001	2002	2003	2004	2005	2006	2007	2008
price growth	0.063	0.043	0.037	0.033	0.025	0.036	0.044	0.064
price index	0.759	0.791	0.821	0.848	0.869	0.900	0.940	1.000
income index (A) ...	0.656	0.683	0.730	0.764	0.803	0.895	0.939	1.000
income index (B) ...	0.655	0.682	0.733	0.765	0.802	0.896	0.939	1.000
income index (C) ...	0.654	0.683	0.731	0.765	0.804	0.895	0.939	1.000
income index (D) ...	0.654	0.683	0.733	0.765	0.803	0.896	0.940	1.000

(A) unbalanced panel, excluding municipalities that are outliers in at least 1 year
(B) unbalanced panel, excluding municipalities that are outliers in at least 2 years
(C) balanced panel[4] excluding municipalities that are outliers in at least 1 year
(D) balanced panel, excluding municipalities that are outliers in at least 2 years

In addition to a close proximity between the price index and income index values, Table 4.1 demonstrates an even closer relationship between the four different specifications of the income index. The income index is insensitive to the number of outliers excluded from estimation as well as the structure of the panel (balanced or unbalanced). It is therefore expected that models with income growth adjusted expenditure and income, estimated using data specifications (A) – (D), will yield similar results.

5. Panel data models for a system of equations

5.1. Time and municipality-constant effects on minimum required expenditures and marginal budget shares

In the context of panel data the linear expenditure system (4.7) may be written as:

(5.1)
$$u_{it} = \alpha_{it} + \beta_{it}\left(y_t - \sum_{i=0}^{12}\alpha_{it}\right) + \varepsilon_{it}$$
$$i = 1,...,12 \quad t = 1,...,8$$

where the index for municipality is implicit and y_t is total exogenous income. The error terms in the sector equations are assumed to be correlated resulting in contemporaneous error correlation:

(5.2)
$$\underset{i \neq j}{Cov}(\varepsilon_{it}, \varepsilon_{jt}) \neq 0$$
$$i, j = 1,...,12$$

Specification (5.2) is reasonable since the error terms for different expenditure categories are expected to reflect some common unobservable or omitted factors.

Estimating the model given by (5.1), however, will lead to biased estimates. This is a result of the fact that the effects on minimum required expenditure (α_{i0} and α_{ij} , j=1,..,r) are assumed to be constant over time and to vary only by sector. However, based on intuitive understanding and past estimations done on cross-sectional data for the years 2001 to 2007 documented in Pedersen (2008), it is known that the α's are increasing over time, as prices and incomes are increasing over time. Secondly, we expect that there may be unobserved effects that may account for the minimum expenditures increasing over time (so-called time effects) as well as unobserved municipality effects that may explain differences between municipalities that are not explained by the included explanatory variables. If these unobserved effects are correlated with at least some of the explanatory variables in the model, model (5.1)

[4] In a balanced panel municipalities that have missing data in some of the years are excluded; these municipalities are given in Table A.6 in Appendix A.

will suffer from omitted variable bias and the estimates will be biased and inconsistent.

One approach to removing the time variation in the minimum required expenditure is to transform the data by the income index, thus accounting for time variation due to income growth. Model 1 is a benchmark model to which other more complex models can be compared.

(Model 1) $$\tilde{u}_{it} = \alpha_{it} + \beta_{it}\left(\tilde{y}_t - \sum_{i=0}^{12}\alpha_{it}\right) + \varepsilon_{it}$$

Where

$$\tilde{u}_{it} = \frac{u_{it}}{R_t},\quad \tilde{y}_t = \frac{y_t}{R_t},\quad R_t = \frac{\bar{y}_t}{\bar{y}_8},\quad \bar{y}_t = \frac{1}{K}\sum_{k=1}^{K} y_{kt} \qquad k = 1,...,K,\ t = 1,...,8$$

(5.3) $$\alpha_{it} = \alpha_{i0} + \sum_{j=1}^{r}\alpha_{ij} z_{jt}$$

and

(5.4) $$\beta_{it} = \beta_{i0} + \sum_{j=1}^{m}\beta_{ij} v_{jt}$$

The expenditure and income variables in Model 1 are adjusted for growth in income, putting the model into real instead of nominal terms. The index $\boldsymbol{R}_t$ by which expenditures and income are deflated is determined as the mean income in each period as a fraction of the mean income in the base year 2008, as described in Section 4.4. The mean income is found as an average over K municipalities (indexed by k) included in the estimation in a given year. R_t is expected to be less than one in the years 2001 – 2007 since incomes have increased from 2001 to 2008 ($\bar{y}_t \leq \bar{y}_8$ for all t) and is equal to 1 in 2008 by definition.

Model 1 is consistent with the budget constraint

$$\sum_{i=0}^{12} u_{it} = y_t$$

Since

$$\frac{1}{R_t}\sum_{i=0}^{12} u_{it} = \frac{1}{R_t} y_t$$

is consistent with the budget constraint and is by definition equal to

$$\sum_{i=0}^{12} \tilde{u}_{it} = \tilde{y}_t$$

which follows directly from Model 1.

5.2. Time variation in minimum required expenditures

To account for other unobserved heterogeneity due to factors other than income growth, an alternative model that accounts for variation over time is introduced (α_{i0} and α_{ij}, j=1,..,r, are assumed to vary over time and are specified as α_{i0t} and α_{ijt}). Some of this variation is due to growing incomes and prices; the rest is due to any unobserved or omitted factors common to all municipalities in a given year. The effects on the marginal budget shares (β_{i0} and β_{ij}, j=1,..,m) are specified as time-invariant based on previous cross-sectional estimation where these parameters are found to be roughly constant throughout the years under consideration. The model is given by equation (5.5).

$$u_{it} = \tilde{\alpha}_{it} + \beta_{it}\left(y_t - \sum_{i=0}^{12}\tilde{\alpha}_{it}\right) + \varepsilon_{it} \tag{5.5}$$

where

$$\tilde{\alpha}_{it} = \alpha_{i0t} + \sum_{j=1}^{r}\alpha_{ijt}z_{jt} \tag{5.6}$$

and β_{it} is given by equation (5.4).

A potential problem with a model given by equations (5.5) and (5.6) is the large number of parameters to be estimated; with a separate minimum expenditure parameter for each sector and year.

5.3. Multiplicative time effect

A time effect implies that expenditures change over time because of unobserved factors such as changes in regulatory or government policies. Using standard panel data methods for fixed effects, we can introduce a dummy variable for each time period (i.e. year) to account for the differences in αs over time. Since from (4.9) α_i is a linear combination of parameters and exogenous variables **z** that explain the variation in the minimum required expenditure, we need to introduce the time dummies in a way that would account for differences over time in the constant term α_{i0} as well as the growth over time in the slope parameters α_{ij}. If the time dummies are introduced additively, the increase in minimum required expenditures over time is not fully internalised because the effect of increasing income on the slope parameters is not accounted for. Thus, the time dummies need to be introduced multiplicatively. This results in Model 2, which is equivalent to model (5.5) with a specific time structure imposed on the α_{i0t} and α_{ijt}, i.e. $\alpha_{i0t} = \alpha_{i0}\tau_{it}$ and $\alpha_{ijt} = \alpha_{ij}\tau_{it}$ or equivalently $\tilde{\alpha}_{it} = \alpha_{it}\tau_{it}$.

$$u_{it} = \alpha_{it}\tau_{it} + \beta_{it}\left(y_t - \sum_{i=0}^{12}\alpha_{it}\tau_{it}\right) + \varepsilon_{it} \tag{Model 2}$$

where τ_{it} is the time effect.

The model is estimated by introducing dummy variables h_t for each year such that for each sector i

$$u_i = \sum_{t=1}^{8}\alpha_{i0}\tau_{it}h_t + \sum_{t=1}^{8}\sum_{j=1}^{r}\alpha_{ij}\tau_{it}z_jh_t + \beta_i\left[y - \sum_{i=0}^{12}\left(\sum_{t=1}^{8}\alpha_{i0}\tau_{it}h_t + \sum_{t=1}^{8}\sum_{j=1}^{r}\alpha_{ij}\tau_{it}z_jh_t\right)\right] + \varepsilon_i$$

where

$$h_t = \begin{cases} 1, & year = t \\ 0, & otherwise \end{cases} \quad t = 1,2,...,8$$

The model has 8 year intercepts $\alpha_{i0t}\tau_{it}$ and may be estimated given the normalization $\tau_{i8}=1$, such that in 2001 the intercept for every sector i is $\alpha_{i0}\tau_{i1}$, in 2002 it is $\alpha_{i0}\tau_{i2}$, and in the base year 2008 α_{i0}.

It may also be desirable to test whether the beta parameters are indeed constant over time. If the betas are assumed to have time variation in the intercept parameters β_{i0t} then Model 2 can be specified with an additive time effect γ_{it} as follows:

(Model 3)
$$u_{it} = \alpha_{it}\tau_{it} + (\beta_{it} + \gamma_{it})\left(y_t - \sum_{i=0}^{12} \alpha_{it}\tau_{it} \right) + \varepsilon_{it}$$

The model is estimated by introducing dummy variables h_t for each year such that for each sector i

$$u_i = \sum_{t=1}^{8} \alpha_{i0}\tau_{it}h_t + \sum_{t=1}^{8}\sum_{j=1}^{r} \alpha_{ij}\tau_{it}z_j h_t + \left(\beta_{i0} + \sum_{t=1}^{8} \gamma_{it}h_t + \sum_{j=1}^{m} \beta_{ij}v_j \right)\left[y - \sum_{i=0}^{12}\left(\sum_{t=1}^{8} \alpha_{i0}\tau_{it}h_t + \sum_{t=1}^{8}\sum_{j=1}^{r} \alpha_{ij}\tau_{it}z_j h_t \right) \right] + \varepsilon_i$$

where $\gamma_{i8} = 0$ and $\tau_{i8} = 1$.

5.4. Municipality fixed effect

Although models 2 and 3 account for unobserved time effects, it may be desirable to test both municipality and time effects and/or combination of the two. In the context of the KOMMODE model, a fixed municipality effect implies that there exist some municipality-specific characteristics that do not change over time and are correlated with the included explanatory variables.

Before introducing the municipality effect, the expenditure and income variables are adjusted for growth in income (R_t), putting the model into real instead of nominal terms. Having accounted for time effects owing to income growth, municipality effects are included by introducing municipality dummy variables. Two specifications are proposed:

(Model 4)
$$\tilde{u}_{ikt} = \alpha_{it} + \theta_{ik} + \beta_{ikt}\left[\tilde{y}_{kt} - \sum_{i=0}^{12} (\alpha_{it} + \theta_{ik}) \right] + \varepsilon_{ikt}$$

$$i = 0,...,12,\ k = 1,...,K,\ t = 1,...,8$$

(Model 5)
$$\tilde{u}_{ikt} = \alpha_{it}\theta_{ik} + \beta_{it}\left(\tilde{y}_{kt} - \sum_{i=0}^{12} \alpha_{it}\theta_{ik} \right) + \varepsilon_{ikt}$$

$$i = 0,...,12,\ k = 1,...,K,\ t = 1,...,8$$

where k is an index for municipality, θ_{ik} is the fixed municipality effect, and in Model 4 one base municipality $\tilde{k}$ is excluded to avoid the dummy variable trap, i.e. $\theta_{i\tilde{k}} = 0$.

Model 4 is estimated by including municipality dummies additively, based on an assumption that only intercepts vary between municipalities. However, if there is also municipality variation in the slope parameters (the marginal effects of the exogenous z variables differ from municipality to municipality), the dummies should be included multiplicatively as in Model 5. However, it is reasonable to assume that any such effects are due to municipality characteristics already included in the model (e.g. municipality size: a unit increase in population for example may be expected to have a higher marginal effect on a smaller municipality's expenditures than a larger municipality).

As there are over 400 municipalities in the sample, there will be many variables in the model making estimation difficult. However, three solutions are proposed and implemented. First, first-differencing may be used to make the model more tractable.

Model 4 then becomes:

(Model 6)

$$\tilde{u}_{ikt} - \tilde{u}_{ikt-1} = \sum_{j=1}^{r} \alpha_{ij} \left(z_{jkt} - z_{jkt-1} \right) + \beta_{it} \left[\tilde{y}_{kt} - \tilde{y}_{kt-1} - \sum_{i=0}^{12} \sum_{j=1}^{r} \alpha_{ij} \left(z_{jkt} - z_{jkt-1} \right) \right] + \varepsilon_{ikt} - \varepsilon_{ikt-1}$$

Transforming Model 5 by first differencing does not decrease the number of explanatory variables. Other methods may be necessary if this model is to be estimated.

There are, however, a number of problems facing first-difference estimation. First, differencing can greatly reduce the variation in the explanatory variables, which can in turn lead to large standard errors. However, the problem is reduced when a large cross section is available. Further, using longer differences over time is sometimes preferred to using year-to-year changes as this may help to mitigate the reduced cross-sectional variation in the explanatory variables since the variation becomes more pronounced over longer periods (Wooldridge, 2002b:423). Alternatively, a within-estimator may be used. In our case, however, only 8 years are available, which does not allow for taking longer time differences. Thus, when Model 6 is estimated using year on year differences, most of the cross-sectional variation is expected to be removed causing many of the estimates to have low t-values and signs that are not in line with theoretical expectations. Since each municipality effect in Model 6 is estimated with 8 observations (one for each year), the poor performance of the model is not surprising (Beck, 2004). Moreover, by first-differencing we lose the first time period for each cross-section (municipality). Thus care must be taken in implementing a differencing model. Provided that the panel is arranged by municipality (each municipality has T consecutive observations for the T time periods under observation), differences for observation numbers 1, T+1, 2T+1, 3T+1,...,(N-1)T+1 must be set to missing as these observations correspond to the first time period for every cross section unit. Also, the explanatory variables (**z** and y) must be time-varying for at least some municipalities, otherwise these variables will fall away from the transformed model and their effect will not be estimated (Wooldridge, 2002a:280). In the KOMMODE model, many of the variables explaining the variation in the minimum required expenditures have only a small time variation. Correlation plots between the years 2001 and 2008 values are presented in Appendix B.

A second method of estimating Model 4 is to isolate and include only the significant municipality effects, thus limiting the number of dummy variables in the model and making it possible to estimate. The significance of the unobserved municipality effects may be judged based on a number of criteria. While it is possible to use the t-statistic or the adjusted R-squared to judge the significance of a given dummy variable or the improvement of the model’s fit, respectively, this paper employs a criterion of economic rather than statistical significance.

If it is not possible to estimate the model from the general version (all municipality effects included) to specific (only the significant effects remain), the alternative would be to start by including one municipality and then carrying out an iterative estimation until all municipalities have been tested. The significance criterion used may be statistical or economic. Some researchers, such as Deirdre McCloskey, are proponents of economic significance. McCloskey and Ziliak (1996) caution against relying on statistical significance without reference to theoretical or policy importance, arguing that an effect can be statistically significant without being important for science or policy, and it can be economically significant without being statistically significant. This paper uses an economic relevance criterion, namely, a municipality effect is deemed significant if it is in absolute value at least as large as 50% of the relevant sector’s per median capita expenditure adjusted by the income index. The selection of relevant municipality effects is carried out in 3 steps. First, the model is estimated 13 times (for sectors 0 to 13) for each municipality, including only one fixed effect at a time, while changing the service sector in which the fixed effect is included. After the significant fixed effects have been revealed, the second step is to include all the significant fixed effects in the model. This yields a more general model that is controlling for significant fixed effects. The third step is to test all the fixed effects again by iteration, while controlling for the fixed effects included in the second step. A second version of step 1 can also be conducted, testing each municipality in all sectors simultaneously. The details and results of the iterative procedure are presented in Section 6.2 and Appendix D.

Although the iteration procedure is instructive in isolating significant fixed effects, it is not without problems. The most significant pitfall is that statistical properties of the iteration procedure are unknown and could be producing poor results.

5.5. Economic region fixed effect

A third alternative specification is therefore proposed for the fixed effects model. In Model 7, fixed effects are included as dummy variables for economic regions into which municipalities may be grouped rather than for individual municipalities. The regional classification is developed in Bhuller (2009) and is based on commuting patterns between municipalities in order to categorise municipalities by the labour market to which they belong. A municipality must have at least 10 percent of its working population commuting to a neighbouring region if it is to be added to that region. The list of the 46 regions is provided in Appendix E.

(Model 7)

$$\tilde{u}_{it} = \alpha_{it} + \rho_{iR} + \beta_{it}\left[\tilde{y}_t - \sum_{i=0}^{12}(\alpha_{it} + \rho_{iR})\right] + \varepsilon_{it}$$

$$i = 0,...,12, \quad R = 1,...,46, \quad t = 1,...,8$$

where ρ_{iR} is the fixed region effect and one base region $\tilde{R}$ is excluded to avoid the dummy variable trap, i.e. $\rho_{i\tilde{R}} = 0$.

5.6. Region and time effects

Once the region effects have been added, it is possible to test both fixed and time effects in one model. Adding region dummies to Model 2 and including an interaction term to account for any time variance in the region effects, Model 8 captures both municipality and time heterogeneity.

(Model 8)

$$u_{it} = (\alpha_{it} + \rho_{iR})\tau_{it} + \beta_{it}\left[y_t - \sum_{i=0}^{12}(\alpha_{it} + \rho_{iR})\tau_{it}\right] + \varepsilon_{it}$$

$$\tau_{i8} = 1, \quad \rho_{i\tilde{R}} = 0$$

This may be specified by introducing dummy variables in the following way:

$$u_i = \sum_{t=1}^{8}\alpha_{i0}\tau_{it}h_t + \sum_{t=1}^{8}\sum_{j=1}^{r}\alpha_{ij}\tau_{it}z_j h_t + \sum_{R=1}^{46}\sum_{t=1}^{8}\rho_{iR}\tau_{it}h_t d_R + \beta_i\left[y - \sum_{i=0}^{12}\left(\sum_{t=1}^{8}\alpha_{i0}\tau_{it}h_t + \sum_{t=1}^{8}\sum_{j=1}^{r}\alpha_{ij}\tau_{it}z_j h_t + \sum_{R=1}^{46}\sum_{t=1}^{8}\rho_{iR}\tau_{it}h_t d_R\right)\right] + \varepsilon_i$$

where

$$h_t = \begin{cases} 1, & year = t \\ 0, & otherwise \end{cases} \quad t = 1,...,8$$

$$d_R = \begin{cases} 1, & region = R \\ 0, & otherwise \end{cases} \quad R = 1,...,46.$$

5.7. Partial adjustment model with time heterogeneity

While Model 8 accounts for time and municipality heterogeneity, it is only a quasi-dynamic model in a sense that it can describe changes in local government behaviour over time and between economic regions but does not say anything about the way in which these changes take place. Model 8 thus assumes that all spending allocations are optimised at any point in time. A partial adjustment model 9 of the form presented in Section 3.2.2. estimates how quickly the spending allocation adjusts to the desired allocation, while also taking into account time heterogeneity. Model 9 assumes existence of inertia in the adjustment of spending to its equilibrium level; that is, it takes time for municipalities to adapt their spending behaviour to changes in income, expectations, government regulation and so on. Langørgen, Pedersen and Aaberge (2010) discuss a number of possible reasons for inertia in spending allocation. Restructuring costs may contribute to spending inertia because it is costly to adapt service production to a desired level in the short term. These costs are a result of difficulty in terminating municipality workers, expensive resources required for faster restructuring and credit rationing (difficulty in obtaining funds needed for restructuring). Moreover, it takes time to free up resources and to adjust production of services to meet the changing needs of the service users or changes in the central government's policy. Thus, Model 9, which explicitly models the speed of adjustment of spending to its equilibrium level rather than assuming this adjustment to be instantaneous, may be an appropriate specification for local government spending.

(5.7)
$$u_{it} = \lambda u_{it}^* + (1-\lambda)\frac{y_t}{y_{t-1}}u_{it-1} + v_{it}$$

(5.8)
$$u_{it}^* = \alpha_{it}\tau_{it} + \beta_{it}\left(y_t - \sum_{i=0}^{12}\alpha_{it}\tau_{it}\right) + \varepsilon_{it}$$

Substituting (5.7) into (5.6) gives Model 9.

(Model 9)
$$u_{it} - \frac{y_t}{y_{t-1}}u_{it-1} = \lambda\left(\alpha_{it}\tau_{it} + \beta_{it}\left(y_t - \sum_{i=0}^{12}\alpha_{it}\tau_{it}\right) - \frac{y_t}{y_{t-1}}u_{it-1}\right) + \tilde{\varepsilon}_{it}$$
$$\tilde{\varepsilon}_{it} = \lambda\varepsilon_{it} + v_{it} \quad \tau_{i8} = 1$$

where λ is the speed of adjustment parameter, which is assumed constant and equal for all service sectors – an assumption also made by Borge, Rattsø and Sørensen (1995). This assumption may be relaxed in future extensions of the model. When the speed of adjustment parameter is 1, adjustment is instantaneous and Model 9 reduces to the time effects Model 2. When the speed of adjustment parameter is 0, the expenditure in year t is simply equal to the previous year's expenditure adjusted for income growth, represented by the $\frac{y_t}{y_{t-1}}$ term.

Since the budget constraint holds by definition both out of and in equilibrium such that

(5.9)
$$\sum_{i=0}^{12}u_{it} = y_t$$

for all t,

$$\sum_{i=0}^{12}u_{it}^* = y_t$$

and hence

$$\sum_{i=0}^{12}\left(\lambda u_{it}^{*}+(1-\lambda)\frac{y_t}{y_{t-1}}u_{it-1}+v_{it}\right)=\lambda y_t+(1-\lambda)y_t=y_t$$

using

$$\sum_{i=0}^{12}u_{it-1}=y_{t-1}\quad \sum_{i=0}^{12}v_{it}=0,$$

Model 9 is a logically consistent expenditure system that satisfies the budget constraint.

While it is possible to specify Model 9 to also include municipality heterogeneity, for instance via regional effects, this more complex version is beyond the scope of this paper and is therefore left to future research.

6. Empirical results

6.1. Data and variables

All models are based on KOSTRA[5] data available from Statistics Norway. Expenditures (u_{it}) are per capita expenditure in sector i. The expenditure in sector 4 (child care) excludes fee income from municipal kindergartens. Per capita income y_t is inclusive of user fees in all sectors except child care and exclusive of employer payroll taxes.

6.1.1. Factors that explain variation in the minimum required expenditures

Langørgen, Pedersen and Aaberge (2010) select the variables in Table 6.1 as significant factors affecting minimum required expenditures in the KOMMODE model, which the authors estimate for the years 2001 to 2008. The minimum quantity of service which must be provided in a given sector is assumed to depend on the size of the target groups for the services in that sector, while other factors affect the unit costs of providing the service. The target group variables and the variables affecting the unit costs of service provision are shown in Table 6.1 together with the sectors in which each variable is relevant.

Population age group variables[6] are included in sectors 2, 4 and 8 and are calculated as the number of municipality residents in a specified age group as a share of that municipality's total population. Since primary education, child care and care for the elderly and disabled are directed towards specific target groups, the age composition of the population is assumed to affect the demand for these services. Parameter estimates of these variables show the increase in minimum quantity when the target group is increased by one person.

[5] As of 2001 all municipalities report their expenses via KOSTRA (Kommune-Stat-Rapportering/ Municipal statistical reporting) to Statistics Norway.

[6] All population variables are measured as of 1 January of the relevant year and sourced from Statistics Norway Section for Population statistics (320).

Table 6.1. Variables that affect minimum required expenditures found to be significant in the cross-sectional analysis

	(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Population 1-5 years of age					X								
Population 6-12 years of age			X										
Population 13-15 years of age			X										
Population 67-79 years of age									X				
Population 80-89 years of age									X				
Population 90 years and above									X				
Children 0-15 years with single mother/ father								X					
Fulltime working women 20-44 years share of total population				X	X								
Refugees with integration grants *				X			X						
Refugees without integration grants							X						
Divorced/ separated 16-59 years							X						
Unemployed 16-59 years							X						
Number of poor							X	X					
Disablement pensioners 18-49 years							X						
Mentally disabled 16 years and above without grants									X				
Mentally disabled 16 years and above with grants									X				
High-cost recipients									X				
Kilometers of municipal roads											X		
Amount of snowfall											X		
Capacity of advanced purification												X	
Index of farming industry		X											
Distance to centre of municipal sub-district **			X		X	X			X				
Inverse population size		X	X		X	X			X	X		X	X
Growth in municipality incomes	X												

Note: All age-group variables are measured as shares of the total population. X shows the sector/s for which a variable is included in the minimum required expenditure.

Sector 0: Budget surplus
Sector 1: Administration
Sector 2: Primary schools
Sector 3: Other education
Sector 4: Child care
Sector 5: Health care
Sector 6: Social services
Sector 7: Child protection
Sector 8: Care for the elderly and disabled
Sector 9: Culture
Sector 10: Municipal roads
Sector 11: Water supply and sanitation
Sector 12: Other infrastructure

* total number of refugees for whom a given municipality has received integration grants throughout a particular year.
** in Norwegian miles (1 mile=10 km)

6.2. Results

The models developed in Section 5 are summarised in Table 6.2. Four versions of each model are estimated. Version A excludes municipalities which are considered outliers in at least 1 year, while version B excludes municipalities which are considered outliers in at least 2 years. The procedure for classifying a municipality as an outlier is explained in Section 4.3.1. Versions C and D are parallel to A and B in their treatment of outliers; however, specifications C and D are estimated on a balanced panel, i.e. additional municipalities are removed which have missing values for some of the years. All 4 versions, however, yield similar results and only version A is reported here. The models' residual plots are reported in Appendix C. The residuals are well-behaved and approximately normally distributed, satisfying the critical assumption of residual normality of FIML estimation. Adjusted R-Squared values are presented in Table 6.3. These statistics show a reasonable to good fit in all service sectors. The values for the R-Squared in Model 6 (first-difference model) are not reported as these are not meaningful in a first-difference model where the constant is differenced away. Model 9 has relatively low adjusted R-Square values, particularly in sector 11. However, this model is specified with the difference between sector expenditure and income growth adjusted lagged sector expenditure as the dependent variable. Thus, adjusted R-squared values are not comparable to the adjusted R-squared values of the other models.

Table 6.2. Summary of estimated models

Model name	Model number	Adjusted by income index	Time effects	Municipality or regional fixed effects
Baseline	Model 1	Yes	No	No
Time effects	Model 2	No	Yes	No
Time effects with time heterogeneity in the budget shares	Model 3	No	Yes	No
Municipality fixed effects	Model 4	Yes	No	Yes
First difference	Model 6	Yes	No	No*
Regional effects	Model 7	Yes	No	Yes
Time and regional effects	Model 8	No	Yes	Yes
Partial adjustment **	Model 9	No	Yes	No

*Municipality effects are differenced away
** Estimates the sector expenditures as a weighted average of the desired allocation and the expenditure in the previous period multiplied by income growth. The weight is the speed of adjustment parameter estimated to be 0.169.

Table 6.3. Adjusted R-Squared

Sector	Model 1	Model 2	Model 3	Model 4*	Model 7	Model 8	Model 9
1. Administration	0.84	0.88	0.88	0.88	0.86	0.89	0.45
2. Primary schools	0.79	0.86	0.86	0.78	0.82	0.88	0.39
3. Other education	0.35	0.40	0.40	0.57	0.45	0.49	0.20
4. Child care	0.35	0.86	0.87	0.39	0.46	0.88	0.30
5. Health care	0.72	0.75	0.75	0.82	0.79	0.81	0.17
6. Social assistance	0.57	0.59	0.59	0.70	0.64	0.66	0.21
7. Child protection	0.23	0.37	0.37	0.45	0.35	0.46	0.13
8. Care for the elderly and disabled	0.87	0.91	0.91	0.86	0.90	0.93	0.38
9. Culture	0.61	0.65	0.65	0.74	0.67	0.70	0.15
10. Municipal roads	0.63	0.66	0.66	0.78	0.72	0.74	0.14
11. Water supply and sanitation	0.23	0.27	0.27	0.55	0.44	0.46	0.08
12. Other infrastructure	0.57	0.59	0.60	0.73	0.65	0.68	0.12
Log likelihood	-28811	-20450	-20255	-23691	-25532	-17037	-3505

*Significant municipality effects are included in 12 service sectors

Model 1 is useful as a point of departure and comparison. The expenditures and income are adjusted by the income growth index, effectively removing time variation in the minimum required expenditures due to the increasing municipality incomes. However, any variation due to unobserved or omitted time-invariant factors is not accounted for in this model. As evident from the significant time effect estimates in Model 2, there is indeed strong justification to explicitly model minimum required expenditures as different for different years. Model 3 is estimated but not reported as the estimates are similar to Model 2 and most of the time-effects imposed on the budget shares are not significant (with the exception of child care and other education where the marginal budget share time effects are significant in 2001 – 2005) as shown in Table 6.4. Model 2 is therefore preferred to Model 3. Following the methodology employed by Langørgen, Pedersen and Aaberge (2010), models 1 and 2 are calibrated such that discretionary income[7] is approximately zero for the municipality with the lowest discretionary income. In Model 1, this is achieved by imposing a restriction on the sum of the constant terms in the minimum required expenditure in each sector[8] to ensure that discretionary income is approximately zero for municipality 0228 (Rælingen). Model 2 is similarly calibrated for municipality 1089 (Songdalen) by imposing a restriction on the constant term in the residual sector's minimum required expenditure[9].

[7] Discretionary income is given by difference between total income and the sum of minimum required expenditures in all sectors, including the residual sector, that is $y-\sum_{i=0}^{12}\alpha_{ikt}$.

[8] $\sum_{i=0}^{12}\alpha_{i0} = 10,72$

[9] $\alpha_{00} = -1,841$

Table 6.4. Additive time effects in the marginal budget shares in Model 3

	2001	2002	2003	2004	2005	2006	2007	2008
Administration	-0.017	-0.038	-0.010	-0.014	-0.016	-0.023	-0.014	0
	(1.66)	(4.18)	(1.09)	(1.80)	(2.10)	(2.86)	(2.11)	-
Primary schools	-0.013	-0.002	-0.000	-0.008	-0.006	-0.010	-0.011	0
	(1.50)	(0.26)	(0.06)	(1.03)	(0.88)	(1.74)	(2.09)	-
Other education	0.010	0.010	0.008	0.008	0.007	0.002	0.002	0
	(2.54)	(3.16)	(2.29)	(2.52)	(2.12)	(0.72)	(0.64)	-
Child care	0.040	0.043	0.029	0.021	0.010	-0.006	-0.003	0
	(6.62)	(8.46)	(5.19)	(4.09)	(2.26)	(1.78)	(1.06)	-
Health care	-0.002	0.012	0.006	0.001	-0.005	-0.005	-0.001	0
	(0.23)	(2.12)	(1.05)	(0.18)	(0.96)	(1.10)	(0.32)	-
Social services	0.000	-0.003	-0.005	-0.002	-0.001	-0.004	-0.003	0
	(0.11)	(0.65)	(1.32)	(0.56)	(0.39)	(1.24)	(1.03)	-
Child protection	-0.003	-0.005	-0.006	-0.004	-0.002	0.001	-0.000	0
	(0.61)	(1.23)	(1.61)	(1.06)	(0.58)	(0.50)	(0.15)	-
Care for the elderly and disabled	-0.013	0.006	0.006	0.018	0.009	-0.004	-0.011	0
	(0.69)	(0.35)	(0.39)	(1.28)	(0.67)	(0.29)	(1.00)	-
Culture	0.009	0.013	0.010	0.011	0.009	0.007	0.002	0
	(1.31)	(1.82)	(1.87)	(2.30)	(1.86)	(1.59)	(0.70)	-
Municipal roads	-0.005	-0.007	-0.002	-0.002	0.001	-0.002	0.003	0
	(1.39)	(2.17)	(0.65)	(0.88)	(0.61)	(0.79)	(1.56)	-
Water supply and sanitation	-0.013	-0.009	-0.003	-0.006	-0.004	-0.002	-0.002	0
	(1.70)	(1.15)	(0.37)	(0.96)	(0.70)	(0.42)	(0.52)	-
Other infrastructure	0.028	0.032	0.018	0.006	-0.010	0.007	-0.008	0
	(2.49)	(2.91)	(1.69)	(0.68)	(1.06)	(0.79)	(1.10)	-

It was not possible to estimate Model 4 with all municipality effects included (removing one to avoid perfect collinearity) using the SAS proc model procedure. A possible reason is the large number of parameters to be estimated and hence the large memory allocation required by SAS. However, the error[10] encountered in trying to estimate this model points to a problem with the SAS software and it may be possible to estimate the model using a different econometric package, or a different version of the SAS software. This may be of interest to future research. Model 4 is therefore estimated including only significant municipality effects. The estimation is conducted in three steps using an economic relevance criterion to determine which municipality effects are significant; namely, a municipality effect is deemed significant if it is in absolute value at least as large as 50% of the relevant sector's per median capita expenditure adjusted by the income index. These values, together with the mean expenditures are given in Table 6.5. The median and the mean values are fairly similar in magnitude, with the median values slightly lower. There is thus a higher probability of the effect being significant when the median is used as the critical value. Model 4 is calibrated in the way described above for municipality 1928 (Torsken) from step 2 onwards.

Table 6.5. Mean and median values of per capita income index adjusted expenditure, by service sector

Adjusted per capita expenditure by sector *	Median	Mean
0. Discretionary income	0.890	1.072
1. Administration	4.316	5.057
2. Primary schools	10.816	11.048
3. Other education	1.218	1.275
4. Child care	3.318	3.453
5. Health care	2.117	2.426
6. Social services	1.440	1.514
7. Child protection	1.117	1.154
8. Care for the elderly and disabled	14.293	14.825
9. Culture	1.761	1.918
10. Municipal roads	0.775	0.877
11. Water supply and sanitation	2.105	2.101
12. Other infrastructure	2.924	3.330

*The expenditures are calculated for the sample of 336 municipalities, where municipalities considered outliers in at least one of the eight years are excluded. Expenditures are divided by the income growth index given by equation (18), described in Section 4.4.

[10] A segmentation violation in task [Model] . SAS version used is 9.2.

We find that when sector zero effects are tested in step 1, 215 significant fixed effects are revealed based on the median expenditure criterion. This is not surprising, however, as the net operating surplus can take on both positive and negative values, leading to the median being a poor criterion of significance. Instead we develop 2 additional versions of step1. First, only those sector 0 effects whose t-value exceeds a generous critical value of 1,5 are included in step 2 together with the significant effects in other sectors whose significance is based on the median criterion. In the second variant all fixed effects are evaluated based on their t-values. Estimation results are reported in Appendix D. The final version of model 4 was estimated based on the effects revealed in step 2 with the additional effects revealed to be significant in step 3. The effects revealed significant in step 3 are presented in Table D.10 in Appendix D. The parameters of interest are reported in Tables D.11 and D.12 in Appendix D. Most of the estimates are comparable to those of Model 7 or 8 where region effects are included, suggesting that economic regions are a good approximation of the municipality-specific effects. As in other models without time effects, the effect of the share of children on the minimum required child care expenditure is biased downwards, and is not significant. In the social services sector the effect of refugees without integration grants is underestimated. One reason for this is that there may be some municipalities whose effects are significant but that are not included in this sector. The small number of significant fixed effects in the sector care for the elderly and disabled results in most of the estimates being closer in magnitude to those of the baseline model than to the region effects model.

Since many of the variables explaining the variation in the minimum required expenditures have only a small time variation, the first difference model (Model 6) produces biased results. Although these near time-invariant variables remain in the model, their estimates have inflated standard errors and hence low t-values. Correlation plots of these variables for the years 2001 and 2008 and selected estimates with standard errors are presented in Appendix B.

Model 7 was first estimated with 45 regional dummy variables, omitting region 12 (Oslo) as the base category. The results with regards to the effects of the factors influencing minimum required expenditures were generally consistent with model 24. However, the estimate of the marginal effect of the share of children (1 – 5 years of age) on the minimum required expenditure in the child care sector was negative and significant (–7.291). The negative sign is not consistent with theoretical expectations as an additional child is expected to increase, not decrease, the minimum required expenditure on child care. Model 7, therefore, appears to produce biased results, possibly due to the fact that time effects are not accounted for in this model's specification. The estimate of the effect of small children on child care's minimum spending may then be capturing unobserved time heterogeneity, which is not accounted for in this model. The problem of the negative effect of small children in the child care sector is also encountered by Borge, Rattsø and Sørensen (1995). Similarly to Model 7, their study does not account for time heterogeneity; although a partial adjustment model is assumed, Borge, Rattsø and Sørensen (1995) do not explicitly model time effects.

Furthermore, the standard errors on the region 23 (Lillehammer) estimates are inflated in every service sector in Model 7, suggesting a problem with this region's inclusion in the model. On closer examination, it was found that only one of the three municipalities in this region was included in the data used for model estimation (municipality 0522), since the other two municipalities (0501 and 0521) were removed as outliers. Hence the dummy variable for region 23 had a value zero for all but 8 observations and was therefore approximately constant across observations leading to inflated standard errors. An alternate version of the model was therefore estimated, with municipalities 0501 and 0521 included in the sample. The regional effects are reported in Table E.3. in Appendix E and summarised in Table 6.6. The remaining parameters are reported in Tables 6.11 – 6.23. These are mostly very close in magnitude to the estimates in Model 1, where no regional effects are included. This finding, combined with the fact that few regional effects are significant, suggests that a model with time effects, such as Model 2, is more appropriate than a model without time effects. The regions that have statistically significant effects on the minimum required expenditures in more than one service sector are: 34, 35 and 36 (Southern Norway), 44 (Bergen), 63 (Namsos), 72, 75, 76, 82 and 83 (Northern Norway). It is indeed plausible that the minimum required expenditures in these regions are on average different from those in the Oslo region.

Table 6.6. Significant region effects by service sector in model 7

Economic region	Number of sectors with significant effect	Service sectors with significant effect
23. Lillehamer	1	6
34. Arendal	2	1 and 5
35. Kristiansand	4	4, 6, 9 and 11
36. Lister	13	All sectors
44. Bergen	3	0, 7 and 11
51. Sunnfjord (Førde/ Florø)	1	6
53. Nordfjord	1	7
55. Ålesund	1	7
61. Trondheim	1	7
63. Namsos	2	0 and 7
71. Bodø	1	11
72. Narvik	2	0 and 7
75. Harstad	10	0, 1, 2, 3, 4, 5, 8, 9,10 and 11
76. Midt-Troms	4	2, 4, 10 and 11
81. Alta	1	0
82. Hammerfest	2	4 and 6
83. Vadsø	10	1, 2, 3, 4, 5, 6, 7, 8, 9 and 11

The effects are statistically significant at 10% significance level

In order to account for possible interaction between time and regional heterogeneity, Model 8 is estimated. Regional and time effects are included in all 13 sectors. The effects on the minimum required expenditures are reported in Section 6.2.1 and the marginal budget shares in Section 6.2.2. Importantly, the effect of the 1 – 5 year old children on the minimum expenditure in the child care sector is no longer negative as in Model 7, and is statistically significant. We observe an increase of NOK 58154 in the minimum required child care expenditure for an additional 1 – 5 year old child in 2008. The regional effects are reported in Table E.4. in Appendix E. Table 6.7 summarises statistically significant regions and the service sectors in which these effects apply.

Table 6.7. Significant region effects by service sector in model 8

Labour market region	Region number	Number of sectors with significant effect	Service sectors with significant effect
Eastern Norway			
Sør-Østfold	11	1	6
Oslo	12		base region
Vestfold	13	2	6,11
Kongsberg	14	2	3,7
Hallingdal	15	5	1,5,7,11,12
Valdres	21	3	3,6,11
Gudbrandsdalen	22	6	1,4,7,8,10,12
Lillehammer	23	0	none
Gjøvik	24	1	6
Hamar	25	1	6
Kongsvinger	26	2	6,7
Elverum	27	3	6,7,10
Tynset/Røros	28	8	0,1,3,4,6,7,8,10
Southern Norway			
Nordvest-Telemark	31	4	0,1,8,10
Øst-Telemark	32	0	none
Sør-Telemark	33	2	3,6
Arendal	34	3	5,6,11
Kristiansand	35	9	1,2,4,6,8,9,10,11,12
Lister	36	3	4,7,8
West Norway			
Stavanger	41	3	3,6,9
Haugesund	42	9	0,1,5,6,7,8,10,11,12
Sunnhordland	43	1	4
Bergen	44	6	0,1,4,6,7,11
Sunnfjord (Førde/Florø)	51	4	0,1,6,10
Sognefjord (Sogndal/Årdal)	52	7	0,1,3,4,9,10,12
Nordfjord	53	2	7,11
Søndre Sunnmøre	54	6	2,3,4,7,8,10
Ålesund	55	4	0,1,4,7
Molde	56	1	7
Nordmøre	57	5	0,1,5,6,10
Kristiansund	58	0	none
Mid-Norway			
Trondheim	61	6	0,6,7,8,10,11
Midt-Trøndelag	62	1	11
Namsos	63	6	0,1,3,7,10,11
Ytre Helgeland	64	6	0,1,6,10,11,12
Indre Helgeland	65	0	none
Northern Norway			
Bodø	71	5	0,1,2,6,11
Narvik	72	2	0,7
Vesterålen	73	0	none
Lofoten	74	1	11
Harstad	75	4	2,3,8,10
Midt-Troms	76	5	0,6,7,10,12
Tromsø	77	6	0,2,7,8,9,11
Alta	81	3	3,9,12
Hammerfest	82	6	0,4,7,8,9,12
Vadsø	83	5	0,4,9,10,12

The effects are statistically significant at 10% significance level

Finally, the partial adjustment model (Model 9) explicitly estimates the dynamics of adjustment of municipality expenditures to their equilibrium values. To facilitate convergence of the model's parameters, a restriction is imposed on the constant term α_{00} in the residual sector's minimum required expenditure (minimum savings). Although this parameter may be given different values, it is set to zero in Model 9.

Aaberge and Langørgen (2003) provide a detailed discussion of the meaning and expected sign of the parameters in sector 0's minimum required expenditure α_0. In KOMMODE and also in the models presented in this paper, α_0 is composed of a constant term α_{00} and a change in real exogenous income from the previous year. Hence $-\alpha_0$ is the present value of changes in future exogenous income. The negative of the constant term $-\alpha_{00}$ captures the present value of a long-term growth trend in exogenous income. Historically this trend is positive in Norway, implying that $\alpha_{00} < 0$. However, the Local Government Act contains a balanced budget rule that prohibits local governments to plan for persistent deficits, although temporary deficits are allowed and observed in practice (Langørgen and Aaberge, 2003). Thus, although $\alpha_{00} < 0$ may be an accurate description of the local governments' saving behaviour at a point in time, in the long run equilibrium the balanced budget rule can be seen to restrict α_{00} to be non-negative. Since in Model 9 this parameter describes the long-run growth trend of the desired/ equilibrium spending u_{it}*, it is reasonable for it to be set to zero. Nevertheless, other specifications are possible and may be explored in future studies.

The adjusted R-Squared reported in Table 6.7 indicate that explanatory power of the model is fairly low, and hence conclusions should be drawn with care. It may be possible to improve the fit of the model by introducing municipality or region fixed effects in the desired expenditure. This is left to future work. The speed of adjustment parameter λ is estimated to be 0.169[11], which implies a fairly slow adjustment to the equilibrium allocation. The effects on the equilibrium minimum required expenditures and marginal budget shares are reported in Tables 6.11 – 6.23. Time effects are found in Table 6.10.

6.2.1. Effects on minimum required expenditures

Time effects estimated in models 2, 8 and 9 are reported in Tables 6.8 – 6.10. The marginal effects on the minimum required expenditures for the base year 2008, when the time effect is normalised to 1, are reported in Tables 6.11 – 6.23. The marginal effects on the minimum required expenditures for the years 2001 – 2007 may be calculated by multiplying the 2008 parameter values found in Tables 6.11 – 6.23 by the time effect in the corresponding year found in Tables 6.8 – 6.10. All estimate values are in 1000s Norwegian kroner (except in Tables 6.8 – 6.10) and all values in parentheses are t-statistics in absolute value.

Table 6.8. Time effects in the time effect model (Model 2)

Service sector	2001	2002	2003	2004	2005	2006	2007
0. Net operating result	0.605	0.881	1.006	0.682	0.550	0.958	0.498
	(9.20)	(13.42)	(10.37)	(9.11)	(7.61)	(11.33)	(9.08)
1. Administration	0.506	0.371	0.522	0.587	0.594	0.558	0.728
	(19.41)	(14.55)	(19.95)	(26.53)	(28.59)	(27.29)	(36.40)
2. Primary schools	0.640	0.689	0.732	0.754	0.785	0.811	0.888
	(58.90)	(69.05)	(67.17)	(78.81)	(86.87)	(93.00)	(96.96)
3. Other education	0.675	0.751	0.759	0.802	0.816	0.792	0.876
	(28.52)	(33.04)	(33.57)	(36.98)	(39.18)	(35.67)	(38.69)
4. Child care	0.237	0.306	0.358	0.456	0.518	0.640	0.805
	(21.07)	(27.40)	(27.82)	(39.85)	(46.13)	(66.33)	(77.60)
5. Health care	0.416	0.513	0.560	0.628	0.644	0.604	0.755
	(13.28)	(17.21)	(18.21)	(22.61)	(26.05)	(24.60)	(31.17)
6. Social services	0.619	0.631	0.630	0.635	0.706	0.767	0.846
	(35.77)	(40.75)	(40.46)	(41.44)	(43.98)	(44.34)	(47.76)
7. Child protection	0.529	0.590	0.598	0.660	0.703	0.747	0.857
	(21.19)	(23.83)	(24.68)	(30.40)	(33.76)	(36.22)	(42.13)
8. Care for the elderly and disabled	0.526	0.610	0.633	0.690	0.711	0.758	0.849
	(38.22)	(48.36)	(47.42)	(58.60)	(65.87)	(75.25)	(84.31)
9. Culture	0.405	0.497	0.462	0.577	0.585	0.436	0.658
	(7.01)	(9.44)	(7.67)	(11.28)	(12.41)	(8.72)	(13.11)
10. Municipal roads	0.545	0.608	0.581	0.660	0.710	0.761	0.841
	(18.19)	(20.05)	(19.58)	(23.58)	(27.61)	(28.68)	(35.67)
11. Water supply and sanitation	0.618	0.679	0.684	0.756	0.766	0.759	0.820
	(16.21)	(18.65)	(19.39)	(22.28)	(23.80)	(23.66)	(25.84)
12. Other infrastructure	0.501	0.560	0.529	0.647	0.629	0.498	0.744
	(8.24)	(8.85)	(8.23)	(11.32)	(10.92)	(8.76)	(13.20)

The 2008 time effects in all service sectors are normalised to 1.

[11] The estimate is statistically significant with the t-value = 66.71.

Table 6.9. Time effects in the time and region effects model (Model 8)

Service sector	2001	2002	2003	2004	2005	2006	2007
0. Net operating result	0.594	0.720	0.731	0.698	0.621	0.573	0.654
	(19.94)	(23.35)	(22.80)	(22.88)	(19.37)	(15.35)	(22.48)
1. Administration	0.633	0.442	0.639	0.656	0.667	0.699	0.809
	(30.74)	(20.46)	(37.69)	(36.80)	(38.68)	(37.39)	(48.11)
2. Primary schools	0.684	0.731	0.782	0.787	0.822	0.871	0.924
	(80.19)	(89.89)	(99.67)	(101.60)	(109.23)	(120.77)	(140.11)
3. Other education	0.770	0.859	0.870	0.894	0.905	0.894	0.941
	(23.53)	(25.61)	(26.67)	(27.51)	(28.66)	(30.92)	(32.90)
4. Child care	0.184	0.258	0.322	0.419	0.495	0.669	0.825
	(12.69)	(18.69)	(23.18)	(33.51)	(42.25)	(71.74)	(93.31)
5. Health care	0.500	0.604	0.680	0.695	0.724	0.766	0.853
	(16.08)	(21.97)	(25.65)	(27.25)	(29.17)	(32.61)	(41.17)
6. Social services	0.666	0.669	0.665	0.659	0.735	0.816	0.878
	(29.69)	(31.67)	(29.80)	(30.45)	(32.03)	(37.61)	(42.09)
7. Child protection	0.546	0.605	0.629	0.681	0.733	0.803	0.887
	(18.89)	(21.90)	(22.52)	(27.61)	(30.71)	(33.95)	(38.04)
8. Care for the elderly and disabled	0.552	0.640	0.673	0.713	0.737	0.817	0.880
	(45.30)	(58.97)	(63.47)	(68.94)	(76.78)	(86.24)	(100.31)
9. Culture	0.512	0.614	0.637	0.674	0.645	0.662	0.801
	(6.41)	(7.82)	(8.72)	(9.40)	(8.74)	(9.20)	(12.37)
10. Municipal roads	0.652	0.706	0.700	0.743	0.809	0.936	0.948
	(16.19)	(19.75)	(20.10)	(23.22)	(23.90)	(24.30)	(32.29)
11. Water supply and sanitation	0.686	0.754	0.780	0.823	0.846	0.904	0.896
	(18.30)	(21.76)	(21.50)	(23.05)	(23.52)	(26.20)	(27.94)
12. Other infrastructure	0.735	0.791	0.895	0.753	0.887	0.804	0.832
	(10.19)	(10.52)	(10.80)	(9.58)	(10.81)	(9.02)	(10.31)

The 2008 time effects in all service sectors are normalised to 1.

Table 6.10. Time effects in the partial adjustment model (Model 9)

Service sector	2002	2003	2004	2005	2006	2007
0. Net operating result	0.648	0.870	0.761	1.092	1.166	0.702
	(9.21)	(7.09)	(7.91)	(9.57)	(11.17)	(7.68)
1. Administration	-0.009	0.687	0.380	0.413	0.558	0.784
	(0.33)	(23.51)	(14.03)	(14.97)	(15.27)	(28.48)
2. Primary schools	0.664	0.636	0.534	0.656	0.713	0.871
	(25.01)	(26.43)	(21.39)	(24.85)	(25.14)	(35.21)
3. Other education	0.878	0.535	0.600	0.629	0.519	0.872
	(16.31)	(12.63)	(12.74)	(16.57)	(11.58)	(17.31)
4. Child care	0.395	0.357	0.481	0.475	0.760	0.870
	(19.09)	(21.49)	(24.24)	(26.09)	(47.09)	(54.15)
5. Health care	0.572	0.482	0.433	0.498	0.634	0.799
	(19.52)	(17.98)	(15.14)	(17.40)	(18.81)	(26.14)
6. Social services	0.674	0.587	0.375	0.641	0.402	0.552
	(16.90)	(15.45)	(11.96)	(18.18)	(10.33)	(13.17)
7. Child protection	0.528	0.455	0.555	0.598	0.666	0.851
	(10.92)	(9.63)	(12.65)	(13.48)	(17.86)	(20.89)
8. Care for the elderly and disabled	0.613	0.432	0.528	0.524	0.707	0.812
	(28.00)	(20.92)	(22.34)	(24.39)	(30.95)	(38.06)
9. Culture	0.545	0.401	0.459	0.554	0.728	0.861
	(12.13)	(9.91)	(10.27)	(12.37)	(13.92)	(20.48)
10. Municipal roads	0.650	0.435	0.640	0.669	0.960	1.039
	(10.58)	(7.58)	(10.96)	(11.94)	(15.70)	(20.13)
11. Water supply and sanitation	0.571	0.451	0.546	0.561	0.712	0.693
	(12.19)	(10.61)	(11.07)	(11.29)	(14.14)	(16.05)
12. Other infrastructure	0.676	0.576	0.699	0.700	0.958	1.202
	(7.80)	(6.17)	(8.63)	(8.40)	(11.14)	(12.27)

The 2008 time effects in all service sectors are normalised to 1. Time effects in 2001 are 0 as this year is effectively removed from estimation since lagged expenditure and income are not defined in 2001.

Most of the time effects are increasing as expected from 2001 to 2008. When a decrease in the time effect is observed, it may occur in different years in models 2 and 8. The decreases in time effects that are common to both models are: a small decrease in 2002 in the administration sector and a decrease in the other education sector in 2006, implying that the effects on the minimum required expenditures are smaller in these years. The culture sector exhibits decreasing time effects in 2005 (Model 8) and in 2003 and 2006 (Model 2). The other infrastructure sector shows a small decrease in 2006. The partial adjustment model shows decreasing time effects in the primary schools sector for the years 2002 – 2004. The increase in the primary schools minimum required expenditures from 2005 onwards could be a result of education policies of the newly elected central government, Stoltenberg II[12], which came into power in October 2005. The time effects are increasing in the child care sector and also increasing from 2006 in the care for the elderly and disabled sector. Other infrastructure and municipal roads sectors have higher time effects in 2007 than in 2008.

The estimated marginal effects on minimum required expenditures are mostly reasonable. However, time effects in Model 2 appear to indicate a decrease in minimum fiscal surplus for the years 2004 to 2005 and in 2007. Model 8 shows decreasing time effects from 2004 to 2006. These results are unexpected and warrant further investigation. One possibility is that interactive time effects are not a good description of the dynamics in this sector. Some dynamic adjustment may be present in the net operating result, meaning that there may be some residual effects from the year before on the current year's net operating result. If this is indeed the case, then the time effect for a specific year may be capturing some effects from the years before. The partial adjustment model (Model 9) shows that the speed of adjustment of the sector expenditures to their respective desired values is indeed relatively small (0.169), suggesting a fairly slow adjustment. However, another possible explanation for the decrease in minimum savings is a change in municipalities' expectations. As the Stoltenberg II government came into power in Norway in 2005, municipality incomes saw a substantial increase and it is reasonable to suppose that the municipalities expected further income increases in the future, leading to higher spending on service provision and lower savings[13]. This is confirmed by the fact that growth in incomes has a positive and significant effect on the minimum savings in all models estimated; anticipating higher incomes in the future, municipalities can decrease their savings in the current period, knowing that they will be able to finance higher savings in the future.

The effect of income growth on equilibrium savings is 5.014 in the partial adjustment model, implying that a 1 kroner increase in real income will increase savings by 5.014 kroners in the long-run. However, the short-run effect, comparable to the static models, is 0.847 (5.014 multiplied by the adjustment coefficient 0.169). That is each year municipalities allocate 84.7% of additional income to savings (a surprisingly large percentage), with the long-run equilibrium reached after approximately 6 years[14].

[12] Stoltenberg II, or Stoltenberg's Second Cabinet, is the current government of Norway appointed on 17 October 2005. It is a coalition between the Labour Party, the Socialist Left Party and the Centre Party. Stoltenberg I was the first cabinet of Jens Stoltenberg, which was in power from 2000 to 2001.

[13] An increase of NOK 5.4 billion in non-earmarked funds provided to municipalities in 2006 was promised by Jens Stoltenberg during his inaugural address (19 October 2005).

[14] The number of time periods it takes to reach equilibrium is given by the inverse of the speed of adjustment (1/0.169) since the adjustment is implicitly assumed to be uniform. Actual spending is assumed to approach the long-run equilibrium asymptotically, closing the gap by a fixed percentage (16.9%) each period.

Table 6.11. Sector 0 Net budget surplus: effects on minimum required expenditure

Model number	(1)	(2)	(6)	(7)	(8)	(9)
Model name	Baseline model	Time effects	First difference	Regional effects	Time and regional effects	Partial adjustment
Time effects	No	Yes	No	No	Yes	Yes
Municipality or region effects	No	No	No	Yes	Yes	No
Adjusted by income index	Yes	No	Yes	Yes	No	No
Constant	-0.977	-1.841	-	-11.839	-3.549	0.000
	-	-	-	-	(8.47)	-
Growth in municipality incomes	0.533	0.595	0.516	0.553	0.567	5.014
	(29.33)	(20.09)	(20.23)	(24.59)	(17.30)	(11.04)

In the administration sector, both the inverse population size and the index of farming industry have positive and significant effects on the minimum required expenditure. Minimum required expenditure on administration is higher for smaller municipalities, as they use a larger share of resources on administration, suggesting that economies of scale play a significant role in this sector. The minimum required expenditures are increasing over time as expected, with the exception of a decrease in 2002. Both the effect of the inverse population size and index of farming industry are higher in model 2 and 8 than in the baseline model, suggesting that the baseline model underestimates these effects due to unobserved time variation in the minimum required expenditure. However, when compared to the cross-sectional estimates[15] for the year 2008, the baseline model estimates are lower. The cross-sectional estimates of the effect of inverse population size and index of farming industry are 4.43 and 4.88 respectively.

Table 6.12. Sector 1 Administration: effects on minimum required expenditure

Model number	(1)	(2)	(6)	(7)	(8)	(9)
Model name	Baseline model	Time effects	First difference	Regional effects	Time and regional effects	Partial adjustment
Time effects	No	Yes	No	No	Yes	Yes
Municipality or region effects	No	No	No	Yes	Yes	No
Adjusted by income index	Yes	No	Yes	Yes	No	No
Constant	2.058	1.968	-	-5.099	1.253	6.080
	(31.47)	(17.99)	-	(1.25)	(5.84)	(16.37)
Inverse population size ...	4.102	5.255	4.603	4.589	5.073	8.172
	(34.31)	(44.93)	(2.08)	(30.77)	(34.82)	(18.70)
Index of farming industry .	3.634	4.997	-18.133	3.650	5.772	15.493
	(5.46)	(6.35)	(1.49)	(3.60)	(4.82)	(6.91)

Primary schools are compulsory for children 6 – 15 years of age. Population shares of children of the primary school-going age have a positive and significant effect on the minimum required expenditure on primary schools, implying that service provision increases as a function of the number of children in this age group. Children aged 6 – 12 years receive less services than children aged 13 – 15 years. This difference is due to the fact that the latter group faces more extensive and demanding lessons, which requires teachers with higher qualifications. Table 6.13 shows that the estimate of the effect of population share of 6 – 12 year old children is in fact lower than that of the 13 – 15 year olds. This difference is most pronounced in the model with both time and regional effects. Compared to the cross-sectional estimates, the baseline, time effects and time and regional effects models predict a smaller effect of the 6 – 12 year olds, but the effect of the 13 – 15 year old children is larger than the cross-sectional estimate.

[15] The latest cross-sectional estimates are presented in Langørgen et al. (forthcoming). All comparisons between cross-sectional estimates and those of the panel data models are based on the base year 2008, unless otherwise stated.

An extra kilometer to the municipal subdistrict increases the minimum required expenditure due to the fact that municipalities that are further from the district centre are more likely to have more schools locally (a decentralised school structure with relatively few pupils per school and small class sizes) so that pupils are not forced to travel long distances to school. The increase is NOK 1346 in the baseline model, marginally higher at NOK 1365 in the time effects model and only NOK 991 in the time and region effect model. The relatively lower effect of distance to centre of municipal subdistrict in models 7 and 8 may suggest that region effects are correlated with the distance variable and therefore account for some of the distance effect. Again economies of scale are present in this sector since class sizes are in general smaller in smaller municipalities, implying more teachers per student and therefore higher costs. Minimum required expenditures are increasing from 2001 to 2008 as expected. The effects of the inverse population size are only marginally higher in models 1, 2 and 8 than in the cross-sectional estimation. However, the effect of the 13 – 15 year old children is higher in all three models than the cross-sectional estimates, suggesting that the panel data models are able to capture more variation between these two effects.

Table 6.13. Sector 2 Primary schools: effects on minimum required expenditure

Model number	(1)	(2)	(6)	(7)	(8)	(9)
Model name	Baseline model	Time effects	First difference	Regional effects	Time and regional effects	Partial adjustment
Time effects	No	Yes	No	No	Yes	Yes
Municipality or region effects	No	No	No	Yes	Yes	No
Adjusted by income index	Yes	No	Yes	Yes	No	No
Constant	0.348	-0.676	-	-5.777	-0.407	1.270
	(1.61)	(2.69)	-	(1.75)	(1.04)	(1.40)
Population 6-12 years of age	52.391	50.451	30.324	54.294	44.327	82.177
	(22.92)	(21.19)	(9.65)	(18.31)	(14.58)	(8.87)
Population 13-15 years of age	64.720	86.446	19.465	68.390	78.142	67.213
	(14.84)	(19.75)	(5.98)	(12.88)	(15.01)	(4.01)
Distance to centre of municipal sub-district	1.346	1.365	0.114	1.030	0.991	1.297
	(30.48)	(31.95)	(0.57)	(16.24)	(14.99)	(8.19)
Inverse population size	2.395	2.461	4.435	2.414	2.205	3.712
	(19.63)	(23.06)	(3.93)	(16.01)	(15.97)	(11.44)

The service sector other education includes day care facilities for schoolchildren, music schools, special schools and adult education. Except for adult education, the relevant group that benefits from other education is the age group 6 – 15 years. Adult education is particularly directed toward recently domiciled refugees in the age group 20 – 59 years. Recently domiciled refugees include refugees who have resided in Norway less than five years.

Table 6.14 shows that the minimum required expenditure for other education is positively and significantly affected by the number of full-time working women and refugees with integration grants. Both effects are increasing from 2001 to 2008. In the time effects model an extra full-time working woman in the municipality’s population increases the minimum expenditure in the other education service sector by NOK 5680 in 2008. In the cross-sectional model this effect is significantly smaller: NOK 3570; and only slightly smaller in the time and regional effects model. The cross-sectional effect of the share of refugees is also smaller than in models 1, 2 and 7 (an additional refugee increases minimum required expenditure on other education by NOK 3237).

Table 6.14. Sector 3 Other education: effects on minimum required expenditure

Model number	(1)	(2)	(6)	(7)	(8)	(9)
Model name	Baseline model	Time effects	First difference	Regional effects	Time and regional effects	Partial adjustment
Time effects	No	Yes	No	No	Yes	Yes
Municipality or region effects	No	No	No	Yes	Yes	No
Adjusted by income index	Yes	No	Yes	Yes	No	No
Constant	0.478	0.445	-	-0.677	0.306	0.762
	(10.44)	(9.34)	-	(1.02)	(3.35)	(5.03)
Full-time working women 20-44 years	5.983	5.680	-0.889	5.213	5.276	7.261
	(9.14)	(8.67)	(0.75)	(5.22)	(5.37)	(3.22)
Refugees with integration grants	38.131	35.992	17.773	38.318	30.745	51.658
	(27.60)	(21.97)	(10.69)	(19.34)	(13.04)	(10.15)

In the child care sector the service provision increases in the population share of children in pre-school age (1 – 5 years) but only in the models where time effects are included. The time effects model predicts that an extra child of age 1 – 5 years will increase the child care minimum expenditure by NOK 57137 in 2008, while in 2001 the increase is a much smaller one of NOK 13541 (calculated by multiplying 57137 by the 2001 time effect found in Table 6.12). The effects are NOK 58154 in 2008 and NOK 10700 (calculated by multiplying 58154 by the 2001 time effect found in Table 6.9) in 2001 when both time and region effects are included. The cross-sectional estimate is a marginal increase of NOK 60310 in 2008 and NOK 13880 in 2001. Thus, there is a large increase from 2001 to 2008 in the minimum required expenditures in the child care sector. This is suggestive of an increased priority placed on the child care sector during these 8 years. Model 1, 6 and 7 have poor explanatory power for this sector as both predict a negative (albeit not significant in Model 1) marginal effect of the population share of small children. Although all three models account for income growth, and models 6 and 7 account for municipality effects, they fails to explain the time effects, which seem to be important for this sector. Full-time working young women have a positive significant effect on the minimum child care expenditure since they are likely to require more child care such as kindergarten places for their children.

Table 6.15. Sector 4 Child care: effects on minimum required expenditure

Model number	(1)	(2)	(6)	(7)	(8)	(9)
Model name	Baseline model	Time effects	First difference	Regional effects	Time and regional effects	Partial adjustment
Time effects	No	Yes	No	No	Yes	Yes
Municipality or region effects	No	No	No	Yes	Yes	No
Adjusted by income index	Yes	No	Yes	Yes	No	No
Constant	1.374	-1.331	-	-1.236	-1.914	-0.239
	(9.25)	(11.53)	-	(0.80)	(9.30)	(0.71)
Population 1-5 years of age	-2.750	57.137	-14.335	-7.621	58.154	94.687
	(1.17)	(31.03)	(4.58)	(2.43)	(20.91)	(13.64)
Full-time working women 20-44 years	25.818	29.149	20.317	28.678	28.197	26.022
	(19.12)	(24.41)	(11.62)	(13.74)	(14.23)	(6.16)

Diseconomies of scale are present in the health sector as both the effect of the distance to the centre of municipal sub-district and the inverse population size have positive effects on the minimum required expenditure; that is the more dispersed the municipality's settlement pattern and the smaller the population, the larger the minimum required expenditure on health care. A possible explanation is that patients in primary health care are entitled to have a physician within reasonable travelling distance, which increases the cost of providing health care in smaller municipalities. Similarly, to maintain a basic capacity of primary physicians in smaller municipalities the physician-patient ratio becomes relatively large, which increases the unit cost. The time effect as well as the time and regional effect models provide smaller estimates of economies of scale than does cross-sectional estimation, indicating that the latter may be capturing additional effects of unobserved time heterogeneity, which is accounted for in models 2 and 8 through time effects.

Table 6.16. Sector 5 Health care: effects on minimum required expenditure

Model number	(1)	(2)	(6)	(7)	(8)	(9)
Model name	Baseline model	Time effects	First difference	Regional effects	Time and regional effects	Partial adjustment
Time effects	No	Yes	No	No	Yes	Yes
Municipality or region effects	No	No	No	Yes	Yes	No
Adjusted by income index	Yes	No	Yes	Yes	No	No
Constant	1.076	1.023	-	-1.906	0.770	2.855
	(27.60)	(17.39)	-	(1.09)	(6.52)	(16.98)
Distance to centre of municipal sub-district	0.230	0.269	0.019	0.123	0.104	0.403
	(8.40)	(8.05)	(0.26)	(3.26)	(2.20)	(4.81)
Inverse population size ...	1.508	1.841	3.858	1.454	1.514	3.222
	(22.29)	(27.67)	(7.96)	(18.91)	(16.44)	(18.17)

A large share of spending in the social assistance sector is cash transfers to support families with insufficient means from other sources of income. The sector also includes in-kind bennefits that aim to prevent alcohol and drugs abuse and other social problems. The potential recipients are either poor, unemployed, refugees or divorced/separated, or possess different combinations of those characteristics.

The number of refugees both with and without integration grants have a significant and positive effect on minimum social assistance expenditure. As expected, a refugee who has lived in Norway for less than 5 years and for whom, therefore, the central government will pay an integration grant to the municipality, increases the minimum required expenditure by a larger amount (NOK 62154 in the time effect model and NOK 56033 in the time and region effect model) than a refugee without a grant (NOK 11038 and NOK 11129 respectively). This is a reasonable result since the refugees qualifying for an integration grant are likely to require more social assistance from the local government. This difference is even more pronounced in the cross-sectional estimates. Other target groups of social assistance, such as the divorced and separated, unemployed, poor and disablement pensioners all have significant positive effects on the minimum required expenditure in this sector, with the unemployed having a relatively larger effect, and the poor relatively smaller. In models 7 and 8, however, disablement pensioners have a relatively small effect, which is not statistically significant. Thus, when the regional variation is taken into account, the share of disablement pensioners appears to be less important for determining minimum required expenditure in social assistance.

Table 6.17. Sector 6 Social assistance: effects on minimum required expenditure

Model number	(1)	(2)	(6)	(7)	(8)	(9)
Model name	Baseline model	Time effects	First difference	Regional effects	Time and regional effects	Partial adjustment
Time effects	No	Yes	No	No	Yes	Yes
Municipality or region effects	No	No	No	Yes	Yes	No
Adjusted by income index	Yes	No	Yes	Yes	No	No
Constant	-0.325	-0.503	-	-1.181	-0.718	-0.606
	(5.23)	(7.28)	-	(2.68)	(4.84)	(2.43)
Refugees with integration grants	54.507	62.154	24.131	53.241	56.033	92.381
	(32.91)	(30.40)	(11.96)	(23.88)	(19.44)	(10.64)
Refugees without integration grants	10.791	11.038	65.349	12.870	11.129	9.494
	(8.04)	(7.63)	(2.22)	(7.63)	(6.49)	(1.66)
Divorced/ separated 16-59 years	10.567	11.955	1.227	13.048	13.486	22.284
	(11.66)	(11.91)	(0.59)	(8.49)	(8.09)	(5.86)
Unemployed 16-59 years	18.421	25.922	13.689	19.542	28.412	33.785
	(11.22)	(10.74)	(8.56)	(8.80)	(7.48)	(4.57)
Number of poor	7.037	8.192	3.220	5.210	5.985	7.715
	(6.78)	(7.18)	(3.99)	(3.96)	(4.03)	(1.78)
Disablement pensioners 18-49 years	10.968	13.303	-6.776	3.187	4.817	5.494
	(6.46)	(6.87)	(1.80)	(1.01)	(1.38)	(0.71)

The child protection sector includes investigation of alleged child abuse, orphan homes, foster care, adoption services, and services aimed at supporting at-risk families so they can remain intact. Children less than 16 years of age are the primary target group for child protection. As expected children with a single parent have a positive marginal effect on the minimum expenditure, as do the poor. The models with time effects estimate that both effects are increasing over time. In contrast and somewhat surprisingly, cross-sectional estimations show a decrease in the marginal effect of share of children with a single parent, from 2007 to 2008. The downward bias in the 2008 estimate may be a consequence of unobserved time heterogeneity, which is taken into account by including time effects in the panel data models. Similarly, the share of poor estimate is much lower in the region effects model (Model 7), albeit not significant. It is also relatively low in model 8, and significant, suggesting that regional variation is accounting for what was previously supposed to be the effect of the poor on minimum expenditure in this sector.

Table 6.18. Sector 7 Child protection: effects on minimum required expenditure

Model number	(1)	(2)	(6)	(7)	(8)	(9)
Model name	Baseline model	Time effects	First difference	Regional effects	Time and regional effects	Partial adjustment
Time effects	No	Yes	No	No	Yes	Yes
Municipality or region effects	No	No	No	Yes	Yes	No
Adjusted by income index	Yes	No	Yes	Yes	No	No
Constant	0.312	0.291	-	-0.133	0.476	0.935
	(7.75)	(6.23)	-	(0.34)	(4.90)	(5.97)
Children 0-15 years with single mother/ father	15.988	17.358	4.506	17.317	17.840	21.412
	(14.76)	(13.12)	(2.53)	(10.02)	(8.59)	(6.05)
Number of poor	5.472	7.053	-0.773	1.787	2.521	6.996
	(7.57)	(8.62)	(1.29)	(1.90)	(2.20)	(2.45)

Care for the elderly and disabled includes nursing homes, ambulant nurses and home care. Since elderly people have a higher probability of becoming recipients of long-term care, spending needs are higher for the elderly than for younger people. Subsistence output is increasing with age, and is highest for the elderly 90 years and above, with an additional person over the age of 90 increasing minimum expenditure by NOK 170567 in 2008 in the time and region effects model, while the increase for a marginal person of 67 – 79 years is significantly smaller (NOK 41659). However, the group of mentally disabled, which by and large is a subgroup of the age group 0 – 66 years, is included to account for the additional cost from being mentally disabled. The cost is higher for those mentally disabled persons with intergovernmental grants than without; with model 8 showing the greatest variation between the effects of mentally disabled with and without grants. High cost recipients have a very large effect in panel data and cross-sectional models. More dispersed municipalities and smaller municipalities face larger minimum required expenditure in this sector (diseconomies of scale are present). This effect, however, is smaller than in the cross-sectional model.

Table 6.19. Sector 8 Care for the elderly and disabled: effects on minimum required expenditure

Model number	(1)	(2)	(6)	(7)	(8)	(9)
Model name	Baseline model	Time effects	First difference	Regional effects	Time and regional effects	Partial adjustment
Time effects	No	Yes	No	No	Yes	Yes
Municipality or region effects	No	No	No	Yes	Yes	No
Adjusted by income index	Yes	No	Yes	Yes	No	No
Constant	2.545	1.615	-	-9.911	0.302	7.059
	(12.85)	(5.55)	-	(1.51)	(0.68)	(6.98)
Population 67-79 years of age	32.120	43.453	30.424	38.273	41.659	74.510
	(10.78)	(12.64)	(5.35)	(9.31)	(8.77)	(7.75)
Population 80-89 years of age	65.407	69.540	23.296	62.307	67.917	55.329
	(13.39)	(12.98)	(2.73)	(9.55)	(9.22)	(3.48)
Population 90 years and above	182.429	179.428	75.810	179.381	170.567	236.207
	(13.18)	(12.23)	(5.15)	(9.42)	(7.74)	(5.27)
High-cost recipients	692.089	768.367	400.545	677.446	685.275	1 293.278
	(13.52)	(15.85)	(7.81)	(10.27)	(10.50)	(8.37)
Mentally disabled 16 years and above without grant	196.699	219.148	15.133	166.918	163.363	339.278
	(10.96)	(12.01)	(0.67)	(6.59)	(5.89)	(5.66)
Mentally disabled 16 years and above with grant	547.640	618.183	-115.539	571.485	634.630	518.110
	(18.15)	(17.94)	(0.32)	(12.13)	(11.74)	(4.82)
Distance to centre of municipal sub-district	0.429	0.542	0.295	0.277	0.245	1.400
	(5.09)	(5.76)	(0.95)	(2.26)	(1.63)	(5.07)
Inverse population size	2.096	1.990	7.799	2.314	1.894	3.313
	(10.99)	(10.01)	(4.19)	(9.02)	(6.75)	(5.11)

The culture sector includes sports, arts, museums, libraries, cinemas and churches. According to the time effects model the minimum required expenditures in this sector have been increasing over the years 2001 – 2002 and 2004 – 2005, decreasing in 2006 and increasing again in 2007. The relatively smaller effect in 2006 is also found in the cross-sectional estimation. However, when region effects are also included, a decrease in minimum required expenditure is observed from 2004 to 2006, with an increase in 2007. Both models therefore seem to indicate that the sector was prioritised starting in 2007. Evidence of economies of scale is also found in this sector, with an additional person decreasing the unit costs of providing cultural services.

Table 6.20. Sector 9 Culture: effects on minimum required expenditure

Model number	(1)	(2)	(6)	(7)	(8)	(9)
Model name	Baseline model	Time effects	First difference	Regional effects	Time and regional effects	Partial adjustment
Time effects	No	Yes	No	No	Yes	Yes
Municipality or region effects	No	No	No	Yes	Yes	No
Adjusted by income index	Yes	No	Yes	Yes	No	No
Constant	0.925	0.877	-	-3.649	0.115	2.917
	(27.98)	(16.63)	-	(1.47)	(0.81)	(17.97)
Inverse population size	0.383	0.473	-0.004	0.410	0.455	0.793
	(7.71)	(9.72)	(0.01)	(5.91)	(6.59)	(5.11)

The minimum expenditure on municipal roads is increasing with the amount of snowfall due to the costs linked to the snow clearing and road maintenance, and is also positively related to the length of municipal roads. All the models estimated, with the exception of the first-difference model, provide estimates that are similar in magnitude.

Table 6.21. Sector 10 Municipal roads: effects on minimum required expenditure

Model number	(1)	(2)	(6)	(7)	(8)	(9)
Model name	Baseline model	Time effects	First difference	Regional effects	Time and regional effects	Partial adjustment
Time effects	No	Yes	No	No	Yes	Yes
Municipality or region effects	No	No	No	Yes	Yes	No
Adjusted by income index	Yes	No	Yes	Yes	No	No
Constant	0.115	0.012	-	-1.145	-0.070	0.289
	(5.99)	(0.45)	-	(1.58)	(1.51)	(3.22)
Amount of snowfall	0.079	0.088	0.023	0.053	0.056	0.130
	(16.57)	(15.86)	(6.12)	(7.93)	(7.76)	(6.72)
Kilometers of municipal roads	21.130	24.238	-6.157	22.732	22.373	31.334
	(32.13)	(31.24)	(1.38)	(24.98)	(21.17)	(13.79)

The water supply and sanitation minimum required expenditure is positively affected by the capacity for advanced purification and is subject to diseconomies of scale (smaller municipalities have higher minimum expenditures in this sector). Advanced purification refers to purification using chemical or biological methods, or a combination of the two.

Both effects are lower in the time effects model than in cross-sectional estimations, and lower still in the model with both time and region effects. The minimum expenditures appear to be increasing over time.

Table 6.22. Sector 11 Water supply and sanitation: effects on minimum required expenditure

Model number	(1)	(2)	(6)	(7)	(8)	(9)
Model name	Baseline model	Time effects	First difference	Regional effects	Time and regional effects	Partial adjustmen t
Time effects	No	Yes	No	No	Yes	Yes
Municipality or region effects	No	No	No	Yes	Yes	No
Adjusted by income index	Yes	No	Yes	Yes	No	No
Constant	1.264	1.100	-	-0.642	1.098	2.452
	(28.88)	(20.83)	-	(0.53)	(9.40)	(11.77)
Capacity of advanced purification	0.580	0.642	0.039	0.243	0.241	0.870
	(16.58)	(15.99)	(0.62)	(3.62)	(3.64)	(6.91)
Inverse population size	0.191	0.248	1.124	0.193	0.012	0.769
	(2.29)	(3.11)	(1.16)	(1.90)	(0.11)	(3.40)

The other infrastructure sector includes residential and commercial infrastructure, land-use planning, environmental management and fire protection. Larger municipalities have smaller minimum expenditures in this sector as a significant positive effect of inverse population size indicates evidence of economies of scale. This effect is relatively larger in the models with time effects than the cross-sectional estimates. The first-difference model has a large downward bias predicting a significant negative effect of inverse population size.

Table 6.23. Sector 12 Other infrastructure: effects on minimum required expenditure

Model number	(1)	(2)	(6)	(7)	(8)	(9)
Model name	Baseline model	Time effects	First difference	Regional effects	Time and regional effects	Partial adjust-ment
Time effects	No	Yes	No	No	Yes	Yes
Municipality or region effects	No	No	No	Yes	Yes	No
Adjusted by income index	Yes	No	Yes	Yes	No	No
Constant	1.526	1.356	-	-7.264	-0.079	3.335
	(22.60)	(13.44)	-	(1.52)	(0.36)	(10.22)
Inverse population size	1.037	1.112	-2.824	1.155	1.077	1.441
	(8.31)	(9.45)	(2.06)	(7.36)	(6.83)	(5.32)

6.2.2. Effects on marginal budget shares

The marginal budget shares are posited to depend on three factors common to all sectors: average education level, share of socialist politicians in the municipal government, and the share of residents in the densely populated areas.

Average education is found to have a positive effect on the budget shares of other education, child care, social services, child protection, culture, other infrastructure and net operating result (saving). The effect is negative for primary schools. This is surprising as one expects municipalities with higher average education level to prioritise education. This is indeed the case for other education with a positive marginal budget share in this sector in all model versions. The partial adjustment model gives the opposite prediction: the effect on the primary schools marginal budget share is positive, and negative for other education. Neither of these is significant, however. The effect is also negative for the administration sector, indicating that this sector is under-prioritised in municipalities with higher average level of education. These conclusions are consistent with those based on the cross-sectional estimation. This is expected as marginal budget shares are assumed to be constant over time; and the time effects on the marginal budget share parameters in Model 3 are found to be mostly insignificant with the exception of the child care service sector.

Table 6.24. Effects of the average education level on the marginal budget shares

Model number	(1)	(2)	(6)	(7)	(8)	(9)
Model name	Baseline model	Time effects	First difference	Regional effects	Time and regional effects	Partial adjustment
Time effects	No	Yes	No	No	Yes	Yes
Municipality or region effects	No	No	No	Yes	Yes	No
Adjusted by income index	Yes	No	Yes	Yes	No	No
Administration	-0.048	-0.039	0.050	-0.005	-0.016	-0.000
	(14.64)	(13.31)	(2.38)	(1.99)	(5.67)	(0.03)
Primary schools	-0.032	-0.012	0.048	-0.008	-0.006	0.012
	(10.33)	(4.56)	(3.42)	(2.02)	(1.96)	(1.27)
Other education	0.010	0.012	0.004	0.002	0.011	-0.004
	(6.86)	(8.78)	(0.69)	(1.94)	(7.75)	(1.24)
Child care	0.047	0.011	-0.001	0.012	0.008	-0.011
	(13.67)	(6.03)	(0.12)	(2.09)	(5.22)	(2.03)
Health care	-0.009	-0.008	-0.001	-0.000	-0.004	0.005
	(4.65)	(4.52)	(0.20)	(0.63)	(2.36)	(0.93)
Social services	0.009	0.009	0.006	0.001	0.007	-0.003
	(5.17)	(6.32)	(0.81)	(1.67)	(4.99)	(0.77)
Child protection	0.003	0.002	-0.004	0.000	-0.000	0.004
	(2.44)	(1.48)	(0.70)	(0.13)	(0.29)	(0.94)
Care for the elderly and disabled	-0.032	-0.029	0.010	-0.002	-0.013	0.022
	(5.54)	(5.17)	(0.43)	(0.95)	(2.59)	(1.38)
Culture	0.008	0.009	0.017	-0.000	0.005	-0.007
	(5.18)	(6.29)	(2.42)	(0.63)	(4.04)	(1.46)
Municipal roads	-0.002	-0.001	-0.010	-0.000	0.000	-0.002
	(2.81)	(1.57)	(2.19)	(0.49)	(0.46)	(0.78)
Water supply and sanitation	-0.006	-0.000	-0.027	-0.001	-0.002	0.007
	(1.99)	(0.09)	(2.63)	(1.41)	(0.99)	(1.16)
Other infrastructure	0.025	0.024	0.055	-0.001	0.006	0.004
	(7.37)	(7.78)	(2.68)	(1.01)	(1.90)	(0.29)
Net operating surplus	0.025	0.024	-0.147	0.002	0.004	-0.026

In agreement with Borge (1995) we expect the socialist parties to prefer a larger local public sector, which would imply a lower share of income allocated to savings. This is indeed the case in models 1, 2 and 8 where the effect of the socialist share on the marginal budget share of net operating surplus is negative. The effect is also negative in the primary schools sector, child care, culture, municipal roads and water supply and sanitation. However the effects on primary schools and culture are not statistically significant at 5% significance level. The effect on health care is positive in the baseline and time effects models but becomes negative when region effects are introduced. The effect on the care for the elderly and disables is relatively large and significant in all models except model 9, implying that the socialist parties place a high priority on care for the elderly.

Table 6.25. Effects of the socialist share on the marginal budget shares

Model number	(1)	(2)	(6)	(7)	(8)	(9)
Model name	Baseline model	Time effects	First difference	Regional effects	Time and regional effects	Partial adjustment
Time effects	No	Yes	No	No	Yes	Yes
Municipality or region effects	No	No	No	Yes	Yes	No
Adjusted by income index	Yes	No	Yes	Yes	No	No
Administration	0.007	0.004	-0.029	0.001	0.004	0.016
	(0.95)	(0.66)	(0.58)	(0.21)	(0.54)	(0.61)
Primary schools	-0.016	-0.006	0.042	-0.001	-0.011	0.004
	(2.05)	(0.97)	(1.41)	(0.49)	(1.64)	(0.17)
Other education	0.005	0.006	-0.002	0.002	0.005	0.012
	(1.49)	(2.24)	(0.16)	(1.39)	(1.77)	(1.33)
Child care	-0.021	-0.011	0.112	-0.007	-0.014	0.040
	(2.25)	(3.11)	(3.81)	(1.69)	(3.32)	(3.07)
Health care	0.003	0.002	0.004	-0.004	-0.017	-0.020
	(0.75)	(0.40)	(0.26)	(1.68)	(4.19)	(1.90)
Social services	0.022	0.018	0.039	-0.001	-0.001	-0.021
	(5.16)	(5.62)	(2.10)	(0.86)	(0.13)	(1.87)
Child protection	0.004	0.002	0.019	0.001	0.001	0.002
	(1.26)	(0.78)	(1.35)	(0.58)	(0.39)	(0.26)
Care for the elderly and disabled	0.029	0.012	0.197	0.007	0.025	-0.023
	(2.16)	(1.12)	(3.80)	(1.32)	(2.17)	(0.60)
Culture	-0.003	-0.003	0.041	-0.001	-0.001	-0.011
	(0.72)	(0.83)	(2.42)	(0.89)	(0.13)	(0.84)
Municipal roads	-0.008	-0.007	-0.019	0.001	0.000	-0.009
	(4.13)	(4.09)	(1.65)	(1.39)	(0.26)	(1.15)
Water supply and sanitation	-0.032	-0.024	-0.036	-0.005	-0.013	-0.009
	(4.46)	(4.31)	(1.47)	(1.65)	(2.13)	(0.58)
Other infrastructure	0.040	0.031	0.118	0.004	0.028	0.018
	(5.79)	(5.09)	(2.14)	(1.26)	(4.41)	(0.51)
Net operating surplus	-0.031	-0.025	-0.487	0.005	-0.008	0.000

Densely populated municipalities appear to prioritise other education, social services, child protection, culture, municipal roads and water supply and sanitation. However, administration, primary schools, child care, care for the elderly and disabled and other infrastructure receive a smaller priority in densely populated areas. Health care appears to be prioritised in densely populated areas when only time heterogeneity is assumed. However, in the presence of regional differences, health care is seen to be under-prioritised in densely populated areas.

Table 6.26. Effects of the share of residents in densely populated areas on the marginal budget shares

Model number	(1)	(2)	(6)	(7)	(8)	(9)
Model name	Baseline model	Time effects	First difference	Regional effects	Time and regional effects	Partial adjustment
Time effects	No	Yes	No	No	Yes	Yes
Municipality or region effects	No	No	No	Yes	Yes	No
Adjusted by income index	Yes	No	Yes	Yes	No	No
Administration	-0.013	-0.007	-0.008	-0.001	-0.001	-0.042
	(2.39)	(1.59)	(0.26)	(0.31)	(0.27)	(2.17)
Primary schools	-0.002	-0.007	-0.032	-0.002	-0.028	-0.008
	(0.39)	(1.78)	(1.67)	(0.82)	(5.44)	(0.52)
Other education	0.008	0.005	-0.013	0.002	0.001	-0.002
	(2.95)	(2.53)	(1.33)	(1.70)	(0.59)	(0.32)
Child care	-0.013	-0.008	-0.032	-0.009	-0.001	-0.023
	(2.12)	(3.41)	(1.56)	(1.95)	(0.19)	(2.67)
Health care	0.005	0.003	-0.007	-0.002	-0.007	-0.022
	(1.59)	(1.06)	(0.76)	(1.54)	(2.05)	(3.13)
Social services	0.010	0.005	-0.025	0.002	0.006	0.013
	(3.48)	(2.17)	(2.30)	(1.49)	(2.04)	(1.91)
Child protection	0.016	0.014	-0.009	0.003	0.009	0.004
	(7.77)	(7.89)	(1.00)	(1.89)	(4.24)	(0.63)
Care for the elderly and disabled	-0.003	-0.001	-0.187	0.002	-0.006	-0.126
	(0.30)	(0.16)	(5.42)	(0.71)	(0.73)	(4.66)
Culture	0.024	0.017	-0.054	0.005	0.013	-0.005
	(8.13)	(7.22)	(5.57)	(1.99)	(4.80)	(0.70)
Municipal roads	0.012	0.011	-0.004	0.002	0.005	-0.010
	(9.19)	(9.57)	(0.50)	(1.93)	(3.51)	(2.06)
Water supply and sanitation	0.035	0.026	0.009	0.007	0.013	-0.001
	(7.03)	(6.59)	(0.60)	(1.97)	(3.00)	(0.10)
Other infrastructure	-0.060	-0.049	-0.074	-0.002	-0.011	0.006
	(11.47)	(10.98)	(2.50)	(0.96)	(2.23)	(0.26)
Net operating surplus	-0.018	-0.008	0.435	-0.008	0.007	0.218

It may also be of interest to examine the changes over time in the average minimum required expenditures and average marginal budget shares. The average marginal budget shares are calculated using the parameter estimates from Tables 6.24 – 6.26 and the intercept parameters not reported here, such that $\bar{\beta}_{it}$ is the average marginal budget share in sector i and year t given by:

$$\bar{\beta}_{it} = \frac{1}{K_t}\sum_{k=1}^{K_t}\left(\beta_{i0} + \sum_{j=1}^{3}\beta_{ij}v_{jkt}\right) \qquad (6.1)$$

where υ_{1kt} is average education in municipality k in year t, υ_{2kt} is the socialists share in municipality k in year t and υ_{3kt} is the share of residents in densely populated areas in municipality k in year t. K_t is the number of municipalities in the sample for year t.

Table 6.27 summarises the average budget shares based on the time effects Model 2 estimation. Although the budget shares are relatively stable over time, the administration, primary schools, health care and care for the elderly and disabled sectors show a slight decrease in their respective budget shares over time. However, other education, social assistance, culture and other infrastructure appear to have received a higher priority in the later years. Child protection, municipal roads and water supply and sanitation have very stable budget shares with no or slight change over time. Model 8 gives similar conclusions but with even smaller variation in the average budget shares over time. The other infrastructure average marginal budget share is almost constant over time in Model 8.

Table 6.27. Model 2: average marginal budget shares by year and service sector

Sector	2001	2002	2003	2004	2005	2006	2007	2008
Net operating surplus	0.145	0.146	0.148	0.149	0.150	0.152	0.153	0.157
Administration	0.142	0.140	0.138	0.135	0.132	0.130	0.127	0.123
Primary schools	0.110	0.109	0.109	0.108	0.107	0.106	0.105	0.104
Other education	0.013	0.014	0.014	0.015	0.016	0.017	0.018	0.019
Child care	0.050	0.051	0.052	0.052	0.053	0.054	0.054	0.056
Health care	0.066	0.065	0.065	0.064	0.064	0.063	0.063	0.062
Social assistance	0.008	0.009	0.010	0.011	0.011	0.012	0.012	0.013
Child protection	0.012	0.012	0.012	0.012	0.012	0.013	0.013	0.013
Care for the elderly and disabled	0.200	0.198	0.196	0.195	0.193	0.191	0.189	0.186
Culture	0.071	0.072	0.073	0.073	0.074	0.074	0.075	0.076
Municipal roads	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023
Water supply and sanitation	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.044
Other infrastructure	0.116	0.117	0.118	0.120	0.122	0.123	0.125	0.126
Number of observations	332	331	331	331	331	330	330	330
Sum	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 6.28. Model 8: average marginal budget shares by year and service sector

Sector	2001	2002	2003	2004	2005	2006	2007	2008
Net operating surplus	0.207	0.207	0.208	0.208	0.208	0.209	0.209	0.210
Administration	0.112	0.111	0.110	0.109	0.108	0.107	0.106	0.104
Primary schools	0.087	0.086	0.086	0.085	0.085	0.085	0.084	0.084
Other education	0.013	0.014	0.015	0.016	0.016	0.017	0.018	0.019
Child care	0.057	0.057	0.058	0.058	0.059	0.059	0.060	0.061
Health care	0.052	0.052	0.052	0.051	0.051	0.050	0.050	0.050
Social assistance	0.010	0.010	0.011	0.011	0.012	0.012	0.013	0.013
Child protection	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Care for the elderly and disabled	0.192	0.191	0.190	0.190	0.189	0.188	0.187	0.185
Culture	0.071	0.072	0.072	0.072	0.073	0.073	0.073	0.074
Municipal roads	0.021	0.021	0.021	0.021	0.022	0.022	0.022	0.022
Water supply and sanitation	0.037	0.037	0.037	0.036	0.036	0.036	0.036	0.036
Other infrastructure	0.130	0.130	0.131	0.131	0.132	0.132	0.132	0.132
Number of observations	332	331	331	331	331	330	330	330
Sum	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

The average minimum required expenditures are calculated using the parameter estimates from Tables 6.8 – 6.23 such that in Model 8 $\bar{\alpha}_{iRt}$ is the average minimum required expenditure in sector i, region R and year t given by:

(6.2) $$\bar{\alpha}_{iRt} = \frac{1}{K_{Rt}} \sum_{k=1}^{K_{Rt}} \left(\alpha_{i0} + \sum_{j=1}^{r} \alpha_{ij} z_{jkt} + \rho_{iR} \right) \tau_{it} \qquad \rho_{i12} = 0$$

and in Model 2 the average minimum required expenditure for sector i and year t is

(6.3) $$\bar{\alpha}_{it} = \frac{1}{K_t} \sum_{k=1}^{K_t} \left(\alpha_{i0} + \sum_{j=1}^{r} \alpha_{ij} z_{jkt} \right) \tau_{it}$$

where z_{jkt} (j=1,...,r) are the variables assumed to affect the minimum required expenditures in a particular service sector for municipality k in year t, ρ_{iR} is the marginal effect of region R compared to region 12 on the minimum required expenditure in sector i, K_{Rt} is the number of municipalities in region R in year t, K_t is the number of municipalities in the sample for year t, and τ_{it} is the year t time effect on the minimum required expenditure in sector i .

In order to see the changes in the minimum required expenditures in all regions, the average minimum required expenditure $\bar{\bar{\alpha}}_{it}$ is calculated over all municipalities:

(6.4) $$\bar{\bar{\alpha}}_{it} = \frac{1}{K_t} \sum_{k=1}^{K_t} \left(\alpha_{i0} + \sum_{j=1}^{r} \alpha_{ij} z_{jkt} + \rho_{iR} \right) \tau_{it}$$

$$\rho_{i12} = 0$$

where K_t is the total number of municipalities in year t.

However, these values are not meaningful, as minimum required expenditures exhibit significant regional differences. The average minimum required expenditure on other infrastructure is negative for all the years as a result of the fact that minimum required expenditures in some regions are higher and some lower than the expenditures in the Oslo region. Since the average minimum required expenditure on other infrastructure is fairly low in the Oslo region, regions that have even lower minimum spending are predicted to have negative spending. However, it is the relative and not absolute magnitudes of minimum required expenditures between regions that are of interest.

The average minimum required expenditures are increasing over time as a result of the significant time effects as well as increasing income, with child care and care for the elderly and disabled showing particularly high increases. The average minimum required expenditure in the culture service sector has increased significantly from 2001 to 2008, as well as from 2007 to 2008 showing an increased priority placed on culture.

Table 6.29. Model 2: average minimum required expenditures by year and service sector

Sector	2001	2002	2003	2004	2005	2006	2007	2008
Net operating surplus	-1.254	-1.573	-1.572	-0.898	-0.642	-0.166	-0.997	-1.442
Administration	1.876	1.379	1.944	2.204	2.231	2.095	2.742	3.766
Primary schools	5.948	6.487	6.969	7.221	7.519	7.756	8.417	9.362
Other education	0.676	0.782	0.795	0.826	0.839	0.803	0.867	0.992
Child care	1.016	1.306	1.480	1.835	2.051	2.554	3.139	3.976
Health care	0.718	0.888	0.968	1.087	1.116	1.048	1.308	1.731
Social assistance	0.887	0.987	1.084	1.067	1.143	1.106	1.098	1.243
Child protection	0.567	0.628	0.660	0.732	0.783	0.835	0.950	1.102
Care for the elderly and disabled	6.743	7.840	8.123	8.905	9.270	9.917	11.287	13.447
Culture	0.408	0.501	0.466	0.582	0.590	0.439	0.665	1.010
Municipal roads	0.317	0.354	0.328	0.391	0.394	0.409	0.497	0.606
Water supply and sanitation	0.913	1.006	1.011	1.126	1.143	1.127	1.227	1.501
Other infrastructure	0.829	0.929	0.878	1.077	1.047	0.829	1.240	1.667
Number of observations	332	331	331	331	331	330	330	330

Table 6.30. Model 8 Average minimum required expenditures by year and service sector for the Oslo region

Sector	2001	2002	2003	2004	2005	2006	2007	2008
Net operating surplus	-2.136	-2.355	-2.222	-1.997	-1.787	-1.196	-2.181	-2.848
Administration	1.275	0.888	1.281	1.313	1.332	1.393	1.606	1.974
Primary schools	5.202	5.644	6.131	6.262	6.570	6.936	7.274	7.737
Other education	0.658	0.766	0.790	0.804	0.818	0.816	0.847	0.894
Child care	0.808	1.124	1.369	1.723	2.010	2.758	3.382	4.174
Health care	0.495	0.598	0.672	0.686	0.714	0.754	0.839	0.981
Social assistance	0.775	0.896	1.003	0.997	1.080	1.110	1.070	1.152
Child protection	0.635	0.701	0.737	0.806	0.873	0.960	1.053	1.184
Care for the elderly and disabled	4.605	5.357	5.589	5.960	6.206	6.863	7.476	8.649
Culture	0.087	0.104	0.108	0.114	0.109	0.111	0.134	0.167
Municipal roads	0.114	0.141	0.113	0.136	0.103	0.163	0.159	0.201
Water supply and sanitation	0.916	1.002	1.025	1.091	1.124	1.211	1.200	1.339
Other infrastructure	0.037	0.039	0.043	0.036	0.042	0.037	0.038	0.044
Number of observations	48	48	48	48	48	48	48	48

Table 6.31. Model 8 Average minimum required expenditures by year and service sector

Sector	2001	2002	2003	2004	2005	2006	2007	2008
Net operating surplus	-3.260	-3.748	-3.648	-3.328	-2.869	-2.095	-3.536	-4.868
Administration	1.656	1.161	1.685	1.741	1.780	1.863	2.165	2.677
Primary schools	5.785	6.258	6.767	6.856	7.161	7.585	7.984	8.534
Other education	0.592	0.689	0.702	0.707	0.715	0.699	0.717	0.765
Child care	0.641	0.891	1.074	1.346	1.560	2.126	2.547	3.162
Health care	0.617	0.746	0.841	0.861	0.898	0.951	1.060	1.242
Social assistance	0.821	0.913	1.013	0.981	1.053	1.031	0.988	1.078
Child protection	0.511	0.564	0.602	0.660	0.720	0.795	0.872	0.979
Care for the elderly and disabled	5.833	6.769	7.111	7.581	7.926	8.847	9.690	11.15
Culture	0.039	0.046	0.048	0.051	0.050	0.054	0.066	0.082
Municipal roads	0.215	0.234	0.224	0.252	0.256	0.289	0.325	0.352
Water supply and sanitation	0.776	0.852	0.880	0.932	0.960	1.019	1.013	1.132
Other infrastructure	-0.046	-0.048	-0.053	-0.043	-0.049	-0.041	-0.041	-0.049
Number of observations	332	331	331	331	331	330	330	330

Comparing the baseline model (1) with the preferred panel data models (time effects and time and region effects models 2, 7, 8), some key differences are observed. In the administration sector, the effects on the minimum required expenditure are much lower in the baseline model than in the time effects and time and region effects models, implying that not including time and/or regional effects in the model specification produces estimates that are biased downwards in this sector. In the primary schools sector the baseline model predicts a higher effect of the 6 – 12 year old children than models with time effects, but underestimates the effect of 13 – 15 year olds. Furthermore, the effect of the distance to the district centre is much lower in the model with both time and region effects both in this sector and in health care, suggesting that the economies of scale are captured by region effects when regional heterogeneity is accounted for. Similarly, the effect of refugees on the minimum spending on other education is lower in the model with time and region effects and highest in the baseline model. This suggests that introducing time effects into the model removes some of the upward bias on the estimates, and the same is true to an even greater degree for the regional effects. The most significant difference between the models is observed in the child care sector. The effect of small children is negative and not significant in the baseline model, which is in conflict with theoretical expectations. This effect is largest in the model with time and regional effects, with the time effects model predicting a slightly lower estimate. In fact the effect is only positive in the models where time effects are included, suggesting that omitting time effects produces biased results, particularly apparent in the child care sector. This is not surprising as we indeed expect the minimum required expenditure on child care to be increasing over the years, not only due to income growth but also due to policy measures that affect all municipalities.

In the social assistance sector the marginal effect of refugees with and without integration grants is lower in the baseline model. The baseline model also underestimates the effect of the unemployed and the divorced and separated on the social assistance minimum spending and the effect of children with a single parent on the minimum child protection spending. However, the effect of the poor is overestimated by the baseline model both in the social assistance and the child protection sectors. The effect of the disablement pensioners is small and not significant in the time and region effects model, but higher and significant when region effects are not included.

The baseline model underestimates the effect of the 67 – 79 year olds on minimum care for the elderly and disabled spending, and overestimates the effect of the share of people of age 90 years and above. Thus the difference between the effects of these two age groups is inflated in the baseline model. The economies of scale effect in culture and effect of road length in the municipal roads sector are also lower in the baseline model. The effects of snowfall in the municipal roads sector, and purification capacity and inverse population size in the water supply and sanitation sector are lowest in the model with both time and region effects and highest in the model with only time effects.

The effects of average education, the composition of the local council and the population density are generally lower in the model with time and region effects than in the baseline model. The share of socialists has a negative effect on the health care and social services marginal budget shares in the time and region effects model. The effect is however not significant in the social services sector. The health care marginal budget shares are also negative in densely populated areas according to the models with region and both time and region effects. A particularly surprising result is that the marginal budget share of primary schools spending is relatively large and negative in the time and region effect model for municipalities with higher average education. The result is surprising since one expects that primary education is prioritised by municipalities where the level of average education is higher. The model with time and region effects also shows a higher savings (net operating result) in densely populated areas, while the effect is opposite in the other models.

Finally, the partial adjustment model yields some interesting results. However, these are not directly comparable to the estimates in other models as this model estimates the effects on the desired or equilibrium minimum required expenditures and marginal budget shares. The effects on the equilibrium minimum spending are generally higher in the partial adjustment model than in the baseline, time and fixed effects models. This is in line with the underlying assumptions of the partial adjustment model, where only a fraction of the optimal spending is achieved in each period as spending is relatively slow to adjust to its optimal level due to adjustment sluggishness (speed of adjustment is 0.169).

One can, however, calculate the estimated effects on the actual expenditure from the long-run values and the partial adjustment coefficient. The partial adjustment model may be written as:

$$u_{it} = \lambda\alpha_{it} + \lambda\beta_i\left(y_t - \sum_{i=0}^{12}\alpha_{it}\right) + (1-\lambda)\frac{y_t}{y_{t-1}}u_{it-1} + \lambda\varepsilon_{it} \quad (6.5)$$

which is directly comparable to Model 2 with λ =1.

Hence multiplying the coefficients in Tables 6.11 – 6.26 by 0.169 yields effects on actual minimum expenditure comparable to the other models where adjustment is by definition instantaneous. However, even after this correction, the effects yielded by the Partial Adjustment Model are notably higher than those in the static models, suggesting that the Partial Adjustment Model may need to be extended to better meet theoretical expectations.

7. Conclusion

The primary focus of this paper is estimating a Linear Expenditure System model in a dynamic context. Although panel data methods such as fixed effects and random effects are well-documented in the literature, it is less so for their application to a system of equations estimated in structural form. This paper proposes specifying each equation in the system to include fixed effects, time effects and/or a combination of the two. These models are then estimated by the maximum likelihood method. The model with both time and fixed effects performs well in explaining the behaviour of local governments over the years analysed. The fact that this model produces markedly different results from the benchmark model with no time or fixed effects suggests that local government spending is subject to both time and economic region unobserved heterogeneity beyond that due to average income growth. This finding has important implications for policy conclusions with respect to the effect of different service target groups and technology factors on the service sector minimum required expenditures. The pitfalls of relying on the benchmark's model's estimates are particularly evident in the child care service sector, where the benchmark model predicts a theoretically unjustifiable negative effect of the share of small children on the minimum child care spending. The models with time effects, however predict the expected positive and significant effect. In the model where both time and region effects are included, an additional child increases minimum spending by NOK 10700 in 2001 and NOK 58154 in 2008. The estimates are particularly sensitive to the inclusion of time effects, suggesting that time heterogeneity is large, while municipality heterogeneity is significant but relatively smaller.

The average minimum required expenditures are increasing over time as a result of the significant time effects as well as increasing income, with child care and care for the elderly and disabled showing particularly high increases. This is consistent with the observed increase in average spending in these sectors. The average minimum required expenditure in the culture service sector has also increased significantly from 2001 to 2008, as well as from 2007 to 2008 showing an increased priority placed on culture. In the care for the elderly and disabled sector, subsistence output is increasing with age and the sector is prioritised by local councils with the larger share of socialists. However, the share of socialists has a negative effect on the share of the budget allocated to health care in the time and region effects model. The health care marginal budget shares are also negative in densely populated areas according to the models with region and both time and region effects. A particularly surprising result is that the marginal budget share of primary schools spending is relatively large and negative in the time and region effect model for municipalities with higher average education level. The result is surprising since one expects that primary education is prioritised by municipalities with higher average education.

In addition to the fixed and time effects models, a dynamic partial adjustment model is estimated, relaxing the assumption that municipality expenditures adjust instantaneously from one year to the next. In contrast to the other models, the partial adjustment model shows a positive, instead of negative, effect of average education on the marginal budget share in the primary schools sector. Thus, in equilibrium, the sign of this effect conforms to theoretical expectations. The model also shows a relatively slow speed of adjustment of municipality spending to its optimal level and relatively higher effects on the optimal minimum spending and marginal budget shares. Although this model yields some important insights into the dynamics of local governments' spending behaviour, it has low explanatory power and can be developed further. First, it is possible to estimate the model assuming that the speed of adjustment varies across service sectors. It is also possible to specify the speed of adjustment parameter as a function of explanatory variables, for example municipality size, given by the inverse population size variable. Second, the assumption on the minimum savings specification should be examined further, and a positive long-term growth trend in the real income ($\alpha_{00} < 0$) considered as an alternative to the current zero long-term growth assumption. Third, the partial adjustment model may be extended to include municipality or region fixed effects in the optimal expenditure specification. Finally, as an alternative to fixed effects estimation, a random coefficient model may also be considered in future work, where the minimum required expenditure parameters can be assumed to be random draws from a Normal distribution. However, this assumption requires careful consideration as it is difficult to specify the correct distribution from which the random parameters originate.

Based on the results discussed in this paper, panel data methods are found to be very well suited to the analysis of local government behaviour in Norway over time, as unobserved time and municipality heterogeneity play an important role in the changes in spending patterns. Moreover, the observed sluggishness of adjustment over time suggests that a combination of fixed and time effects with a dynamic partial adjustment is a promising specification, which should be developed in future work on the subject.

Bibliography

Aaberge, R., Bhuller, M., Langørgen, A. and M. Mogstad (2010): “The Distributional Impact of Public Services When Needs Differ”, IZA Discussion Paper 4826, Institute for the Study of Labor (IZA), http://ftp.iza.org/dp4826.pdf, accessed 12 April 2010.

Aaberge, R. and A. Langørgen (2003): “Fiscal and spending behaviour of local governments: Identification of price effects when prices are not observed”, *Public Choice*, Vol. 117, 125 – 161.

Aaberge, R. and A. Langørgen (2006): “Measuring the Benefits from Public Services: The Effects of Local Government Spending on the Distribution of Income in Norway”, *The Review of Income and Wealth*, Vol. 52, No. 1, 61 – 83.

Ahangarani, P. M. (1999): “Demand system estimation with panel data”, www-scf.usc.edu/~mashayek/paper/AIDSpaper.pdf, accessed 2 April 2010.

Allers, M. (2007): “Deriving spending needs from local government budget data: an alternative approach”, Paper to be presented at the IIPF Congress in Warwick, https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=IIPF63&paper_id=55, accessed 20 November 2009.

Allers, M. A. and J. P. Elhorst (2007): “Independent Behaviour of Local Governments: Dutch Evidence Using a Linear Expenditure System”, Paper prepared for presentation at the Spatial Econometrics Conference in Cambridge 11-14th July and the 47th Congress of the European Regional Science Association in Paris, August 29th to September 2rd 2007, https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=IIPF63&paper_id=54, accessed 20 February 2010.

Arellano, M. (2003): *Panel Data Econometrics*. Oxford University Press, Oxford.

Arellano, M. and B. Honoré (2000): “Panel Data Models: Some Recent Developments”, Working paper 0016, ftp://ftp.cemfi.es/wp/00/0016.pdf, accessed 2 March 2010.

Bai, J. (2006): “Panel Data Models with Interactive Fixed Effects”, www.atl-res.com/macro/papers/Bai%20paper.pdf , accessed 20 February 2010.

Balestra, P. and S. Negassi (1992): “A Random Coefficient Simultaneous Equation System with an Application to Direct Foreign Investment by French Firms”, *Empirical Economics*, Vol. 17, 205 – 220.

Baltagi, B. H. (2005): *Econometric Analysis of Panel Data, 3rd ed.* John Wiley & Sons Ltd., Chichester.

Beck, N. (2004): “Longitudinal (Panel and Time Series Cross-Section Data”, Note, http://weber.ucsd.edu/~tkousser/Beck%20Notes/longitude20041short.pdf, accessed 30 March 2010.

Beck, N. (2006): “Time-Series-Cross-Section Methods”, Draft of June 5, 2006, http://as.nyu.edu/docs/IO/2576/beck.pdf, accessed 30 March 2010.

Biørn, E. (1999): “Estimating Regression Systems from Unbalanced Panel Data: A Stepwise Maximum Likelihood Procedure”, Department of Economics, University of Oslo, Memorandum No. 20.

Bhuller, M. (2009): “Inndeling av Norge i arbeidsmarkedregioner”, Statistisk sentralbyrå, Notat 2009/24, http://www.ssb.no/emner/00/00/20/notat_200924/notat_200924.pdf , accessed 9 April 2010.

Borge, L-E., Rattsø, J. and R. Sørensen (1995): “Local government service production: The politics of allocative sluggishness”, *Public Choice*, Vol. 82, 135 – 157.

Borge, L-E. (1995): “Economic and political determinants of fee income in Norwegian local governments”, *Public Choice*, Vol. 83, 353 – 373.

Chamberlain, G. (1980): "Analysis of Covariance with Qualitative Data," *Review of Economic Studies*, Vol. 47, NO.1, 225-238.

Elhorst, J. P. (2003): “Specification and Estimation of Spacial Panel Data Models”, *International Regional Science Review*, Vol, 26, No. 3, 244 – 268.

Greene, W. (2001):"Estimating Econometric Models with Fixed Effects", New York University, Leonard N. Stern School Finance Department Working Paper Series 01-10, New York University, Leonard N. Stern School of Business.

Greene, W. H. (2003): *Econometric Analysis, 5th ed.* Prentice Hall, New Jersey.

Gujarati, D.N. (2003): *Basic Econometrics, 4th ed.* McGraw-Hill, New York.

Hausman, J. A. and W. E. Taylor (1981): “Panel data and unobservable individual effects”, *Econometrica*, Vol. 49, No. 6, 1377 – 1398.

Honoré, B. E. (2002): “Nonlinear Models with Panel Data”, *Portuguese Economic Journal*, Vol. 1, No. 2, 163 – 179.

Hsiao, C: (1975): “Some estimation methods for a Random Coefficient Model”, *Econometrica*, Vol. 43, No. 2, 305 – 325.

Hsiao, C. (1985): “Benefits and limitations of panel data”, *Econometric Reviews*, Vol, 4, No. 1, 121 – 174.

Hsiao, C. (2003): *Analysis of Panel Data, 2nd ed.* Cambridge University Press, Cambridge.

Hsiao, C. and M. H. Pesaran (2004): “Random Coefficient Panel Data Models”, CESifo working paper 1233, http://www.cesifo-group.de/DocCIDL/ cesifo1_wp1233.pdf, accessed 9 April 2010.

Hübler, O. (2006): “Multilevel and nonlinear models”, *Allgemeines Statistisches Archiv*, Vol. 90, 121 – 136.

Langørgen, A., Galloway, T. A., Mogstad, M. and R. Aaberge (2005): “Sammenlikning av simultane og partielle analyser av kommunenes økonomiske atferd”, Rapporter 2005/25, Statistisk sentralbyrå.

Langørgen, A., Pedersen, S. and R. Aaberge (2010): “Stabilitet i kommunenes økonomiske atferd 2001-2008”, Statistisk sentralbyrå, Rapport 25/2010

McCloskey, D. N. and S. T: Ziliak (1996): “The Standard Error of Regressions”, *Journal of Economic Literature*, Vol. XXXIV, 97 – 114.

Ministry of Local Government and Regional Development (2009): “Rapport fra Det tekniske beregningsutvalg for kommunal og fylkeskommunal økonomi”, http://www.regjeringen.no/nb/dep/krd/dep/443466/Teknisk-beregningsutvalg-for-kommunal-og.html , accessed 3 November 2009.

Neyman, J. and E. L. Scott (1948): “Consistent estimates based on partially consistent observations”, *Econometrica*, Vol. 16, No. 1, 1 – 32.

Norges offentlige utredninger NOU (2005/18): “Fordeling, forenkling, forbedring - Inntektssytemet for kommuner og fylkeskommuner”, http://www.regjeringen.no/Rpub/NOU/20052005/018/PDFS/NOU200520050018000DDDPDFS.pdf, accessed 4 January 2010.

Pedersen, S. (2008): “Kommunenes økonomiske atferd 2001 - 2007”, Notater 2008/60, Statistisk sentralbyrå.

Pinheiro, J. C. and D. M. Bates (2000): *Mixed Effects Models in S and S-Plus*, Springer, New York.

Polacheck, S. W. and M-K. Kim (1994): “Panel estimates of the gender earnings gap: individual-specific intercept and individual-specific slope models”, *Journal of Econometrics*, Vol. 61, 23 – 42.

Pollak, R. A. and T: J. Wales (1981): “Demographic Variables in Demand Analysis”, *Econometrica*, Vol. 49, No. 6, 1533 – 1551.

Rongen, G. (1995): “Efficiency in the provision of local public goods in Norway”, *European Journal of Political Economy*, Vol. 11, 253 – 264.

Statistics Norway (2009a): “Culture Statistics 2007”, http://www.ssb.no/english/subject/07/nos_cultural/nos_d410_en/nos_d410_en.pdf, accessed 4 January 2010.

Statistics Norway (2009b): “Kulturstatistikk 2008”, http://www.regjeringen.no/upload/KKD/Kultur/Rapporter%20og%20utredninger/Kulturstatistikk2008-nos_d429.pdf, accessed 2 April 2010.

Stoltenberg, J. (2005): “The Stoltenberg II Government’s inaugural address to the Storting”, http://www.regjeringen.no/nb/dep/smk/aktuelt/taler_og_artikler/statsministeren/statsminister_jens_stoltenberg/2005/the-stoltenberg-ii-governments-inaugural.html?id=420704, accessed 20 April 2010.

Terzi, S. (1992): “Simultaneous Equations with Random Coefficients: Estimating the Structural Form”, Statistical Methods and Applications, Vol. 1, No. 2, 275 – 286.

Wooldridge, J. M. (2002a): Econometric analysis of cross section and panel data. The MIT Press: Cambridge, Massachusetts.

Wooldridge, J. M. (2002b): Introductory Econometrics: A Modern Approach, 2nd ed. South-Western, div. of Thomson Learning.

Appendix A: Outlier municipalities and income index derivation

Table A.1. Municipalities that are outliers in 1 year or more

No.	Name	no. yrs out	2001	2002	2003	2004	2005	2006	2007	2008
0104	Moss	3				1	1		1	
0105	Sarpsborg	1		1						
0111	Hvaler	3				1	1		1	
0121	Rømskog	3				1		1	1	
0301	Oslo	8	1	1	1	1	1	1	1	1
0402	Kongsvinger	1								1
0434	Engerdal	8	1	1	1	1	1	1	1	1
0441	Os	1	1							
0501	Lillehammer	3		1	1		1			
0511	Dovre	1			1					
0512	Lesja	1			1					
0514	Lom	1			1					
0515	Vågå	1			1					
0520	Ringebu	1							1	
0521	Øyer	1							1	
0544	Øystre Slidre	2					1		1	
0545	Vang	1	1							
0619	Ål	5				1	1	1	1	1
0632	Rollag	6		1		1	1	1	1	1
0821	Bø	1						1		
0830	Nissedal	1							1	
0831	Fyresdal	1								1
0834	Vinje	1	1							
0928	Birkenes	1			1					
0935	Iveland	1							1	
0938	Bygland	1				1				
0941	Bykle	8	1	1	1	1	1	1	1	1
1021	Marnardal	2				1			1	
1026	Åseral	5	1		1		1	1		1
1027	Audnedal	2		1						1
1029	Lindesnes	1								1
1046	Sirdal	7	1	1	1	1	1	1	1	
1129	Forsand	7	1	1		1	1	1	1	1
1133	Hjelmeland	1							1	
1151	Utsira	8	1	1	1	1	1	1	1	1
1219	Bømlo	1					1			
1224	Kvinnherad	2		1						1
1227	Jondal	1				1				
1232	Eidfjord	8	1	1	1	1	1	1	1	1
1233	Ulvik	5	1	1	1		1		1	
1242	Samnanger	1	1							
1243	Os	1		1						
1252	Modalen	8	1	1	1	1	1	1	1	1
1256	Meland	1							1	
1259	Øygarden	1						1		
1265	Fedje	1								1
1411	Gulen	1							1	
1412	Solund	1				1				
1417	Vik	3		1					1	1
1418	Balestrand	7	1	1	1	1	1	1	1	
1419	Leikanger	1								1

1421 ...... Aurland	2					1	1		
1424 ...... Årdal	1	1							
1431 ...... Jølster	1						1		
1433 ...... Naustdal	1			1					
1438 ...... Bremanger	2							1	1
1503 ...... Kristiansund	1							1	
1524 ...... Norddal	1							1	
1534 ...... Haram	2		1						1
1535 ...... Vestnes	2		1	1					
1546 ...... Sandøy	1								1
1547 ...... Aukra	1								1
1554 ...... Averøy	1							1	
1569 ...... Aure	1				1				
1573 ...... Smøla	3		1	1	1				
1617 ...... Hitra	1								1
1664 ...... Selbu	1	1							
1665 ...... Tydal	2			1		1			
1721 ...... Verdal	1					1			
1739 ...... Røyrvik	6	1	1			1	1	1	1
1740 ...... Namskogan	3	1	1				1		
1749 ...... Flatanger	1							1	
1755 ...... Leka	1							1	
1805 ...... Narvik	1							1	
1811 ...... Bindal	1	1							
1822 ...... Leirfjord	4				1	1	1	1	
1826 ...... Hattfjelldal	2							1	1
1827 ...... Dønna	1	1							
1828 ...... Nesna	1				1				
1832 ...... Hemnes	1							1	
1833 ...... Rana	1							1	
1834 ...... Lurøy	4				1	1		1	1
1835 ...... Træna	3	1	1						1
1836 ...... Rødøy	3	1				1	1		
1840 ...... Saltdal	1			1					
1842 ...... Skjerstad	2	1	1						
1853 ...... Evenes	1								1
1856 ...... Røst	1			1					
1857 ...... Værøy	1			1					
1859 ...... Flakstad	1						1		
1911 ...... Kvæfjord	8	1	1	1	1	1	1	1	1
1919 ...... Gratangen	1					1			
1920 ...... Lavangen	1				1				
1923 ...... Salangen	4	1				1		1	1
1929 ...... Berg	3				1	1	1		
1939 ...... Storfjord	1							1	
1943 ...... Kvænangen	1	1							
2003 ...... Vadsø	2						1	1	
2014 ...... Loppa	2	1	1						
2015 ...... Hasvik	1							1	
2017 ...... Kvalsund	1							1	
2021 ...... Karasjok	3	1	1		1				
2027 ...... Unjárga Nesseby	8	1	1	1	1	1	1	1	1
Total by year (103 municipalities)	243	30	28	25	28	30	26	45	31

Table A.2. Descriptive statistics for total per capita income used in calculating the income index for an unbalanced panel data set where only municipalities that are considered outliers in at least 1 year are excluded

Year	Observations	Obs excl. missing	Mean	Std Dev	Minimum	Maximum
2001	332	329	32.837	7.322	21.68	62.415
2002	331	329	34.173	7.551	23.372	66.779
2003	331	329	36.554	7.803	22.768	72.80
2004	331	330	38.237	8.144	25.22	77.791
2005	331	330	40.175	8.371	26.946	77.785
2006	330	329	44.792	9.428	30.675	81.98
2007	330	329	46.976	10.425	32.543	87.118
2008	330	328	50.054	11.25	34.736	92.316

All values in thousands Norwegian kroner.

Table A.3. Descriptive statistics for total per capita income, used in calculating the income index for an unbalanced panel data set where municipalities that are considered outliers in at least 2 years are excluded

Year	Observations	Obs excl. missing	Mean	Std Dev	Minimum	Maximum
2001	392	389	33.807	7.900	21.68	62.415
2002	391	388	35.19	8.194	23.372	66.779
2003	391	389	37.786	8.740	22.768	72.80
2004	391	390	39.445	8.963	25.22	77.791
2005	391	390	41.385	9.2	26.946	77.785
2006	389	388	46.20	10.405	30.675	86.914
2007	389	388	48.437	11.487	32.543	89.032
2008	388	385	51.577	12.4	33.949	96.907

All values in thousands Norwegian kroner.

Table A.4. Descriptive statistics for total per capita income used in calculating the income index for a balanced panel data set where municipalities that are considered outliers in at least 1 year are excluded as well as municipalities that have missing data in some of the years

Year	Observations	Obs excl. missing	Mean	Std Dev	Minimum	Maximum
2001	315	315	32.808	7.276	21.68	62.415
2002	315	315	34.242	7.561	23.372	66.779
2003	315	315	36.629	7.873	22.768	72.80
2004	315	315	38.33	8.243	25.22	77.791
2005	315	315	40.288	8.483	26.946	77.785
2006	315	315	44.89	9.528	30.675	81.98
2007	315	315	47.079	10.544	32.543	87.118
2008	315	315	50.132	11.402	34.736	92.316

All values in thousands Norwegian kroner.

Table A.5. Descriptive statistics for total per capita income used in calculating the income index for a balanced panel data set where municipalities that are considered outliers in at least 2 years are excluded as well as municipalities that have missing data in some of the years

Year	Observations	Obs excl. missing	Mean	Std Dev	Minimum	Maximum
2001	370	370	33.786	7.885	21.68	62.415
2002	370	370	35.285	8.233	23.372	66.779
2003	370	370	37.872	8.818	22.768	72.80
2004	370	370	39.529	9.048	25.22	77.791
2005	370	370	41.506	9.279	26.946	77.785
2006	370	370	46.34	10.499	30.675	86.914
2007	370	370	48.567	11.611	32.543	89.032
2008	370	370	51.688	12.501	33.949	96.907

All values in thousands Norwegian kroner.

Table A.6. List of municipalities that have missing values for some of the years for the variables included in the model

Number	Name	Years missing
0216	Nesodden	2 002
0430	Stor-Elvdal	2 002,2003
0513	Skjåk	2 002
0718	Ramnes	2 001
1101	Eigersund	2 005
1102	Sandnes	2 005
1154	Vindafjord	2 001,2002,2003,2005
1159	Ølen	2 002,2003,2004,2005
1160	Vindafjord	2 006
1201	Bergen	2 001
1211	Etne	2 001
1214	Ølen	2 001
1216	Sveio	2 005
1219	Bømlo	2 005
1244	Austevoll	2 001,2002
1503	Kristiansund	2 007
1505	Kristiansund	2 008
1556	Frei	2 007
1569	Aure	2 001,2002,2003,2005
1572	Tustna	2 001,2002,2003,2004,2005
1576	Aure	2 006
1842	Skjerstad	2 001,2002,2003,2004
1856	Røst	2 002,2003
1871	Andøy	2 003,2004
1874	Moskenes	2 002,2003,2008
1928	Torsken	2 003,2004,2005,2006,2007,2008
1939	Storfjord	2 008

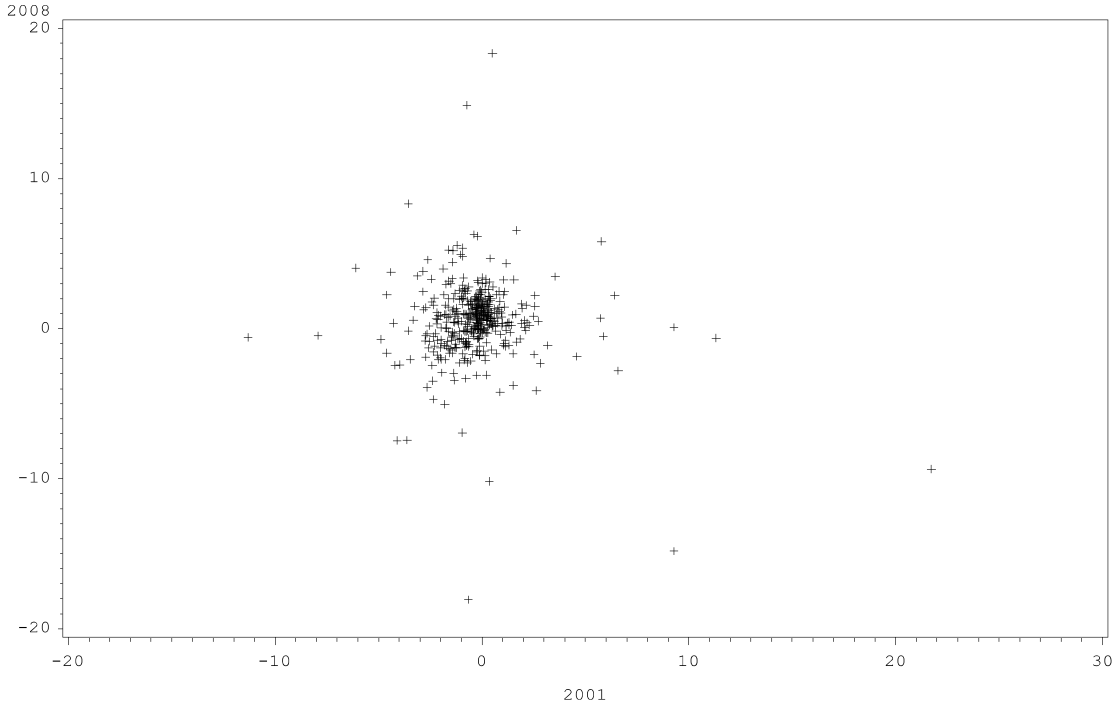
Appendix B: Time-invariant variables and correlation plots

Table B1 Model 6 version A – inflated standard errors

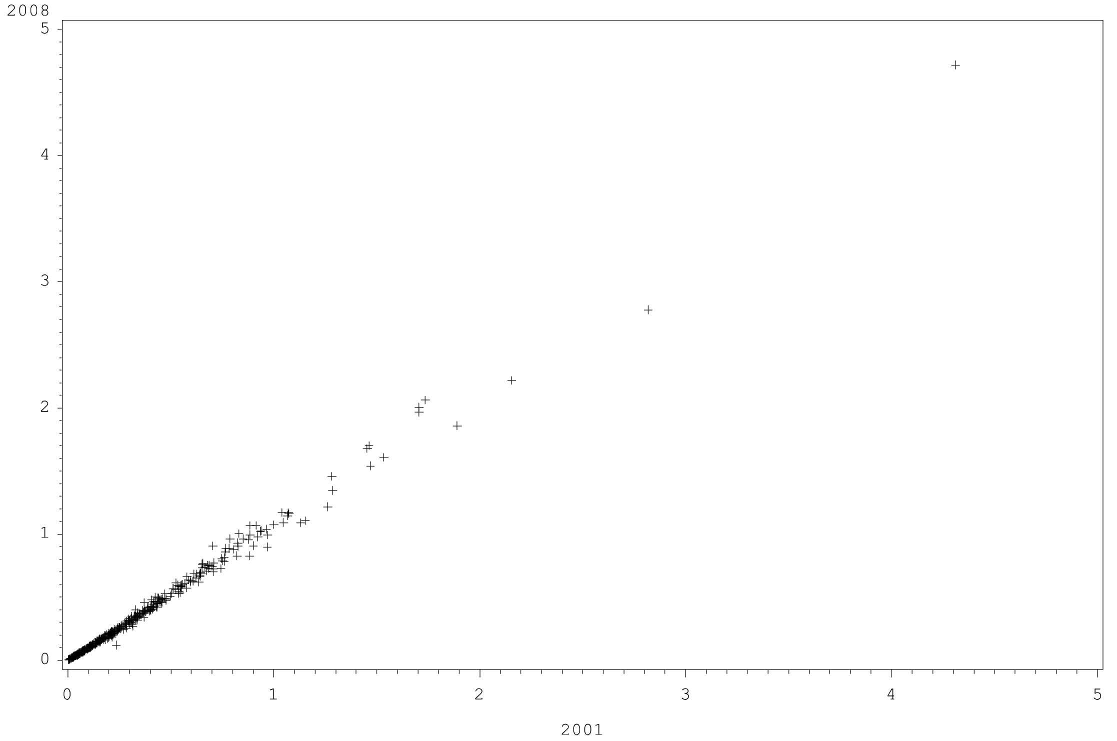
Sector	Variable (first difference)	Estimate	Std error	t-value
Budget surplus	Growth in municipality incomes	0.516	0.026	20.23
Administration	Inverse population size	4.603	2.217	2.08
	Index of farming industry	-18.133	12.195	-1.49
Primary schools	Population share 6-12 years of age	30.324	3.143	9.65
	Population share 13-15 years of age	19.465	3.256	5.98
	Distance to centre of municipal sub-district	0.114	0.199	0.57
	Inverse population size	4.435	1.129	3.93
Other education	Share of fulltime working women 20-44 years	-0.889	1.188	-0.75
	Refugees with integration grants	17.773	1.662	10.69
Child care	Population share 1-5 years of age	-14.335	3.127	-4.58
	Share of fulltime working women 20-44 years	20.317	1.748	11.62
Health care	Distance to centre of municipal sub-district	0.019	0.075	0.26
	Inverse population size	3.858	0.485	7.96
Social services	Refugees with integration grants	24.131	2.018	11.96
	Refugees without integration grants	65.349	29.465	2.22
	Share of divorced/ separated 16-59 years	1.227	2.067	0.59
	Unemployed 16-59 years share of total population	13.689	1.599	8.56
	Number of poor share of total population	3.220	0.806	3.99
	Share of disablement pensioners 18-49 years	-6.776	3.771	-1.80
Child protection	Share of children 0-15 years with single mother/ father	4.506	1.783	2.53
	Number of poor share of total population	-0.773	0.600	-1.29
Care for the	Population share 67-79 years of age	30.424	5.689	5.35
elderly and	Population share 80-89 years of age	23.296	8.525	2.73
disabled	Population share 90 years and above	75.810	14.710	5.15
	High-cost recipients share of total population	400.545	51.283	7.81
	Share of mentally disabled 16 years and above without grant	15.133	22.623	0.67
	Share of mentally disabled 16 years and above with grant	-115.539	365.50	-0.32
	Distance to centre of municipal sub-district	0.295	0.312	0.95
	Inverse population size	7.799	1.861	4.19
Culture	Inverse population size	-0.004	0.555	-0.01
Municipal roads	Amount of snowfall	0.023	0.004	6.12
	Kilometers of municipal roads	-6.157	4.476	-1.38
Water supply	Capacity of advanced purification	0.039	0.064	0.62
and sanitation	Inverse population size	1.124	0.969	1.16
Other infrastructure .	Inverse population size	-2.824	1.370	-2.06

Correlation plots

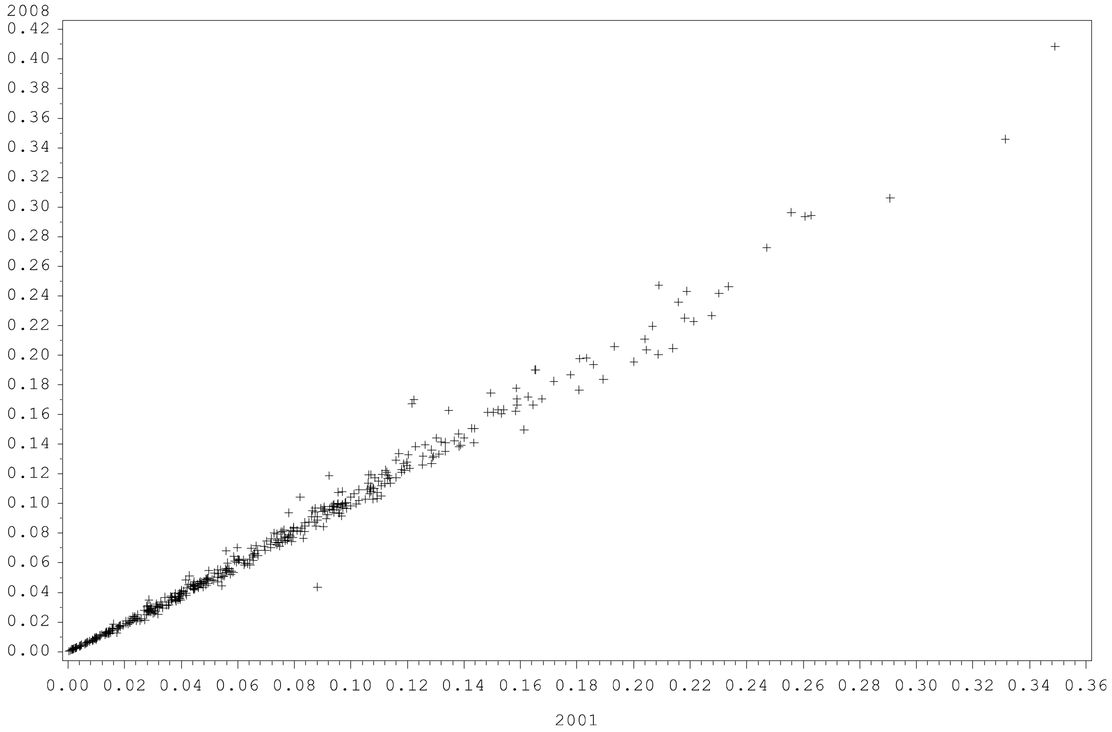
Growth in municipality incomes 2001 vs 2008



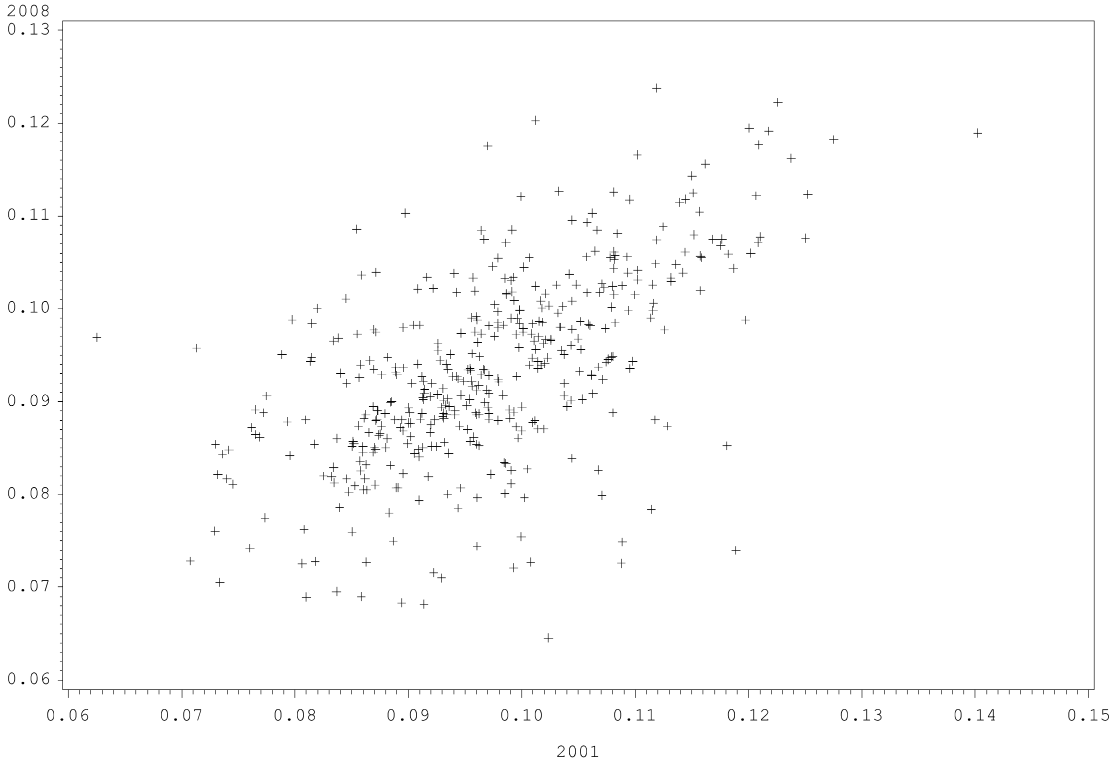
Inverse population size 2001 vs 2008

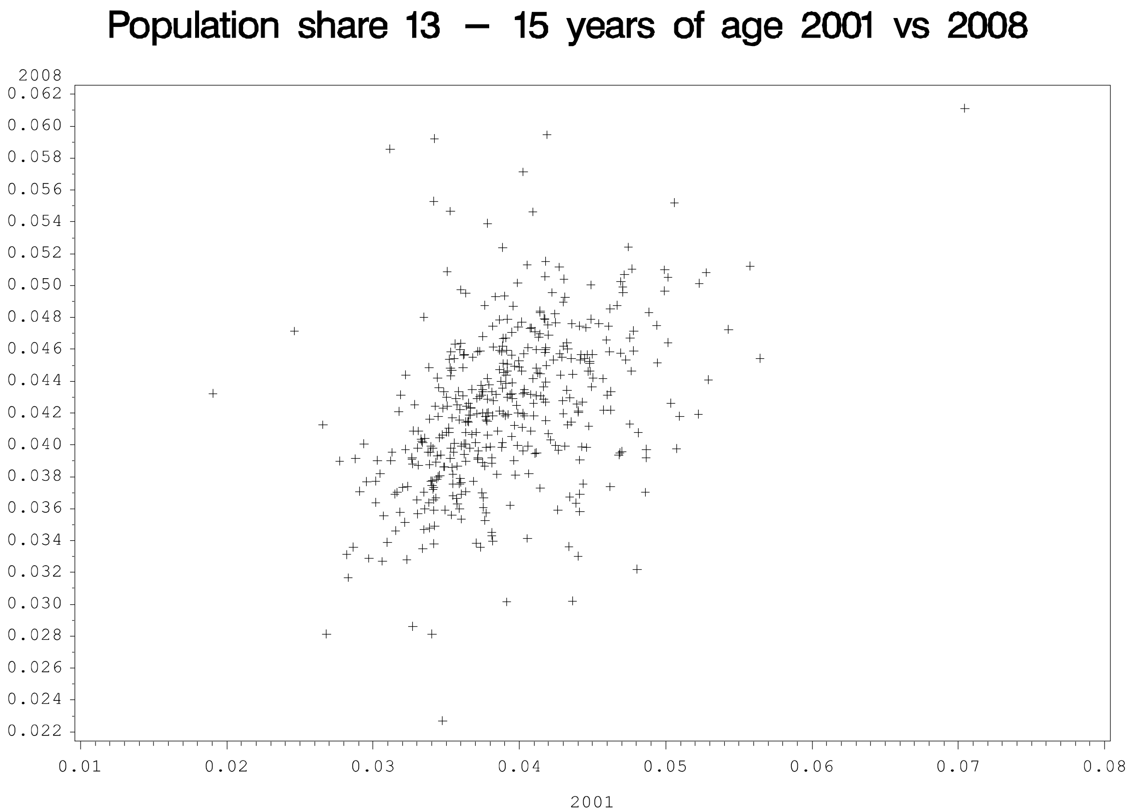


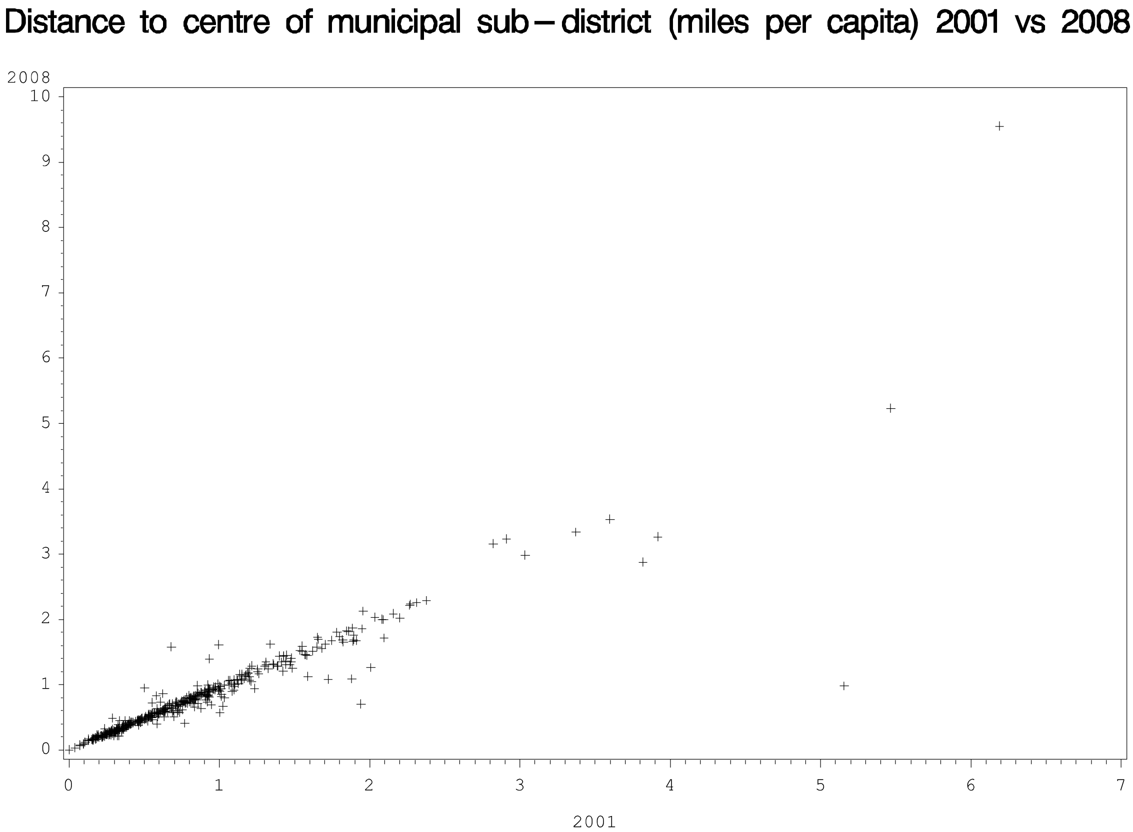
Index of farming industry 2001 vs 2008



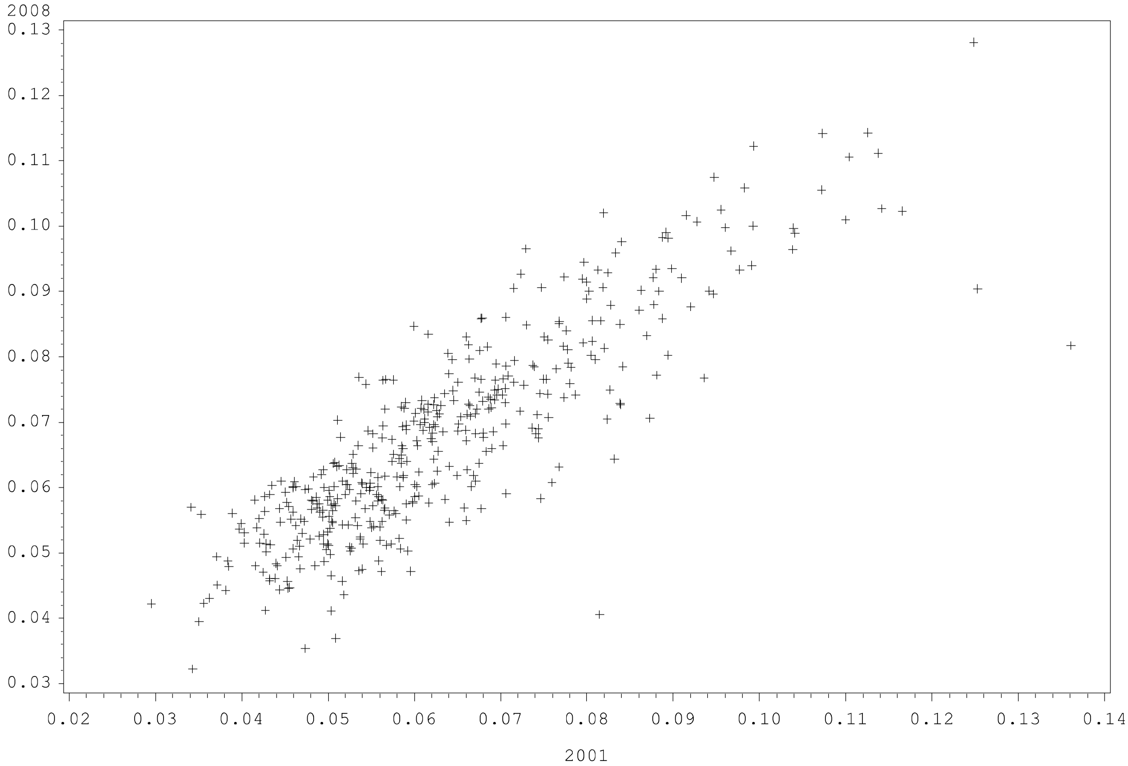
Population share 6 – 12 years of age 2001 vs 2008



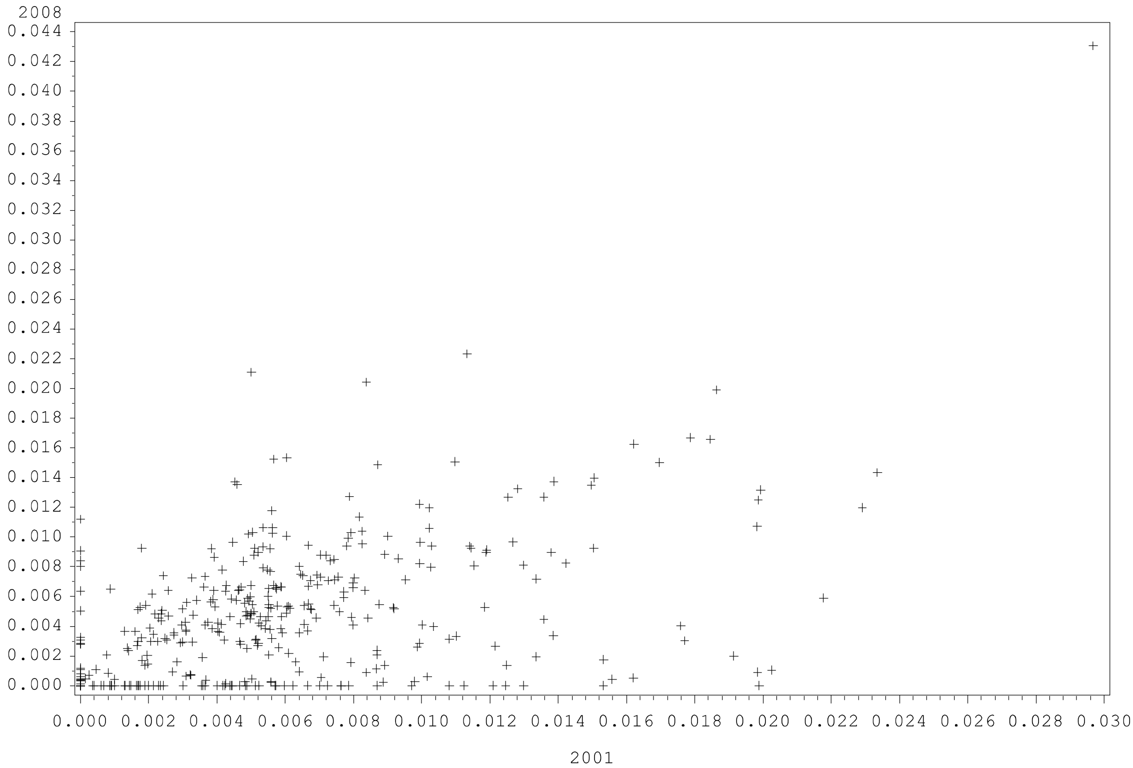

Population share 13 – 15 years of age 2001 vs 2008
2008
0.062
0.060
0.058
0.056
0.054
0.052
0.050
0.048
0.046
0.044
0.042
0.040
0.038
0.036
0.034
0.032
0.030
0.028
0.026
0.024
0.022
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
2001


Distance to centre of municipal sub–district (miles per capita) 2001 vs 2008
2008
10
9
8
7
6
5
4
3
2
1
0
0
1
2
3
4
5
6
7
2001

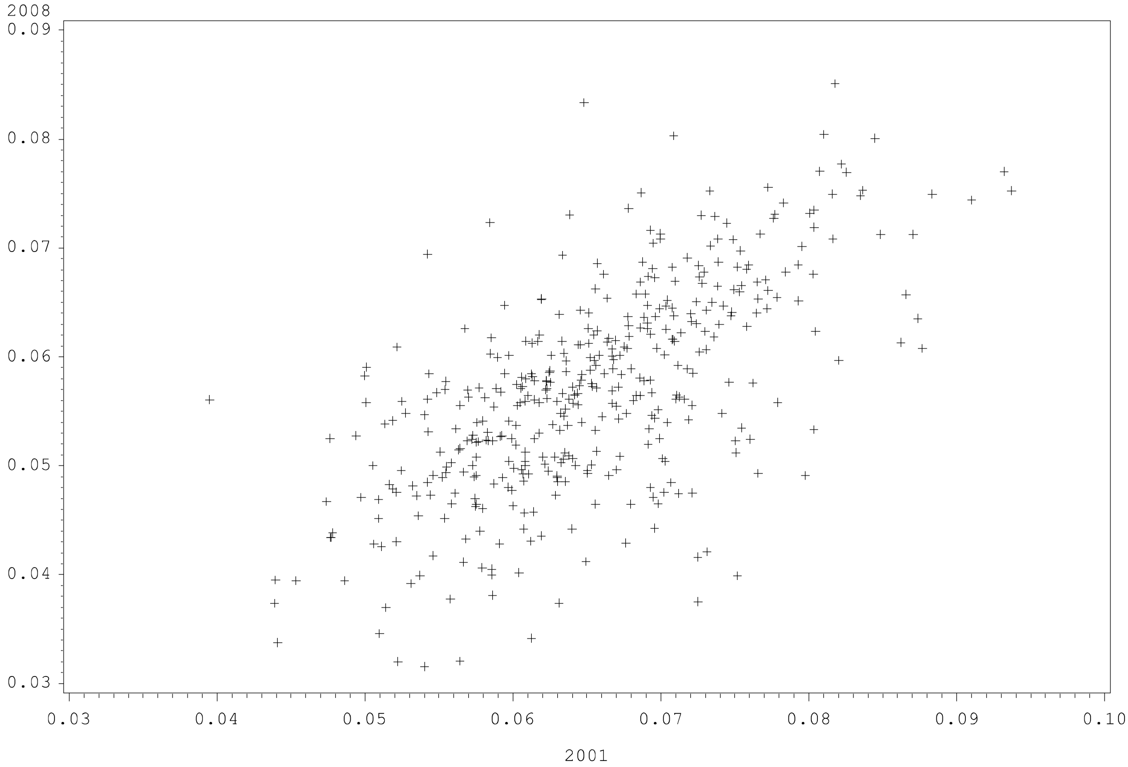
Full-time working women 20 – 44 years share of total population 2001 vs 2008



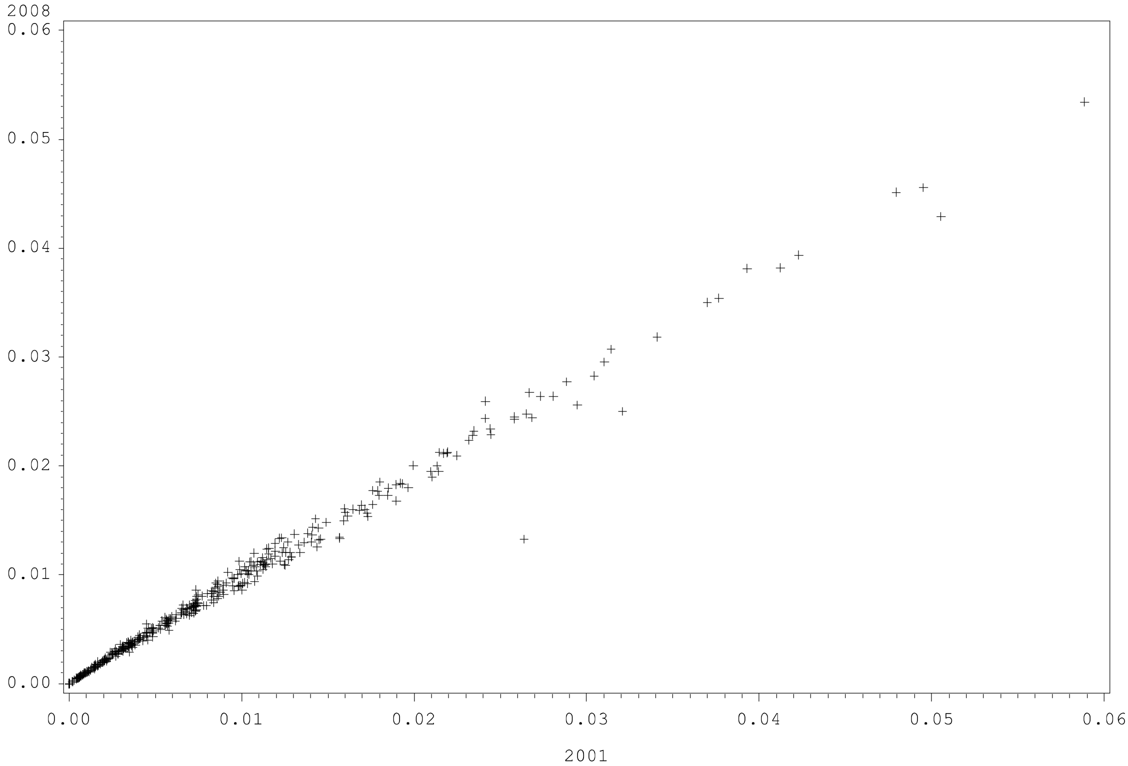
Refugees with integration grants 2001 vs 2008



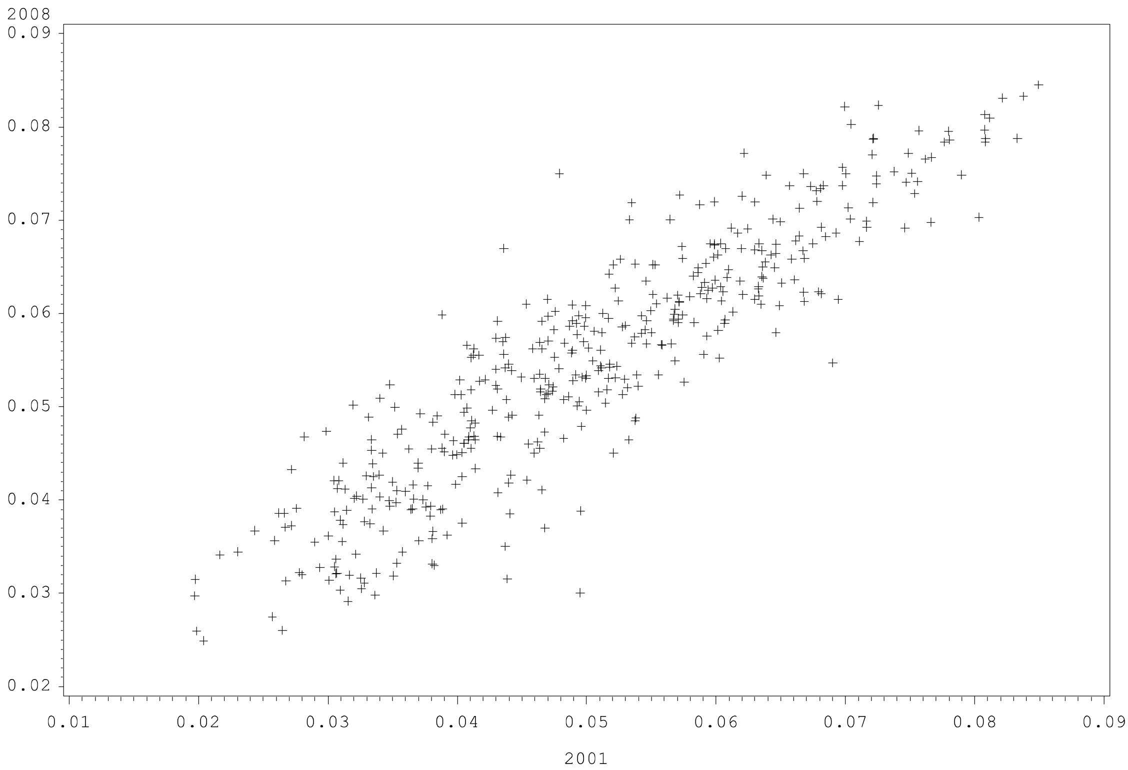
Population share 1 – 5 years of age 2001 vs 2008



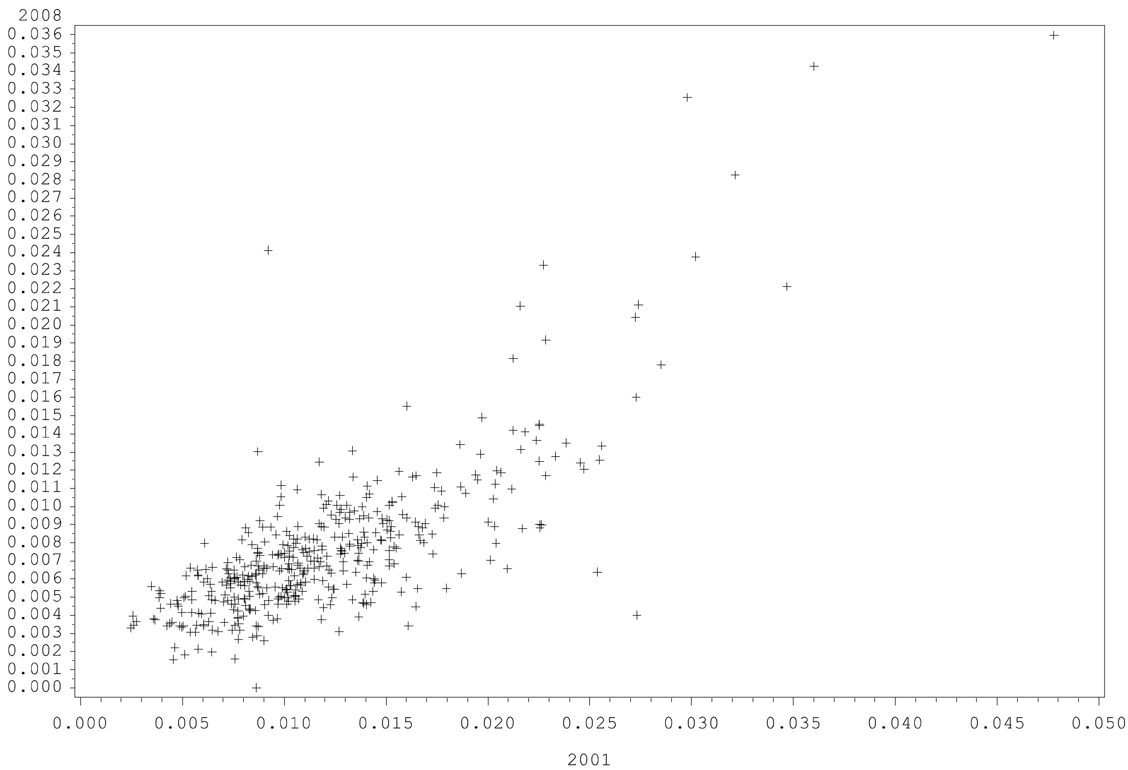
Refugees without integration grants 2001 vs 2008

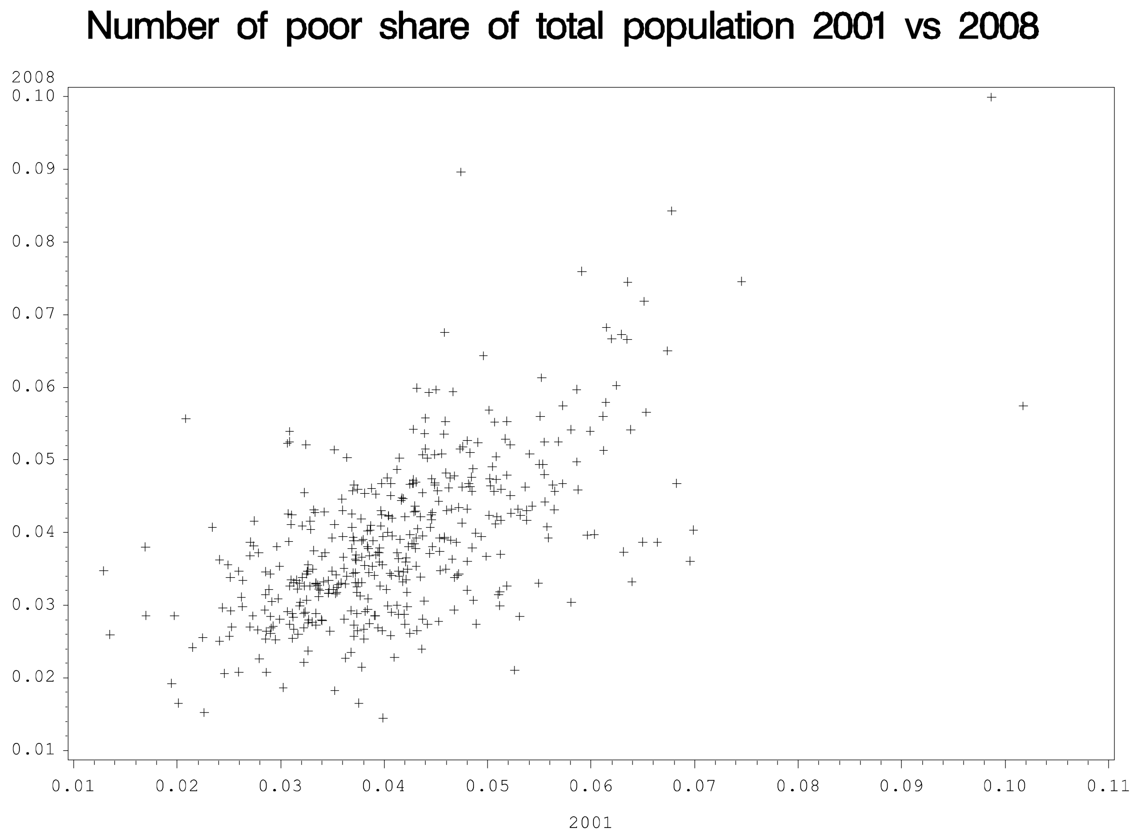


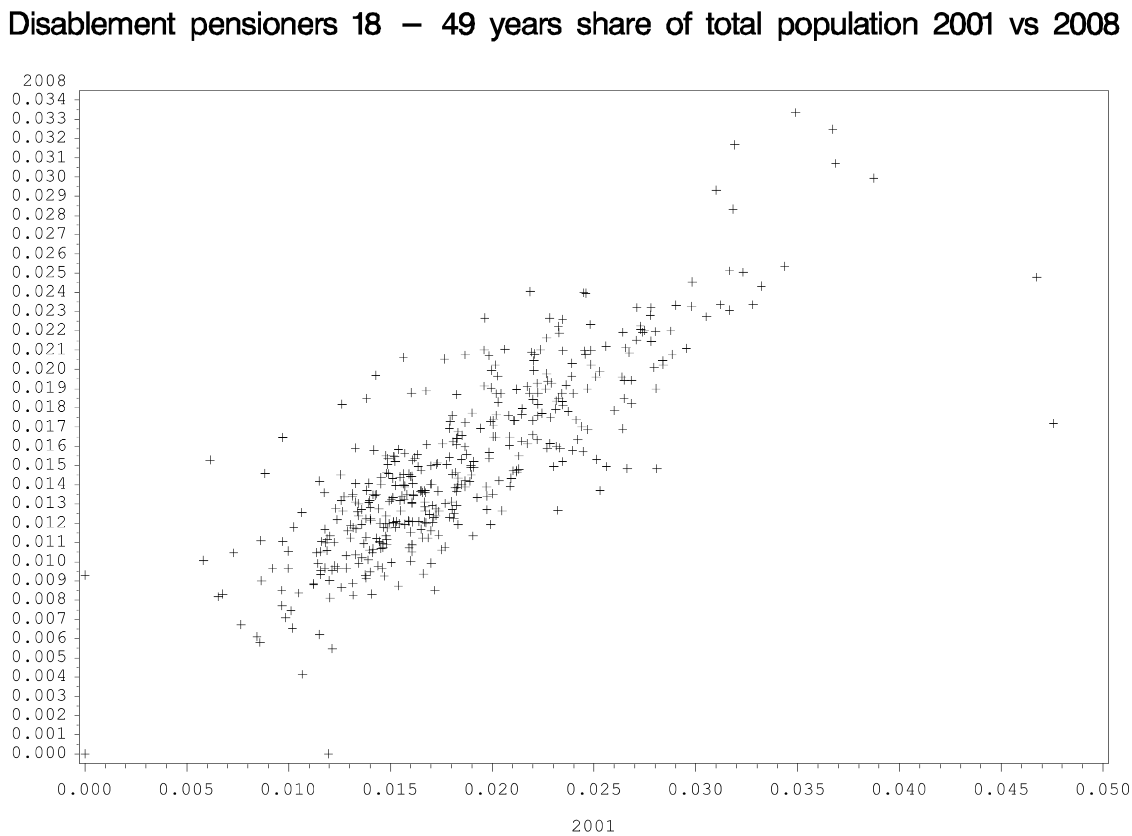
Divorced / separated 16 – 59 years share of total population 2001 vs 2008



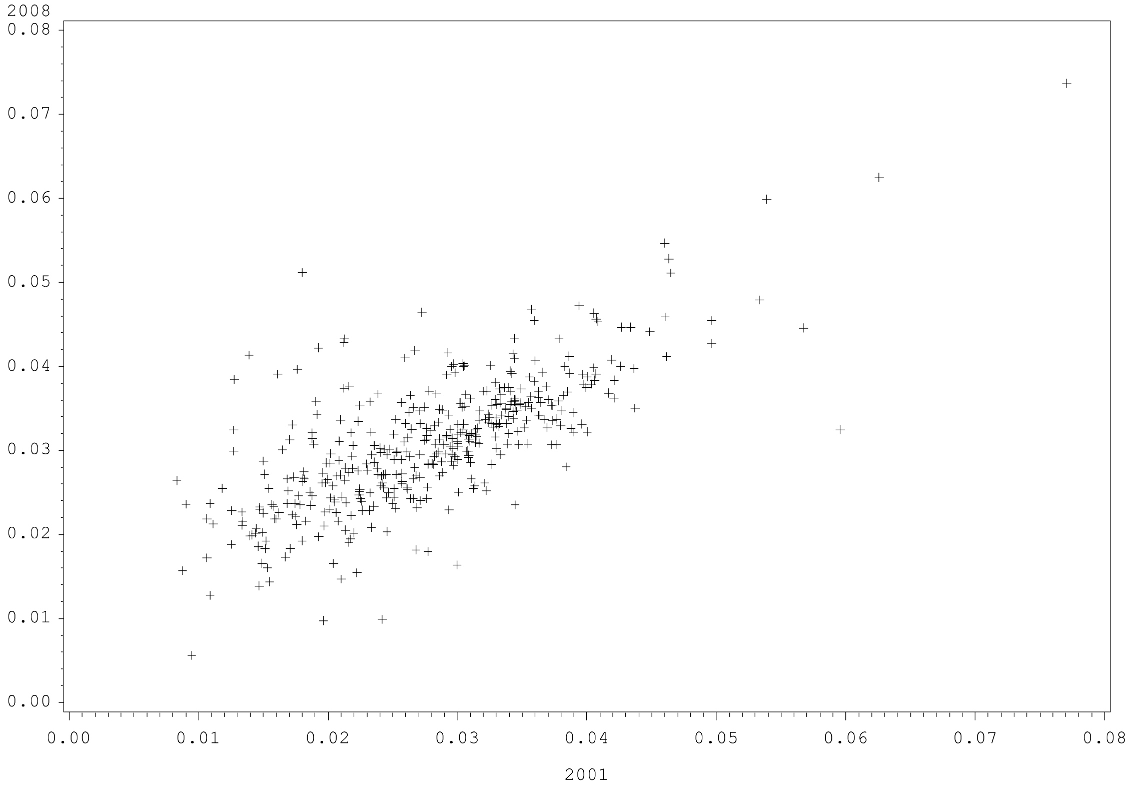
Unemployed 16–59 years share of total population 2001 vs 2008



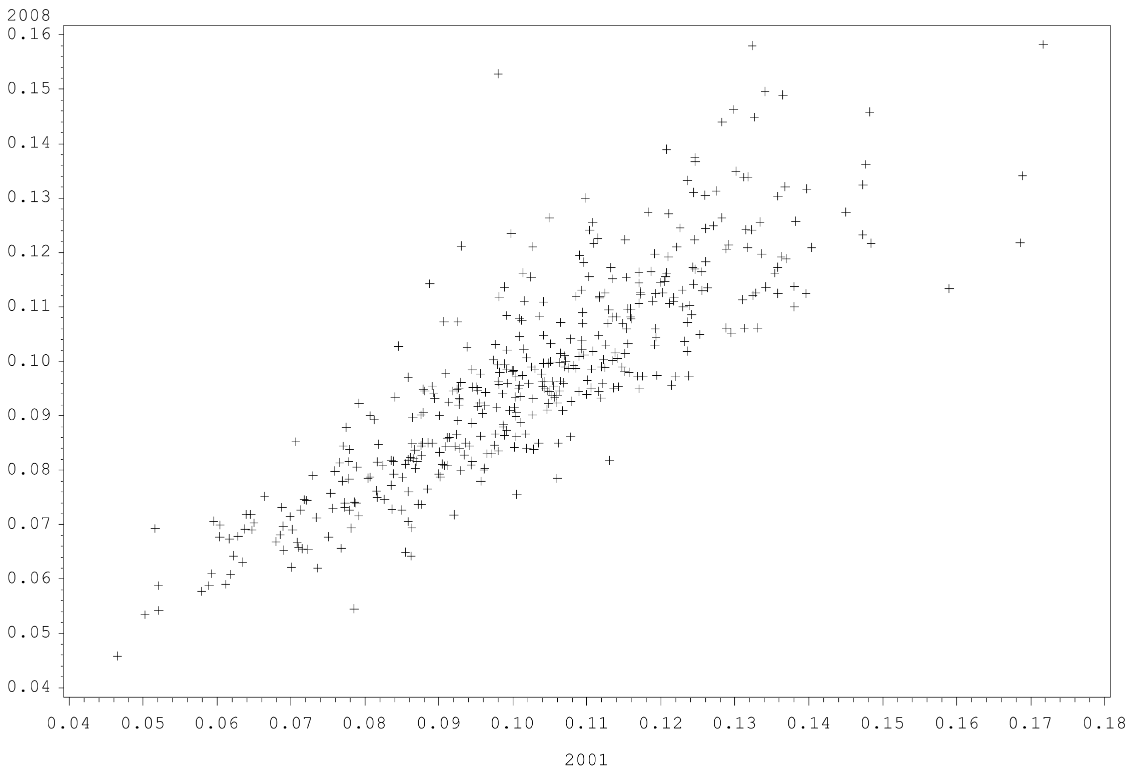

Number of poor share of total population 2001 vs 2008
2008
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11
2001


Disablement pensioners 18 – 49 years share of total population 2001 vs 2008
2008
0.034
0.033
0.032
0.031
0.030
0.029
0.028
0.027
0.026
0.025
0.024
0.023
0.022
0.021
0.020
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
0.000 0.005 0.010 0.015 0.020 0.025 0.030 0.035 0.040 0.045 0.050
2001

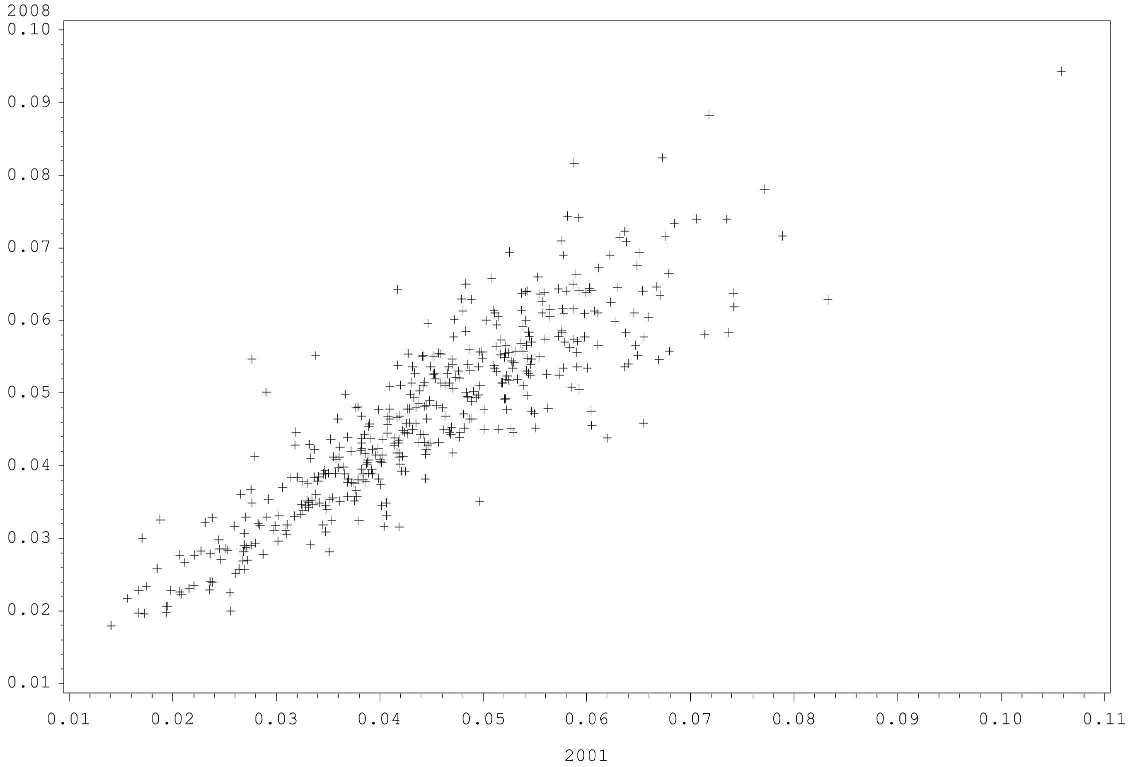
Children 0–15 years with single mother or father share of total population 2001 vs 2008 plot



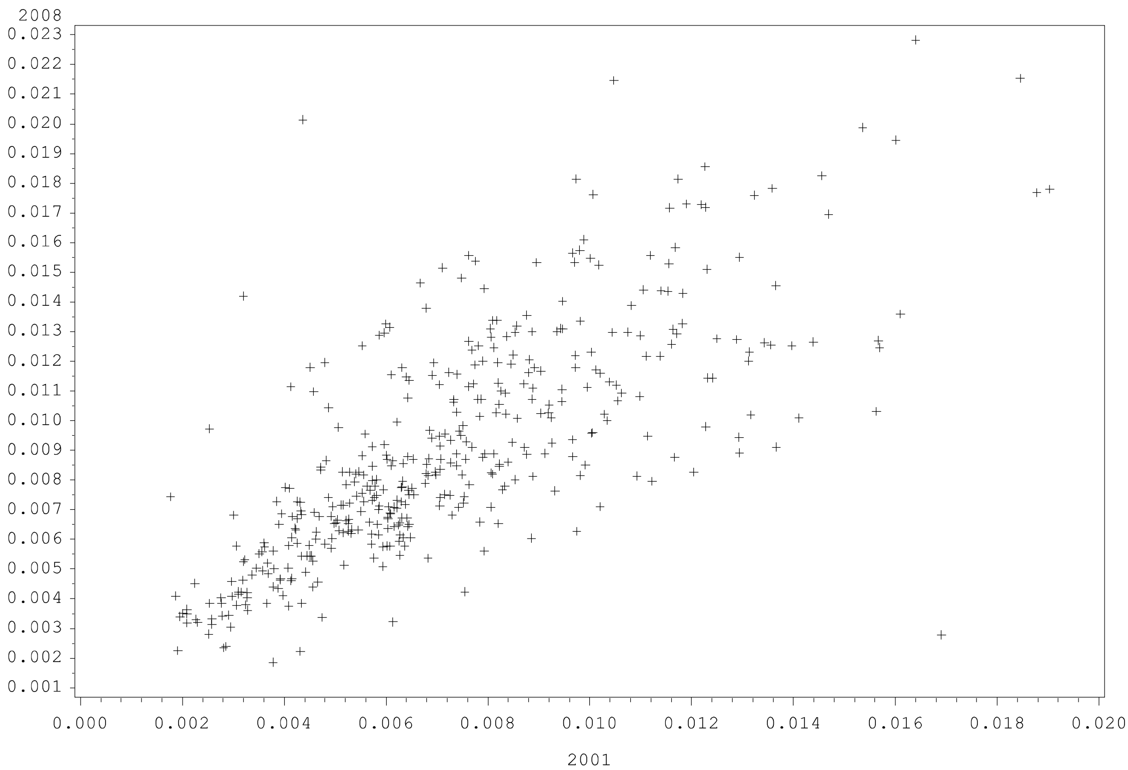
Population share 67–79 years 2001 vs 2008



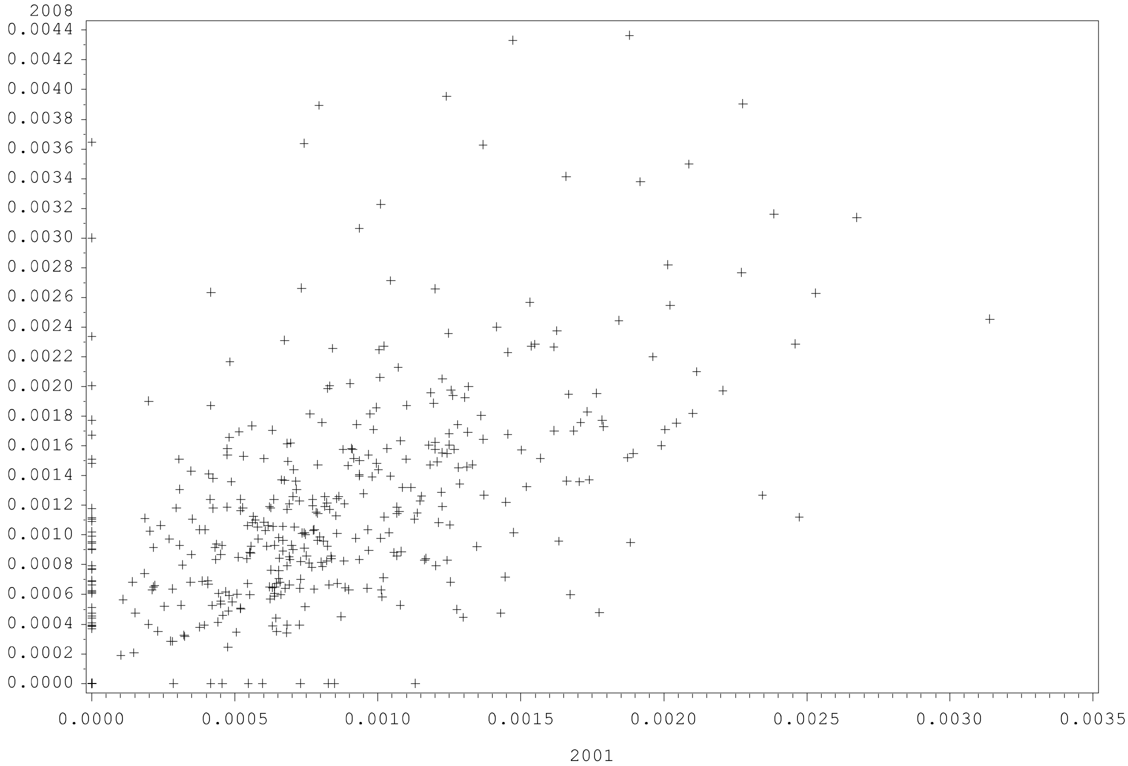
Population share 80 – 89 years 2001 vs 2008



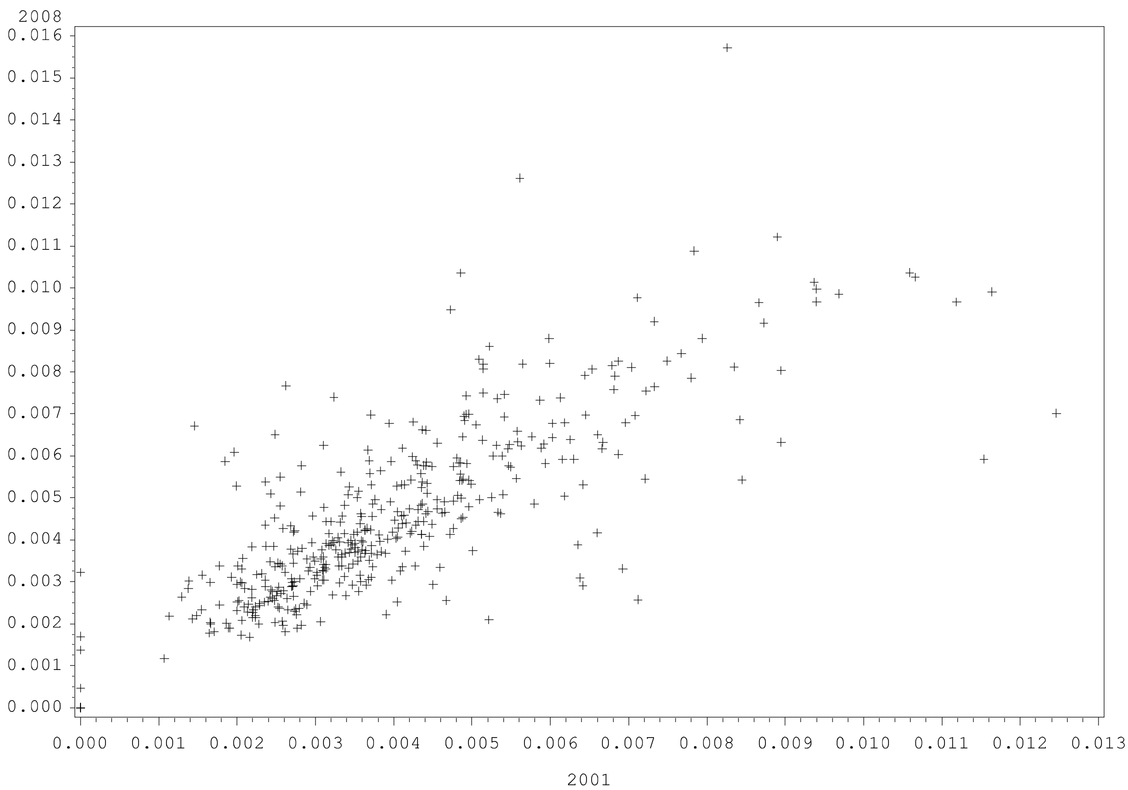
Population share 90 years and above 2001 vs 2008



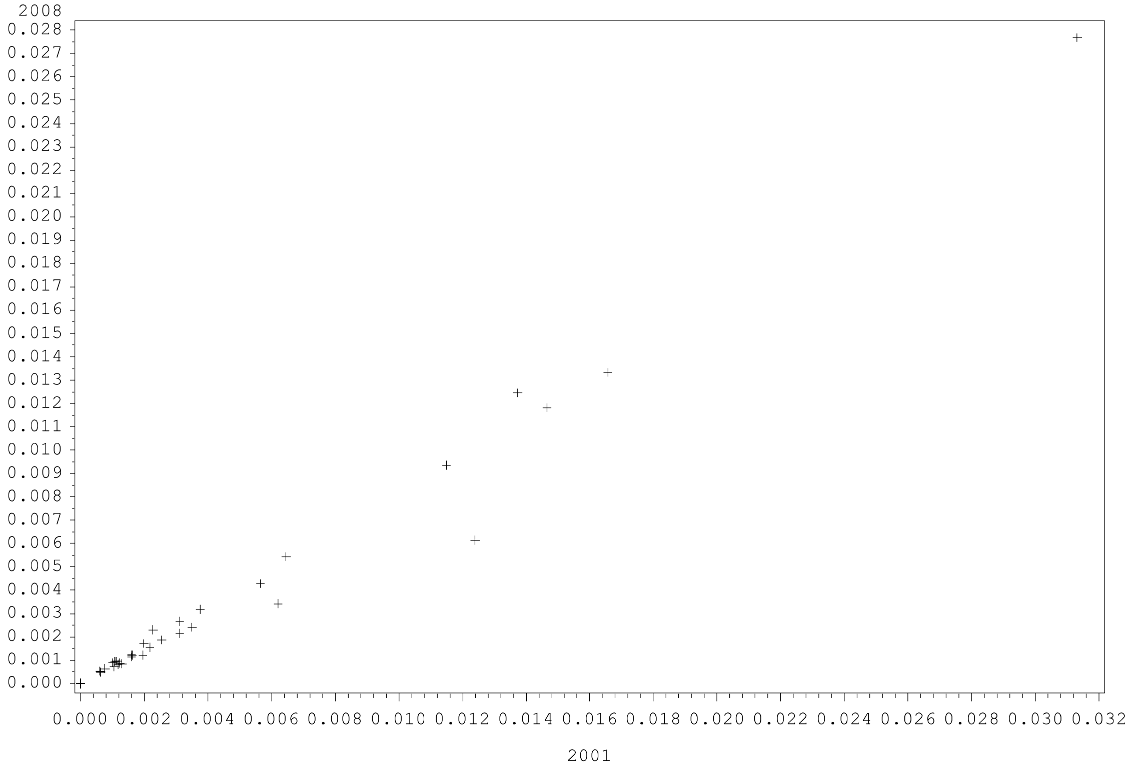
High–cost recipients share of total population 2001 vs 2008



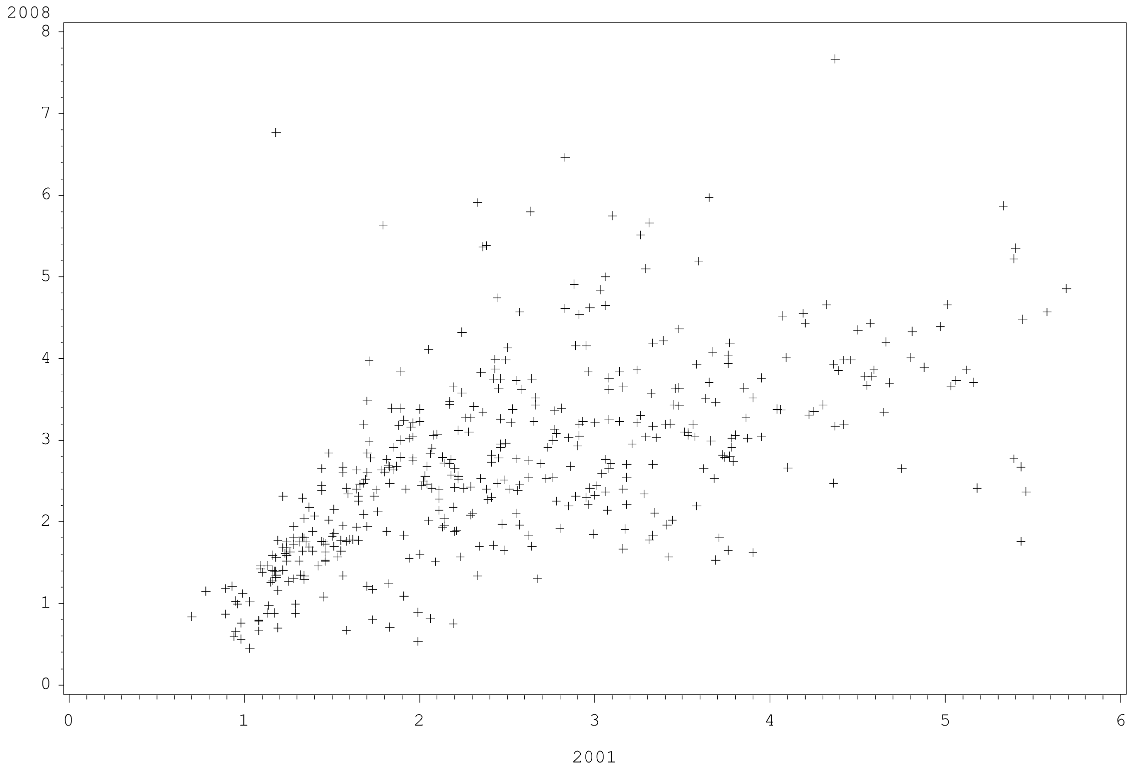
Mentally disabled 16 years and above share of total population without grant 2001 vs 2008

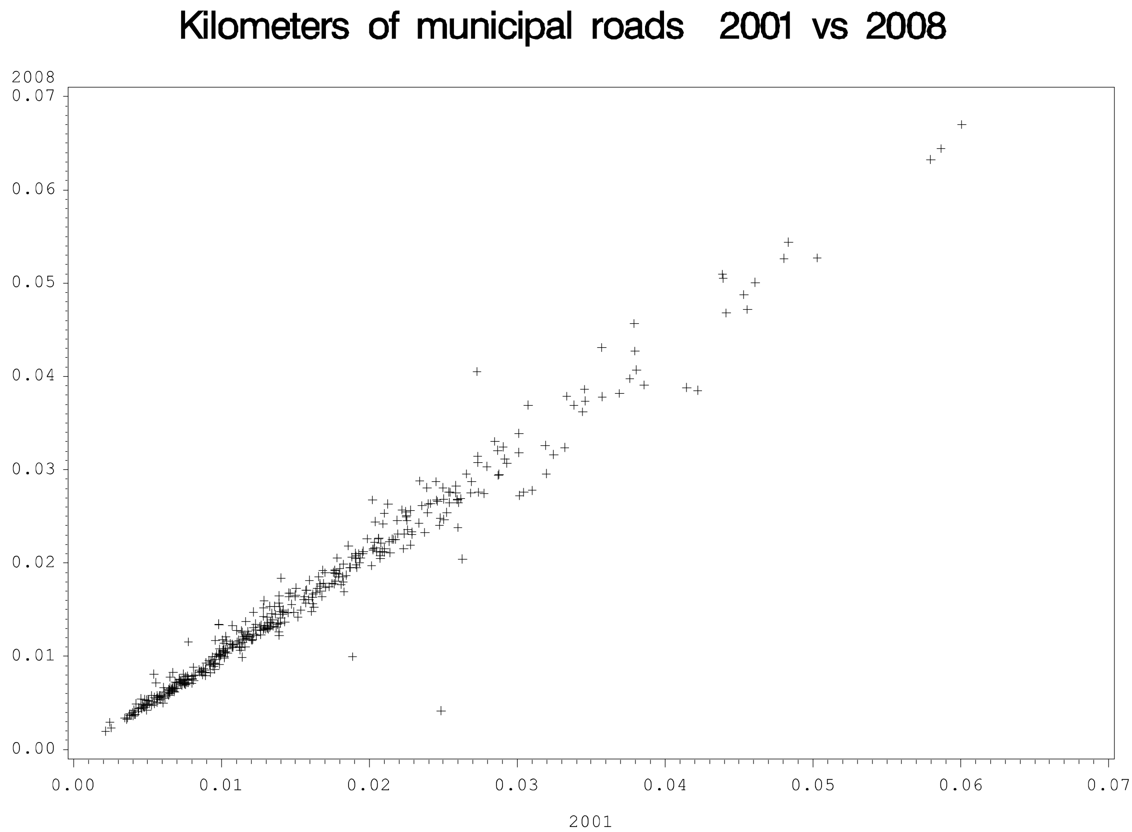


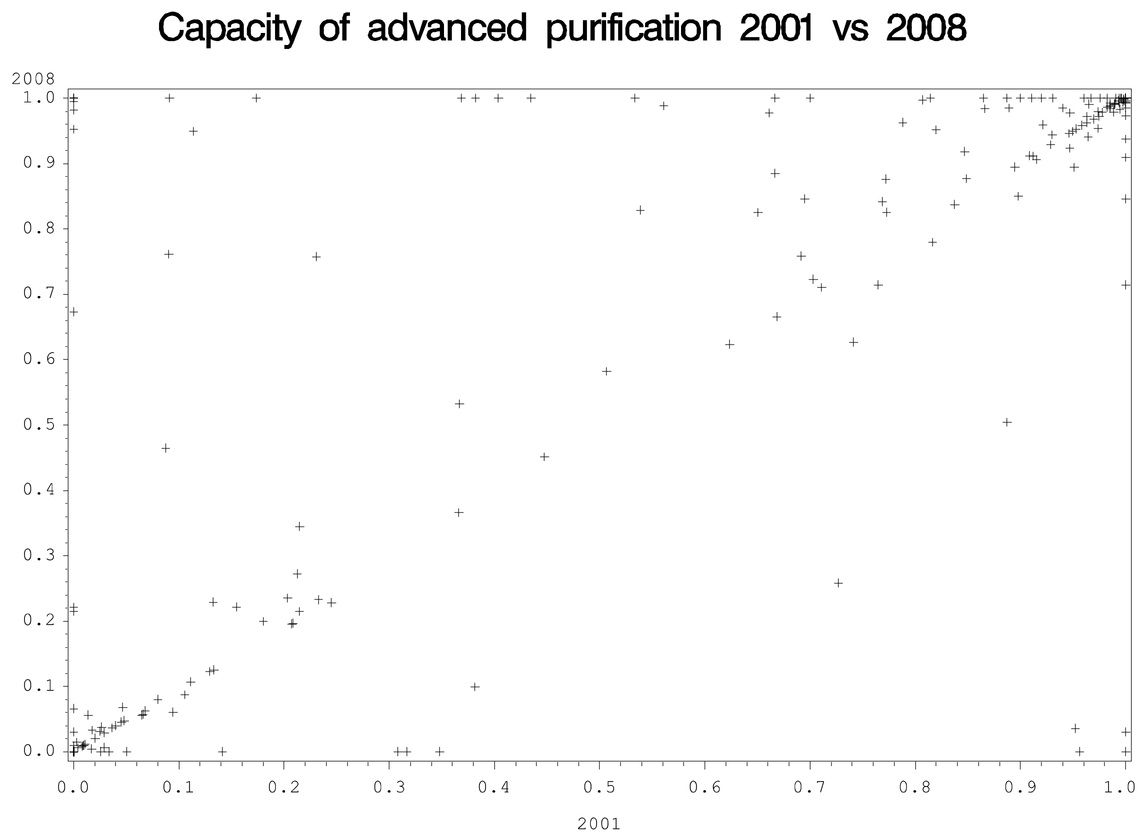
Mentally disabled 16 years and above share of total population with grant 2001 vs 2008



Amount of snowfall (meters) 2001 vs 2008 plot

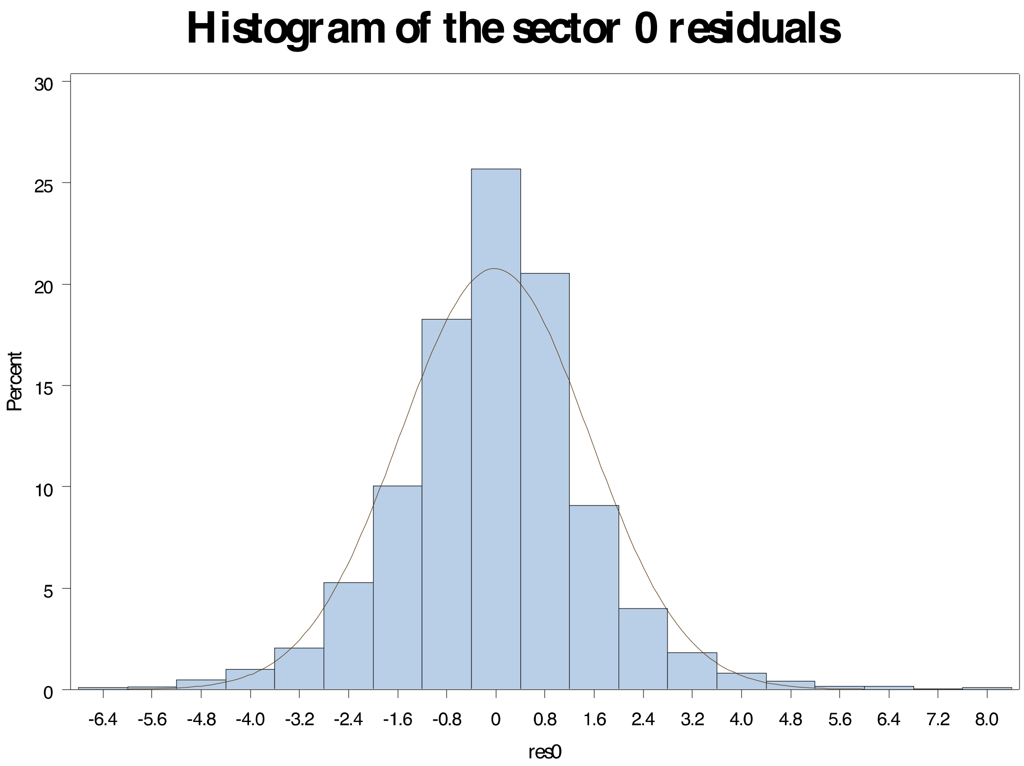


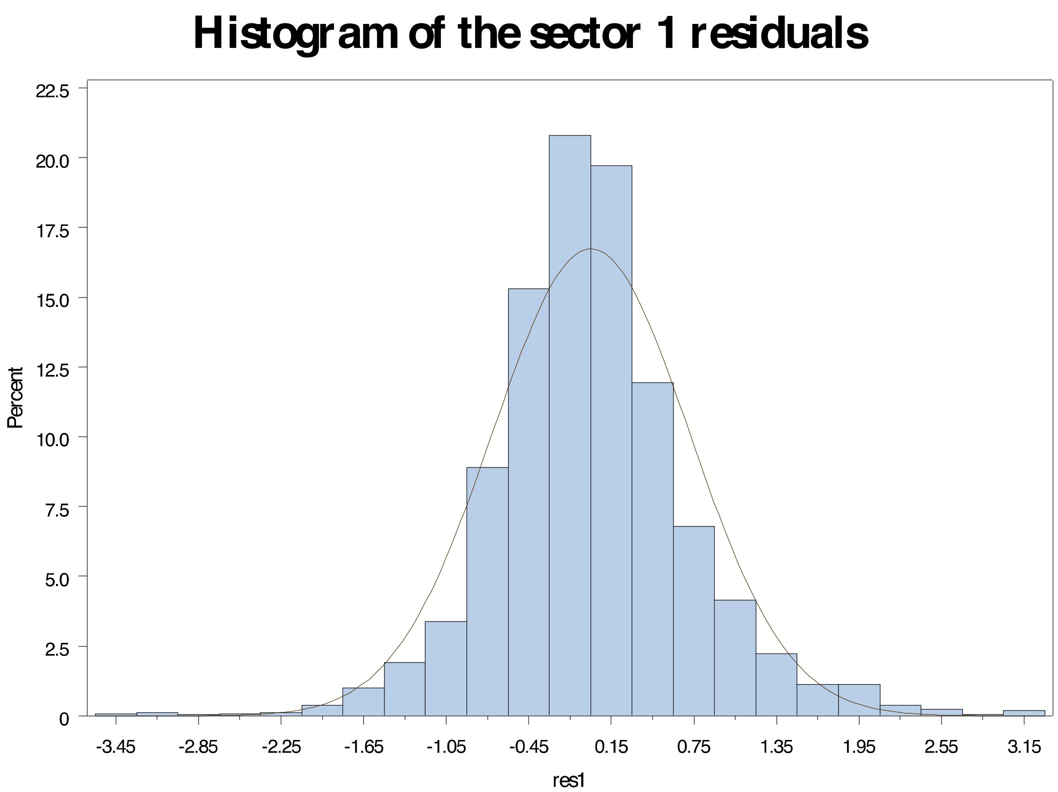

Kilometers of municipal roads 2001 vs 2008
2008
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
2001

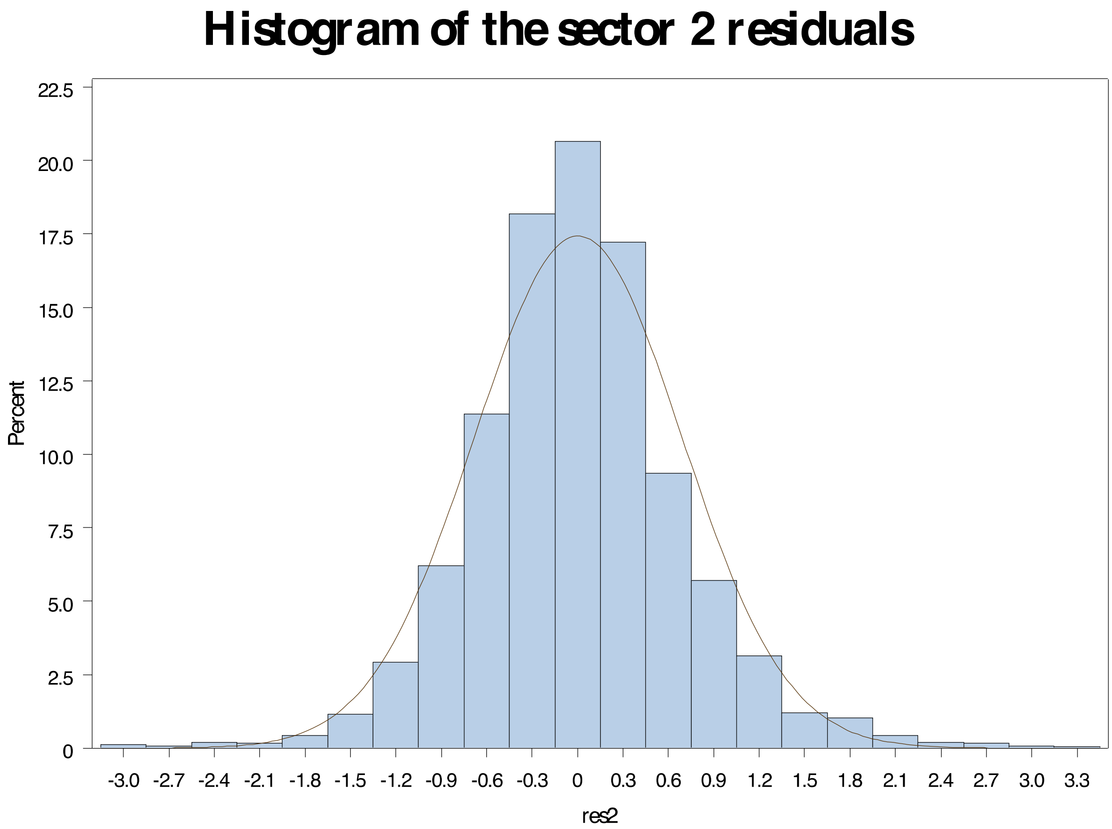

Capacity of advanced purification 2001 vs 2008
2008
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
2001

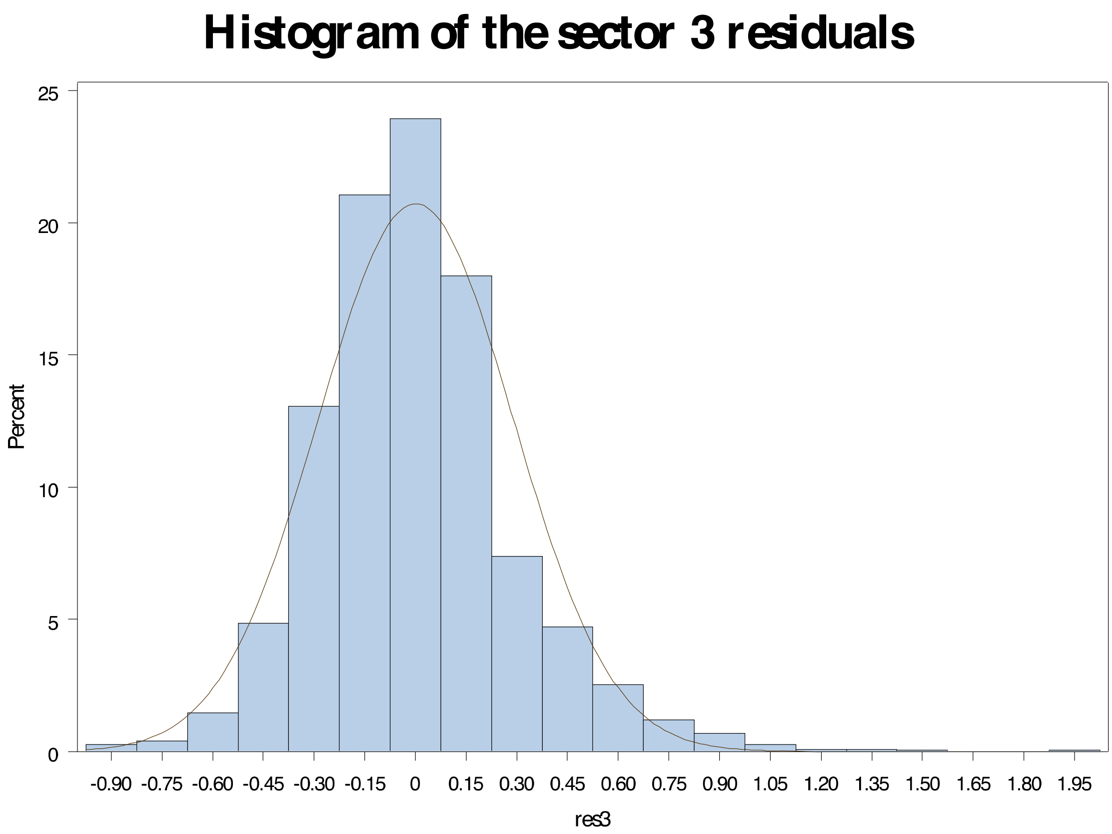
Appendix C: Residual plots

Model 2 (A)

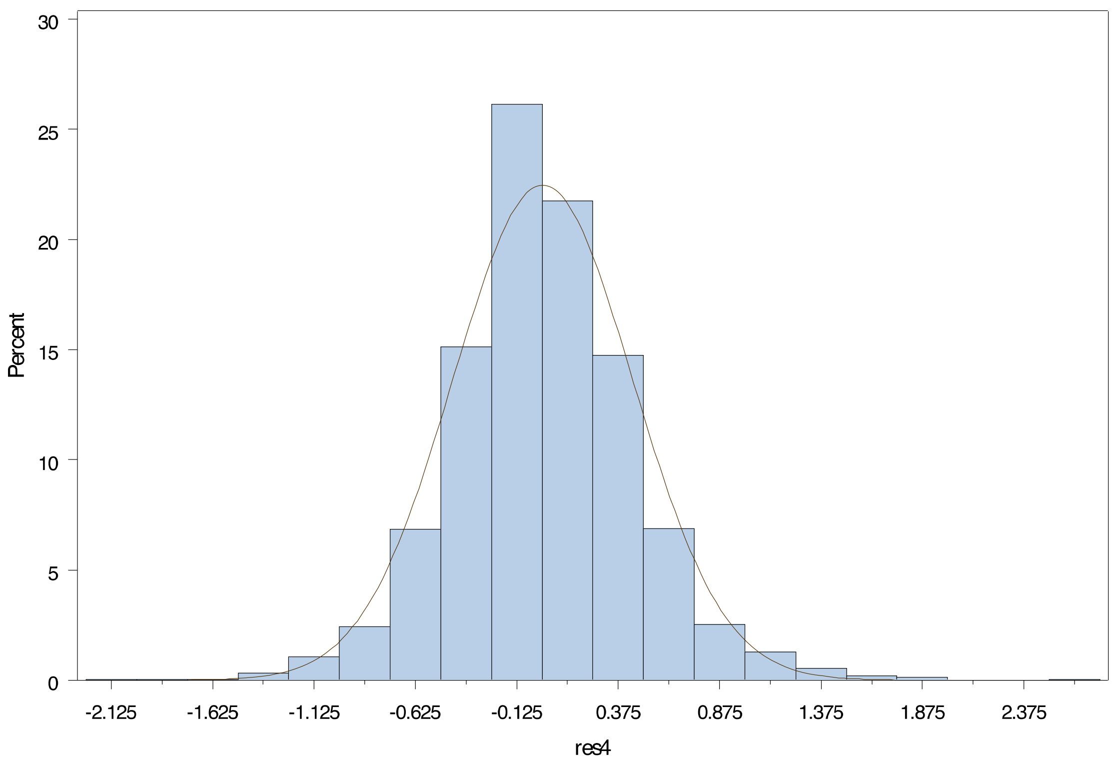




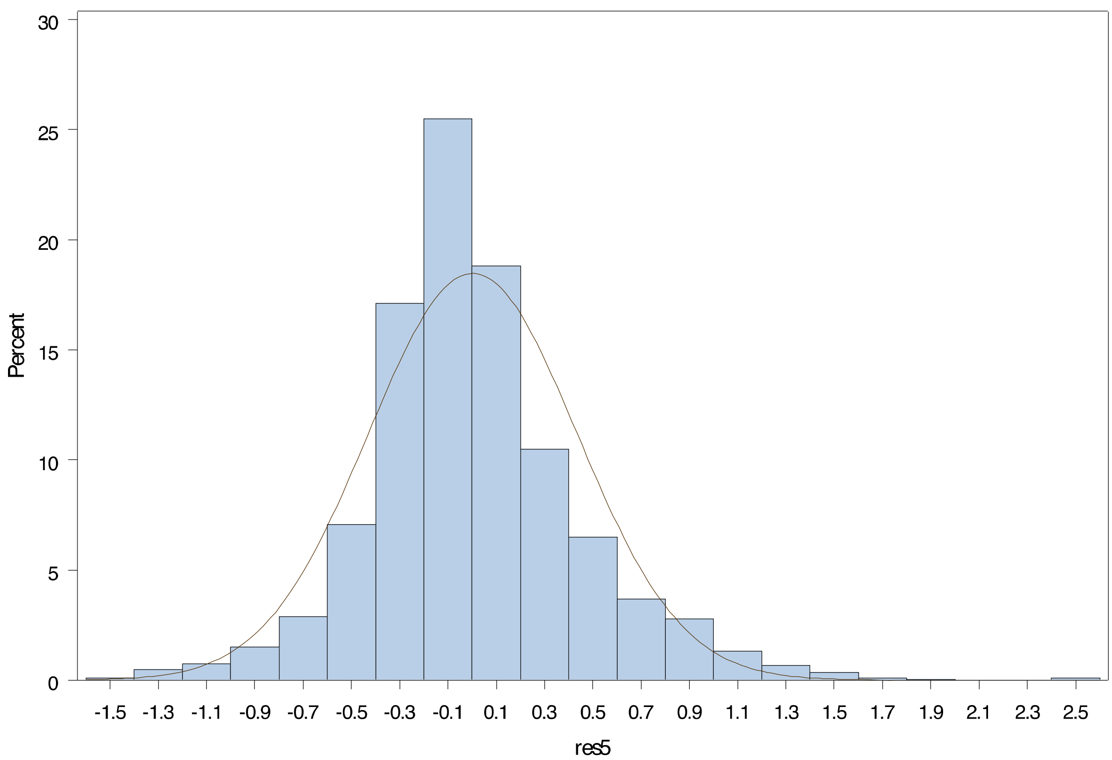

Histogram of the sector 2 residuals
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0
Percent
-3.0 -2.7 -2.4 -2.1 -1.8 -1.5 -1.2 -0.9 -0.6 -0.3 0 0.3 0.6 0.9 1.2 1.5 1.8 2.1 2.4 2.7 3.0 3.3
res2


Histogram of the sector 3 residuals
25
20
15
10
5
0
Percent
-0.90 -0.75 -0.60 -0.45 -0.30 -0.15 0 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.20 1.35 1.50 1.65 1.80 1.95
res3

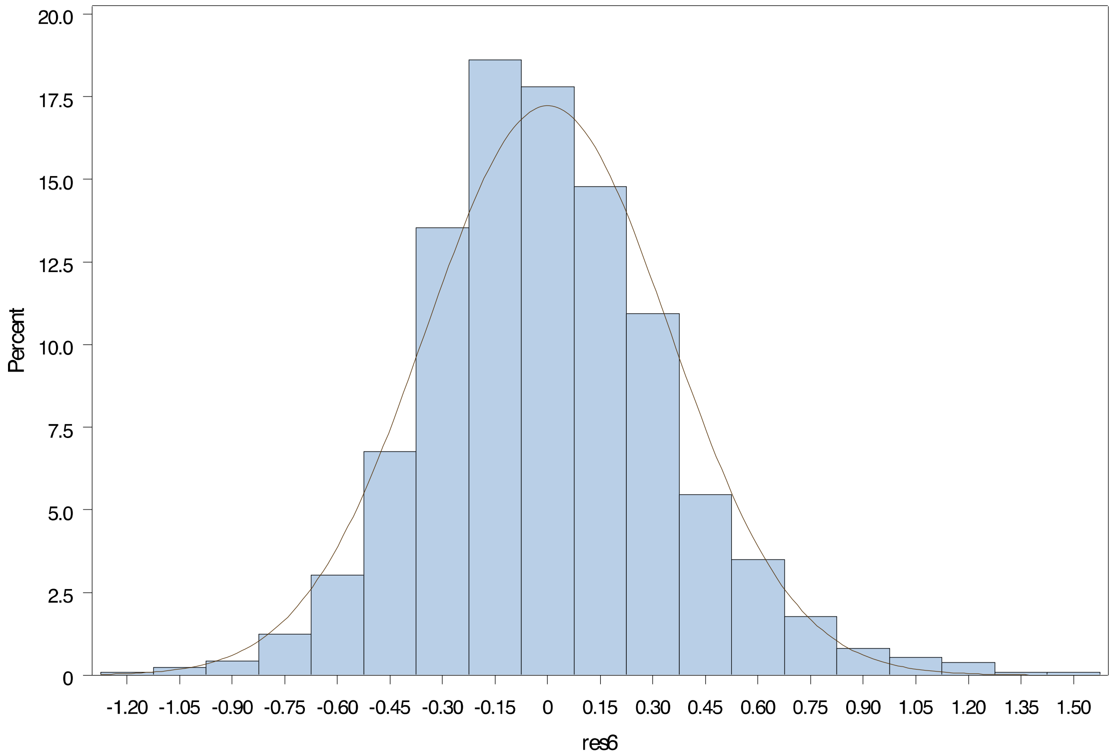
Histogram of the sector 4 residuals



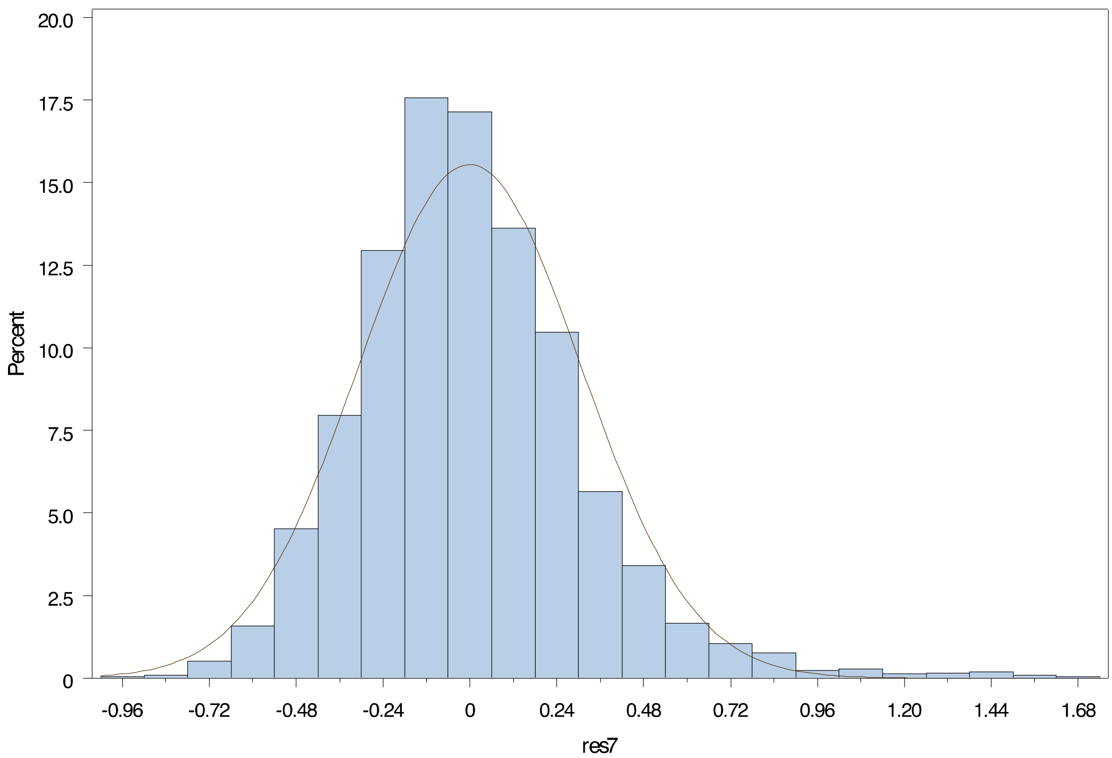
Histogram of the sector 5 residuals

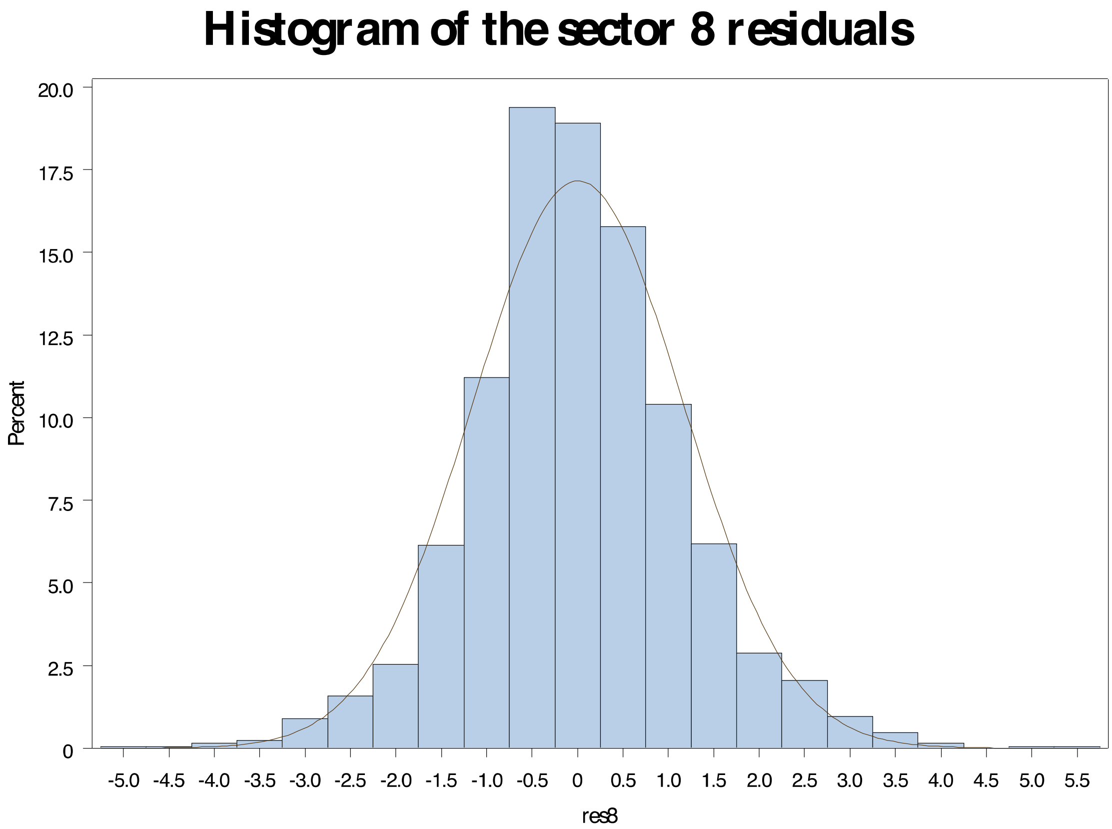


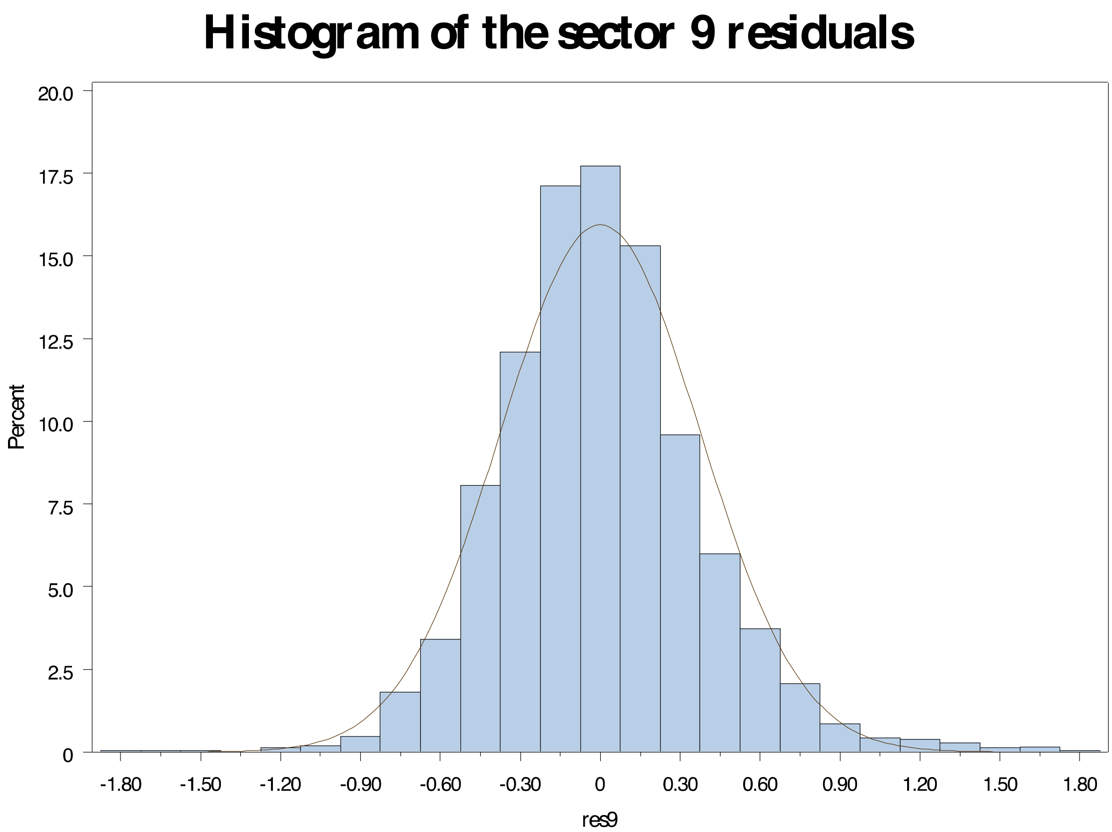
Histogram of the sector 6 residuals

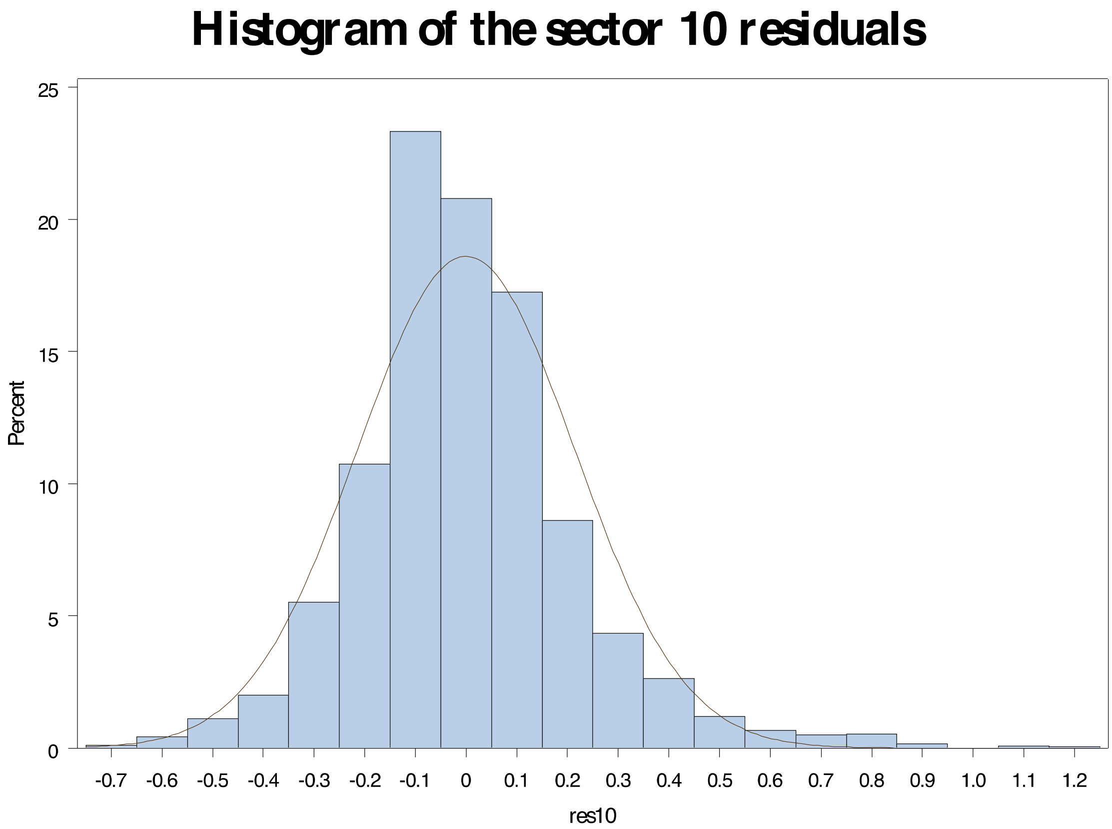


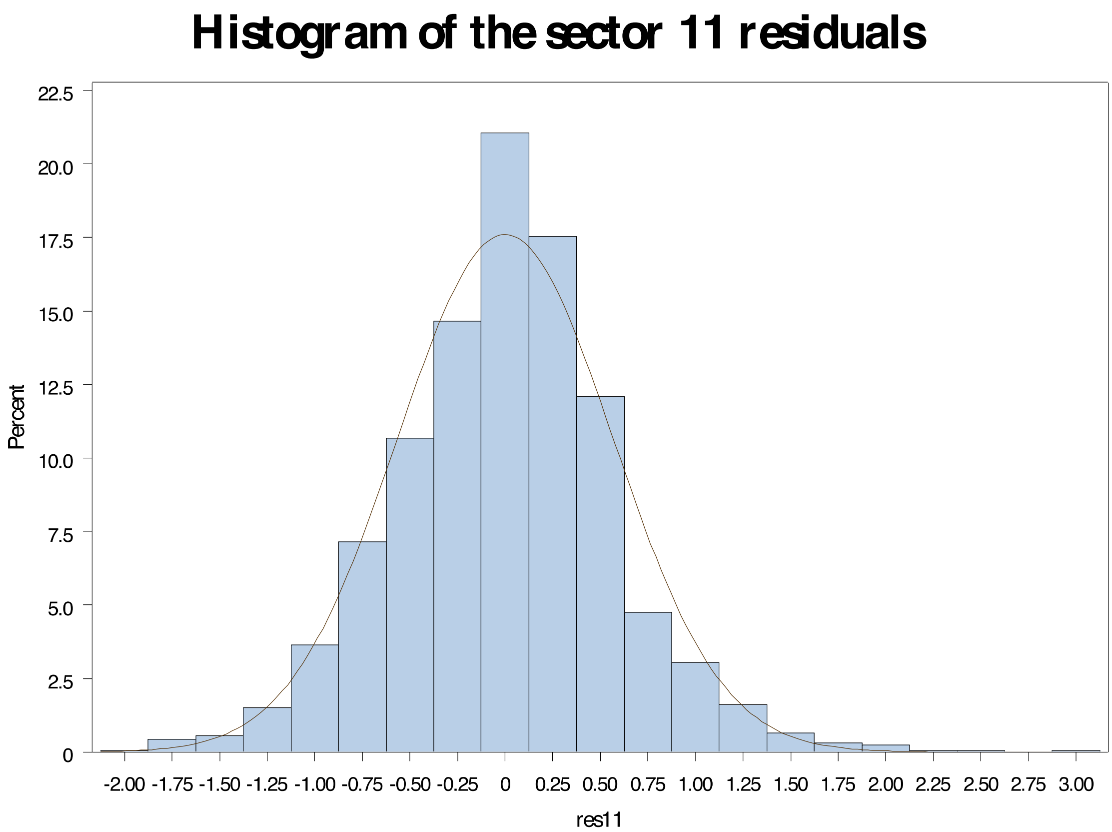
Histogram of the sector 7 residuals

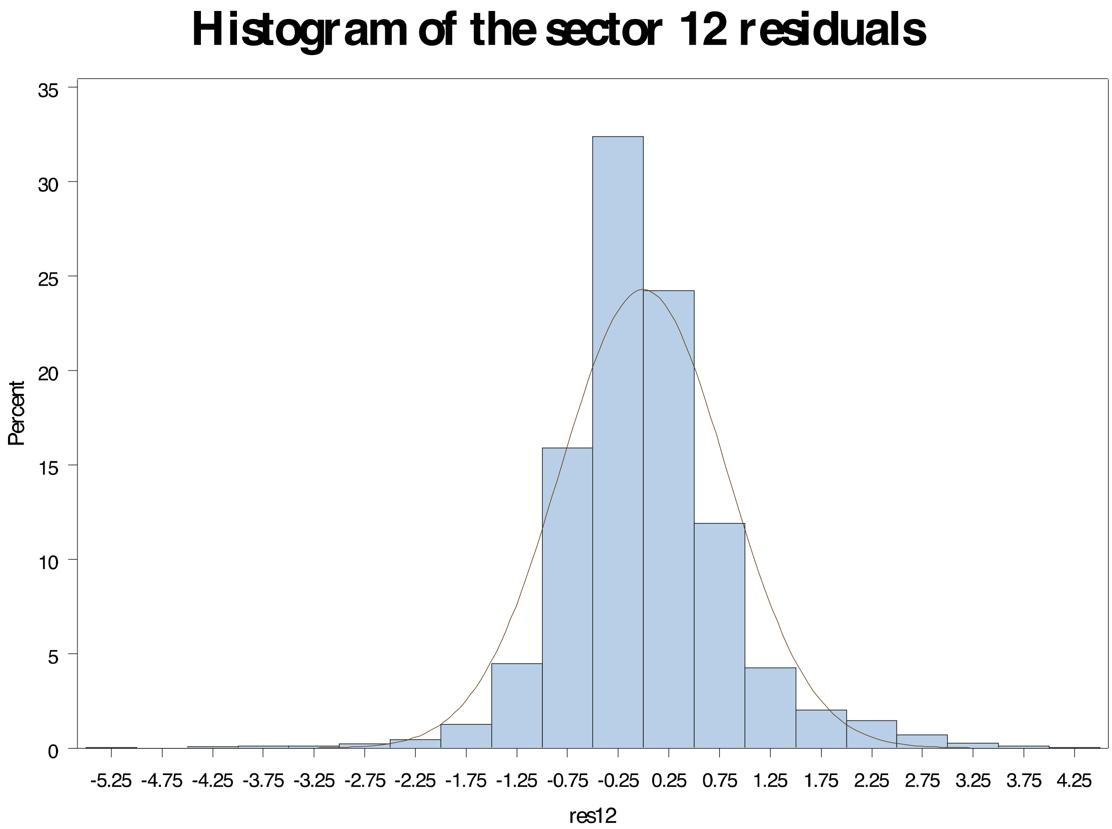



Histogram of the sector 8 residuals
Percent
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0
-5.0 -4.5 -4.0 -3.5 -3.0 -2.5 -2.0 -1.5 -1.0 -0.5 0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5
res8

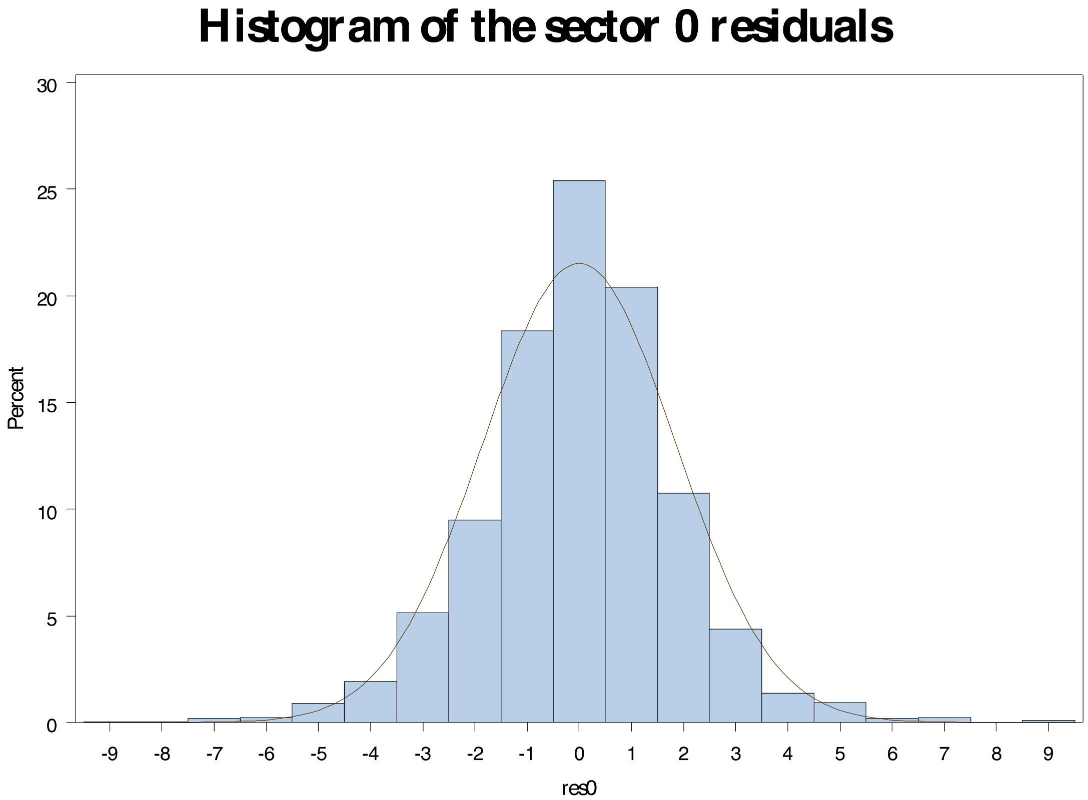

Histogram of the sector 9 residuals
Percent
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0
-1.80 -1.50 -1.20 -0.90 -0.60 -0.30 0 0.30 0.60 0.90 1.20 1.50 1.80
res9

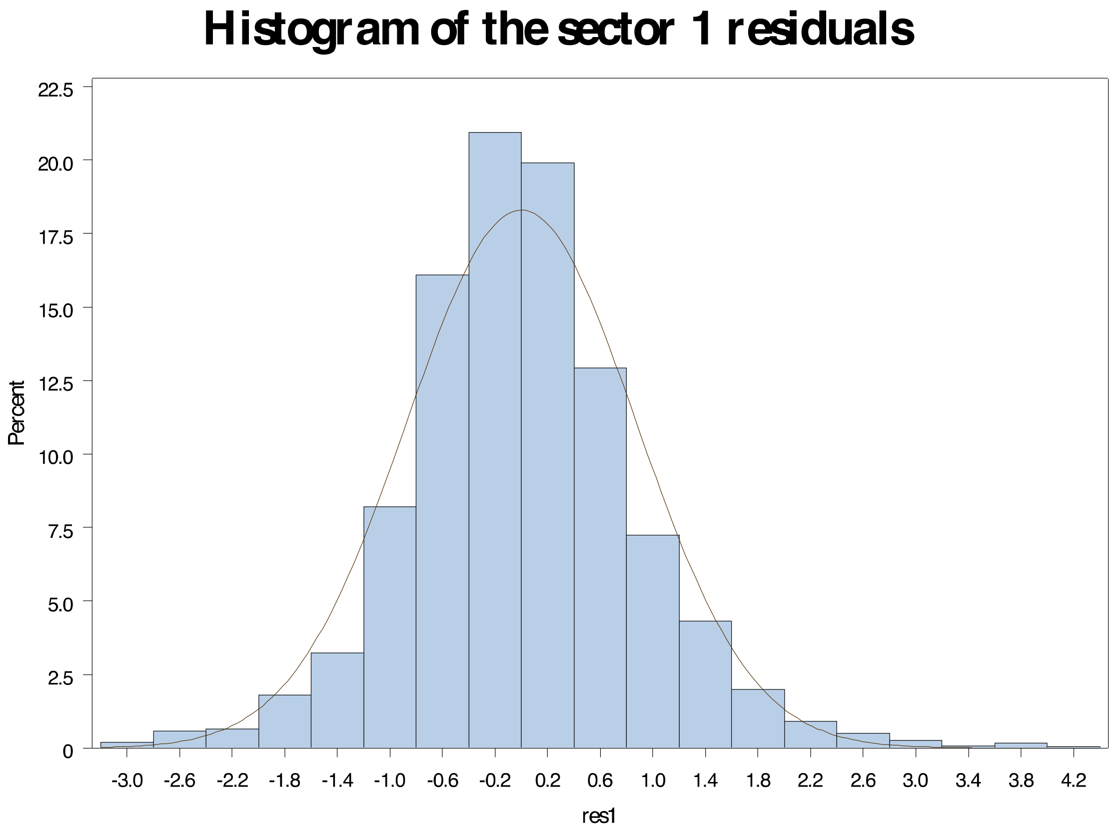

Histogram of the sector 10 residuals
Percent
25
20
15
10
5
0
-0.7 -0.6 -0.5 -0.4 -0.3 -0.2 -0.1 0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2
res10

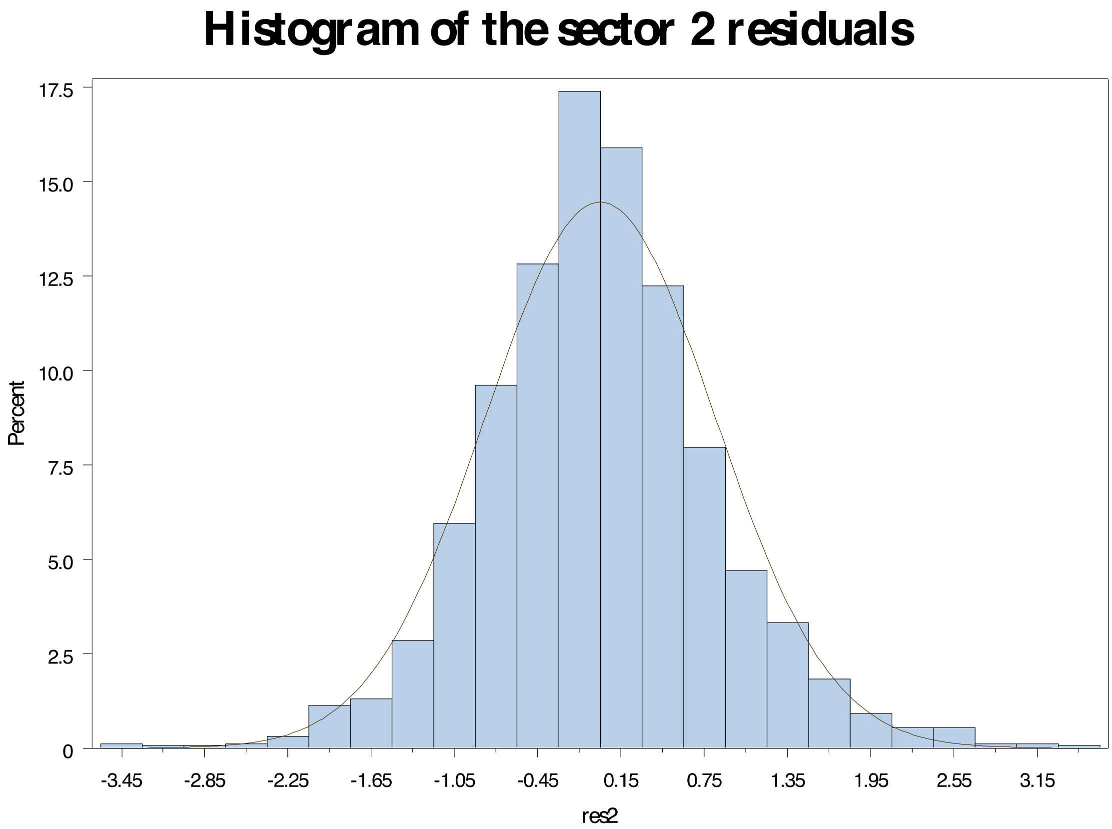

Histogram of the sector 11 residuals
Percent
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0
-2.00 -1.75 -1.50 -1.25 -1.00 -0.75 -0.50 -0.25 0 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
res11

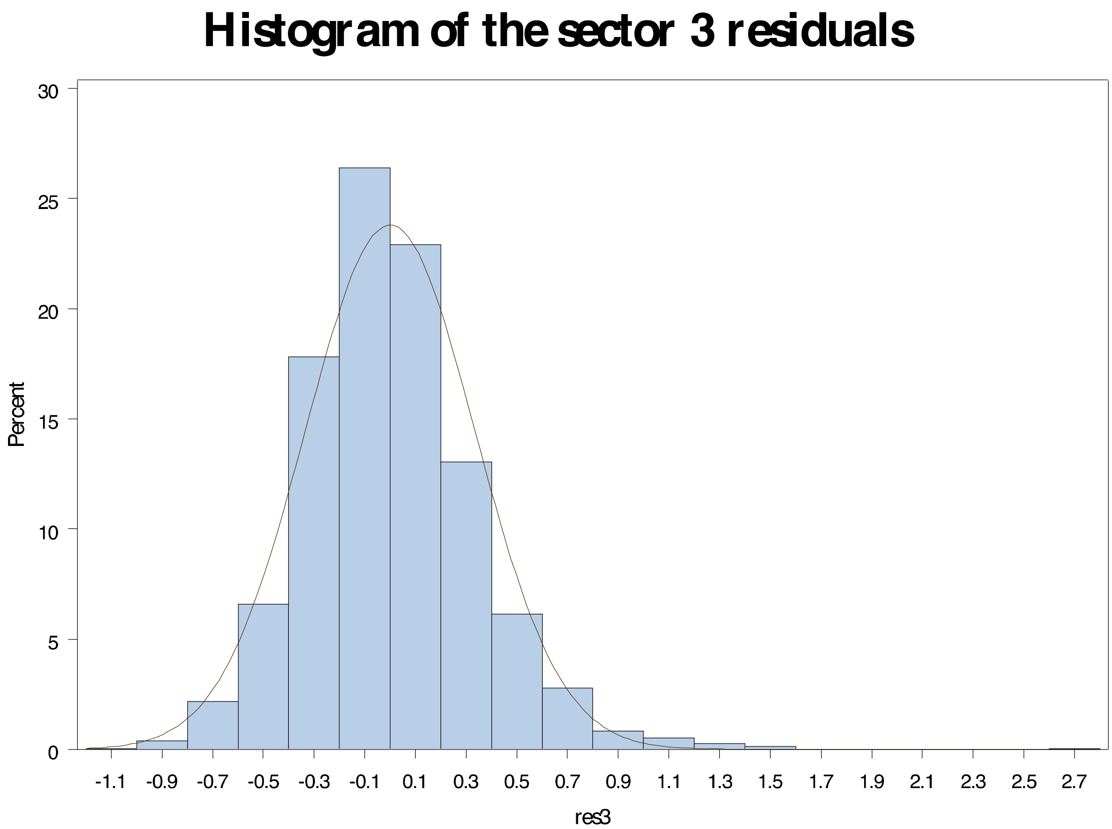

Histogram of the sector 12 residuals
Percent
35
30
25
20
15
10
5
0
-5.25 -4.75 -4.25 -3.75 -3.25 -2.75 -2.25 -1.75 -1.25 -0.75 -0.25 0.25 0.75 1.25 1.75 2.25 2.75 3.25 3.75 4.25
res12

Model 7(A)

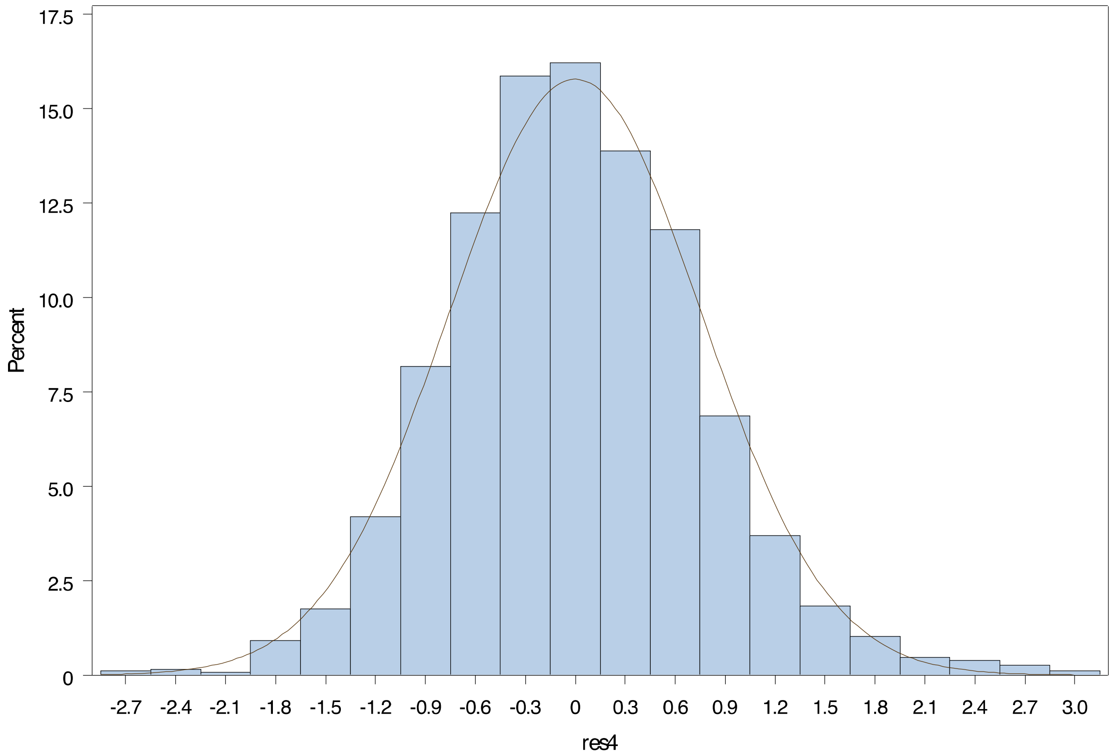

Histogram of the sector 0 residuals
Percent
30
25
20
15
10
5
0
-9
-8
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
res0


Histogram of the sector 1 residuals
Percent
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0
-3.0
-2.6
-2.2
-1.8
-1.4
-1.0
-0.6
-0.2
0.2
0.6
1.0
1.4
1.8
2.2
2.6
3.0
3.4
3.8
4.2
res1

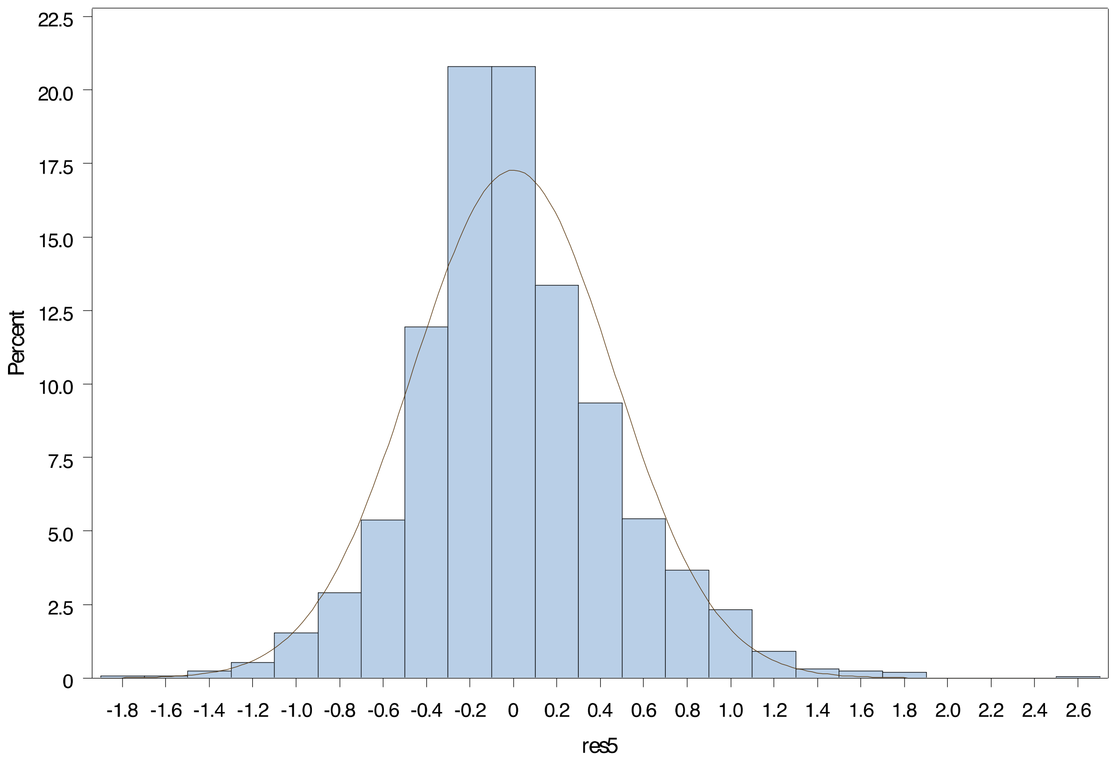

Histogram of the sector 2 residuals
Percent
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0
-3.45 -2.85 -2.25 -1.65 -1.05 -0.45 0.15 0.75 1.35 1.95 2.55 3.15
res2


Histogram of the sector 3 residuals
Percent
30
25
20
15
10
5
0
-1.1 -0.9 -0.7 -0.5 -0.3 -0.1 0.1 0.3 0.5 0.7 0.9 1.1 1.3 1.5 1.7 1.9 2.1 2.3 2.5 2.7
res3

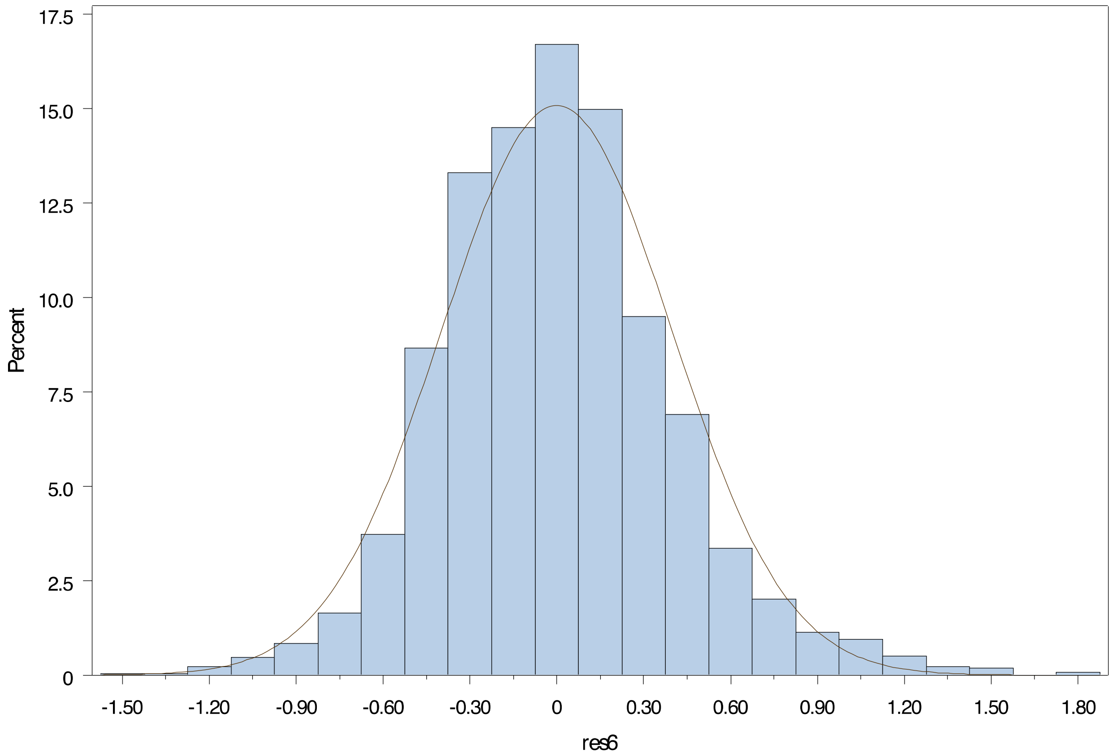
Histogram of the sector 4 residuals



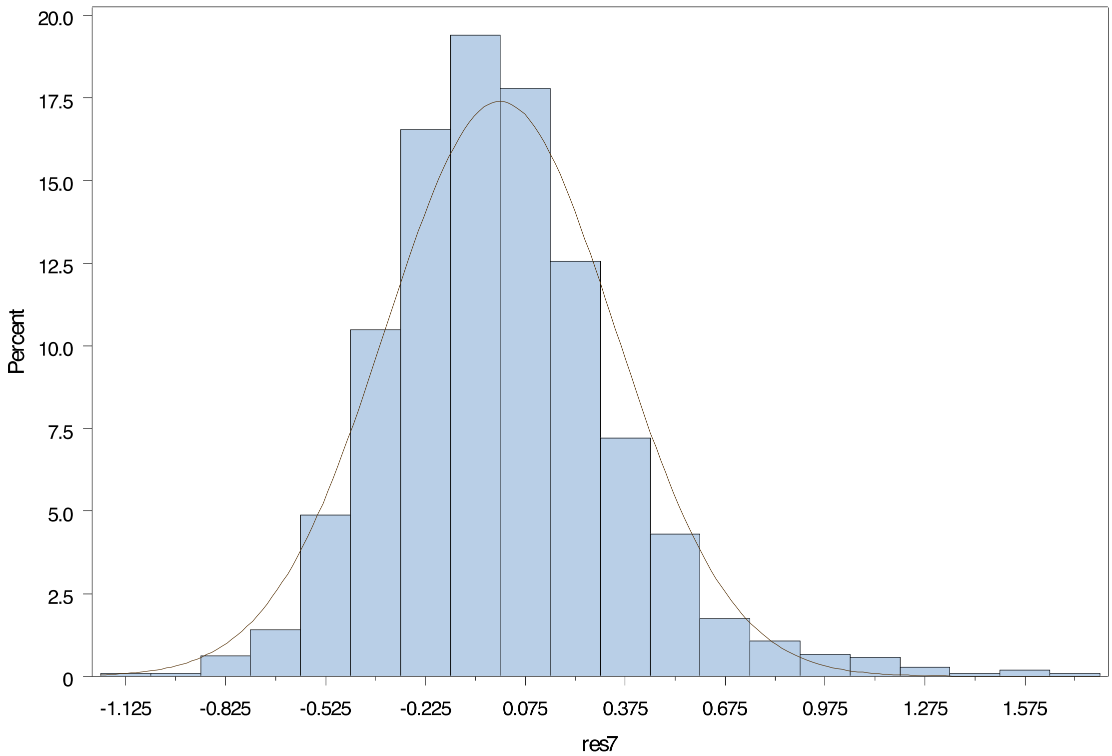
Histogram of the sector 5 residuals



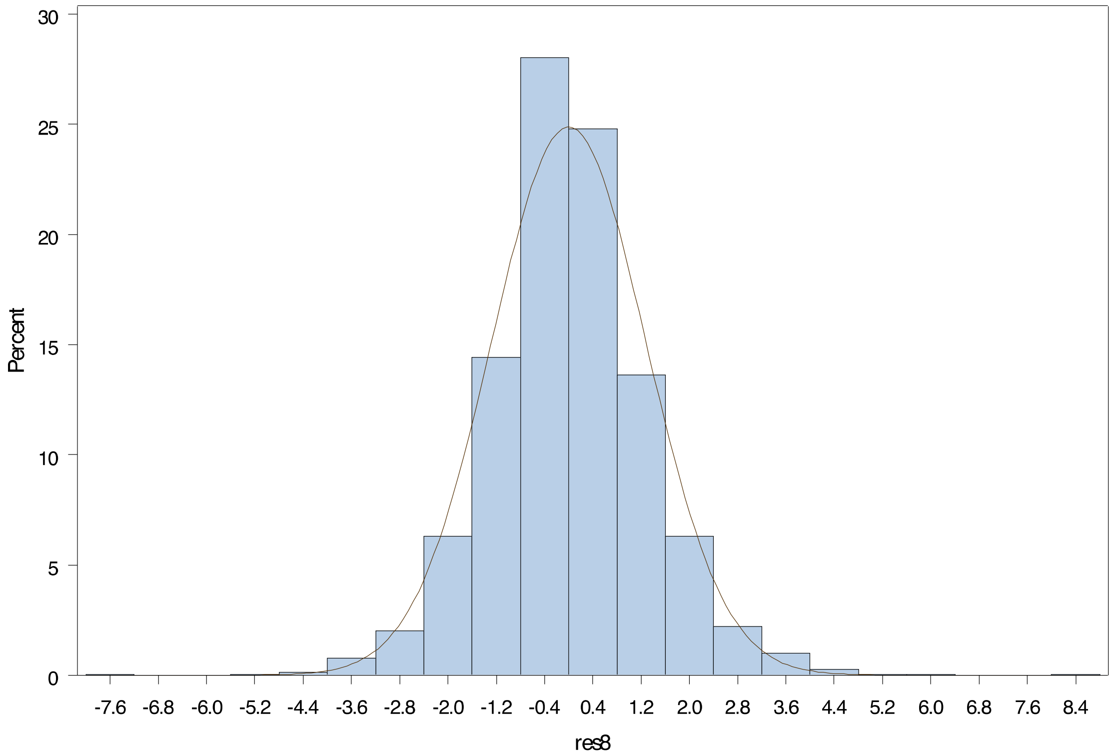
Histogram of the sector 6 residuals



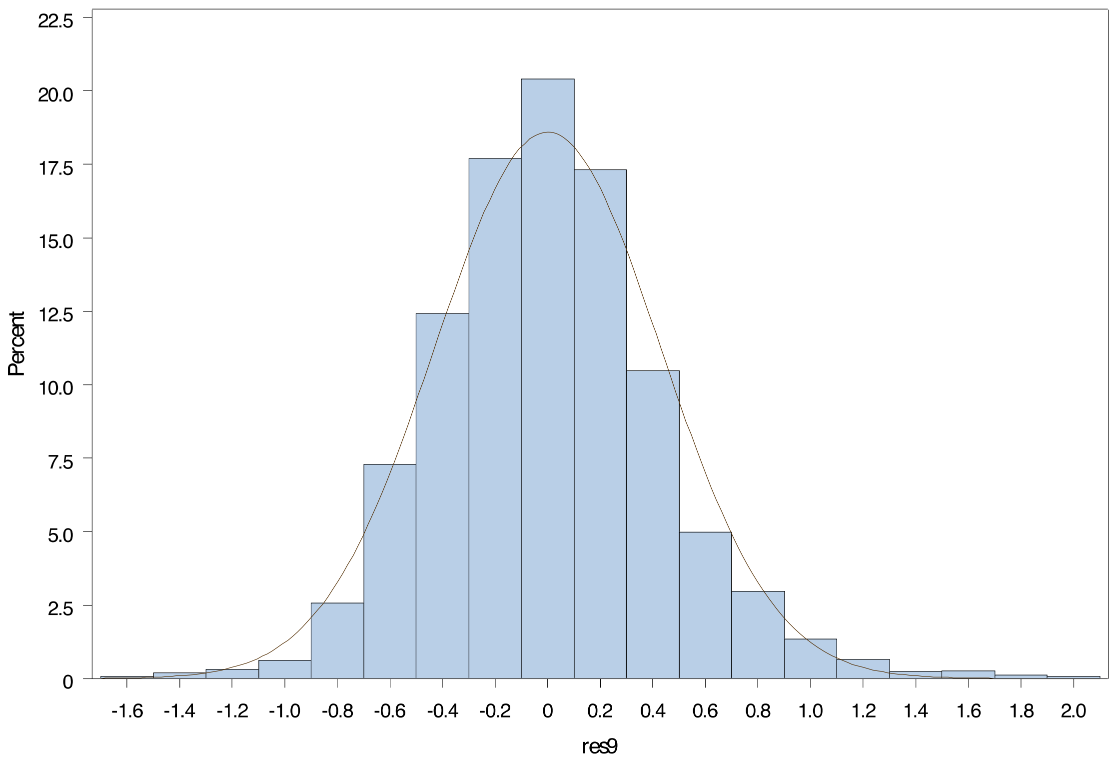
Histogram of the sector 7 residuals

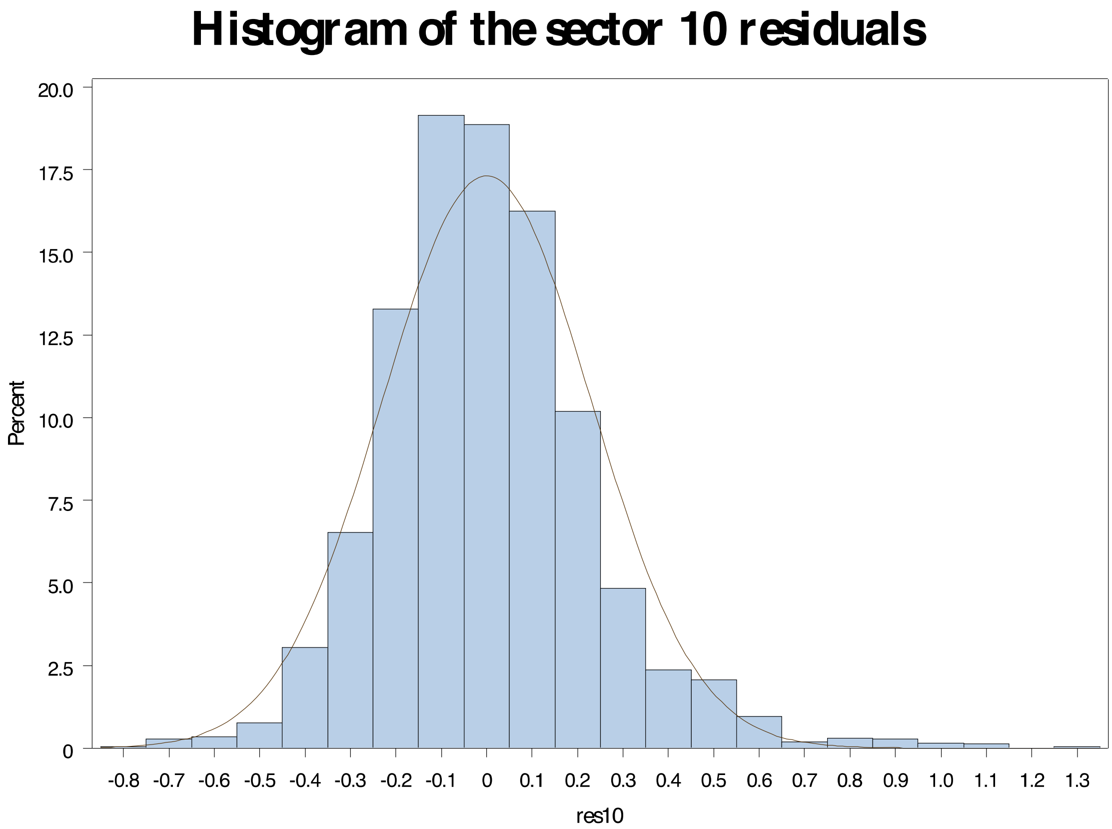


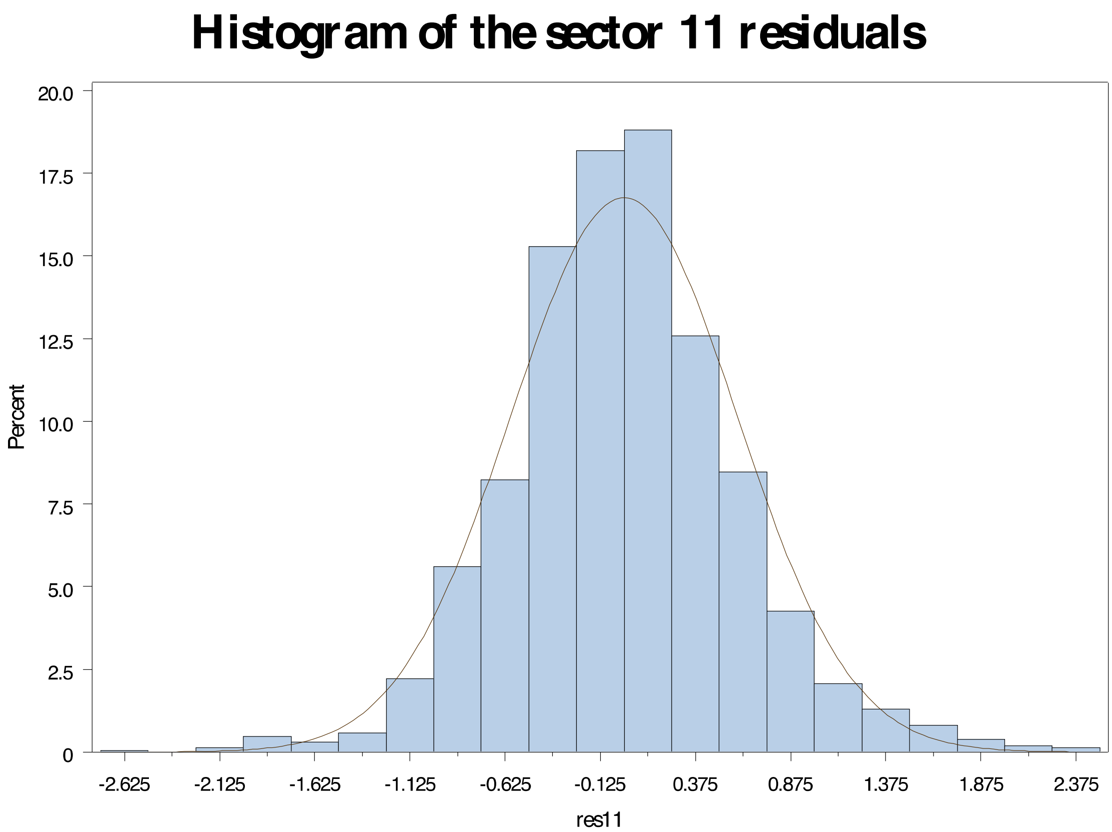
Histogram of the sector 8 residuals

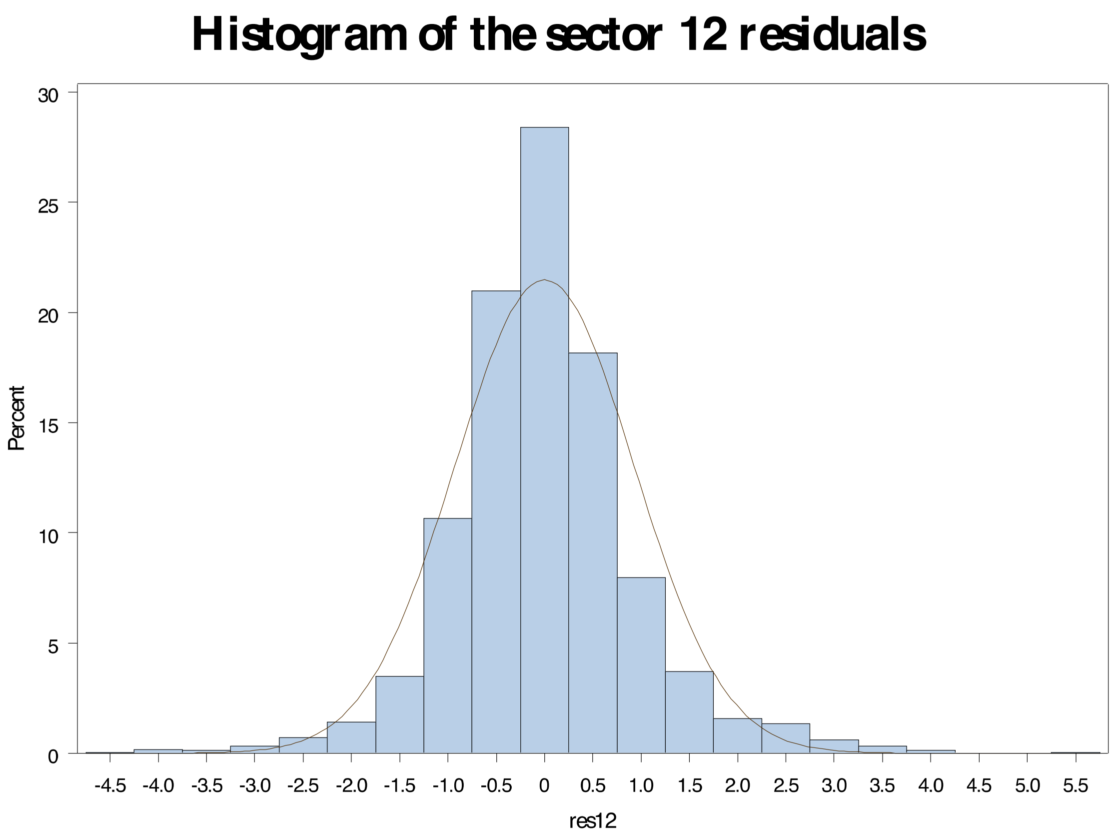


Histogram of the sector 9 residuals

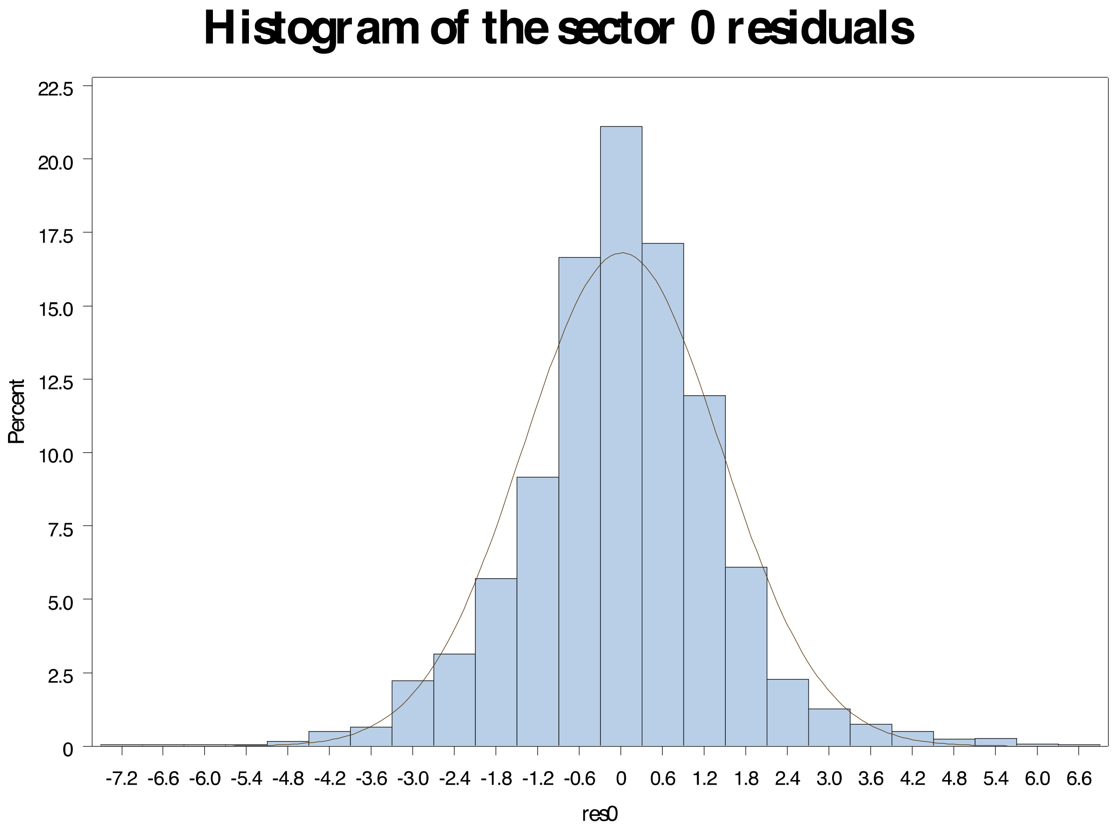


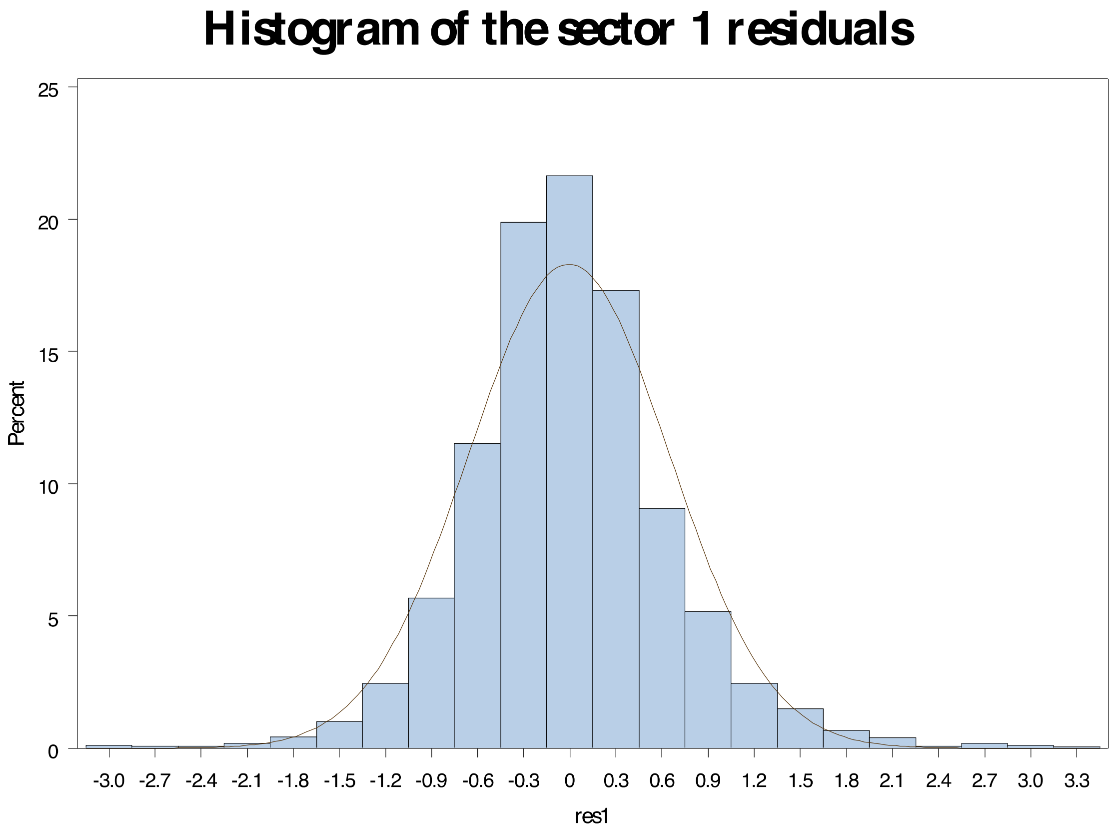

Histogram of the sector 10 residuals
Percent
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0
-0.8 -0.7 -0.6 -0.5 -0.4 -0.3 -0.2 -0.1 0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3
res10

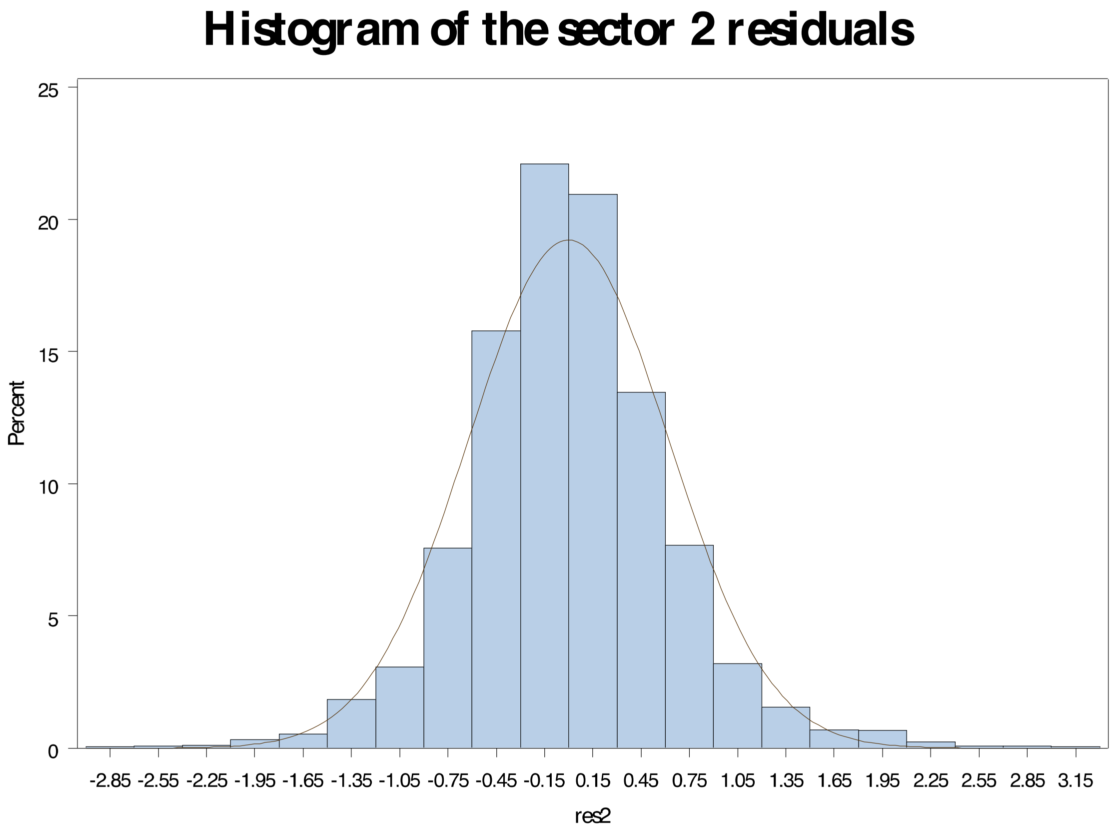

Histogram of the sector 11 residuals
Percent
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0
-2.625 -2.125 -1.625 -1.125 -0.625 -0.125 0.375 0.875 1.375 1.875 2.375
res11

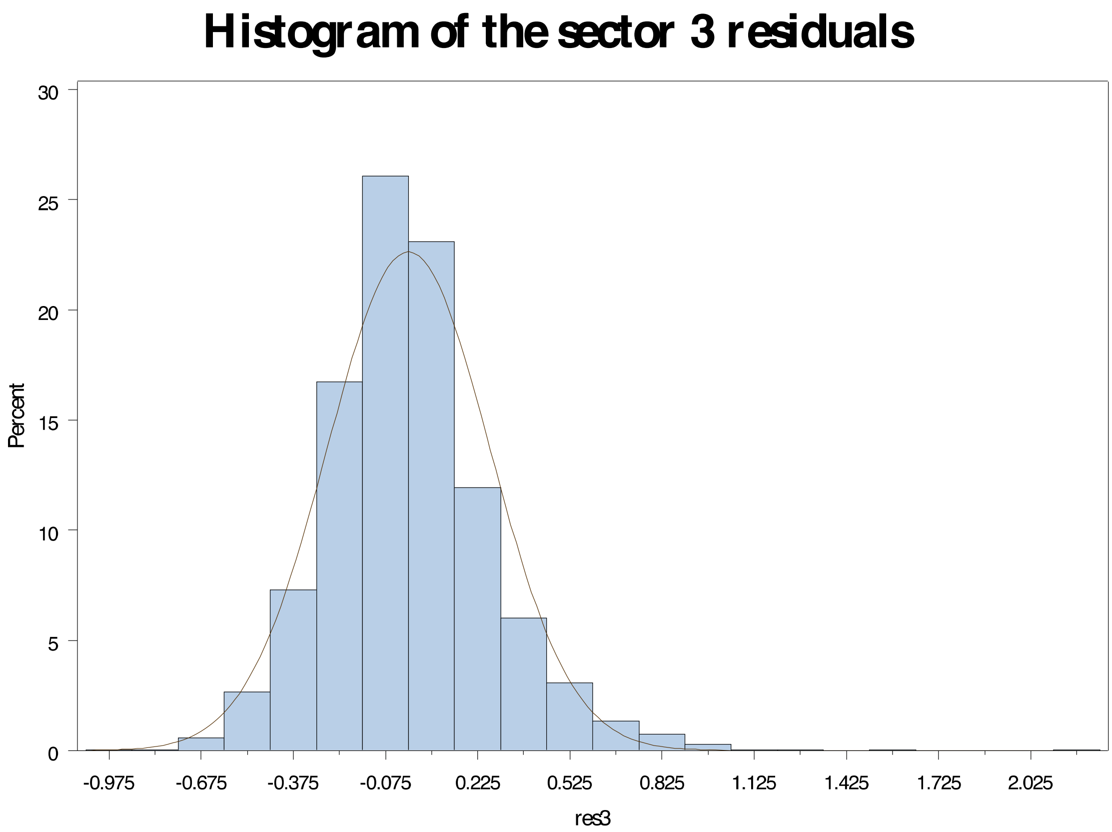

Histogram of the sector 12 residuals
Percent
30
25
20
15
10
5
0
-4.5 -4.0 -3.5 -3.0 -2.5 -2.0 -1.5 -1.0 -0.5 0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5
res12

Model 8 (A)

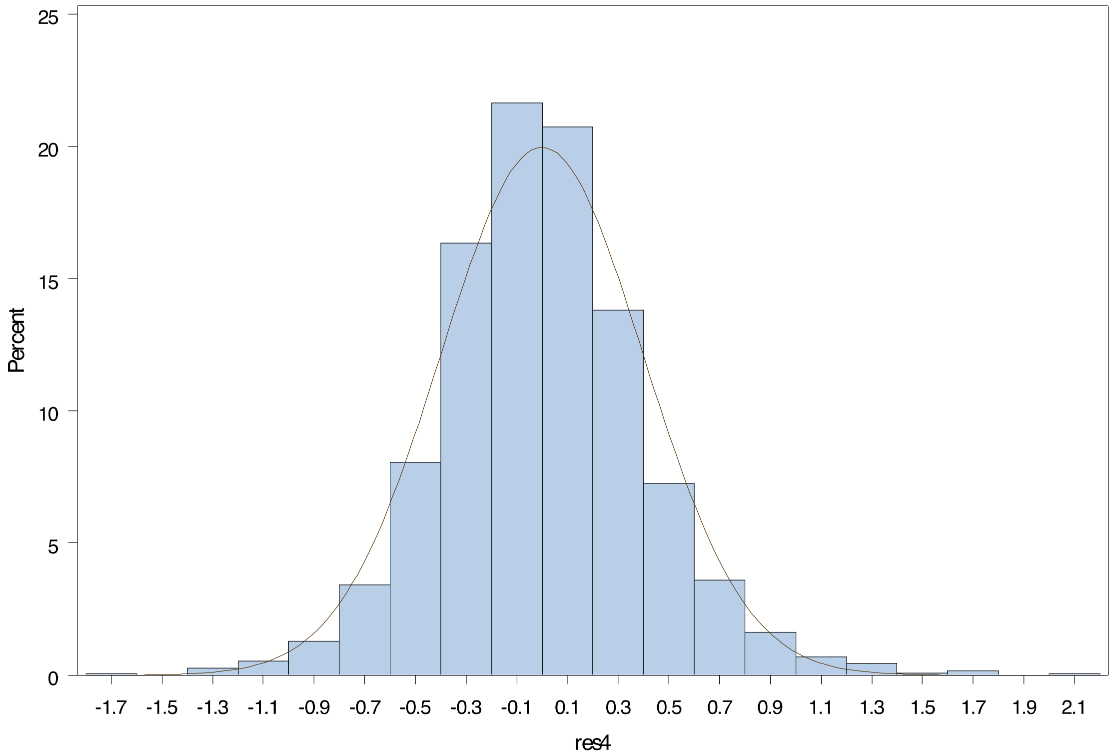

Histogram of the sector 0 residuals
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0
Percent
-7.2 -6.6 -6.0 -5.4 -4.8 -4.2 -3.6 -3.0 -2.4 -1.8 -1.2 -0.6 0 0.6 1.2 1.8 2.4 3.0 3.6 4.2 4.8 5.4 6.0 6.6
res0


Histogram of the sector 1 residuals
25
20
15
10
5
0
Percent
-3.0 -2.7 -2.4 -2.1 -1.8 -1.5 -1.2 -0.9 -0.6 -0.3 0 0.3 0.6 0.9 1.2 1.5 1.8 2.1 2.4 2.7 3.0 3.3
res1

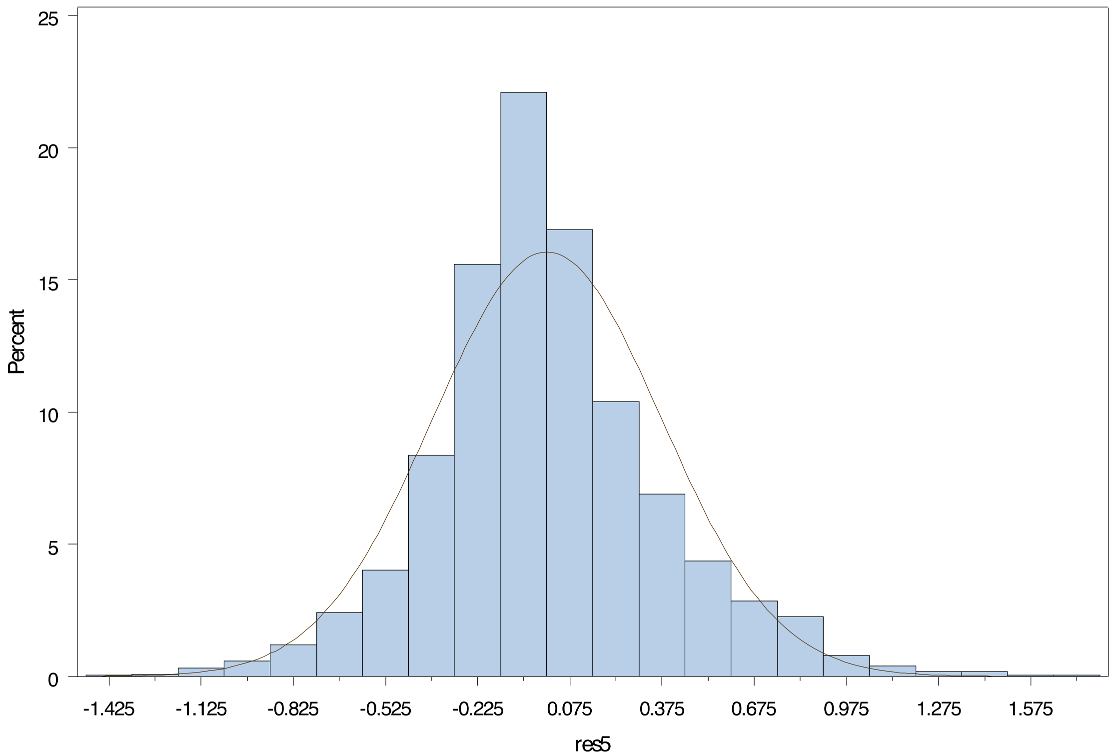

Histogram of the sector 2 residuals
Percent
0
5
10
15
20
25
-2.85 -2.55 -2.25 -1.95 -1.65 -1.35 -1.05 -0.75 -0.45 -0.15 0.15 0.45 0.75 1.05 1.35 1.65 1.95 2.25 2.55 2.85 3.15
res2

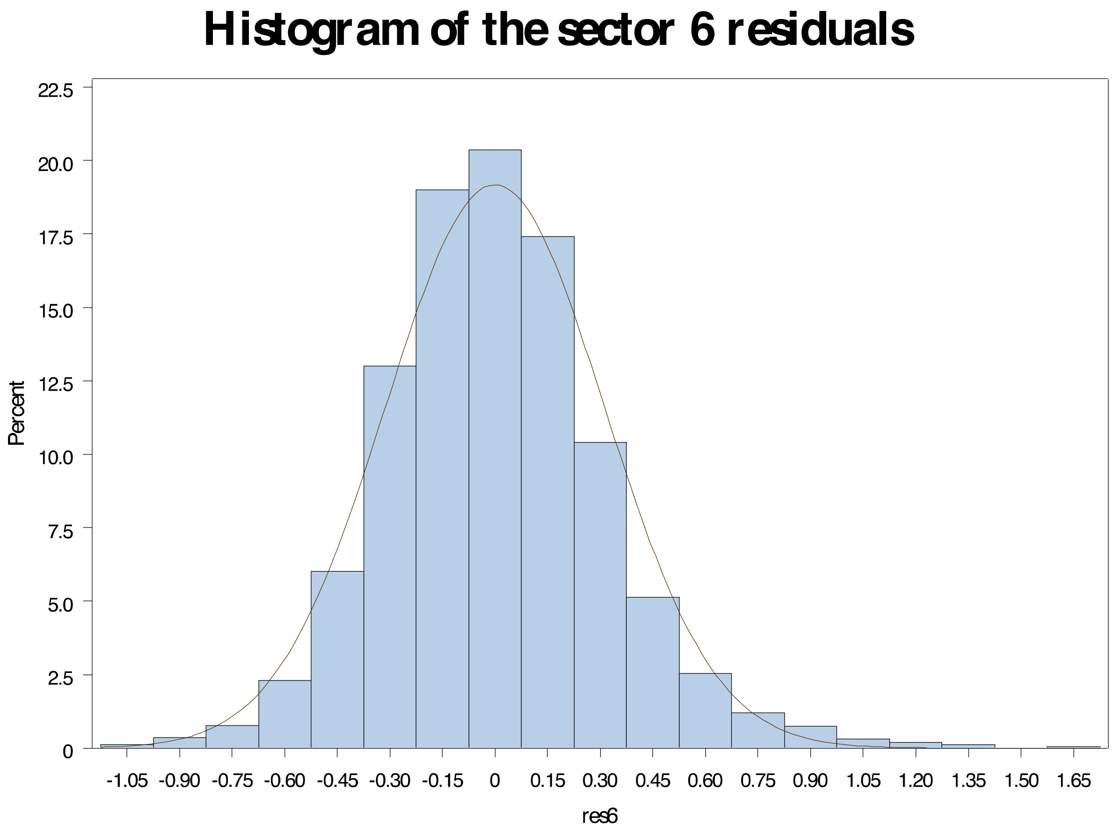

Histogram of the sector 3 residuals
Percent
0
5
10
15
20
25
30
-0.975 -0.675 -0.375 -0.075 0.225 0.525 0.825 1.125 1.425 1.725 2.025
res3

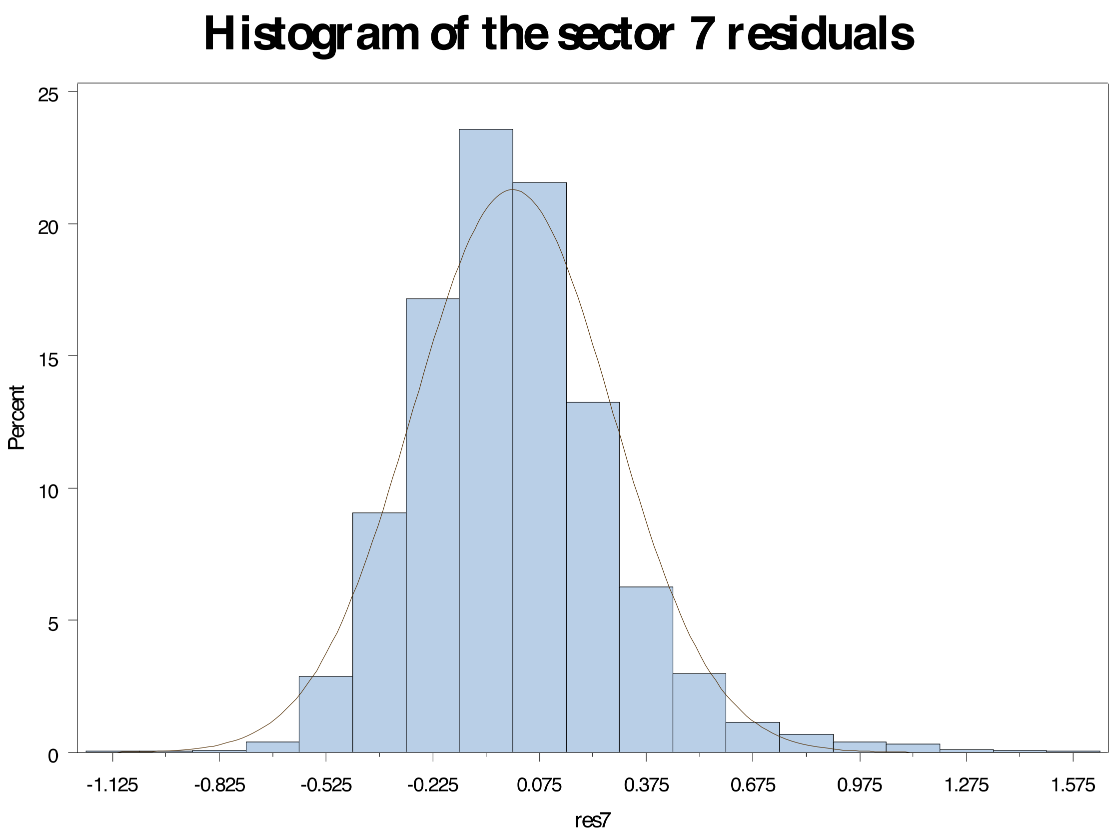
Histogram of the sector 4 residuals

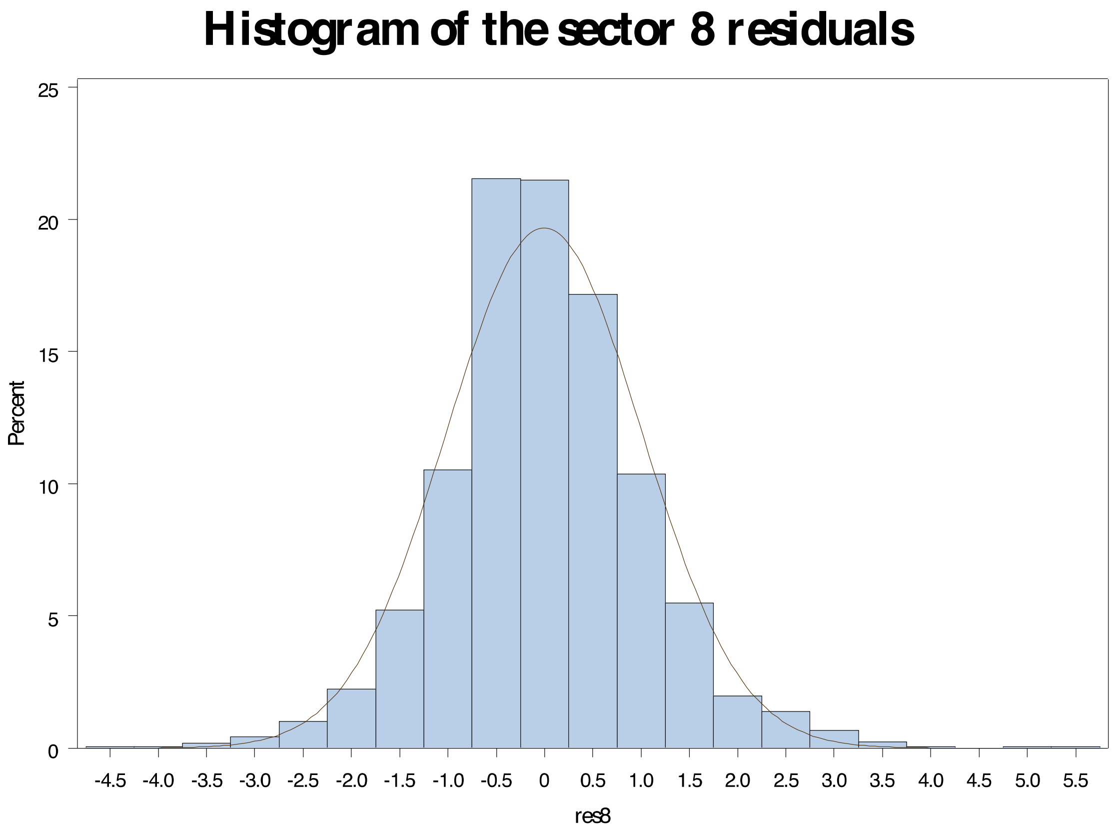


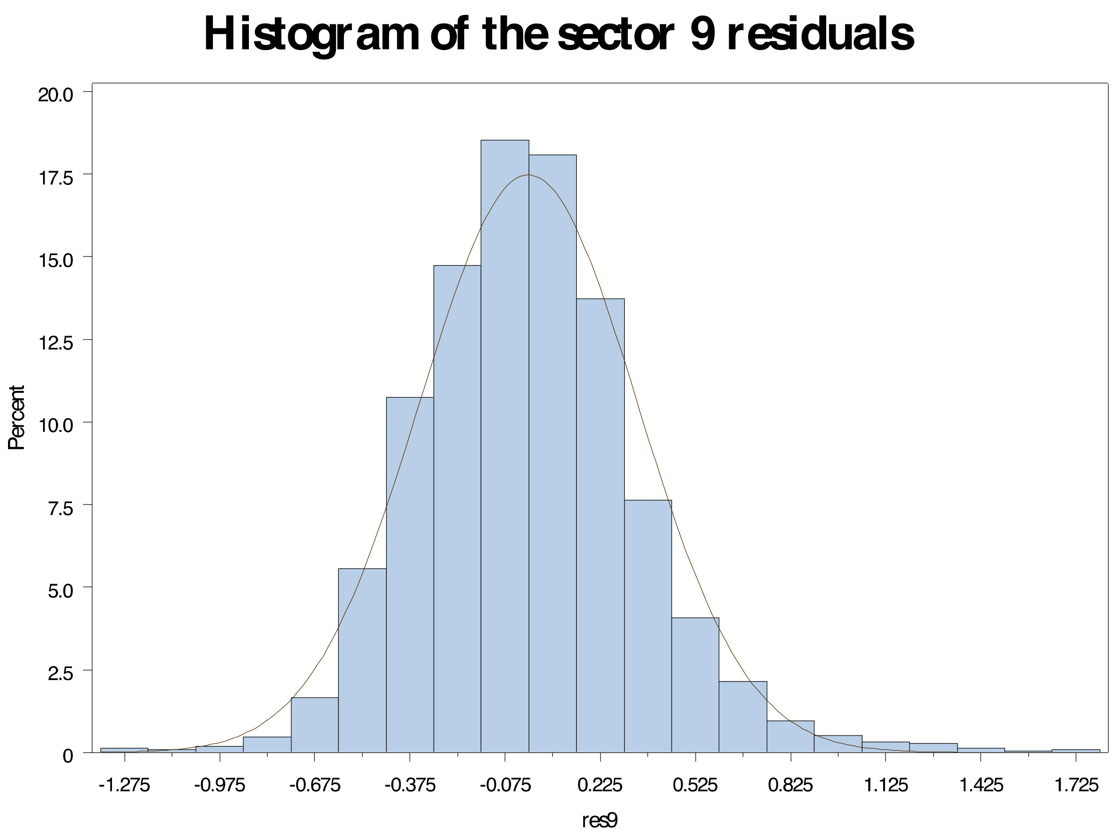
Histogram of the sector 5 residuals



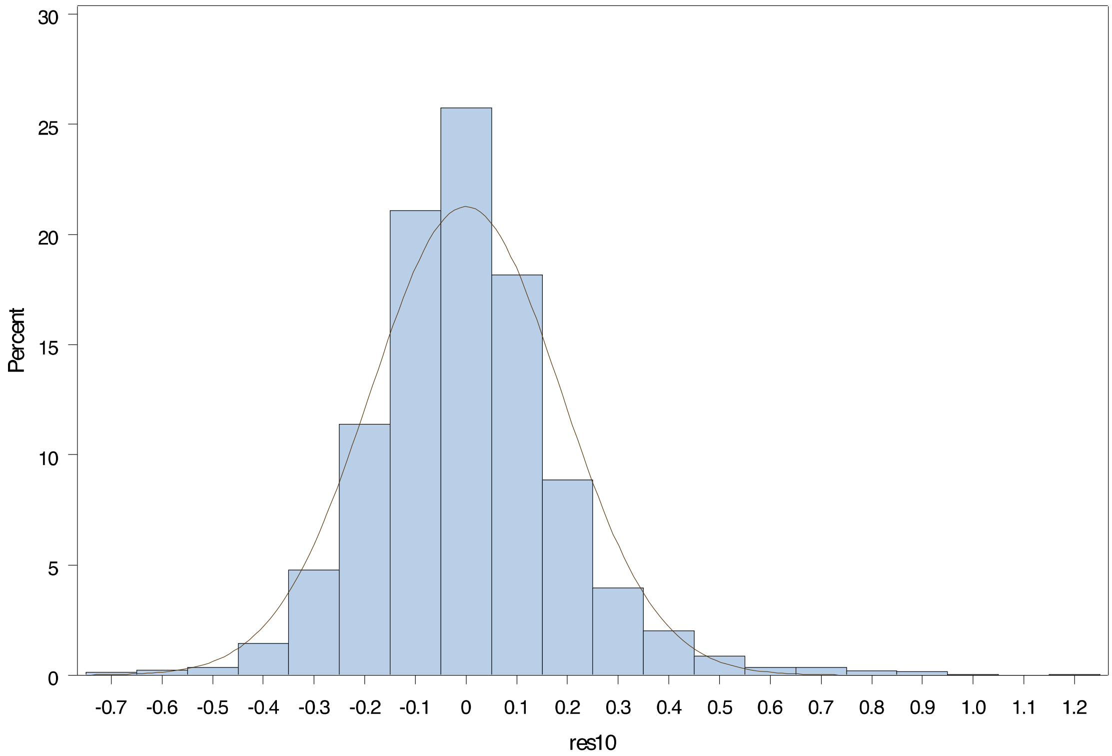

Histogram of the sector 6 residuals
Percent
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0
-1.05 -0.90 -0.75 -0.60 -0.45 -0.30 -0.15 0 0.15 0.30 0.45 0.60 0.75 0.90 1.05 1.20 1.35 1.50 1.65
res6


Histogram of the sector 7 residuals
Percent
25
20
15
10
5
0
-1.125 -0.825 -0.525 -0.225 0.075 0.375 0.675 0.975 1.275 1.575
res7

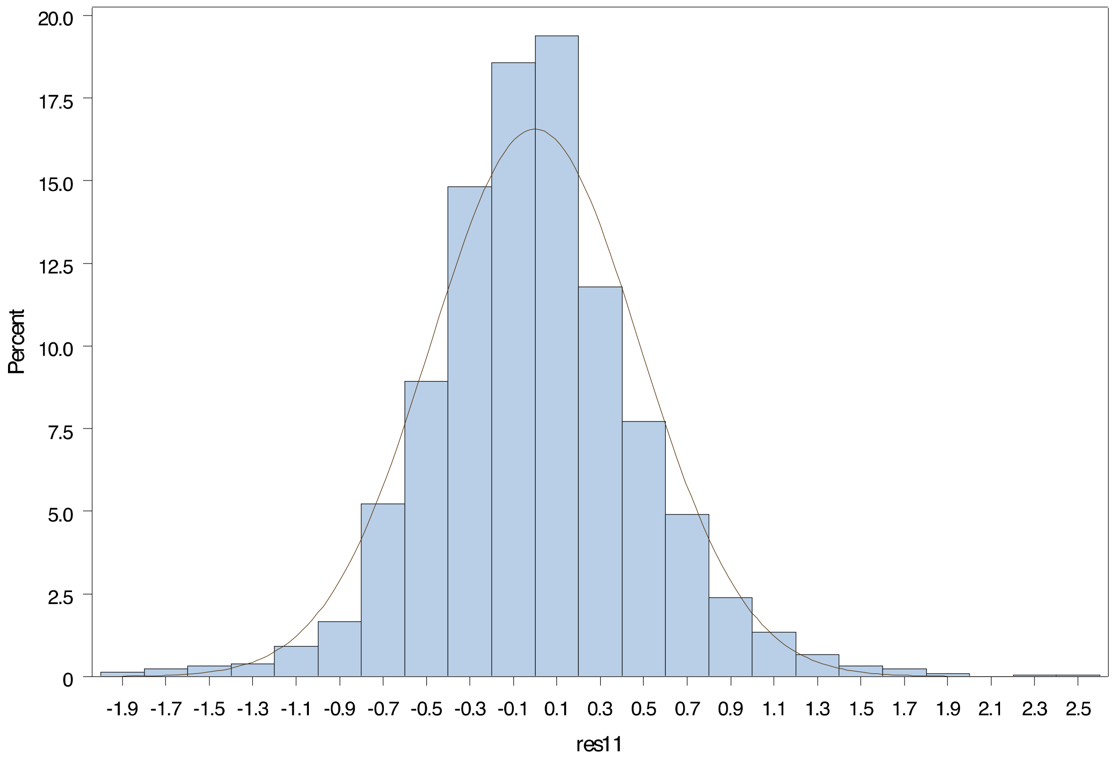

Histogram of the sector 8 residuals
25
20
15
10
5
0
Percent
-4.5 -4.0 -3.5 -3.0 -2.5 -2.0 -1.5 -1.0 -0.5 0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5
res8

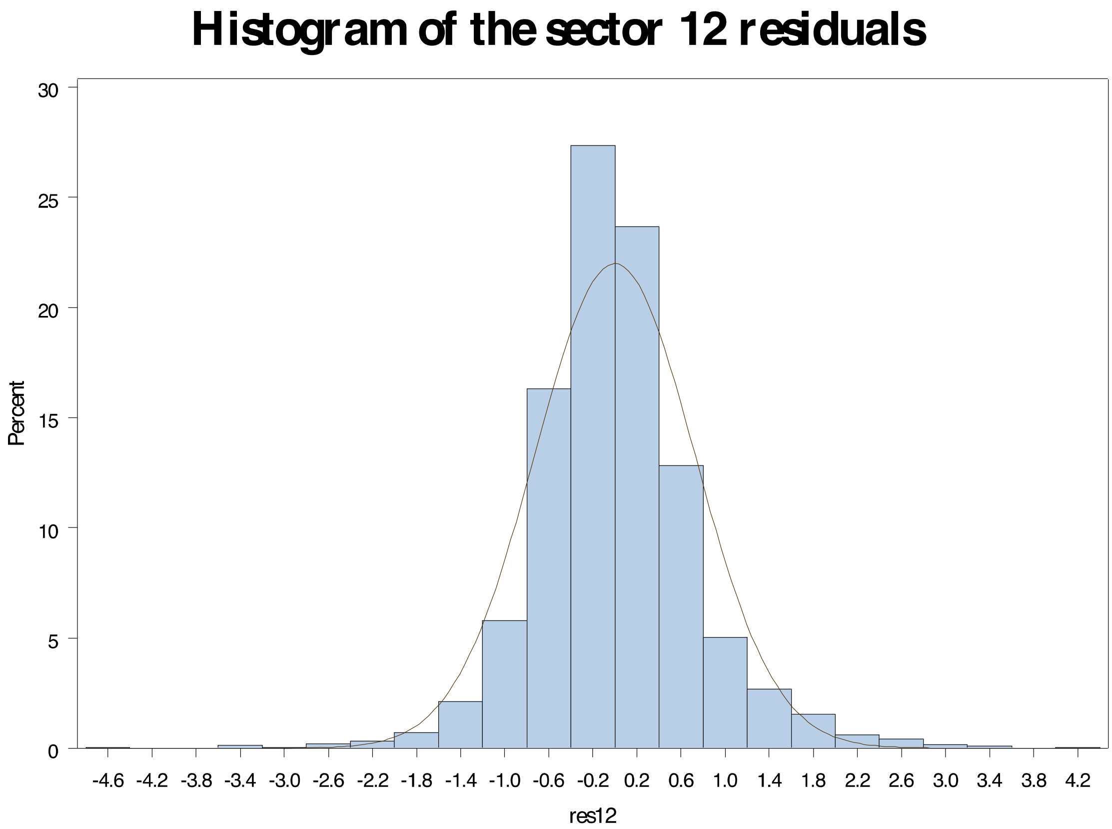

Histogram of the sector 9 residuals
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0
Percent
-1.275 -0.975 -0.675 -0.375 -0.075 0.225 0.525 0.825 1.125 1.425 1.725
res9

Histogram of the sector 10 residuals

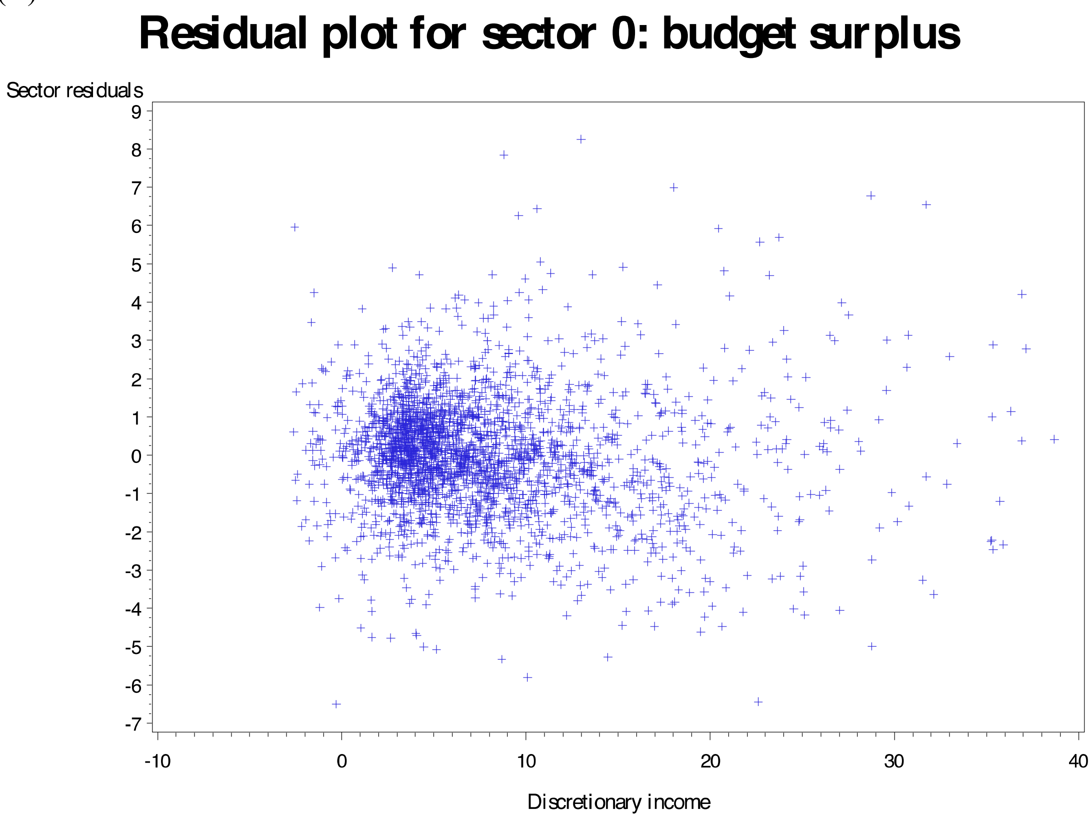


Histogram of the sector 11 residuals

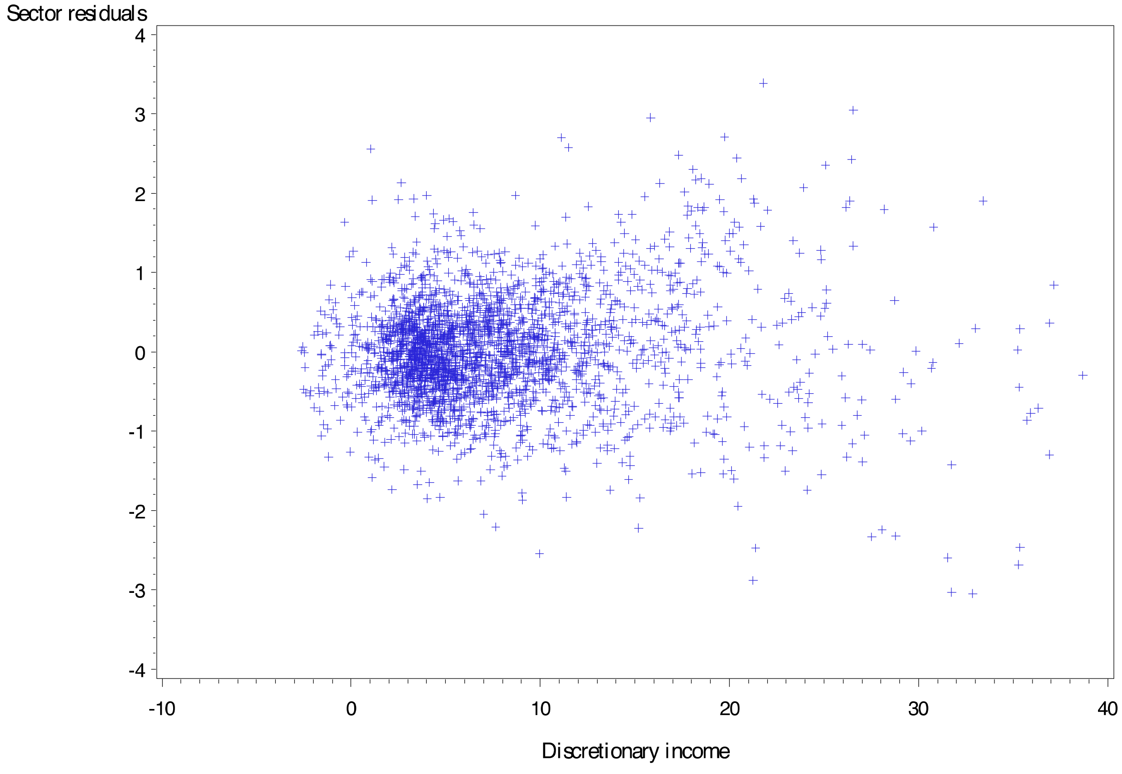



Histogram of the sector 12 residuals
Percent
30
25
20
15
10
5
0
-4.6 -4.2 -3.8 -3.4 -3.0 -2.6 -2.2 -1.8 -1.4 -1.0 -0.6 -0.2 0.2 0.6 1.0 1.4 1.8 2.2 2.6 3.0 3.4 3.8 4.2
res12

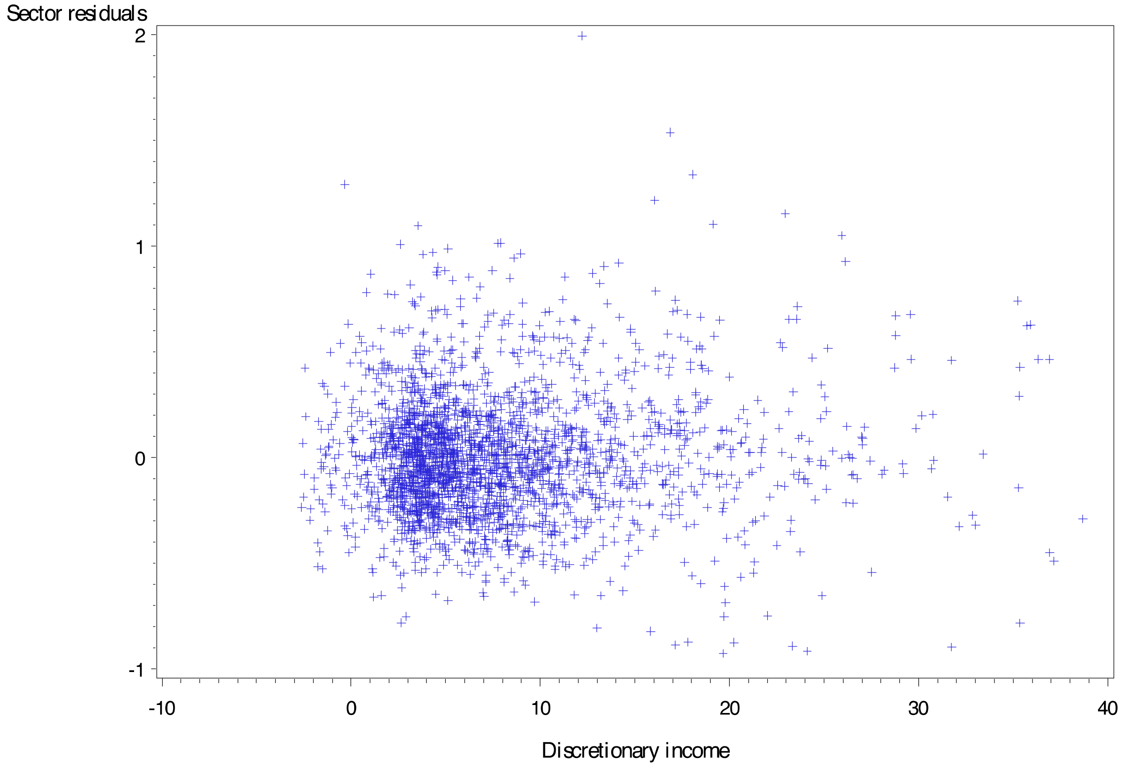
Residual plots by sector
Model 2
(A)

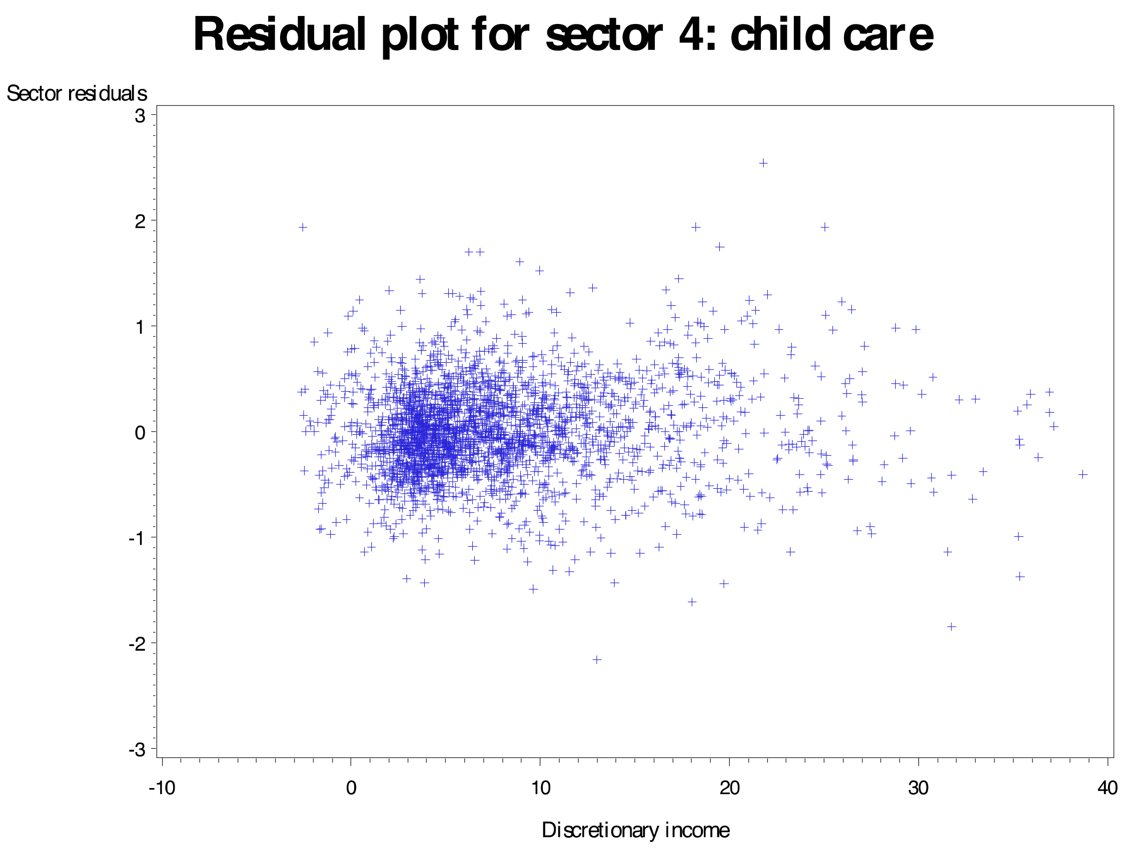


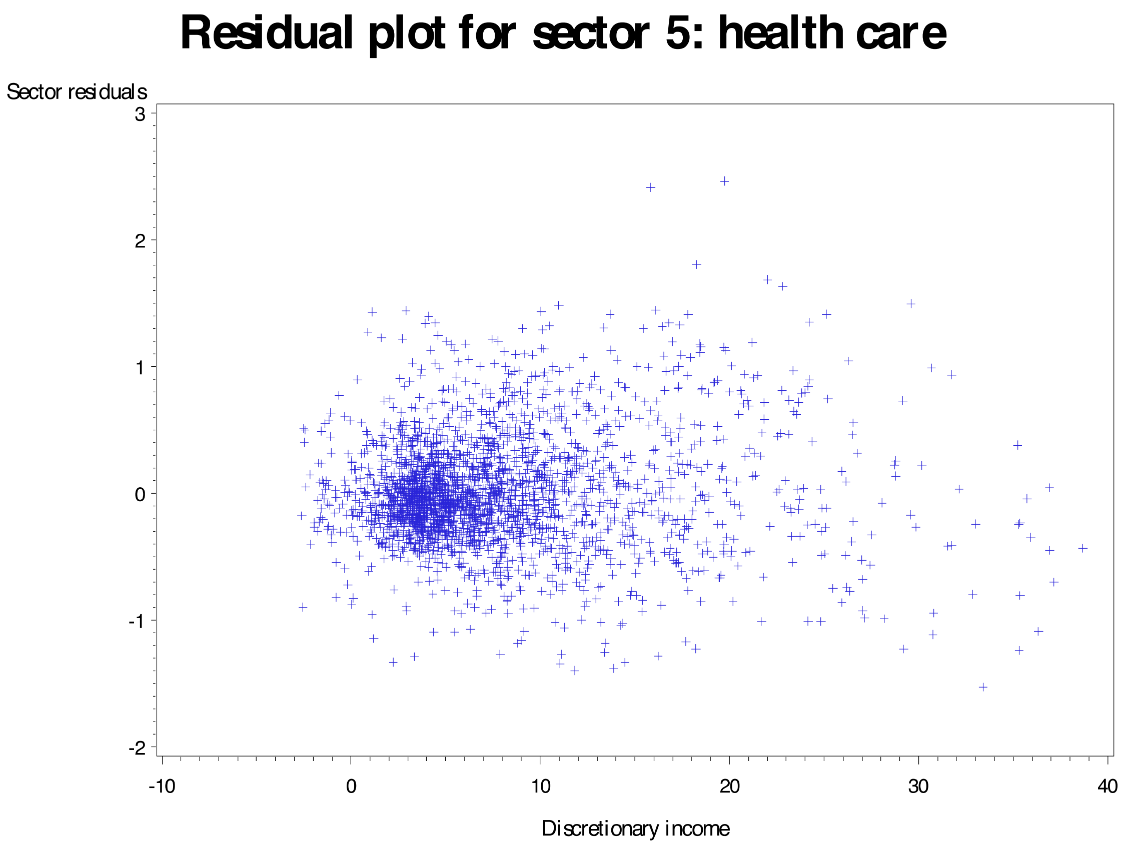
Residual plot for sector 2: primary schools



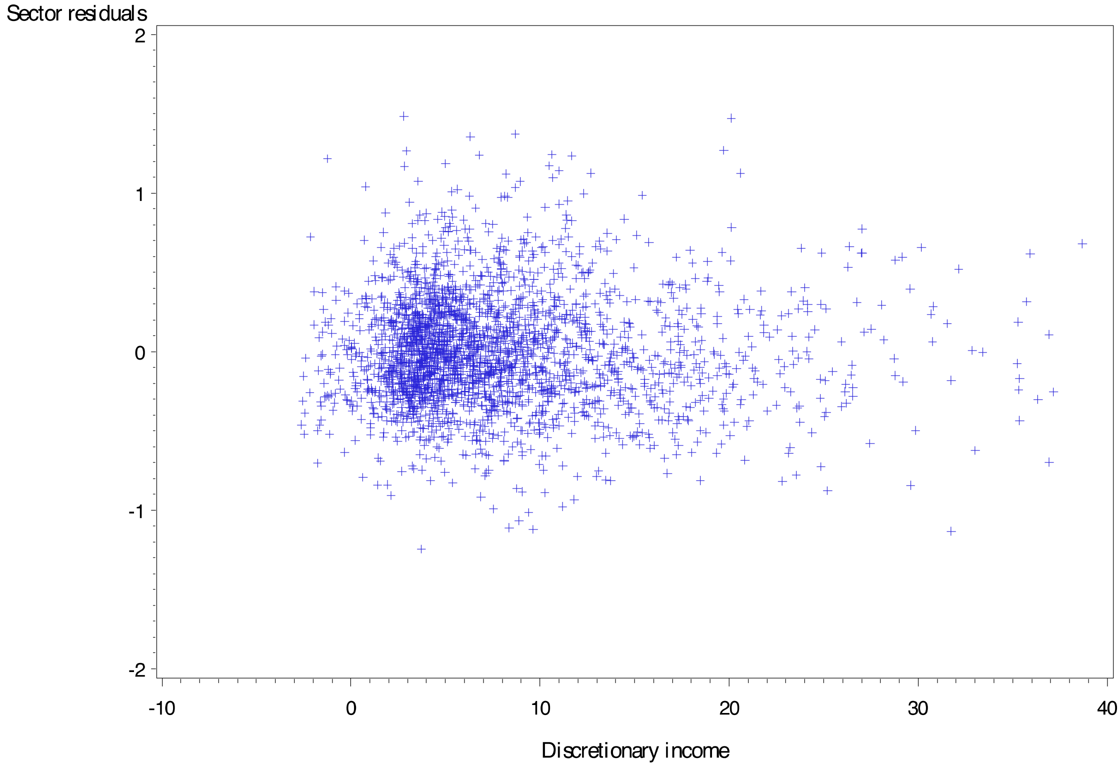
Residual plot for sector 3: other education



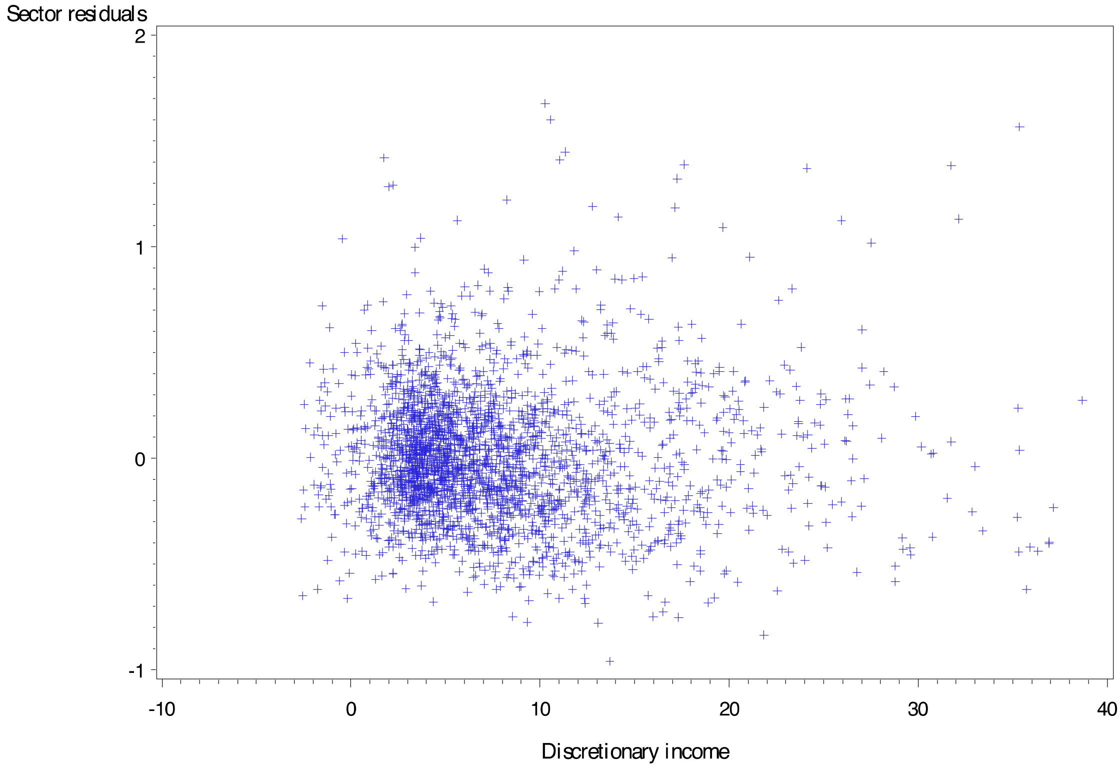

Residual plot for sector 4: child care
Sector residuals
3
2
1
0
-1
-2
-3
-10
0
10
20
30
40
Discretionary income


Residual plot for sector 5: health care
Sector residuals
3
2
1
0
-1
-2
-10
0
10
20
30
40
Discretionary income

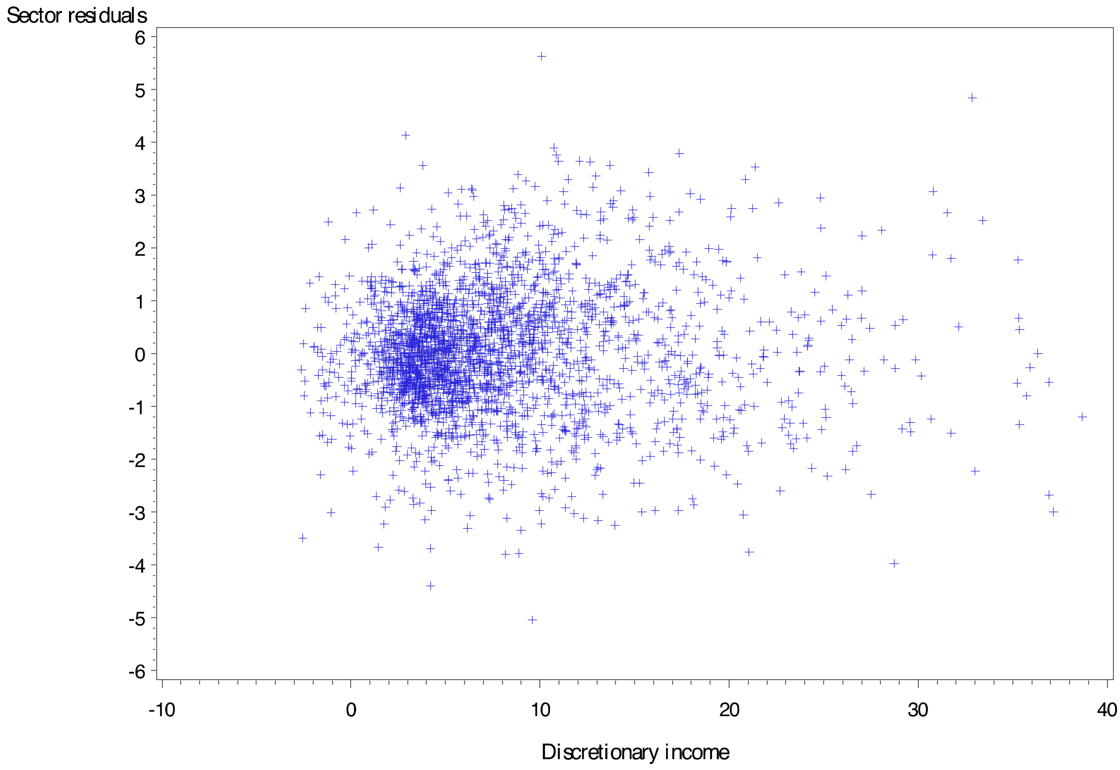
Residual plot for sector 6: social services



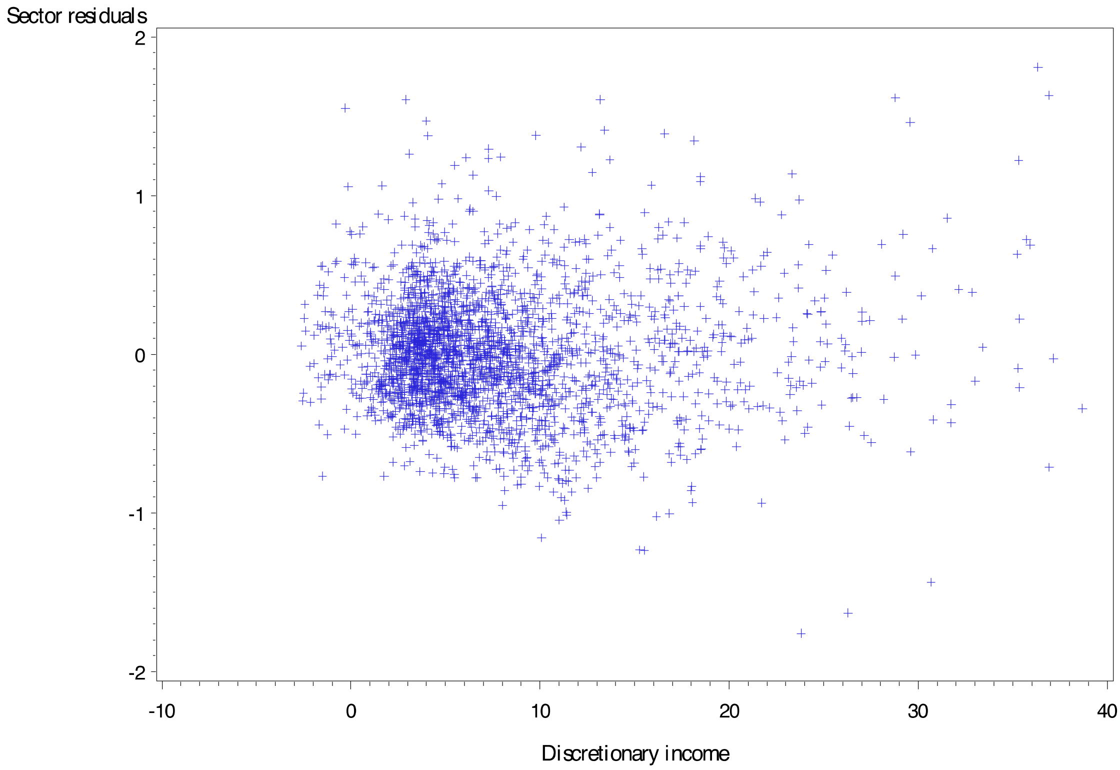
Residual plot for sector 7: child protection



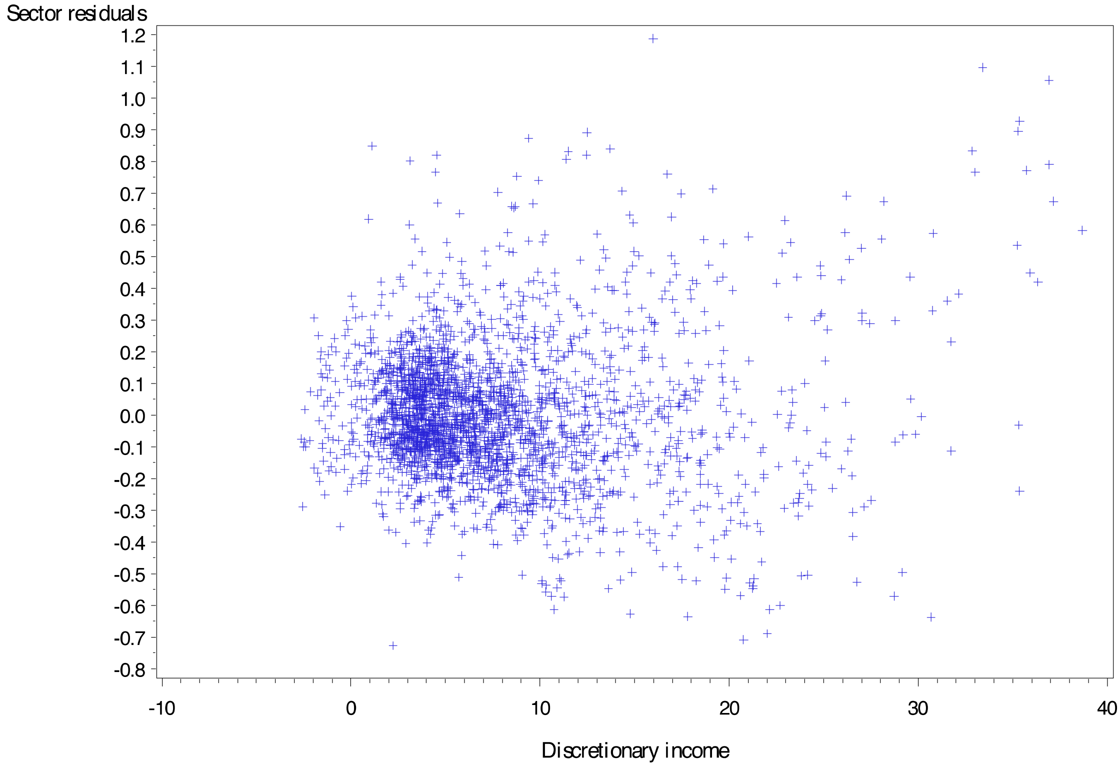
Residual plot for sector 8: care for the elderly and disabled



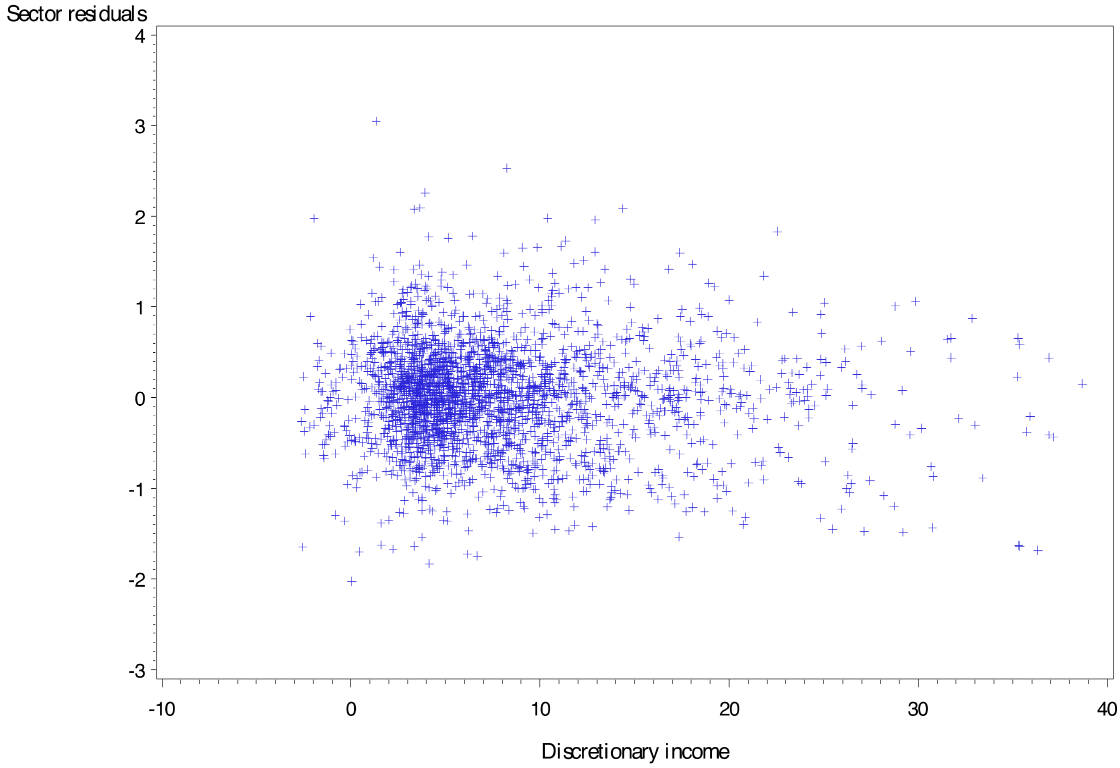
Residual plot for sector 9: culture

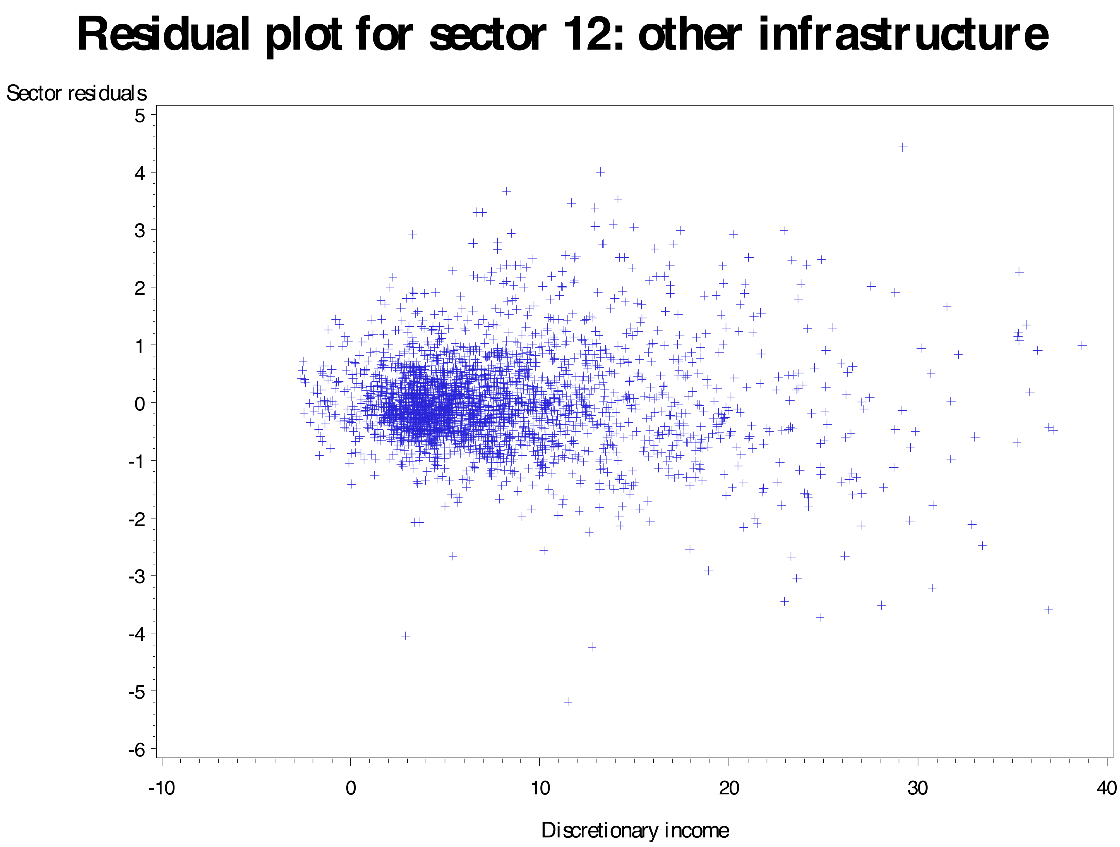


Residual plot for sector 10: municipal roads



Residual plot for sector 11: water supply and sanitation

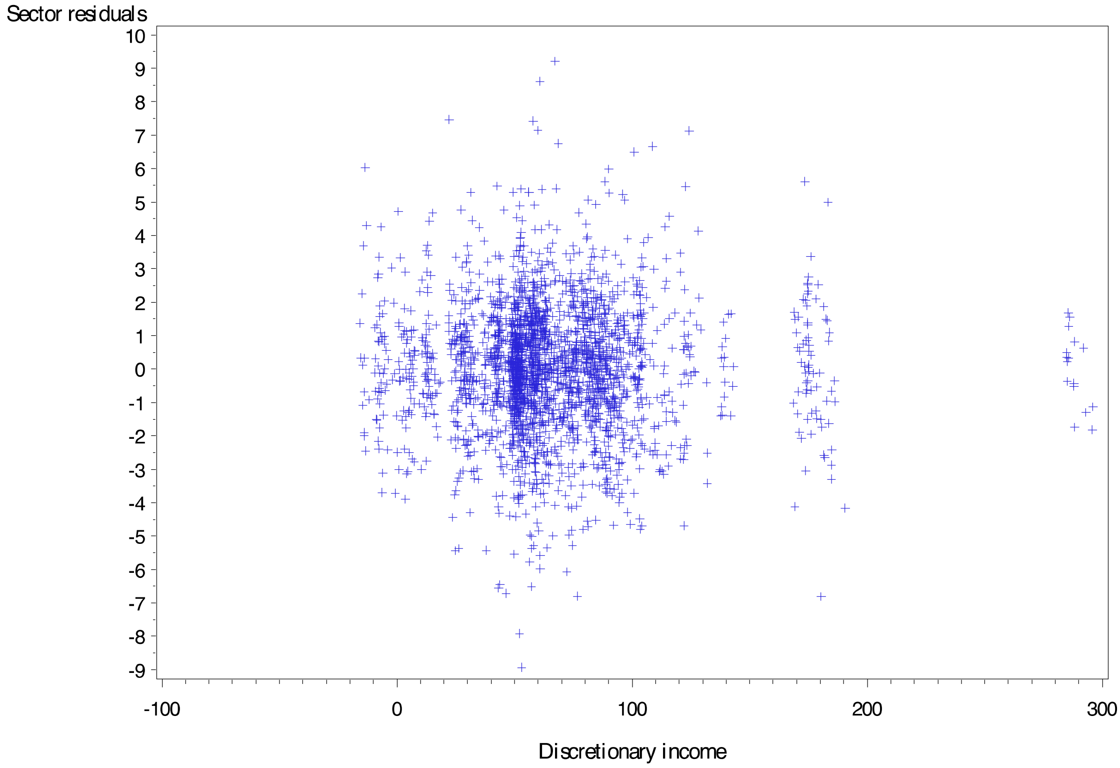



Residual plot for sector 12: other infrastructure
Sector residuals
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-10
0
10
20
30
40
Discretionary income

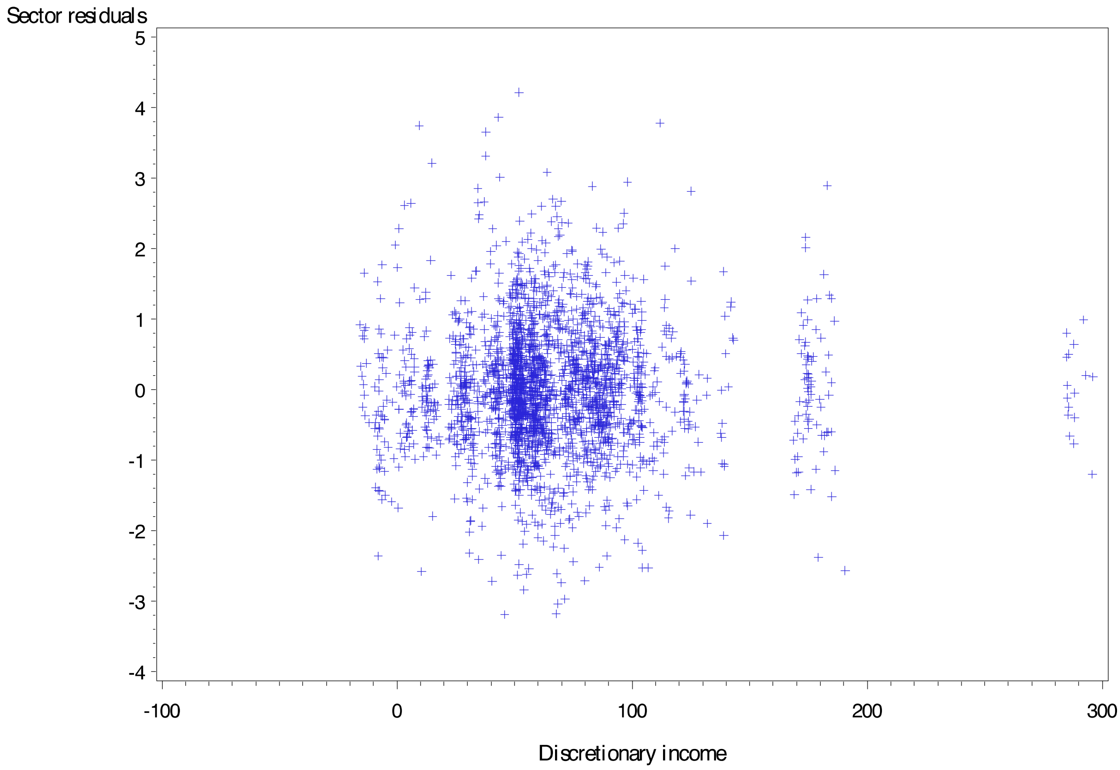
Model 7 (A)

)

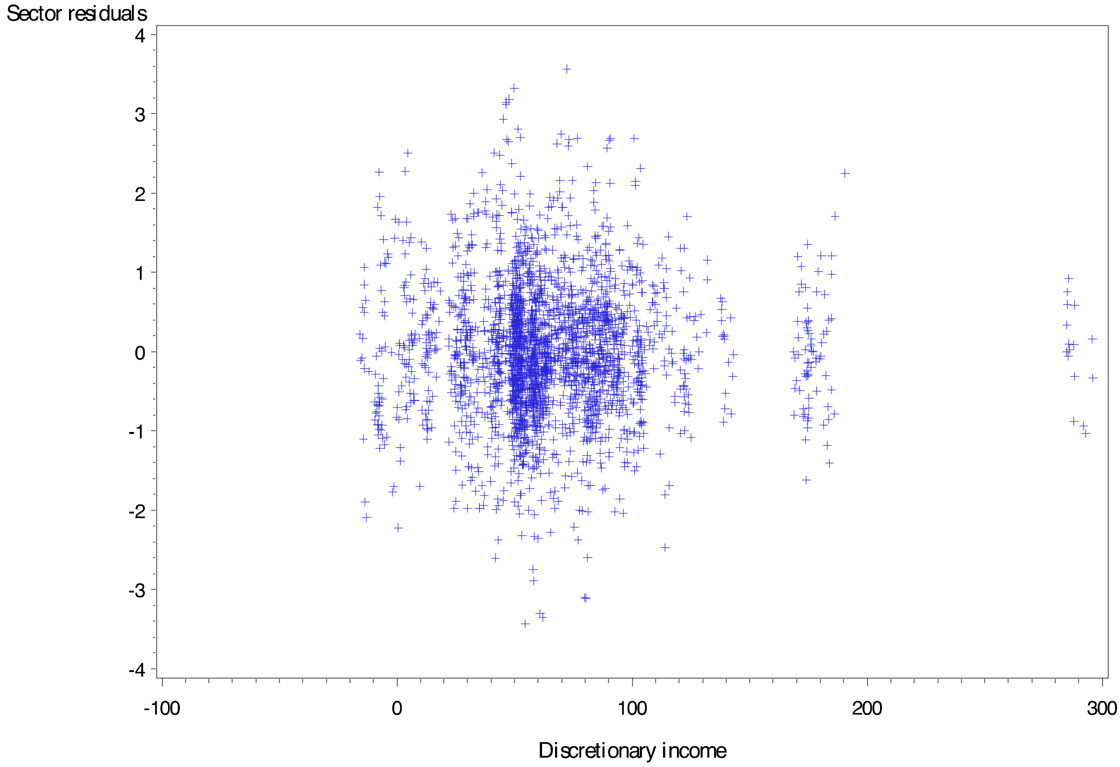
Residual plot for sector 0: budget surplus



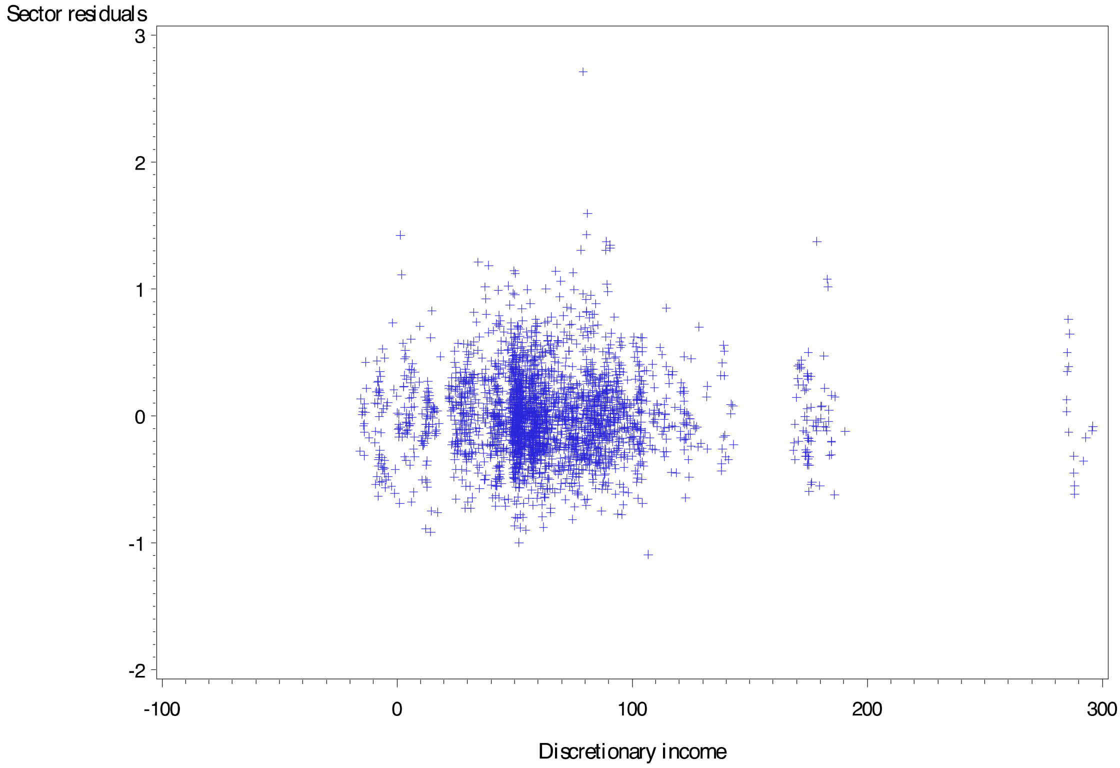
Residual plot for sector 1: administration



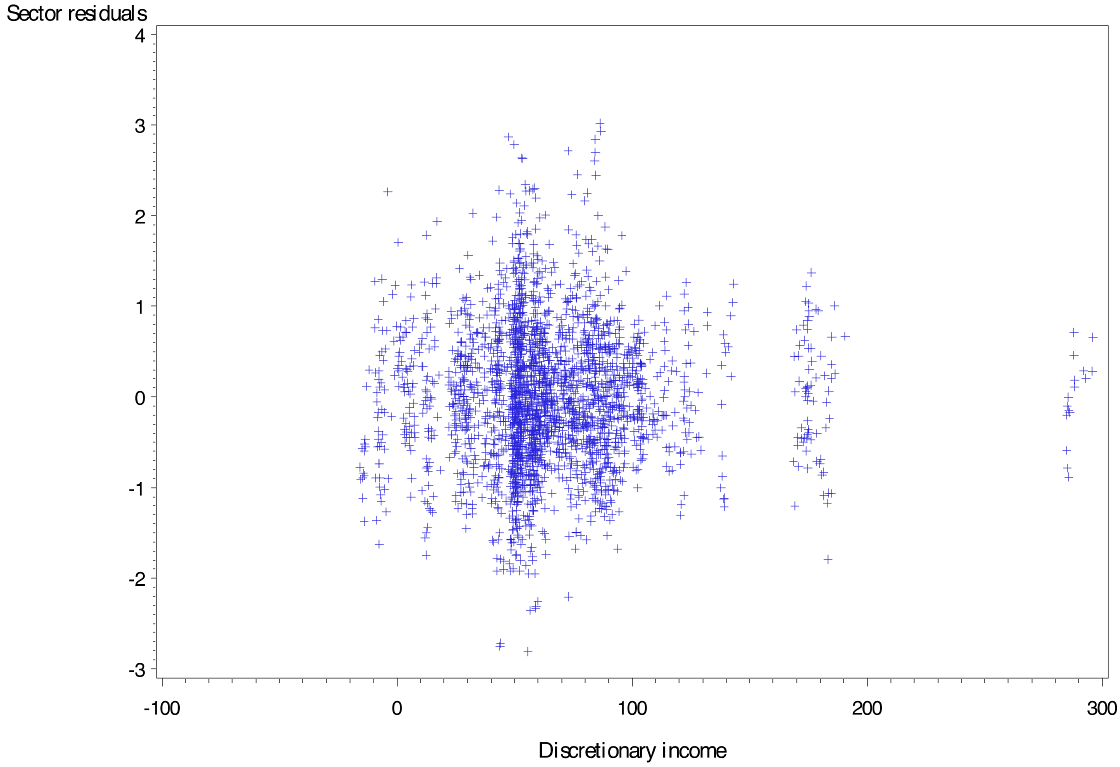
Residual plot for sector 2: primary schools



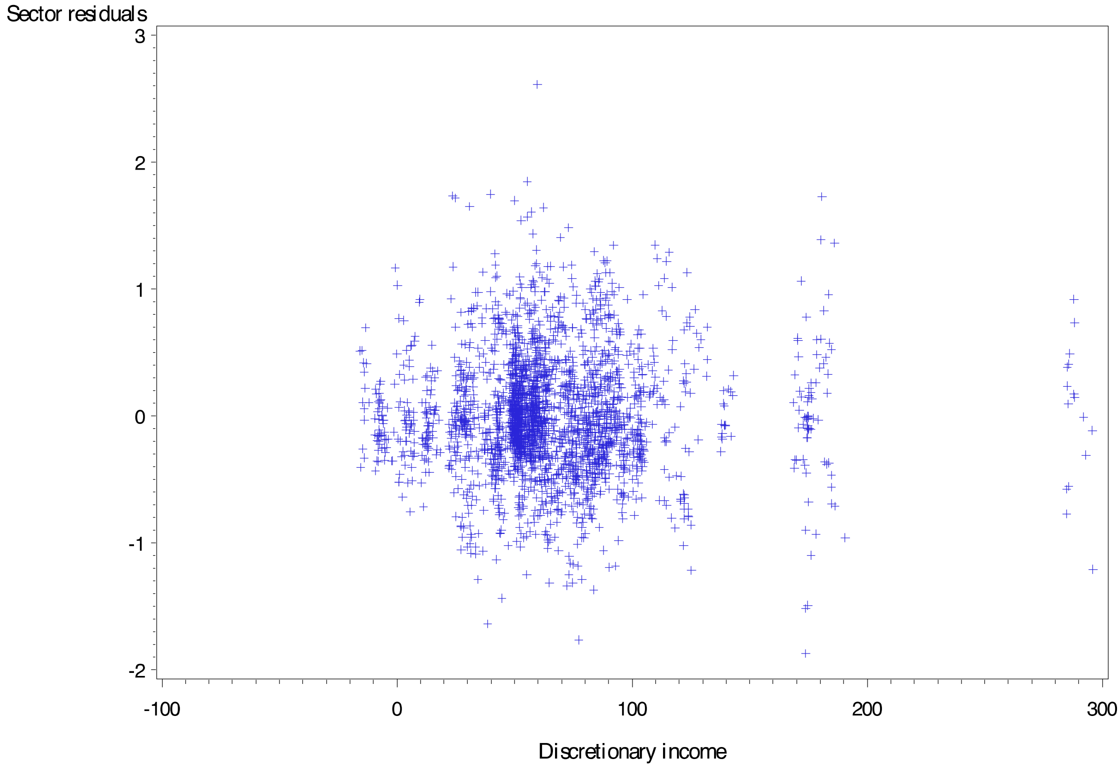
Residual plot for sector 3: other education



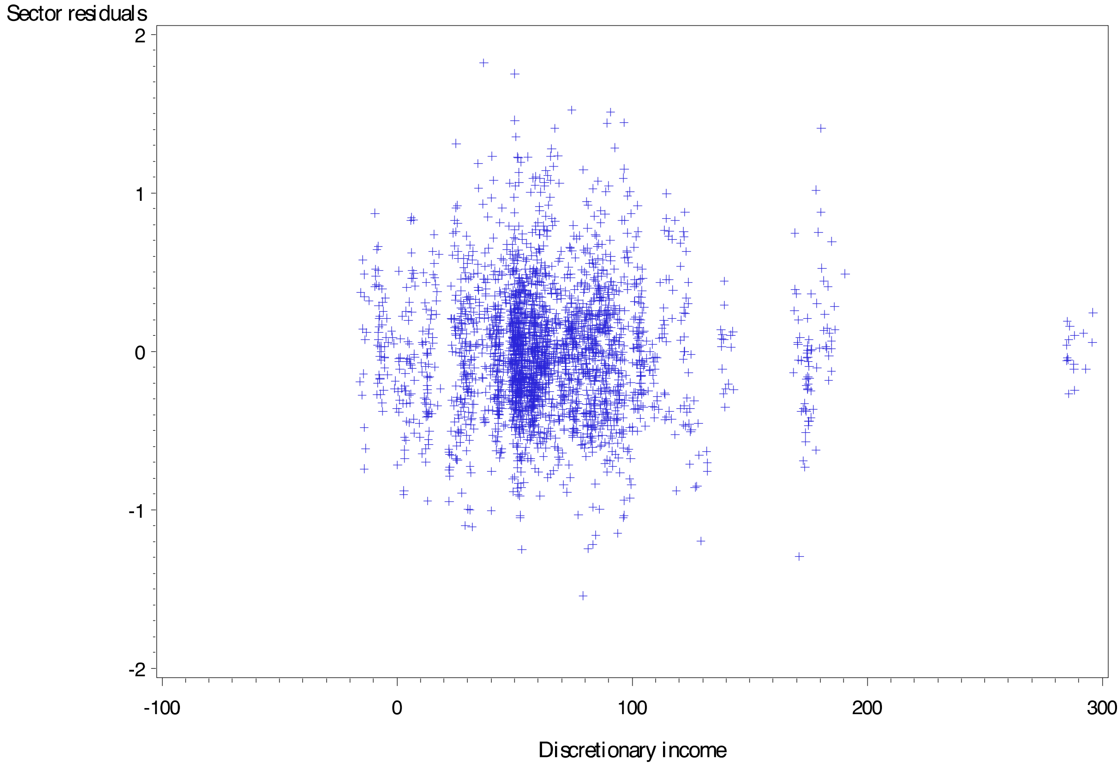
Residual plot for sector 4: child care



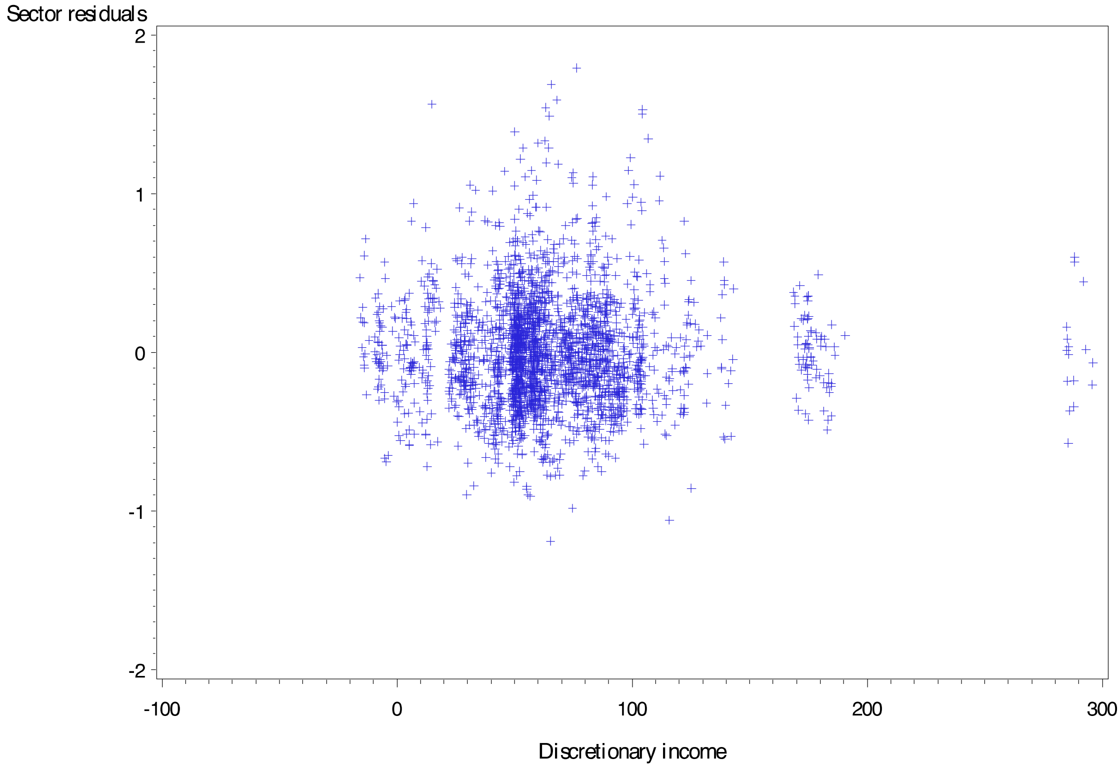
Residual plot for sector 5: health care



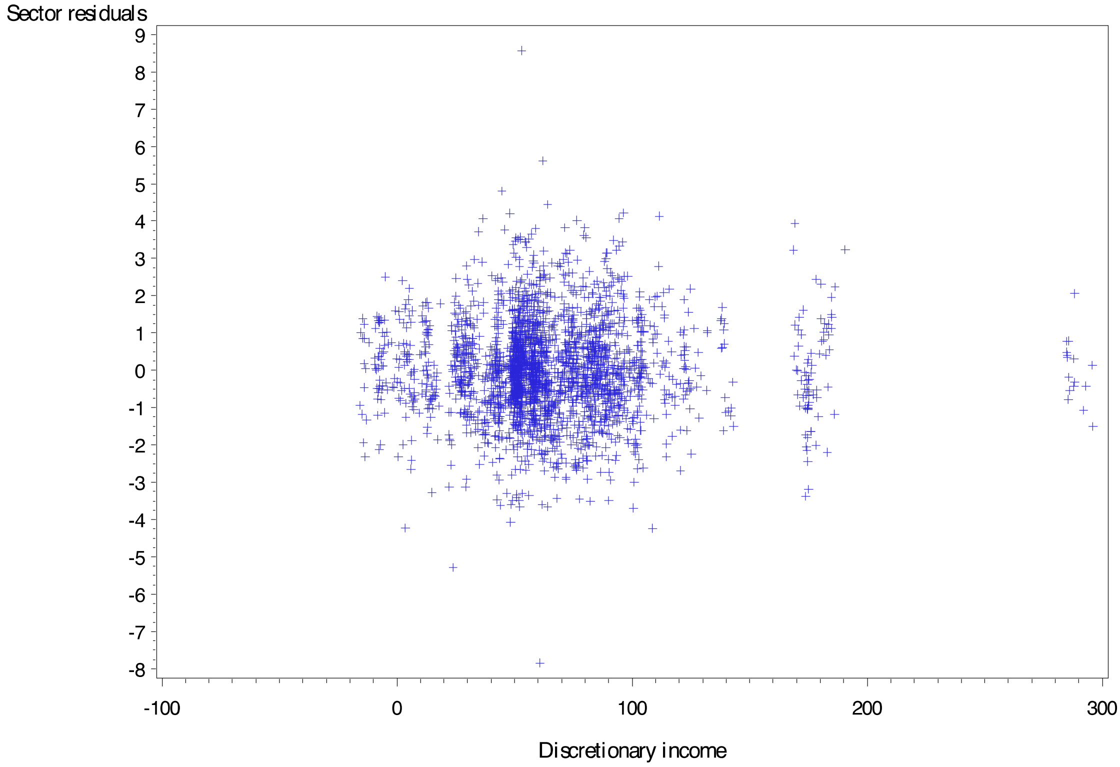
Residual plot for sector 6: social services



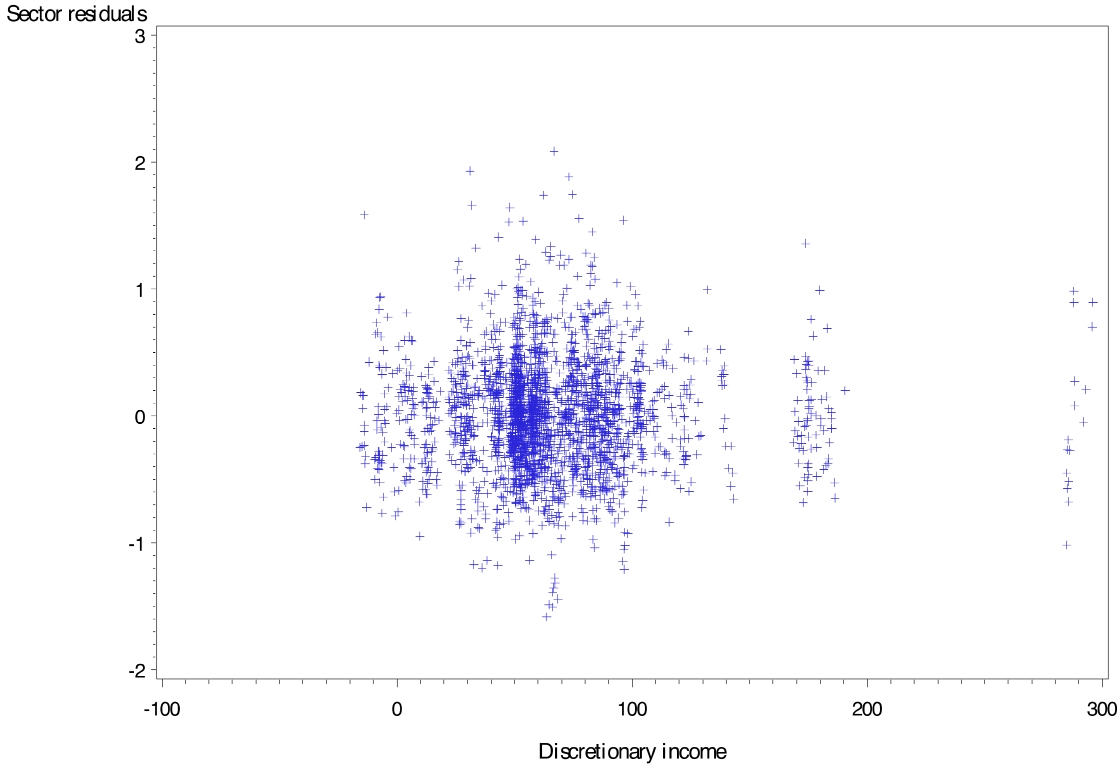
Residual plot for sector 7: child protection



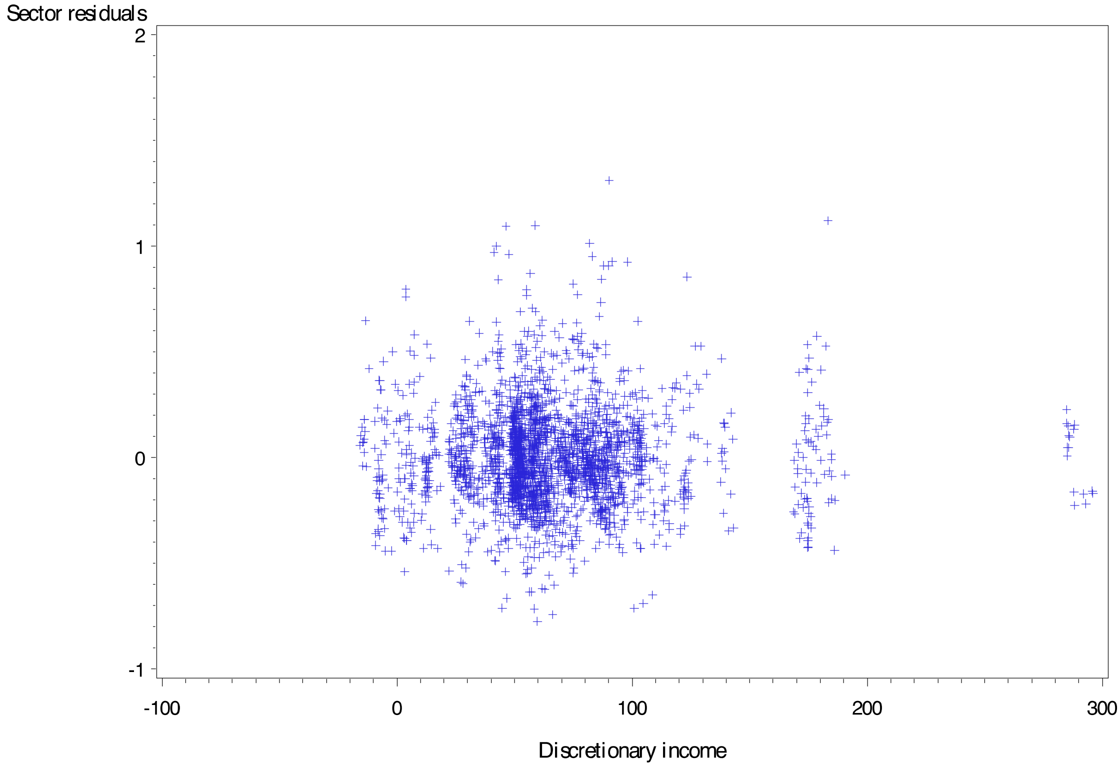
Residual plot for sector 8: care for the elderly and disabled



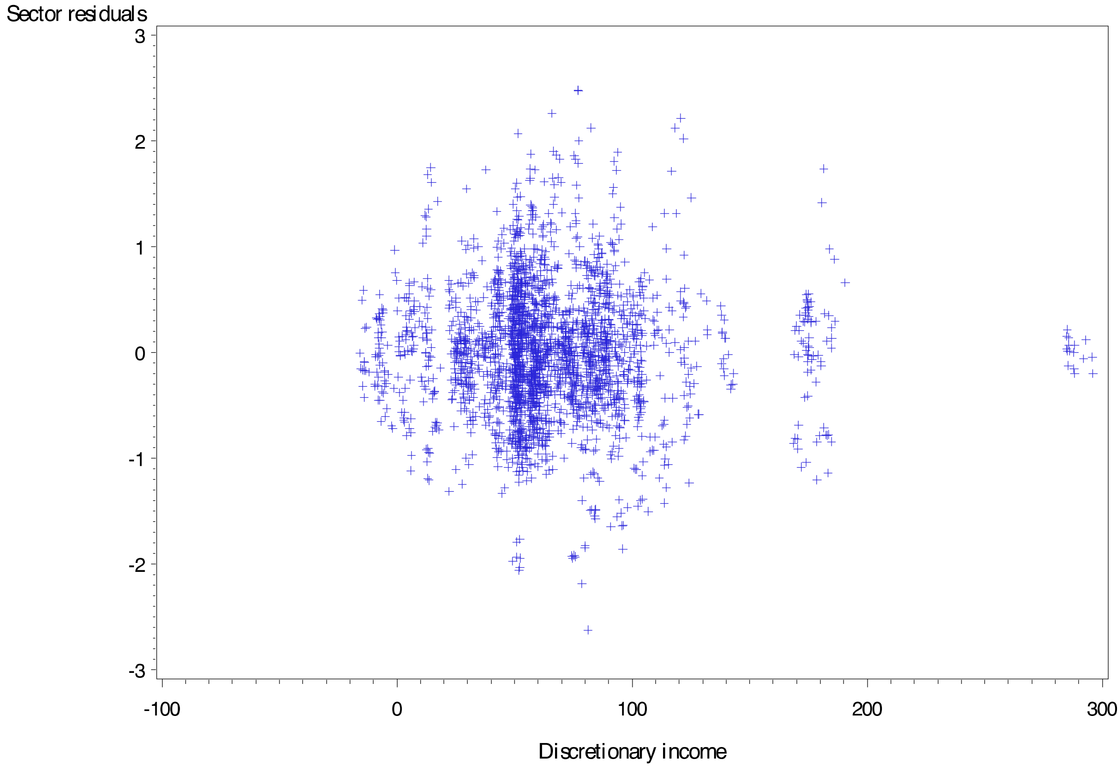
Residual plot for sector 9: culture



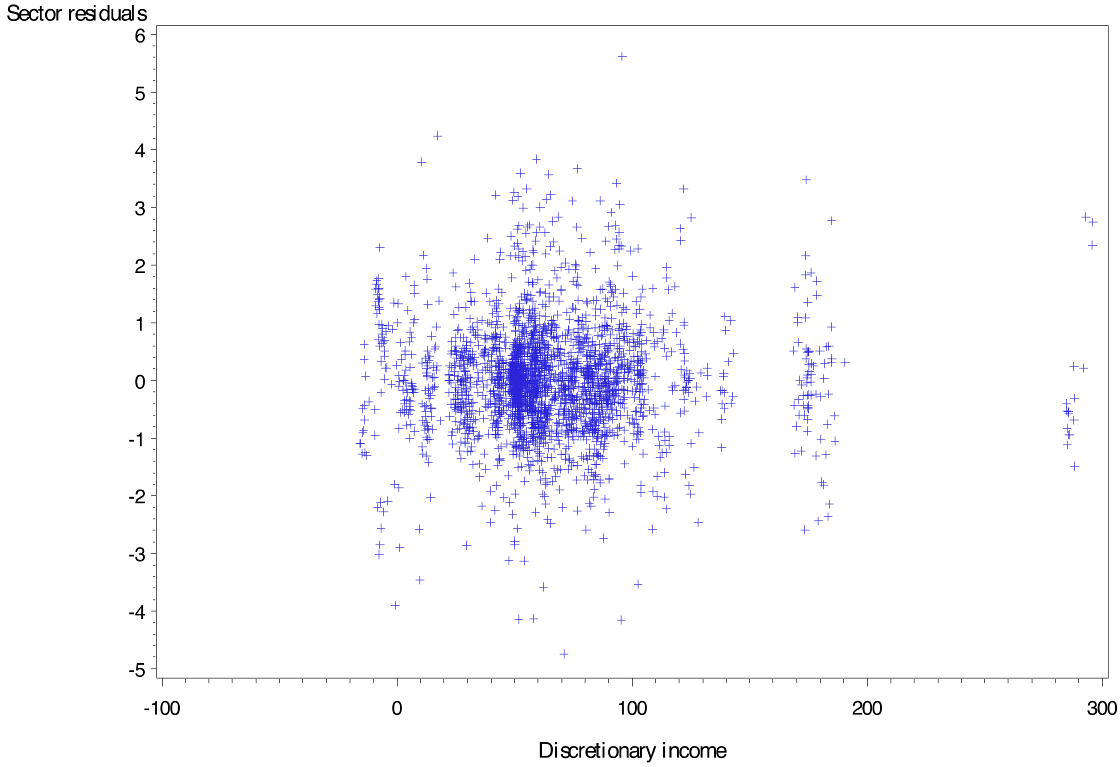
Residual plot for sector 10: municipal roads



Residual plot for sector 11: water supply and sanitation



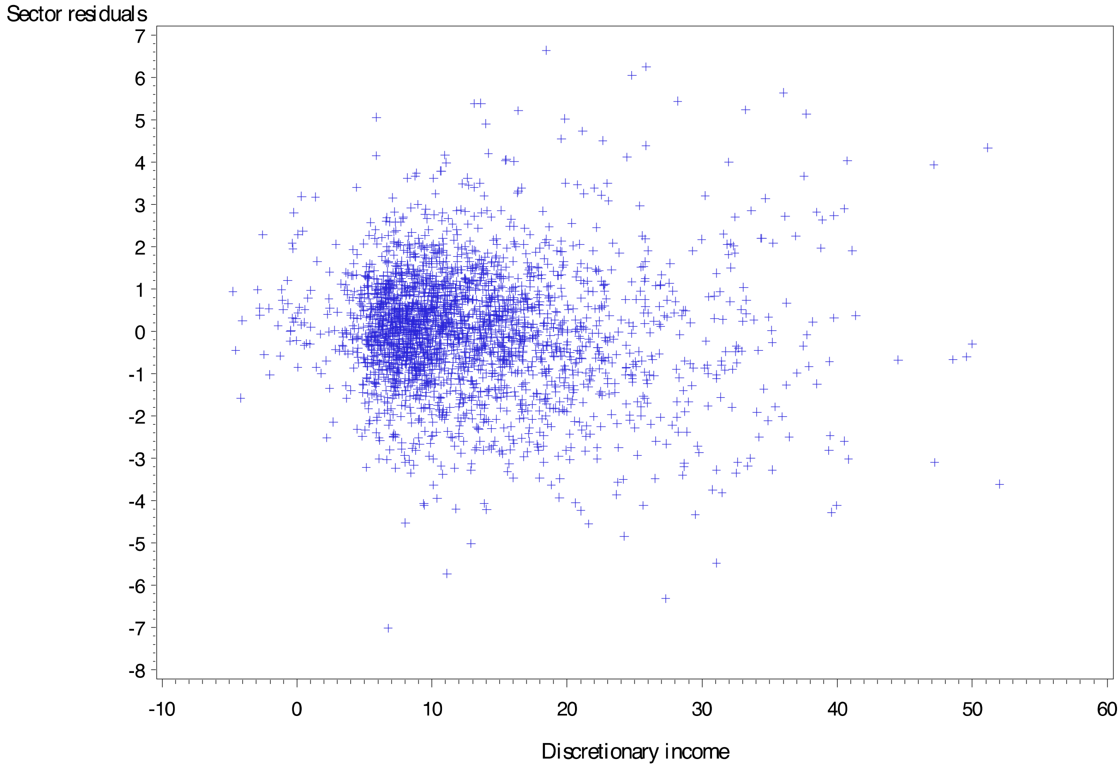
Residual plot for sector 12: other infrastructure



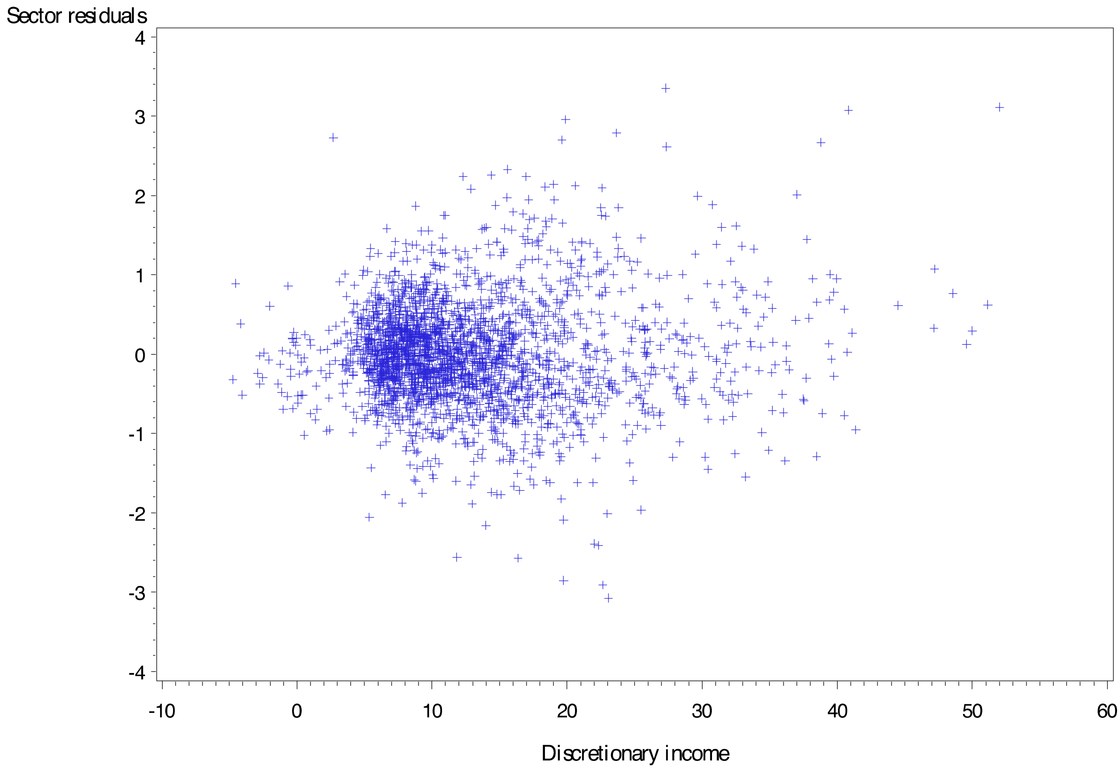
Model 8 (A)

)

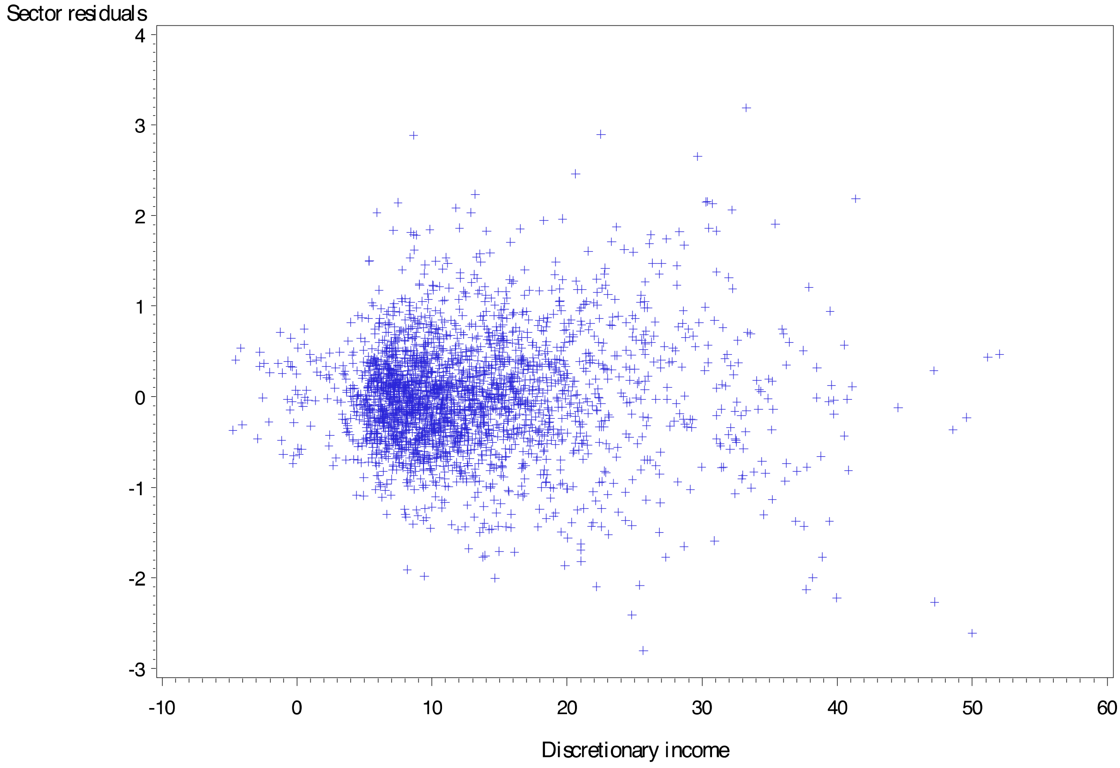
Residual plot for sector 0: budget surplus



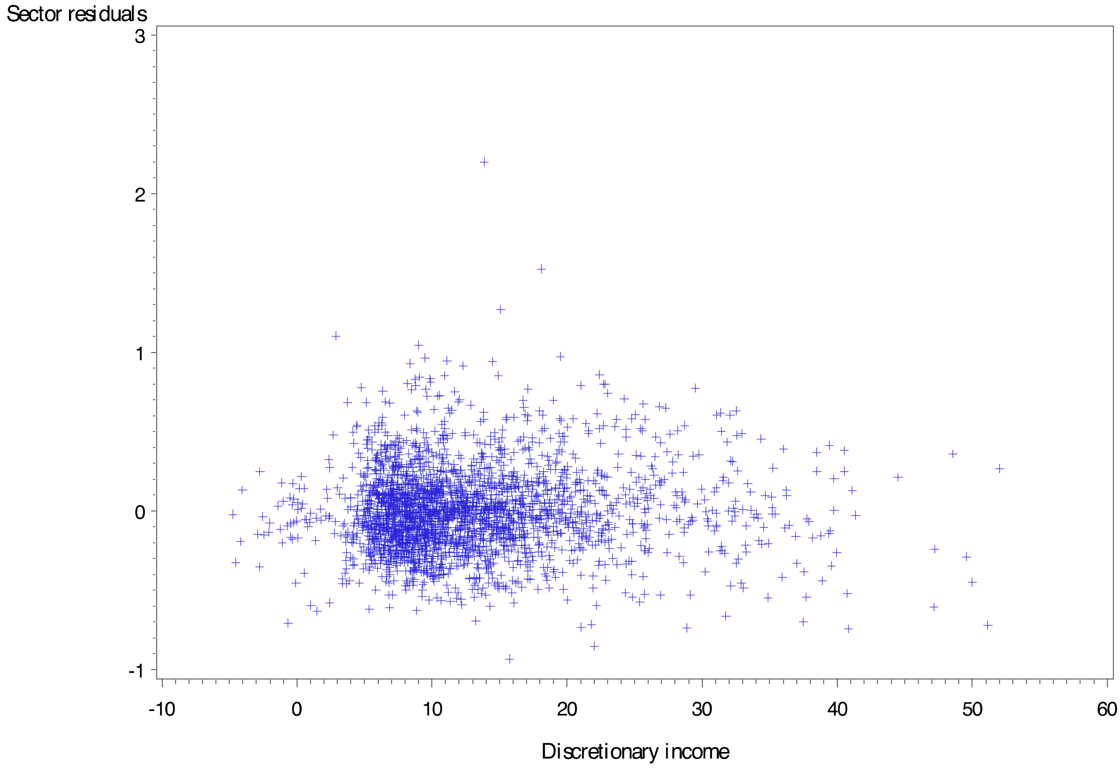
Residual plot for sector 1: administration



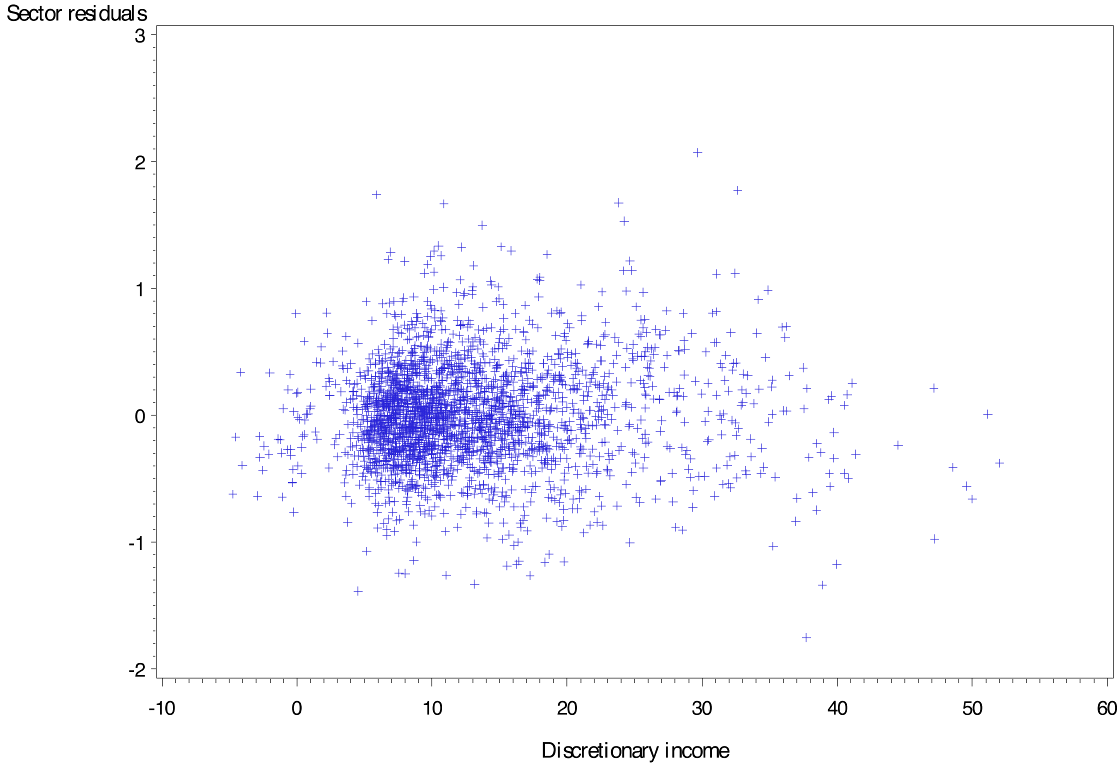
Residual plot for sector 2: primary schools



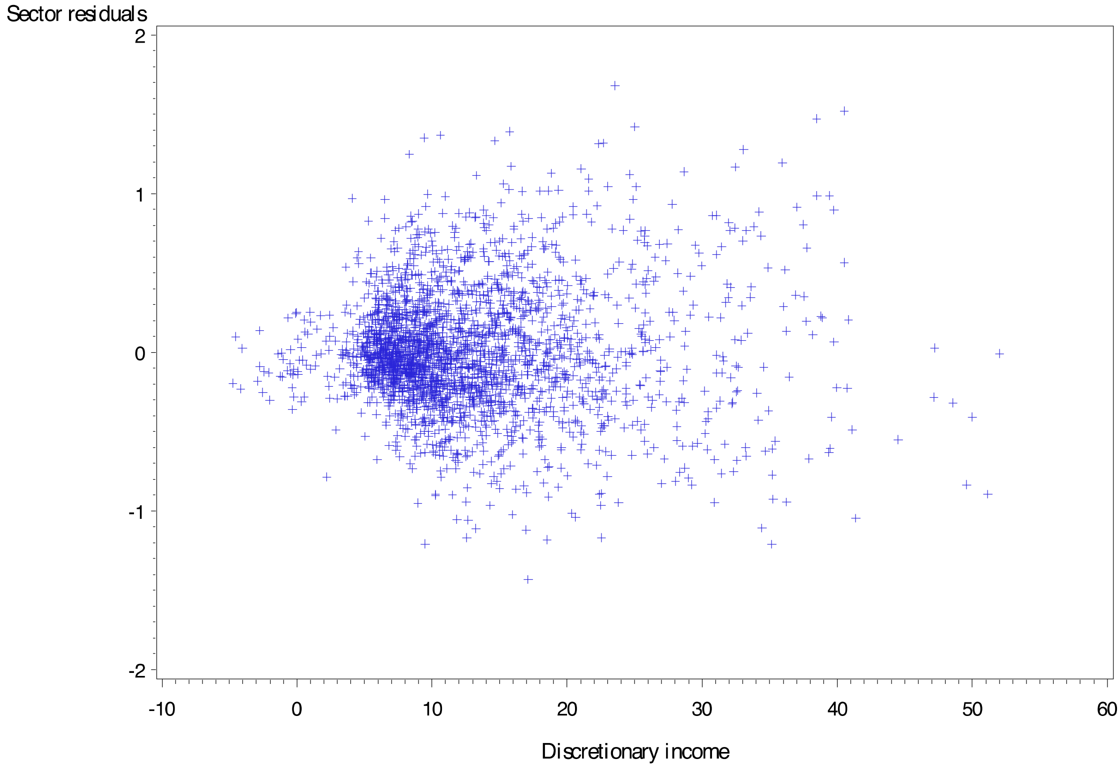
Residual plot for sector 3: other education



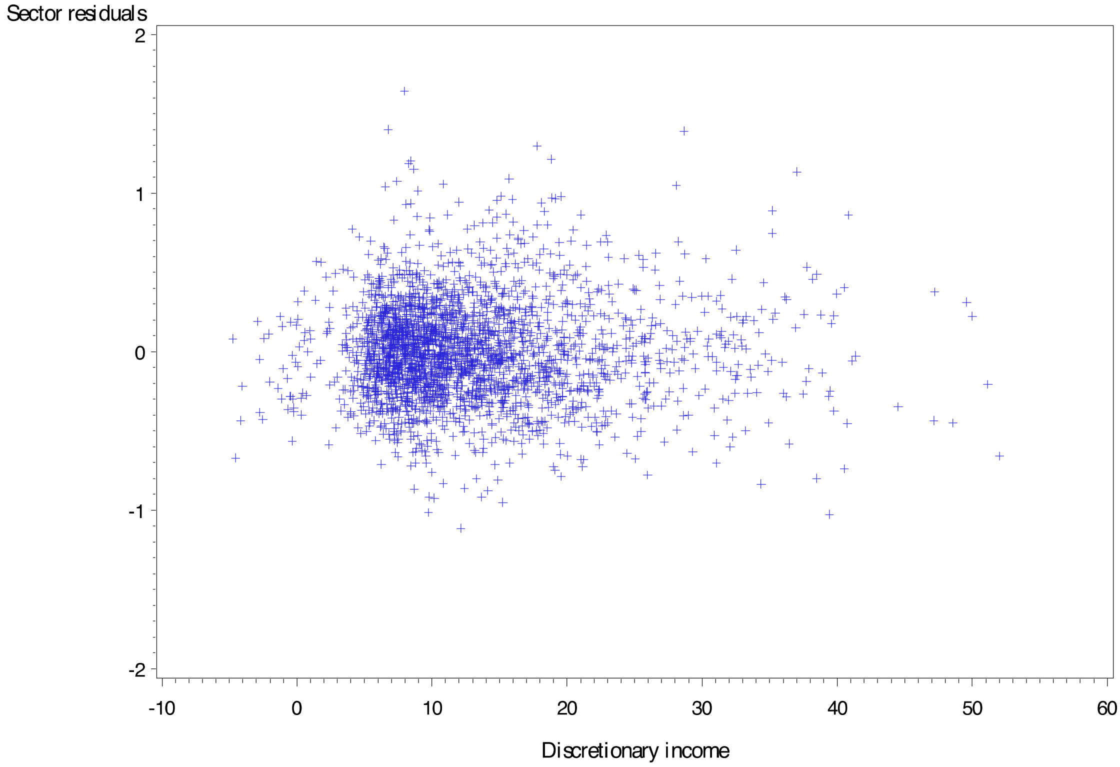
Residual plot for sector 4: child care



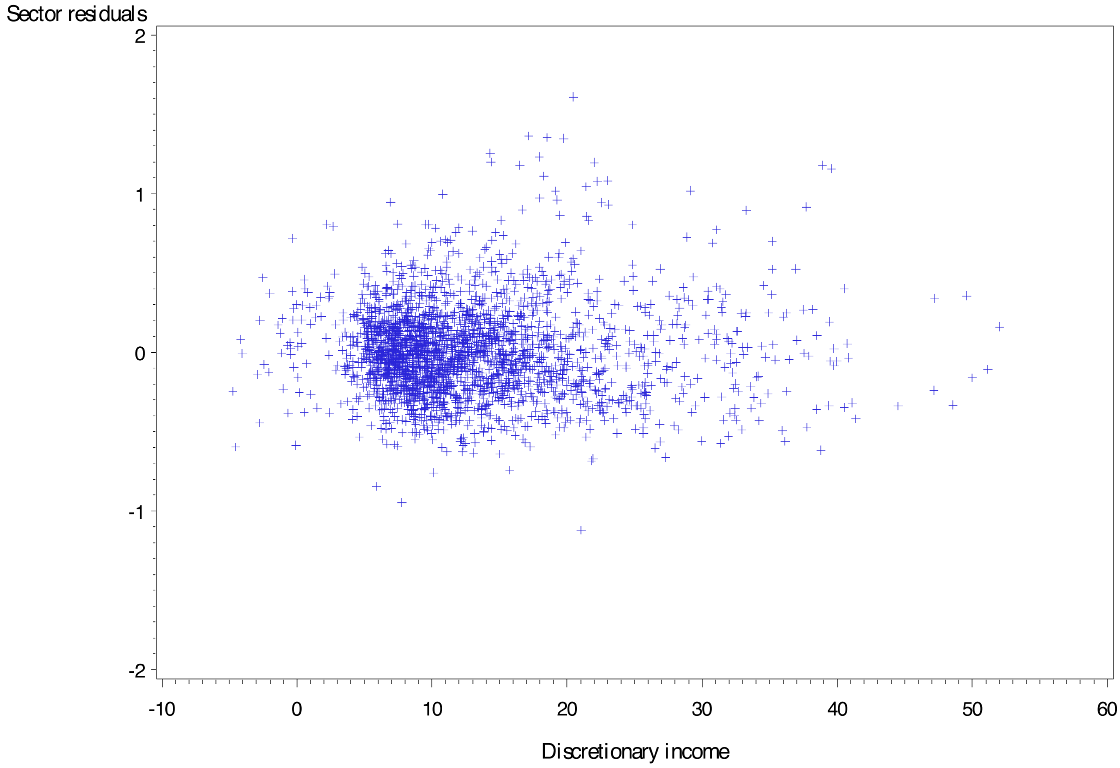
Residual plot for sector 5: health care



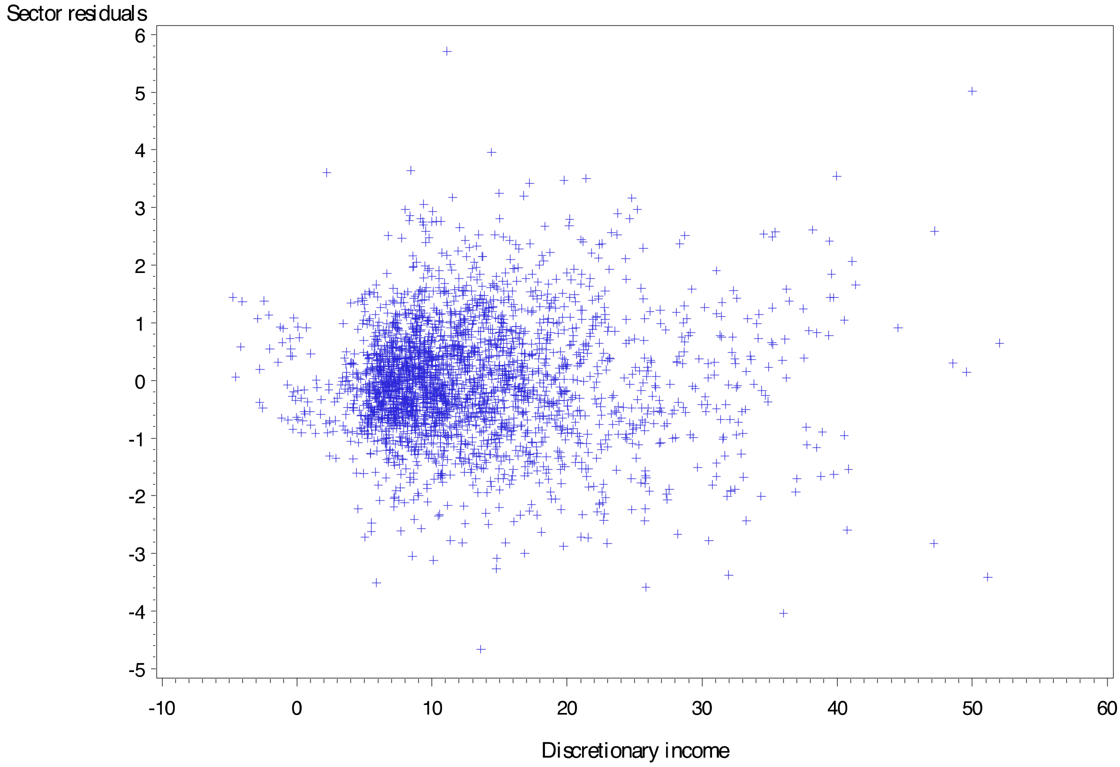
Residual plot for sector 6: social services



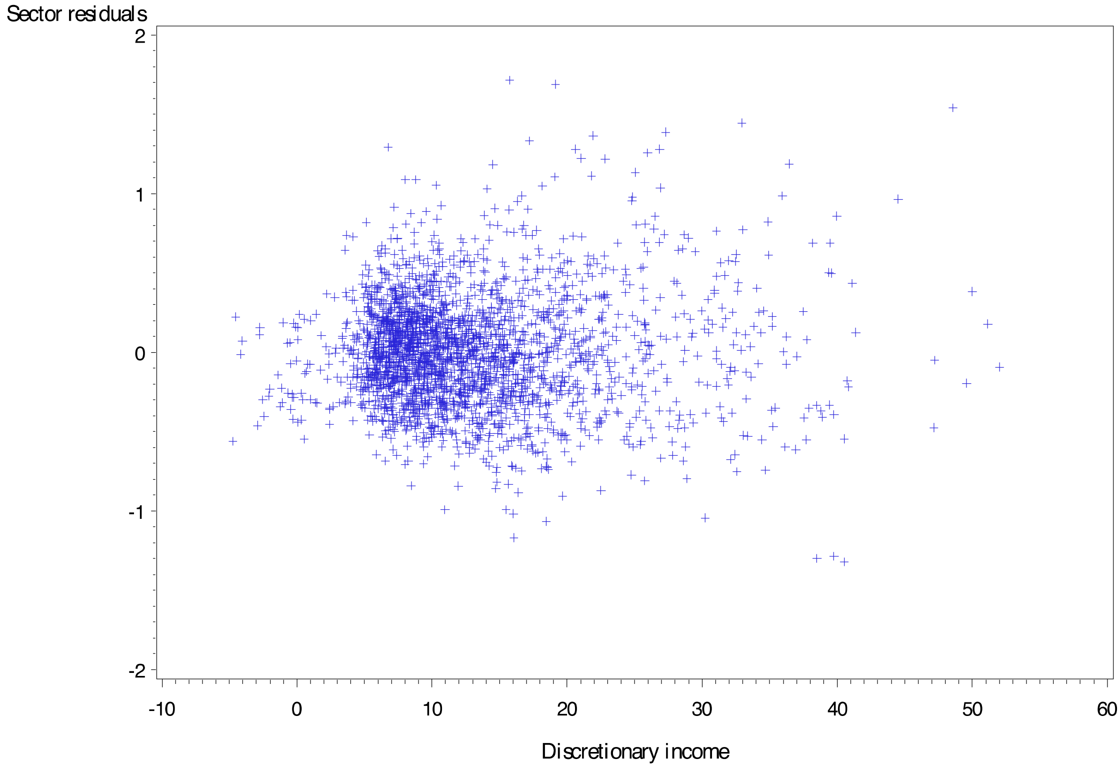
Residual plot for sector 7: child protection

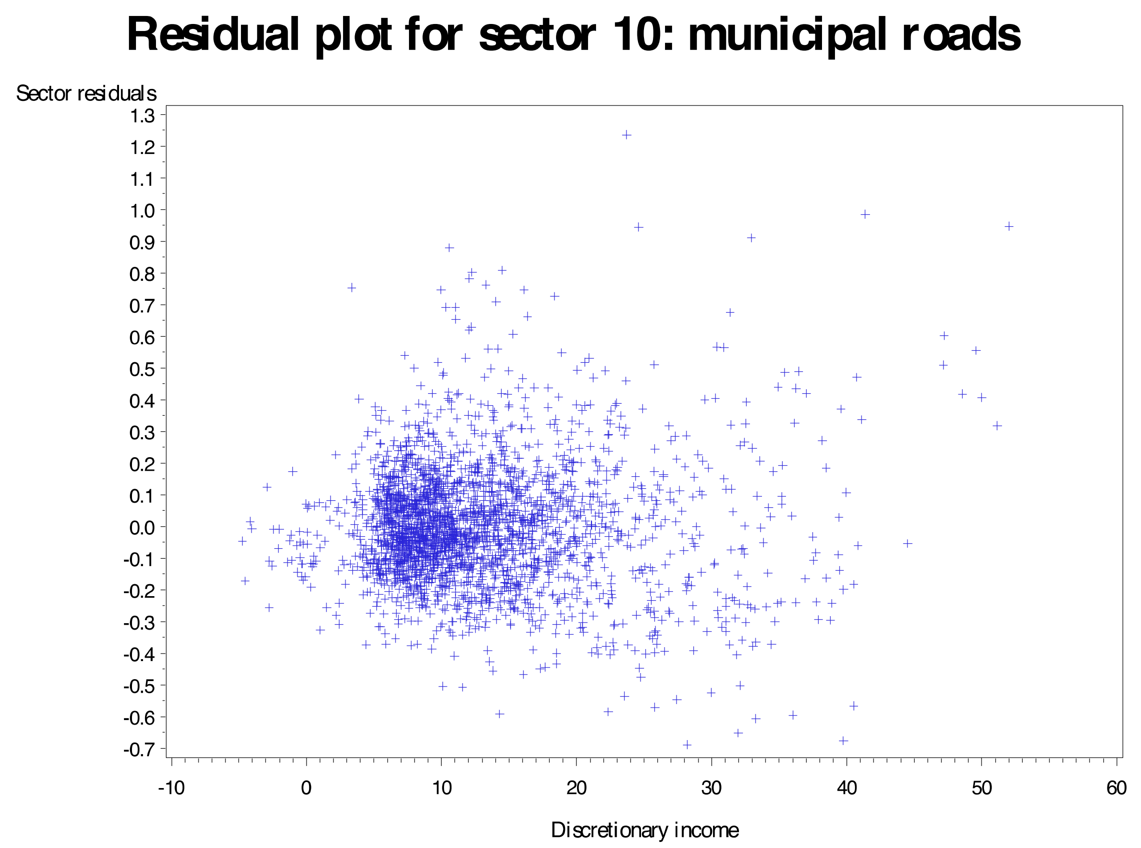


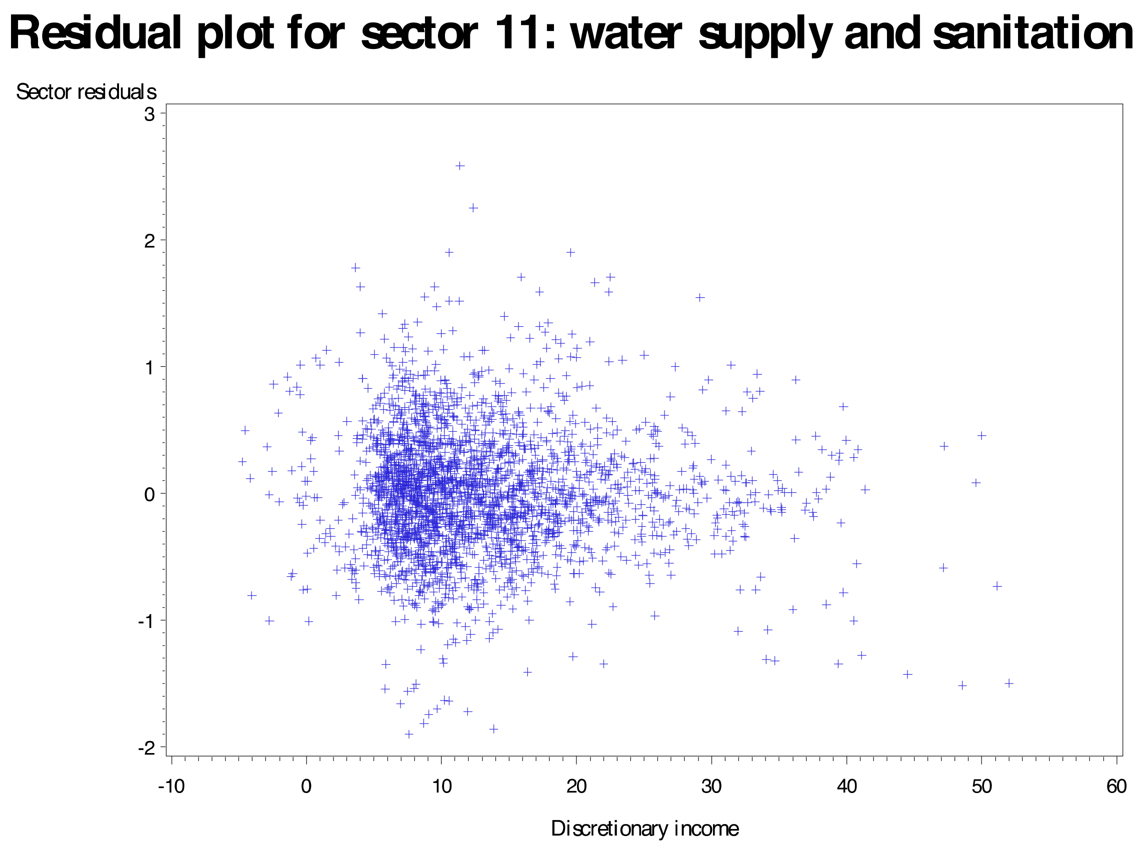
Residual plot for sector 8: care for the elderly and disabled

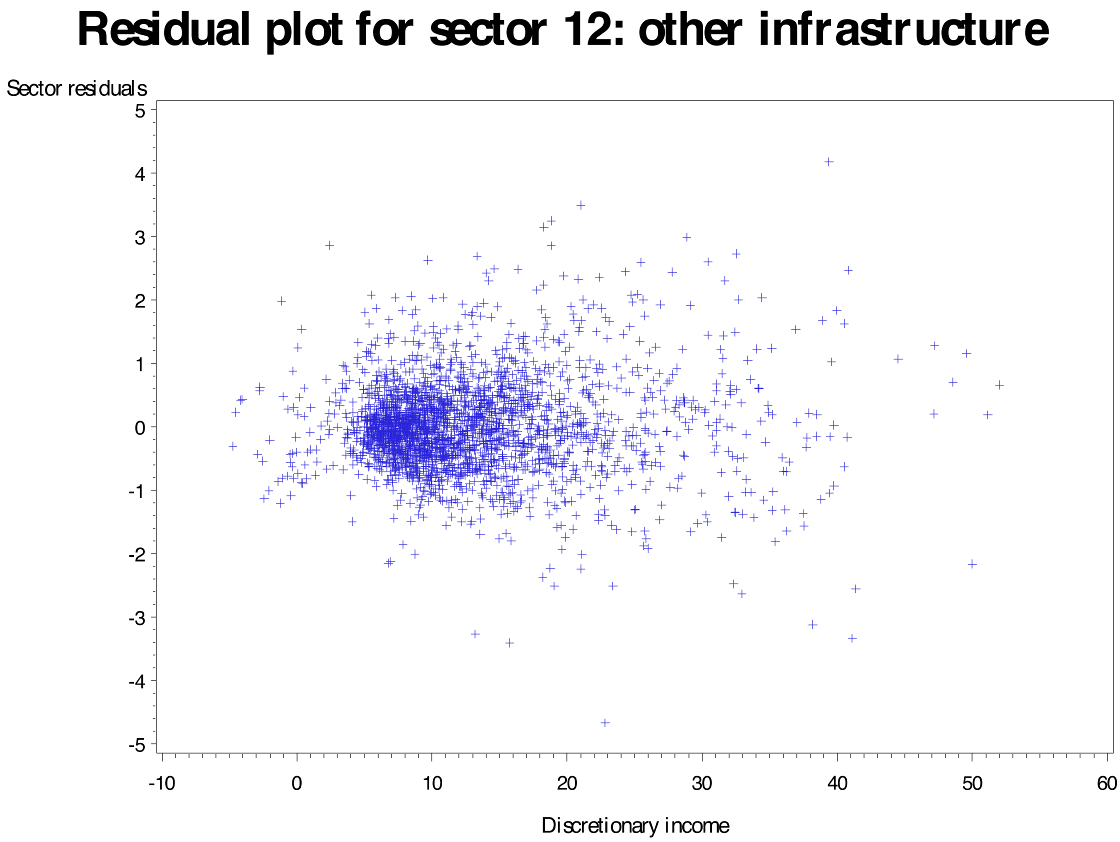


Residual plot for sector 9: culture



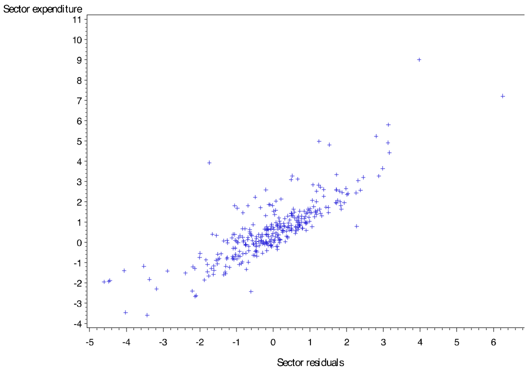

Residual plot for sector 10: municipal roads
Sector residuals
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-10
0
10
20
30
40
50
60
Discretionary income


Residual plot for sector 11: water supply and sanitation
Sector residuals
3
2
1
0
-1
-2
-10
0
10
20
30
40
50
60
Discretionary income

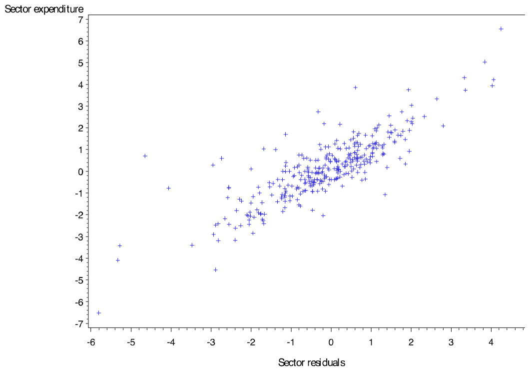

Residual plot for sector 12: other infrastructure
Sector residuals
5
4
3
2
1
0
-1
-2
-3
-4
-5
-10
0
10
20
30
40
50
60
Discretionary income

Residual plots for Model 2 by year and by sector

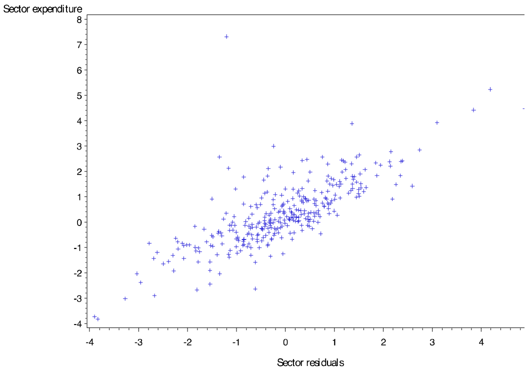
2001 Residual plot for sector 0: budget surplus



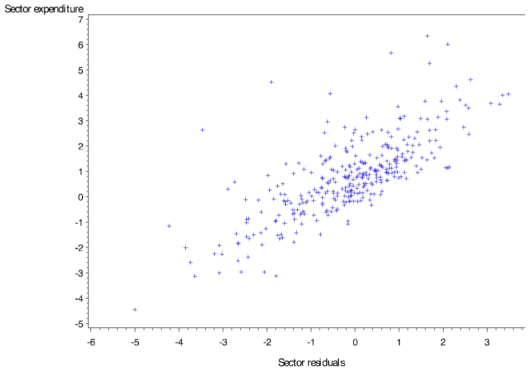
2002 Residual plot for sector 0: budget surplus



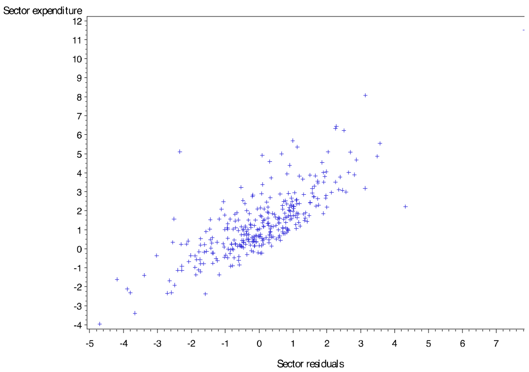
2003 Residual plot for sector 0: budget surplus



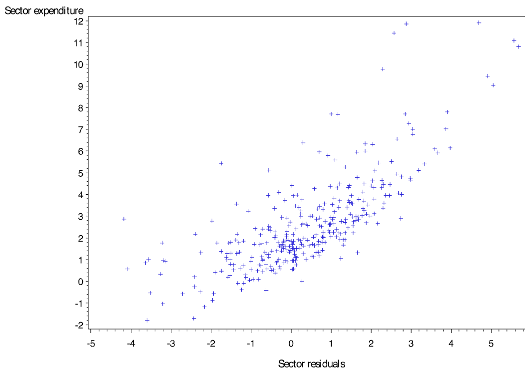
2004 Residual plot for sector 0: budget surplus



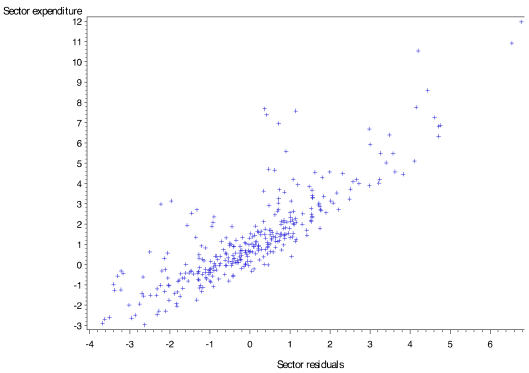
2005 Residual plot for sector 0: budget surplus



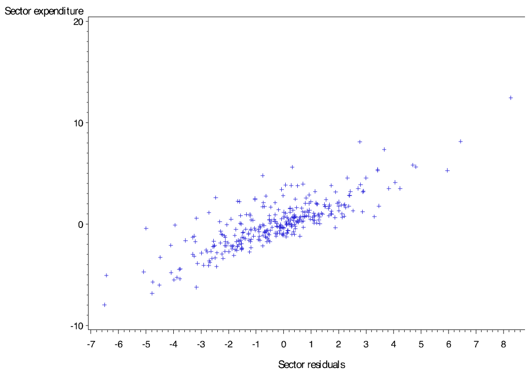
2006 Residual plot for sector 0: budget surplus



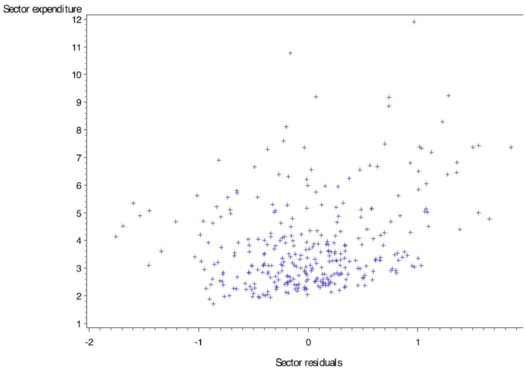
2007 Residual plot for sector 0: budget surplus



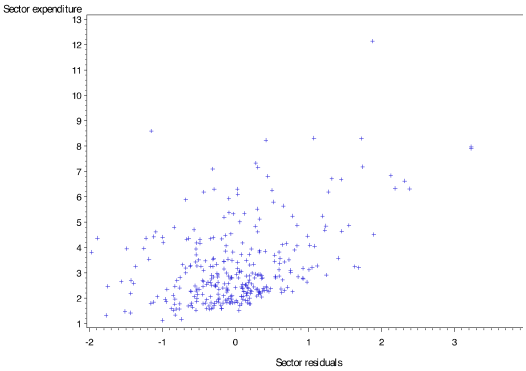
2008 Residual plot for sector 0: budget surplus



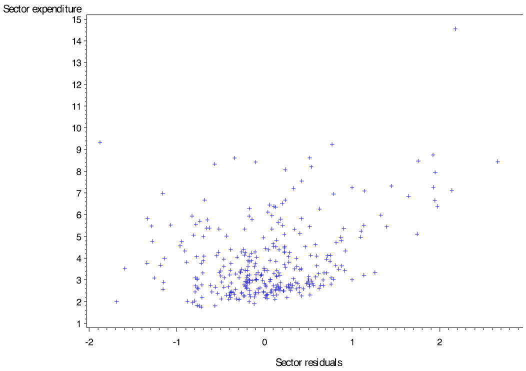
2001 Residual plot for sector 1: administration



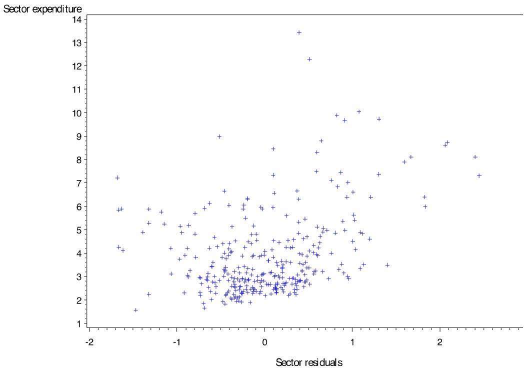
2002 Residual plot for sector 1: administration



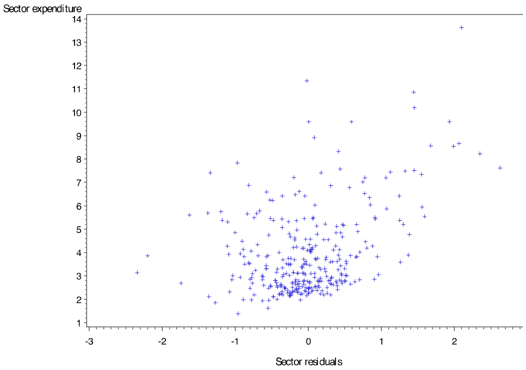
2003 Residual plot for sector 1: administration



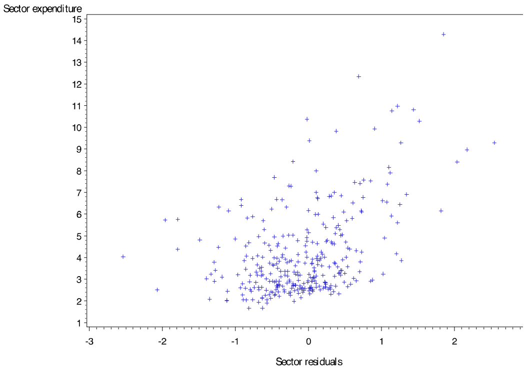
2004 Residual plot for sector 1: administration



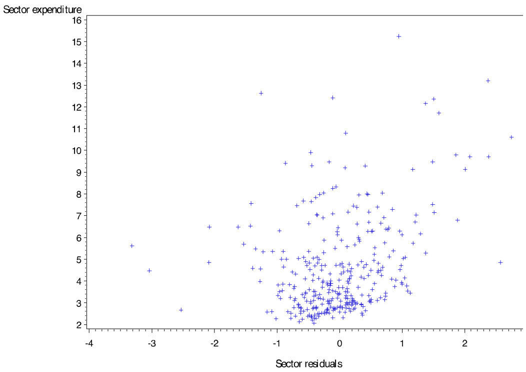
2005 Residual plot for sector 1: administration



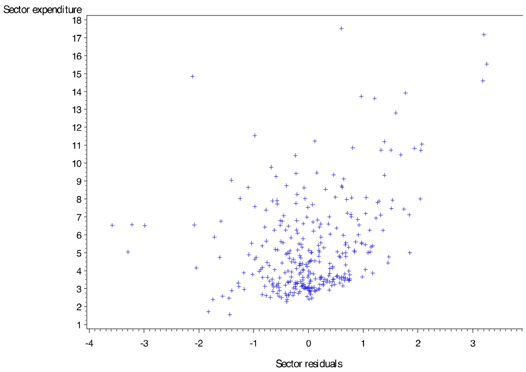
2006 Residual plot for sector 1: administration



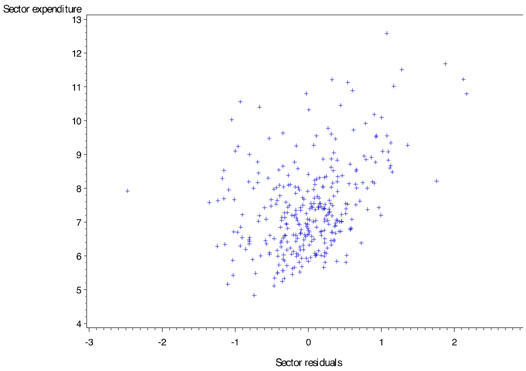
2007 Residual plot for sector 1: administration



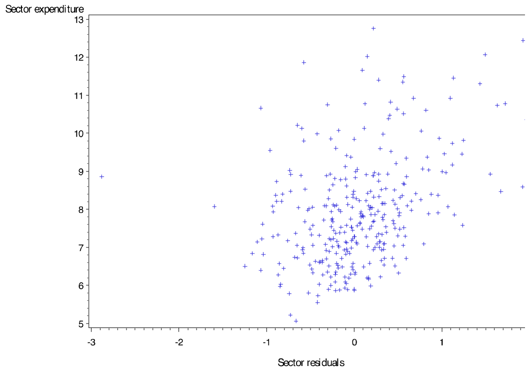
2008 Residual plot for sector 1: administration



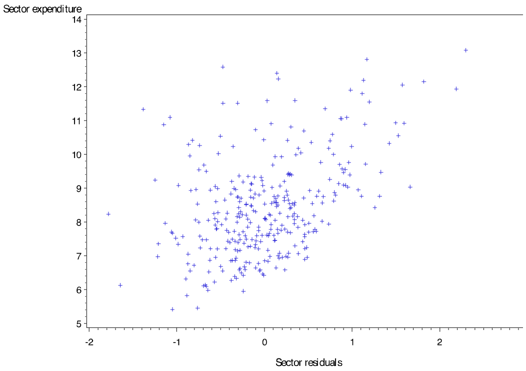
2001 Residual plot for sector 2: primary schools



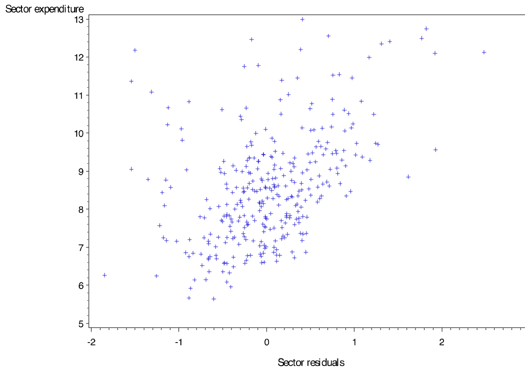
2002 Residual plot for sector 2: primary schools



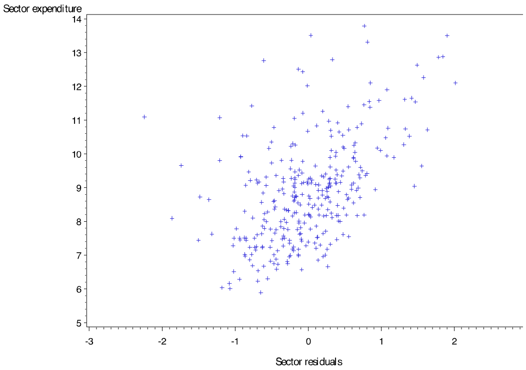
2003 Residual plot for sector 2: primary schools



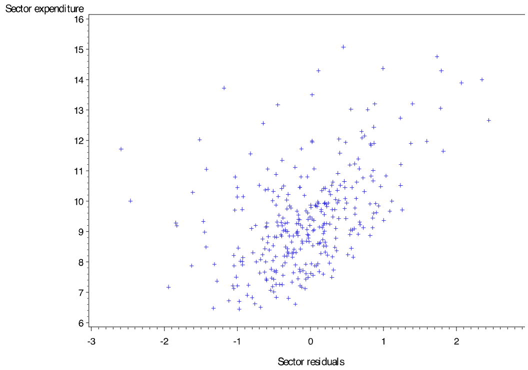
2004 Residual plot for sector 2: primary schools



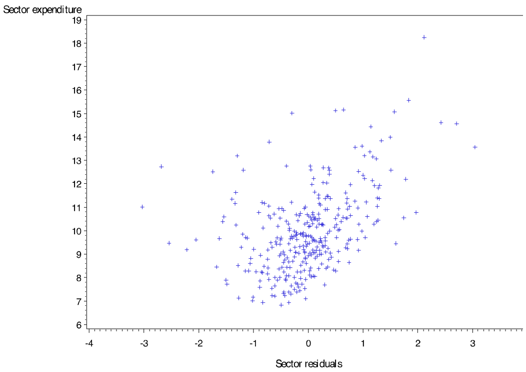
2005 Residual plot for sector 2: primary schools



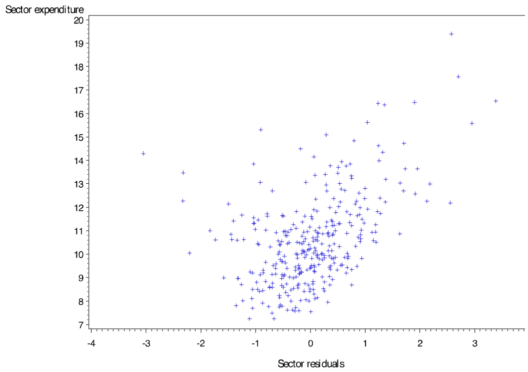
2006 Residual plot for sector 2: primary schools



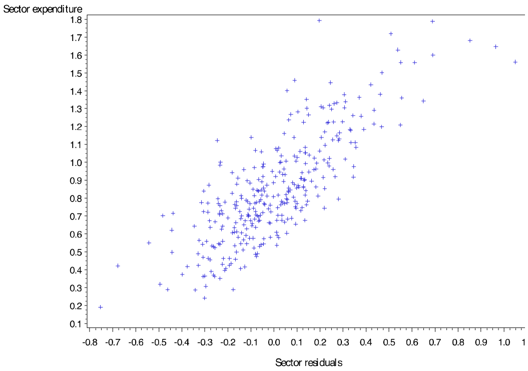
2007 Residual plot for sector 2: primary schools



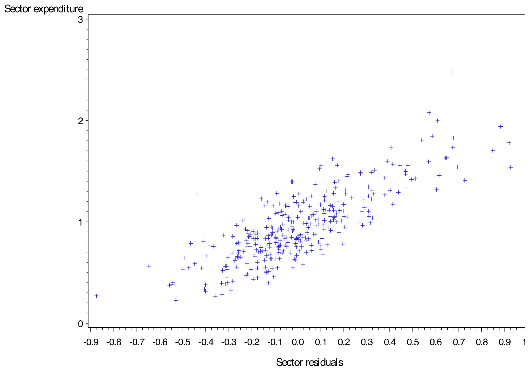
2008 Residual plot for sector 2: primary schools



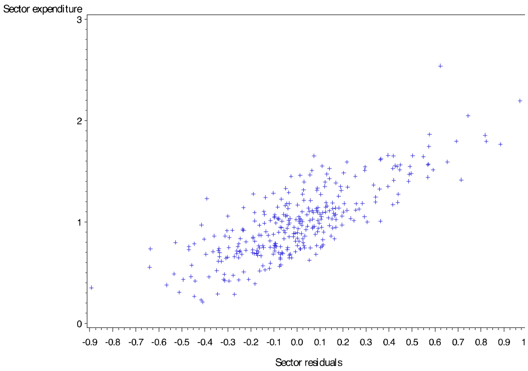
2001 Residual plot for sector 3: other education



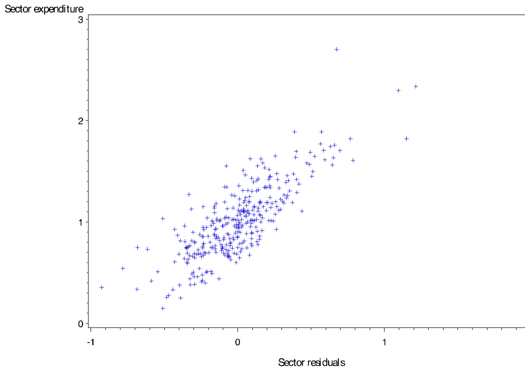
2002 Residual plot for sector 3: other education



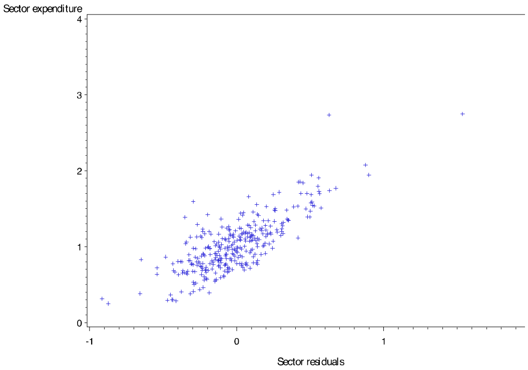
2003 Residual plot for sector 3: other education



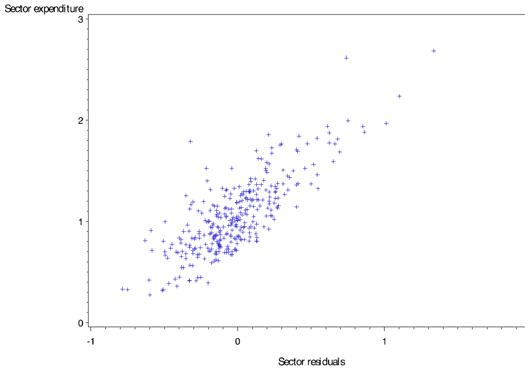
2004 Residual plot for sector 3: other education



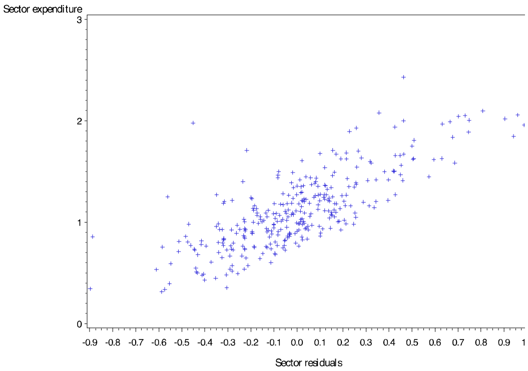
2005 Residual plot for sector 3: other education



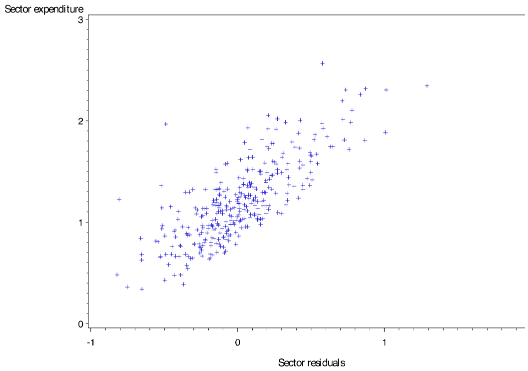
2006 Residual plot for sector 3: other education



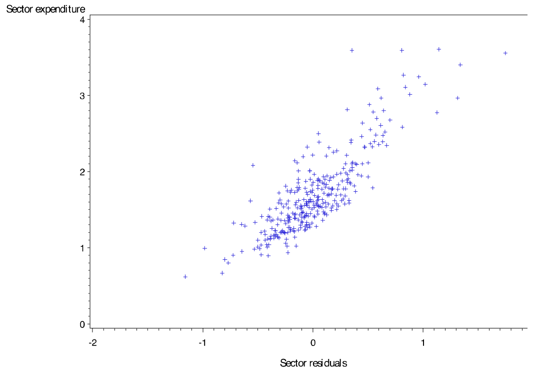
2007 Residual plot for sector 3: other education



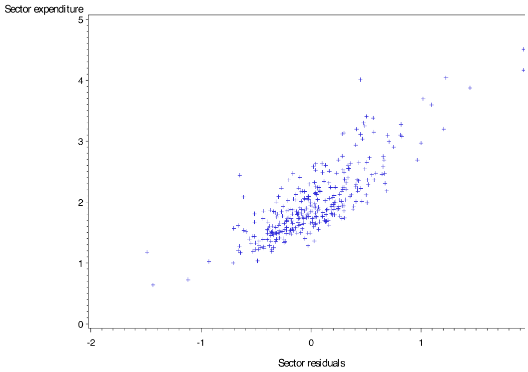
2008 Residual plot for sector 3: other education



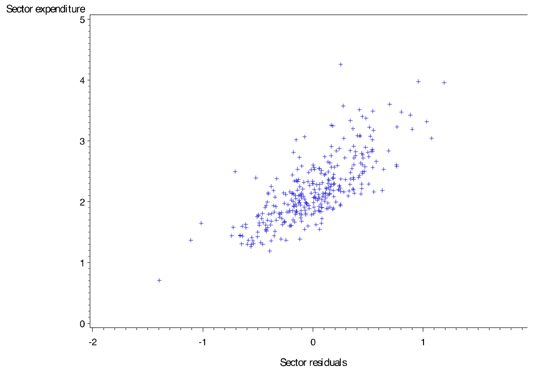
2001 Residual plot for sector 4: child care



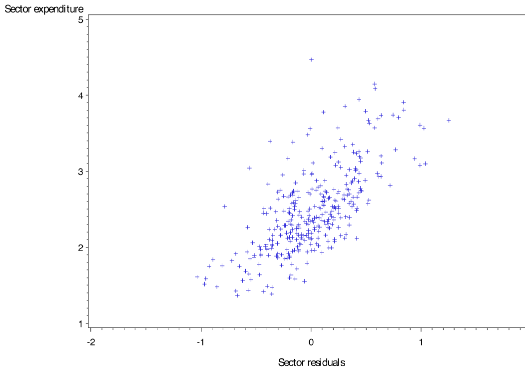
2002 Residual plot for sector 4: child care



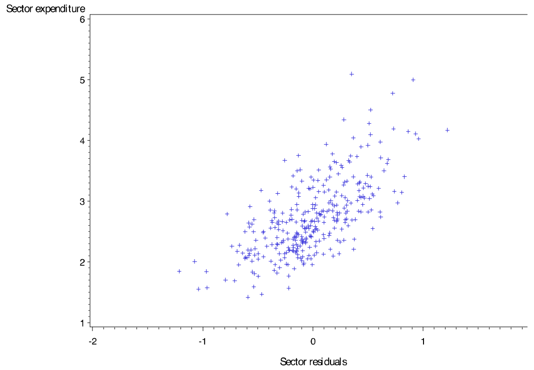
2003 Residual plot for sector 4: child care



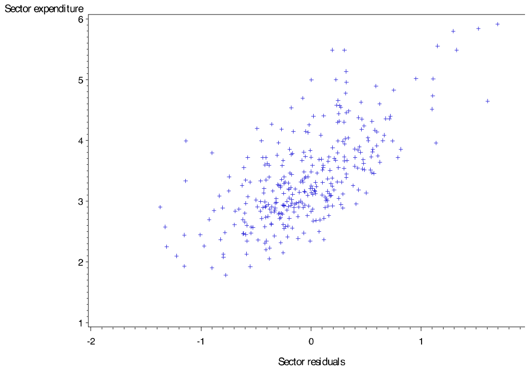
2004 Residual plot for sector 4: child care



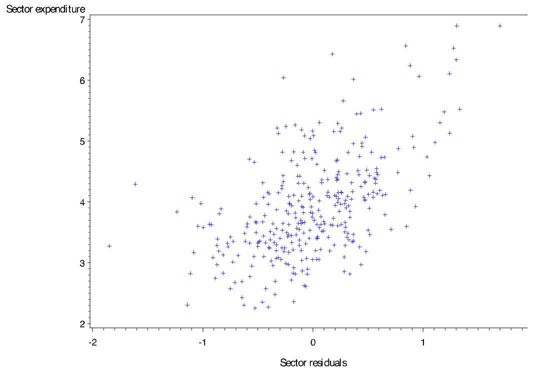
2005 Residual plot for sector 4: child care



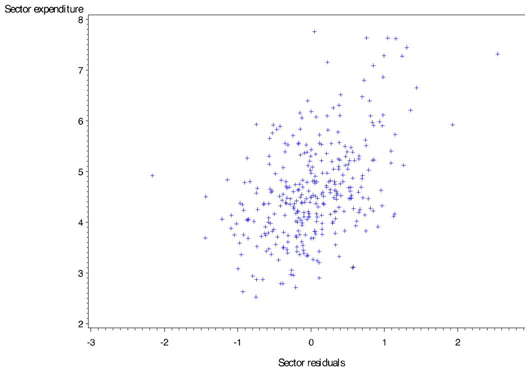
2006 Residual plot for sector 4: child care



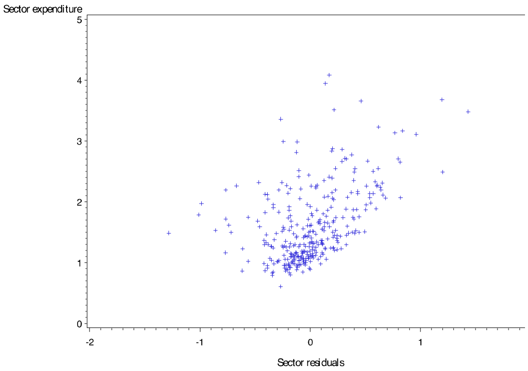
2007 Residual plot for sector 4: child care



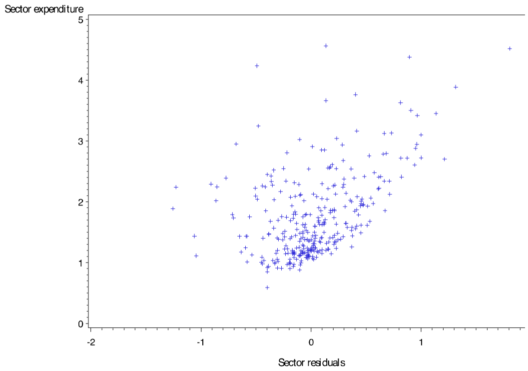
2008 Residual plot for sector 4: child care



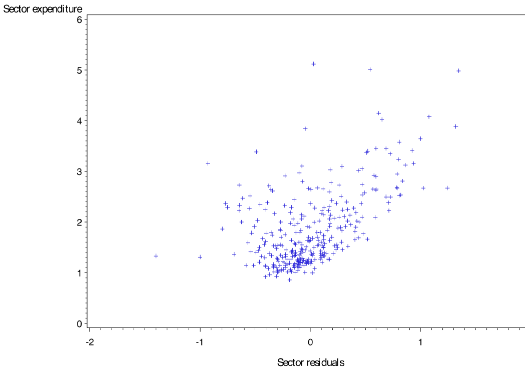
2001 Residual plot for sector 5: health care



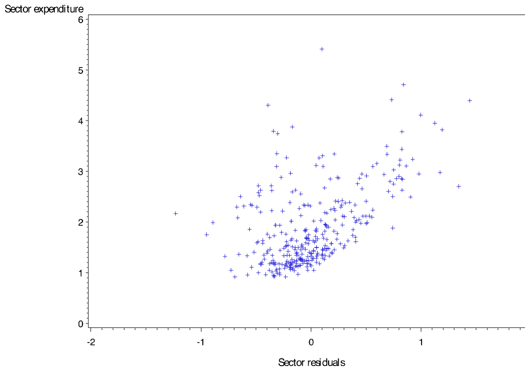
2002 Residual plot for sector 5: health care



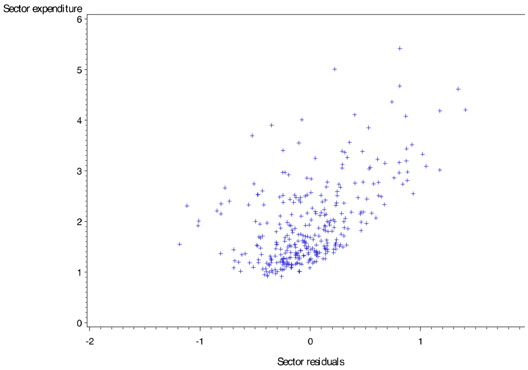
2003 Residual plot for sector 5: health care



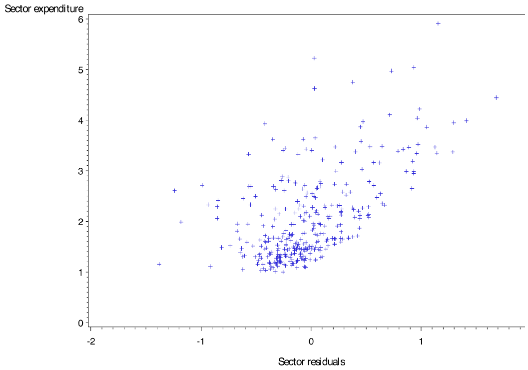
2004 Residual plot for sector 5: health care



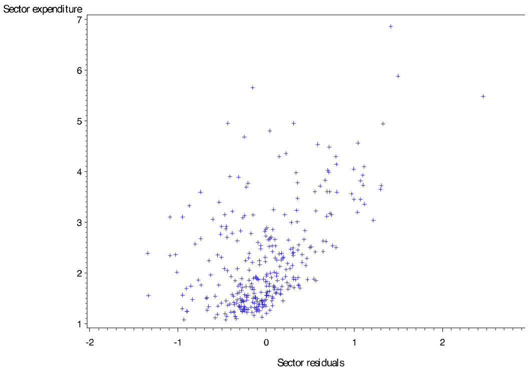
2005 Residual plot for sector 5: health care



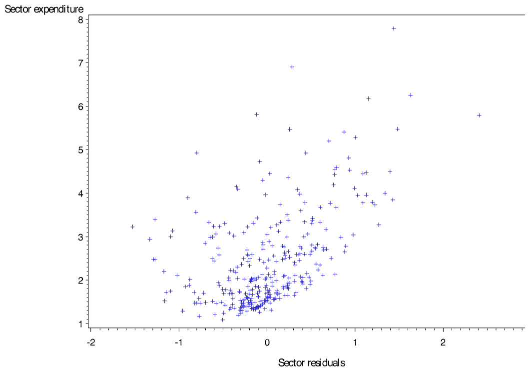
2006 Residual plot for sector 5: health care



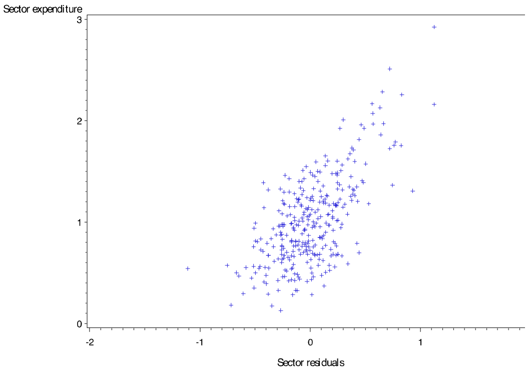
2007 Residual plot for sector 5: health care



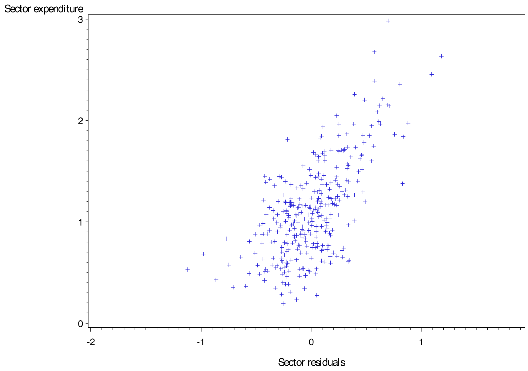
2008 Residual plot for sector 5: health care



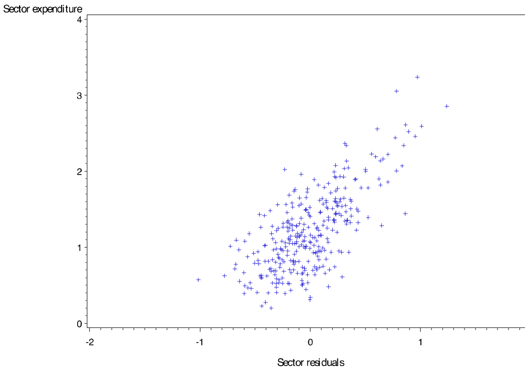
2001 Residual plot for sector 6: social services



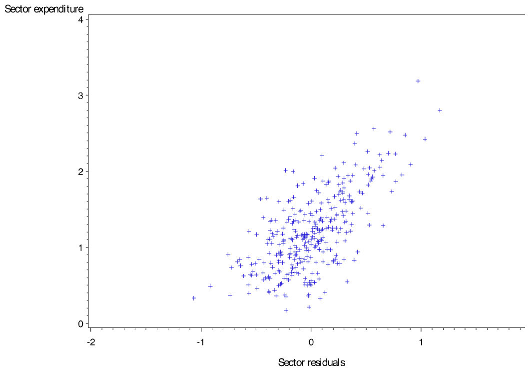
2002 Residual plot for sector 6: social services



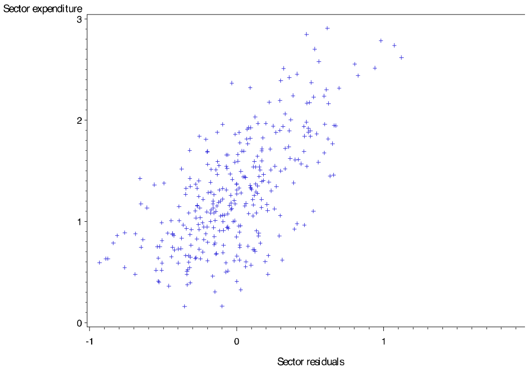
2003 Residual plot for sector 6: social services



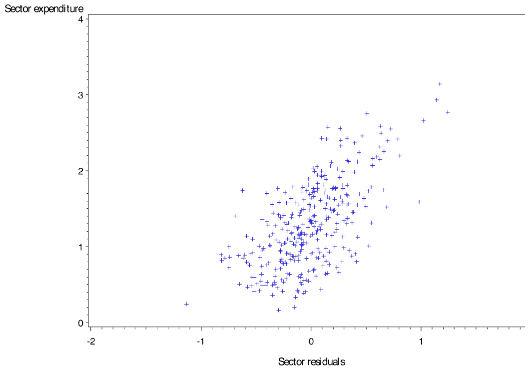
2004 Residual plot for sector 6: social services



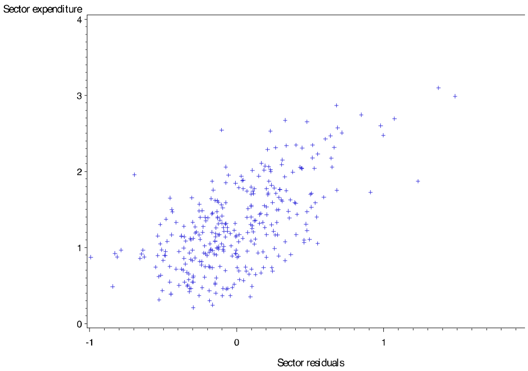
2005 Residual plot for sector 6: social services



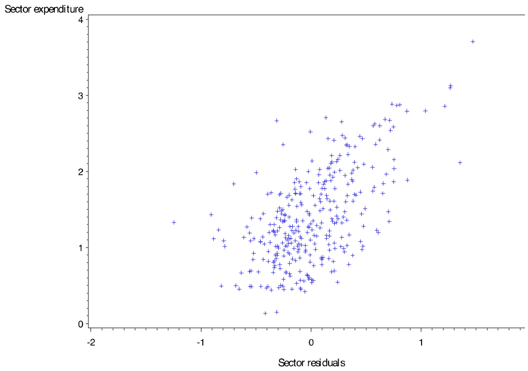
2006 Residual plot for sector 6: social services



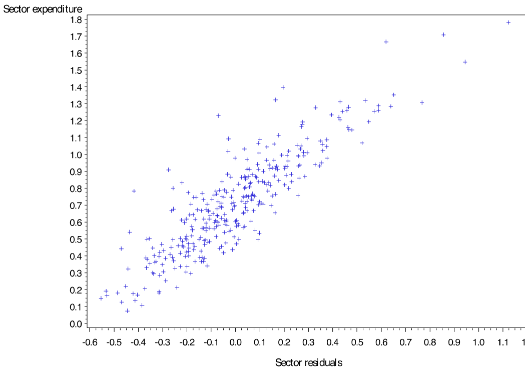
2007 Residual plot for sector 6: social services



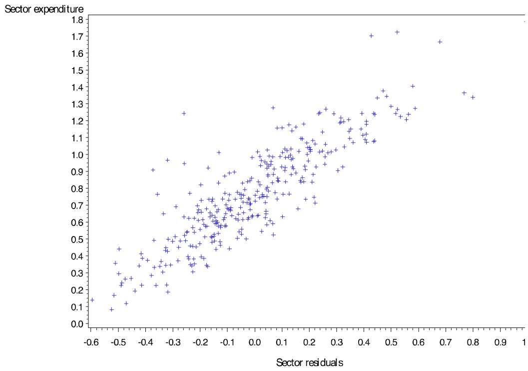
2008 Residual plot for sector 6: social services



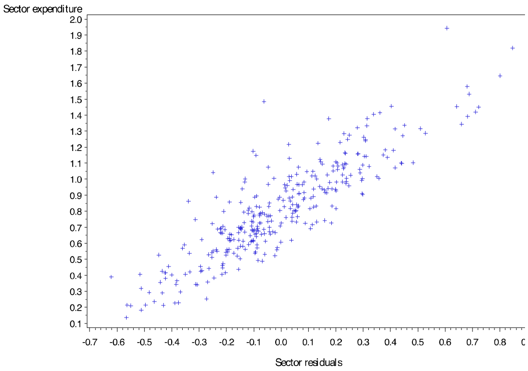
2001 Residual plot for sector 7: child protection



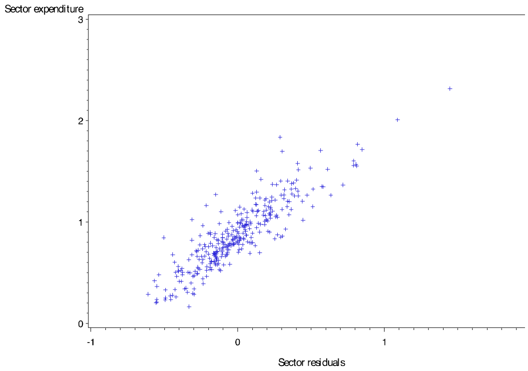
2002 Residual plot for sector 7: child protection



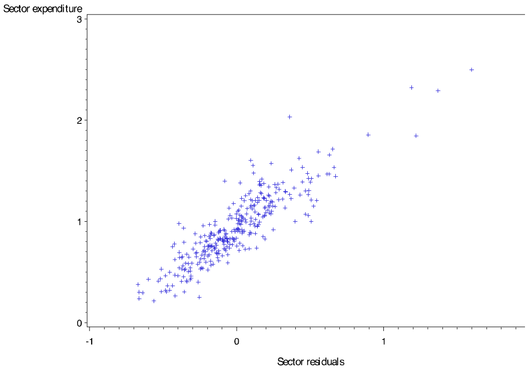
2003 Residual plot for sector 7: child protection



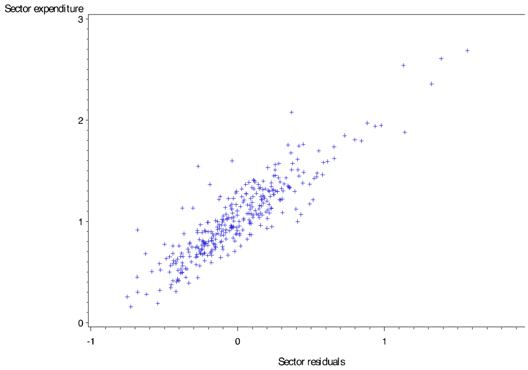
2004 Residual plot for sector 7: child protection



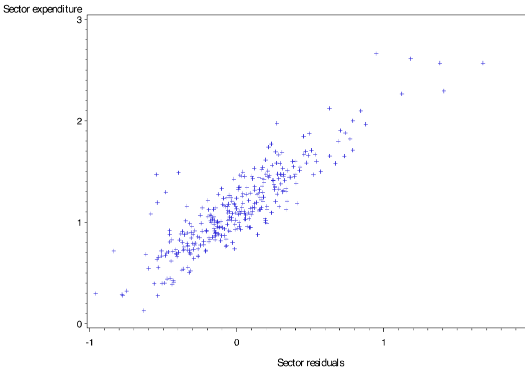
2005 Residual plot for sector 7: child protection



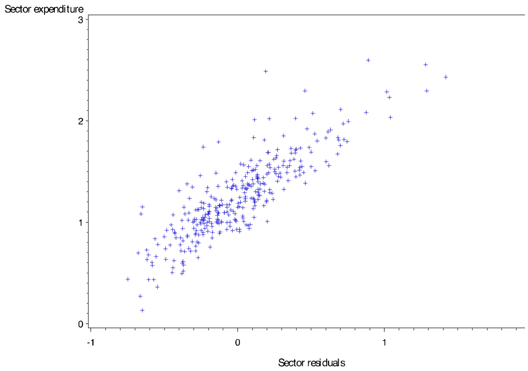
2006 Residual plot for sector 7: child protection



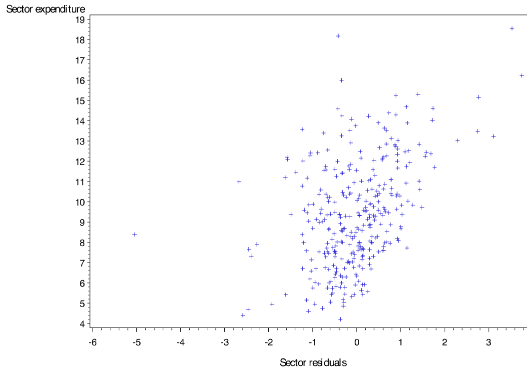
2007 Residual plot for sector 7: child protection



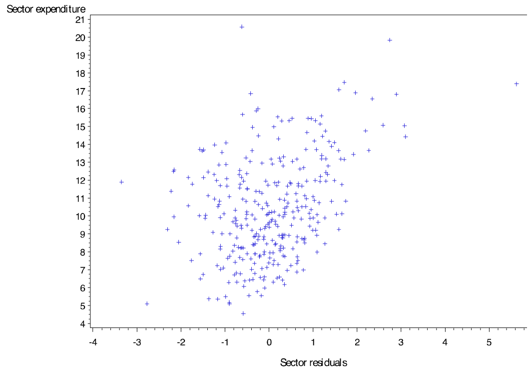
2008 Residual plot for sector 7: child protection



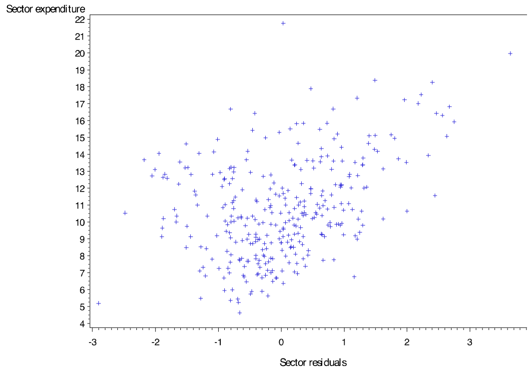
2001 Residual plot for sector 8: care for the elderly and disable



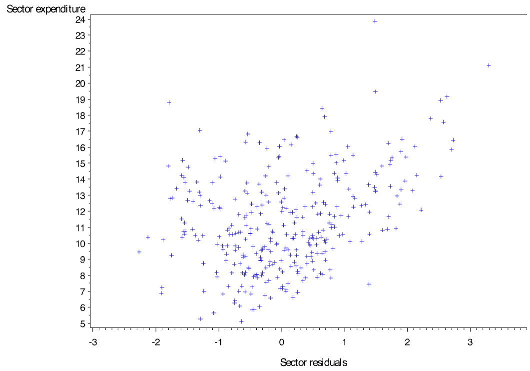
2002 Residual plot for sector 8: care for the elderly and disable



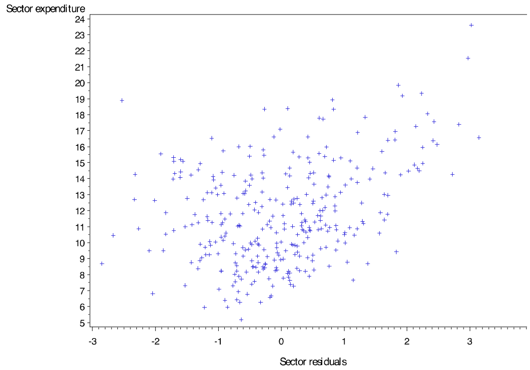
2003 Residual plot for sector 8: care for the elderly and disable



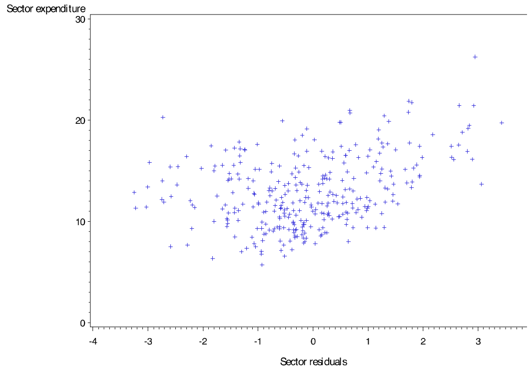
2004 Residual plot for sector 8: care for the elderly and disable



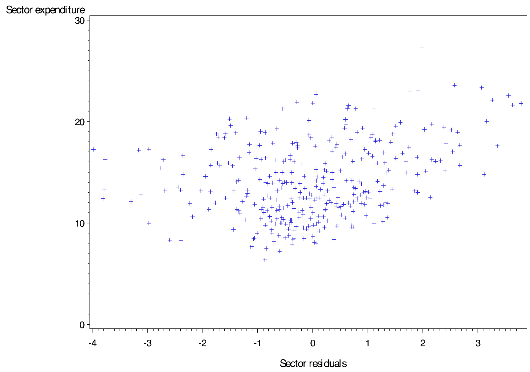
2005 Residual plot for sector 8: care for the elderly and disable



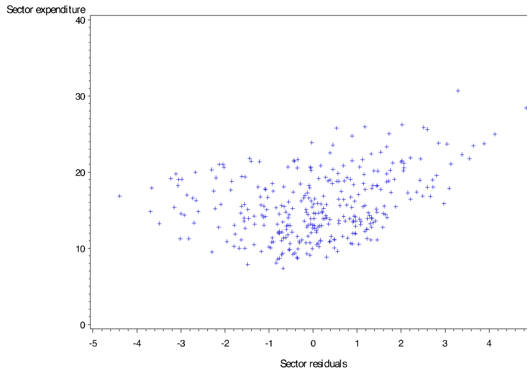
2006 Residual plot for sector 8: care for the elderly and disable



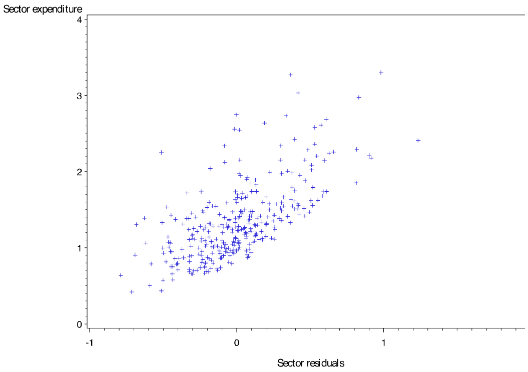
2007 Residual plot for sector 8: care for the elderly and disable



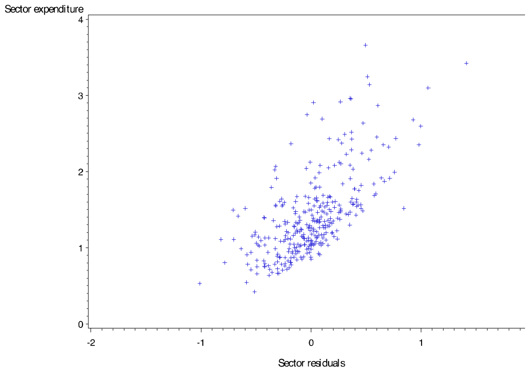
2008 Residual plot for sector 8: care for the elderly and disable



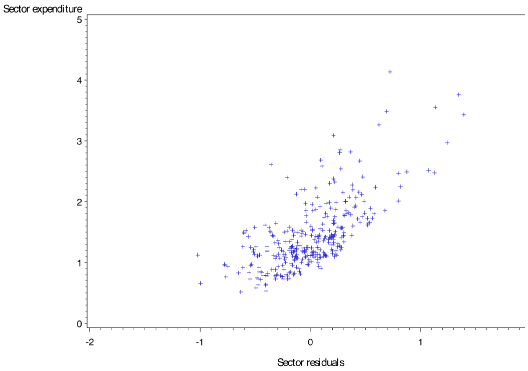
2001 Residual plot for sector 9: culture



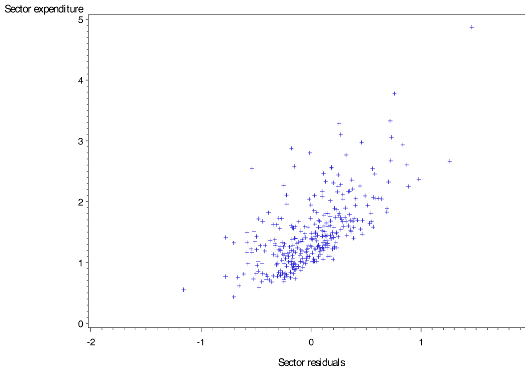
2002 Residual plot for sector 9: culture



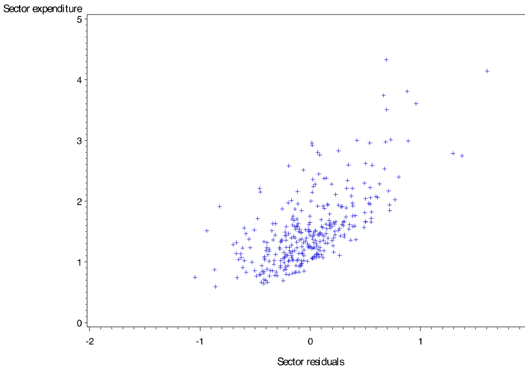
2003 Residual plot for sector 9: culture



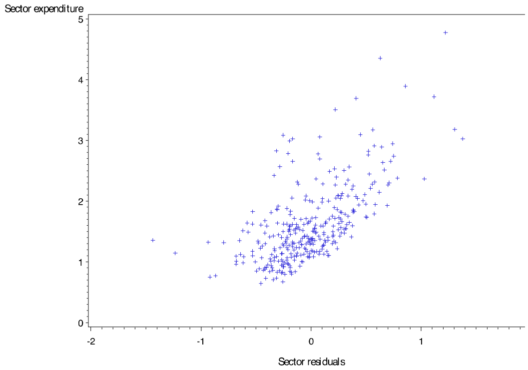
2004 Residual plot for sector 9: culture



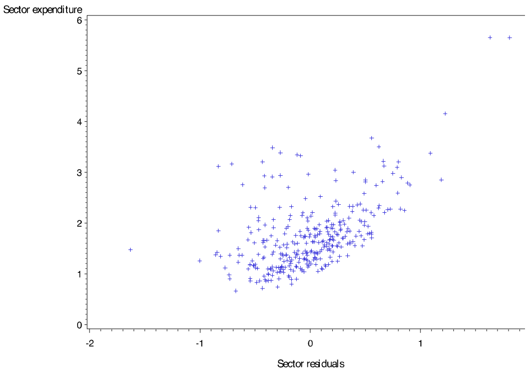
2005 Residual plot for sector 9: culture



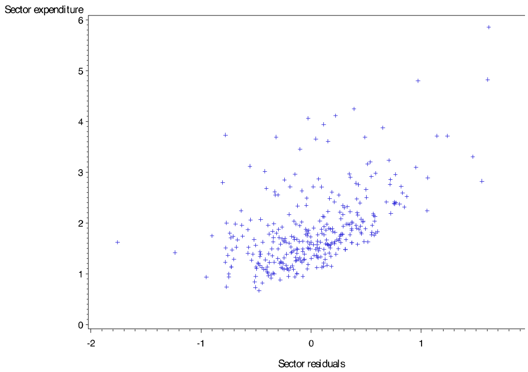
2006 Residual plot for sector 9: culture



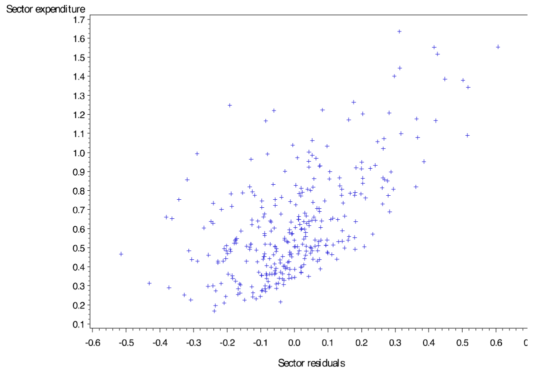
2007 Residual plot for sector 9: culture



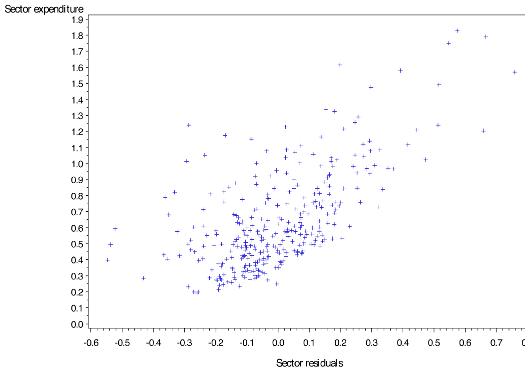
2008 Residual plot for sector 9: culture



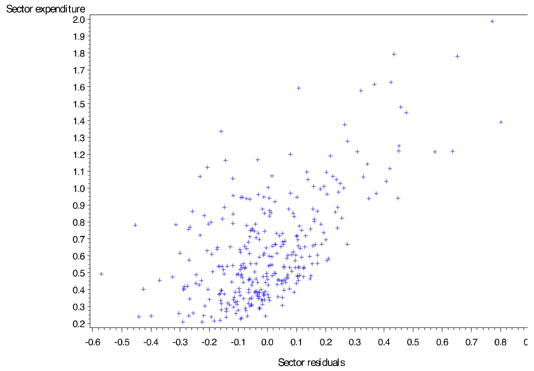
2001 Residual plot for sector 10: municipal roads



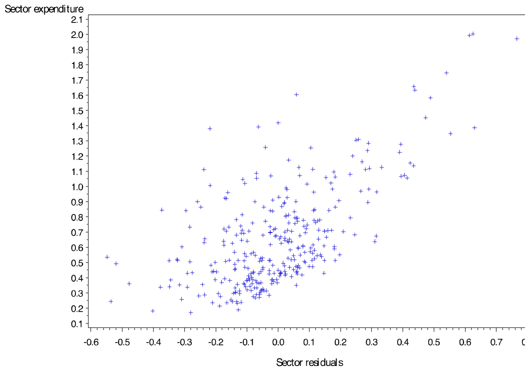
2002 Residual plot for sector 10: municipal roads



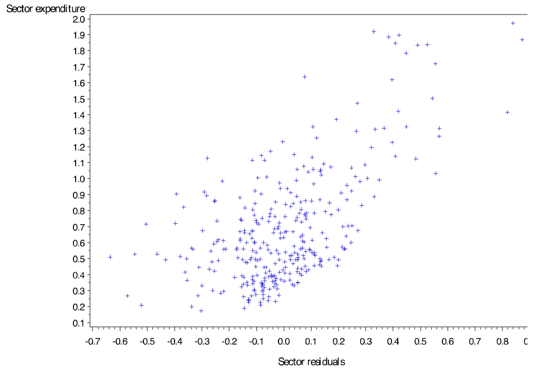
2003 Residual plot for sector 10: municipal roads



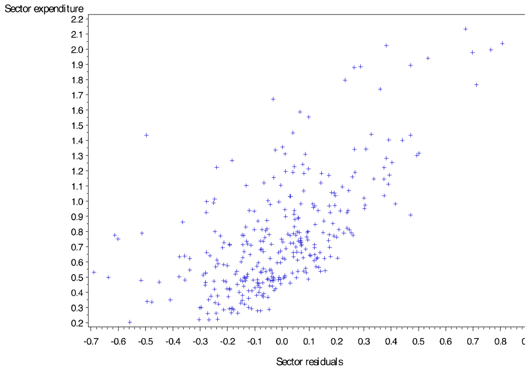
2004 Residual plot for sector 10: municipal roads



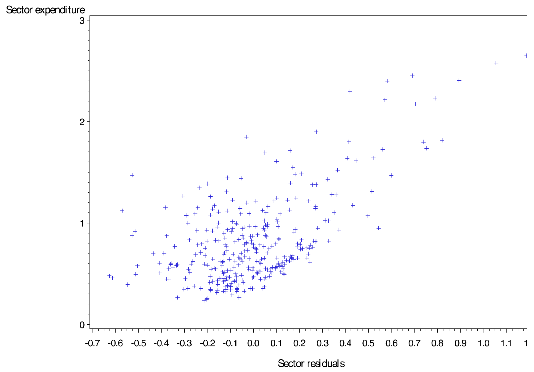
2005 Residual plot for sector 10: municipal roads



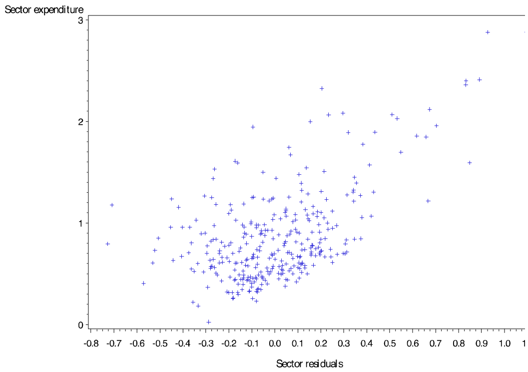
2006 Residual plot for sector 10: municipal roads



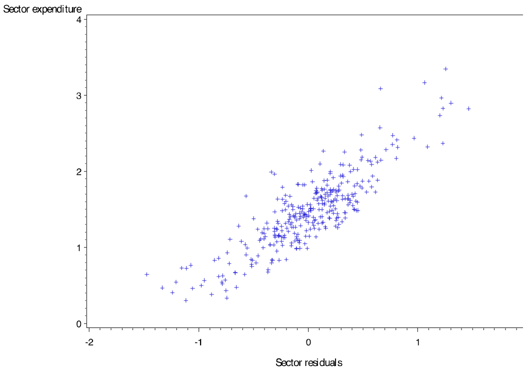
2007 Residual plot for sector 10: municipal roads



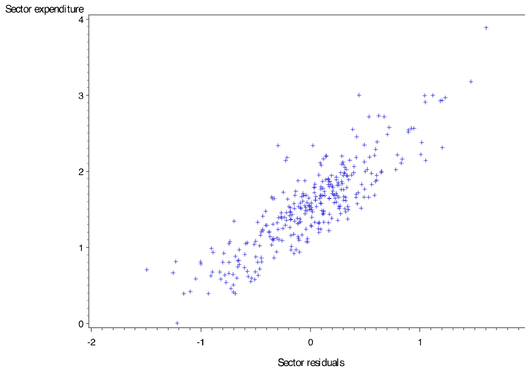
2008 Residual plot for sector 10: municipal roads



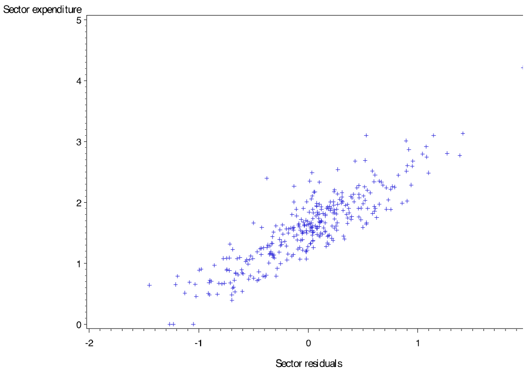
2001 Residual plot for sector 11: water supply and sanitatio



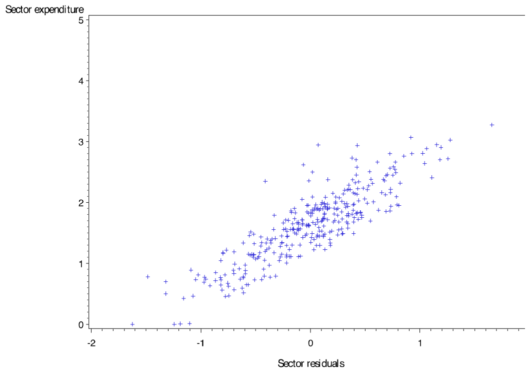
2002 Residual plot for sector 11: water supply and sanitatio



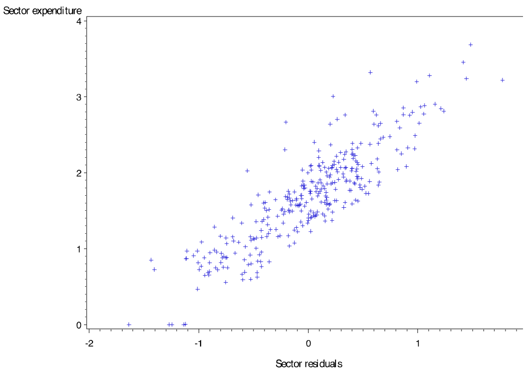
2003 Residual plot for sector 11: water supply and sanitatio



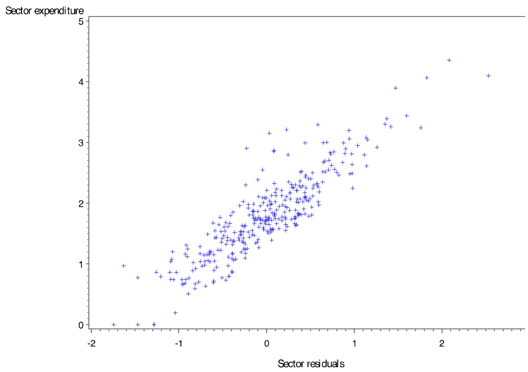
2004 Residual plot for sector 11: water supply and sanitatio



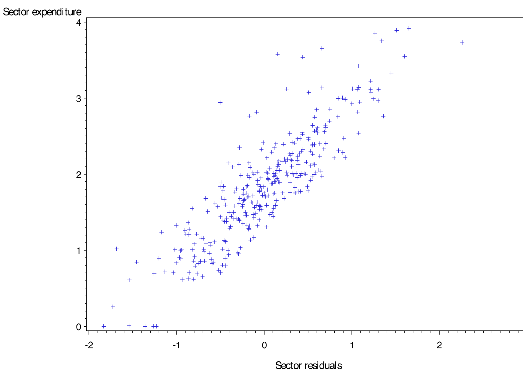
2005 Residual plot for sector 11: water supply and sanitatio



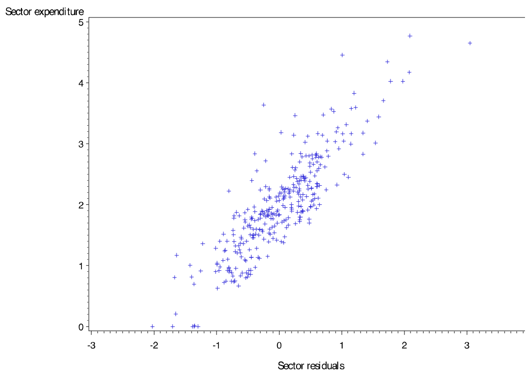
2006 Residual plot for sector 11: water supply and sanitatio



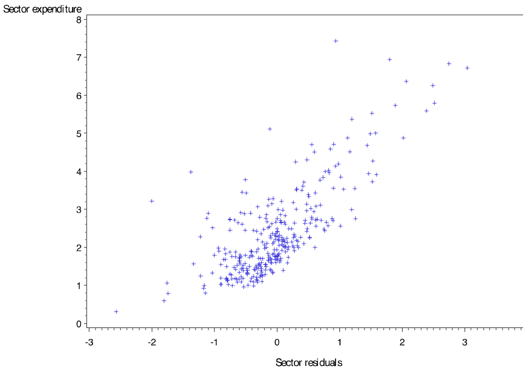
2007 Residual plot for sector 11: water supply and sanitatio



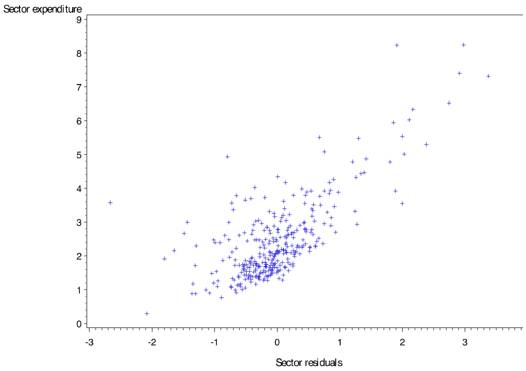
2008 Residual plot for sector 11: water supply and sanitatio



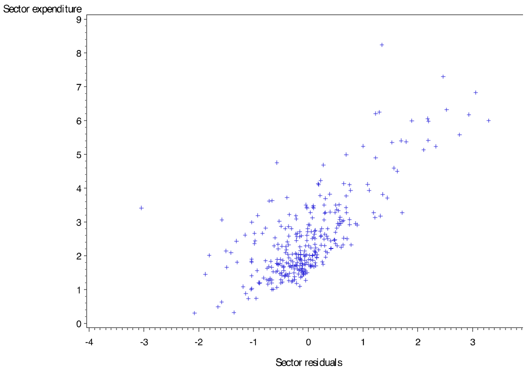
2001 Residual plot for sector 12: other infrastructure



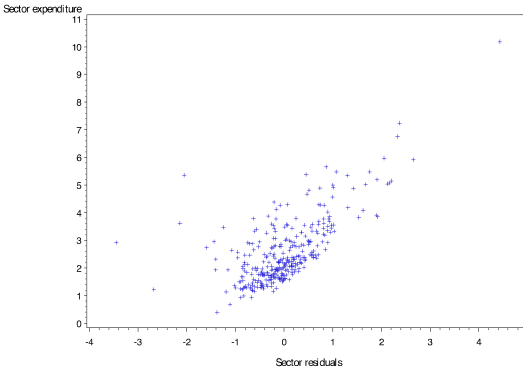
2002 Residual plot for sector 12: other infrastructure



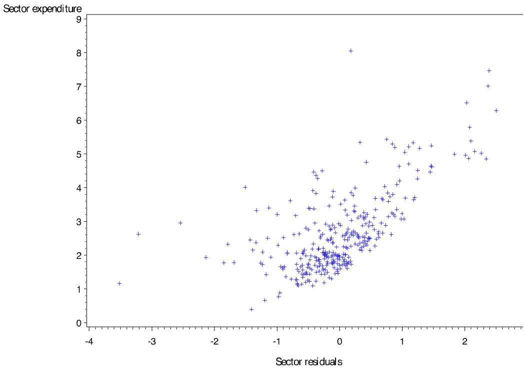
2003 Residual plot for sector 12: other infrastructure



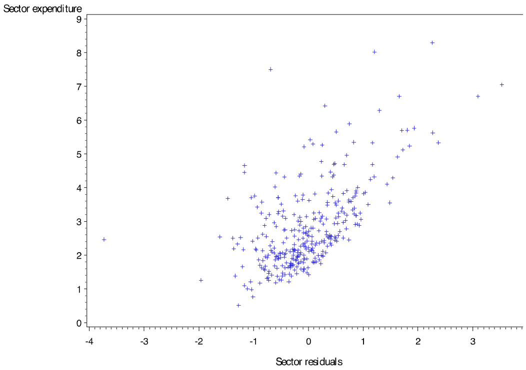
2004 Residual plot for sector 12: other infrastructure



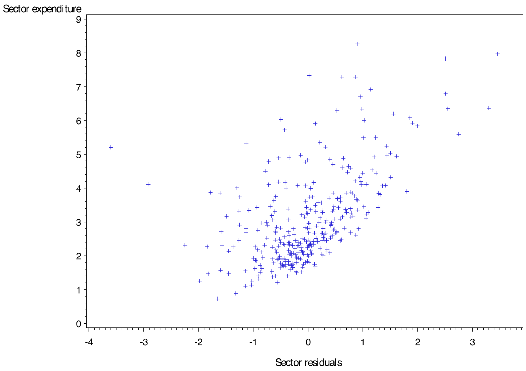
2005 Residual plot for sector 12: other infrastructure



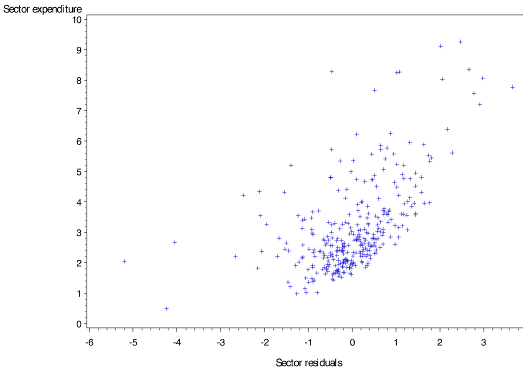
2006 Residual plot for sector 12: other infrastructure



2007 Residual plot for sector 12: other infrastructure



2008 Residual plot for sector 12: other infrastructure



Appendix D Finding significant fixed effects in Model 4

Table D. 1. Municipality dummy numbers

Dummy number	Name	Municipality #
1	Halden	0101
2	Fredrikstad	0106
3	Aremark	0118
4	Marker	0119
5	Trøgstad	0122
6	Spydeberg	0123
7	Askim	0124
8	Eidsberg	0125
9	Skiptvet	0127
10	Rakkestad	0128
11	Råde	0135
12	Rygge	0136
13	Våler	0137
14	Hobøl	0138
15	Vestby	0211
16	Ski	0213
17	Ås	0214
18	Frogn	0215
19	Nesodden	0216
20	Oppegård	0217
21	Bærum	0219
22	Asker	0220
23	Aurskog-Høland	0221
24	Sørum	0226
25	Fet	0227
26	Rælingen	0228
27	Enebakk	0229
28	Lørenskog	0230
29	Skedsmo	0231
30	Nittedal	0233
31	Gjerdrum	0234
32	Ullensaker	0235
33	Nes	0236
34	Eidsvoll	0237
35	Nannestad	0238
36	Hurdal	0239
37	Hamar	0403
38	Ringsaker	0412
39	Løten	0415
40	Stange	0417
41	Nord-Odal	0418
42	Sør-Odal	0419
43	Eidskog	0420
44	Grue	0423
45	Åsnes	0425
46	Våler	0426
47	Elverum	0427
48	Trysil	0428
49	Åmot	0429
50	Stor-Elvdal	0430
51	Rendalen	0432
52	Tolga	0436
53	Tynset	0437
54	Alvdal	0438
55	Folldal	0439
56	Gjøvik	0502
57	Skjåk	0513
58	Nord-Fron	0516
59	Sel	0517
60	Sør-Fron	0519
61	Gausdal	0522
62	Østre Toten	0528
63	Vestre Toten	0529
64	Jevnaker	0532
65	Lunner	0533
66	Gran	0534
67	Søndre Land	0536
68	Nordre Land	0538
69	Sør-Aurdal	0540
70	Etnedal	0541
71	Nord-Aurdal	0542
72	Vestre Slidre	0543
73	Drammen	0602
74	Kongsberg	0604
75	Ringerike	0605
76	Hole	0612
77	Flå	0615
78	Nes	0616
79	Gol	0617
80	Hemsedal	0618
81	Hol	0620
82	Sigdal	0621
83	Krødsherad	0622
84	Modum	0623
85	Øvre Eiker	0624
86	Nedre Eiker	0625
87	Lier	0626
88	Røyken	0627
89	Hurum	0628
90	Flesberg	0631
91	Nore og Uvdal	0633
92	Borre	0701
93	Holmestrand	0702
94	Tønsberg	0704
95	Sandefjord	0706
96	Larvik	0709
97	Svelvik	0711
98	Sande	0713
99	Hof	0714
100	Re	0716
101	Ramnes	0718
102	Andebu	0719
103	Stokke	0720
104	Nøtterøy	0722
105	Tjøme	0723
106	Lardal	0728
107	Porsgrunn	0805
108	Skien	0806
109	Notodden	0807
110	Siljan	0811
111	Bamble	0814
112	Kragerø	0815
113	Drangedal	0817
114	Nome	0819
115	Sauherad	0822
116	Tinn	0826
117	Hjartdal	0827
118	Seljord	0828
119	Kviteseid	0829
120	Tokke	0833
121	Risør	0901
122	Grimstad	0904

123	Arendal	0906
124	Gjerstad	0911
125	Vegårdshei	0912
126	Tvedestrand	0914
127	Froland	0919
128	Lillesand	0926
129	Åmli	0929
130	Evje og Hornnes	0937
131	Valle	0940
132	Kristiansand	1001
133	Mandal	1002
134	Farsund	1003
135	Flekkefjord	1004
136	Vennesla	1014
137	Songdalen	1017
138	Søgne	1018
139	Lyngdal	1032
140	Hægebostad	1034
141	Kvinesdal	1037
142	Eigersund	1101
143	Sandnes	1102
144	Stavanger	1103
145	Haugesund	1106
146	Sokndal	1111
147	Lund	1112
148	Bjerkreim	1114
149	Hå	1119
150	Klepp	1120
151	Time	1121
152	Gjesdal	1122
153	Sola	1124
154	Randaberg	1127
155	Strand	1130
156	Suldal	1134
157	Sauda	1135
158	Finnøy	1141
159	Rennesøy	1142
160	Kvitsøy	1144
161	Bokn	1145
162	Tysvær	1146
163	Karmøy	1149
164	Vindafjord	1154
165	Ølen	1159
166	Vindafjord	1160
167	Bergen	1201
168	Etne	1211
169	Ølen	1214
170	Sveio	1216
171	Stord	1221
172	Fitjar	1222
173	Tysnes	1223
174	Odda	1228
175	Ullensvang	1231
176	Granvin	1234
177	Voss	1235
178	Kvam	1238
179	Fusa	1241
180	Austevoll	1244
181	Sund	1245
182	Fjell	1246
183	Askøy	1247
184	Vaksdal	1251
185	Osterøy	1253
186	Radøy	1260
187	Lindås	1263
188	Austrheim	1264
189	Masfjorden	1266
190	Flora	1401
191	Hyllestad	1413
192	Høyanger	1416
193	Sogndal	1420
194	Lærdal	1422
195	Luster	1426
196	Askvoll	1428
197	Fjaler	1429
198	Gaular	1430
199	Førde	1432
200	Vågsøy	1439
201	Selje	1441
202	Eid	1443
203	Hornindal	1444
204	Gloppen	1445
205	Stryn	1449
206	Molde	1502
207	Ålesund	1504
208	Kristiansund	1505
209	Vanylven	1511
210	Sande	1514
211	Herøy	1515
212	Ulstein	1516
213	Hareid	1517
214	Volda	1519
215	Ørsta	1520
216	Ørskog	1523
217	Stranda	1525
218	Stordal	1526
219	Sykkylven	1528
220	Skodje	1529
221	Sula	1531
222	Giske	1532
223	Rauma	1539
224	Nesset	1543
225	Midsund	1545
226	Fræna	1548
227	Eide	1551
228	Frei	1556
229	Gjemnes	1557
230	Tingvoll	1560
231	Sunndal	1563
232	Surnadal	1566
233	Rindal	1567
234	Halsa	1571
235	Tustna	1572
236	Aure	1576
237	Trondheim	1601
238	Hemne	1612
239	Snillfjord	1613
240	Frøya	1620
241	Ørland	1621
242	Agdenes	1622
243	Rissa	1624
244	Bjugn	1627
245	Åfjord	1630
246	Roan	1632
247	Osen	1633
248	Oppdal	1634
249	Rennebu	1635
250	Meldal	1636
251	Orkdal	1638
252	Røros	1640
253	Holtålen	1644
254	Midtre Gauldal	1648
255	Melhus	1653
256	Skaun	1657
257	Klæbu	1662
258	Malvik	1663

259	Steinkjer	1702
260	Namsos	1703
261	Meråker	1711
262	Stjørdal	1714
263	Frosta	1717
264	Leksvik	1718
265	Levanger	1719
266	Mosvik	1723
267	Verran	1724
268	Mandalseid	1725
269	Inderøy	1729
270	Snåsa	1736
271	Lierne	1738
272	Grong	1742
273	Høylandet	1743
274	Overhalla	1744
275	Fosnes	1748
276	Vikna	1750
277	Nærøy	1751
278	Bodø	1804
279	Sømna	1812
280	Brønnøy	1813
281	Vega	1815
282	Vevelstad	1816
283	Herøy	1818
284	Alstahaug	1820
285	Vefsn	1824
286	Grane	1825
287	Meløy	1837
288	Gildeskål	1838
289	Beiarn	1839
290	Fauske	1841
291	Sørfold	1845
292	Steigen	1848
293	Hamarøy	1849
294	Tysfjord	1850
295	Lødingen	1851
296	Tjeldsund	1852
297	Ballangen	1854
298	Vestvågøy	1860
299	Vågan	1865
300	Hadsel	1866
301	Bø	1867
302	Øksnes	1868
303	Sortland	1870
304	Andøy	1871
305	Moskenes	1874
306	Harstad	1901
307	Tromsø	1902
308	Skånland	1913
309	Bjarkøy	1915
310	Ibestad	1917
311	Bardu	1922
312	Målselv	1924
313	Sørreisa	1925
314	Dyrøy	1926
315	Tranøy	1927
316	Torsken	1928
317	Lenvik	1931
318	Balsfjord	1933
319	Karlsøy	1936
320	Lyngen	1938
321	Kåfjord	1940
322	Skjervøy	1941
323	Nordreisa	1942
324	Vardø	2002
325	Hammerfest	2004
326	Kautokeino	2011
327	Alta	2012
328	Måsøy	2018
329	Nordkapp	2019
330	Porsanger	2020
331	Lebesby	2022
332	Gamvik	2023
333	Berlevåg	2024
334	Tana	2025
335	Båtsfjord	2028
336	Sør-Varanger	2030

Table D.2. Step 1.1:finding the significant fixed effects by iteratively testing each municipality in all 12 sectors simultaneously . Significance criteria: 50% of median adjusted sector expenditure

Parameter	Estimate
theta1_103	2.404057
theta1_129	-2.66378
theta1_131	2.290095
theta1_149	-3.2466
theta1_160	-3.93952
theta1_161	-3.55073
theta1_176	-2.19223
theta1_180	2.270809
theta1_192	3.127054
theta1_195	-2.41826
theta1_236	3.447772
theta1_247	-2.31918
theta1_248	-2.39635
theta1_253	2.215618
theta1_291	2.414206
theta1_292	4.084143
theta1_293	2.966558
theta1_294	2.949771
theta1_295	2.703473
theta1_296	2.968162
theta1_309	3.628285
theta1_315	3.794161
theta1_316	7.930382
theta1_319	3.212174
theta1_321	4.829273
theta1_326	2.547324
theta1_331	4.548194
theta1_332	3.259316
theta1_38	-2.58827
theta1_43	3.171417
theta1_5	-2.82006
theta1_57	-3.04013
theta1_81	-4.94442
theta1_82	-3.62313
theta1_9	-3.44967
theta2_316	6.342183
theta3_112	0.698214
theta3_130	-0.86624
theta3_131	1.013903
theta3_149	-0.65107
theta3_162	0.645201
theta3_193	-0.69541
theta3_204	1.252457
theta3_212	0.738463
theta3_213	0.720791
theta3_216	0.722032
theta3_225	0.970766
theta3_227	0.985286
theta3_261	0.694881
theta3_280	0.756862
theta3_282	-0.71083
theta3_292	0.678692
theta3_309	0.772991
theta3_310	1.156009
theta3_316	1.221829
theta3_327	0.736867
theta3_334	0.661489
theta3_58	-0.68513
theta3_77	-0.83687
theta3_81	-0.94337
theta3_82	-0.75033
theta3_83	-0.62043
theta3_91	-1.39847

Parameter	Estimate
theta4_21	-2.07514
theta4_316	3.915541
theta4_321	2.395222
theta4_326	2.080152
theta4_329	1.957284
theta4_332	1.746173
theta4_77	-2.52762
theta4_81	-2.32969
theta5_106	-1.05959
theta5_110	-1.21387
theta5_137	-1.18654
theta5_156	-2.07
theta5_160	-2.01137
theta5_161	-1.627
theta5_186	1.424814
theta5_188	1.293389
theta5_192	1.097574
theta5_194	1.546095
theta5_198	1.531417
theta5_204	1.085437
theta5_225	1.636792
theta5_236	1.540516
theta5_247	-1.05927
theta5_248	-1.28538
theta5_272	1.615199
theta5_273	1.126029
theta5_292	1.289591
theta5_294	1.54802
theta5_295	1.194185
theta5_298	1.458837
theta5_316	1.130055
theta5_320	1.388373
theta5_326	2.982329
theta5_327	1.264381
theta5_329	1.595299
theta5_330	1.113504
theta5_334	1.739266
theta5_335	1.206732
theta5_38	-1.66219
theta5_43	2.192481
theta5_49	-1.26666
theta5_52	1.462753
theta5_70	-1.47176
theta5_77	-1.58851
theta5_81	-1.70193
theta5_83	-1.80093
theta5_9	-2.14543
theta5_91	-1.55885
theta6_100	0.763381
theta6_124	1.180949
theta6_16	0.77392
theta6_167	1.126614
theta6_17	-0.93898
theta6_171	0.783714
theta6_199	0.762514
theta6_247	1.111636
theta6_284	1.171212
theta6_290	0.95498
theta6_317	-1.20385
theta6_324	0.93081
theta6_328	-1.07171
theta6_331	0.765217
theta6_43	0.977553

Parameter	Estimate
theta6_44	1.151028
theta6_45	0.846589
theta6_50	1.179623
theta6_52	1.269983
theta6_58	-0.82491
theta6_80	-0.78239
theta6_81	-1.21995
theta6_84	-0.74826
theta7_11	0.562993
theta7_129	0.619829
theta7_130	-0.56771
theta7_131	-0.56336
theta7_140	-0.71193
theta7_158	1.003216
theta7_160	-0.81661
theta7_174	0.67088
theta7_176	-0.65609
theta7_185	0.67363
theta7_187	0.671623
theta7_198	0.758549
theta7_218	-0.73307
theta7_229	0.683547
theta7_239	0.931053
theta7_250	0.587988
theta7_261	-0.65074
theta7_263	0.692625
theta7_281	0.817853
theta7_282	-0.62124
theta7_283	1.184047
theta7_286	-0.63074
theta7_316	1.061718
theta7_323	0.693972
theta7_331	0.587057
theta7_55	-0.56089
theta7_57	-0.7997
theta7_78	0.823883
theta7_91	1.032027
theta8_316	7.589541
theta8_331	8.089162
theta8_77	-8.28568
theta8_81	-7.59881
theta9_100	1.01388
theta9_110	-1.01464
theta9_118	0.923678
theta9_120	1.244113
theta9_124	-0.89083
theta9_131	1.914893
theta9_135	0.88411
theta9_137	-1.10925
theta9_141	1.26723
theta9_149	-1.20403
theta9_15	-1.01588
theta9_174	1.288746
theta9_176	-0.89274
theta9_192	1.78163
theta9_203	-1.35044
theta9_21	-1.09607
theta9_216	-1.24239
theta9_224	0.966738
theta9_229	1.01988
theta9_23	-1.01279
theta9_242	-1.03744

theta9_245	-1.19931
theta9_247	-1.45589
theta9_25	-0.89443
theta9_252	1.387739
theta9_260	1.049503
theta9_282	0.93606
theta9_286	-1.24486
theta9_29	-1.38128
theta9_293	1.18994
theta9_294	1.085808
theta9_295	1.282079
theta9_3	1.695476
theta9_30	-1.4425
theta9_316	2.293634
theta9_321	1.290059
theta9_322	1.520106
theta9_323	0.891887
theta9_326	1.738271
theta9_328	-1.08181
theta9_329	1.621966
theta9_331	1.972695
theta9_332	1.144739
theta9_336	2.082639
theta9_37	-0.94503
theta9_38	-1.58528
theta9_39	-1.31639
theta9_43	1.56987
theta9_61	-0.98052
theta9_64	-1.07913
theta9_65	-1.33154
theta9_70	-0.88242
theta9_72	-0.92107
theta9_77	-2.95127
theta9_79	-0.89704
theta9_81	-2.38197
theta9_83	-1.03935
theta9_89	-0.92963
theta9_9	-1.16864
theta10_116	-0.41599
theta10_131	0.693728
theta10_135	0.493697
theta10_148	-0.43757
theta10_149	-0.58219
theta10_159	0.46295
theta10_160	-0.57921
theta10_189	-0.88912
theta10_191	0.406919
theta10_215	0.44846
theta10_218	0.489732
theta10_225	0.388109
theta10_238	-0.51054
theta10_245	-0.57854
theta10_248	-0.48088
theta10_279	-0.42923
theta10_282	-0.69048
theta10_289	0.505231
theta10_291	0.877839
theta10_292	0.3897
theta10_301	0.640167
theta10_309	0.84836
theta10_310	0.715607
theta10_313	0.63757
theta10_315	0.865825
theta10_316	1.3887
theta10_317	0.525375
theta10_319	0.899104
theta10_320	0.395722
theta10_321	0.557889
theta10_322	0.59834
theta10_324	-0.4604
theta10_325	0.657532
theta10_331	1.121825
theta10_332	0.679638
theta10_333	-0.47974
theta10_38	-0.39369
theta10_49	-0.49275
theta10_50	-0.45041
theta10_51	-0.55062
theta10_55	-0.66427
theta10_57	-0.91424
theta10_61	-0.4643
theta10_64	-0.38908
theta10_65	-0.43242
theta10_77	-0.87967
theta10_81	-0.62981
theta10_83	-0.5096
theta10_9	-0.4905
theta10_91	-0.43558
theta11_105	1.570932
theta11_113	-1.13633
theta11_121	1.397151
theta11_126	1.746544
theta11_129	-1.32254
theta11_140	-2.03057
theta11_148	-1.13767
theta11_156	-2.48381
theta11_160	-2.60046
theta11_171	1.626438
theta11_182	-1.76152
theta11_189	-1.23077
theta11_203	-1.50873
theta11_217	2.244192
theta11_230	1.060146
theta11_233	-1.23731
theta11_236	1.068391
theta11_24	-1.2123
theta11_246	1.480379
theta11_259	1.351866
theta11_260	1.162224
theta11_262	-1.06232
theta11_266	-1.18993
theta11_272	1.128706
theta11_276	1.287011
theta11_286	-1.15916
theta11_287	-1.07203
theta11_289	-1.11993
theta11_291	-1.11112
theta11_294	1.497659
theta11_305	-1.22923
theta11_309	1.239804
theta11_312	1.150815
theta11_316	2.589788
theta11_318	-1.40946
theta11_319	1.241107
theta11_329	1.317011
theta11_331	1.362959
theta11_332	1.562619
theta11_334	1.413035
theta11_47	-1.47334
theta11_64	-1.0799
theta11_65	-1.19759
theta11_69	1.11716
theta11_71	1.160781
theta11_72	1.066333
theta11_80	2.266015
theta11_9	-1.40978
theta11_90	1.071149
theta12_103	1.806263
theta12_110	-2.1854
theta12_114	2.435614
theta12_117	-2.32232
theta12_12	1.697484
theta12_120	2.963367
theta12_131	1.638038
theta12_137	-1.89879
theta12_141	2.570161
theta12_144	-1.69412
theta12_149	-3.43906
theta12_15	-1.51954
theta12_153	-1.71347
theta12_174	2.348354
theta12_175	2.279476
theta12_176	-1.95005
theta12_179	-1.91504
theta12_184	2.399103
theta12_189	-2.09002
theta12_193	-1.62494
theta12_194	3.11192
theta12_216	-1.50363
theta12_227	-1.73945
theta12_236	2.334612
theta12_238	-2.20622
theta12_239	2.501142
theta12_245	-1.7439
theta12_260	1.844493
theta12_261	-2.24588
theta12_271	3.715081
theta12_272	1.912137
theta12_282	-2.9557
theta12_295	2.235561
theta12_296	1.837957
theta12_3	1.656567
theta12_301	1.547405
theta12_309	-3.06046
theta12_316	3.557688
theta12_320	1.818825
theta12_321	2.008455
theta12_322	2.652602
theta12_323	1.501828
theta12_326	2.471078
theta12_328	-1.63554
theta12_331	1.665773
theta12_333	-3.80595
theta12_335	-1.76931
theta12_38	-3.03992
theta12_39	-1.65795
theta12_4	-1.69906
theta12_40	-1.77555
theta12_43	1.908517
theta12_46	3.153131
theta12_5	-1.94082
theta12_56	-1.75913
theta12_57	-3.71838
theta12_62	-2.11997
theta12_64	-1.75334
theta12_65	-2.64933
theta12_78	2.634668
theta12_80	2.521675
theta12_81	-2.44852
theta12_83	-3.79524
theta12_9	-3.14685
theta12_99	-1.60724

Table D.3. Step 1.2 : inding the significant fixed effects by iteratively testing each municipality in each sector separately. Significance criteria: 50% of median adjusted sector expenditure

Parameter	Estimate
theta1_49	2.675429
theta1_77	2.447552
theta1_129	-2.61258
theta1_161	-2.80228
theta1_292	2.561889
theta1_293	2.174959
theta1_296	2.944082
theta1_315	3.031456
theta1_316	2.325234
theta1_321	2.178223
theta3_69	-0.72318
theta3_91	-0.89141
theta3_108	0.653298
theta3_112	0.790381
theta3_130	-0.86873
theta3_131	0.902343
theta3_162	0.619189
theta3_189	0.740446
theta3_193	-0.67446
theta3_204	1.084486
theta3_212	0.682027
theta3_213	0.7749
theta3_216	0.790045
theta3_225	0.679343
theta3_227	1.12961
theta3_261	0.769137
theta3_280	0.682911
theta3_282	-0.62712
theta3_310	1.106615
theta3_326	-1.13103
theta5_52	1.18638
theta5_70	-1.11806
theta5_79	1.313334
theta5_117	1.279862
theta5_119	1.308152
theta5_141	-1.28824
theta5_156	-1.52663
theta5_161	-1.18956
theta5_173	1.229448
theta5_186	1.291621
theta5_188	1.152739
theta5_189	1.397765
theta5_194	1.116138
theta5_198	1.145146
theta5_272	1.067865
theta5_282	1.185119
theta5_291	-1.3611
theta5_296	-1.3892
theta5_316	-1.90145
theta5_326	1.717065
theta5_328	1.221282
theta5_333	1.438533
theta5_335	1.484908
theta6_16	0.76074
theta6_17	-0.91809
theta6_44	1.00963
theta6_45	0.759663
theta6_50	1.189923

Parameter	Estimate
theta6_52	1.084153
theta6_80	-0.77019
theta6_81	-0.89684
theta6_84	-0.72857
theta6_89	0.788844
theta6_124	1.297489
theta6_167	0.949125
theta6_190	-0.76672
theta6_247	1.318633
theta6_284	1.184726
theta6_290	0.875752
theta6_317	-1.18945
theta6_324	0.803027
theta6_328	-0.94841
theta7_5	0.574164
theta7_55	-0.56491
theta7_57	-0.59888
theta7_78	0.781906
theta7_81	0.664595
theta7_83	0.654688
theta7_91	1.22706
theta7_129	0.672908
theta7_130	-0.65441
theta7_131	-0.65921
theta7_140	-0.67016
theta7_158	0.917371
theta7_160	-0.71154
theta7_176	-0.58503
theta7_185	0.648741
theta7_187	0.602232
theta7_189	0.568557
theta7_198	0.615895
theta7_217	-0.58095
theta7_218	-0.71089
theta7_229	0.607823
theta7_239	0.840565
theta7_250	0.635286
theta7_260	-0.5905
theta7_263	0.745341
theta7_271	-0.592
theta7_281	0.745883
theta7_283	1.203853
theta7_286	-0.57212
theta7_296	-0.70757
theta7_329	-0.61393
theta9_3	1.305605
theta9_54	0.912712
theta9_57	1.050132
theta9_77	-1.10134
theta9_80	-0.89288
theta9_84	1.050792
theta9_131	1.384572
theta9_147	0.903929
theta9_161	1.060093
theta9_194	-1.12884
theta9_225	-0.98143
theta9_247	-1.17927
theta9_252	1.557777
theta9_261	1.101456
theta9_267	-1.04635
theta9_282	1.863152

theta9_305	-0.9662
theta9_319	-0.97212
theta9_330	-1.01706
theta9_336	1.306519

theta10_48	0.430449
theta10_51	-0.51072
theta10_55	-0.48696
theta10_57	-0.5422
theta10_129	0.48258
theta10_131	0.49746
theta10_159	0.503876
theta10_173	0.47712
theta10_176	0.526341
theta10_189	-0.61743
theta10_193	0.516093
theta10_218	0.549219
theta10_253	-0.41456
theta10_282	-0.64367
theta10_285	0.398382
theta10_288	-0.40124
theta10_291	0.617929
theta10_300	-0.45889
theta10_301	0.467864
theta10_309	0.51387
theta10_310	0.614615
theta10_313	0.490303
theta10_314	0.396658
theta10_315	0.628729
theta10_317	0.513632
theta10_319	0.563562
theta10_324	-0.52513
theta10_325	0.744901
theta10_326	-0.75253
theta10_331	0.611699

theta11_24	-1.19743
theta11_47	-1.38467
theta11_55	1.076062
theta11_72	1.224848
theta11_75	-1.25027
theta11_80	2.443337
theta11_105	1.588572
theta11_121	1.28425
theta11_126	1.745308
theta11_129	-1.19009
theta11_140	-2.0513
theta11_156	-2.10452
theta11_160	-1.96153
theta11_171	1.360916
theta11_182	-1.38481
theta11_203	-1.07476
theta11_217	2.131248
theta11_246	1.655787
theta11_259	1.058892
theta11_262	-1.11148
theta11_276	1.43714
theta11_277	1.068457
theta11_287	-1.11591
theta11_288	-1.22303
theta11_289	-1.33623
theta11_290	-1.22585
theta11_291	-1.54209
theta11_293	-1.30073
theta11_305	-1.36397
theta11_309	1.133231
theta11_316	1.277997
theta11_318	-1.38101
theta11_322	-1.46219

theta12_46	2.64055
theta12_57	-2.01023
theta12_70	1.921818
theta12_77	2.569448
theta12_78	2.433505
theta12_79	1.808474
theta12_80	3.095128
theta12_83	-2.11764
theta12_91	2.715081
theta12_114	1.613251
theta12_117	-2.04918
theta12_120	1.56106
theta12_144	-1.93198
theta12_156	1.485173
theta12_157	2.050122
theta12_158	-1.49348
theta12_160	3.254111
theta12_175	1.634188
theta12_184	1.548583
theta12_194	2.734418
theta12_237	1.478127
theta12_239	2.892337
theta12_247	1.885476
theta12_261	-1.61098
theta12_271	2.919608
theta12_282	-3.01394
theta12_291	-1.49728
theta12_294	-1.86956
theta12_309	-4.7214
theta12_315	-1.65668
theta12_331	-1.4713
theta12_332	-1.47994
theta12_333	-3.13194
theta12_335	-1.65296
theta12_336	-1.80781

theta0_2	-1.08427
theta0_3	-1.85679
theta0_4	1.065492
theta0_5	1.448805
theta0_6	0.502213
theta0_7	0.620795
theta0_9	3.212049
theta0_10	-0.50797
theta0_11	-0.45135
theta0_12	-0.8952
theta0_13	0.565355
theta0_15	1.350448
theta0_18	-0.52221
theta0_19	0.473782
theta0_21	1.540622
theta0_23	1.517267
theta0_25	0.840511
theta0_26	1.082202
theta0_28	-0.45771
theta0_29	1.430644
theta0_30	1.744571
theta0_34	0.714256
theta0_37	1.570725
theta0_38	3.220085
theta0_39	1.992623
theta0_40	1.280709
theta0_42	0.952414
theta0_43	-2.5243
theta0_44	-0.51509
theta0_46	-0.90824

theta0_47	0.784008
theta0_48	0.561184
theta0_49	0.965651
theta0_52	-1.49464
theta0_54	-0.535
theta0_55	1.31035
theta0_56	1.071145
theta0_57	2.481737
theta0_58	1.009483
theta0_59	-0.46032
theta0_61	1.956757
theta0_62	1.768722
theta0_64	1.721936
theta0_65	2.530854
theta0_66	0.719493
theta0_67	0.723852
theta0_68	0.649073
theta0_69	-1.40252
theta0_70	1.195802
theta0_71	-0.97487
theta0_72	0.836836
theta0_73	-1.28805
theta0_76	1.605037
theta0_77	3.335019
theta0_78	-0.9109
theta0_80	-1.26168
theta0_81	3.170913
theta0_82	1.513362
theta0_83	2.665912
theta0_86	0.517231
theta0_89	1.029835
theta0_90	-0.98953
theta0_92	-0.89099
theta0_93	-1.21688
theta0_96	-0.65276
theta0_97	-1.00515
theta0_99	0.548412
theta0_100	-0.86821
theta0_103	-1.44984
theta0_106	0.788311
theta0_107	-0.4936
theta0_109	-0.7943
theta0_110	1.764727
theta0_114	-1.3054
theta0_117	1.039107
theta0_118	-1.37758
theta0_120	-1.65463
theta0_121	-0.49379
theta0_122	-0.57739
theta0_124	2.011116
theta0_125	1.127203
theta0_129	0.5623
theta0_131	-3.38981
theta0_135	-1.46442
theta0_137	1.79168
theta0_138	1.059496
theta0_139	0.761058
theta0_140	0.728076
theta0_141	-1.34219
theta0_144	0.560805
theta0_145	-1.13697
theta0_147	-0.7315
theta0_148	1.542388
theta0_149	2.592547
theta0_150	0.969751
theta0_152	1.003066
theta0_153	0.783099
theta0_154	1.118718
theta0_155	0.639283
theta0_156	1.036514
theta0_158	-0.85289
theta0_159	-1.49675
theta0_160	2.338303
theta0_161	0.893329
theta0_164	0.595244
theta0_168	0.887902
theta0_170	0.653876
theta0_171	-0.81488
theta0_174	-2.05132
theta0_175	-1.25682
theta0_176	1.847951
theta0_178	-0.95782
theta0_179	1.094608
theta0_180	-1.28312
theta0_182	1.298062
theta0_184	-0.77795
theta0_186	-0.62131
theta0_188	-0.63852
theta0_189	2.003406
theta0_190	-1.23224
theta0_191	-1.04553
theta0_192	-2.77074
theta0_193	1.215782
theta0_194	-0.98964
theta0_195	0.522417
theta0_196	-0.44554
theta0_198	-1.59018
theta0_199	-0.53516
theta0_203	1.892306
theta0_204	-0.94715
theta0_205	-0.46038
theta0_206	-0.61526
theta0_213	0.710306
theta0_215	-1.12145
theta0_216	1.814372
theta0_217	-1.15547
theta0_218	-1.25263
theta0_219	-0.66539
theta0_221	0.794129
theta0_224	-1.34555
theta0_225	-1.09943
theta0_227	1.843773
theta0_229	-0.87869
theta0_230	-0.63382
theta0_233	0.980511
theta0_234	-0.93491
theta0_236	-2.37316
theta0_238	1.624696
theta0_241	-0.85586
theta0_242	1.122105
theta0_245	2.063861
theta0_246	0.887386
theta0_247	2.273133
theta0_248	1.596903
theta0_249	1.15039
theta0_250	0.455395
theta0_251	1.471437
theta0_252	-1.81495
theta0_253	-1.32105
theta0_254	-1.02625
theta0_255	0.838881
theta0_259	-1.46131
theta0_260	-1.78362
theta0_261	0.670739
theta0_262	-0.65558
theta0_264	-0.89529
theta0_266	1.001853
theta0_269	0.454789

theta0_271	-2.06453
theta0_272	-1.13246
theta0_273	-0.47732
theta0_275	-0.87427
theta0_277	-0.7015
theta0_279	1.164979
theta0_281	0.827389
theta0_282	0.960478
theta0_286	1.156234
theta0_288	0.515526
theta0_289	-0.64542
theta0_290	-0.50994
theta0_292	-1.8741
theta0_293	-1.99079
theta0_294	-2.10157
theta0_295	-2.13101
theta0_296	-2.23417
theta0_300	0.952365
theta0_301	-1.4465
theta0_302	-0.93668
theta0_307	-0.65346
theta0_308	0.844743
theta0_309	-0.56257
theta0_311	-1.43473
theta0_312	-0.91633
theta0_313	-0.86962
theta0_314	0.770876
theta0_315	-0.99681
theta0_316	-4.65528
theta0_317	-0.88818
theta0_318	0.948898
theta0_319	-1.89237
theta0_320	-1.60093
theta0_321	-2.79152
theta0_322	-2.51557
theta0_323	-1.34995
theta0_324	1.127504
theta0_326	-3.57345
theta0_328	0.865011
theta0_329	-2.26257
theta0_330	-0.48776
theta0_331	-4.00124
theta0_332	-2.27405
theta0_333	1.167172
theta0_334	-0.65499
theta0_335	0.603645
theta0_336	-2.49253

Table D.4. Step 1.3 : finding the significant fixed effects by iteratively testing each municipality in each sector separately. Significance criteria: Significance criteria : t-value >=1.5

Parameter	Estimate	t-value
theta0_124	2.011	2.99
theta0_137	1.792	2.88
theta0_149	2.593	1.61
theta0_15	1.350	1.92
theta0_156	1.037	2.18
theta0_160	2.338	2.97
theta0_161	0.893	1.70
theta0_176	1.848	2.45
theta0_189	2.003	5.00
theta0_203	1.892	1.74
theta0_21	1.541	1.85
theta0_216	1.814	2.57
theta0_227	1.844	3.52
theta0_245	2.064	1.89
theta0_247	2.273	3.29
theta0_266	1.002	1.52
theta0_333	1.167	1.71
theta0_38	3.220	2.45
theta0_39	1.993	1.82
theta0_49	0.966	1.84
theta0_55	1.310	2.44
theta0_57	2.482	1.68
theta0_61	1.957	3.16
theta0_65	2.531	3.15
theta0_70	1.196	1.88
theta0_77	3.335	5.18
theta0_81	3.171	7.67
theta0_82	1.513	2.28
theta0_83	2.666	2.38
theta0_9	3.212	2.76
theta1_11	0.858	1.74
theta1_124	0.701	1.55
theta1_131	0.630	2.04
theta1_140	1.113	3.22
theta1_158	1.554	2.38
theta1_170	0.465	1.50
theta1_22	1.425	2.89
theta1_234	0.894	1.75
theta1_242	1.071	1.72
theta1_246	1.382	3.11
theta1_253	1.933	4.95
theta1_277	0.756	1.50
theta1_286	1.401	1.98
theta1_288	0.907	2.42
theta1_289	0.630	1.55
theta1_290	1.386	1.52
theta1_291	1.174	3.04
theta1_292	2.562	4.68
theta1_293	2.175	4.45
theta1_294	1.591	4.72
theta1_296	2.944	7.83
theta1_297	1.914	5.15
theta1_300	1.129	2.79
theta1_305	1.707	3.22
theta1_309	2.128	4.24
theta1_315	3.031	5.64
theta1_321	2.178	3.85
theta1_331	1.496	2.68
theta1_332	0.824	2.76
theta1_333	1.593	4.56
theta1_47	0.873	1.64
theta1_49	2.675	5.30

Parameter	Estimate	t-value
theta1_60	1.095	2.45
theta1_77	2.448	8.16
theta1_80	0.947	1.68
theta1_90	1.452	3.06
theta1_91	1.207	2.55
theta2_110	1.330	2.32
theta2_120	1.817	4.26
theta2_124	0.925	2.78
theta2_129	1.189	3.93
theta2_138	0.645	1.54
theta2_141	1.118	2.95
theta2_160	2.108	4.93
theta2_161	1.031	1.55
theta2_176	1.401	2.98
theta2_197	1.157	2.19
theta2_198	0.824	2.17
theta2_200	1.479	4.90
theta2_229	1.126	3.39
theta2_239	1.354	2.80
theta2_246	0.956	3.48
theta2_247	1.595	4.93
theta2_266	0.839	2.31
theta2_270	1.033	2.05
theta2_275	1.023	1.84
theta2_281	0.714	1.82
theta2_288	1.254	3.07
theta2_291	2.713	5.77
theta2_308	1.635	1.74
theta2_311	1.951	5.04
theta2_321	2.870	4.03
theta2_326	2.494	4.38
theta2_330	2.893	5.91
theta2_334	1.252	2.82
theta2_43	1.138	1.58
theta2_54	0.895	2.37
theta2_55	1.247	3.48
theta2_58	1.240	1.59
theta2_72	1.154	2.68
theta2_88	2.014	5.38
theta2_90	0.656	1.71
theta3_108	0.653	1.57
theta3_112	0.790	1.62
theta3_121	0.588	1.82
theta3_131	0.902	4.93
theta3_156	0.402	1.51
theta3_162	0.619	2.05
theta3_189	0.740	3.77
theta3_19	0.459	3.93
theta3_191	0.507	1.82
theta3_204	1.084	7.38
theta3_212	0.682	3.32
theta3_213	0.775	5.26
theta3_216	0.790	2.39
theta3_225	0.679	3.67
theta3_227	1.130	5.10
theta3_229	0.320	2.78
theta3_23	0.523	2.43
theta3_230	0.446	4.76
theta3_238	0.556	2.86
theta3_24	0.336	1.83
theta3_261	0.769	2.93
theta3_269	0.489	3.35
theta3_279	0.346	1.56

theta3_280	0.683	2.30
theta3_283	0.609	2.74
theta3_285	0.407	3.16
theta3_292	0.402	2.35
theta3_293	0.277	2.15
theta3_295	0.252	2.38
theta3_309	0.463	4.99
theta3_310	1.107	10.71
theta3_328	0.477	2.12
theta3_334	0.354	1.64
theta3_52	0.335	1.50
theta3_67	0.206	2.99
theta3_72	0.396	7.80
theta3_96	0.588	1.69
theta4_116	1.214	2.90
theta4_136	1.054	3.78
theta4_14	0.340	1.76
theta4_145	0.752	2.75
theta4_151	0.413	1.54
theta4_153	1.028	4.19
theta4_155	0.804	3.59
theta4_159	0.756	3.61
theta4_160	1.178	4.25
theta4_162	0.922	3.09
theta4_181	0.536	1.56
theta4_182	1.243	6.43
theta4_183	0.822	4.49
theta4_191	0.866	1.50
theta4_212	0.900	7.61
theta4_221	0.797	2.71
theta4_222	0.314	1.62
theta4_225	0.958	1.87
theta4_227	0.504	1.88
theta4_229	0.992	3.37
theta4_247	1.205	2.64
theta4_248	0.719	1.70
theta4_262	0.572	1.66
theta4_264	0.857	2.59
theta4_276	0.887	3.96
theta4_296	0.789	2.31
theta4_30	0.644	2.81
theta4_317	0.823	2.12
theta4_32	0.346	2.26
theta4_321	1.407	3.70
theta4_326	0.933	2.04
theta4_329	1.472	2.20
theta4_33	0.394	1.56
theta4_332	1.066	3.39
theta4_335	0.895	1.77
theta4_42	0.687	1.56
theta4_6	0.379	1.90
theta5_116	0.992	3.03
theta5_117	1.280	6.11
theta5_118	0.654	1.55
theta5_119	1.308	2.99
theta5_13	0.803	2.16
theta5_173	1.229	2.12
theta5_186	1.292	2.15
theta5_188	1.153	3.71
theta5_189	1.398	7.78
theta5_194	1.116	2.39
theta5_198	1.145	4.61
theta5_216	0.414	1.60
theta5_217	0.659	2.60
theta5_218	0.674	1.82
theta5_225	0.626	1.66

theta5_240	0.513	2.00
theta5_25	0.505	1.54
theta5_261	0.409	1.51
theta5_264	0.699	1.73
theta5_268	0.670	3.29
theta5_270	0.489	2.29
theta5_272	1.068	1.90
theta5_273	0.976	2.96
theta5_279	0.566	2.48
theta5_281	0.483	3.10
theta5_282	1.185	6.46
theta5_292	0.431	1.65
theta5_293	0.301	1.94
theta5_294	0.708	3.80
theta5_298	1.023	4.19
theta5_299	0.340	2.11
theta5_317	0.662	1.60
theta5_318	1.011	2.20
theta5_320	0.809	2.96
theta5_326	1.717	9.78
theta5_327	0.555	2.46
theta5_328	1.221	7.24
theta5_333	1.439	5.59
theta5_334	0.944	1.89
theta5_335	1.485	5.84
theta5_43	0.655	3.22
theta5_50	0.824	3.18
theta5_52	1.186	1.86
theta5_71	0.605	3.05
theta5_79	1.313	3.78
theta6_100	0.656	2.33
theta6_104	0.294	1.70
theta6_108	0.421	2.28
theta6_124	1.297	6.14
theta6_126	0.388	2.22
theta6_131	0.554	2.86
theta6_16	0.761	3.57
theta6_167	0.949	1.72
theta6_171	0.651	2.01
theta6_176	0.408	1.57
theta6_199	0.690	3.48
theta6_2	0.625	2.42
theta6_225	0.330	2.24
theta6_230	0.466	1.82
theta6_247	1.319	3.48
theta6_278	0.363	1.81
theta6_284	1.185	4.50
theta6_287	0.509	1.69
theta6_290	0.876	2.44
theta6_291	0.283	1.55
theta6_294	0.586	2.99
theta6_324	0.803	5.69
theta6_329	0.398	2.23
theta6_331	0.487	1.96
theta6_333	0.408	2.45
theta6_37	0.619	1.97
theta6_43	0.708	3.35
theta6_44	1.010	6.10
theta6_45	0.760	3.12
theta6_49	0.533	2.01
theta6_50	1.190	3.65
theta6_52	1.084	4.34
theta6_55	0.372	4.07
theta6_59	0.576	1.55
theta6_70	0.326	2.03
theta6_89	0.789	6.35
theta6_96	0.546	1.78

theta7_10	0.471	2.58
theta7_115	0.395	2.47
theta7_119	0.377	2.20
theta7_129	0.673	8.09
theta7_137	0.478	1.80
theta7_14	0.448	2.05
theta7_142	0.545	2.34
theta7_15	0.450	1.97
theta7_158	0.917	3.82
theta7_174	0.554	4.52
theta7_185	0.649	1.93
theta7_186	0.221	1.60
theta7_187	0.602	2.65
theta7_189	0.569	3.20
theta7_191	0.445	2.91
theta7_198	0.616	3.16
theta7_229	0.608	7.54
theta7_239	0.841	9.12
theta7_243	0.469	1.77
theta7_250	0.635	4.31
theta7_263	0.745	3.48
theta7_266	0.460	2.78
theta7_27	0.347	1.77
theta7_281	0.746	3.68
theta7_283	1.204	12.40
theta7_309	0.399	3.51
theta7_323	0.552	2.51
theta7_324	0.185	1.60
theta7_331	0.365	1.97
theta7_335	0.223	1.74
theta7_5	0.574	2.90
theta7_59	0.215	2.46
theta7_70	0.285	2.10
theta7_78	0.782	6.24
theta7_81	0.665	3.54
theta7_83	0.655	5.69
theta7_91	1.227	10.87
theta7_93	0.467	2.02
theta8_125	4.655	3.40
theta8_140	1.766	2.24
theta8_141	3.806	3.21
theta8_180	1.910	1.57
theta8_184	3.637	5.55
theta8_191	2.215	1.94
theta8_192	1.552	2.85
theta8_203	3.100	3.27
theta8_210	4.546	7.29
theta8_225	2.203	2.11
theta8_233	2.567	1.76
theta8_254	1.767	2.01
theta8_257	1.921	1.95
theta8_266	2.599	4.66
theta8_268	2.288	1.97
theta8_271	2.784	3.61
theta8_281	4.653	3.75
theta8_282	5.073	7.20
theta8_288	3.546	4.57
theta8_289	1.569	1.50
theta8_300	2.613	3.62
theta8_302	2.238	2.12
theta8_304	1.971	2.75
theta8_306	2.638	3.36
theta8_308	2.780	3.05
theta8_309	1.400	1.92
theta8_312	1.638	2.46
theta8_314	2.861	2.60
theta8_324	3.251	3.69
theta8_331	3.386	5.09
theta8_44	2.732	3.14
theta8_48	1.930	1.56
theta8_69	2.192	2.82
theta8_75	1.718	1.83
theta9_10	0.469	1.51
theta9_118	0.579	4.09
theta9_120	0.450	2.38
theta9_131	1.385	8.00
theta9_135	0.583	1.84
theta9_144	0.756	3.43
theta9_147	0.904	2.73
theta9_153	0.477	2.12
theta9_156	0.876	6.87
theta9_160	0.451	2.52
theta9_161	1.060	6.52
theta9_162	0.554	1.73
theta9_174	0.591	2.03
theta9_190	0.413	1.56
theta9_192	0.695	1.53
theta9_2	0.451	1.54
theta9_202	0.652	1.59
theta9_218	0.521	2.17
theta9_229	0.527	1.76
theta9_230	0.696	1.56
theta9_252	1.558	3.89
theta9_261	1.101	3.41
theta9_275	0.619	2.20
theta9_277	0.683	2.01
theta9_282	1.863	7.99
theta9_293	0.754	2.10
theta9_296	0.505	3.04
theta9_3	1.306	4.92
theta9_50	0.377	1.64
theta9_54	0.913	3.30
theta9_57	1.050	4.12
theta9_59	0.750	2.53
theta9_83	0.451	1.94
theta9_84	1.051	1.87
theta9_91	0.400	2.45
theta9_95	0.656	1.96
theta9_99	0.823	1.78
theta9_329	0.473	1.91
theta9_331	0.398	1.66
theta9_333	0.353	1.76
theta9_336	1.307	6.82
theta10_129	0.483	3.69
theta10_131	0.497	6.62
theta10_135	0.352	2.58
theta10_140	0.191	2.60
theta10_146	0.229	1.55
theta10_159	0.504	4.17
theta10_161	0.167	1.65
theta10_173	0.477	3.64
theta10_176	0.526	8.28
theta10_181	0.299	1.79
theta10_191	0.230	2.92
theta10_193	0.516	2.14
theta10_195	0.226	1.70
theta10_198	0.226	3.89
theta10_203	0.369	2.00
theta10_215	0.372	4.51
theta10_218	0.549	6.72
theta10_220	0.298	2.90
theta10_226	0.258	1.69

theta10_271	0.137	2.91
theta10_285	0.398	3.08
theta10_287	0.317	2.10
theta10_289	0.368	4.24
theta10_291	0.618	4.51
theta10_299	0.218	1.53
theta10_301	0.468	3.49
theta10_309	0.514	4.27
theta10_310	0.615	5.55
theta10_313	0.490	2.46
theta10_314	0.397	1.76
theta10_315	0.629	5.59
theta10_317	0.514	3.65
theta10_319	0.564	4.19
theta10_320	0.183	1.85
theta10_325	0.745	6.05
theta10_331	0.612	4.54
theta10_332	0.273	3.49
theta10_48	0.430	3.28
theta11_105	1.589	2.95
theta11_121	1.284	1.90
theta11_126	1.745	3.85
theta11_128	0.800	4.23
theta11_130	0.903	3.48
theta11_138	0.919	2.43
theta11_171	1.361	2.24
theta11_18	0.779	1.91
theta11_217	2.131	5.54
theta11_241	0.786	2.24
theta11_246	1.656	4.52
theta11_259	1.059	5.16
theta11_267	0.684	2.02
theta11_276	1.437	3.36
theta11_294	0.867	3.30
theta11_30	0.938	1.78
theta11_309	1.133	1.88
theta11_312	0.889	2.63
theta11_332	1.042	3.08
theta11_54	0.775	1.79
theta11_59	0.760	1.61
theta11_70	0.818	5.78
theta11_72	1.225	2.29
theta11_80	2.443	5.66
theta11_94	0.962	2.60
theta12_114	1.613	1.84
theta12_116	1.459	3.14
theta12_12	1.163	3.12
theta12_120	1.561	4.88
theta12_130	0.699	2.30
theta12_156	1.485	7.13
theta12_157	2.050	8.96
theta12_160	3.254	5.65
theta12_175	1.634	4.17
theta12_18	0.566	1.51
theta12_184	1.549	3.23
theta12_194	2.734	5.76
theta12_217	1.278	1.80
theta12_237	1.478	2.42
theta12_239	2.892	6.51
theta12_247	1.885	5.51
theta12_266	0.767	1.76
theta12_271	2.920	6.44
theta12_272	0.982	2.66
theta12_275	0.946	2.39
theta12_296	1.117	2.50
theta12_301	0.997	1.66
theta12_305	1.429	2.57
theta12_320	0.780	1.53
theta12_46	2.641	5.30
theta12_49	0.839	1.60
theta12_70	1.922	4.20
theta12_72	1.101	1.72
theta12_77	2.569	8.15
theta12_78	2.434	4.36
theta12_79	1.808	5.88
theta12_80	3.095	12.59
theta12_81	1.205	2.05
theta12_91	2.715	5.28
theta12_92	0.829	1.92

Table D. 5. Summary of the number of significant effects in estimating model 4

Service sector	Number of significant fixed effects (12 sectors simultaneously tested)	Number of significant fixed effects (13 sectors simultaneously tested)	Number of significant fixed effects (13 sectors separately tested). Significance criterion: 50% median adjusted expenditure	Number of significant fixed effects (13 sectors separately tested). Significance criterion: t-value >= 1,5
0. Budget surplus …………	0	328	215	30
1. Administration …………	35	310	10	37
2. Primary schools ………	1	273	0	35
3. Other education ………	27	283	20	37
4. Child care ………………	8	288	1	37
5. Health care …………….	40	310	23	45
6. Social assistance ……..	23	256	19	37
7. Child protection ……….	29	274	31	38
8. Care for the elderly and disabled ……………………	4	286	0	34
9. Culture ………………….	59	316	20	41
10. Municipal roads ………	50	309	30	38
11. Water supply and sanitation ………………….	49	303	33	25
12. Other infrastructure ….	65	319	35	35
Total without sector 0 ……	390	n/a	222	439
Total with sector 0 ……….	390	3 855	437	469

Table D. 6. Step 2.1: Model 4 estimates with the significant fixed effects found in step 1.1

	Estimate	t-value
theta1_103	1.207	1.40
theta1_129	-2.146	-6.03
theta1_131	2.447	5.92
theta1_149	-0.918	-1.05
theta1_160	-2.345	-6.48
theta1_161	-3.065	-7.28
theta1_176	-1.289	-1.75
theta1_180	0.536	0.78
theta1_192	1.780	2.63
theta1_195	-1.263	-2.43
theta1_236	2.739	0.24
theta1_247	-1.591	-3.64
theta1_248	-0.579	-0.51
theta1_253	1.719	5.79
theta1_291	2.014	5.56
theta1_292	3.246	6.95
theta1_293	2.630	4.72
theta1_294	2.725	7.69
theta1_295	1.303	1.92
theta1_296	3.140	9.20
theta1_309	2.263	5.07
theta1_315	3.908	8.38
theta1_316	6.463	0.18
theta1_319	2.233	3.50
theta1_321	2.690	5.38
theta1_326	1.029	1.81
theta1_331	3.856	1.35
theta1_332	1.977	4.17
theta1_38	-0.693	-0.54
theta1_43	0.481	0.55
theta1_5	-1.356	-2.99
theta1_57	-1.173	-1.26
theta1_81	-0.771	-0.30
theta1_82	-1.580	-3.87
theta1_9	-1.224	-1.16
theta2_316	3.917	0.09
theta3_112	0.792	1.98
theta3_130	-0.749	-3.49
theta3_131	0.999	3.69
theta3_149	-0.270	-0.63
theta3_162	0.684	3.41
theta3_193	-0.585	-1.66
theta3_204	1.231	10.32
theta3_212	0.754	4.67
theta3_213	0.828	7.62
theta3_216	0.816	3.13
theta3_225	0.760	4.65
theta3_227	1.130	5.70
theta3_261	0.802	3.52
theta3_280	0.672	3.42
theta3_282	-0.397	-1.25
theta3_292	0.576	4.34
theta3_309	0.857	7.35
theta3_310	1.309	16.06
theta3_316	0.868	0.14
theta3_327	0.499	1.67
theta3_334	0.454	1.22
theta3_58	-0.529	-1.37
theta3_77	-0.259	-0.65
theta3_81	-0.345	-0.50
theta3_82	-0.473	-0.82
theta3_83	-0.356	-0.96
theta3_91	-0.961	-3.31
theta4_21	-1.962	-3.31
theta4_316	2.793	0.16

	Estimate	t-value
theta4_321	1.844	2.72
theta4_326	1.498	1.43
theta4_329	1.677	1.68
theta4_332	1.676	2.65
theta4_77	-1.573	-1.35
theta4_81	-1.062	-0.36
theta5_106	-0.678	-1.72
theta5_110	-0.273	-0.64
theta5_137	-0.526	-0.59
theta5_156	-1.659	-4.45
theta5_160	-1.285	-3.19
theta5_161	-1.461	-8.46
theta5_186	1.325	2.60
theta5_188	1.203	4.97
theta5_192	0.264	0.59
theta5_194	1.325	3.28
theta5_198	1.080	6.52
theta5_204	0.666	1.70
theta5_225	0.814	2.88
theta5_236	1.007	0.14
theta5_247	-0.893	-2.75
theta5_248	-0.364	-0.43
theta5_272	1.257	2.88
theta5_273	0.936	3.80
theta5_292	0.739	3.55
theta5_294	1.022	6.89
theta5_295	0.424	0.82
theta5_298	1.169	7.11
theta5_316	0.116	0.01
theta5_320	0.806	3.40
theta5_326	2.209	6.68
theta5_327	0.894	5.29
theta5_329	0.831	2.29
theta5_330	0.178	0.45
theta5_334	1.134	2.68
theta5_335	1.359	5.47
theta5_38	-0.734	-0.70
theta5_43	0.982	5.31
theta5_49	-0.715	-1.27
theta5_52	1.069	2.59
theta5_70	-1.309	-3.53
theta5_77	-0.424	-0.90
theta5_81	-0.038	-0.02
theta5_83	-0.887	-1.17
theta5_9	-1.098	-0.84
theta5_91	-0.759	-1.46
theta6_100	0.756	3.48
theta6_124	1.338	8.56
theta6_16	0.789	5.45
theta6_167	1.016	2.84
theta6_17	-0.779	-3.81
theta6_171	0.738	3.20
theta6_199	0.728	5.01
theta6_247	1.189	3.11
theta6_284	1.172	6.00
theta6_290	0.880	3.05
theta6_317	-1.155	-5.94
theta6_324	0.751	6.52
theta6_328	-1.099	-3.07
theta6_331	0.732	0.96
theta6_43	0.832	2.42
theta6_44	1.121	8.99
theta6_45	0.856	4.53
theta6_50	1.198	3.71
theta6_52	1.193	5.75
theta6_58	-0.684	-2.92

theta6_80	-0.593	-2.00	theta9_30	-0.736	-2.57
theta6_81	-1.078	-0.64	theta9_316	1.331	0.07
theta6_84	-0.726	-5.00	theta9_321	0.178	0.35
theta7_11	0.526	1.28	theta9_322	0.600	2.70
theta7_129	0.719	8.16	theta9_323	0.106	0.21
theta7_130	-0.613	-1.90	theta9_326	0.758	2.96
theta7_131	-0.589	-1.19	theta9_328	-0.474	-1.78
theta7_140	-0.551	-2.30	theta9_329	0.877	4.66
theta7_158	0.945	5.52	theta9_331	1.731	1.83
theta7_160	-0.685	-0.84	theta9_332	0.681	2.12
theta7_174	0.590	5.87	theta9_336	1.361	10.79
theta7_176	-0.557	-2.75	theta9_37	-0.177	-0.40
theta7_185	0.645	2.69	theta9_38	-0.702	-0.91
theta7_187	0.598	3.83	theta9_39	-0.600	-0.99
theta7_198	0.614	4.23	theta9_43	0.061	0.07
theta7_218	-0.739	-2.13	theta9_61	-0.355	-0.72
theta7_229	0.571	8.75	theta9_64	-0.187	-0.35
theta7_239	0.903	12.61	theta9_65	-0.521	-0.62
theta7_250	0.702	6.50	theta9_70	-0.790	-4.11
theta7_261	-0.494	-1.52	theta9_72	-0.726	-2.61
theta7_263	0.702	4.34	theta9_77	-1.466	-5.01
theta7_281	0.754	4.88	theta9_79	-0.802	-4.34
theta7_282	-0.367	-1.22	theta9_81	-0.380	-0.21
theta7_283	1.256	16.57	theta9_83	-0.007	-0.01
theta7_286	-0.436	-1.94	theta9_89	-0.623	-1.39
theta7_316	0.919	0.10	theta9_9	-0.052	-0.04
theta7_323	0.605	3.31	theta10_116	-0.200	-2.46
theta7_331	0.580	0.69	theta10_131	0.753	7.03
theta7_55	-0.517	-2.42	theta10_135	0.413	4.33
theta7_57	-0.678	-1.99	theta10_148	-0.239	-2.05
theta7_78	0.824	7.92	theta10_149	-0.204	-0.46
theta7_91	1.203	8.77	theta10_159	0.410	5.23
theta8_316	4.386	0.06	theta10_160	-0.210	-0.66
theta8_331	6.132	4.74	theta10_189	-0.579	-2.13
theta8_77	-2.942	-2.60	theta10_191	0.219	3.87
theta8_81	-1.633	-0.27	theta10_215	0.373	7.01
theta9_100	0.531	1.97	theta10_218	0.523	7.72
theta9_110	-0.077	-0.15	theta10_225	0.132	0.52
theta9_118	0.503	5.39	theta10_238	-0.306	-1.54
theta9_120	0.787	5.92	theta10_245	-0.225	-1.48
theta9_124	-0.540	-1.82	theta10_248	-0.184	-0.88
theta9_131	1.568	2.94	theta10_279	-0.331	-2.62
theta9_135	0.664	2.85	theta10_282	-0.325	-2.16
theta9_137	-0.375	-0.57	theta10_289	0.500	4.43
theta9_141	0.416	1.80	theta10_291	0.876	7.44
theta9_149	-0.022	-0.03	theta10_292	0.215	0.95
theta9_15	-0.225	-0.51	theta10_301	0.560	4.95
theta9_174	0.787	3.24	theta10_309	0.837	6.06
theta9_176	-0.519	-2.34	theta10_310	0.777	10.38
theta9_192	0.990	3.28	theta10_313	0.539	3.18
theta9_203	-0.879	-3.04	theta10_315	0.836	10.32
theta9_21	-0.646	-1.24	theta10_316	1.167	0.17
theta9_216	-0.830	-1.64	theta10_317	0.556	4.57
theta9_224	0.198	0.81	theta10_319	0.779	5.74
theta9_229	0.505	2.38	theta10_320	0.257	3.20
theta9_23	-0.232	-0.42	theta10_321	0.275	3.30
theta9_242	-0.255	-0.72	theta10_322	0.320	2.82
theta9_245	-0.160	-0.87	theta10_324	-0.446	-2.54
theta9_247	-1.173	-5.62	theta10_325	0.726	7.38
theta9_25	-0.406	-0.50	theta10_331	1.048	3.36
theta9_252	1.444	5.30	theta10_332	0.549	7.16
theta9_260	0.928	1.77	theta10_333	-0.346	-3.76
theta9_282	1.456	6.00	theta10_38	-0.126	-0.31
theta9_286	-0.588	-1.38	theta10_49	-0.307	-2.56
theta9_29	-0.511	-1.78	theta10_50	-0.363	-1.01
theta9_293	0.997	2.92	theta10_51	-0.520	-3.29
theta9_294	0.843	3.41	theta10_55	-0.495	-3.30
theta9_295	0.578	1.07	theta10_57	-0.586	-4.85
theta9_3	1.417	7.18	theta10_61	-0.272	-1.04

theta10_64	-0.112	-0.61
theta10_65	-0.212	-1.04
theta10_77	-0.315	-1.13
theta10_81	0.053	0.13
theta10_83	-0.154	-0.64
theta10_9	-0.101	-0.14
theta10_91	-0.055	-0.24
theta11_105	1.584	4.75
theta11_113	-1.009	-1.45
theta11_121	1.197	3.06
theta11_126	1.695	5.98
theta11_129	-1.299	-1.52
theta11_140	-1.859	-2.59
theta11_148	-0.781	-2.08
theta11_156	-2.063	-3.20
theta11_160	-1.731	-2.58
theta11_171	1.444	4.14
theta11_182	-1.289	-5.91
theta11_189	-0.984	-4.49
theta11_203	-1.193	-2.12
theta11_217	2.302	9.71
theta11_230	0.938	0.77
theta11_233	-0.926	-1.76
theta11_236	0.745	0.07
theta11_24	-1.177	-12.35
theta11_246	1.604	6.95
theta11_259	1.102	8.92
theta11_260	1.093	2.37
theta11_262	-1.031	-0.81
theta11_266	-1.222	-2.12
theta11_272	0.837	1.14
theta11_276	1.442	5.41
theta11_286	-0.776	-0.92
theta11_287	-0.902	-1.24
theta11_289	-1.275	-1.27
theta11_291	-1.285	-2.86
theta11_294	1.430	7.70
theta11_305	-1.216	-1.99
theta11_309	0.790	1.78
theta11_312	0.923	4.05
theta11_316	2.104	0.12
theta11_318	-1.287	-5.50
theta11_319	1.000	1.71
theta11_329	0.811	0.99
theta11_331	1.227	0.64
theta11_332	1.085	2.56
theta11_334	1.072	0.70
theta11_47	-1.258	-0.76
theta11_64	-0.613	-0.82
theta11_65	-0.799	-0.83
theta11_69	0.741	1.95
theta11_71	0.838	1.72
theta11_72	1.074	2.45
theta11_80	2.507	7.31
theta11_9	-0.747	-0.34
theta11_90	0.894	1.91
theta12_103	1.024	0.99
theta12_110	-0.565	-0.72
theta12_114	1.460	2.86
theta12_117	-2.204	-6.04
theta12_12	1.078	4.91
theta12_120	1.954	7.84
theta12_131	0.610	0.62
theta12_137	-0.783	-0.63
theta12_141	1.568	2.24
theta12_144	-1.531	-3.38
theta12_149	-1.561	-0.38
theta12_15	-0.263	-0.17
theta12_153	-0.845	-0.89
theta12_174	1.487	3.37
theta12_175	1.838	7.06
theta12_176	-1.526	-3.74
theta12_179	-1.060	-0.99
theta12_184	1.545	5.13
theta12_189	-1.411	-2.29
theta12_193	-0.631	-0.75
theta12_194	2.805	9.01
theta12_216	-0.881	-0.97
theta12_227	-0.415	-0.26
theta12_236	1.707	0.99
theta12_238	-1.269	-1.93
theta12_239	3.382	11.56
theta12_245	0.114	0.13
theta12_260	1.618	2.31
theta12_261	-2.225	-4.53
theta12_271	2.432	7.62
theta12_272	1.288	3.30
theta12_282	-2.989	-5.25
theta12_295	0.823	1.26
theta12_296	1.454	4.63
theta12_3	1.265	3.27
theta12_301	0.793	1.78
theta12_309	-4.315	-7.39
theta12_316	1.448	0.04
theta12_320	0.946	2.34
theta12_321	0.122	0.14
theta12_322	0.927	1.81
theta12_323	0.136	0.28
theta12_326	1.147	2.01
theta12_328	-1.763	-3.18
theta12_331	0.527	0.45
theta12_333	-3.700	-9.44
theta12_335	-1.661	-2.81
theta12_38	-1.529	-0.80
theta12_39	-0.391	-0.23
theta12_4	-0.484	-0.90
theta12_40	-0.948	-0.91
theta12_43	-0.371	-0.36
theta12_46	2.599	8.37
theta12_5	-1.018	-0.65
theta12_56	-0.686	-0.70
theta12_57	-2.628	-5.05
theta12_62	-1.145	-0.63
theta12_64	-0.481	-0.36
theta12_65	-1.248	-0.72
theta12_78	2.472	5.97
theta12_80	3.242	17.39
theta12_81	0.455	0.13
theta12_83	-2.287	-2.86
theta12_9	-1.470	-0.87
theta12_99	-1.154	-1.33

Table D.7. Step 2.2: Model 4 estimates with the significant fixed effects found in step 1.2

	Estimate	t-value		Estimate	t-value
theta1_49	2.563	5.86	theta6_167	0.991	2.56
theta1_77	2.128	6.11	theta6_190	-0.656	-5.14
theta1_129	-2.194	-1.72	theta6_247	1.258	3.34
theta1_161	-2.908	-5.40	theta6_284	1.197	5.90
theta1_292	2.527	5.18	theta6_290	0.855	2.30
theta1_293	1.887	4.38	theta6_317	-1.163	-6.08
theta1_296	2.199	3.16	theta6_324	0.790	6.94
theta1_315	3.503	6.04	theta6_328	-0.911	-3.25
theta1_316	2.116	0.60	theta7_5	0.546	3.76
theta1_321	2.119	4.46	theta7_55	-0.467	-2.19
theta3_69	-0.728	-1.24	theta7_57	-0.581	-1.80
theta3_91	-0.887	-4.45	theta7_78	0.853	8.31
theta3_108	0.732	2.22	theta7_81	0.529	2.95
theta3_112	0.837	2.45	theta7_83	0.613	3.11
theta3_130	-0.735	-3.51	theta7_91	1.325	14.55
theta3_131	0.880	4.74	theta7_129	0.671	4.11
theta3_162	0.670	3.40	theta7_130	-0.577	-1.69
theta3_189	0.719	3.44	theta7_131	-0.449	-2.15
theta3_193	-0.517	-1.38	theta7_140	-0.491	-1.83
theta3_204	1.183	10.61	theta7_158	0.872	4.76
theta3_212	0.744	4.79	theta7_160	-0.583	-1.63
theta3_213	0.801	7.54	theta7_176	-0.549	-2.96
theta3_216	0.815	3.32	theta7_185	0.605	2.67
theta3_225	0.648	4.44	theta7_187	0.592	3.59
theta3_227	1.100	7.10	theta7_189	0.615	4.40
theta3_261	0.854	3.42	theta7_198	0.551	3.81
theta3_280	0.632	3.21	theta7_217	-0.545	-1.10
theta3_282	-0.371	-0.88	theta7_218	-0.743	-2.38
theta3_310	1.239	15.51	theta7_229	0.534	8.59
theta3_326	-0.993	-2.53	theta7_239	0.873	12.42
theta4_316	2.390	0.52	theta7_250	0.655	6.03
theta5_52	1.184	2.73	theta7_260	-0.629	-1.77
theta5_70	-0.912	-3.04	theta7_263	0.633	3.96
theta5_79	1.375	5.47	theta7_271	-0.412	-1.73
theta5_117	1.192	7.50	theta7_281	0.858	5.63
theta5_119	1.324	4.44	theta7_283	1.249	16.26
theta5_141	-1.251	-4.22	theta7_286	-0.452	-3.63
theta5_156	-1.642	-3.93	theta7_296	-0.648	-2.15
theta5_161	-1.136	-5.12	theta7_329	-0.668	-2.16
theta5_173	1.146	1.90	theta9_3	1.252	6.46
theta5_186	1.287	2.80	theta9_54	0.832	4.17
theta5_188	1.194	5.94	theta9_57	0.787	2.10
theta5_189	1.404	9.01	theta9_77	-0.586	-1.93
theta5_194	1.267	3.55	theta9_80	-0.448	-1.20
theta5_198	1.064	7.44	theta9_84	0.999	2.02
theta5_272	1.053	3.13	theta9_131	1.421	9.04
theta5_282	1.285	4.45	theta9_147	0.940	3.53
theta5_291	-1.317	-3.07	theta9_161	0.777	5.64
theta5_296	-1.025	-3.17	theta9_194	-0.666	-7.50
theta5_316	-1.432	-0.58	theta9_225	-0.861	-2.89
theta5_326	1.363	6.10	theta9_247	-0.752	-5.15
theta5_328	1.357	9.12	theta9_252	1.457	4.95
theta5_333	1.675	6.61	theta9_261	1.032	3.69
theta5_335	1.710	7.71	theta9_267	-0.948	-1.93
theta6_16	0.766	5.03	theta9_282	1.831	7.00
theta6_17	-0.755	-3.59	theta9_305	-0.851	-2.59
theta6_44	1.084	8.48	theta9_319	-0.737	-1.50
theta6_45	0.846	4.26	theta9_330	-0.990	-3.67
theta6_50	1.131	4.58	theta9_336	1.083	7.65
theta6_52	1.106	5.67	theta10_48	0.435	5.06
theta6_80	-0.665	-2.13	theta10_51	-0.492	-2.77
theta6_81	-0.935	-2.80	theta10_55	-0.466	-3.09
theta6_84	-0.609	-4.02	theta10_57	-0.491	-3.68
theta6_89	0.851	9.19	theta10_129	0.381	1.08
theta6_124	1.358	9.18	theta10_131	0.711	11.90
			theta10_159	0.419	5.21

theta10_173	0.408	3.40
theta10_176	0.533	10.83
theta10_189	-0.483	-1.72
theta10_193	0.504	2.65
theta10_218	0.526	8.80
theta10_253	-0.379	-2.85
theta10_282	-0.337	-1.90
theta10_285	0.455	5.00
theta10_288	-0.265	-1.98
theta10_291	0.703	4.64
theta10_300	-0.348	-3.87
theta10_301	0.487	5.41
theta10_309	0.645	7.14
theta10_310	0.678	8.88
theta10_313	0.557	3.78
theta10_314	0.504	2.71
theta10_315	0.851	9.23
theta10_317	0.546	4.52
theta10_319	0.603	5.74
theta10_324	-0.442	-2.41
theta10_325	0.790	8.69
theta10_326	-0.748	-3.94
theta10_331	0.662	6.47
theta11_24	-1.212	-11.67
theta11_47	-1.294	-0.79
theta11_55	0.959	1.37
theta11_72	1.132	3.63
theta11_75	-1.267	-2.08
theta11_80	2.360	6.11
theta11_105	1.655	4.56
theta11_121	1.151	2.61
theta11_126	1.739	5.47
theta11_129	-1.306	-0.91
theta11_140	-1.998	-2.62
theta11_156	-2.265	-3.63
theta11_160	-1.238	-2.28
theta11_171	1.404	3.82
theta11_182	-1.224	-5.33
theta11_203	-0.957	-2.14
theta11_217	2.247	7.52
theta11_246	1.520	6.92
theta11_259	1.104	8.33
theta11_262	-1.070	-0.96
theta11_276	1.348	4.81
theta11_277	0.901	1.70
theta11_287	-1.028	-1.29
theta11_288	-1.420	-3.44
theta11_289	-1.351	-1.71
theta11_290	-1.206	-1.18
theta11_291	-1.713	-2.66
theta11_293	-1.331	-2.14
theta11_305	-1.586	-2.86
theta11_309	0.482	1.13
theta11_316	0.801	0.19
theta11_318	-1.432	-5.57
theta11_322	-1.592	-2.89
theta12_46	2.696	8.64
theta12_57	-1.560	-3.57
theta12_70	1.853	5.92
theta12_77	2.207	6.33
theta12_78	2.558	6.02
theta12_79	2.068	10.00
theta12_80	2.939	9.59
theta12_83	-1.785	-2.81
theta12_91	2.593	6.40
theta12_114	1.580	2.94
theta12_117	-1.595	-3.92
theta12_120	1.508	6.17
theta12_144	-1.569	-3.27
theta12_156	0.345	1.56
theta12_157	1.929	13.40
theta12_158	-0.859	-1.53
theta12_160	0.898	2.23
theta12_175	1.843	6.60
theta12_184	1.514	4.84
theta12_194	2.374	7.37
theta12_237	1.602	4.59
theta12_239	3.121	10.04
theta12_247	1.458	5.43
theta12_261	-1.121	-3.74
theta12_271	2.389	7.35
theta12_282	-2.075	-4.07
theta12_291	-1.676	-3.69
theta12_294	-1.859	-4.45
theta12_309	-4.687	-10.67
theta12_315	-0.584	-1.07
theta12_331	-1.856	-8.96
theta12_332	-1.679	-5.47
theta12_333	-2.715	-6.09
theta12_335	-1.456	-2.20
theta12_336	-0.823	-0.59

Table D. 8. Step 2.3: Model 4 estimates with the sector 0 significant fixed effects found in step 1.3 and the other effects found in step 1.2

	Estimate	t-value
theta0_124	1.364	2.33
theta0_137	1.901	3.33
theta0_149	2.528	1.94
theta0_15	1.173	1.81
theta0_156	-0.383	-0.57
theta0_160	2.437	2.64
theta0_161	0.837	1.36
theta0_176	2.345	2.65
theta0_189	2.071	1.89
theta0_203	1.811	1.60
theta0_21	1.643	2.19
theta0_216	1.682	1.55
theta0_227	1.508	2.40
theta0_245	2.142	1.89
theta0_247	2.243	1.65
theta0_266	1.676	2.64
theta0_333	2.053	2.91
theta0_38	3.127	2.60
theta0_39	1.901	1.98
theta0_49	1.601	3.24
theta0_55	1.319	0.81
theta0_57	2.602	1.05
theta0_61	1.990	3.49
theta0_65	2.535	3.42
theta0_70	1.952	1.63
theta0_77	4.432	4.21
theta0_81	3.545	4.48
theta0_82	1.999	3.32
theta0_83	2.132	2.02
theta0_9	3.619	3.27
theta1_49	2.627	5.95
theta1_77	2.541	4.25
theta1_129	-2.216	-1.69
theta1_161	-2.893	-5.06
theta1_292	2.520	5.25
theta1_293	1.870	4.31
theta1_296	2.176	3.08
theta1_315	3.469	6.06
theta1_316	2.067	0.57
theta1_321	2.108	4.46
theta3_69	-0.717	-1.27
theta3_91	-0.906	-4.30
theta3_108	0.730	2.25
theta3_112	0.838	2.32
theta3_130	-0.733	-3.59
theta3_131	0.873	4.50
theta3_162	0.670	3.37
theta3_189	0.691	2.30
theta3_193	-0.528	-1.40
theta3_204	1.188	10.69
theta3_212	0.744	4.76
theta3_213	0.807	7.57
theta3_216	0.809	2.08
theta3_225	0.667	4.54
theta3_227	1.092	4.91
theta3_261	0.848	3.40
theta3_280	0.635	3.18
theta3_282	-0.377	-0.84
theta3_310	1.239	15.43
theta3_326	-0.987	-2.49
theta4_316	2.421	0.52
theta5_52	1.178	2.67
theta5_70	-0.873	-2.11
theta5_79	1.366	5.41
theta5_117	1.182	7.45
theta5_119	1.317	4.36
theta5_141	-1.246	-4.22
theta5_156	-1.623	-3.38
theta5_161	-1.132	-4.17
theta5_173	1.142	1.84
theta5_186	1.280	2.75
theta5_188	1.187	5.87
theta5_189	1.448	4.51
theta5_194	1.261	3.47
theta5_198	1.059	7.28
theta5_272	1.049	3.11
theta5_282	1.241	4.25
theta5_291	-1.327	-3.00
theta5_296	-1.030	-3.14
theta5_316	-1.447	-0.57
theta5_326	1.369	6.01
theta5_328	1.340	8.99
theta5_333	1.660	6.02
theta5_335	1.684	7.14
theta6_16	0.767	5.07
theta6_17	-0.764	-3.62
theta6_44	1.086	8.50
theta6_45	0.851	4.31
theta6_50	1.134	4.72
theta6_52	1.112	5.67
theta6_80	-0.661	-2.09
theta6_81	-0.955	-2.21
theta6_84	-0.600	-3.98
theta6_89	0.855	9.25
theta6_124	1.342	8.77
theta6_167	0.981	2.46
theta6_190	-0.661	-5.22
theta6_247	1.239	2.78
theta6_284	1.197	5.94
theta6_290	0.848	2.29
theta6_317	-1.164	-6.14
theta6_324	0.802	7.02
theta6_328	-0.887	-3.19
theta7_5	0.553	3.81
theta7_55	-0.473	-0.87
theta7_57	-0.592	-1.63
theta7_78	0.853	8.32
theta7_81	0.525	2.64
theta7_83	0.606	3.05
theta7_91	1.338	14.63
theta7_129	0.680	4.03
theta7_130	-0.575	-1.70
theta7_131	-0.434	-2.00
theta7_140	-0.480	-1.76
theta7_158	0.877	4.71
theta7_160	-0.560	-1.35
theta7_176	-0.547	-2.40
theta7_185	0.609	2.68
theta7_187	0.593	3.60
theta7_189	0.597	2.03
theta7_198	0.558	3.82
theta7_217	-0.545	-1.09
theta7_218	-0.733	-2.28
theta7_229	0.541	8.67
theta7_239	0.883	12.61
theta7_250	0.655	6.04
theta7_260	-0.630	-1.77
theta7_263	0.647	4.08
theta7_271	-0.407	-1.71
theta7_281	0.861	5.64

theta7_283	1.248	16.32
theta7_286	-0.450	-3.60
theta7_296	-0.638	-2.10
theta7_329	-0.674	-2.16
theta9_3	1.240	6.45
theta9_54	0.822	4.16
theta9_57	0.894	2.32
theta9_77	-0.428	-1.40
theta9_80	-0.465	-1.23
theta9_84	0.997	2.03
theta9_131	1.409	8.98
theta9_147	0.932	3.51
theta9_161	0.767	4.81
theta9_194	-0.678	-7.65
theta9_225	-0.866	-2.95
theta9_247	-0.710	-4.19
theta9_252	1.450	4.97
theta9_261	1.024	3.68
theta9_267	-0.951	-1.93
theta9_282	1.752	6.49
theta9_305	-0.866	-2.61
theta9_319	-0.736	-1.49
theta9_330	-0.992	-3.69
theta9_336	1.083	7.69
theta10_48	0.430	5.05
theta10_51	-0.493	-2.82
theta10_55	-0.457	-2.95
theta10_57	-0.468	-2.98
theta10_129	0.378	1.03
theta10_131	0.700	11.52
theta10_159	0.423	5.30
theta10_173	0.408	3.39
theta10_176	0.563	11.42
theta10_189	-0.481	-1.34
theta10_193	0.503	2.65
theta10_218	0.535	8.91
theta10_253	-0.370	-2.80
theta10_282	-0.344	-1.91
theta10_285	0.454	4.97
theta10_288	-0.271	-2.06
theta10_291	0.693	4.63
theta10_300	-0.353	-3.97
theta10_301	0.478	5.32
theta10_309	0.641	7.13
theta10_310	0.673	8.90
theta10_313	0.562	3.84
theta10_314	0.508	2.67
theta10_315	0.854	9.29
theta10_317	0.542	4.52
theta10_319	0.598	5.69
theta10_324	-0.446	-2.45
theta10_325	0.790	8.66
theta10_326	-0.757	-3.97
theta10_331	0.657	6.46
theta11_24	-1.216	-11.66
theta11_47	-1.299	-0.82
theta11_55	0.974	0.94
theta11_72	1.132	3.59
theta11_75	-1.272	-2.04
theta11_80	2.341	5.97
theta11_105	1.646	4.53
theta11_121	1.149	2.59
theta11_126	1.739	5.48
theta11_129	-1.309	-0.90
theta11_140	-1.997	-2.49
theta11_156	-2.240	-3.51
theta11_160	-1.209	-2.22
theta11_171	1.400	3.75
theta11_182	-1.225	-5.30
theta11_203	-0.945	-1.83
theta11_217	2.238	7.42
theta11_246	1.515	6.91
theta11_259	1.100	8.27
theta11_262	-1.073	-0.96
theta11_276	1.341	4.80
theta11_277	0.911	1.72
theta11_287	-1.019	-1.26
theta11_288	-1.416	-3.43
theta11_289	-1.350	-1.61
theta11_290	-1.210	-1.16
theta11_291	-1.710	-2.54
theta11_293	-1.330	-2.08
theta11_305	-1.607	-2.81
theta11_309	0.454	1.05
theta11_316	0.754	0.18
theta11_318	-1.424	-5.54
theta11_322	-1.606	-2.93
theta12_46	2.691	8.65
theta12_57	-1.321	-3.00
theta12_70	1.993	4.02
theta12_77	2.691	6.21
theta12_78	2.554	5.98
theta12_79	2.062	9.94
theta12_80	2.905	9.34
theta12_83	-1.693	-2.65
theta12_91	2.627	6.40
theta12_114	1.579	2.94
theta12_117	-1.609	-3.94
theta12_120	1.519	6.23
theta12_144	-1.559	-3.25
theta12_156	0.363	1.33
theta12_157	1.934	13.39
theta12_158	-0.893	-1.58
theta12_160	0.844	1.89
theta12_175	1.816	6.44
theta12_184	1.509	4.82
theta12_194	2.357	7.26
theta12_237	1.612	4.60
theta12_239	3.082	9.81
theta12_247	1.612	3.28
theta12_261	-1.134	-3.75
theta12_271	2.376	7.29
theta12_282	-2.165	-4.14
theta12_291	-1.679	-3.61
theta12_294	-1.875	-4.44
theta12_309	-4.712	-10.75
theta12_315	-0.613	-1.12
theta12_331	-1.865	-8.96
theta12_332	-1.706	-5.47
theta12_333	-2.727	-6.18
theta12_335	-1.461	-2.18
theta12_336	-0.830	-0.59

Table D. 9. Step 2.4: Model 4 estimates with all significant fixed effects found in step 1.3

	Estimate	t-value
theta0_124	1.738	1.33
theta0_137	1.973	3.13
theta0_149	2.446	1.8
theta0_15	1.364	1.77
theta0_156	1.282	1.45
theta0_160	4.317	1.82
theta0_161	2.547	4.46
theta0_176	1.739	1.41
theta0_189	1.192	1.16
theta0_203	1.987	1.38
theta0_21	1.777	2.21
theta0_216	1.817	1.2
theta0_227	1.590	1.89
theta0_245	1.965	1.75
theta0_247	2.832	1.49
theta0_266	0.705	0.47
theta0_333	2.965	0.82
theta0_38	3.393	2.77
theta0_39	2.142	2.1
theta0_49	1.425	2.61
theta0_55	0.484	0.56
theta0_57	2.872	1.74
theta0_61	2.279	3.85
theta0_65	2.556	3.39
theta0_70	1.668	0.57
theta0_77	4.979	4.83
theta0_81	2.598	4.26
theta0_82	1.461	2.32
theta0_83	2.758	2.33
theta0_9	3.572	2.89
theta1_11	0.673	2.05
theta1_124	0.770	1.05
theta1_131	2.516	7.03
theta1_140	1.278	3.66
theta1_158	1.425	2.79
theta1_170	0.358	1.7
theta1_22	1.118	3.81
theta1_234	0.789	2.19
theta1_242	1.006	2.44
theta1_246	1.723	3.96
theta1_253	1.775	6.59
theta1_277	1.027	2.05
theta1_286	1.356	2.75
theta1_288	1.370	3.11
theta1_289	1.169	3.25
theta1_290	1.111	1.49
theta1_291	2.289	6.37
theta1_292	3.069	7.08
theta1_293	2.920	4.6
theta1_294	1.946	8.17
theta1_296	3.531	6.51
theta1_297	1.695	5.88
theta1_300	0.858	1.84
theta1_305	1.639	4.19
theta1_309	2.531	4.52
theta1_315	3.571	8.02
theta1_321	2.834	5.89
theta1_331	2.806	3.51
theta1_332	1.210	3.14
theta1_333	2.316	3
theta1_47	0.624	1.69
theta1_49	2.824	5.6
theta1_60	1.061	3.39
theta1_77	2.815	6.77

	Estimate	t-value
theta1_80	1.628	3.53
theta1_90	1.569	3.61
theta1_91	2.347	5.2
theta2_110	1.295	3.44
theta2_120	2.150	6.71
theta2_124	0.934	2.2
theta2_129	1.251	2.44
theta2_138	0.495	1.54
theta2_141	1.499	5.06
theta2_160	2.253	5.55
theta2_161	1.751	2.27
theta2_176	1.124	2.18
theta2_197	0.950	2.27
theta2_198	1.612	2.45
theta2_200	1.467	6.86
theta2_229	1.580	2.16
theta2_239	1.746	4.51
theta2_246	1.231	5.84
theta2_247	1.682	5.78
theta2_266	1.407	2.57
theta2_270	1.357	2.7
theta2_275	1.480	3.63
theta2_281	1.838	5.01
theta2_288	1.692	4.6
theta2_291	2.690	6.84
theta2_308	1.828	1.64
theta2_311	1.923	7.51
theta2_321	2.871	3.47
theta2_326	2.869	5.69
theta2_330	2.730	7.14
theta2_334	1.591	3.64
theta2_43	1.410	2.7
theta2_54	1.261	3.87
theta2_55	1.035	2.61
theta2_58	1.148	2.41
theta2_72	1.459	3.82
theta2_88	1.844	7.63
theta2_90	0.971	2.55
theta3_108	0.718	2.27
theta3_112	0.827	2.72
theta3_121	0.692	3.64
theta3_131	1.358	7.47
theta3_156	0.549	1.99
theta3_162	0.694	2.84
theta3_189	0.841	3.9
theta3_19	0.606	7.75
theta3_191	0.497	0.98
theta3_204	1.238	13.03
theta3_212	0.688	3.16
theta3_213	0.824	8.48
theta3_216	0.830	2.57
theta3_225	0.808	2.57
theta3_227	1.120	5.42
theta3_229	0.417	1.54
theta3_23	0.428	3.19
theta3_230	0.593	8.18
theta3_238	0.646	5.39
theta3_24	0.339	2.49
theta3_261	0.918	3.05
theta3_269	0.584	6.1
theta3_279	0.369	1.82
theta3_280	0.701	4.13
theta3_283	0.526	2.21
theta3_285	0.454	4.56
theta3_292	0.622	5.54
theta3_293	0.571	3.04

theta3_295	0.242	3.28	theta5_279	0.676	3.64
theta3_309	0.942	9.92	theta5_281	1.063	4.45
theta3_310	1.420	19.99	theta5_282	1.468	12.92
theta3_328	0.463	2.84	theta5_292	0.787	4.9
theta3_334	0.542	2.4	theta5_293	0.761	3.59
theta3_52	0.559	3.4	theta5_294	1.046	8.11
theta3_67	0.220	4.66	theta5_298	1.038	7.61
theta3_72	0.669	14.49	theta5_299	0.397	4.47
theta3_96	0.664	2.37	theta5_317	0.681	1.36
theta4_116	1.364	2.82	theta5_318	1.011	4.12
theta4_136	0.963	3.77	theta5_320	0.880	4.74
theta4_14	0.616	1.51	theta5_326	1.954	13.77
theta4_145	0.857	3.17	theta5_327	0.725	5.73
theta4_151	0.706	2.76	theta5_328	1.383	11.73
theta4_153	1.479	4.72	theta5_333	1.940	2.11
theta4_155	0.819	4.08	theta5_334	1.281	3.82
theta4_159	1.276	5.79	theta5_335	1.647	8.66
theta4_160	1.381	3.19	theta5_43	0.917	6.87
theta4_162	1.265	2.41	theta5_50	1.044	3.46
theta4_181	0.790	2.24	theta5_52	1.210	2.82
theta4_182	1.678	9.35	theta5_71	0.656	6.01
theta4_183	0.885	4.97	theta5_79	1.345	6.52
theta4_191	1.136	1.56	theta6_100	0.624	2.97
theta4_212	1.160	6.18	theta6_104	0.410	3.48
theta4_221	0.873	3.26	theta6_108	0.596	4.3
theta4_222	0.502	2.87	theta6_124	1.279	7.69
theta4_225	1.419	2.34	theta6_126	0.486	3.44
theta4_227	0.458	1.29	theta6_131	0.643	3.97
theta4_229	1.156	1.67	theta6_16	0.832	6.06
theta4_247	0.954	2	theta6_167	1.054	2.98
theta4_248	0.662	1.64	theta6_171	0.769	3.61
theta4_262	0.795	2.61	theta6_176	0.362	1.32
theta4_264	0.829	2.02	theta6_199	0.755	5.57
theta4_276	0.580	2.61	theta6_2	0.787	2.48
theta4_296	1.476	2.51	theta6_225	0.481	1.75
theta4_30	0.809	2.6	theta6_230	0.697	3.22
theta4_317	0.867	1.02	theta6_247	1.240	2.21
theta4_32	0.424	2.91	theta6_278	0.448	3.01
theta4_321	1.544	2.43	theta6_284	1.322	8.48
theta4_326	1.045	1.71	theta6_287	0.445	2.22
theta4_329	1.779	3.39	theta6_290	0.955	3.7
theta4_33	0.319	1.34	theta6_291	0.156	1.19
theta4_332	1.587	2.9	theta6_294	0.645	2.41
theta4_335	1.299	1.98	theta6_324	1.122	8.28
theta4_42	0.450	1.18	theta6_329	0.646	3.44
theta4_6	0.260	1.37	theta6_331	0.852	1.89
theta5_116	1.188	6.35	theta6_333	0.594	1.02
theta5_117	1.285	10.04	theta6_37	0.718	3.01
theta5_118	0.724	2.29	theta6_43	0.883	4.65
theta5_119	1.280	5.13	theta6_44	1.248	8.68
theta5_13	0.796	4	theta6_45	0.889	5.02
theta5_173	1.164	2.01	theta6_49	0.607	2.44
theta5_186	1.280	3.2	theta6_50	1.409	4.53
theta5_188	1.159	6.69	theta6_52	1.265	6.43
theta5_189	1.500	7.15	theta6_55	0.611	6.64
theta5_194	1.309	4.55	theta6_59	0.774	2.68
theta5_198	1.227	1.99	theta6_70	0.487	1.65
theta5_216	0.561	2.27	theta6_89	0.914	10.85
theta5_217	0.850	4.79	theta6_96	0.592	2.4
theta5_218	0.684	2.52	theta7_10	0.521	2.29
theta5_225	0.950	1.81	theta7_115	0.438	4.07
theta5_240	0.584	4.27	theta7_119	0.473	4.32
theta5_25	0.481	2.7	theta7_129	0.816	10.11
theta5_261	0.668	1.96	theta7_137	0.502	2.51
theta5_264	0.695	2.2	theta7_14	0.517	1.49
theta5_268	0.796	4.36	theta7_142	0.546	3.41
theta5_270	0.660	3.84	theta7_15	0.517	2.89
theta5_272	1.165	3.5	theta7_158	1.011	5.32
theta5_273	0.978	4.64	theta7_174	0.476	4.97

theta7_185	0.659	2.92	theta9_153	0.604	3.14
theta7_186	0.264	2.45	theta9_156	1.096	9.05
theta7_187	0.612	3.83	theta9_160	1.741	3.7
theta7_189	0.712	2.79	theta9_161	1.388	7.89
theta7_191	0.410	1.03	theta9_162	0.572	1.71
theta7_198	0.673	4.45	theta9_174	0.484	2.32
theta7_229	0.654	4.41	theta9_190	0.339	2.12
theta7_239	1.004	10.77	theta9_192	0.801	3.12
theta7_243	0.526	2.92	theta9_2	0.487	1.39
theta7_250	0.741	7.09	theta9_202	0.562	1.95
theta7_263	0.755	4.84	theta9_218	0.775	4.15
theta7_266	0.617	3.95	theta9_229	0.654	2.2
theta7_27	0.408	2.98	theta9_230	0.691	1.48
theta7_281	0.895	2.68	theta9_252	1.528	5.58
theta7_283	1.280	15.72	theta9_261	1.160	3.14
theta7_309	0.568	5.26	theta9_275	1.099	5.06
theta7_323	0.611	4.25	theta9_277	0.609	1.93
theta7_324	0.218	1.55	theta9_282	2.279	12.36
theta7_331	0.476	1.42	theta9_293	0.918	1.89
theta7_335	0.244	2.09	theta9_296	1.123	10.29
theta7_5	0.612	4.15	theta9_3	1.251	6.68
theta7_59	0.345	3.94	theta9_50	0.567	2.19
theta7_70	0.509	2	theta9_54	1.027	5.66
theta7_78	0.892	8.96	theta9_57	1.124	6.77
theta7_81	0.694	3.51	theta9_59	0.834	3.54
theta7_83	0.687	3.18	theta9_83	0.538	1.47
theta7_91	1.435	10.75	theta9_84	1.048	2.81
theta7_93	0.468	3.04	theta9_91	0.794	5.62
theta8_125	4.221	5.02	theta9_95	0.686	3.1
theta8_140	1.924	2.76	theta9_99	0.783	2.8
theta8_141	3.924	3.54	theta9_329	0.679	3.66
theta8_180	1.600	1.71	theta9_331	1.149	5.34
theta8_184	3.778	8.31	theta9_333	0.932	2.05
theta8_191	3.410	1.83	theta9_336	1.248	10.6
theta8_192	2.212	5.85	theta10_129	0.510	2.54
theta8_203	3.451	4.2	theta10_131	0.888	13.47
theta8_210	4.406	10.76	theta10_135	0.383	4.05
theta8_225	3.321	4.43	theta10_140	0.346	5.29
theta8_233	2.650	2.93	theta10_146	0.209	2.19
theta8_254	2.184	4	theta10_159	0.434	4.98
theta8_257	1.344	1.93	theta10_161	0.287	3.05
theta8_266	2.985	6.09	theta10_173	0.430	3.3
theta8_268	2.948	2.08	theta10_176	0.542	10.5
theta8_271	2.752	4.46	theta10_181	0.252	1.97
theta8_281	5.636	5.54	theta10_191	0.344	4.64
theta8_282	5.740	9.5	theta10_193	0.496	2.73
theta8_288	4.187	4.45	theta10_195	0.375	4.06
theta8_289	2.215	2.24	theta10_198	0.219	1.03
theta8_300	2.538	2.76	theta10_203	0.480	2.86
theta8_302	2.035	2.89	theta10_215	0.377	6.99
theta8_304	1.632	3.85	theta10_218	0.591	9.85
theta8_306	2.339	4.44	theta10_220	0.323	4.69
theta8_308	3.811	4.35	theta10_226	0.304	3.14
theta8_309	1.845	1.87	theta10_271	0.323	5.23
theta8_312	1.482	0.98	theta10_285	0.465	4.64
theta8_314	3.458	4.18	theta10_287	0.346	3.42
theta8_324	3.000	3.38	theta10_289	0.636	9.1
theta8_331	5.235	8.93	theta10_291	0.933	8.04
theta8_44	3.560	4.81	theta10_299	0.255	2.38
theta8_48	3.141	3.06	theta10_301	0.589	5.56
theta8_69	2.149	4.27	theta10_309	0.915	9.72
theta8_75	2.081	3.24	theta10_310	0.745	9.95
theta9_10	0.350	1.01	theta10_313	0.589	4.1
theta9_118	0.595	5.01	theta10_314	0.599	3
theta9_120	0.928	6.57	theta10_315	0.923	11.34
theta9_131	1.558	8.97	theta10_317	0.558	3.68
theta9_135	0.559	2.84	theta10_319	0.759	8.83
theta9_144	0.763	6.03	theta10_320	0.240	3.06
theta9_147	0.827	3.36	theta10_325	0.764	8.08

theta10_331	0.992	7.81	theta11_54	0.941	2.22
theta10_332	0.442	5.11	theta11_59	0.922	1.77
theta10_48	0.514	5.68	theta11_70	0.938	1.9
theta11_105	1.685	3.78	theta11_72	1.469	3.44
theta11_121	1.364	2.51	theta11_80	2.652	5.84
theta11_126	1.813	3.88	theta11_94	0.986	3.15
theta11_128	0.866	5.81	theta12_114	1.503	2.76
theta11_130	1.051	4.72	theta12_116	1.643	4.75
theta11_138	1.109	3.15	theta12_12	1.092	4.51
theta11_171	1.430	3.1	theta12_120	2.316	8.59
theta11_18	0.958	2.42	theta12_130	1.023	4.63
theta11_217	2.482	3.76	theta12_156	2.086	8.57
theta11_241	0.764	2.78	theta12_157	2.113	14.09
theta11_246	1.749	4.88	theta12_160	3.172	3.43
theta11_259	1.191	7.32	theta12_175	1.646	5.47
theta11_267	0.633	2.37	theta12_18	0.729	2.26
theta11_276	1.325	3.59	theta12_184	1.676	4.27
theta11_294	1.122	3.21	theta12_194	2.967	8.66
theta11_30	1.077	1.88	theta12_217	1.533	1.63
theta11_309	0.956	1.42	theta12_237	1.540	4.25
theta11_312	0.902	0.86	theta12_239	3.363	9.86
theta11_332	0.681	1.07			

Table D.10. Additional significant fixed effects revealed in step 3 of estimating Model 4 where each municipality is tested in 12 service sectors simultaneously conditioning on the effects found to be significant in step 1.1

Service sector	Municipality name	Municipality number
1. Administration	Moskenes	1874
	Nordkapp	2019
2. Primary schools	none	none
3. Other education	Risør	0901
	Masfjorden	1266
	Sør-Aurdal	0540
4. Child care	none	none
5. Health care	Åmli	0929
	Snillfjord	1613
	Tjeldsund	1852
6. Social services	Valle	0940
	Kristiansand	1001
	Fredrikstad	0106
7. Child protection	Stranda	1525
	Tjeldsund	1852
8. Care for the elderly and disabled	none	none
9. Culture	Suldal	1134
	Bardu	1922
10. Municipal roads	Åmli	0929
	Odda	1228
	Vefsn	1824
	Dyrøy	1926
11. Water supply and sanitation	Vevelstad	1816
	Ringerike	0605
12. Other infrastructure	Sauda	1135
	Askøy	1247
	Nore og Uvdal	0633

Table D.11. Model 4 parameter estimates where step 3 was carried out in 12 sectors simultaneously

Sector	Parameter	Estimate	t-value
Budget surplus	Intercept	-2.340	-
	Growth in municipality incomes	0.556	25.15
Administration	Intercept	1.411	17.92
	Inverse population size	4.390	29.10
	Index of farming industry	5.463	6.87
Primary schools	Intercept	-0.917	-3.61
	Population share 6-12 years of age	54.939	19.77
	Population share 13-15 years of age	70.270	13.13
	Distance to centre of municipal sub-district	1.691	31.58
	Inverse population size	2.510	14.12
Other education	Intercept	0.463	10.44
	Share of fulltime working women 20-44 years	5.373	8.90
	Refugees with integration grants	33.241	25.80
Child care	Intercept	1.114	6.56
	Population share 1-5 years of age	0.440	0.16
	Share of fulltime working women 20-44 years	22.329	13.97
Health care	Intercept	0.601	13.77
	Distance to centre of municipal sub-district	0.357	13.27
	Inverse population size	1.823	22.13
Social services	Intercept	-0.317	-5.25
	Refugees with integration grants	52.401	30.81
	Refugees without integration grants	3.475	2.39
	Share of divorced/ separated 16-59 years	11.383	12.81
	Unemployed 16-59 years share of total population	13.654	7.98
	Number of poor share of total population	6.534	6.72
	Share of disablement pensioners 18-49 years	8.978	4.74
Child protection	Intercept	0.248	5.53
	Share of children 0-15 years with single mother/ father	14.738	13.49
	Number of poor share of total population	4.875	6.79
Care for the elderly and disabled	Intercept	1.068	4.49
	Population share 67-79 years of age	30.925	9.16
	Population share 80-89 years of age	66.160	11.93
	Population share 90 years and above	203.886	12.91
	High-cost recipients share of total population	739.977	13.17
	Share of mentally disabled 16 years and above without grant	222.763	11.47
	Share of mentally disabled 16 years and above with grant	505.276	16.33
	Distance to centre of municipal sub-district	0.795	8.55
	Inverse population size	2.117	8.17
Culture	Intercept	0.614	15.70
	Inverse population size	0.451	6.23
Municipal roads	Intercept	0.021	1.13
	Amount of snowfall	0.065	14.73
	Kilometers of municipal roads	25.190	36.26
Water supply and sanitation	Intercept	1.000	21.85
	Capacity of advanced purification	0.585	19.71
	Inverse population size	0.423	3.67
Other infrastructure	Intercept	0.799	9.89
	Inverse population size	1.573	10.57

Table D.12. Effects on the marginal budget shares in Model 4 with municipality effects included in 12 service sectors

Sector	Explanatory variable	Estimate	t-value
1. Administration	Constant	0.184	20.65
	Average education	-0.027	-10.09
	Share of socialists	0.001	0.14
	Share of residents in a densely populated area	0.004	0.71
2. Primary schools	Constant	0.167	18.18
	Average education	-0.024	-7.78
	Share of socialists	-0.001	-0.07
	Share of residents in a densely populated area	0.002	0.29
3. Other education	Constant	-0.014	-4.56
	Average education	0.007	6.56
	Share of socialists	0.017	5.55
	Share of residents in a densely populated area	0.008	4.02
4. Child care	Constant	-0.060	-6.89
	Average education	0.050	17.70
	Share of socialists	-0.018	-1.91
	Share of residents in a densely populated area	-0.023	-4.22
5. Health care	Constant	0.072	13.53
	Average education	-0.005	-3.27
	Share of socialists	0.006	1.41
	Share of residents in a densely populated area	0.002	0.81
6. Social assistance	Constant	-0.009	-2.40
	Average education	0.004	3.07
	Share of socialists	0.012	3.23
	Share of residents in a densely populated area	0.016	5.52
7. Child protection	Constant	0.001	0.33
	Average education	0.003	2.97
	Share of socialists	-0.007	-2.40
	Share of residents in a densely populated area	0.016	9.14
8. Care for the elderly and disabled	Constant	0.245	14.75
	Average education	-0.019	-3.41
	Share of socialists	0.007	0.54
	Share of residents in a densely populated area	-0.005	-0.65
9. Culture	Constant	0.058	14.08
	Average education	0.001	1.08
	Share of socialists	-0.000	-0.08
	Share of residents in a densely populated area	0.012	4.55
10. Municipal roads	Constant	0.017	6.93
	Average education	-0.001	-0.95
	Share of socialists	-0.010	-4.67
	Share of residents in a densely populated area	0.013	9.42
11. Water supply and sanitation	Constant	0.045	6.75
	Average education	-0.003	-1.72
	Share of socialists	-0.012	-1.87
	Share of residents in a densely populated area	0.017	4.15
12. Other infrastructure	Constant	0.123	14.74
	Average education	0.003	1.04
	Share of socialists	0.033	4.72
	Share of residents in a densely populated area	-0.041	-7.75

Appendix E: Economic regions and region fixed effects

Table E.1. Labour market regions

	Labour market region	Region number
	ØST-NORGE	
1	Sør-Østfold	11
2	Oslo	12
3	Vestfold	13
4	Kongsberg	14
5	Hallingdal	15
6	Valdres	21
7	Gudbrandsdalen	22
8	Lillehammer	23
9	Gjøvik	24
10	Hamar	25
11	Kongsvinger	26
12	Elverum	27
13	Tynset/Røros	28
	SØR-NORGE	
14	Nordvest-Telemark	31
15	Øst-Telemark	32
16	Sør-Telemark	33
17	Arendal	34
18	Kristiansand	35
19	Lister	36
	VEST-NORGE	
20	Stavanger	41
21	Haugesund	42
22	Sunnhordland	43
23	Bergen	44
24	Sunnfjord (Førde/Florø)	51
25	Sognefjord (Sogndal/Årdal)	52
26	Nordfjord	53
27	Søndre Sunnmøre	54
28	Ålesund	55
29	Molde	56
30	Nordmøre	57
31	Kristiansund	58
	MIDT-NORGE	
32	Trondheim	61
33	Midt-Trøndelag	62
34	Namsos	63
35	Ytre Helgeland	64
36	Indre Helgeland	65
	NORD-NORGE	
37	Bodø	71
38	Narvik	72
39	Vesterålen	73
40	Lofoten	74
41	Harstad	75
42	Midt-Troms	76
43	Tromsø	77
44	Alta	81
45	Hammerfest	82
46	Vadsø	83

Table E.2. Municipalities grouped by labour market region

Region	Municipality
11	0101
	0105
	0106
	0111
	0118
	0128
12	0104
	0119
	0121
	0122
	0123
	0124
	0125
	0127
	0135
	0136
	0137
	0138
	0211
	0213
	0214
	0215
	0216
	0217
	0219
	0220
	0221
	0226
	0227
	0228
	0229
	0230
	0231
	0233
	0234
	0235
	0236
	0237
	0238
	0239
	0301
	0532
	0533
	0534
	0602
	0605
	0612
	0621
	0622
	0623
	0624
	0625
	0626
	0627
	0628
	0711
	0713
13	0701
	0702
	0704
	0706
	0709
	0714
	0716
	0719
	0720
	0722
	0723
	0728
14	0604
	0631
	0632
	0633
15	0615
	0616
	0617
	0618
	0619
	0620
21	0540
	0541
	0542
	0543
	0544
	0545
22	0511
	0512
	0513
	0514
	0515
	0516
	0517
	0519
	0520
23	0501
	0521
	0522
24	0502
	0528
	0529
	0536
	0538
25	0403
	0412
	0415
	0417
26	0402
	0418
	0419
	0420
	0423
	0425
27	0426
	0427
	0428
	0429
	0430
	0434
28	0432
	0436
	0437
	0438
	0439
	0441
	1640
	1644
31	0826
	0828
	0829
	0830
	0831
	0833
	0834
32	0807
	0821
	0822
	0827
33	0805
	0806
	0811
	0814
	0815
	0817
	0819
34	0901
	0904
	0906
	0911
	0912
	0914
	0919
	0929
35	0926
	0928
	0935
	0937

	0938
	0940
	0941
	1001
	1002
	1014
	1017
	1018
	1021
	1026
	1027
	1029
36	1003
	1004
	1032
	1034
	1037
	1046
41	1101
	1102
	1103
	1111
	1112
	1114
	1119
	1120
	1121
	1122
	1124
	1127
	1129
	1130
	1133
	1141
	1142
	1144
42	1106
	1134
	1135
	1145
	1146
	1149
	1151
	1160
	1211
	1216
43	1219
	1221
	1222
	1223
	1224
44	1201
	1227
	1228
	1231
	1232
	1233
	1234
	1235
	1238
	1241
	1242
	1243
	1244
	1245
	1246
	1247
	1251
	1252
	1253
	1256
	1259
	1260
	1263
	1264
	1265
	1266
	1411
51	1401
	1412
	1413
	1416
	1418
	1428
	1429
	1430
	1431
	1432
	1433
	1438
52	1417
	1419
	1420
	1421
	1422
	1424
	1426
53	1439
	1441
	1443
	1444
	1445
	1449
54	1511
	1514
	1515
	1516
	1517
	1519
	1520
55	1504
	1523
	1524
	1525
	1526
	1528
	1529
	1531
	1532
	1534
	1546
56	1502
	1535
	1539
	1543
	1545
	1547
	1548
	1551
	1557
57	1560
	1563
	1566
	1567
	1571
58	1503
	1554
	1573
	1576
	1576
61	1601
	1612
	1613
	1617
	1620
	1621
	1622
	1624
	1627
	1630
	1632
	1633
	1634
	1635
	1636
	1638
	1648
	1653

	1657
	1662
	1663
	1664
	1665
	1711
	1714
	1718
	1723
62	1702
	1717
	1719
	1721
	1724
	1725
	1729
	1736
63	1703
	1738
	1739
	1740
	1742
	1743
	1744
	1748
	1749
	1750
	1751
	1755
64	1811
	1812
	1813
	1815
	1816
	1818
	1820
	1822
	1827
	1834
	1835
65	1824
	1825
	1826
	1828
	1832
	1833
71	1804
	1836
	1837
	1838
	1839
	1840
	1841
	1845
	1848
	1849
72	1805
	1850
	1851
	1852
	1853
	1854
	1919
73	1866
	1867
	1868
	1870
	1871
74	1856
	1857
	1859
	1860
	1865
	1874
75	1901
	1911
	1913
	1915
	1917
76	1920
	1922
	1923
	1924
	1925
	1926
	1927
	1928
	1929
	1931
77	1902
	1933
	1936
	1938
	1939
	1940
	1941
	1942
	1943
81	2011
	2012
	2014
	2015
82	2004
	2017
	2018
	2019
	2020
	2021
	2022
	2023
83	2002
	2003
	2024
	2025
	2027
	2028
	2030

Table E.3. Regional effects in model 7 for sector 0 – 12

Region	0	1	2	3	4	5	6	7	8	9	10	11	12
11	4.416	3.220	2.900	0.387	1.213	1.474	0.731	0.445	5.594	2.690	0.573	1.276	4.539
13	-2.685	-1.386	-0.718	-0.272	-0.550	-0.800	0.149	-0.213	-2.103	-0.547	-0.220	-0.027	-1.352
14	4.010	3.891	2.500	0.008	1.218	1.060	0.468	0.577	4.853	2.184	0.497	1.389	4.510
15	-12.824	-8.127	-7.243	-1,738*	-3.877	-3.266	-0.934	-0.471	-15.558	-5.602	-1.504	-1.552	-8.054
21	-5.666	-3.383	-1.748	-0.716	-1.418	-1.139	0.163	-0.298	-4.318	-1.895	-0.594	0.263	-2.489
22	-9.880	-6.816	-4.927	-1.448	-1.836	-2.556	-0.306	-0.943	-10.881	-3.387	-1.344	-1.245	-7.665
23	12.408	8.321	7.320	1.261	2.802	3.484	1,273*	0.380	14.165	5.208	1.398	3.254	9.455
24	4.894	3.061	2.572	0.668	0.989	1.420	0.723	0.205	5.458	2.226	0.489	1.281	3.571
25	-3.695	-2.966	-2.498	-0.510	-0.958	-1.333	0.310	-0.524	-4.557	-1.997	-0.609	-0.543	-3.749
26	3.866	3.753	3.517	0.717	1.352	1.756	1.153	0.169	7.716	2.145	0.547	1.171	4.252
27	-1.279	0.053	-0.519	-0.212	-0.254	0.116	0.616	-0.379	-0.590	-0.332	-0.248	-0.386	0.355
28	-7.662	-4.803	-2.975	-0.819	-1.816	-1.484	0.172	-0.541	-7.475	-2.159	-1.087	-0.679	-4.578
31	14.065	9.467	8.942	1.486	3.884	5.146	1.029	0.869	14.684	6.521	1.647	3.109	12.345
32	-12.761	-7.993	-5.164	-1.188	-2.973	-2.633	-0.291	-0.786	-12.519	-4.625	-1.414	-1.800	-9.110
33	-11.909	-7.562	-5.995	-1.049	-2.589	-3.130	-0.436	-0.772	-12.531	-4.540	-1.318	-2.403	-8.213
34	-10.554	-6,961*	-4.804	-1.064	-2.232	-3,104*	0.030	-0.635	-9.423	-3.852	-1.079	-1.403	-7.242
35	7.527	5.427	4.477	0.755	2,304*	2.174	0,807**	0.399	8.775	3,470*	1.009	2,015**	6.434
36	-29,160*	-18,540*	-14,293*	-2,871*	-6,830*	-8,354*	-1,742*	-1,933**	-27,411*	-11,091*	-3,17*	-5,638*	-21,16*
41	-0.084	-0.430	-0.041	-0.244	0.512	-0.271	0.126	0.077	-0.205	0.206	-0.033	-0.354	-0.310
42	-3.201	-2.356	-0.696	-0.254	0.023	-1.110	0.228	-0.312	-2.324	-0.560	-0.325	-0.658	-1.607
43	-17.083	-10.641	-7.797	-1.811	-4.171	-4.365	-0.720	-1.208	-16.669	-6.635	-1.843	-2.567	-12.139
44	-8,541*	-5.137	-3.220	-0.843	-1.656	-1.963	-0.082	-0,524*	-7.193	-2.944	-0.838	-1,821*	-5.748
51	0.842	1.164	1.721	0.234	0.808	0.997	0,491*	0.152	3.100	1.141	0.252	0.412	2.006
52	0.170	1.113	1.595	-0.067	0.637	1.131	0.587	0.075	2.469	0.700	0.232	0.384	1.908
53	-8.938	-6.198	-4.238	-0.845	-2.093	-2.518	-0.426	-0,790*	-7.450	-3.359	-0.827	-2.160	-6.120
54	0.451	0.521	1.556	0.371	0.738	0.276	0.102	-0.151	2.293	0.514	0.297	0.168	1.147
55	-6.138	-4.008	-2.609	-0.410	-1.149	-1.314	-0.277	-0,802**	-5.468	-2.391	-0.431	-0.962	-4.337
56	-8.047	-4.514	-3.082	-0.518	-1.365	-1.936	-0.142	-0.798	-5.530	-2.609	-0.569	-1.277	-5.216
57	-5.322	-3.112	-1.892	-0.347	-0.854	-1.443	0.093	-0.328	-3.899	-1.296	-0.538	-0.718	-3.319
58	-6.085	-3.359	-2.735	-0.544	-1.288	-1.562	-0.037	-0.453	-4.916	-2.003	-0.594	-1.113	-3.809
61	-2.104	-1.071	-0.592	-0.099	-0.123	-0.459	0.126	-0,229*	-1.923	-0.617	-0.268	-0.437	-0.838
62	2.186	1.859	1.639	0.249	1.108	1.063	0.311	0.059	3.418	1.073	0.336	0.206	2.438
63	-7,859*	-4.513	-2.895	-0.764	-1.283	-1.432	-0.221	-0,680**	-5.676	-2.395	-0.835	-0.498	-4.035
64	-3.269	-1.715	-0.602	-0.163	-0.228	0.032	0.379	-0.015	-0.297	-0.758	-0.440	-0.925	-2.064
65	-18.667	-11.698	-9.465	-1.793	-3.462	-4.791	-0.747	-1.518	-19.749	-7.455	-1.866	-3.869	-13.984
71	-3.122	0.536	0.409	-0.150	-0.291	0.038	0.371	-0.054	0.202	-0.449	-0.030	-1,275*	-1.056
72	-28,005*	-15.474	-13.075	-2.765	-5.832	-7.146	-1.427	-2,077**	-26.899	-10.169	-3.025	-4.817	-20.041
73	9.607	7.579	6.079	1.145	2.905	3.450	0.791	0.363	13.965	4.359	1.327	2.049	8.118
74	-8.103	-4.317	-3.011	-0.660	-0.919	-1.125	-0.163	-0.815	-5.745	-2.970	-0.649	-2.286	-5.458
75	12,483*	9,419*	8,631**	1,743**	3,487*	3,974*	0.542	0.668	17,219**	5,524*	2,06**	2,919**	9.171
76	4.240	4.120	3,863*	0.685	1,771*	1.804	0.284	0.141	7.404	2.483	1,07**	1,469*	4.108
77	-3.309	-0.029	1.017	-0.105	0.442	0.273	0.130	-0.233	1.352	-0.385	0.112	-0.911	-0.434
81	-53,380*	-32.411	-23.014	-5.623	-11.378	-12.611	-3.120	-3.152	-51.989	-20.332	-6.224	-9.736	-39.090
82	1.749	4.031	3.540	0.547	1,740**	2.051	0,606**	0.198	5.663	1.925	0.848	1.202	2.295
83	5.839	5,479*	5,020**	0,859*	1,782**	3,188**	0,987**	0,549*	9,342*	3,391*	0.772	1,837*	4.324

Region 12 (Oslo) is the base region.
* indicates significance at 10% significance level
** indicates significance at 5% significance level

Table E.4. Regional effects in model 8 for sectors 0 – 12.

	Region 0	1	2	3	4	5	6	7	8	9	10	11	12
11	-1.364	-0.371	0.075	-0.126	-0.466	-0.099	0,447**	0.123	-0.334	0.469	-0.084	0.185	0.374
13	-0.601	0.058	0.367	-0.006	0.286	-0.169	0,283**	-0.055	0.333	0.418	0.041	0,423**	0.367
14	-1.391	0.634	-0.380	-0,483*	-0.392	-0.449	0.139	0,358*	-0.759	-0.032	-0.126	0.355	0.423
15	2.133	1,936**	0.490	-0.170	-0.461	0,981**	-0.012	0,510**	0.134	0.294	0.168	1,127**	2,990**
21	-1.202	-0.362	0.739	-0,192**	-0.570	0.197	0,496**	-0.016	0.640	-0.114	-0.080	1,133**	1.039
22	-3.011	-1,943**	-0.567	-0.505	-0,975*	-0.485	0.127	-0,485**	-3,074*	-0.395	-0,428**	0.158	-1,678*
23	-0.908	-1.174	-0.357	0.172	-0.962	-0.503	0.386	-0.615	-0.518	-0.553	-0.329	0.358	0.059
24	-0.069	-0.122	0.125	0.157	-0.114	0.063	0,422**	-0.081	0.112	0.349	-0.075	0.341	-0.106
25	-0.794	-1.037	-0.815	-0.140	-0.343	-0.506	0,495*	-0.367	-1.576	-0.917	-0.247	-0.020	-1.352
26	-2.408	-0.722	0.169	0.066	-0.104	-0.115	0,787**	-0,199*	0.774	-0.445	-0.194	-0.081	-0.637
27	-1.83	0.005	-0.430	-0.136	-0.397	0.162	0,597**	-0,425**	-0.727	-0.368	-0,239**	-0.361	0.360
28	-3,28**	-1,692**	-0.463	-0,225*	-0,922**	-0.098	0,448**	-0,304**	-2,363**	-0.271	-0,526**	0.223	-0.849
31	-3,64**	-1,645*	0.108	-0.213	-0.649	0.462	0.008	-0.178	-3,568**	-0.406	-0,317*	-0.079	-0.594
32	-3.688	-1.838	-0.292	-0.130	-0.994	0.034	0.277	-0.308	-2.730	-0.928	-0.308	-0.036	-1.712
33	-1.268	-0.323	-0.106	0,215**	-0.213	-0.081	0,226*	-0.071	-0.738	-0.019	0.014	-0.233	0.324
34	-0.981	-0.682	0.180	-0.004	0.031	-0,428*	0,609**	-0.055	0.818	0.009	0.039	0,381**	0.220
35	1.568	1,621**	1,103**	0.094	0,941**	0.479	0,423**	0.029	2,363**	1,131**	0,295**	0,757**	1,612**
36	-1.092	-0.031	0.587	0.074	-0,635**	-0.311	-0.014	-0,311*	2,539**	0.343	0.066	-0.143	0.571
41	0.234	-0.169	0.289	-0,172**	0.095	-0.146	0,159*	0.096	0.198	0,404*	-0.000	-0.225	0.053
42	-3,53**	-1,904**	-0.204	-0.133	-0,652**	-0,973**	0,221*	-0,310**	-1,652**	-0.421	-0,254**	-0,525**	-0,865**
43	-2.310	-0.873	0.009	-0.164	-0,873**	-0.042	0.168	-0.360	-0.663	-0.671	-0.078	0.274	-0.468
44	-2,10**	-0,732**	0.283	-0.091	-0,358**	-0.028	0,324**	-0,145**	0.048	-0.320	-0.088	-0,601**	-0.509
51	-2,71**	-0,980**	-0.166	-0.128	-0.382	0.087	0,262**	-0.047	-0.315	-0.244	-0,144*	-0.233	-0.572
52	-5,22**	-1,532**	-0.366	-0,517*	-1,126*	0.046	0.238	-0.165	-1.775	-1,373**	-0,265**	-0.436	-1,369*
53	-0.996	-0.945	-0.030	-0.008	-0.358	-0.189	0.050	-0,369**	1.138	-0.118	0.086	-0,577*	0.144
54	-0.492	-0.046	1,071**	0,284**	0,715**	0.047	0.050	-0,197*	1,343*	0.207	0,167*	-0.005	0.489
55	-1,60*	-0,704*	0.088	0.121	-0,441*	0.080	0.052	-0,498**	-0.060	-0.380	0.119	0.065	-0.420
56	-2.055	-0.173	0.506	0.215	-0.151	-0.027	0.290	-0,418**	1.587	0.048	0.173	0.002	-0.055
57	-3,20**	-1,364*	-0.463	-0.014	-0.722	-0,759*	0,231*	-0.119	-0.936	-0.225	-0,237**	-0.240	-1.039
58	-1.525	-0.019	-0.335	-0.090	-0.070	-0.160	0.244	-0.165	0.146	-0.204	-0.072	-0.221	-0.094
61	-1,08*	-0.319	0.084	0.028	-0.096	-0.164	0,172**	-0,157**	-0,814*	-0.210	-0,144**	-0,260**	0.058
62	-1.671	-0.432	-0.250	-0.126	0.101	0.124	0.042	-0.108	-0.510	-0.486	-0.086	-0,436**	-0.328
63	-2,91**	-0,960**	-0.147	-0,172*	-0.273	0.136	0.030	-0,420**	0.104	-0.354	-0,197**	0,442**	0.067
64	-3,15**	-1,169**	0.053	0.040	-0.508	0.265	0,412**	0.033	0.531	-0.484	-0,347**	-0,662**	-1,308**
65	-3.254	-1.062	-0.375	0.019	-0.752	-0.339	0.152	-0.580	-2.669	-1.025	0.057	-0.701	-1.367
71	-3,23**	0,996*	0,721*	-0.022	-0.339	0.230	0,386**	-0.039	0.965	-0.251	0.033	-1,144**	-0.557
72	-4,85**	0.759	0.062	-0.163	-0.603	-0.228	0.014	-0,698**	-0.846	-0.294	-0.225	0.016	-0.960
73	-2.231	0.167	0.288	0.044	0.116	0.266	0.034	-0.318	2.304	-0.201	-0.014	-0.170	-0.416
74	-3.044	-0.354	0.467	0.067	-0.253	0.527	0.125	-0.506	0.700	-0.623	0.062	-0,994*	-0.682
75	-0.959	0.862	1,659**	0,368**	0.778	0.260	-0.230	-0.036	4,160**	0.308	0,529**	0.478	-0.749
76	-3,17**	-0.441	0.163	-0.066	-0.241	-0.152	-0,200*	-0,227**	0.082	-0.414	0,232**	0.166	-1,285**
77	-4,08**	-0.044	1,111**	-0.048	0.270	0.268	0.054	-0,253**	1,274*	-0,491*	0.081	-0,983**	-0.428
81	-9.102	-2.377	1.118	-0,495**	-1.144	0.485	-0.485	-0.287	-2.681	-1,882**	-0.793	-0.783	-3,389**
82	-6,63**	-0.465	0.618	-0.013	-0,897**	0.317	0.076	-0,352**	-1,985*	-1,093**	0.028	-0.115	-2,772**
83	-6,13**	-1.275	0.333	-0.016	-1,808**	0.423	0.251	-0.161	-1.929	-0,973**	-0,489**	-0.162	-3,216**

Region 12 (Oslo) is the base region.
* indicates significance at 10% significance level
** indicates significance at 5% significance level

List of tables