ERSA 2002 Conference

August 27th – 31st in Dortmund, Germany

Regulation of Intercommunal Financial Flows
with Geostatistics and GIS

Marion Czeranka, André Odermatt, Marcel Frehner

Corresponding Address: Dr. André Odermatt
Department of Geography, University of Zurich
Winterthurerstr. 190, CH-8057 Zurich
odermatt@geo.unizh.ch

Abstract

Usually, some historical, functional, and/or structural indicators are used for the characterisation of municipalities. These variables are structured more or less simple, referring to inhabitant number, political importance, constellation of infrastructure like hospitals and schools, number of jobs, or the like.

An application field where a quite specific and at the same time comprehensible classification for each municipality is of fundamental interest, is the local financial adjustment between municipalities. Therefore, well elaborated methods are needed to define the amount of money which has to be transferred, generally spoken, from rich municipalities to the poorer ones. It is obvious that a pure redistribution of revenues between financially strong and financially weak municipalities would lead in principle to a more or less equal financial outfit. Indeed, this is not sufficient for a fair system of financial adjustment, as such a redistribution method would not consider the specific financial loads of the budgets of different types of municipalities.

This paper presents a study carried out for the Canton of Zurich, Switzerland, which made part of the cantonal revision of the system of inter-communal financial adjustment. The aim was to provide means for a cantonal regulation on how the financial adjustment between the municipalities should be regulated. Therefore, socio-demographic and geographic indicators have been evaluated using multiple linear regression in order to find rules to reflect the financial load of the municipal budgets and finally care for a fair redistribution of financial means. Besides the presentation of the technical approach this paper discusses also the perspective of regional policy and territorial justice.

1   Introduction

This article presents some results of a broader political motivated research project that aims to achieve a revision of the system of financial adjustment for the Swiss canton (i.e., province) of Zurich. Our goal was to provide support for decision-making when it comes to dealing with excessive financial burdens which are currently weighing down a lot of Swiss municipalities. For this reason, GIS technology and (geo-)statistical methods were used to support this politically motivated research in the realm of financial regional policy.

2   The Swiss Financial System and Its Week Points

2.1   Overview of the Current System

The existing regional disparities between municipalities on all levels, municipal as well as cantonal level, are the result of processes of social and functional differentiation. In Switzerland, which has a true confederational structure, these disparities have a distinct financial dimension: Federalism leads to highly different tax burdens in cantons and municipalities because the Swiss financial system confers a large degree of autonomy with regard to collecting taxes both on the cantonal and on the municipal level (Janos/Odermatt/Wachter 1998, 148f).

Each public financial order may be characterised by four elements, each of them having a spatial dimension (Hotz-Hart/Mäder/Vock 1995, 480):

a) Territorial organisation

Switzerland is subdivided into 26 cantons and nearly 3,000 municipalities, which are extremely heterogeneous with regard to size, administration, financial potential, socio-economic nature etc.

b) Distribution of tasks

In Switzerland the distribution of tasks is not regulated very systematically. As a result, funds are continually transferred between public administrations on all levels. An incomplete list of the principal tasks falling upon the federal administration comprises social security, national defence, agriculture, the national traffic system, international relations, etc. In contrary, secondary and university education, regional traffic infrastructures, the maintenance of public health etc. are incumbent upon the cantons. In addition, municipalities are responsible for elementary education, social welfare, cultural and leisure activities, garbage collection etc.

c) Distribution of revenues

On both the local and the cantonal level it is the people - the voters - who have the right to decide about taxes and tax rates. Indirect taxes such as the VAT, however, are a federal prerogative. As far as the rates of direct taxes are concerned, cantons and local municipalities are in competition with each other. In other words, the Swiss system of tax autonomy allows the cantons and municipalities to make their own decisions as to tax rates.

d) Transfer of funds

The Swiss system of public finances is an intricate network of rules and regulations which co-ordinate the transfer of funds between the confederation and the cantons on the one hand and between cantons and their municipalities on the other hand. Two basic components of the transfer system are the - usually horizontal - balancing out of financial resources and the - mostly vertical - compensation for specific expenditures (see an explanation of these two components further down, same chapter).

As mentioned above, functional, social, and spatial differentiation have a direct impact on the budgets of the different territorial units in Switzerland (Odermatt 1999, 21f). With regard to revenues and expenditures, the cantons as well as municipalities are faced with problems caused by system fallacies beyond their control:

- **Excessive financial burdens:** These occur when cities and towns function as centres of larger suburban areas governed by different local authorities each of which has sovereignty of taxation: The results are financial spill-overs that are not or not fully compensated for.
  As municipalities are in charge for numerous social obligations, in particular social welfare, a socio-demographically disproportionate population structure may lead to immoderate social expenditures.
  Apart from these costs concerning mainly the large cities (known as "costs of density", see chapter 3.3.2), excessive financial burdens may also become a problem for rural areas due to peripheral geographical location, disperse settlement, or the topographical situation, for instance in remote mountainous areas (known as "costs of width").

- **Weak financial potential:** This may have one or more of the following reasons:

  - Unfavourable sociodemographic structures lead to below-average tax revenues.

  - Revenues are drained away as a result of large scale commuting because taxes are not paid in the municipality of employment but at the domicile.

  - Fragile economic structures may result from a weak business sector.

  As a result, certain municipalities are forced to put into effect higher tax rates than others, whose financial burdens are small, whose population is financially better off, whose busi-

ness sector prospers, or which enjoy a combination of these (see also figure 1). The problem is made worse by the fact that municipalities with high expenditures often suffer from an insufficient financial potential.

These two factors ("excessive financial burdens" and "weak financial potential") alone or in combination lead to distinct dissimilarities of tax rates in cantons and local municipalities. In other words, the level of taxation may be used as an indicator with regard to differing financial burdens and potential on the cantonal as well as on the municipal level.

If the autonomy of the municipalities and cantons is to be preserved within the Swiss federal system of government, then the municipalities and cantons need a sufficient financial basis enabling them to carry out their tasks comprehensively. That is also the reason why Switzerland has used various instruments of financial re-funding since several decades, like many other countries with a federal structure.

a) **Balancing of resources** is performed to counterbalance the differing financial potentials of cantons and local municipalities.

b) **Compensation for excessive financial burdens** is provided individually for immoderate financial encumbrances of cantons and municipalities.

Quite often these two instruments are combined in the sense that the balancing out of resources contains additional components focussing on the compensation for excessive financial burdens. Despite all efforts at evening out incongruous differences, the taxation disparities and spill-over problems have increased in Switzerland on all levels, occasionally reaching bizarre heights. As a result, today we are faced with three main problem domains:

- The principle of fair taxation is increasingly impaired.

- From the point of view of regional economics a financial system that allows for spill-overs harms fiscal equivalence (Meier 1996, 66 and Janos/Odermatt/Wachter 1997, 184f) and impedes allocation effectiveness.

- From the perspective of regional policy, highly different tax rates are a risk factor since they further social segregation between municipalities and increase geographical disparities.

2.2   Motivation of this Study

While a revision of the system of financial adjustment on the national level is ongoing, several cantons have started to amend intra-cantonal financial adjustment systems at the same time. All of them are following more or less the same principle of revision: Their aim is to separate the adjustment of financial resources - without taking into account the different financial burdens of cantons and municipalities - from a compensation for special or excessive burdens of cantons

or municipalities. The reforms propose to disentangle the puzzling network of tasks and obligations involving authorities on all levels and to achieve a more effective re-allocation of funds (EFD 2002, 8).

The canton of Zurich initiated a project to revise its own system of financial adjustment in 1999. According to a preliminary study (DJI 2001) Zurich's current system of re-allocating funds is considered fairly efficient. A nation-wide comparison shows today's tax rate disparity on the municipal level in the canton of Zurich to be about average. Nevertheless, the system suffers from certain shortcomings, such as the following (DJI 2001, 1):

- The disparity of tax rates has increased in the last few years considerably.

- The city of Zurich, which is by far the biggest community in the canton (and in Switzerland), is excluded from the balancing out of financial resources and adjustment of tax rates.

- Certain parts of the compensation for specific expenditures allocated to the city of Zurich have only been granted for a limited time period.

- The tools of financial adjustment are not very efficient.

Above all, a revision of the system of financial adjustment intends to re-build and to separate the balancing out of financial resources on the one hand and to compensate for specific expenditures on the other hand. A further goal is the inclusion of the city of Zurich in the revised system.

Figure 1 shows the tax rates of the 171 municipalities of the canton of Zurich in 2001.

As pointed out, the different tax rates may be used as an indicator highlighting weak financial potentials and/or extraordinary financial burdens. Thus, the figure gives an impression of the situation and the problems the canton of Zurich currently is facing.
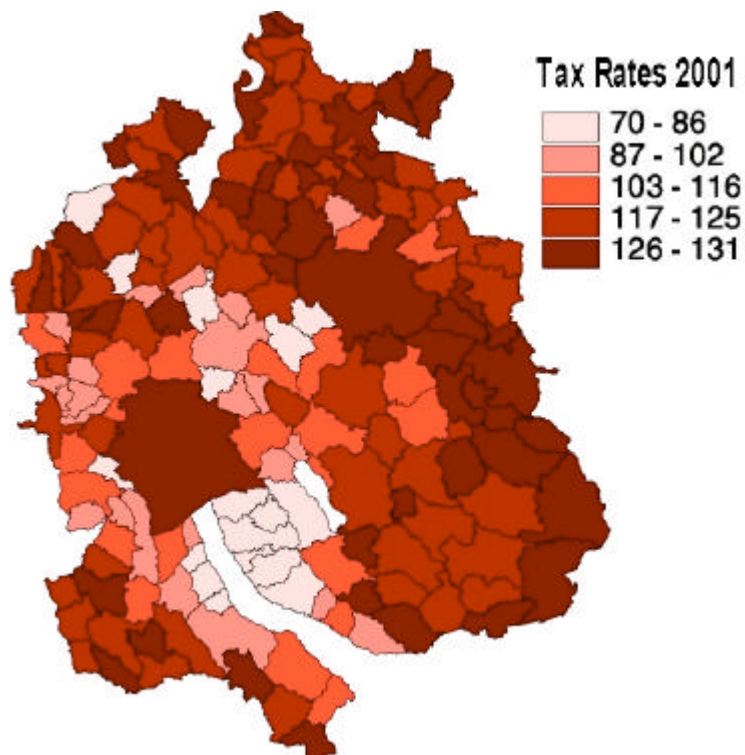

Figure 1:   Tax rates of municipalities within the canton of Zurich

3 Aim and Methodology

3.1 Main Aim of the Study

The main aim of this study was to develop a model based on objective criteria, which would tell for each municipality of the canton of Zurich how big the real financial demand is, to finally allow for a reasonable redistribution of the fiscal means (Czeranka/Frehner/Odermatt 2001/2002). This means that, as a first step, it was necessary to discover a possible set of variables which is suited to describe and model the financial burdens of all municipalities of the canton of Zurich. Therefore, a statistical methodology had to be developed with the aim, to draw conclusions about the relevance of variables for the communal financial strains imposed on all different types of municipalities. This methodology should be based on variables, a) describing directly the financial demand of each municipality, and b) covering additional aspects having indirectly an impact on financial needs. Therefore, a whole range of (geo-) statistical data has been tested on suitability and causality.

This tackles, however, an immanent problem: an indicator which really tells about financial needs, not financial desire or financial claim without real needs, is not readily available. So, the investigated variables have to be tested for suitability somehow. That means for our approach of statistical testing some kind of a reference variable first had to be found against which the explanatory variable set could be proven to be valid.

3.2 Methodological Approach for Modelling the Financial Load of the Municipalities

As the knowledge about a statistical correlation between more or less evident variables or even about the semantic net is quite poor, a deterministic model could not be developed. So the methodology was based on data-mining methods, aiming to discover the immanent patterns within the investigated variables, which have been selected under certain expectations. Normative rules have been avoided and multiple linear regression with different methods for variable selection was chosen as the adequate means for data mining. Furthermore, some main assumptions had to be made, under which the modelling has been carried out:

- The financial burden of the municipalities of the canton can be modelled using socio-demographic and geographic variables.

- Not all of the municipalities might be represented by the same model. As one obvious difference exists in the size of the municipalities, they have been grouped into size-classes (here, thresholds had to be found in preprocessing steps and finally were set to 3000 and 6000 inhabitants).

- The wealthy municipalities (definition will be given in chapter 4.2) and the municipality of Zurich as the regional or even national "megacity" (and possibly also the second biggest city of the canton: Winterthur) might falsify the models for the remaining municipalities and, therefore, might be considered separately.

3.3   Variables under Investigation

For the planned regression analysis, two classes of variables had to be investigated: a) the target variable (the dependent variable of the regression), which represents best the real financial load of a municipality, and b) the explanatory variables (independent variables of the regression), which are used to explain or to model the financial load of each municipality.

3.3.1   The Target Variable

For the representation of the financial burden of each municipality we considered the net expenditure to be appropriate. As a better suited dataset is not available, the GEFIS dataset (of the year 1999) has been used as the target variable for the regression analysis (note: GEFIS abbreviates "Gemeindefinanzdaten", which is a dataset comprising the synopsis of the financial data of all municipalities of the canton of Zurich). This GEFIS database covers for the 171 municipalities of the canton about 320'000 datasets divided into 10 main classes covering the following budget positions:

0: General Administration

1: Legal Protection and Safety

2: Education

3: Culture and Recreation

4: Health

5: Social Welfare

6: Transportation

7: Environment and Planning

8: Political Economy

9: Finances and Taxes

This GEFIS-dataset, however, was not readily usable: it had to be cleared concerning different aspects, having to do with the in-
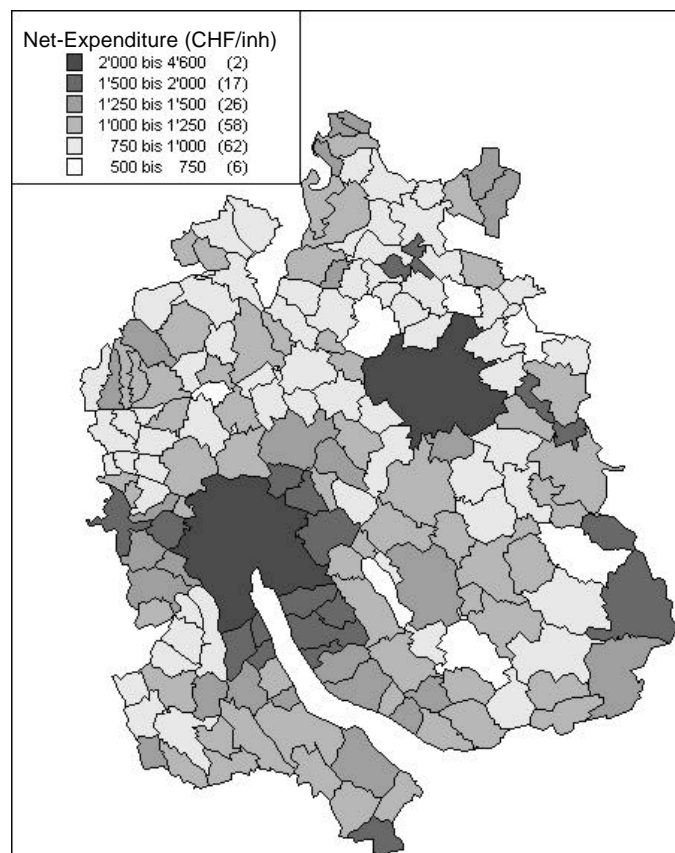

Figure 2:   Net expenditure per inhabitant within the canton of Zurich

tercommunal comparability of the expenditures. Furthermore, not all of the above mentioned GEFIS-classes are well suited to reflect the communal needs: the educational expenses, though making a big part of the overall costs of a municipality, are not comparable, as the political municipalities and the so-called "school municipalities" are not at all congruent. This means, that the educational expenses have been excluded from the finally regarded net expenses of a municipality. Similarly, the health care system does not allow a financial comparison between municipalities, as the state provides direct fiscal means for hospitals, nursing homes, and the like. As people from nearby municipalities also use, e.g., the facilities of the health care centres, these communal burdens have to be tackled with some respect.

For these and similar reasons, not all of the GEFIS-classes were used as input for the final target variable of the regression. In the beginning of the data mining approach each class separately and several class combinations were used to allow for a better perception of the explanatory variables. Finally, we settled on a fix set for the target variable: the sum of the classes no. 0, 1, 3, 5, 6 (i.e.: General Administration, Legal Protection and Safety, Culture and Recreation, Social Welfare, Transportation).

After the individual clearing of each of these GEFIS-classes, the financial burden was calculated per inhabitant (i.e.: net expenses per head per year) to allow for a comparison between different municipalities. This variable, though not considering all the expenditures of a municipality, is called in the following: "net expenditures per inhabitant" (see its spatial distribution in figure 2). Nevertheless, some respect has to be paid to this target variable definition, as it does not tell if the expenditure was necessary or just desired by the respective municipality.

3.3.2   General Remarks Concerning the Explanatory Variables

The social composition of the population in densely inhabited areas and in rural areas differ from each other. Therefore, varying financial loads for varying types of municipalities can be characterised by the following two concepts: "costs of width" and "costs of density". The latter costs are stemming from disproportionally high socio-demographic burdens and high costs of infrastructure in central municipalities. Typical assumptions for these core cities are a larger percentage of old people, foreigners, and young people resulting in a higher financial demand for public services. In addition, these urban centres have to provide infrastructure and services not only for the local population, but also for the whole catchment area.

In contrary, the "costs of width" are mainly explained by geographical factors, like peripheral and/or mountainous locations and typically low population density. This implies a relatively high financial load for the particular community, e.g., for streets' upkeep or for the fire brigade.

3.3.3   Explanatory Variables

Main criteria for the selection of the explanatory variables were evidence for the facts mentioned in chapter 3.3.2., interpretability (also in a political sense) concerning the target variable, and reliability of the data. The variables were drawn from sociodemographic, economic, and geographic/topographic realms.

Sources were the census from 1990 (the census 2000 data was not yet fully available); additional cantonal and communal statistical data from 1999, the geographical vector-model of the canton including, e.g., streets, landuse, planning zones concerning urban development and planned enlargements of the built-up areas, and the digital terrain model to allow for integration of relief impact. Reason for this widespread variable repository was the data driven approach to find the most declarative variables without too much heuristic interference. Therefore, initially a wide range of variables was considered as maybe having an impact on the financial expenses and, later on, was stepwise reduced.

The categories, providing supposingly an ability to explain financial burden or at least contributing to characterise every single municipality, were the following:

- **Demographics**: all inhabitants, inhabitants between 0 and 19 years, older than 65 years, older than 80 years, quota of foreigners.

- **Employment**: available workplaces per inhabitant, employment quota, employees within the three economical sectors, quota of tax payers, quota of unemployed, quota of commuters to workplaces in other cities.

- **Financial and social aspects**: quota of one-family-houses, inhabitants per flat, quota of the poor, quota of managers, quota of well-educated, mean net savings per inhabitant.

- **Geography**: quota of built-up area, quota of agricultural land, street length per inhabitant, length of all streets and paths per inhabitant, length of drainage system per inhabitant, height above sea level, mean slope, centrality factor (note: the definition of centrality being in itself a research question, we defined it in accordance to the class of gravitation models, see, e.g., Bähr 1983, as the distance to centres weighted with the logarithm of the inhabitants, see also figure 3).

- **Structure**: population density, inhabitants per forested area, per agricultural area, per built-up area, per area destined to get build-up, per area planned to get build-up within the next 5 years, number of stops of the public transport system, number of departures of the public transport system per inhabitant.

These about 40 variables were reduced by data preprocessing and backward selection regression (see also chapter 4.1). In addition, some variables were perceived not being good

indicators for our aims, as, e.g., people older than 65 years have to be considered ambiguously: especially along the lake Zurich, wealthy elderly people are relieving the public budgets, whereas the poorer elderly are a serious impact for public resources in other municipalities of the canton.

Finally, some explanatory variables, like "commuter_quota", turned out to be most important for the modelling of the net expenditures. Some results are presented in chapters 4 and 5.
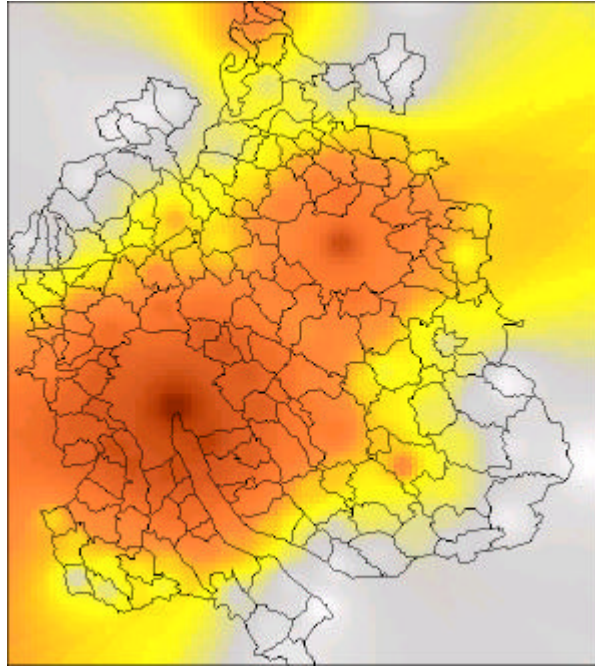

Figure 3:   Centrality (the darker the colour the more central)

4   Regression Analysis and Interpretation

4.1   Data Preprocessing for Linear Regression Analysis

Certain requirements have to be fulfilled, if a regression analysis should produce reliable results: both, the target variable and the explanatory variables, have to show a more or less normal distribution and should have a similar range of values. Therefore, within this study, all variables have been standardised to a mean of 0 and a standard deviation of 1. Before this standardisation the severely skew variables needed some additional treatment to get closer to a normal distribution as, e.g., the population numbers were quite skewed (i.e., from lots of municipalities with only some hundred inhabitants to a by far lonesome Zurich with about 335'000 inhabitants).

Therefore, the skew variables like inhabitants, commuters, and some more were logarithmically transformed before standardisation. Using this logarithmisation a variable gets transformed from an absolute scale to a relative scale allowing for a better comparability: an increase of 100 inhabitants for a municipality facing a population of 800 means much more impact than the increase of 100 persons for a municipality having currently 100'000 inhabitants.

Furthermore, the explanatory variables have to be linearly independent from each other. That's why they were tested for multi-collinearity by principal component analysis and stepwise omission of one of the collinear variables, if any.

4.2   Regression Results

In our data mining approach we used multiple linear regression analysis with backward selection of the explanatory variables. This means that all possibly explanatory variables first have been included within the analysis and then, in subsequent regression steps, always the least weighty variable got omitted before the regression process started again. This was done as long as just 2, respectively 3 variables were left over (bearing in mind that we wanted to search for a model being as simple as possible but not overseeing a significant change in results if an additional variable would be used for explanation). These calculations were performed for three size classes of municipalities (resulting finally in a segmented linear model) and the whole set of municipalities.

Figures 4 and 5 show two out of the diversity of the calculated regression lines: the x-axis shows the modelled net expenditure per inhabitant and the y-axis pictures the applied GEFIS-value (the target variable). Each cross marks a municipality: in figure 5 Zurich as well as the second largest city Winterthur are clearly visible (note: the small dots mark the regression line). These scatterplots actually show that it is hard to precisely model the expenditures of the
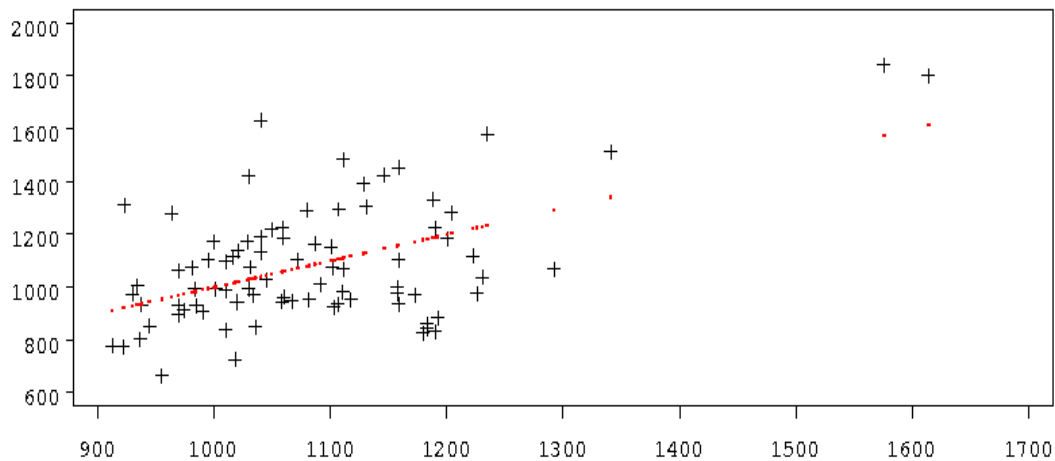

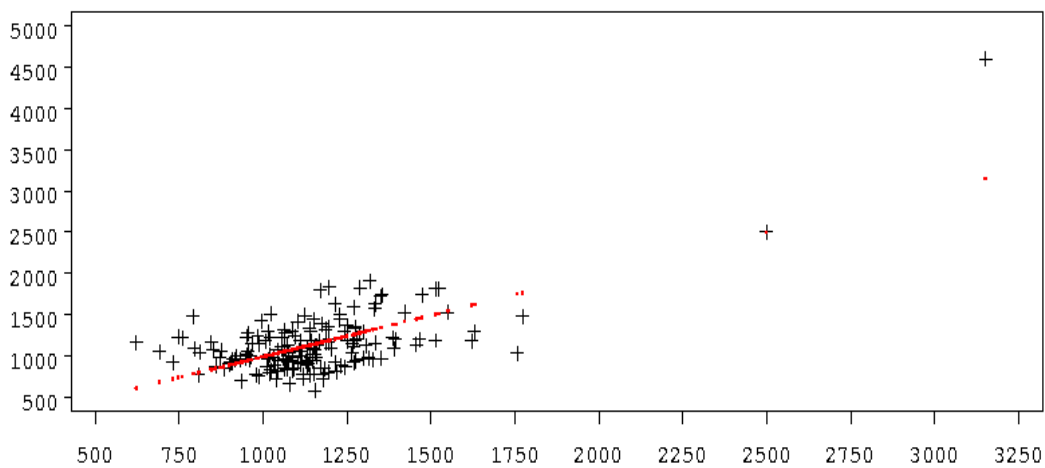Figure 4:   Regression for commuter_quota, mean_slope (class: small municipalities)

Figure 5:   Regression for commuter_quota, centrality (class: all municipalities incl. Zurich)

municipalities and that the deviations from the models are more or less large into both directions (reported also in figures 6ff). Nevertheless, the best models were searched for and reported in tables 1 and 2.

Table 1 shows that the regression results are quite disperse concerning the achievable goodness of fit with a simple model (the coefficients of determination are showing how much of the variance in the dataset is explainable by the respective 2 or 3 variables). For one part, the fit naturally gets increased by using more variables, but the gain from 2 to 3 variables is negligibly small.

Furthermore, the goodness of the models is quite high for the large municipalities (here: including the city of Zurich); though it is conceivable that the models especially for small municipalities have a very bad explanatory power (note: further investigations showed that this stems from a very inhomogeneous social and/or geographic structure especially of these small communes). The medium size municipalities as well as all municipalities together seem considerably good represented by the models, as a coefficient of determination of around 40 % does not seem too bad (though the results shown in table 2 put this into perspective). All in all it is noteworthy that the commuter quota to other cities, as one criterion for non-centrality, and the number of inhabitants per flat seem to have an above average significance for all commune sizes. For small size municipalities also the variable for terrain characterisation "mean slope" has a considerably high importance.

	85 small municipalities (<3000 inhabitants)	44 medium municipalities (3000-6000 inh.)	42 large municipalities (6000-335000 inh.)	all 171 municipalities
2 variables	commuter_quota mean_slope 28 %	commuter_quota inh/flat 36 %	inhabitants inh/flat 77 %	commuter_quota inh/flat 42 %
3 variables	commuter_quota inhabitants mean_slope 31 %	commuter_quota employed_agric. inh/flat 42 %	1famhouse_quota inh/flat inhabitants 80 %	commuter_quota inh/built-up_area centrality 48 %

Table 1: Explanatory variables (percentages show the coefficients of determination)

Table 2 shows regression results for the wealthy municipalities which were treated separately (note: wealthy municipalities are defined as those who had to balance out for municipalities having not enough own financial resources; in the year 1999 this made a set of 20 communes). Reason for this partial analysis was that the more wealthy communes supposingly are spending more money than comparable ones (in the sense of similar socio-demographic or topographic circumstances) and, therefore, regression results for the remainder of the municipalities might get better. The results in column 2 of table 2 generally seem to support this idea, however, the increase of model fitness from 42% to 44 % (or 48 % to 51 %, respectively) is unimpressive.

Furthermore, table 2 shows results for the analysis with and without Zurich (being by far the biggest centre of the canton and eating up a lot of financial means because of its outstanding functionalities). A bit astonishingly the regression for all municipalities got downgraded significantly from 42 % to 29 % (48 % to 33 %, respectively). This result even gets worse when it comes to all municipalities without the wealthy ones and without Zurich. This means the wealthy communes and Zurich are affecting the municipality-classes severely. On the other hand the factors characterising the remaining municipalities don't show a high statistical importance and, therefore, also fail in having a politically acceptable or utilisable importance.

	all municipalities (171 municipalities)	without wealthy munic. (151 municipalities)	all munic. except Zurich (170 municipalities)	without wealthy munic., without Zurich (150 m.)
2 variables	commuter_quota inh/flat 42 %	commuter_quota inh/built-up_area 44 %	commuter_quota inh/flat 29 %	commuter_quota inh/built-up_area 25 %
3 variables	commuter_quota inh/built-up_area centrality 48 %	commuter_quota inh/built-up_area centrality 51 %	commuter_quota inh/flat mean_slope 33 %	commuter_quota inh/built-up_area inh/flat 29 %

Table 2:   Regression model with and without the wealthy municipalities and Zurich

5   Estimation of the Financial Load

Using the regression results, the financial burden of each municipality has been calculated in order to allow an interpretation of the goodness of the models by comparison of the real load (here, the partial GEFIS-sum of the year 1999) versus the modelled one.

In this sense, figure 6 is showing the differences between the values of the net expenditure (in Swiss Francs per inhabitant) and the modelled expenditures (here, the model-results with 2 variables for the whole municipality-set have been used). The communes with full colours show a more or less
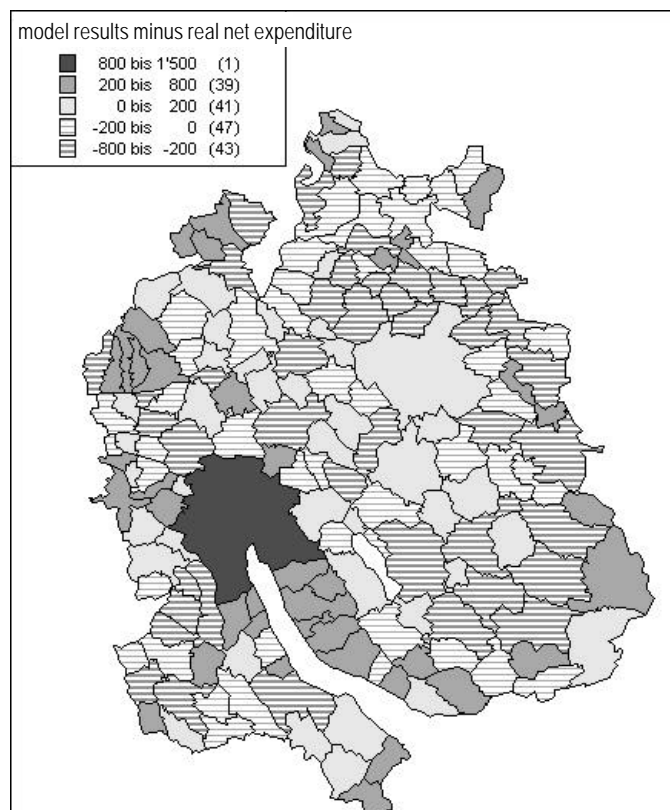

Figure 6:   Discrepancy between the model values and the net expenditures per inhabitant

surplus of the model results over the real expenditures whereas the hatched communes are having less expenditures than the model predicts. For example, the expenditures of the city of Zurich get highly underestimated by this model and also the more wealthy communes along the lake of Zurich (the long narrow band reaching north into the city of Zurich) as well as some peripheral municipalities are underestimated systematically. In contrary, the municipalities situated more apart from Zurich but mainly not building the direct outskirts of the canton are overestimated, i.e., they typically don't spend as much money as the model predicts.

In addition to figure 6, the figures 7 and 8 (at the end of this paper) are showing other interpretations of the comparison of model results and real-world data. Here, the residuals of the models with 2 and with 3 variables (using the respective model for the whole municipality-set) are sorted differently: figure 7 shows the results sorted according to the size of the commune and figure 8 is sorted according to the amount of expenditures. Both figures show that the models with 2 and with 3 variables are fitting each other quite well, though for some municipalities differences are clearly visible. According to the two sorting methods, a simple rule for these variations cannot be derived.

Furthermore, in figure 8 a slight trend is perceivable telling that the communes with less expenditures are modelled a bit better and are usually overestimated in comparison with the communes with high expenditures, being usually underestimated.

6   Conclusions for the Canton of Zurich

- Main aim of the study was the evaluation of socio-demographic and topographic indicators for an explanation of financial burdens of the municipalities in the canton of Zurich. The results of the study provided decision support if a statistically valid model may be created regulating the compensation for excessive financial burdens. Such a model would have to be easily comprehensible to be politically acceptable which assumes that the basic (regression) calculations would produce clear and convincing results. Even though we could generate some regression models with statistically acceptable or even good results, they were not overwhelming. Therefore, the development of a compensation model for excessive financial burdens based on indicators had to be renounced.

- The city of Zurich as well as the wealthy municipalities of the canton of Zurich are influencing the regression calculations quite strongly. If these communes are omitted from the calculations the regression results, however, get worse: the net expenditures of the remaining communes are not any more satisfactory explainable with the available explanatory variables. This means that a compensation model just for these supposingly more homogeneous groups of communes cannot be created neither.

- All in all, the municipalities of the canton of Zurich cannot be classified into clear categories with similar financial burdens. This stems from individual factors differencing the seemingly similar municipalities into numerous small, yet undiscovered classes.

- The variable "centrality" usually has a high importance in characterising municipalities. Here, centrality was defined more or less normatively according to gravity models, whereas variables like "commuters" or "available work places" are also usable in certain senses to express some kind of centrality. If, anyway, a compensation model for the financial burdens of the various types of municipalities should be defined, probably more normative rules would have to be developed. But still the most important premise would be to attain political acceptance for the methodology.

7   Research Outlook

In addition to the conclusions for the canton of Zurich presented in the previous chapter, here, we are pointing out some research directions which we think are worth to consider.

Selection and preparation of variables with regard to financial aspects:

- Could the target variable, i.e., the financial burden of a municipality, be better chosen in order to represent the "real" load, taking into account divers functions and the status of wealth of the respective community?

- May the models be further improved, if more heuristics is applied?

- Are there better suited explanatory variables or could a better preselection and preparation of these variables happen?

Methodological aspects

- A model could assumingly be more specific if the municipalities are sorted into meaningful classes and modelled separately, e.g., taking into account the size of the municipality, structural type, wealthiness. But which are the suggestive classes and are these class-wise models still meaningful and desirable?

- How many indicators, i.e., explanatory variables, should be found (the larger the number of explanatory variables, the better the modelling but the more complicated the interpretation)?

- Are there better and still sensible data-mining tools instead of the multiple linear regression models (e.g., non-linear models)?

Furthermore, for some of the broached subjects the scientific background is not readily enlightened. This concerns, e.g., the concepts of "costs of width" and "costs of density". And finally, a comparison of methods and techniques for this kind of analysis across borders would be interesting to see.

Acknowledgements

Literature

Bähr, J. (1983): Bevölkerungsgeographie. UTB, Stuttgart.

Czeranka, M. / Frehner, M. / Odermatt, A. (2001/2002): Evaluierung von Inditkatoren soziodemografischer und topografischer Natur als Massgrössen für die Belastungsstruktur der Gemeindehaushalte im Kanton Zürich. Studie A and Studie B (unpublished).

DJI (Direktion der Justiz und des Innern des Kantons Zürich) (2001): Vorstudie des Zürcher Finanzausgleichs. Zürich (unpublished).

EFD (Eidgenössisches Finanzdepartement) (2002): Neugestaltung des Finanzausgleichs und der Aufgaben zwischen Bund und Kantonen NFA. Reform für mehr Effizienz und günstigere Leistungen unseres Staates. Bern.

Hotz-Hart, B. / Mäder, S. / Vock, P. (1995): Volkswirtschaft der Schweiz. Zürich.

Janos, E. / Odermatt, A. / Wachter, D. (1997): Sozioökonomische Strukturen im Raum Zürich. Wirtschaftsgeographie und Raumplanung. Vol. 24. Zürich.

Meier, A. (1996): Das heutige System des bundesstaatlichen Finanzausgleichs. Eine kritische Betrachtung aus Sicht der Wissenschaft. In: Mäder, H. / Schedler, K. (Hrsg.): Perspektiven des Finanzausgleichs in der Schweiz. Bern / Stuttgart / Wien. S. 65-77.

Odermatt, A. (1999): Räumlich-soziale Entmischung und die Finanzkrise der Kernstädte – das Beispiel Zürich. Geographica Helvetica. Heft 4, 1999, S. 251-261.
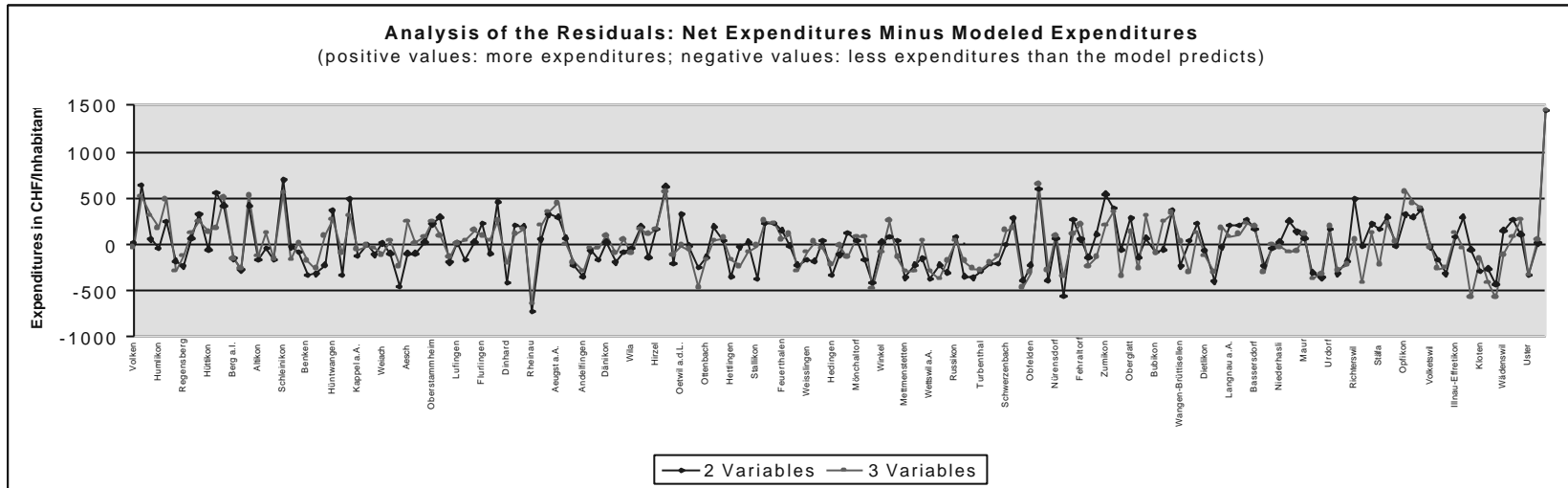
Figure 7:   Residuals sorted according to the size of the municipalities (small municipalities are on the left; large municipalities are on the right)
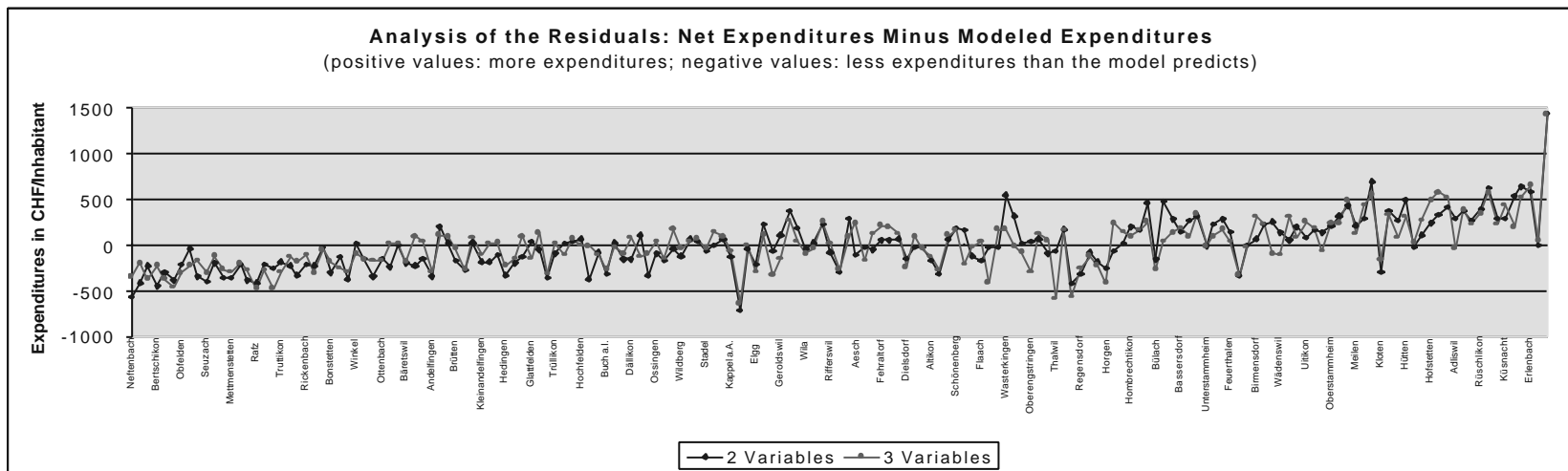

Figure 8:   Residuals sorted according to the size of the target variable (net expenditure per inhabitant; the small amounts are on the left)