
Modelling firm (re-)location choice in UrbanSim

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Abstract

Competition between nations, regions, and towns attracting new firms and inhabitants is one of the mayor political discussions nowadays and led among others to tax reductions, incentives for new establishments, and business destination promotion activities. On the one hand, this paper investigates the effects of different possible options for cantonal and municipal authorities' intent to attract firms: improvements in transport infrastructure, designation of new building zones, and last but not least tax reductions. These actions have been tested by simulating the decisions of firms in the case study area of St.Gallen region, Switzerland. On the other hand, the paper aims to provide an approach to implement these models in UrbanSim.

Keywords

UrbanSim, simulation, firm, location choice, business development, St. Gallen, IVT, Zürich

1 Introduction

Over the last decade, low economic growth rates resulted in intensified competition between nations, regions, and towns in trying to attract new firms and inhabitants. In particular, the establishment of new firms has become one of the most vital objectives of governments and public authorities all over Europe. To raise the attractiveness of a region, different instruments have been used: tax reductions, incentives for new establishments, as business destination promotion activities, supply of outstanding infrastructure and public services.

The first part of this paper gives a short overview to relevant scientific work in this field. Focus lies on specific findings in Switzerland. For more details, we refer to Bodenmann and Axhausen (2011b).

The second part presents the reference model and investigates effects of different possible options for cantonal and municipal authorities' intent to attract firms: improvements in transport infrastructure, designation of new building zones, and last but not least tax reductions. These actions have been tested by simulating the decisions of existing firms. The parameters for these simulations have been estimated with a discrete choice model using data of the cantons St.Gallen and both Appenzell as well as Zurich. These chapters base on research projects of Transport Planning and Systems (IVT) published by Bodenmann and Axhausen (2011a/2011b).

The second part of the paper aims to provide an approach to implement these models in UrbanSim. UrbanSim is a software-based simulation system for supporting planning and analysis of urban development, incorporating the interactions between land use, transportation, the economy, and the environment. At the moment, UrbanSim is adapted to a European context (see the according research project SustainCity, www.sustaincity.eu).

2 Research in firm location choice

Due to the rising importance of business development by authorities, different authors have been working on this subject. Credit Suisse (CS, 2003) gives an overview of cantonal business development efforts. They analysed several economic development measures supporting firms to intensify their local business activities with the objective of strengthen the economy of a region. The report shows that, since the 1990's authorities in Switzerland became more sensitive to business development issues. As a reaction to the fact that by international standards Swiss economic growth remains below average, cantonal authorities intensified their promotion activities with firms. In 2001 Swiss cantons spent more than CHF 95 million and engaged about 100 full time equivalents (FTE) positions.

With the rising importance of official business development efforts, different authors initiated research on this impact. The location promotion agency of the region of Winterthur (Marfurt and Domeisen, 2010) names seven important location factors: a) quality of life, b) population and income, c) accessibility and infrastructure, d) tax burden, e) number of employees and industries present, f) innovation and educational milieu, g) availability and price of land as well as rentable premises. Generally, this list corresponds with the view point of trade associations (Swissmem, 2009; SwissHoldings, 2010). Taking into consideration different concepts and models discussed by several authors, Bodenmann and Axhausen (2010) show that the factors listed above are also relevant from an empirical point of view. Indeed, generally authorities only have three main options to raise their attractiveness in the short term: to reduce the tax burden, to provide specific infrastructure and to facilitate business activities (Siebert, 2000; Brenner and Fornahl, 2002).

On a national as well as international level, especially the offer of subsidies and taxes reductions became popular but controversial tools. Several studies all over the world demonstrate a positive effect of low taxes on relocations and establishments of firms (e.g. Siebert, 1996). Indeed, Bodenmann and Axhausen (2011a) show that firms are significantly more sensitive to tax levels than partnerships and sole traders. Bondonio and Greenbaum (2007) studied the impact of tax incentives on local economic growth in enterprise zone programs (EZ) of different US states. They show that EZ incentives do have a significant positive impact on new firm establishments and, to a smaller extent, on existing firms. But, Bondonio and Greenbaum also reveal negative side effects as EZ policies tend to accelerate business closures as well. In addition, Neumark and Kolko (2010) investigated the impact of EZ on the

number of jobs in California could not show a positive effect. They noted, that “the program [in California] is ineffective in achieving its primary goals”.

Providing special infrastructure is an effective but costly way to raise the attractiveness of a region. Different studies show a positive influence of traffic infrastructure (Hilber, 1999) as well as leisure and school quality (Gatzweiler *et al.*, 1991). Amongst others, De Bok (2007) demonstrated that accessibility has a positive effect on service businesses. Bodenmann and Axhausen (2011a) show that generally this holds for other sectors, too. Especially the presence of motorway connections and railway stations are highly valued. Key disadvantages of providing infrastructure are very high short- and long-term costs. Particularly long-term costs are quite difficult to estimate (Gilgen and Aliesch, 2004).

To facilitate business activities, authorities usually try to create a business friendly atmosphere. This is certainly the primary task of business development agencies. However, measuring effects of the impact of business development is very difficult. That is certainly one reason for the absence of performance reviews in this field (Kleinewefers, 2004). On the basis of a survey of all cantonal business development agencies, CS (2003) created a business development index representing the allocation of resources. The following factors were used to construct this index: a) numbers of FTE persons employed in the cantonal business promotion offices, b) marketing and promotion budget, c) characterization of the development style, d) establishing and maintaining the main location factors, e) website, f) legal establishment of the cantonal promotions, and h) the public visibility of the leading person in the media with regards to economic development issues. The CS research team compared this business development index with economic growth or establishment of firms. However, it was not possible to show any evidence for a relation between these indicators. Therefore, they conclude that “economic relationships and historically developed economic structures are too complex to make a final assessment”, in particular, “regional economic and industrial structures characterize the different growth potentials” and tend to distort the detection of impacts. Working with the same index, Baranzini *et al.* (2006) showed an impact in a more complex and comprehensive model. They show that business development by Swiss cantons has a significant positive influence on the number of newly established and relocating firms.

Devereux *et al.* (2007) investigated the impact of governmental subsidies by using data of multi-plant firms in Great Britain. They reveal that the positive impact of subsidies becomes more important with a rising number of firms already established. However, conditional on agglomeration effects, they conclude that grants have only a small effect on location choice.

3 Reference model and simulations

3.1 Data and szenarios considered

3.1.1 Agents: firms

Key information about 54,600 firms between 1991 and 2006 has been extracted from the commercial registers of the cantons of St. Gallen, and both Appenzell. The data set includes joint stock companies (Aktiengesellschaften, AG) and limited liability companies (Gesellschaften mit beschränkter Haftung, GmbH), sole traders, and partnerships. Compared to other European countries, the share of limited liability companies is very small. In Switzerland, only 40.0% of all companies are limited liability companies (data 2008; FSO, 2009) – whereas e.g. in Germany, this share is 98.3% (data 2008; DESTATIS, 2010). Specifically, this data set of the commercial registers contains the city of residence as well as business demographic events like establishments, closures and relocations of firms. This data base has been enhanced with a sector and size indication from the business and trade register (BUR) of the Swiss Federal Statistical Office (FSO). Unfortunately, data from BUR can be traced back only till year 2003. The records do not include sector affiliation data. However, this information was identified based on the firm's name and business goal, which are recorded in the business register.

Generally, once established, firms keep their location – only about 1.77% of all firms relocate every year (for further details see Bodenmann and Axhausen, 2009/2011a). Firms in the sector of service and finance (2.26%) relocate considerably more often than firms in the sector of agriculture and mining (0.82%). The spatial pattern of migrations illustrates two important characteristics of firm migration (Bodenmann and Axhausen, 2011a): a) firms stick to their region of origin and, generally, do not move long distances; b) towns not only play an important role for new firm establishments, but also for migrating firms.

Since only few firms are affected by relocations, only a random sample of 1% of the non-movers has been included in the models. In contrast, the entire population of migrating firms has been considered. Therefore, the number of observations decreases from 392,000 to about 11,000. This approach reduces the processing time for the estimation of the models from more than one week to less than three hours.

3.1.2 Alternatives: municipalities

Selectable alternatives are municipalities, which are characterised by a large set of variables covering three different groups: production factors, business environment, and governmental environment. The selection of the variables used bases on the theoretical overview in Bodenmann and Axhausen (2010) and is discussed in detail in Bodenmann and Axhausen (2011a). Most of the data is available for all Swiss municipalities and the whole period of 16 years. Still, three variables are only available for the cantons observed: degree of land use in building zones, land prices at municipal level, and duration of the approval process for building licence applications. These datasets are from cantonal sources¹ and from a special survey covering the case study area exclusively.

Production factors are modelled by land prices for different land-use types (commerce and industry, residential use), degree of land use in building zones, rate of unemployment, and share of economically active population with a graduate degree. Additionally, following Guevara (2010) land prices have been estimated by a linear regression using as explanatory variables the same variables involved in the discrete choice models. The resulting residuals are included in the discrete choice model as control variables. The labour market is modelled by the rate of unemployment and the rate of economically active population with graduate degree (FSO, 2009). Since employees of a firm do not have to reside in the same municipality as the firm, these two variables are calculated as a weighted sum comprising municipalities within a radius of 30 km employing a negative exponential weighting function.

Business environment is represented by the share of employees within the same sector (localisation effects) and the index of diversity of sectors (urbanisation effects). Similar to the two variables representing labour market, these indicators are calculated as a weighted sum. Regarding diversity, the richness in work places of different sectors is calculated on NOGA-code level 2 in each municipality (Baumgärtner, 2003; Hoffmann, 2006). The number of employees and work places by sector is extracted from the Swiss census of enterprises (FSO, 2009). Bodenmann and Axhausen (2008) demonstrated that cities play an essential role in firmographics; therefore, a dummy variable for large and intermediate cities² has been introduced.

¹ Record on the current status of building zones (“Überbauungsstand”).

² Consistent with the FSO’s typology of municipalities, this covers all agglomeration centers with a minimum of 45,000 inhabitants (Schuler *et al.*, 2005).

Governmental environment has been modelled with several variables: tax burden for different legal forms of businesses, infrastructure as access to motorway and railway, accessibility to employees, duration of the approval process for building licence applications, and an index for cantonal business development of CS (CS, 2003). Data on tax burden is available from the Swiss Federal Tax Administration (FTA) on a yearly basis since 1994 (FTA, 2007). Information regarding motorway and rail station in municipalities as well as their accessibility has been provided by the Institute for Transport Planning and Systems (IVT) of ETH Zürich (Tschopp, 2007; Fröhlich, 2008).

Distances are important for the calculation of several variables and for the distance between the actual and a potential site. Based on Fröhlich (2008) shortest road network distances have been used.

3.1.3 Scenarios: options for action of authorities

Different sets of scenarios have been tested: 1) transport infrastructure projects, 2) designations of new building zones, 3) tax reductions, and 4) all scenarios combined. On the one hand these scenarios cover important factors in the model and, on the other hand, factors which can be influenced by authorities. All of the supposed interventions are certainly not run-of-the-mill, but it is not impossible to find authorities implementing even stronger and more comprehensive interventions.

The first set of scenarios addresses various existing transport infrastructure projects. Figure 1 provides an overview on the tested projects. These projects are defined in the cantonal directive plans of St. Gallen (AREG, 2010) and Appenzell Ausserrhoden (PA AR, 2001).

Designation of new building zones is another often discussed option for action. Because spatial planning in Switzerland is assigned to cities and municipalities, the effect has been tested in three municipalities: the city of St. Gallen, Gossau and Ebnat-Kappel. They represent three different types of municipalities: the centre of an agglomeration (city of St. Gallen), a municipality in an agglomeration (Gossau), and a rural municipality distant from the large transport axes (Ebnat-Kappel). Additionally, they vary considerably in number of inhabitants and size of building zones: St. Gallen is the unrivalled largest city in the region with 72,600 inhabitants, with 17,500 inhabitants Gossau is a clearly smaller city, and Ebnat-Kappel with 4,900 inhabitants is a village comparable (in size) to a large number of other municipalities (numbers for 2009, FSO 2009).

In all scenarios for designated new building zones, 10 ha of new building zones for commercial and industrial use have been added. Without doubt, 10 ha is quite a large area. But in

Switzerland there are examples of even larger expansions: e.g. the saw mill of the Mayr-Melnhof-Group in Domat-Ems (20 ha; Canton of Graubünden, 2010) and the new factory for Amgen in Galmiz (55 ha; ARE, 2004) mentioned above. In fact, the model does not use the dimension of building zones as such, but the resulting degree of land use instead. The impact on a small village like Ebnat-Kappel (-3.7 inhabitants and employees per hectare) is much larger than on a city like St. Gallen (-0.6).

The third set of scenarios considers tax reductions on two levels: a) on a municipal level, authorities can change tax burden for partnerships and sole proprietorships. These firms are treated as natural persons with a tax rate fixed by the municipality. In these scenarios the same municipalities have been chosen as in the scenarios regarding building zones. b) On a cantonal level, authorities control tax burden for companies treated as legal persons. On this level, only one scenario with the canton of Appenzell as actor has been calculated. In all scenarios taxes are supposed to decline by 100% of the standard deviation – this is in the range of the observed decrease in tax rates over the last ten years (ESTV, 2006/2010).

3.2 Base model and simulation procedure

3.2.1 Estimation of base model

In the discrete choice model employed, each year firms face 120 alternatives: all 114 municipalities in the case study area, plus 6 municipalities randomly selected out of the rest of Switzerland. The set of alternatives contains only Swiss municipalities that are involved in at least one migration observed between 1991 and 2006 (584 municipalities). This scheme reflects the point of view of the decision making firms: for each observation the first alternative represents the current location of the firms. The structure is modelled in a Nested Logit (NL) model with several nests (McFadden, 1978; Train, 2003): Nest 1 “Stay” has one alternative (present location); the additional nests contain all other alternatives divided in 12 districts to detect spatial autocorrelation. With regards to the correction of a potential selection bias, for alternative 1 the respective correction suggested by Bierlaire *et al.* (2008) has been estimated.

Bodenmann and Axhausen (2011a) provide a detailed description of the model. All parameter estimations are performed using software BIOGEME 1.9 (Bierlaire, 2003 and Bierlaire 2010). Due to the high complexity of calculations, CFSQP was employed as optimization algorithm (developed by Panier, Tits, Zhou, and Lawrence; Lawrence *et al.*, 1997). For spatial analysis and data preparation GIS-software GeoMedia Professional 6.1 has been used (Intergraph, 2010).

Table 1 Estimated marginal effects in the base model for mean values

Elasticities for alternative	1 “stay”	2 to 120 “move”
Geographical aspects		
Distance to the previous site**		0.454
Factors of production		
Land-price for commerce and industry	0.002 *	0.104 *
Residuals of land-price for commerce and industry	-0.005	-0.290
Land-price for residential use	-0.004 *	-0.217 *
Residuals of land-price for residential use	-0.010 *	-0.584 *
Degree of land use in building zones	-0.008 *	-0.446 *
Rate of unemployment	0.004 *	0.238 *
Rate of population economically active with graduate degree	0.007 *	0.387 *
Business environment		
Previous site is in a large or intermediate city (d)	-0.008 *	
Alternative is a large or intermediate city (d)		0.859 *
Rate of employees within the same sector	0.001 *	0.044 *
Index of diversity in different sectors	0.023 *	1.310 *
Governmental environment		
Tax burden for partnerships	-0.015 *	-0.872 *
Tax burden for companies	-0.080 *	-4.509 *
Municipality with a motorway connection (d)	0.001 *	0.042 *
Municipality with a railway station (d)	0.003 *	0.150 *
Accessibility to employees	0.006 *	0.323 *
Duration of the approval process for building licence application	-0.004 *	-0.210 *
Index of cantonal business development	0.037 *	2.110 *

(d) Dummy variable

* Significant according to t-test

** Distance d has been transformed into $e^{\lambda \times d}$, with $\lambda = -0.056$ (estimated in base model)

Model information: 10,708 observations; 120 alternatives; 13 nests; adjusted rho-square: 0.404.

Table 1 lists the resulting elasticities of model variables for alternative 1 (previous location) and all other alternatives. The point elasticity has been calculated for the mean value of each variable. As alternative 1 is the predominant alternative, elasticity for this alternative are generally quite a lot smaller than for the average of the other alternatives. Regarding the other alternatives, chosen by relocating firms, tax burdens as well as the indexes of cantonal business development and diversity of places of employment in different sectors show the largest elasticity. Specifically, tax burden for companies is, as compared to the other variables, highly elastic. As the index of cantonal business development is a complex indicator composed of

different monetary and nonmonetary variables, the interpretation of this effect is to be performed with caution. But it certainly shows the high importance of business development efforts. At first sight, distance between an alternative municipality and the previous site has only a small impact on the choice probability. Indeed, as distance is exponentially transformed, the elasticity increases considerably with decreasing distance between the previous site and the respective alternative. For the mean moving distance of 36 km, the elasticity is 0.454. For decreasing distances like 10 km and 5 km, the elasticity increases considerably to 1.948 and 2.577, respectively. The elasticity of land-price for commerce and industry is positive and small. Indeed, the residuals representing the part not explained by the variables in this model are significantly larger and negative. Thus, high land prices have only a negative impact if prices can not be explained by other positive impacts for firms (e.g. low taxes). Due to crowding-out effects, land-prices for residential use have a stronger negative impact.

3.2.2 Simulation procedure

Since the dataset only covers firms in the case study area, the simulations consider only firms staying and relocating in this case study area. Due to a large number of firms migrating between cities – in the case of this study between St.Gallen and other cities outside the case study area (Bodenmann and Axhausen, 2008) – this approach leads to an overestimation of the number of firms leaving the town of St.Gallen. Therefore this parameter has to be re-estimated with the new sample to get correct results. Based on Monte-Carlo simulation (Train, 2003), 1000 simulated choices are drawn and compared with the simulated choices of other scenarios. All simulations are performed using BIOSIM 1.9, the simulation software based on BIOGEME (Bierlaire, 2010). Using the parameter estimation of the previous chapter, BIOSIM produces probabilities for each alternative in each observation of the sample. The simulated choice of a certain alternative is distributed according to these probabilities.

In a first step, the number of firms observed in each municipality is compared with the corresponding simulation results. At the level of municipality, differences vary substantially. The main reason for this relates to the large number of municipalities with a small number of firms: the majority of municipalities have less than 30 firms in the sample covering 16 years. At the level of districts and cantons³ the difference between observed and simulated choices are at 8% at most. It is not surprising that the district showing the maximum difference is also one of the smallest districts – all other districts show a maximal difference of 4%.

³ Districts with less than 30 firms per year have been merged.

In a second step, a scenario 0 has been created. It is assumed that all firms in the dataset face all alternatives in the case study area, but the variables characterising alternatives are all set to the value of the simulation base-year 2006. Therefore, variables characterising alternatives do not vary in time any more. A comparison between simulations with correct years and all firms set to 2006 shows relatively large differences. Particularly, both cantons of Appenzell seem to have improved their position in the competition between cantons. Certainly, the main reason for this result is the lowered tax rates in these cantons.

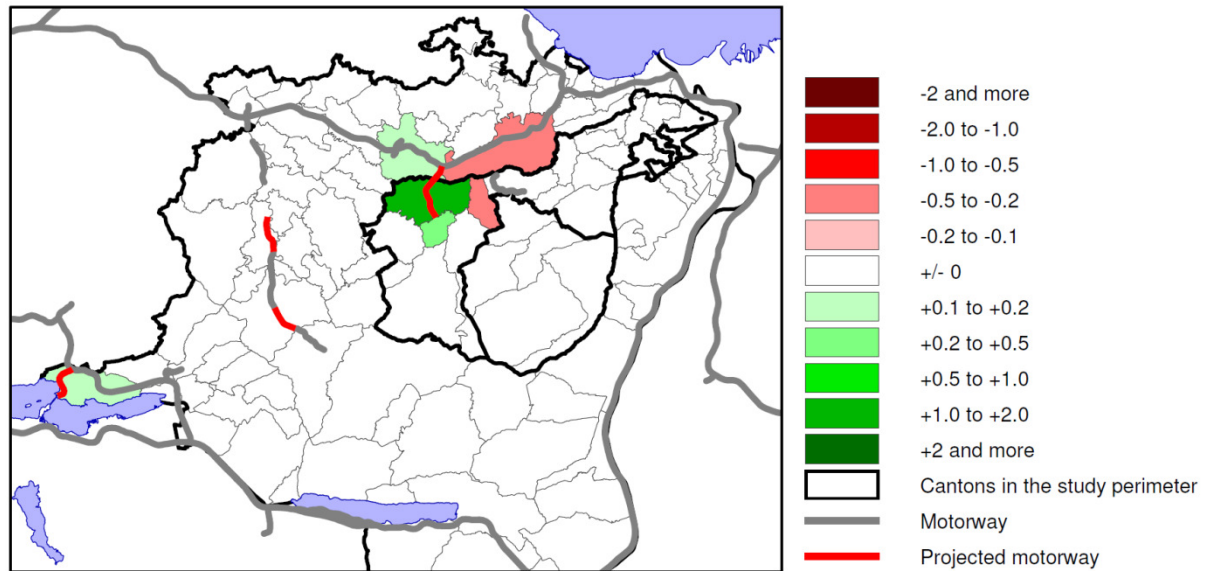
The third step is to create the scenarios to be tested and the corresponding simulations. The scenarios have been introduced in chapter 3.1.3; all other variables are identical to scenario 0. Due to the high number of simulations, results are very robust and random errors small. All results presented in the following chapters refer to the number of firms per year. Generally, these numbers are small and show impressively, that relocating firms are quite rare events. To avoid random noise, the following maps only include differences of more than 0.1 firms.

3.3 Results

Figure 1 shows the relocation pattern of firms due to the projected bypasses in Rapperswil-Jona and in the district of Toggenburg, as well as the motorway connection and access highway for the region of Appenzell. Given that the two scenarios are spatially separated, the effects of the different projects can be described in one chart. The new bypasses in the district of Toggenburg have a surprisingly small impact. One reason is that in rural areas distances between municipalities are relatively large. Additionally, residential population and numbers of employees in these municipalities are small. Therefore, accessibility is generally low and, due to the negative exponential transformation, remaining small despite of travel time savings.

The new access highway for the region of Appenzell has a considerable impact on various municipalities. In contrast to a rural region, travel time savings affects an area with a relatively high density of residential population and firms. Although the model used for this paper considers only the later, municipalities along this new highway are impacted significantly. The positive effects are even further enhanced due to direct access to the motorway A1: Chur - St.Gallen - Zürich - Bern. Specifically, Herisau is affected with 1.94 additional firms per year. But also Waldstatt and Gossau benefit from positive effects. Interventions regarding transport infrastructure have a larger impact in densely populated areas. Negative effects can be shown for areas along existing important traffic corridors (e.g. St. Gallen) but also in the hinterland of municipalities directly concerned (e.g. Stein AR).

Figure 1 Impact of projected transport infrastructure projects [number of additional firms per year]



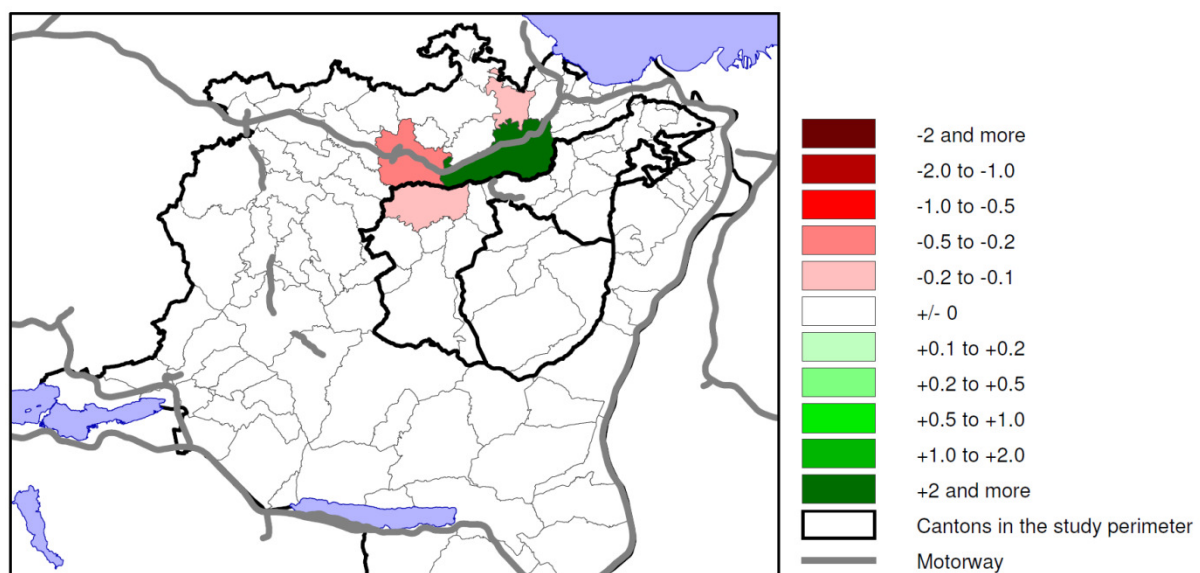
Sources: Districts GG25 © 2006 swisstopo (DV33492.2)

According to the estimated elasticities of the model presented in Table 1, designation of new building zones have a slightly larger impact than transport infrastructure projects – even if motorway connections are taken into account. However, new building zones have positive effects only for the corresponding municipality and, as degree of land use is modelled, the effect of new building zones is influenced by the dimension of all building zones in these municipalities. For the scenarios considered, differences between the three municipalities are very important: due to the designation of 10 ha of new unbuilt building zones, the degree of land use in St. Gallen decreases by 0.6% only, whereas in Gossau and Ebnat-Kappel density decreases by 2.1% and 7.4%, respectively.

Due to this uneven impact, we would assume that the simulation results show the largest positive effect in Ebnat-Kappel. However, this is not the case: In Ebnat-Kappel, only an additional 0.1 firms would be gained per year. The positive effects in Gossau (+0.17) and St. Gallen (+0.33) are also small – but still considerably larger. A reason for this result may be the large number of firms in and near the city of St. Gallen. Interestingly, this finding strongly resembles the results of Devereux *et al.* (2007) regarding taxes and incentives: effects tend to be stronger, if, at a specific site, numerous firms are present already. Indeed, relatively to the trend observed in the last years, Ebnat-Kappel shows a +20% higher growth rate. This is a good deal more than Gossau (+1%) and St. Gallen (+0.3%).

In our scenarios tax reductions have a high impact for two reasons: On the one hand, the respective elasticities estimated in the base model are relatively important – specifically, the variable of tax burden for companies is very elastic. On the other hand, the projected tax reductions in the amount of one standard deviation are, compared to the variance in other scenarios, very large (about 14% in all scenarios concerned). Indeed, as mentioned in chapter 3.1.3, this assumption corresponds to development observed in Swiss municipalities and cantons over the last decade.

Figure 2 Impact of a tax reduction for natural persons in the town of St. Gallen [number of additional firms per year]

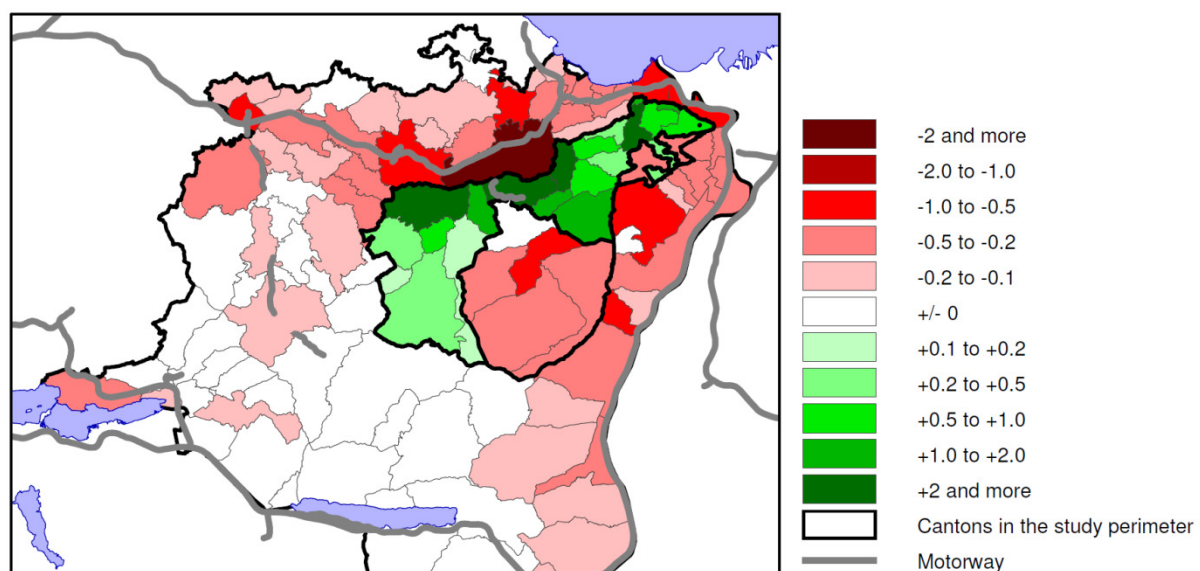


Sources: Districts GG25 © 2006 swisstopo (DV33492.2)

Regarding tax reduction for natural persons, effects have been simulated for the same municipalities as in scenarios above. Results are similar; but, as expected, positive effects are much stronger: St.Gallen benefits from an additional 2.57 firms per year. But also Gossau (+0.82) and Ebnat-Kappel (+0.16) show positive effects. Indeed, as illustrated in Figure 2 showing the results for the city of St. Gallen, the large positive effects have negative effects in adjacent municipalities. In the case of St. Gallen, predominantly Gossau, Wittenbach, and Herisau note a loss of immigrating firms. Due to the spatial vicinity as well as the high number of firms in St.Gallen and Gossau, these two towns show strong interactions in the simulations. Not surprisingly, in a scenario with tax reductions in Gossau, it is St.Gallen, which is losing most firms.

Figure 3 shows the simulation results of a tax reduction for legal persons in the canton of Appenzell Ausserrhoden. Self-evidently, all municipalities of this canton show a gain of immigrating firms. But there are large differences: municipalities with or located nearby municipalities with a larger number of firms benefit with relatively large gains. These are Herisau (+5.53 additional firms every year), Teufen (+3.36), Heiden (+2.80), and Speicher (+2.00). Not surprisingly, the additional 25 firms in the canton of Appenzell Ausserrhoden have a large impact on the remaining municipalities. First and foremost, the centre of the region, St. Gallen, would have to deal with a considerable loss of migrating firms. But also smaller towns like Gossau, Appenzell and Wil would have considerably negative effects. In fact, negative effects are detectable in towns also over large distances.

Figure 3 Impact of a tax reduction for legal persons in the canton of Appenzell Ausserrhoden [number of additional firms per year]



Sources: Districts GG25 © 2006 swisstopo (DV33492.2)

4 Implementation in UrbanSim

4.1 SustainCity project

SustainCity – Micro-simulation for the prospective of sustainable cities in Europe – is part of the 7th Framework Programme for Research of the European Commission (January 2011 to December 2012)⁴.

Increasing concerns about sustainable development and the growth of urban areas have brought forth in recent years a renewed enthusiasm and need for the use of quantitative models in the field of transportation and spatial planning. This project proposes to improve urban simulation models and their interaction with transport models. Unified operational models that favour a microscopic approach, such as UrbanSim and ILUTE (Integrated Land Use, Transportation, and Environment Modelling System) have recently gained a lot of interest both in the land use and transport communities. Nevertheless, in their current forms these models still require further development to support a comprehensive analysis of the main environmental and socio-economic questions of the sustainability of urban growth and the relevant public policies.

The aim of this project is to address the modelling and computational issues of integrating modern mobility simulations with the latest micro-simulation land use models. The project intends to advance the state-of-the-art in the field of the microsimulation of prospective integrated models of Land-Use and Transport (LUTI). On the modelling side, the main challenges are to integrate a demographic evolution module, to add an environmental module, to improve the overall consistency and, last but not least, to deal with the multi-scale aspects of the problem: several time horizons and spatial resolutions are involved.

The SustainCity project includes also three case studies to take advantage of the achievements of the other tasks in order to undertake an empirical analysis on three European agglomerations (Ile-de-France, Brussels and Zurich).

⁴ see www.sustaincity.eu.

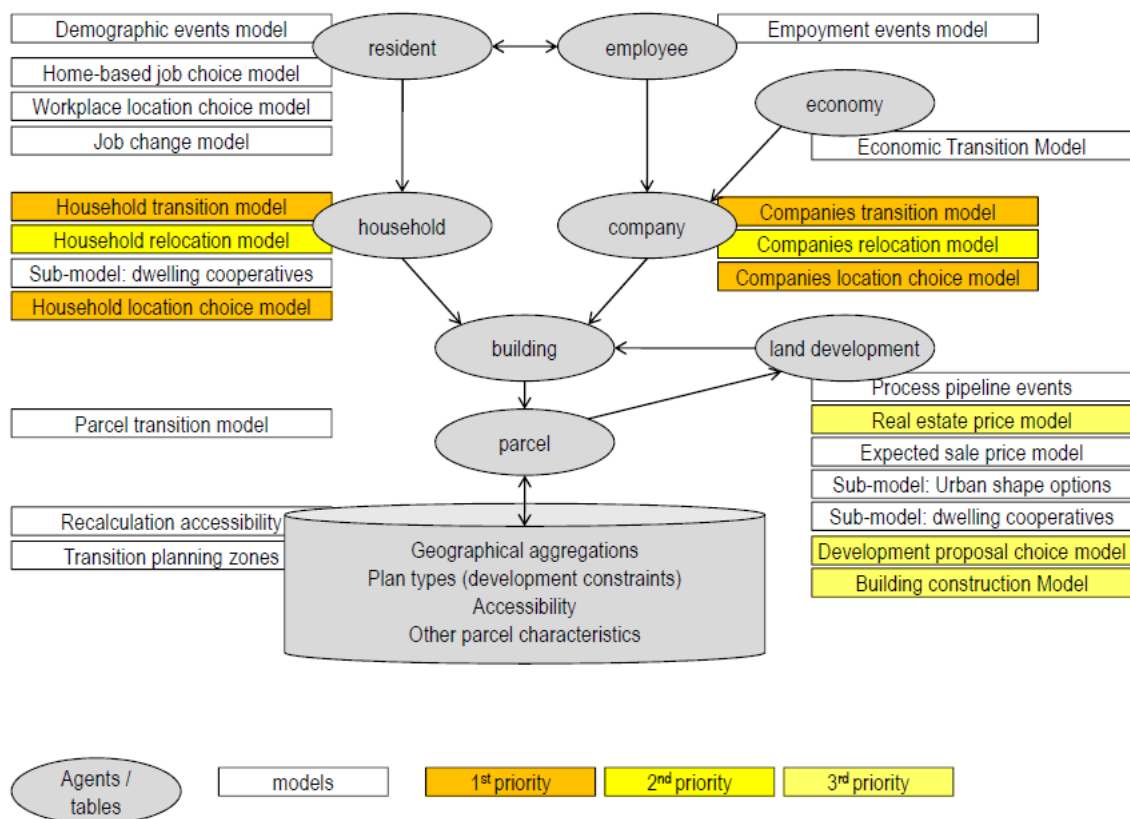
4.2 Model structure for SustainCity case study in Zurich

The Institute for Transport Planning and Systems (IVT) at ETH Zurich is responsible for estimating and modelling the case study in Zurich. Due to data limitations the case study area coincide with the Canton of Zurich. The focus lies on the estimation of the following models (for an overview see Figure 4). Partially, parameters of these models have already been estimated, corresponding references are added in brackets:

- Household location, transition and relocation choice
- Employment location, transition and relocation choice
- Urban shape options, parcel transition model
- Land development: Real estate price model
development proposal choice, building construction, process pipeline events

The model structure will be implemented in UrbanSim and, when available, UrbanSimE. The aim for the chosen simulation structure is to distinguish between decisions concerning companies and employees – analogous to the distinction household - resident.

Figure 4 Planned model structure UrbanSim case Study



Source: Schirmer *et al.* (2011)

Picard and Antoniou (2011) give a good overview in the context of the whole SustainCity project in their *Econometric Guidance* for the SustainCity project. Additionally, Schirmer *et al.* (2011) discuss the Zurich case study in further detail. The following chapters base on the concerned parts of the *Econometric Guidance* and are brought to the actual status.

4.3 Models of firms location choice

Zurich case study bases employs firmography results from the adjacent St.Gallen region as discussed in chapter 3. These models address location behaviour of companies (on the level of plants). Therefore, the intended model structure will model companies' transition, relocation and location choice. The jobs provided are subsidiary modelled based on the behaviour of the companies (Figure 4).

It is proposed to model firmography in a three-step model which decomposes the plants and subsidiary jobs evolution:

1. Firmographics events like birth / closures / relocation / growth of plants
2. Location choice of new established plants
3. Location choice of relocating plants

Using data from the three cantons of St.Gallen and both Appenzell, most of these models have been estimated and calibrated. This dataset provides information on more than 50,000 companies during a period from 1991 to 2006. The first model will consist of different sub-models and draw from a macro-econometric transition model.

Due to data restrictions, firmographics in Switzerland generally distinguish between ten sectors (Bürgle, 2006; Bodenmann and Axhausen, 2011a). If possible, the sector of service and finance is additionally divided in smaller sections: i) finance, ii) business services, and iii) public and personal services (see Bodenmann and Axhausen, 2011a).

4.3.1 Firmographic events

In general, this model is based on the results of Bodenmann and Axhausen (2008). Using business demographic data of St.Gallen region, four basic variables show up in the migration behaviour of companies: age, size, branch and location (community type) of the business. Using a logit-loglinear model, the relevant effects on the behaviour of the companies have been quantified. A short summary gives the following picture:

- **Age:** Young companies relocate frequently, especially across longer distances. They also are relatively often affected by business deaths. Newly arrived companies also relocate more often - and they also often change communities at the same time.
- **Size:** Small companies clearly relocate more often and at further distances than larger ones. Surprisingly, the likelihood that businesses with 10 employees or more will leave their location is no longer dependent on their size.
- **Sector:** Businesses in growth sectors relocate more often, usually into another community. Businesses dependent on their location basically avoid moving. Especially across larger distances, the likelihood of relocation considerably decreases.
- **Location:** Clearly more enterprises leave their location in cities than in agricultural areas. A majority of these migrations are between the larger cities.

The results achieved basically confirm the expectations and were also confirmed in various other works. The logit-loglinear model, however, allows showing which effects are brought about by the individual characteristics of the businesses – whereby the effects of all other characteristics can be taken into account. For example, several papers point out that young companies relocate frequently. Because young companies are also usually small, the question remains whether company size is responsible for this connection. With the estimated model, this question can be cleared up unambiguously: age and size have an independent effect on the behaviour of a business. The age of a company has a predominant influence on migration behaviour: smaller companies often relocate across community boundaries. In comparison, the size of a business has a noticeable effect on the exit rate: the larger the business, the less likely a closure will occur. The effect on migration rates is therefore considerably smaller.

The present analysis shows that several more factors play a part in the decisions on choice of location: among others, the availability of building land and the price of space. This shows up particularly in the modelled effects between the branches. These themes as well as that of infrastructure (accessibility for customers and employees) and the behaviour of communities and cantons (i.e., taxes) will be explored in further studies.

4.3.2 Location choice of newly established plants

The location choice model for newly established plants has to be re-estimated with the dataset of St.Gallen region. Based on the results of Bodenmann and Axhausen (2010/2011a), Bürgele (2006) and Bodenmann (2006) a Nested Logit (NL) model will be estimated. Generally, the same variables will be used as for the location choice of relocating plants discussed below.

4.3.3 Location choice of relocating plants

In general, this model is based on the results discussed in chapter 3.2.1 and – in more detail – on Bodenmann and Axhausen (2011a). Table 2 shows the ranking of estimated parameters in different sectors. They are sorted according to the relevance of the parameters in a model including companies from all sectors. In general, the most important factors on location decisions of companies are cities, cantonal business development and tax burden.

Table 2 Ranking of utility parameters overall and by sector

parameter	All**	Manu- factur- ing	Whole- sale trade	Retail trade	Gastro hotels	Bus. ser- vices	Pers. ser- vices
Alternative is a city	1*	3*	2*	1*	1	2*	1*
Cantonal business development	2*	2*	3*	2*	3	3*	2*
Tax burden for joint stock companies	3*	4*	4*	6*	4	4*	4
Previous site is in a city	4	1*	1	3	2	1*	8
Municipality with a rail station	5*	6*	5*	4*	5	8*	3*
Index of diversity in sectors of trade	6*	5*	9*	8*	8	5*	11
Population with graduate degree	7*	8*	14*	7*	6	6*	14
Motorway connection	8*	10*	6*	10*	11	9*	6
Tax burden for partnerships	9*	7*	8*	5*	17	7*	10
Accessibility to employees	10*	9*	10*	9*	12	10*	5*
...							
Land price for commerce	18	18	18	16	16	18	16

* Significant parameter according to t-test

** Model including all companies observed, apart from holding companies

The fact that a potential site is in a city summarizes different advantages and disadvantages of these locations. This result corresponds to the innovative milieu approach and other agglomeration effects (e.g. Hunecke, 2003; Florida, 2005; Bodenmann and Axhausen, 2010). The differences regarding the valuation of a site in a city suggest that companies in the sector of manufacturing tend to leave cities. In contrast, companies in the sectors of retail trade as well as public and personal services significantly tend to chose new locations in cities. The parameters regarding tax burden and cantonal business development indicate the very positive effect of governmental business friendliness. But also the various accessibility indicators play a strong role in most of the models. Interestingly, the various parameters for land prices have all only minor effects. The strongest effect has land price for residential use, this indicates a crowding-out effect between residential and business use.

5 Conclusions

This paper presents in a first step results of preliminary research in the field of firm relocation choice in St.Gallen region in Switzerland and investigates various possible options for action of cantonal and municipal authorities by using simulations. The focus is set on the impact of improvements in transport infrastructure, designation of new building zones, and last but not least tax reductions on the behaviour of firms. The parameters for these simulations have been estimated in a discrete choice model using data of the commercial registers of the cantons St.Gallen and both Appenzell covering the years from 1991 to 2006 (Bodenmann and Axhausen, 2011a). The second part of this paper discusses the implementation of these models in an integrated land use and transportation modelling system such as UrbanSim.

These results show evidence, that governments and politicians have several options to influence the site competition for companies between regions: business friendliness, taxes, and, with a smaller effect, accessibility. Regarding business friendliness, (cantonal) business development is most visible for companies and therefore has a large impact. However, Devereux et al. (2007) showed that grants do not have a strong effect on companies' decisions. As a consequence, business development is more successful in supporting companies: e.g. during the process of formation or migration, as well as regarding information about potential new sites. All over the world, low taxes are a common instrument to attract companies (and natural persons). The models show, that this is certainly an effective option. Indeed, at least in Switzerland over the last 15 years, taxes in most cantons decreased significantly; so it will be difficult to further lower corporate taxes substantially. In contrast to the first two options for action, accessibility became less important over the last decades (Tschopp, 2007). In this period, differences regarding accessibility between municipalities and regions became significantly smaller. Therefore, from a governmental point of view the cost-benefit ratio of such projects lost attractiveness.

Generally, results of the presented simulations are consistent with the estimated model parameters. As expected, tax reductions show the largest effects. The positive effects of designating new building zones and tax reduction are limited to the municipalities concerned. In contrast, the effects of transport infrastructure projects are spatially unequally distributed. In line with results from research by Devereux *et al.* (2007), all actions examined tend to have a larger impact in regions with a higher number of firms present. First and foremost, this holds for transport infrastructure. But, and this is unexpected, also tax reduction and designation of new building zones show this tendency. This may be an interesting effect of spatial proximity

and accessibility. Business development activities regarding a whole region – and not just one firm – is therefore more effective in dense areas with a large number of firms already present.

Explicitly, we have to emphasize that the results described only address behavioural patterns of firms. Due to different preferences, results for resident population would certainly deviate considerably. Comparing the findings of this paper with those of Bodenmann (2003) regarding development of resident population, the impact of transport infrastructure in rural areas has a manifestly more positive effect on the resident population. Obviously, also the impact of tax reductions is quite different. On the one hand, reductions of tax rates for natural persons have a positive effect, too (Creedy and Gemmell, 2006). On the other hand, due to crowding-out effects, reductions of tax rates for legal persons tend to have a negative effect on the growth of resident population (Bodenmann, 2003). This has to be considered in practice.

This work will be continued and integrated in the SustainCity project – namely Zurich case study. This project aims to advance the state-of-the-art in the field of micro-simulation of integrated models of land-use and transport, and to develop a prospective modelling platform adapted for the context of Europe (de Palma *et al.*, 2010). The further research shall give additional insights to the impact of firms' migration behaviour on the spatial distribution of types and degree of land use. In addition, these comprehensive land use models will allow to reproduce and test crowding-out effects.

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