Effects and side effects
A micro-simulation study of firm location choice

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Abstract

This paper investigates effects of different possible options for cantonal and municipal authorities’ intent on attracting 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 commercial registers of the cantons St.Gallen and both Appenzell covering the years 1991 to 2006. The aim of this paper is to show not only the effects, but also to detect potential negative side effects.

The simulation results show, that tax reductions have unrivalled large effects, meaning positive effects in the municipalities concerned as well as negative side effects in adjacent municipalities. Generally, effects are more intense in regions with a large number of firms already present. Interestingly, due to large positive effects in a specific region, negative side effects can also be identified over long distances in other regions. Especially cities and towns are affected by these long distance effects.

Keywords

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. These intense activities also led to different kind of rankings, for instance with regards to taxation (BAK, 2005), and benchmarking-models, e.g. regarding accessibilities (Bleisch, 2005) or school systems (OECD, 2010).

In Switzerland, generally this competition between cantons and regions finds common assent. However, to date cantonal business development programs have not been subject to any independent effectiveness assessment or such assessments are not publicly available (Kleinewefers, 2004). Public authorities generally limit themselves to inform in an aggregate manner (e.g. annual report of the business development agency of the region of Winterthur; SRW, 2010) or they publish individual success stories like the arrival of PUMA in Oensingen (Canton of Solothurn, 2004), Google in Zürich (NZZ Online, 2007) or McDonalds in Geneva (swissinfo.ch, 2009). Most of these announcements have been implicitly registered by authorities and politicians. In a position paper SwissHoldings (2009) provides a good overview of headquarters settled in the Greater Zurich Area. Still, some projects to attract new firms triggered heavy discussions about purpose and means to be used in the competition for business development. In Switzerland, the prime illustrating examples include the construction of a new factory for Amgen in Galmiz (ARE, 2004) and most recently the heavily disputed subsidies for a saw mill of the Mayr-Melnhof-Group in Domat-Ems (Canton of Graubünden, 2010).

The lack of any effectiveness assessment and detailed investigation on the impact of cantonal and regional business development programs on the local and surrounding economic system highlights the need for an adequate evaluation of these efforts. On the one hand, the aggregate annual reports do not differentiate between the impacts of business development programs in a specific location and general regional trends. On the other hand case studies do not inevitably lead to generally valid evidence. This situation is further aggravated by the fact, that detailed agreements between the different parties involved in a particular case are never published. At least, the successful acquisitions of large (foreign) firms and headquarters give a
hint about the relative effectiveness of different tactics in this competition. Most strikingly, reports currently published completely disregard the interdependencies between regions and impacts on surrounding areas. However, the comprehensive understanding of these interdependencies is of utmost importance in order to give a full account of the effectiveness of business development programs currently employed.

Using simulations of prospective actions taken by cantonal and municipal authorities based on a discrete choice model of firm behaviour, this paper will show spatial impacts of the use of different options of business development activities, a) on the respective region and b) on the adjacent regions. The focal point is the (re-)distribution of firms, its effect on land use and therefore answers in the field of spatial planning and their translation into adequate behaviour of authorities and politicians. Indeed, we have to highlight the fact that this paper cannot serve as a comprehensive effectiveness assessment of cantonal business development in the sense of Kleinewefers (2004), especially, since (long-term) cost for infrastructure are very difficult to estimate (Gilgen and Aliesch, 2004). However, the discrete choice models presented can certainly be used to evaluate cantonal and regional business development programs, as they show and quantify impacts on the behaviour of migrating firms.

Following this introduction, the second section of this paper provides an overview of the political discussions about the subject of the competition between Swiss cantons and regions. In addition, a short overview to research in this field is presented. The third section gives an introduction to the data used and the scenarios tested regarding the impact of infrastructure improvements, additional building zones and tax reductions. In this section, we will also address the base model and the simulation procedure. Section four lists the results of the simulation runs and the last section will discuss conclusions and further research.

2 Background

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 viewpoint 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 (2011) 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 (2011) 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 rea-
son 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.

Given the availability of data and the estimated effects of the different location factors in the preliminary work of the authors in this field (Bodenmann and Axhausen, 2011/2008) in the following we primarily focus on improvements in three areas, namely on transport infrastructure, on designations of new building zones and on tax incentives. Based on existing literature this paper will test the following hypothesis: a) in accordance with the results of the nested-logit models of Bodenmann and Axhausen (2011) the three tested factors have a positive effect on the relocation behaviour of firms. The effect of tax reductions should have the largest effect. The positive effects of designating new building zones and tax reduction will be restricted to the municipalities concerned. In contrast, the impact of transport infrastructure projects will be spatially unequally distributed. Therefore, the aim of this paper is to detect and quantify side effects of these governmental interventions. This leads us to a second hypothesis: b) As a large majority of relocating firms chose a new site close to the previous site, adjacent municipalities are expected to mainly experience the (negative) side effects.
3 Data and scenarios considered

3.1 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, 2009/2011). 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, 2011): 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.

3.2 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 (2011). 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 sources 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 cities has been introduced.

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 the index for cantonal business development of CS introduced in chapter 2 (CS, 2003). Data on tax burden is available from the Swiss Federal Tax Administration (FTA) on a yearly basis since

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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).
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.

### 3.3 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.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Transport infrastructure projects considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project</td>
<td>Canton</td>
</tr>
<tr>
<td>Szenario 1a</td>
<td></td>
</tr>
<tr>
<td>Congestion relief Rapperswil-Jona</td>
<td>SG</td>
</tr>
<tr>
<td>Bypass Bütschwil – Dietfurt</td>
<td>SG</td>
</tr>
<tr>
<td>Bypass Wattwil – 2nd phase</td>
<td>SG</td>
</tr>
<tr>
<td>Szenario 1b (including scenario 1a)</td>
<td></td>
</tr>
<tr>
<td>Motorway connection Gossau SG and access RA</td>
<td>AR/SG</td>
</tr>
<tr>
<td>Bypass Herisau</td>
<td>AR</td>
</tr>
<tr>
<td>Sources: AREG (2010), PA AR (2001)</td>
<td></td>
</tr>
<tr>
<td>Abbreviations: SG - St. Gallen, AR - Appenzell Ausserrhoden, RA - region of Appenzell</td>
<td></td>
</tr>
</tbody>
</table>

The first set of scenarios addresses various existing transport infrastructure projects. Table 1 provides an overview on the corresponding assumptions. Scenario 1a assumes the realisation of a congestion relief project in Rapperswil-Jona, a bypass of Bütschwil - Dietfurt, and the second phase of the bypass of Wattwil. These projects are defined in the cantonal directive plan of St. Gallen (AREG, 2010), and they are in an advanced phase of planning. Scenario 1b additionally includes the so called “access highway for the region of Appenzell” including a
new motorway connection in the eastern part of Gossau and a bypass for Herisau (AREG, 2010; PA AR, 2001). Since this project affects the federal motorway network, for the time being it might materialize only in a distant future.

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. In these three municipalities the simulation results based on the estimated model coincide well with the observed migrations in the sample. Compared to the number of firms choosing these locations in the sample, the errors are only between 1% (St.Gallen) and 11% (Gossau). They also 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). They also 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).

Table 2 Designation of building zones: values for 2006 and scenarios

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average of all municipalities</strong></td>
<td>130</td>
<td>45.6</td>
<td>1395</td>
<td>86.0</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>(155)</td>
<td>(12.4)</td>
<td>(1405)</td>
<td>(85.4)</td>
</tr>
<tr>
<td><strong>St.Gallen (scenario 2a):</strong></td>
<td>1395</td>
<td>86.0</td>
<td>1405</td>
<td>85.4</td>
</tr>
<tr>
<td><strong>Gossau SG (scenario 2b):</strong></td>
<td>473</td>
<td>56.4</td>
<td>483</td>
<td>55.2</td>
</tr>
<tr>
<td><strong>Ebnat-Kappel (scenario 2c):</strong></td>
<td>127</td>
<td>50.1</td>
<td>137</td>
<td>46.4</td>
</tr>
</tbody>
</table>

Sources: ARE SG (2010), PA AR (2001)
Abbreviations: SG - St. Gallen, AR- Appenzell Ausserrhoden, RA - region of Appenzell

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. Table 2
shows that 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).

Table 3  Tax burden for partnerships and companies

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average of all municipalities</td>
<td>99,173</td>
<td>(14,368)</td>
<td>216,466</td>
<td>(24,738)</td>
</tr>
<tr>
<td>St.Gallen (scenario 3a)</td>
<td>113,600</td>
<td>99,232</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gossau (scenario 3b)</td>
<td>100,350</td>
<td>85,982</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ebnat-Kappel (scenario 3c)</td>
<td>115,450</td>
<td>101,082</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appenzell Ausserrhoden (scenario 3d)</td>
<td>181,571</td>
<td>156,833</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* taxable entity: natural person, married with 2 children, taxable income CHF 500,000
** taxable entity: legal person, taxable profit CHF 1,000,000

Sources: FTA (2007, 2009)

4  Base model and simulation procedure

4.1 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 (the 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 (2011) 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 4 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 burden 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.
Table 4  Estimated marginal effects in the base model for mean values

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

(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.

4.2 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 4.1, BIOSIM produces predicted 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 cantons\(^3\) 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%.

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 3.3; 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. Additionally, the number of firms moving in a certain municipality often is almost balanced by the number of firms leaving. The median of the growth in municipalities due to migrating firms is only +0.19 firms p.a.. The significantly rising number of registered firms is caused by new firm establishments. The median of the difference between new establishments and closings is +3.19 firms. But, compared to existing firms, newly established firms are in general smaller and are more affected of closings (Bodenmann and Axhausen 2008). Indeed, to avoid random noise, the following maps only include differences of more than 0.1 firms.

\(^3\) Districts with less than 30 firms per year have been merged.
5 Results

5.1 Transport infrastructure projects

Figure 1 shows the relocation pattern of firms due to the projected bypasses in Rapperswil-Jona and in the district of Toggenburg (scenario 1a), as well as the motorway connection and access highway for the region of Appenzell (scenario 1b). 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 effect of the project in Rapperswil-Jona to relief traffic congestion has at least a traceable impact, but the modelled travel time savings are small and therefore only Rapperswil-Jona itself profits with a positive balance of relocating firms. However, it has to be highlighted that presumably positive effects in adjacent municipalities like Pfäffikon SZ and Rüti ZH are not modelled, since they are outside the case study area.

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

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

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 rela-
tively 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 (+0.35) and Gossau (+0.11) benefit from positive effects. In contrast, the city of St. Gallen (-0.35) and the small village of Stein AR (-0.40) lose considerably attractiveness. Considering that Stein AR was growing in the last years by only about 0.44 firms every year, this manifestly affects this village in an unfavourable way (-91%). 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).

5.2 Designation of new building zones

According to the estimated elasticities of the model presented in Table 4, 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%).
5.3 Tax reductions

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 3.3, 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 scenario set 2. 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 simultaneously have negative effects in adjacent municipalities. In the case of St. Gallen, predominantly Gossau (-0.23), Wittenbach (-0.19), and Herisau (-0.13) 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 -5.75 migrating firms per year. But also smaller towns like Gossau (-0.93), Appenzell (-0.90) and Wil (-0.68) would have considerably negative effects. In fact, negative effects are detectable in towns also over large distances.

Figure 4 provides an overview on the simulation results considering all scenarios at once: all road projects designation of new building zones, tax reduction for natural persons in the three described municipalities as well as tax reduction for legal persons in the canton of Appenzell Ausserrhoden. At first sight, the figure resembles Figure 3 showing the results for the scenario with tax reduction for legal persons. But there are some differences predominantly regarding the three municipalities with modelled interventions. And, interestingly, the joint
scenario result is not just the sum of the effects of the individual scenarios. Hence, the simulations are influenced also by the differences of the estimated utilities between the municipalities. In fact, this is a systemic effect.

Figure 4 Impact of all scenarios [number of additional firms per year]

The strong positive effect of a tax reduction for legal persons in Appenzell Ausserrhoden still induces a substantial gain of firms settling in the municipalities concerned. Due to the absence of considerable negative effects in Ebnat-Kappel, this is the only municipality in the canton of St.Gallen indicating a gain of firms (+0.21 firms per year). On the other side, in St.Gallen and Gossau losses due to tax reduction in Appenzell Ausserrhoden are moderated substantially. As compared to scenarios previously discussed, yearly losses of firms decrease for St.Gallen from -5.75 to -3.18 and for Gossau from -0.93 to -0.11.

6 Conclusions

This paper investigates various possible options for action of cantonal and municipal authorities by using simulations of decisions of existing firms. The focal point 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, 2011).
Generally, results of these 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.

In addition, authorities also have to take into account costs (e.g. for infrastructure) and decreasing public revenues (e.g. due to lowered tax rates). Cash benefits received from companies are twofold: firstly, corporate income tax paid by the company. Secondly, tax revenues generated with the company’s employees domiciled in the locality. In fact, revenues from natural persons are considerably more important than revenues from legal persons: e.g. in Appenzell Ausserrhoden the share of taxes paid by natural persons accounts for 92% of total tax revenues vs. 8% received from legal persons (numbers for 2006; DF AR, 2007). In St. Gallen shares amount to 75% and 25% respectively (FD SG, 2007). Therefore, from a monetary point of view, wages (and domicile) of employees do matter most. Assuming that relocating companies realise an annual profit of CHF 24,000 and engage in average 9 persons with wages totalling CHF 800,000 p.a., the compound sum of annual taxes generated by one company varies between CHF 66,000 and 76,000 (depending on municipality and canton chosen as domicile).

Regarding the first scenario, the canon of Appenzell estimated construction costs for the bypass of Herisau and the motorway access for Appenzell region to 336 mCHF, or 8.4 mCHF annually over a period of 40 years (BU AR, 2008). However, estimated additional tax revenues generated anticipating an additional 2.4 companies domiciled in Gossau, Herisau and Waldstatt amount to only about CHF 190,000. Therefore, infrastructure projects can hardly be justified as an effective business destination promotion activity. This holds true even if the effects of new infrastructure keep their value for several years. In contrast, monetary costs for designation of (new) building zones are quite low. In the city of St. Gallen planning-costs of

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4 This is the median of all companies paying taxes in Switzerland in 2006 (FTA, 2009).
5 Swiss statistics of firmographics UDEMO revealed that on average firms have 8.71 employees (data from 2004; FSO, 2009).
about CHF 20,000 trigger tax revenues of CHF 28’000 p.a. (0.33 companies p.a.). From a monetary perspective, this is certainly impressive, however a) effects are still relatively small and b) public concerns regarding for instance (more) traffic and urban sprawl are not taken into account. Nevertheless, these results show, that spatial coordination is an effective issue to be considered more carefully in future. The results for taxes are ambiguous. Due to the predominant importance of taxes on income from natural persons, reductions of these taxes lead to extremely high losses in revenues: e.g. in St.Gallen revenues lost on individual income tax in the amount of mCHF 27.4 significantly exceed additional revenues generated with corporate income tax in the amount of CHF 210,000 (2.57 companies). In contrast, reductions of taxes for legal persons are much more effective: for Appenzell Ausserrhoden revenues lost on corporate income tax in the amount of mCHF 1.4 are more than compensated by additional revenues generated on individual income tax in the amount of mCHF 2.0 (25.0 companies) assuming local residents.

The results presented also show that in general negative side effects occur in adjacent municipalities. Indeed, side effects are not equally distributed across the adjacent municipalities and there are two basic exceptions: a) like positive effects, negative side effects of transport infrastructure projects are spatially unequally distributed, and b) very large positive effects trigger side effects also over large distances. Particularly cities are affected by these long distance effects. The strong side effects of the reduction of tax rates for legal persons in Appenzell Ausserrhoden show that tax competition between cantons is only effective, if exclusively smaller cantons lower tax rates. Due to the limited number of firms in a region, large cantons lowering taxes cannot attract an adequate number of firms to offset the revenue losses.

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 with regards to land-use modelling. Specifically, results will be integrated in the SustainCity project: 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). Three case studies form part of this project as well: Paris, Brussels and Zurich. These case studies shall give further 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.

7 Literature


Effects and side effects: A micro-simulation study of firm location choice


