



# The socio-economic determinants of urban sprawl between 1980 and 2010 in Switzerland



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## HIGHLIGHTS

- We model determinants of Swiss land use patterns at municipal level.
- Socio-economic determinants of sprawl remain quite stable over time (30 years).
- Accessibility as a determinant of sprawl is more important than population growth.
- Densification follows expansion and can be explained by the same set of drivers.
- Spatial spillovers are a noticeable trait of expansion and densification patterns.

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## ABSTRACT

Sprawl, as a particular characterisation of spatial extension of urbanised areas, is a contested issue. In this paper we provide an analysis of the major socio-economic determinants of changes in those urban patterns considered as sprawl in Switzerland. Our analysis covers the years 1980–2010, and has been conducted for all of the 2495 Swiss municipalities. The spatially explicit model gives evidence of the importance of spillover effects. Employing regression modelling of different urban sprawl metrics that capture urban development patterns we show that the socio-economic explanatory variables yield different results in explaining those metrics and thus give insights in the highly complex matter that is sprawl. These metrics which include the extent of built-up areas, dispersion of settlements and utilisation density provide a composite metric for urban sprawl. Our results show that the densification of built-up areas gains increasing influence in shaping urban patterns and that, in Switzerland, accessibility is a key determinant of sprawl.

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## 1. Introduction

Urban sprawl is receiving increased public attention both by policy makers and in scholarly literature. Urban areas, it is claimed, take up space, encroaching excessively on valuable agricultural land (Brueckner, 2000; Coisnon, Oueslati, & Salanié, 2013; Wissen, Jaeger, Schwick, Jarne, & Schuler, 2010). As a consequence of sprawl, aesthetic benefits of open space are lost, natural ecosystems get disrupted and local communities change their structure (Brown, Johnson, Loveland, & Theobald, 2005; Gagné & Fahrig, 2010; Lopez & Hynes, 2006; Polyzos, Minetos, & Niavis, 2013).

Some authors link sprawl directly to economic development and the resulting distribution of population and urban land.

Accordingly, negative socio-economic effects of sprawl are considered as market failure. It is the externalities of traffic congestion, unvalued suburban infrastructure, and unvalued open-space amenities that may make suburban living and urban growth economically inefficient and ecologically unsustainable (Brueckner & Helsley, 2011; Hersperger & Bürgi, 2009; Nechyba & Walsh, 2004; Pflieger & Ecoffey, 2011).

The scientific discussion on urban sprawl is not conclusive, however. It appears that the concept of sprawl lacks both an accurate, generally accepted definition and appropriate measurements (Cutsinger, Galster, Wolman, Hanson, & Towns, 2005; Galster et al., 2001; Pirotte & Madre, 2011; Siedentop, 2005). Thus, researchers working on urban sprawl usually define it depending on either the context or the function of the term, while its operationalisation critically hinges on the availability of appropriate data (Herold, Goldstein, & Clarke, 2003; Irwin, Cho, & Bockstael, 2007; Paulsen, 2014; Sutton, 2003).

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The absence of a common understanding of sprawl on the one hand, and the lack of data on the other seems to have constrained investigations of underlying causal processes, and the determinants of sprawl. For example, although land use change is recognised to be a spatio-temporal process (Anas, Arnott, & Small, 1998; Durantón & Puga, 2014; Irwin & Bockstael, 2004), in regression analyses the spatial characteristics of urban growth have long been neglected (Yu & Ng, 2007). However, to clarify the discourse about urban sprawl and its determinants, it is essential to improve the quantitative knowledge-base through valid and reliable data, especially regarding projections of future land use (Burchfield, Overman, Puga, & Turner, 2006; Oueslati, Alvanides, & Garrod, 2014; Paulsen, 2012; Siedentop, 2005).

The analysis on the causes of urban sprawl presented in this paper is carried out in Switzerland, a country where national land use policies have been established in the 1970s and adjustments thereof have been prompted in recent years. After half a century of economic and population growth and of internal migration, Switzerland today has an urbanisation level of about 73% and an average population density of 188 inhabitants/km<sup>2</sup>. However, the spatial distribution of the urbanised areas is very uneven. The average population density in the Swiss plateau, a relatively flat part of the country's surface which covers about 30% of the country, is over 400 inhabitants/km<sup>2</sup> (SFSO Swiss Federal Statistical Office, 2014). A recent study of Hennig et al., (2015) which looks at the level of urban sprawl in Europe ranks the Swiss plateau in the upper tercile in terms of sprawl, comparable to other densely populated and economically successful regions in Europe, like the south of England, northwest Germany, or the north of Italy.

Considering that the major Swiss cities are small (Zurich, the largest city, has 400,000 inhabitants although greater area of Zurich includes 1.66 m inhabitants), urban development is dispersed, putting pressure on open spaces in a polycentric network of cities. Not surprisingly, strong sentiments against urban sprawl have developed, and in Switzerland these are rooted in the perception that urban growth has gone awry. Over the last three decades, the Swiss settlement area has increased by 23% while the population increased by only 17% (SFSO Swiss Federal Statistical Office, 2013). At the same time, the annual population growth rate of 1.2% for the period of 2011–2015, makes Switzerland one of the few growing regions in Europe (World Bank, 2016). In the Swiss strategy for sustainable development, a clear boundary to spatial growth was set: limiting the settlement area at 400 m<sup>2</sup>/head. However, recent statistics indicate that land consumption today is already at 406.9 m<sup>2</sup>/head (SFSO Swiss Federal Statistical Office, 2013). In spring 2013, the issue of urban growth and high land consumption was on the national agenda and the topic of a public vote. In an unexpectedly high turnout (63%) the Swiss population endorsed a tightening of the national law on spatial development.

This paper is intended to improve the understanding of determinants of urban sprawl conceptualised by four different dimensions of urban growth. In particular, we explore the determinants of urban sprawl in Switzerland and compare our findings with those in the existing literature. Special attention is given to the analysis of socio-economic (economic, demographic and social) determinants (cf. 3.2.). In contrast to previous studies on urban sprawl, we investigate sprawl at the level of the municipalities (cf. 2.2.) and for the surface of an entire country (Switzerland). The analysis is conducted for 1980, 1990, 2000, and 2010.

In a cross-sectional analysis, we employ four different metrics able to depict multiple characteristics of urban sprawl (cf. 3.1.). Our hypothesis is that the socio-economic determinants of sprawl exert different influences on the different metrics. Furthermore, we assume that the sprawl pattern surrounding a municipality spills over to its neighbouring jurisdiction (Irwin & Bockstael, 2004; Vance & Iovanna, 2008). We therefore expand our anal-

ysis with a model that controls spatial interdependence in the data.

Based on an overview of the international literature, Section 2 gives a synthesis of methods to measure urban sprawl, determinants of urban sprawl, and discusses the implications of our choice of the unit of analysis. Section 3 provides details about the operationalisation of the set of variables we consider in this study and gives some information about the model specifications. Section 4 presents and Section 5 discusses the results of the analysis. Finally, the conclusion in Section 6 provides a synthesis as well as policy recommendations.

## 2. How to understand and measure urban growth and determinants of urban sprawl

### 2.1. Methods of measurements

Despite disagreements and contradictions in defining urban sprawl, it is agreed that not all spatial development is sprawl (Cutsinger et al., 2005; Galster et al., 2001), and that all sprawl is not the same. A rough common understanding is that sprawl is the uncontrolled outwards growth, i.e. an overly space-consuming expansion of urban land area that is usually considered as a problematic and unsustainable form of urban growth.

Just as sprawl is defined in various ways, so too there are multiple methods to measure sprawl empirically: It is a matter of definition at which point of which scale the negative effects of urban growth may be called urban sprawl and which dimension of urban growth, such as spatial growth, discontinuity or population and housing unit density should be considered. In order to measure sprawl, the metrics that have been developed often focus on only one dimension. The respective variable that is employed is very often a measure of density or the spatial extension of the settlement area (Brueckner & Fansler, 1983; Fulton, Pendall, Nguyen, & Harrison, 2001; Spivey, 2008; Sutton, 2003; Wassmer, 2008). This focus on a single dimension stands in contrast with more elaborate, so called multidimensional measurements of urban sprawl, that have been proposed in recent years. In these, different characteristics of sprawl, such as expansion, density and dispersion are measured separately but sometimes combined into a single index of sprawl (Cutsinger et al., 2005; Ewing, Pendall, & Chen, 2003; Hamidi & Ewing, 2014; Jaeger & Schwick, 2014; Jaeger, Bertiller, Schwick, Cavens et al., 2010; Torrens, 2008). Paulsen (2014) offers a good overview and discussion on multi- and uni-dimensional measurements as do Hamidi and Ewing (2014). In our analysis we use a multidimensional metric that combines three characteristics of urban patterns (Jaeger & Schick, 2010a, 2014) (cf. 3.1.). Also we do not explicitly set limits for sprawl/no sprawl, but we compare our results over space and time and hence are able to evaluate developments of urban patterns.

### 2.2. Determinants of sprawl: the classical Monocentric city model and the Tiebout model

The understanding and measurement of what drives urban sprawl is hotly debated in the literature (Burchfield et al., 2006; Irwin & Bockstael, 2004; Oueslati et al., 2014; Polyzos et al., 2013; Yue, Liu, & Peilei, 2012). A theoretical model that provides a basic explanation of urban spatial structure is the monocentric city model of Muth (1969) and Mills (1972) which identifies changes in population, income, transportation cost and agricultural land prices as essential determinants of changes in urban patterns (Brueckner & Fansler, 1983; Glaeser & Kahn, 2003; Nechyba & Walsh, 2004). The model, however, does not account for other household characteristics than income and acts on the assumptions that households

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