A conceptual, agent-based model of land development for UrbanSim

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Abstract

Housing supply is a central issue in most urban areas. To advance this topic in land use transport interaction modelling we focus on real estate developers, who to a large extent drive human-caused land use change in urban areas. Real estate developers have gained little attention in the research community until now even though they actually perform land use development.

Land use change is driven by multiple autonomous actors. They act and react according to their strategies and respond to the opportunities offered by their environment. How the locations will be transformed depends, therefore, not only on demand but also on the developers providing the building supply. To identify the developers and explore the interplay between different actors and its effects on the development process is the ultimate goal. Literature suggests to use agent-based modelling for such complex systems.

A literature review is carried out to obtain an overview on existing analysis and data sources. The literature review is also providing general information on the market conditions like market segmentation and prices. A second source of information is to analyse the existing data on real estate developers by statistical means. Data sources are a dataset containing the history of building projects and the buildings- and dwellings register. The canton Zurich is chosen as perimeter following the case study delimitation, for which the land use transport interaction model finally will be applied. In the case study the land use model UrbanSim and the transport model MATSim will be implemented.

The paper will first synthesise the literature review. In a second step we describe the real estate developers present in canton Zurich's real estate market based on the available data.

Drawing from the literature review and the data analysis a conceptual model of real estate developer agents will be outlined. Hence, the contribution is a concept for an agent-based developer model to predict probabilities for certain development events at a location also considering developer characteristics.

Keywords: Real estate developers, land use model, conceptual model, canton Zurich

1   Introduction

It is well-accepted that the urban development plays a crucial role in achieving sustainability in future. The fact that a majority of people live in cities where most of the economic production is realised suggests that achieving sustainable urban development is crucial. Three problems are of particular concern. Urbanisation is consuming limited land resources and a big potential for energy savings lies within the urban system. Energy savings potentials lie in the renewal of energy inefficient buildings (Ott et al., 2005) and better allocation of land uses in order to reduce traffic. The building stock is also relevant as a major asset. In Switzerland it comprises approximately half of the national wealth (Hoesli et al., 1993, 685).

The second energy related aspect concerns the distribution of buildings because they are locations of activities and therefore origins and destinations of trips. That means that the spatial distribution of buildings dedicated to certain activities is a key factor in traffic volume generation and thus for energy consumption in the transport sector. Appropriate building stock development could help to reduce traffic volume by providing origins and destinations closer to each other.

Land use transport interaction is a central tenet of urban design thinking (Straatemeier and Bertolini, 2008, 1) and many models have been developed to trace its impact (Waddell, 2002; Salvini and Miller, 2005; Moeckel et al., 2006). The strong linkage between land use and transport is also manifested in the ongoing scientific discussion on accessibility and its application (Metz, 2008; Iacono and Levinson, 2008; Levinson, 1998).

Hunt (2005, 358) points out that the supply side of the modelling frameworks is often the weakest one. He locates the reasons in lack of good data, complexity of the supply process and relatively few analysable decisions which makes it difficult to derive sound statistical models. Also Coiacetto (2001, p. 55) notes a lack of research in respect of the supply side of real estate development, especially regarding heterogeneity and appropriate responses of public authorities. This research need is also identified by Ball (2003, 914) who states that consequences for the housebuilding industry are often neglected.

Public authorities influence real estate development by means of zoning plans and by acting themselves as developers. Developers of the private sector have to follow the restrictions im-

posed by the zoning plan, even if it can be negotiated to some extent. The zoning plans provide constraints private actors have to consider when taking their own decisions.

We hypothesise that differences in real estate developers' behaviour and their share in the real estate market play a crucial role in respect of possible development paths. In this respect we want to investigate how the composition and market structures determine the probability of sustainable development. Therefore, we focus in this work on two aspects of heterogeneity: purpose and strategy. The main hypothesis for this work is that it makes a difference whether a developer develops for his own use or for selling a product on a market. Thus the main task is to verify whether developer types can be identified in terms of different behaviour.

In terms of purpose we can distinguish between actors that build and keep the property for their own usage and actors that provide the development service and sell the building afterwards. The first category we refer to as *self-owning* and the second category as *promoters*. We can assume that they have different objectives, resources, information and therefore different opportunities. We hypothesis that promoters are better able to take advantages of short term opportunities, while *self-owning* developers tend to consider longer time horizons. In this realm we are also interested in the difference between profit and non-profit institutions, because there is a considerable share of non-profit housing providers.

In the following sections the paper describes the theoretical background, the research method, the context of the study and a conceptual model for heterogeneous developers. In the last section we make a conclusion.

2   Theoretical background

In this section we outline the theoretical background which forms the context of this work. Therefore, we look at literature on the development process, real estate markets, its actors and their behaviour. The section shall also clarify some terms.

2.1   Modelling the development process

The interplay of real estate developers and urban development has not often been the focus of research so far (Henneberry and Roberts, 2008; Haider and Miller, 2004). A possible reason is its complexity and dynamic. The land development process is indeed a long lasting and complex process. Rybczynski (2007) describes this nicely with a particular American story. The very tricky thing with development projects is their diversity. Each project is unique. It starts from the parcel with its specific characteristics, includes different market situations and neighbourhood and also the set of specialists for project realisation are often arranged newly. The development of a building project is therefore very much dependent on alliances and co-operation. In the following we describe previous attempts to simplify the development process in models.

Healey (1991) identifies four approaches of modelling the development process. The following paragraphs summarise Healey's conclusions.

Equilibrium models are based in neoclassical economic theory. The core idea is that development activities are structured by signals of economic demand. There may be supply constraints such as these imposed by the planning system. The development process is seen as unproblematic. The concept of "rational expectations" is also applied. Critique includes (1) failure of explaining market creation, (2) that demand is not diversified (e.g. user, investor), (3) assuming certainty in assessing future gains, (4) no differentiation of valuation methods and (5) oversimplifying the development process itself.

Event-sequence models outline the development as a sequence of processes and actions, e.g. (1) "maturing of circumstances", (2) purchase, (3) preparation of the land, (4) preparation of development scheme (detailed planning, get permissions) (5) arragement of finance, (6) construction, (7) occupation or disposal (Goodchild and Munton, 1985). The main drawback of

this models is that sequences are fixed and consequently its lack of an explanation for changing sequences.

The **agency models** focus on actors and their roles in the development process. Events may occur in parallel as well as in sequence. Such models allow to consider interests and strategies of actual entities and to link them in a broader context which may shape the behaviour of an actor. On one hand these models open up complexity, on the other hand they cannot highlight critical elements or relations in respect of the overall outcome. A main reason is identified in the lack of driving forces inside the model.

Structural models recognise the importance of real estates as financial assets and thus the dependency on financial markets which determine the capital flow into the production of estates. Harvey (1985) conceptualised his idea by postulating three circuits of capital. The first is the production circuit, the second is the consumption circuit and the third is the social expenditure circuit. In this framework the social expenditure circuit is after all dependent on state functions. It is noted that these model hardly treat the interactions between agencies which is necessary to explain development at a specific place. Consequently, the claim is that empirical analysis must enter into the details of agency relations.

Land use transport interaction (LUTI) models simulate the development process focusing on the feedback between land use change and transport network developments. Within LUTI models we often find discrete choice models applied. Location choices of people and firms are simulated using random utility or discrete choice theory (Ben-Akiva and Lerman, 1985). The selection probabilities are the logits calculated per alternative from the respective utilities and all alternatives in the choice set. Utilities depend on characteristics of the alternatives and the decision maker. The utility function consists of deterministic part and a stochastic part which is assumed to follow a pre specified distribution. The deterministic part is explained by the decision makers preferences and characteristics of the alternative. A review of current models representing the state of the art was written by Wegener (2004). An overview on operational systems can be found in Hunt et al. 2005. In the following three examples are described of how the supply side of the real estate markets are modelled within LUTI models.

In MUSSA (Martinez, 2000) real estate supply is estimated based on trends of statistical data, its variability and rent prices. Rent prices are determined by simulated auctions in which the highest bid sets the price. This way the model predicts the distribution of real estate supply by zone and household type applying Alonso's (1964) bid rent theory. MUSSA is the only model which determines the prices by simulating an multi agent auction process (Hunt et al., 2005,

353). Lately the MUSSA developers are also experimenting with so called hyper networks approach. This conceptualisation introduces "...parallel or orthogonal layers..." (Briceño et al., 2008, 222) to integrate more dimensions of the urban system. These other dimensions are thought to be important for decision making and therefore influence the development process of the whole system. Information from other dimensions may be lagged, consequently a partial equilibrium is calculated modelling a dynamic process.

A state of the art in land use model is UrbanSim (Katoshevski-Cavari, 2007; Waddell, 2002). The model is steadily developed and is now available as a stable release version 4.3. This most recent version allows considering parcels and buildings. The model is characterised by an explicit modelling of the real estate market. It is currently the only LUTI model allowing a dynamic equilibrium (Löchl et al., 2007). UrbanSim is a *composite model* because it links several sub models. This allows to consider different modelling techniques. Driven by exogenous data about demographic and economic trends nine sequentially executed sub models allocate households, jobs and real estate developments based on accessibility and other attributes of locations. Starting from a base year future annual states are simulated by updating the current state for a given time span which lies typically between 10 to 40 years.

The real estate developments are generated from a list of development templates which can be historical events or user specified. These development templates are evaluated for parcels to be developed. Which template is chosen in a specific case depends on the return on investment (ROI) estimated. For the selection of a template to be realised a probability is calculated that is proportional to the expected ROI. A selected template will be added to the *Building Construction Model* responsible for realisation in later time steps (Waddell et al., 2008). The demand is derived from comparison between simulated and expected vacancy rates.

Arentze and Timmermans (2007) model a part of the real estate suppliers based on their activities. Until now developers providing areas for services such as retail, school or post offices are considered. For each sector of services an agent is concerned of providing enough built space. This sector agent controls sub agents charged with developing and maintaining facilities. Sector agents have differing behaviour, e.g. developer agents for retail areas perform a catchment area analysis in order to select a site for development. The size of the installed facility depends on the estimated visitors and constraints of the site.

Ball (2003) focuses on institutions and networks in the real estate and construction industry. The main interest is to explain how the observed network emerges. According to his findings

institutional networks are path dependent and convergence is not obvious. In terms of the development process he identifies three overlapping functions as shown in figure 1.

Figure 1   Ball's functions in housebuilding process
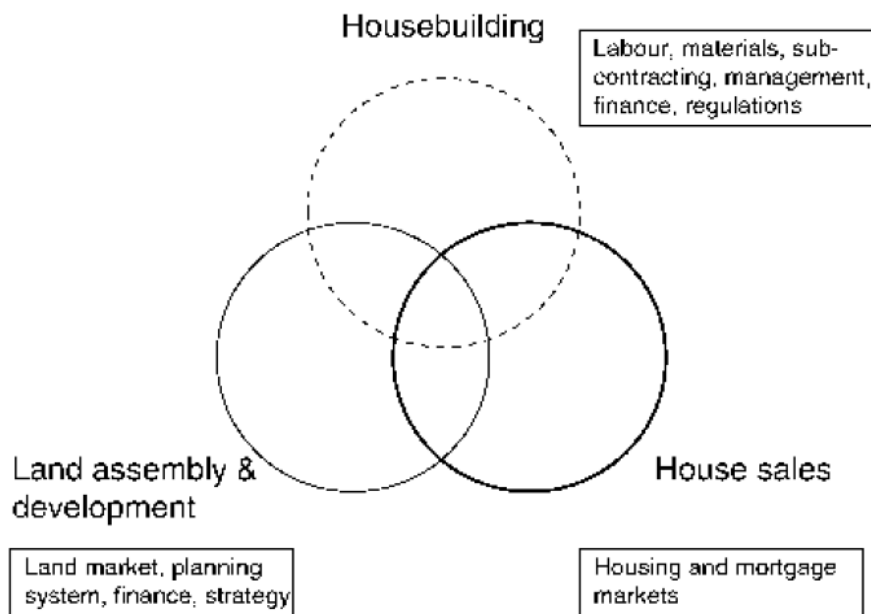
Source: Ball, 2003, 903

This illustration is an example of an agency model in which the functions are specified but no strict order of execution. The three functions may also be seen as markets which are not clearly separable. It visualises that within a development process various alliances are made. Some of these alliances are unstable which seems to be an important characteristic of the real estate supply side. The point about the instability in the development industries is also made by Coiacetto (2009, p. 133). This is possibly a reason why we often find acknowledgement of developers but they are seldom pinned down.

A physical model of building stock evolution is presented by Schwaiger (2003). The work is very detailed in how such a model could look like but there is no computational tool provided. The model does neither provide information of what actions owner might choose.
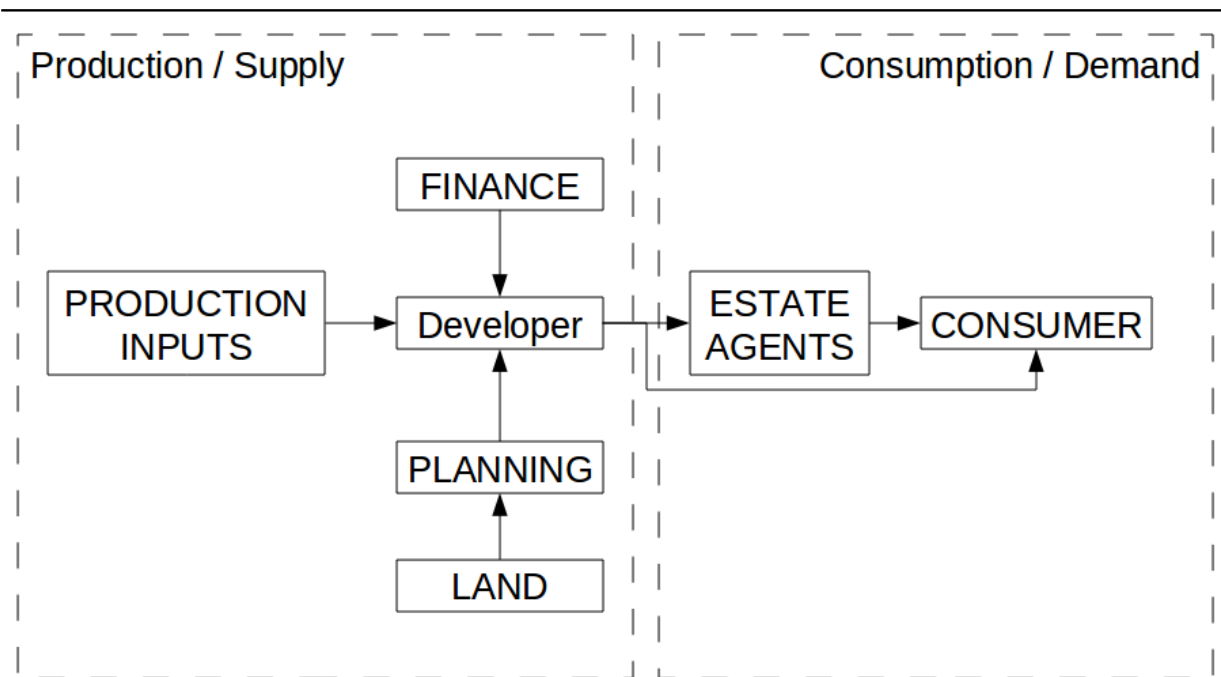
2.2   Developers

Relating to the above discussion about the development process we define a developer as an a individual or organisational entity that takes decisions on modifying the building stock. The result of its decisions are buildings dedicated to certain uses. This is part of the overall pro-cess of spatial development very crudely summarised in figure 1 on page 6. The legal defini-tion of parcels is the basis on which a developer market can exist because land is the primary resource for developers. Therefore, they have or have to get access to land they can add value to by constructing. The value is added by bringing in know-how and contacts to assemble the necessary specialists. The resulting durable good is the marketed to households and firms. When moving in they populate the area and thus form in some way a society.

Table 1   Position of developers in the development process

Process	Actor	Output
Population	People, Firms	Society
Infrastructure building	Real estate developer (builder)	Infrastructure (like houses)
Parcelling	Spatial planner (U.S. Developer)	Parcel, lot

Within the development process the developer plays a central role. He searches for suitable lots, assembles the necessary inputs, organises the production and eventually also markets the product. The necessary inputs are primarily specialists that provide their know-how.

Figure 2   The position of developers in a market framework

Source: adapted from Healey, 1991, 225

We can assume that real estate developers have a strategy. A strategy is a plan of actions to meet a goal. The strategy defines the assembly of actions at given dimensions. With this understanding we can distinguish strategies with one or several dimensions included. I.e. with the dimensions space and time we can distinguish between spatial, temporal and spatio-temporal strategies. While a developer with a single building lot could only apply a temporal strategy, it is possible for actors not committed to a certain parcel adopt spatio-temporal strategies. Hence, it depends also on the endowment of the developers what strategies they apply. Another important part of a developers' strategy is the decision about the products he wants to sell. This can also be seen as a decision on the sub markets in which to engage.

2.2.1   Developer types

Research has shown that differences between actors in the urban development process exist (van Wezemael, 2005; Healey, 1994; Coiacetto, 2001). It is also noted that they can play an important role in explaining urban development phenomena (Diappi and Bolchi, 2006). For the explanation of urban phenomena possible categorisation also depend on data availability.

In the following a short overview shall be given on categorisation found in literature. The Swiss context is thereby stressed.

At least three typologies of developers have already been developed for Switzerland (Schüssler and Thalmann, 2005; van Wezemael, 2005; Friedrich, 2004). All three studies focus on housing. While Schüssler, Thalmann and Van Wezemael concentrate on the total production of housing, Friedrich concentrates on the treatment of the housing stock at the fringe of Zurich.

Schüssler and Thalmann (2005) focus on the objectives of developers. They conclude that the difference in behaviour of real estate developers originates in this respect from their business plan. Either a developer is a promoter or he is an owner-occupier. Developers in the first category want to sell the product after the development, the latter keeps the building and manages it. This distinction includes other consideration of the time horizon for evaluation. Promoters will consider a shorter time horizon than owner-occupiers. Within the second category one can additionally distinguish on the basis of the main management goal. A first subcategory is mainly interested in the financial aspect. Developers of this category see their engagement as investment. A second subcategory has as the main goal the utility maximisation of the community. This concerns public housing developers and to some extent cooperatives. A third category tries to sell the development as soon as market conditions are good enough. Further distinctions are found in terms of motif, required conditions for a development start, information considered, frequency of development (proxy for professionalism), size (proxy for available resources) and evaluation of profitability.

Van Wezemael (2005) identifies three "lines of differentiation". In a first dimension which may be named purpose, he identifies commercial and public authorities. A second line concerns the strategy, where van Wezemael sees institutional developers that follow portfolio management strategies to achieve their primarily financial interests and other developers which follow an object oriented management strategy. In an object oriented strategy the option of selling is not present. In the size dimension a third line of differentiation between bigger and smaller players can be found. Bigger players have more resources they can exploit, which will also concern them in their choice of properties.

Friedrich (2004) uses in her study a less developed typology with three categories. Is is distinguished between institutional, public and private developers. Different levels of building activity are noticed.

The typology used by administrations is often based on the legal status. This is also the case in the federal building statistic where we find the categories such as *private person*, *property fund* or *housing cooperative*.

Coiacetto (2001) identifies in his analysis of two shires in eastern Australia six developer types according to their behaviour with semi-structured, flexible and interactive interviews. The distinction is made between *passive local property owning developers*, *"Means to a mission" developers*, *Specialised client developers*, *Showpiece developers*, *"Eye on the street" developers* and *Value adding opportunity developers*.

Ball (2003, p. 907) lists dwelling types according to three development types which represent the developer type owner-developer, construction firm and social / semi-public developers.

The typology of Ruming (2010) is based on the developers size and the area of activity. He finds Small local, Medium local/regional and Large regional developers. Informal associations with the councils are found to be very important to facilitate the approval process.

When it comes to the marketing of real estates as a product theories form marketing science may also be considered. In this respect we find another line of differentiation according to target groups on which developers may specialise. The segmentation of target groups plays an important role in marketing and thus also for developers (Coiacetto, 2007). Target groups are for example the *Sinus-Milieus®* developed by *Sinus Sociovision (Mc Cutcheon, 2010b)*. When real estate developers have to choose a location, it gets also important to know where a certain target group is located, because empirical results show that people do not move very far (Beige, 2008, p. 96; Schneeberger, 2011). This can be done by calculating probabilities for target groups in a region, e.g. Mc Cutcheon (2010a) derives these as *micro Geo Milieus*.

Our classification focuses on purpose and endowment with properties. We distinguish the three types promoter, self-owning with portfolio strategy and self-owning without portfolio strategy. The classification is chosen according to the research hypotheses in chapter 1 and the available data described in more detail in the section below.

3   Approach and methodology

Our intention is to explain the evolution of the building stock with behavioural models considering real estate developers. For the implementation of some aspects like portfolio management strategies, it is necessary to assign multiple buildings to a specific actor. Therefore, we want to introduce actors of the supply side explicitly into an advanced microsimulation of land use that provides already useful functionality and information.

Doing so we use the basic idea of the agent-based microsimulation approach, which is to analyse microscopic mechanisms and to find the resulting emergent picture by integrating the known microscopic processes into a joint computational model. This inductive kind of research allows conclusions to be drawn for the whole system, starting from analysing the behaviour of individual actors.

We identify the home-builders in the study area by acquiring and analysing the data of building announcements. We obtained an interesting dataset containing address information of home-builders, planers and engineers associated with building announcements. The dataset comprises 60'056 announcements covering the canton of Zurich during the period from 2000 until 2010. The private company documedia collects the data for providing construction firms and craftsmen with business contacts. These addresses are used to contact home-builders of different types that are defined a priory drawing from literature and research hypotheses.

A few of the sampled home-builders are questioned in an open, semi-structured interview following the method describe by Gläser and Laudel (2004). Following the classification of Mayring (2002) the survey method is a problem centric interview. We first set the information goal, which is the detection of different behaviour among real estate developers. Thereby, we focus on strategy, motivation and decision making. Accordingly formulated questions capture the items. The interview guideline is structured in five sections questioning information on the developer, the decision process, the type of projects and the location of projects. The interviews generate qualitative data which will help us to specify quantitative models later on. Some preliminary results are presented on page 19.

We identified the decision makers regarding the investment, which is in the case of development projects the home-builder, as best interview candidates. Best suited are experienced pro-

ject managers. However, it is a priori unclear if they are available and willing to give the information.

For sampling we decided to consider project records for which the announcement was made after the 4.12.09. This time interval covers the last year of the dataset. In addition the project has to be a new construction. The phone number is required to be present because we want to recruit the interviewees by phone. We decided to recruit by phone call because of immediate feedback, which gives a first impression of the interview candidate. Also the phone number is the most complete contact detail. Duplicated phone numbers where excluded. The aim is to interview up to five developers of each developer type.

The types of developers have to be defined in advance for the sampling. The types are derived from literature, the research question and the typology in the quantitative data. The table 2 below shows the a priory assumed types of real estate developers.

For address selection from the documedia data we stratify the population in sub populations according to the attribute *purpose* and number of project announcements. The attribute *purpose* distinguishes projects for own use, letting and sale. Promoters are identified by having applied for multiple projects and having sale as purpose. Type AB is identified by having applied for several projects and having sale or letting as purpose. Type BB is identified by having applied for one project and having sale or letting as purpose.

Table 2   Identification of developer types in documedia data

Developer type code	Developer type name	Attribute *purpose*	Number of applied projects
AB	Self-owning with portfolio strategy	Own use, letting	Several
BA	Promoter	Sale	Several
BB	Self-owning without portfolio strategy[1]	Own use, letting	1

The interview are conducted using skype because of the following reasons:

- Low expenses
- Easy recording with *Skype call recorder*
- Hands free
- Good connection

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[1]   In the housing / building market

To establish more trust from the beginning a caller identification is set in the skype account making a phone number visible on displays. A mobile phone number has to be used because the verification is done by SMS. There was no announcement letter sent to the interview candidates because we expect that the given address is generally not the one of the candidate we are interested in.

4   Agent-based modelling of a real estate industry

4.1   The real estate market of the canton of Zurich

The environment in which real estate developers act is the real estate market which can be segmented in sub-markets. Therefore, we describe briefly the conditions of the observed market. This provides a necessary background for the interpretation of the behaviour of real estate developers.

This work focuses on the canton of Zurich, which is located in the North of Switzerland. Figure 3 below shows the canton and its settlements in black. The two major cities are Zürich in the North of the lake of Zurich and Winterthur 20 km to the North-East. Its real estate market is a spatial sub-market of the national real estate market in Switzerland.

Figure 3   Canton Zurich
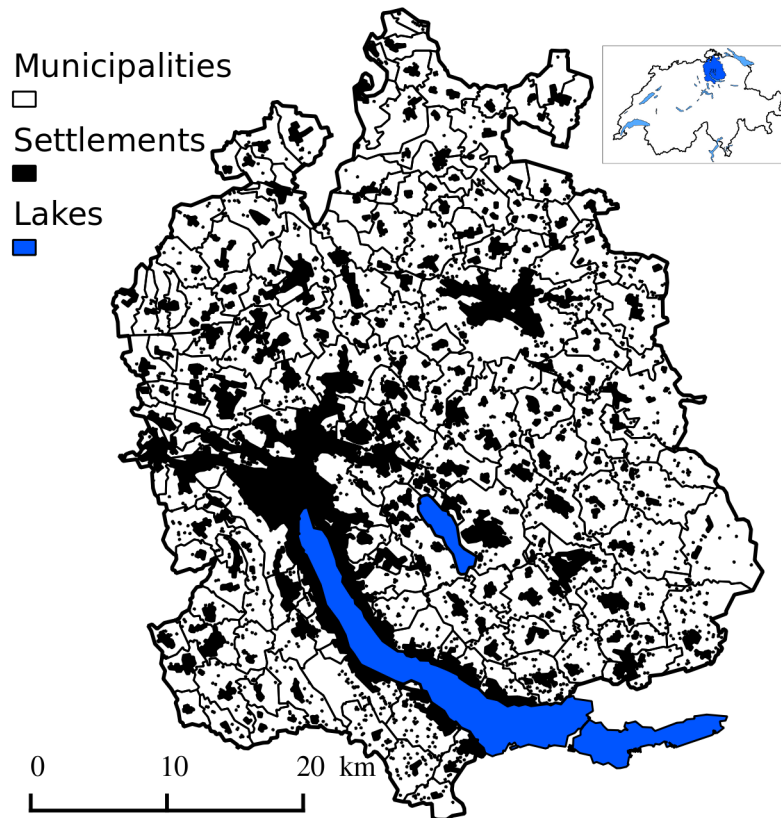
Source: Data © 2009 swisstopo (JD082776)

Prices for residential units have been rising since the year 2000. This is true for renting and selling. The quality corrected index of residential property prices went up from 177 index points to 250, an increase of 41% (Zürcher Kantonalbank, 2011). This index also shows the previous 20 year which were characterised by a steep price increase during the eighties which was followed by a price decrease until 2000. There are studies explaining the price with hedonic regression methods (Löchl, 2006; Haase, 2011; Kubli et al., 2008), of which Haase focuses on commercial real estate. These studies use characteristics of the property and the locality to explain the prices.

The construction activity in the residential sector was constant over the last ten year and produced about 2000 residential units a year. Half of the new apartments are built within the two major cities Zurich and Winterthur (Kubli et al., 2008). An increasing number of apartments is under construction. At the end of 2010 it were about 15000 apartments. Objects for selling as well as for renting are absorbed quickly by the market. Rent apartments are on average no

longer on the market than 25 days. Objects for selling are approaching this absorption level but still remain about 5 days longer on the market. Interest rates for 5 year mortgage loans have been between about 4% before 2008. In 2008 interest rates dropped to 3% (Lüscher and Meier, 2011). The average net return from a rental object was 4.9% in 2010 (Bröhl et al., 2011).

The circumstances have an impact on the behaviour of developers. Hauri and Steiner (2006, p. 44) come to the conclusion that the recession at the end of the nineties forced developers to carry out tasks that are up- or downstream to the actual task of producing houses. These big players try to cover more of the development process and function rather as coordinators. In this role they engage in a lot of subcontracting and thus bring together the necessary resources within a very fragmented industry.

Segmentation of the market

Zurich's real estate market can be segmented along usual dimensions use, estate type, marketing type and space. The segmentation according to use is most common and also present in Zurich. The residential market is best observed and most discussed. The remaining uses are hard to track because of their small numbers and diversity. Therefore, we often find only two use segments housing and commercial, i.e. Ball (2006) In the case of Zurich we further find commercial use, and mixed use distinguished.

In a previous study by Rey (2009) spatial segmentation was chosen on a regional level distinguishing four bigger regions: city of Zurich, lake sides of lake of Zurich, agglomeration and peripheral areas. These regions are similar to a concentric circles around the city of Zurich disturbed by the presence of lake Zurich. On a local scale 12 subspaces are defined. A similar spatial subdivision is used by Kubli et al. (2008).

Another line of differentiation is according to building type. We find segments like single family house, terraced house or multiple-family dwelling. This segmentation is interesting in respect of developers specialised to build certain building types.

The distinguished forms of marketing estates are renting or selling. In combination with the building type we can also identify condominium ownership as segment of the market. For the Swiss market Schüssler and Thalmann (2005) note a tendency towards condominium ownership during the nineties. This is also visible in cantonal data (Rey, 2009). The shift continues since 1999 at a lower speed.

Developers in the market

In the last decade Zurich's real estate market is characterised by stable demand, moderate production and rising prices. Therefore, it is not surprising that international developers enter this promising markets (Cramer, 2008). Cramer (2008) lists the nine major market players, six medium market players and seven foreign market players.

In the Swiss housing market non-profit housing providers are found to be weakly influencing (Kemeny et al., 2005). In this study the Swiss rental market is found to be *unitary*, which is defined as market "in which barriers to non-profit providers competing on the rental market are removed".

4.2   Developers in Zurich's real estate industry

To investigate the research questions we need data on building projects and developers. The data source used here is again the documedia dataset. The project partners are additionally identified by an ID. In a first approach we only consider announcements for new construction, because they are considered more relevant than addition, alteration, renovation and demolition. It can be argued that once an investor announces his project it is in a mature planning stage and the next step is realisation. Further we can assume a strong commitment to building and that a lot of decisions have already been made.

We set our focus on the home-builders, asking the question: Who are the developers? Following the definition in table 2 we get 576 promoters, 10240 developers with a portfolio and 10907 developers without portfolio that were active during the last 10 years. Applying the classification of Ruming (2010) we find 12 large developers, 82 medium developers and 16385 small developers. 14267 of the small developers have only built once. If we plot logarithm of the size, measured in number of announcements, against the number of developers, we see a heavily right skewed distribution. This confirms results of Coiacetto (2009) who finds that the real estate industry is oligopolistic with many opportunities for small-scale firms. He also states that the highly dynamic industry is not competitive and that it is likely to concentrate further. The oligopolistic structure is also observed by Farooq (2010).

Figure 4   Number of developers by number of projects
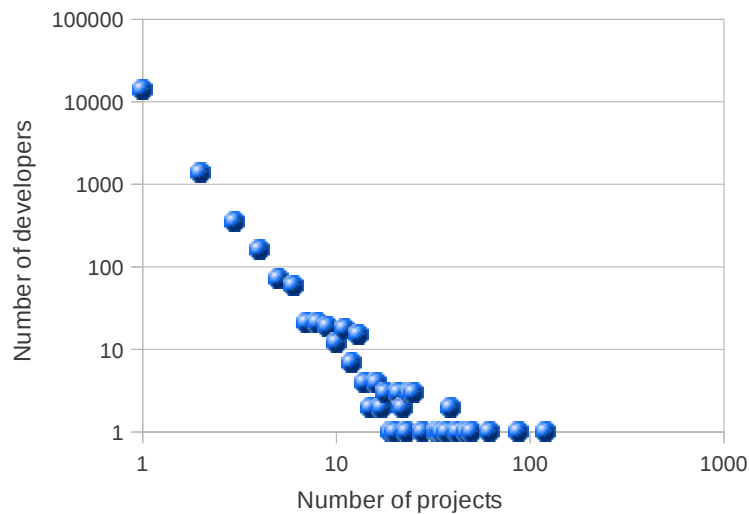
In most cases it is possible to find the developer in the central companies index if the develop-ing entity is no private person or public institution. Ten of twelve large developers can be identified in the central companies index. There is a public institution and one developer that established several companies for individual projects. This seems to be common practice when large projects endanger the continued existence of developer company.

On the basis of home-builder names we can identify 108 general constructors, 136 cooperat-ives and 839 architects, which is of course a very rough analysis. Nevertheless, it shows that cooperatives are present in the construction market.

On the basis of c/o signs it can be seen that some home-builders mandate a professional to take care of their building project. This indicates that investors mandate the execution of the development buying development services. In such cases we find the name of the investor and a c/o in the *branch* field. The contact details then refer to the developer.

It is clear that this first crude analysis has to be improved. However, it is obvious that a lot of relevant information on the developers can not be found in the data. This concerns aspects like strategy, motivation or real estate portfolio. Therefore, a qualitative research is carried out by conducting open, standardised interviews.

4.3   Preliminary findings of in-depth interviews

The recruitment calls have shown that the decision not to send a announcement letter can be justified. Usually, a second or third contact is the potential interview candidate.

The stratification for the address sampling documedia data is not always correct. With an intuitive judgement on the name of the home-builder the interviewer knows the most likely what type of home-builder is at hand.

In respect of reaching investors it is unfortunate that we often find the developers' contact details in the fields envisaged for the home-builder. Nevertheless, we can expect the builders to have some knowledge on the investment decisions of their clients.

First interviews confirm that there is a large variety of home-builders. There, seems to be an individual story behind each project, especially for the smaller scale home-builders.

4.4   A conceptual model of real estate developers

As mentioned in the methodological part we plan to integrate the agent-based developer model into the existing land use simulation UrbanSim. So far real estate development is modelled assuming a representative agent. Most recent work aims at incorporating different developer types as well. However, these developer types will be assigned to different development projects.

Our basic idea is to assign some agents the role of real estate developers pictured in figure 5. In this role the agents have to decide when, where to build how much built space for what use. All these decisions are simplified into one simultaneous decision applying choice theory.

Figure 5   Introduce developer roles in UrbanSim
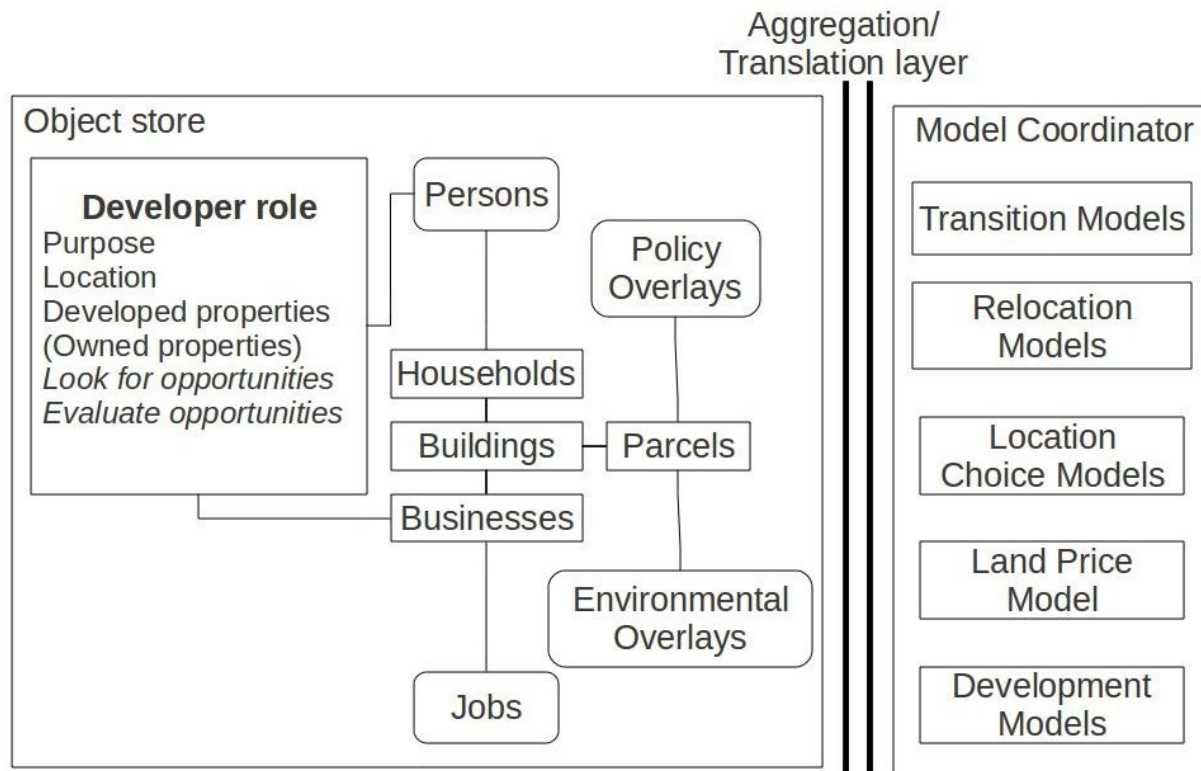
Source: adapted from Waddell, 2002, 305

These agents can be private people or companies. Depending on attributes such as resources, purpose, developed properties, developer location different behavioural models shall be applied. The behaviour shall reflect the resources and strategy with specific search spaces determining the choice sets and specific objective functions based on purposes. Drawing from literature and the first qualitative results we expect to distinguish between:

1. Promoters

2. Self-owning with portfolio strategy

3. Self-owning without portfolio strategy

Promoters will be implemented in the usual manner optimising the return on investment derived from estimated sale prices and construction costs.

For self-owning developers we are thinking of different objective functions. In case of households building their single family house it will be a utility function similar to examples estim-

ating buying prices of single family houses. With the distinction between promoters and self-owning developers we try to capture long term commitments and their consequences.

A special category of self-owning developers with portfolio strategy will be cooperatives. These institutions have other regulatory constraints and are pursuing different objectives than commercial developers. The objective function should capture the goals of social housing providers such as providing living space for families and being able to offer moderate rents.

On the basis of the first qualitative results and other studies finding spatial inertia (Haider and Miller, 2004) in real estate developments we hypothesise that previously developed projects and the endowment with property should be considered. Therefore, we plan to consider earlier projects and possibly the real estate portfolio of actors. In such cases we want to apply portfolio strategies for a certain fraction of the developer population. Referring to figure 2 on page 8 we try to emphasise the financial side of development activities and the land resources available. The portfolio strategies still have to be elaborated (Elton and Gruber, 1995).

As discussed before the market of real estate development may be segmented from a spatial and a specialisation point of view. Thus, a developer decides (explicitly or implicitly) in which area to be active and what building types to produce. To become active in an other market is associated with additional costs often related to gathering information about the market and acquiring the respective know how. Only developers with enough resources can be active in multiple sub markets in terms of development type.

5   Conclusions and outlook

This paper is a first small step to better understand markets that play an important role for spatial development, which is identified as critical gap in our field of research (Boarnet, 2011). In this particular case we try to identify the heterogeneity of actors in real estate production which should finally help us answering questions on how policies influence decisions of house builders. This can be seen as an attempt to "ground land use-travel research in the context of planing, cities, and the human experience" (Boarnet, 2011, p. 209).

Literature, first data analysis and interviews indicate that different developer types are present in Zürich. Developers can be identified in the dataset of building project announcements but we have to be careful about the interpretation of their role. In the data it is not clear whether the home-builder is actually the decision maker on the investment or acts as contractor. However, it is interesting to see contracting in the data. Typically, the actors hold a specialised role inside the development process. However, there are indications that contractors also act as investors, which shows that actors play different roles. An individual or organisational entity may change its role. An agent-based modelling approach allows to implement such roles.

It is plausible that possession of real estate and thus real estate portfolios of investors play an important role within urban development. The potential impact on the development path can be assumed to be considerable. It can be assumed that developers with several objects act differently than developers with a single one, e.g. it is possible for them to pursue portfolio management with several estates whereas developers of a single property will follow an object oriented strategy. Portfolio management means applying financial-portfolio theory, a method for evaluating alternative, regional-scale investment possibilities on the basis of their estimated distributions of risk and return. In this respect the literature review has to be extended. We will have to study literature on portfolio optimisation in real estate and portfolio choice theory.

An interesting aspect in this realm is the tax burden that comes with property. In Switzerland the owner-occupiers have to pay imputed rent. The owner-occupier has to add the saved rent to his income. The income tax thus rises in case of owner-occupied property. The tax burden also rises if the assessment of value of the property rises. Consequently, rising price levels in a region can force residents to sell their properties.

Next steps are evaluating the qualitative data of the interviews, further analysis of data, estimation of choice models and implementation in UrbanSim. From the qualitative analysis and the data on developments we will derive discrete choice models considering developer types that shall be implemented in the existing land use transport interaction model UrbanSim. It will be challenging to reveal the developer behaviour from the available data. The data at hand promises some chances but needs to be analysed in much more detail. For the implementation we try to attach developer roles to companies and households. Another challenge is to implement an ownership structure. In this respect we plan to use a dataset from the cantonal building insurance which contains also information on the ownership structure. Once the simulation is set up we plan to run scenarios investigating different market shares of developer types. Each scenario will be run multiple times because it is a stochastic simulation of which the distribution is of interest.

Acknowledgement

6 Literature

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