Institutional factors and the timing of land development: a survival analysis applied to the GZM Metropolis in Poland

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Abstract

Purpose – The purpose of the article is to improve the understanding of the role of institutional factors in real estate development. The authors take into account zoning (existence and type), type of right of disposal and type of buyer and seller of property in a multivariate econometric estimation. Dependent variable of the analysis is the time between acquisition of empty land and the application for a building permit, a period when many important development decisions have to be made. This indicator is closely related to debated phenomena like land hording and speculation.

Design/methodology/approach – The authors estimate a Cox proportional hazard model with the time between acquisition and application for a building permit as dependent variable and institutional indicators and a number of control variables as explanatory variables. Study area is the GZM Metropolis in the South of Poland. This region shows enough variability in institutional arrangements to allow for this type of analysis.

Findings – The analysis shows that institutional factors significantly influence the real estate development process. In areas that have not issued a zoning plan, the period until the building permit application is significantly longer. When the state is involved in a transaction (as purchaser or seller), it also takes longer until the building permit application is submitted. Although the instrument is usually intended to speed up development, perpetual usufruct implies a longer period until building permit application. Because of the results the authors get for control variables and for robustness checks, the authors are confident of the results of the analysis.

Originality/value – To the authors' knowledge, this is the first study that deals with the question how institutional factors influence the timing of real estate development. By using data for a region in Poland, the authors also add to knowledge about real estate development in CEE countries.

Keywords Poland, Survival analysis, Land development, Building permit, Silesian metropolitan area

Paper type Research paper

1. Introduction

Real estate development is a complex, risky and time-consuming process. "Developers purchase a tract of land, determine the target market, develop the building program and

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design, obtain the necessary public approvals and financing, build the structure, and lease, manage, and ultimately sell it." (Frej and Peiser, 2003, p. 3). Usually, this takes place in a dynamic environment. Infrastructure investments, population dynamics, competing or complementary developments may change the prospects of a project just like changes in regulations, in the financial market, in macroeconomic conditions, in public perception, etc. Since real estate development takes time, the developer needs to form expectations about the environment and observe the value of alternative options (Womack, 2015).

When purchasing a certain tract of land, the real estate developer physically locates his/her ideas for the development project. Typically, the developer wants to secure the land before investing into detailed planning of the project. However, when bought too early, changes in the environment may jeopardise the project and even devaluate the land.

In most countries, developers cannot just break the ground and start building, but need a building permit from public authorities. This instrument is supposed to coordinate the developer's interest in the property with the wider interests of the city and its inhabitants. In order to obtain a building permit, the developer typically has to provide detailed information about the project and to convince the public authorities that the project meets regulations and requirements and contributes to the development of the neighbourhood and of the city.

The prerequisites for a building permit may differ widely over locations and projects. Larger, more complex projects may take longer until they can apply for a permit. The environment may be more volatile at some locations than at others. Professional development companies may be better able to develop a project idea quickly. On the other hand, they may also be able to hold land and to speculate on improving opportunities. Formal and informal institutions (regulations, planning practices, orientation and attitude of authorities, etc.) may differ substantially between locations. In Poland, land use planning policies allow for areas without zoning. This complicates development and makes it dependent on arbitrary administrative decisions (Gluszak and Zygmunt, 2018, p. 153). Lengthy procedure for obtaining the land development decision (LDD) often delay development and discourage investors from building (Krajewska *et al.*, 2014, p. 54). Perpetual usufruct rights (Foryś and Gaca, 2018) may cause additional uncertainty in real estate development in Poland. An alternative to ownership transfer, perpetual usufruct is the right to use the land for a period between 40 and 99 years. It is typically passed to investors with certain requirements like industrial usage, or finishing construction within 3 years. Perpetual usufruct is perceived as a relic of the former system in Poland and often criticised (Norkowska, 2014, p. 143). For residential real estate, it was transformed ex officio into ownership right in 2019. This legal instrument creates many difficulties from a legal as well as practical point of view (Kuryśko, 2018, p. 18) and leads to lower prices (Trojanek *et al.*, 2019).

Developers will react to all those factors in a number of ways. One possible reaction is the timing of the building permit application for a plot of land they have purchased. In this paper, we investigate this dynamic aspect of real estate development. Our dependent variable is the duration between the purchase of land and the application for a building permit. We use survival analysis to identify the factors that significantly influence this duration. In particular, we focus on institutional factors and their effect on the timing of land development. We use data for the Metropolitan Association of Upper Silesia and Zagłębie (GZM Metropolis) in Poland. This region is particularly well suited for our analysis as it currently undergoes substantial transformations in terms of economic structure, institutional arrangements and the regulatory framework. The region includes very different locations for real estate development. They range from the inner city of Katowice to rural areas. Since zoning is not obligatory in Poland, the study area includes jurisdictions with and without a spatial development plan. Similarly, the use of perpetual usufruct differs between places. This enables us to analyse the impact of such institutions on the timing of land development. The results can be generalised to the rest of Poland, and as a review of institutional literature will

show (see Nozeman and van der Vlist, 2014; Anderson, 2019) to other Central and East European (CEE) countries, as the levels of institutions' development, procedures and informal institutions are similar. Due to the transformation process, the development activity is high in the GZM Metropolis, generating a sufficient number of observations for our analysis.

In Section 2, the paper will briefly review the literature concerning urban land, land development, institutional impact, real options and speculation. Section 3 will describe survival analysis, the empirical method used in this paper. In Section 4 we will describe the study area and the institutional framework of real estate development in the GZM Metropolis. Section 5 will turn to the empirical analysis and its results. We present descriptive statistics of the explanatory variables and of the survival process. Then, we will present the results of the estimation and discuss them. The paper closes with conclusions in Section 6.

2. Literature review

We limit our literature review to the dynamic aspects of land development in growing urban areas. Emphasis is on institutions and regulations and implications of withholding the land from market as vacant land and for speculation.

As the focus of the empirical research is on a growing metropolitan area, we investigate theories of urban growth. Brueckner and Fansler (1983) show that urban land use is related to population, income and the price of agricultural land rent (McDonald and McMillen, 2011). Brueckner (2000) demonstrates that in a growing city, developers may postpone construction work, wait for better opportunities and leave land undeveloped in a leapfrog pattern.

Nozeman and van der Vlist (2014) argue that land as property is highly impacted by institutions, both formal and informal ones. In this respect, Needham and Louw (2006) list a wide range of institutions from legal definition of rights and requirements for registering property to unwritten agreements, trust and the use of networks. Institutions include the local governance of land use, zoning and the regulation and the planning of real estate development (Needham and Louw, 2006; Ratcliffe *et al.*, 2009). The institution of perpetual usufruct enables public authorities to control timing and direction of future land development. Zoning plans classify the plot usage, specify characteristics of buildings (e.g. its height, sometimes finishing materials, the number of parking places, etc.) and characteristics of plots (e.g. the minimum plot surface).

Even within the legal framework, cities cannot design institutions freely. They compete with each other for inhabitants, investors and investments. Public facilities attract people and cause the appreciation of real estate prices. The extent to which cities use property taxes, rezoning and subdivision fees to finance the investments or use general taxes, distributes the costs of urban development between developers and population.

In a Europe-wide comparison, Nozeman and van der Vlist (2014) find that the number of administrative steps from initiation until completion of construction is one of the largest in Poland (similar to Russia, Czech Republic and Hungary). Land use regulations affect the prices of developed houses and of vacant land. Anderson (2019) shows that in more developed countries access to land for development is more difficult due to fierce competition and the scarcity of land resources, but getting permits is less difficult. As compared to western countries, CEE countries require a larger number of permits and procedures, and it takes longer to get those permits. Sometimes, firms pay bribes to overcome those obstacles (Anderson, 2019).

Substantial research demonstrates the strong and sometimes problematic impact of institutions on real estate development. Researching the municipality of Dobra in Poland, Nowak and Foryś (2019) argue that a spatial policy, that does not require establishing local plans, results in price differences for land located in areas with and without zoning and in higher uncertainty for investors. Hutchison and Disberry (2015) have shown that the most

important factors that hinder development on brown-fields are market factors. However, amongst the five biggest constraints are also institutional ones, like land ownership and difficulties with planning negotiations. Jou and Lee (2009) present the example of an urban growth control policy in the USA The institution of a development moratorium, intended to slow down development, and in the end had the opposite effect. Needham and Louw (2006) describe the case of long lasting and self-reinforced policy in the Netherlands that has been stable and unchanged even when it did not fit the market conditions anymore. These examples show that land use polices may lead to uncertainty and hinder development. Other research shows that zoning regulations constrain subdivision density (McConnell *et al.*, 2006), and that regulatory delays hinder converting plots to residential subdivisions (Wrenn and Irwin, 2015).

Time is a crucial factor in the development of land. Investments are irreversible, long lasting and the surroundings of the property change with time, especially when the city is in transformation. For investors it is sometimes worth waiting with the construction for a more profitable use of the vacant site. Titman (1985) established the basis of the concept of real option. He noticed that vacant land might be more valuable as a potential site for future development than it is for constructing any particular building at present time. The option to build in the future has a value, which is greater when there is more uncertainty in the market. This reduces the relative attractiveness of constructing a building at the current time and raises the value of keeping alternatives open. "The decision to build or not to build can be thought of as weighing the opportunity costs associated with keeping the land vacant against the expected gain from constructing a more appropriate building in the future" (Titman, 1985, p. 513).

According to Womack (2015), the theory was developed further by McDonald and Siegel (1982), Williams (1991), Capozza and Li (1994) and Grenadier (1995). Quigg (1993), Grovenstein *et al.* (2011) and Ooi *et al.* (2006) conducted empirical studies. Cunningham (2006) empirically researched the impact of house-price uncertainty on the timing of development and land values employing a survival analysis. He finds that one-standard deviation increase in uncertainty lowers the chance of development by 11% and increases lot prices by 1.6%. Dong and Sing (2017) have taken into account the heterogeneity of developers. Their survey reveals that stronger, more experienced and larger developers exercise the development option quicker than weaker and smaller ones. Yang and Wu (2019) researched land acquisition outcome, developers' risk attitude and the land development timing in China [1]. Consistent with the previous research, they found that uncertainty has a negative effect on the hazard of development both until the time of presale and until completion (Yang and Wu, 2019) [2]. Further findings show that prior loss/gain significantly affects (delays/accelerates) the time to presale but does not significantly affect the time to construction completion. The findings are consistent with the literature on behavioural real estate. Moreover, the prior gains' positive effects are much bigger than the negative effects of prior losses (Yang and Wu, 2019, p. 266).

According to Schenk (1978), there are three main reasons for urban land to stay vacant: the first one is structural. It refers to ownership problems, lack of utilities, strict regulation, expected flood, hazard, slope or foundations problems, odd-sized or odd-shaped lot, etc. The second is frictional. Land is kept vacant due to market imperfections, especially high cost of information. The third reason is holding the land in reserve for the future. This third reason is considered in Titman's real option model mentioned above (Morandé *et al.*, 2010).

When developers keep land vacant and do not develop it, they may be accused of speculation in the public and political debate. Land speculation is defined as land acquisition without actual development. It is holding land primarily to meet future demand and not present needs (Thontteh and Babarinde, 2018). Lowe (1975) defines land speculation as buying and selling that relies on anticipated price increases rather than the quality,

usefulness or earnings of an asset. It is a common phenomenon in many regions and countries (Hoyt and Millis, 2000; Thontteh and Babarinde, 2018).

The main market causes of land speculation are rising population, the anticipation of city growth and market distortions such as uncertainty and information asymmetry. Gul *et al.* (2018) point at the role of real estate agents in land speculation, as they unveil new investment opportunities to the owners in order to gain commission. Likewise, local policy makers have their share in land speculation, by ineffective government interventions like imperfect regulations, badly written planning documents that require interpretation, improper enforcement of building regulations or corruption (Markowski *et al.*, 2016; Stanley, 2016). As Stanley (2016) points out, land speculation may be triggered by the announcement of big public investments and when local government aims principally at attracting investors to cities and provide the space ready to buy and develop (Evans, 2004). The state may become a speculator itself. Evans (2004) provided the example of a new Scottish city that kept a belt of land around a newly developed shopping area empty with the intention to sell it later when population has grown. The speculation of the public sector differs from that of market participants, as the state knows when and how the zoning will change. Market speculators may just anticipate it.

The results of land speculation are rising land and house prices, bubbles and burst, market inefficiencies, decreasing overall productivity, as capital and labour ready for affix to land go elsewhere (Gul *et al.*, 2018). In the context of a spatial economy, further effects may be seen in urban sprawl, chaotic development and gentrification as current inhabitants may be pushed out by rising land prices. As property taxes are usually imposed on buildings and not on idle land, cities usually suffer also financially from speculation.

Konowalczuk (2014) investigated land speculations in the Silesia Voivodeship by searching for double sales of land. While mostly individuals initiate sales that start a process of speculative price increases, corporate market participants dominate the final purchase. This difference may be caused by weaker information that individuals possess as compared to corporations (Konowalczuk, 2014).

Idle sites may not result from speculation, but from land banking. According to Evans (2004) it is common for developers to bank land, as land is not available "off the shelf", and acquiring land requires time, money and possession of information, e.g. about the land owners to make them a buy-out offer. Developers have to have an inventory of land to ensure the continuous operation of their enterprise. The uncertainty connected with zoning changes contributes to land banking as well. When a planning system makes the process of acquisition more uncertain, firms are more likely to hold larger land banks than they would otherwise (Evans, 2004, p. 180). Local government also banks land in order to avoid urban sprawl and speculation. The state buys land from farmers in the early stage, as the farmers are unlikely willing to wait for the higher prices resulting from city growth. Local government builds the infrastructure and provides the land later to developers "off the shelf". Often local governments sell this land for a low price and in return impose certain constraints on the developer in order to promote affordable housing and control urban sprawl. Sweden and the Netherlands achieved positive effect through public land banking (Evans, 2004). In less fair countries, however, this instrument may result in manipulation and corruption rather than lower house prices.

As the literature review shows, institutional factors are likely to influence the timing of land development. In the empirical analysis, we will try to capture those influencing factors with the "key variables". The literature review also shows that additional factors may influence the development process: uncertainty in the market, location, size, price of the plot, etc. Although these factors are not in the focus of our analysis, we have to allow for them in a range of "control variables" in order to keep our main results free of bias.

3. Methods

Our analysis focusses on the time interval between the acquisition of plots of land and the application or awarding of a building permit. The most appropriate research method for such type of questions is survival analysis. It is a standard method in demography, health and medical studies. Only few applications of this method exist in the real estate literature. Examples are: Bulan *et al.* (2009) – the impact of uncertainty and competition on timing of condominium development in Vancouver; McMillen and O'Sullivan (2013) – measuring the time until the construction on a plot is demolished applying uncertainty and irreversibility variables to the model; Wrenn and Irwin (2015) – the impact of regulations on the timing of parcel subdivision, finding that these regulation-induced implicit costs reduce the probability of subdivision development on any given parcel; Gnagey (2018) – the impact of newly implemented land use regulation on land use patterns; Cajias and Heller (2018) – measuring the liquidity of property on the market; An and Brown (2008) – applying survival analysis to find temporal trends of land use change.

Survival analysis models and analyses time-to-event data. Such data have a principal endpoint; the time when an event occurs. The literature generally refers to such events as "failures" (Tableman and Kim, 2004), even in the case of a positive event. Since in empirical research observation periods are limited, a "failure" does not always show up in the data. Such observations are referred to as "censored". The necessity to accommodate censoring is the primary reason for the development of specialised models and procedures for failure time data (Tableman and Kim, 2004, p. 1).

In our research, we use the following terms specific to survival analysis:

Event: When the application for the building permit is submitted by the investor (in medical researches event is usually death, disease occurrence, recurrence and recovery).

Time: The time from the beginning of an observation period (time zero, time origin) to (1) an event or (2) the end of the study or (3) loss of contact or withdrawal from the study. In our research it is the time from buying the property (date of transaction) until (1) building permit application, or (2) end of study – the date of the last transaction,

Censoring/Censored observation: When a subject does not have an event during the observation time, the observation is said to be censored. Nothing is observed or known about that subject after the time of censoring. A censored subject may or may not have an event after the end of observation period. In our survey, right censoring occurs in all transactions that do not produce a building permit application until the end of study period.

Following Tableman and Kim (2004), survival analysis can be formalised as follows:

Let T denote a nonnegative ($T \geq 0$) random variable representing the lifetimes of individuals in some population. Let F denote the (cumulative) distribution function of T with corresponding probability density function f. Then

$$F(t) = P(T \leq t) = \int_0^t f(x)dx \tag{1}$$

The probability that an individual survives to time t is given by the survival function:

$$S(t) = P(T \geq t) = 1 - F(t) = \int_t^\infty f(x)dx \tag{2}$$

The probability density function f can be expressed as:

$$f(t) = \lim_{\Delta t \to 0+} \frac{P(t \leq T < t + \Delta t)}{\Delta t} = \frac{dF(t)}{dt} = -\frac{dS(t)}{dt} \tag{3}$$

The hazard function $h(t)$ specifies the instantaneous rate of failure at $T = t$ given that the individual survived up to time t. It is defined as:

$$h(t) = \lim_{\Delta t \to 0+} \frac{P(t \le T < t + \Delta t | T \ge t)}{\Delta t} = \frac{f(t)}{S(t)} \tag{4}$$

We see that $h(t)\Delta t$ is approximately the probability of a death in the time interval $[t, t + \Delta t]$, given survival time t. The hazard function is also referred to as the risk or mortality rate. We can view this as a measure of intensity at time t or a measure of the potential of failure at time t. The hazard is a rate, rather than probability. It can assume values in $[0, \infty]$.

$$h(t) = -\frac{dS(t)/dt}{S(t)} = -\frac{d\log(S(t))}{dt} \tag{5}$$

Integrating the hazard function over $(0, t)$ gives the cumulative hazard function $H(t)$:

$$H(t) = \int_0^t h(u)du = -\log(s(t)) \tag{6}$$

Several types of censoring may occur in survival data. Since in our study there may still be plots without building permit application at the end of the observation period, we need to account for right censoring.

A useful descriptive tool in the context of survival data is the Kaplan–Meier estimator of survival also known as the product limit estimator. It is a non-parametric statistic used to estimate the survival function from observed data. The empirical survival function denoted by $s_n(t)$ is a right continuous step function which steps down at each empirical time period. Kaplan–Meier adjusts the function to reflect the presence of right-censored observations. When comparing the probability of survival between groups, we use a log-rank test. It tests the null hypothesis of no difference in survival between two or more independent groups. The log-rank test is a non-parametric test that makes no assumptions about the survival distributions. The test statistic is chi-square distributed with the number of degrees of freedom being the number of groups minus 1.

Our main interest is in the relationship between failure (application for a building permit) and some explanatory variables. Following Tableman and Kim (2004) we denote failure time by T, and by $x = (x_1, \ldots x_m)$ a vector of explanatory variables. We are interested in modelling and determining the relationship between T and the elements of x.

A commonly used specification is the Cox proportional hazard model. It assumes that the hazard function can be subdivided into a time dependent baseline hazard function, $h_0(t)$ and a scaling function, $\exp(x'\beta)$, that depends only on the covariates:

$$h(t|x) = h_0(t) * \exp(x'\beta) \tag{7}$$

For two different vectors x_1 and x_2, the hazard ratio

$$\frac{h(t|x_1)}{h(t|x_2)} = \frac{\exp(x_1'\beta)}{\exp(x_2'\beta)} = \exp\left((x_1' - x_2')\beta\right) \tag{8}$$

is constant with respect to time t and depends only on the explanatory variables. This defines the proportional hazards property. The Cox proportional hazards model is a semi-parametric model since it does not require any assumptions about the shape of the baseline hazard function.

4. Study area, institutional framework and data

4.1 The Metropolitan Association of Upper Silesia and Zagłębie

Study area of our analysis is the Metropolitan Association of Upper Silesia and Zagłębie (GZM Metropolis). It is located in the South of Poland and consists of 41 communes, including 13 cities with county rights and 13 municipalities, inhabited by 2,255,505 people (stat.gov.pl, accessed online 10-07-2020). The main city of the GZM Metropolis is Katowice, Poland's 11th largest city. Figure 1 shows the area of the GZM Metropolis. It is 2,553 km^2 and covers 20.7% of the Voivodeship.

Historically, the economic base of the region is in mining (coal, iron-ore), heavy industry and machinery. Since the end of the communist period, the region experienced substantial economic restructuring away from the traditional economic base towards services, trade, education, health, etc. This restructuring process is a major driver of the real estate market and of real estate development in the region. More details about the study area can be found in Appendix 1 available in OSF.

4.2 The institutional framework

A number of regulations set the stage for property development in Poland. The most important ones are the Property Management Act, the Building Law, the Act on Spatial

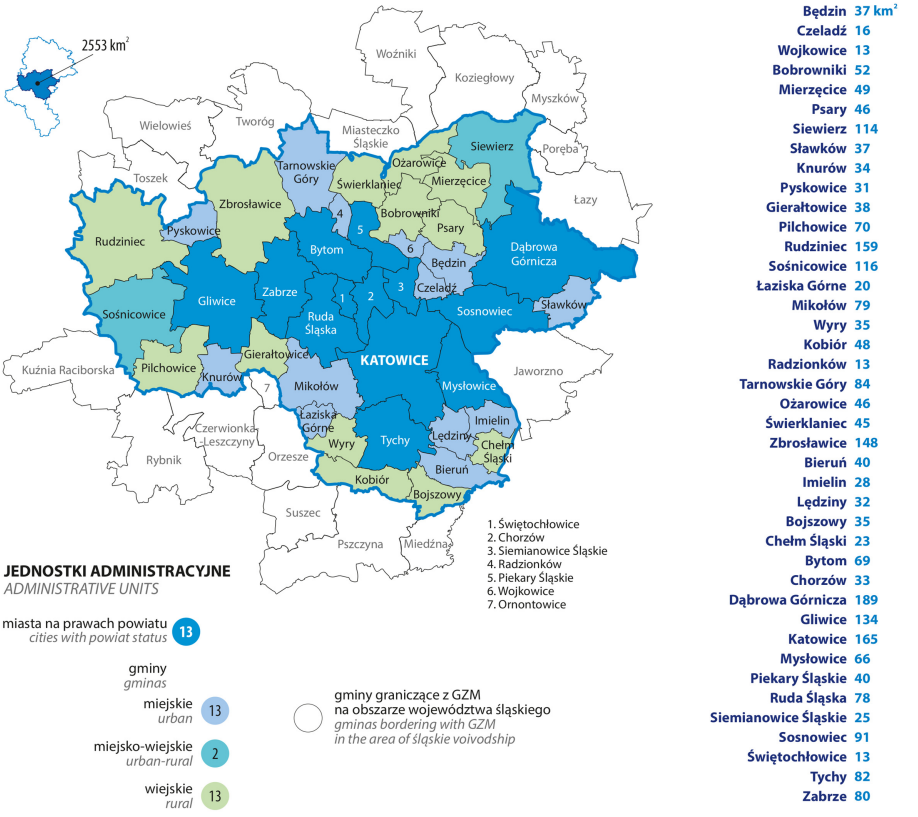


Figure 1.
Metropolitan area Silesia in Silesian Voivodeship

Source(s): Statistical Picture of the Górnośląsko-Zagłębiowska Metropolis in 2017, Statistical Office in Katowice

Planning and Development, the Farm and Woodland Conservation Act (UKUR) and the Act on Protecting the Rights of Purchasers of Apartments and Houses. In recent years, UKUR was sharpened to cope with agricultural land speculations. In 2018, the Act on Facilitating the Preparation and Implementation of Housing Investments and Associated Investments (so called "Lex Developer") was introduced. It enables housing investments by developers apart from previous procedures. The Act on the National Real Estate Resources, implemented in 2017, enables the government to collect land from state-owned companies and to build affordable houses on it.

The spatial development plan (SDP) is the basic legal instrument of spatial design at the municipal level. As the SDP is not obligatory, not every commune elaborates SDPs for the whole area. Only circa 30% of the area of Poland is covered with SDPs. In the Silesian Voivodeship this percentage is 71% (2018) [3]. An LDD [4] may be issued only and exclusively for land which is not encompassed by SDP. An LDD is issued for an indefinite time. If there is no master plan, an LDD is required for any land-use change. The commune head, mayor or president of the city is the authority to issue a LDD. Municipal authorities issue such a permit in various places that often are not adequately connected to infrastructure or to the respective development centre (Zybała, 2019).

The building permit must be in accordance with the respective SDP or LDD. According to the Building Law, the authority should decide about a building permit within 65 days of the application. The building permit does not obligate the investor to start construction. It should be noted, that compared to SDP, LDD framework is more flexible from an investor perspective. In contrast to SDP, having LDD yields an effective real option to expand the development size (density), but the expansion is conditional on the result of relatively risky and long administrative procedure (and obtaining superior LDD decision). In general, multiple applications for LDD can be filed for one plot (varying by development density, public road access, buildings locations on site, etc.) (Gluszak and Zygmunt, 2018, p. 155). Therefore, Polish spatial planning policy may be considered ambiguous. Areas without local plans on the one hand allow for more liberal constructions, as designations stated in Studies of Conditions and Directions of Spatial Development are very general. On the other hand, LDD depends on the official's decision, what adds a human factor and thus more uncertainty to the development process. Sometimes investors may take advantage of this situation by building what they want or speculate, and sometimes uncertainty related to this hinders them from land development (Evans, 2004).

In addition to regulatory measures, municipalities can influence development with various other measures and incentives (Kokot, 2009); likewise on the country level (Cymerman and Zapotoczna, 2016). One instrument to control land development that we will take into account in the empirical analysis is "perpetual usufruct". We discussed this instrument in Section 1.

4.3 Data and variables

For the empirical analysis, we merged two data sets. The first one contains property land sales transactions in the GZM Metropolis 2014–2019 and is accessed from the notary deeds [5]. The second data set contains building permit applications and permissions for particular plots in the GZM Metropolis 2016–2019 [6]. This led to a data set with information about the date of transacted land and its characteristics, and dates of application for and – if applicable – issuing of the building permits. The number of property transactions varies from 2,179 (volume circa 580M PLN) in 2014 to 2,818 (volume 697M PLN) in 2018. The average number of building permits per year is 906.

Data management consisted of cleaning the data from double entries, renaming variables, and putting variables in aggregated categories (zoning type, buyer/seller type). Plots that

were already bought with the building permit decision (369 observations) were coded as their elapse of time is 0.5. We deleted plots with area smaller than 100 sqm, as they are too small for construction. Our final data set contains 13,901 observations. Prices were deflated by the Consumer Price Index. With the use of GIS software (QGIS), we added the distance from the precinct in which the respective plot is located to the nearest city centre of the GZM Metropolis (Katowice or Gliwice). All calculations are executed *R* (R Core Team, 2017).

4.4 Data operationalisation

We proxy the exact time of land development by the date of application for the building permit by the investor. Table 1 describes the explanatory variables of our study [7]. We differentiate between key variables and control variables. Key variables are our main concern as they allow us to identify the impact of institutional factors on land development. Control variables shall capture other influencing factors that we do not want to bias our empirical results.

Following previous theoretical and empirical research as well as practical market knowledge, we operationalise the main research question stated in the introduction of this paper through the following sub-questions:

Key variables		
Zoning: intended use of property in spatial development plan		
Lack of plan	1,530 transactions	11%
Commerce	1,051 transactions	8%
Housing	5,299 transactions	38%
Rest	5,565 transactions	40%
No information	456 transactions	3%
Type of seller: the seller of the plot		
Corporate (firms)	1,692 transactions	12%
Individual	10,163 transactions	73%
State (municipality or government)	301 transactions	2%
Other	1,556 transactions	11%
Type of purchaser: the buyer of the plot		
Corporate (firms)	2,105 transactions	15%
Individual	11,104 transactions	80%
State (municipality or government)	302 transactions	2%
Other	328 transactions	2%
Type of ownership right: whether plot has ownership right or perpetual usufruct		
Perpetual usufruct	689 transactions	3%
Ownership right	13,212 transactions	97%

Control variables
Plot area: plot area in square meters
Min. 100, Median 932, Mean 2,172, Max. 277,812
Total price: total price of plot in PLN, deflated by consumer price index
Min. 505, Median 108,266, Mean 259,944, Max. 61,724,489
Unit price: unit price per sqm of plot (PLN/sqm)
Min. 1.00, Median 109.95, Mean 131.93, Max. 5,830.90
House price volatility: variance of house prices in the Silesian Voivodeship
Distance: kilometres from the precinct where the plot is located to the city centre
Min. 0.00, Median 13.00, Mean 13.69, Max. 32.00

Source(s): Own work

Table 1.
Variables' description and basic statistics

(1) *Market participants:* Which group of market participant applies for building permits the fastest after purchase? Corporation, individual or state?

(2) *Zoning:* Which plots get the application of building permit faster?

- With/without zoning
- Commerce/housing/lack of plan

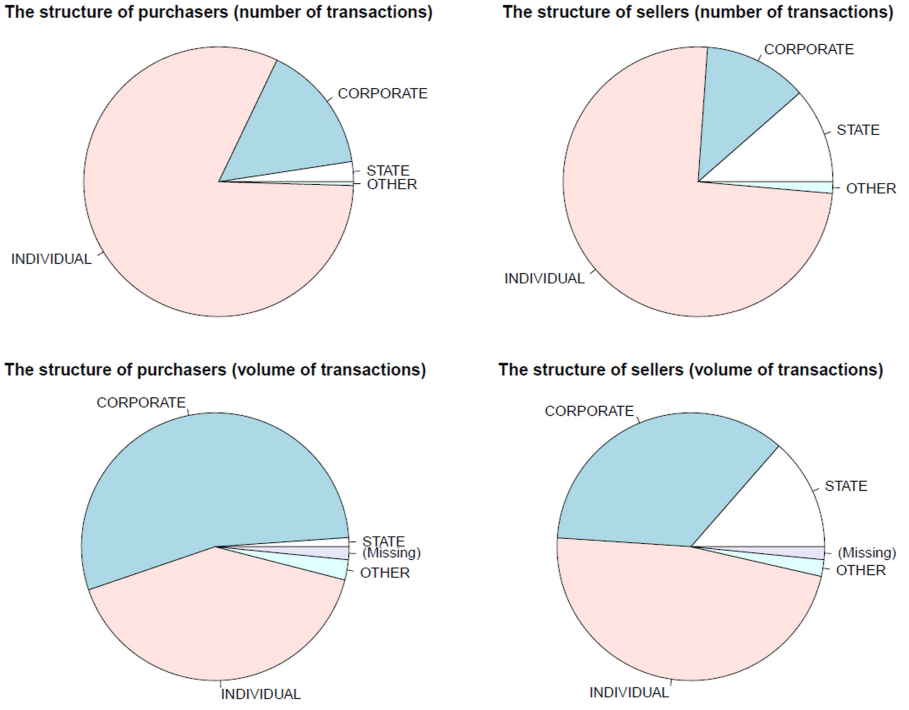
(3) *Ownership:* Which plots get the application of building permit faster? Plots with ownership right or perpetual usufruct right?

5. Analysis and findings

5.1 Descriptive statistics

Figure 2 shows the structure of market participants in transacted properties. The biggest share in the number of bought and sold plots have individuals. Corporate purchasers have the largest share in the value of bought plots. The quota of the state is the lowest amongst all market participants.

Figure 3 shows the volume of transactions and building permits and the value of sold properties in particular municipalities. As can be seen, the six biggest cities (Gliwice, Katowice, Mikołów, Mysłowice, Tarnowskie Góry and Tychy) have by far the highest number as well as volume (represented by the size of the dots) of transacted properties.



Source(s): Own work

Figure 2.
The structure of market participants in transactions (by number and by value)

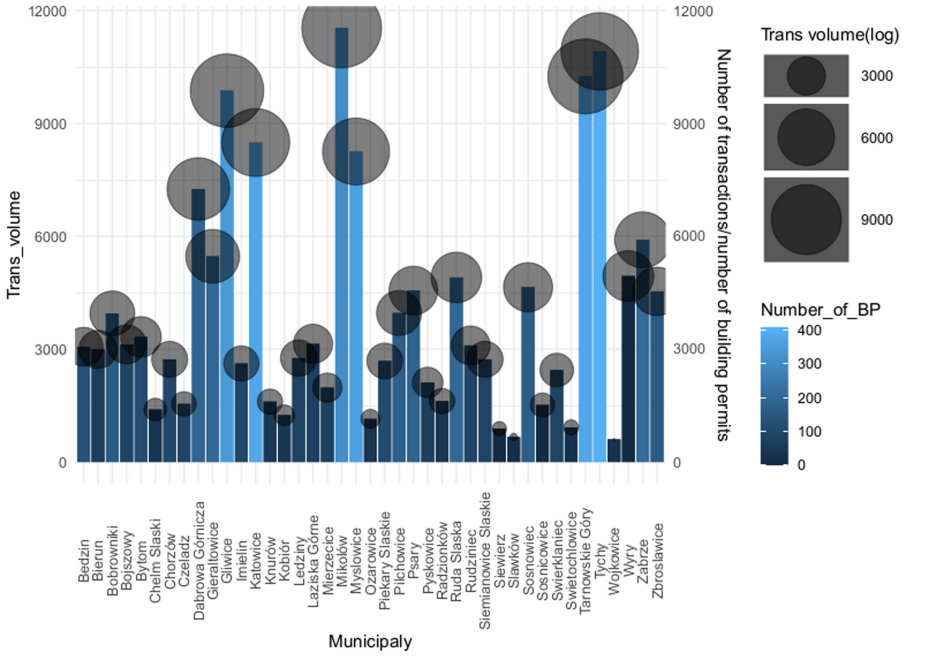


Figure 3.
The volume of transactions and building permits decisions and the value of transacted plots in particular municipalities of GZM Metropolis in 2014–2019

Source(s): Own work

5.2 Findings of survival analysis

In a first analytical step, we generate Kaplan–Meier survival functions for groups of observations and test for difference (details in Appendix 2, available in OSF). Differentiating by type of buyers we find that corporate buyers applied for building permit faster than individuals or the state. A similar result holds for the type of seller. When a property is sold by a corporation, it gets a building permit faster than when it is sold by an individual or the state. Owners apply for a building permit sooner after purchase when the plot is subject to an SDP and when the basis for use is ownership rather than perpetual usufruct. Similarly, the period between purchase and the application for a building permit is shorter for plots in the cities with universities, higher densities and lower unemployment rates. The log–rank tests confirm that all these differences are statistically significant.

However, these results are based on univariate analyses. Some of them may be spurious and may not hold in a multivariate context. To check for this, in the second step we estimate a Cox proportional hazard model with the explanatory variables of Table 1. The results are reported in Table 2. The overall tests (likelihood ratio, Wald and score test) are all highly significant, indicating that the model as a whole represents the data very well. In addition, most of the variables used in the multivariate Cox analysis are significant ($p < 0.05$) as well [8].

With respect to the individual explanatory variables, the results are as follows:

5.2.1 Key variables. Zoning: The base category for zoning is "lack of a spatial development plan". The results for all zoning categories need to be interpreted relative to this base category.

(1) For property zoned for housing, the estimated coefficient is significantly positive (coef = 0.187). This means that the chance for applying for a building permit is 21% higher for property designated for housing use than for plots without any zoning designation.

	coef	exp(coef)	se(coef)	z	Pr(> |z|)
Zoning (base category: "lack of SDP")					
COMMERCE	−0.081	0.922	0.070	−1.163	0.245
HOUSING	0.187	1.206	0.049	3.856	0.001***
Lack of info	−0.238	0.788	0.091	−2.621	0.009**
REST	0.050	1.052	0.049	1.020	0.308
Type of purchaser (base category: "the state")					
CORPORATE	0.653	1.922	0.135	4.853	<1.0e-4***
INDIVIDUAL	0.606	1.833	0.128	4.730	<1.0e-4***
OTHER	0.914	2.495	0.223	4.099	<1.0e-4***
Type of seller (base category: "the state")					
CORPORATE	0.240	1.272	0.059	4.074	<1.0e-4***
INDIVIDUAL	0.253	1.287	0.049	5.196	<1.0e-4***
OTHER	0.025	1.025	0.145	0.172	0.864
Type of ownership (base category: "perpetual usufruct")					
OWN	0.145	1.156	0.073	1.990	0.047*
Log(Total price)	0.438	1.549	0.023	18.648	<1.0e-4***
Log(Plot area)	−0.293	0.746	0.026	−11.297	<1.0e-4***
Log(House price Volatility)	−0.042	0.959	0.015	−2.876	0.004**
Distance to CBD	−0.010	0.990	0.003	−3.860	0.001***
Concordance	0.615	se = 0.004			
Likelihood ratio test	712.2	15 df, $p < 2e\text{-}16$			
Wald test	697.6	15 df, $p < 2e\text{-}16$			
Score (log-rank) test	687.1	15 df, $p < 2e\text{-}16$			

Note(s): Significance codes: 0 "***" 0.001 "**" 0.01 "*" 0.05 "." 0.1 " " 1
Source(s): Own work

Table 2. Estimation results of the Cox proportional hazard model with all variables

(2) For property zoned for commerce, the coefficient is negative (coef = −0.081) and insignificant. The coefficient implies that the hazard is 8% lower for commerce use than for plots without a zoning plan. Since, the coefficient for housing is positive and highly significant and the one for commerce zoning negative, there is a highly significant difference between these two zoning types. Applications for building permit for property zoned for housing are much faster than those for commercial property.

Seller and purchaser: The base category for both groups of variables is "the state". The coefficients for corporations and individuals are significantly positive in both cases. This means that the hazard is higher when the market participants (both buyer and seller) are individuals or corporations than when the state is the market participant. For an individual or corporate buyer the hazard is almost 100% higher. We conclude that individuals and corporations are much more likely to apply for a building permit than the state.

Type of ownership: The base category is "perpetual usufruct". The positive coefficient (coef = 0.145) for "own" means that the hazard is 15% higher when the developer owns the property as compared to perpetual usufruct.

5.2.2 Control variables. Total price (log): A 10% increase in total price is associated with a 4.2% increase in hazard rate.

Plot area (log): A 10% increase in plot area is associated with a 0.3% decrease in the hazard rate.

House price volatility (log): A 10% increase in house price volatility is associated with a 0.04% decrease in the hazard rate.

Distance to Central Business District (CBD): A one unit increase in distance is associated with a 1% decrease in the hazard rate, meaning a lower chance of applying for a building permit.

5.3 Discussion

With the results of the survival analysis we can answer the research questions stated in sections 1 and 4.4 of the article. With respect to the first question, we find that, all groups of market participants (both buyer and seller) apply for the building permit quicker than the state. The fastest group is corporations. The output is intuitive, as corporations need to act faster on the market. It is interesting to see that the state is slowest when it comes to applying for the building permit. When the state is the buyer, it may mean that the state is actually speculating and holds the land. When the state is the seller, it means that the state does not have or does not use properly its measures to prevent land banking and land speculation. However this result must be interpreted with caution as the state acts as buyer in only 2.5% and as seller in only 11% of the observations.

The second question concerned the function of an SDP. When we consider zoning as a binary variable, lots with SDP apply for a building permit faster than those without (11% of plots in the sample do not have a SDP). We interpret this as the positive effect of reduced uncertainty that is associated with a SDP. Taking into account the type of zoning, plots with individual housing designation apply for building permit fastest than those with any other zoning designation. The implied significant difference between housing and commerce designation may result from the higher level of complexity typically associated with commercial projects.

The third question concerns the ownership title. Plots that have an ownership title get the application of building permit faster than those with perpetual usufruct. This result is surprising. Perpetual usufruct allows the owner to impose contractual restrictions on the developer. One frequently mentioned restriction is the maximal time for construction, forcing the investor to build faster. Our research shows, however, that such restrictions do not work in practice. They are either not imposed or not executed. Since we do not have access to the contracts, we cannot identify the reason why this instrument does not work as intended.

The results to these three questions (referring to the key variables) confirm that institutional aspects of land development significantly influence the timing of land development. The remaining parameter estimates refer to the control variables. As has been mentioned above, the main purpose of these variables is to capture other important influences, thus avoiding missing variable bias in our key variable estimates. In addition, plausible results for the control variables will support confidence into our overall model and consequently also into our results for the key variables.

For all the control variables, our results are plausible and consistent with theory and previous research. The price effect is positive and highly significant: the higher the lot price, the earlier the application for the building permit. Keeping expensive land idle for long is just too costly for the developer. The bigger the plot area, the longer the time of applying for the building permit. Planning for bigger plots is probably more complicated and more expensive and therefore requires more time to implement. Plots that are located further away from the centre of the big cities get the application for the building permit slower. The interpretation is that in the city centres, competition is stronger and market participants have to operate and build faster. The last variable concerns house price volatility. Our results indicate that the higher the volatility of house prices in the Silesia Voivodeship, the slower investors apply for the building permit. This is consistent with the theoretical argument that in periods of higher price volatility (higher risk) it is profitable to postpone investments.

The robustness checks (details are reported in Appendix 3 available in OSF) do not raise any concerns about the validity of our results.

6. Conclusion

Our study of the timing of LDD shows that institutional factors play an important role in the real estate development process. Public authorities set or influence these institutions (e.g., the regulatory framework) in order to guide real estate development in the jurisdiction so that it develops in an orderly fashion and land use conflicts are curtailed. We use data from the GZM Metropolis in the South of Poland. In the observation period, this region underwent a substantial restructuring process. As the number and value of transacted properties and the number of issued building permits show, this transformation is accompanied by major adjustments in the real estate market of the region. Our findings may be transferred to other Polish regions and other CEE countries, as the level of institutions' development and real estate market maturity are similar there.

Our research represents an advance in the field of timing of land development by adapting the survival analysis method. The novelty is the concentration on institutional influences, such as spatial planning, type of property right and type of market participant. The impact of control variables on time of land development such as land and house prices, plot area, distance to CBD is consistent with previous research. The study highlights the important and somewhat ambiguous role of municipalities. We find that land is withheld from development mainly by public authorities, and that lack of zoning further delays the process. The significant negative influence of our perpetual usufruct variable suggests insufficient implementation and execution of this instrument in the cities. Regarding zoning, our study suggests to municipalities that establishing spatial development plans may accelerate land development. The study contributes empirical results to discussion on regulations imposed by public authorities and their quality. The literature (Nozeman and van der Vlist, 2014; Needham and Louw, 2006; Ratcliffe *et al.*, 2009; Ihlanfeldt, 2007; Kaufman *et al.*, 2015; Anderson, 2019; Nowak and Foryś, 2019) argues for their high impact on real estate markets.

Just like any other study that uses secondary data; our analysis is constrained by data limitations. For example, due to lack of information we cannot take into account the type of investor of a project (local, international, big, small, etc.) Similarly, our survival analysis cannot answer the question why land is withheld from development nor identify the mechanisms by which institutional factors influence real estate development. We intend to answer such question with future interviews with investors and municipal policy officials. Hopefully, such interviews will shed light on the roles of these actors and on their interrelated role through institutions in the real estate development process.

Notes

1. The variable land acquisition outcome has been computed as the difference between cost of purchased land by developer and its intrinsic value, resulting in perceived loss or gain by the developer. Land development timing was calculated from the acquisition of land until (1) the presale or (2) construction completion. Market uncertainty was measured as the difference between real and forecasted house market prices.
2. In another study on China, Wang *et al.* (2016) find such a negative effect only for policy uncertainty and for market uncertainty a positive effect.
3. Own calculation (ratio of SDP surface to country/voivodeship surface), based on data from: https://bdl.stat.gov.pl/
4. LDD should be guided by the principles of the Studies of Conditions and Directions of Spatial Development document.

5. Data on sale transactions were disclosed by the Department of Investment and Real Estate at the University of Economics in Katowice for purposes of scientific research and come from property valuers' database "Śląsk". Other researchers assessed the database of property appraisers that we used for the research as a reliable and relatively complete source of data (Konowalczuk and Ramian, 2009, p. 83).
6. It is available online from the Main Building Supervision Office (http://wyszukiwarka.gunb.gov.pl/, accessed online 10.12.2019).
7. For continuous variables, the table gives location parameters, for categorical variables the breakdown by categories.
8. We also performed a range of robustness checks, the results of which are reported in Appendix 3 available in OSF.

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Appendix 1
The Metropolitan Association of Upper Silesia and Zagłębie
This appendix is available in Open Science Framework.

Appendix 2
Descriptive statistics of survival analysis
This appendix is available in Open Science Framework.

Appendix 3
Robustness checks
This appendix is available in Open Science Framework.

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