

Understanding the costs and revenues of land development

An empirical analysis into the financial effects of
location features

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Abstract

As a means to sustainable urban development, redeveloping brownfield sites is advocated over greenfield development in most Western countries. There is much case study research into the factors that influence the (financial) costs, revenues and results of land development. What is virtually absent in the literature is large-scale quantitative research, in which costs and revenues of land development are systematically related to location features. This paper reports on the results of such a research project in the Netherlands in which multivariate regression analyses have been carried out to estimate the relative value of these location features to the costs and revenues of land development. The research shows that much of the financial variance can be explained by basic location features. Especially previous land use (brownfield versus greenfield) and the fragmentation of land ownership seem to play a key role in understanding the financial structure of land development.

1 Introduction

Land and property development have come under pressure since the start of the global financial crisis in 2008¹. Many land development projects have come to a hold because of a decline in property and housing demand (and through that prices), leading to problems with regard to the financial feasibility of these projects. However, the financial feasibility of land development is not only a function of global events. Moving down to the micro-level, we observe that different locational features shape costs and revenues in the development process. For instance, the policy shift from greenfield to brownfield development that occurred in many countries is assumed to have a negative impact on the financial feasibility of land development (Adams & Watkins, 2002). But also other location factors, such as the fragmentation of land ownership and the soil condition, might affect the costs and revenues. The question to be addressed in this paper is: how do different basic location features affect the costs and revenues, and hence the financial result of land development? Although, in principle every land development project is different, we aim at finding commonalities.

The *process* of land development in general has received much scholarly attention in recent decades (e.g. Healey & Barrett, 1990; Healey, 1991; Healey, 1992; Gore & Nicholson, 1991; Van der Krabben, 1995; Guy & Henneberry, 2002; Verhage, 2002; Buitelaar, 2004). Most of this knowledge is based on *institutional* analyses. These studies try to research the question (conceptually or empirically), how the behaviour of developers is shaped and changed through local development institutions and the wider institutional context.

Studies on the (financial) *outcome* of land development are much rarer. And in those financial analyses that exist (e.g. Verhage, 2002; Needham *et al.*, 2003), case study research seems to be the norm (with Korthals Altes, 2010, as a notable exception). Where case study research is superior in identifying causal mechanisms, it is less suitable for analysing the extent to which certain phenomena take place. In other words, it is aimed at depth, not breadth.

In this paper we analyse a large number of land development projects (ninety) in the Netherlands, in particular the (financial²) costs and revenues of these developments in relation to a number of location features. These features are the location in relation to the urban centre, the land-use designation (zoning), the share of public space, the size of the development site, the previous land use, the soil type and the number of landowners. These variables have been identified on the basis of the literature (see next section). Where other studies have focused on one feature, such as previous land use (brownfield versus greenfield development) (Adams & Watkins, 2002) or land ownership constraints (Louw, 2008; Adams *et al.*, 2002), we focus on the relative impact of the earlier mentioned location features on the costs and revenues of land development.

¹ In the autumn of 2008 the global financial crisis took off with the fall of Lehman Brothers.

² Probably needless to say, but a financial analysis is distinct from an economic analysis, such as a cost-benefit analysis (CBA).

On the basis of multivariate regression analyses, we searched for associations between the costs and revenues on the one hand and location features on the other. For our analysis, we use a unique and very precise dataset of land servicing accounts in the Netherlands. Different from other countries, in Dutch location development projects there is often a clear distinction between the stage in which the land is serviced and the property development stage (Verhage, 2002)³. This has to do with the fact that since the Second World War, servicing the land in the Netherlands is often carried out by local authorities⁴; they buy the land, service it for development and then sell it off to parties that take care of the actual property development (Needham, 1997)⁵. Although this division is typically Dutch, the costs and revenues of land development and the location features that are associated with these are likely to apply elsewhere.

Based on our analysis, we find that costs and revenues are primarily driven by the location of a site within the urban area, the previous land use of the site and the number of land owners. Other features such as the share of public space and the size of development sites – hence, economies of scale – play no or hardly any role. On the basis of the empirical results we reflect on the practice of land development projects, in particular on the application of residual valuation and value capturing.

In the next section we will explore the relevant literature on urban economics and land development, which will result in a number of hypotheses that are to be tested. Section 3 unfolds the way the data were assembled, the structure of the dataset and the research method we used. After the elaboration on the results of the empirical study, a reflection on the costs and revenues of land development and the financial feasibility is made in the final section.

³ Morley (2002: 83) shows that in the UK these two are often integrated.

⁴ It started already in the second half of the nineteenth century, in order to facilitate the urban extension of the Dutch overpopulated medieval cities. This development took off at a large scale after WWII to facilitate the reconstruction of cities and the to approach the large housing need.

⁵ It needs to be noted that the system in which Dutch municipalities act as a land developer has come under pressure in the last decade (Buitelaar, 2010).

2 Urban economics and land development

Ricardo’s theory of land rents is probably the first theory that relates the value of land to its specific features. He argues that the use of land and its revenue, determines the value of land, not the other way around: “The price of corn is not high because a rent is paid, but a rent is paid because the price of corn is high” (Ricardo, 1821: 63). Although it was developed as a positive theory to explain land values it is being applied in many countries, such as the United Kingdom and the Netherlands (Morley, 2002; Buitelaar, 2010), as a normative theory, or method, to estimate land values. This method has become known as the residual land value method (Evans, 2004): the land value – the residue - is what results when the costs of development are deducted from its revenues. This implies that when the land has to be assembled for housing development, for instance, the expected house prices or rents have to be reduced by the building (and the additional) costs, the costs of servicing the land, of plan-making, of preparatory research, and so on. This is shown, in simplified form, in Table 2.1.

Table 2.1: The residual valuation approach and land development

Real estate price (sales price or net future income from rents)
<i>Minus</i>
Building and additional costs
<i>Equals</i>
Balance building account
<i>Equals</i>
Price of serviced land
<i>Equals</i>
Land revenues
<i>Minus</i>
Land production costs
* Costs of preparatory research
* Costs of servicing the land
* Plan-making & process costs
* Costs of infrastructural works outside the site
* (Other costs)
<i>Equals</i>
Balance land servicing account
<i>Equals</i>
Price of unserved land

Table 2.1 also shows the earlier mentioned typically Dutch distinction between the land servicing process and the actual building process. The implication is that there are usually two analytical distinctions in the building chain where it makes sense to

estimate the residual land value: at the stage of the building account and, earlier, at the stage of the land servicing account⁶. On the land account, the price of un-serviced land – also called ‘raw’ building land – is a cost, while the price of serviced land, land that is ready for property development, represents a revenue. Table 2.2 shows the costs and revenues on a land servicing account.

Table 2.2: The land servicing account

Costs	Revenues
Land assembly costs (price of unserviced land) ⁷	Land revenue (price of serviced land) ⁸
Costs of servicing the land ⁹	Gap funding (e.g. subsidies) ¹⁰ *
Plan-making and process costs ¹¹	
Costs of infrastructural works outside the site ^{12**}	
Costs of research ^{13**}	
<i>Balance</i>	

* In the analysis this is left out of the equation because it is a function of the costs, revenues and the balance.

** In the analysis these are left out of the equation because its share in the total amount of costs is only marginal (2,6% and 1% respectively). In addition, in the literature there is hardly any attention for these types of costs, which makes hypothesising on their relationship with location features rather difficult.

The implication of a residual approach is that most costs and revenues are the result of decisions with regard to the location and the content of the plan. Mainstream urban economics helps to make that connection. We assume that on an aggregate level the financial patterns follow a logic that is close to the assumptions of neoclassical urban economics. However, because of the fact that all costs and revenues are a function of deliberate public and private decision-making, which takes place within a political and institutional context, (old) institutional economics (e.g. Needham, Segeren & Buitelaar, 2011; Adams, Leishman & Watkins, 2012) also comes into the picture to amend some of the neoclassical reasoning.

In this section we will hypothesise on the relation between location factors and the various items of the land servicing account. The location factors are categorised into contextual factors, plan-related factors and site-specific constraints. By contextual factors we imply factors that deal with the location of the site within its context, particularly in relation to the urban centre. Plan-related factors concern basic decisions

⁶ Here we follow the translation used by Needham (2007).

⁷ Land assembly costs concern the sum of appraised land values, demolition costs and the costs involved with the removal of property rights from the land within the plan area.

⁸ Land yields concern the sum of appraised land values of serviced land.

⁹ Land servicing consists of remediation of soil contamination and ground works such as draining, grading, elevating or excavating land. Furthermore, costs involved with providing utilities and site infrastructure are also included.

¹⁰ Gap funding (additional funding) can come from the municipal account or from subsidies of other tiers of government (provinces, central government or the EU).

¹¹ These are costs associated with the municipal bureaucracy and the plan-making process.

¹² These are costs for facilities, such as infrastructure, that are necessary for the development but lie outside the plan area.

¹³ Research in land development can be related to ground work, acoustics, environmental issues, archeology, and so on.

with regard to the content of the land-use plan for a particular site, such as zoning, density requirements and the scope of the plan area. Site-specific factors regard features of the site before (re)development has taken place (the existence of buildings, the condition of the soil and the fragmentation of land ownership). Notwithstanding this analytical distinction, we acknowledge that in practice the boundaries between the categories are sometimes arbitrary and blurred. For instance, the location decision of a development project is part of the plan-making process, hence fusing contextual and plan-related factors.

2.1 Contextual factors

Where Ricardo's theory focused primarily on the fertility of land in relation to its value, Von Thünen focused on the importance of distance (Von Thünen, 1842). The greater the distance from the place of production to the market (the centre), the greater the transportation costs and the lower the land rents. At least theoretically. This idea was advanced by Alonso (1964). Based on theoretical predecessors such as Von Thünen, he developed a theory in which the land rent that people would be prepared to pay, given a particular utility, is made dependent on the distance to the economic centre. This relationship is depicted by the so-called *bid-rent* curve, an L-shaped curve, that shows decreasing land rents with increasing distance. Different land uses have different curves with different coefficients (e.g. McDonald & McMillen, 2007). Yet, the bottom line of the argument here is that the location towards the economic centre has an effect on land values and therewith on land servicing accounts.

The closer a location is towards the economic centre, the higher the rents. In the case of land development projects it might be assumed that both the land revenues and the costs of land assembly per square meter¹⁴ might be higher when the site is closer to the centre. This should be the case both when the centre of an urban area is considered and when the (economic) centre of a country is considered. For instance, land values in Manhattan are higher than in Queens, while in New York as a whole land values are higher than in Houston. Consequently and residually, there should be no effect on the financial balance of a land development project, since both land assembly costs and the revenue are expected to increase with a decrease of distance to the centre at the same rate.

2.2 Plan-related factors

Zoning

Alonso's bid-rent curves suggest that land use is a function of distance to the centre. Although in practice, land-use patterns do resemble neoclassical bid-rent curves – the most profitable land uses are indeed often located in city centres – empirical conformance to this theory is not self-evident and automatic. In many countries, land uses are designated by government and therefore also follow a political logic. Land-use zoning affects costs and revenues. In the Netherlands, land that is designated for

¹⁴ When costs and revenues are discussed we relate them to the size of the site (in square meters).

housing generally has a higher land price than land that is designated for an industrial estate (Pols *et al.*, 2009). In addition, based on empirical research, areas with mixed land uses can be assumed to have higher land prices than mono-functional housing areas (Koster & Rouwendal, 2010). However, when land prices are derived from residual valuation, there should be no effect on the financial balance of the development project.

Also, we expect that the land servicing costs and the plan-making (including the process) costs of housing areas and mixed-use areas are higher than of industrial estates, because quality requirements for housing and its public space are generally higher than for business- and industrial estates. This is assumed because local policy-makers and politicians are likely to be more concerned about the value of housing than about types of property because the electorate is too (Fischel, 2001).

Density requirements

Bid-rent curves become steeper with a decrease in distance to the centre, for there is a substitution effect of land by capital near the centres, as a result of which plots are more intensively used. Taller buildings and higher densities are the logical result. But, as is the case with zoning, in practice density does not follow the strict logic of the bid-rent curve perfectly. Instead, density requirements are often imposed by the land-use plan as a result of political process. In the Netherlands, for instance, one can observe high-rise buildings in suburban areas. This has been made possible with the use of stringent land-use planning and a shortage of housing as a result of that.

Whatever causes a particular density, residually, greater densities should lead to higher land assembly costs and higher land revenues. On the other hand, it could be expected that the costs of servicing the land and preparing it for building, especially the costs of providing public spaces, decrease with an increase in density, since higher densities often occur at the expense of public space.

Size of the plan area

In urban economics it is often stated that the bigger the city, the lower the costs of public services per capita, such as infrastructure and utilities (e.g. Carruthers & Ulfarsson, 2003). This is due to 'economies of scale', which refers to the cost advantages that occur with an increase in scale (McDonald & McMillen, 2007). Following this economic rationale, it might also be assumed that the costs of servicing land and the plan-making and process costs per square meter decrease with an increase in the size of a plan area. In the Netherlands, this is often the argument that local authorities use for acquiring and servicing great tracts of land (Needham, 1997).

2.3 Site-specific factors

Greenfield or brownfield

It has often been argued that brownfield development is more costly and less profitable than greenfield development (e.g. Adams & Watkins, 2002). This is mainly due to the fact that the costs of demolishing structures is higher on brownfield sites than on greenfield sites (if any). Also, it might be assumed that the process costs (i.e. transaction costs) are higher on brownfield sites because a greater number of

stakeholders (such as land owners and tenants) are involved. In addition, brownfield sites can be assumed to have higher land values and land acquisition costs because they are generally closer to the (economic) centre of an urban area than greenfield sites. So, here we consider greenfield and brownfield not only as a proxy of previously developed land but also of a location within an urban area. In addition, land assembly costs might also be higher because in some cases the use value of previously developed land is higher than the residual value of the planned, new land use (Buitelaar & Segeren, 2011). As a result, it might be expected that the financial balance of a brownfield redevelopment is worse than of the development of a greenfield site.

On the other hand, it might be assumed that the costs of servicing the land and the costs of public services is lower on brownfield sites than on greenfield sites, because existing facilities (such as roads, utilities and sewerage) can be used, at least partly, for the new development.

Physical geographic constraints

When a site has not been previously developed, it does not imply that development and building can be considered as a straightforward process. In development projects, especially for the cost of development, the suitability of the soil of the site for building is pivotal. Physical constraints to building such as water bodies, the solidness of the soil and the ruggedness are to be considered (e.g. Saiz, 2010). Recent research shows that such physical constraints can hamper housing supply significantly and therewith have an effect on house prices: the more stringent these constraints are, the higher the house prices (e.g. Saiz, 2010; Glaeser, Gyourko & Saiz, 2008). However, in general physical constraints do not necessarily make building impossible. Technically much is possible, however, not without costs. Therefore, it seems reasonable to assume that the more stringent the physical constraints, the higher the land servicing costs.

In the case of the Netherlands, ruggedness is not much of an issue since the country is virtually flat. But soil conditions, on the contrary, are of vital importance. A large part of the country lies below sea level and has a clay or peat soil. These are conditions that require greater investments into land servicing, such as drainage works and the elevation of land, than is the case with a sandy soil (Wigmans, 2002).

Number of landowners

Much has been written on land assembly and the fragmentation of land ownership and their effect on development (Eckart, 1985; O'Flaherty, 1994; Adams et al., 2002; Louw, 2008)¹⁵. From this, it can be derived that the greater the number of landowners, the greater the plan-making and process costs, in other words transaction costs. Generally, this is due to the fact that there are more people to deliberate and negotiate with. However, as in the case of density and in the distinction between greenfield and brownfield sites, the number of landowners could also be a proxy for distance to the centre. More central locations tend to have more fragmented land ownership than peripheral locations, because of the substitution of land by capital. Hence, more landowners might also correlate positively with land assembly costs and land revenues.

¹⁵ Here again, the distinction between plan-related and area-specific factors is arbitrary. The extent to which developments face ownership constraints is a function of the plan and its boundaries; ownership constraints are therefore not exogenous (Buitelaar & Segeren, 2011).

Table 2.3 gives an overview of the hypotheses that have been derived from the literature exploration above, in relation to the operationalisation of variables as is explained in the next section.

Table 2.3: Hypotheses¹⁶

2.1 Contextual factors
The land assembly costs and the land revenues increase with a decrease in distance to the economic centre of a country
2.2 Plan-related factors
Zoning
Mixed-use sites have higher land assembly costs and revenues than housing sites, which have higher costs and revenues than industrial estates
Mixed-use sites and housing sites have higher land servicing costs and plan-making and process costs than industrial estates
Density requirements
The land assembly costs and the land revenues increase with an increase in density
The land servicing costs decrease with an increase in density
Size of the plan area
The land servicing costs and the plan-making and process costs decrease with an increase in the size of the plan area
2.3 Site-specific factors
Greenfield or brownfield
Brownfield sites have higher land assembly costs and land revenues than greenfield sites
Brownfield sites have a worse financial balance than greenfield sites
Brownfield sites have higher plan-making and process costs than greenfield sites
Brownfield sites have lower land servicing costs than greenfield sites
Physical geographic constraints
Peat-soil sites and clay-soil sites have higher land servicing costs than sand-soils sites
Number of landowners
The land assembly costs and the land revenues increase with an increase in the number of landowners
The plan-making and process costs increase with an increase in the number of landowners

¹⁶ Yield and costs are all per unit, in this case per square meter.

3 Research approach

3.1 Dataset

For the analysis we use a unique dataset consisting of publicly available land servicing accounts, which have recently become available through a change in the law. With the introduction of the 'new' Dutch spatial planning act (Wro)¹⁷ in 2008, cost recovery of public expenditures by local authorities has become mandatory when a land-use plan (*bestemmingsplan*) allows for building activities. In that case, the land-use plan needs to be accompanied by a development plan (*exploitatieplan*) in which the costs and revenues of development are lined out and which prescribes precisely how much of the costs should be recovered and from which party. A land servicing account (*exploitatieopzet*), which includes the costs and revenues of the development, is required as part of that development plan. The land servicing account consists of a combination of actual and estimated costs and revenues.

A development plan is not required when cost recovery has been accounted for differently, for instance through a bilateral and voluntary agreement between the local authority and the developer(s). These agreements are not publicly available (only a summary), because these are agreements under private law and do not fall under the regime of the Dutch planning act. Since the assembly of land servicing accounts associated to private agreements requires the consent of the contracting parties, we solely focus on development plans with publicly available land servicing accounts. We assembled all development plans that were adopted in the first two years after the introduction of the act (1 July 2008 till 1 July 2010). This led to a dataset of 89 development plans, accompanied by land servicing accounts. According to the PBL (2012), this is 3-4% of all land-use plans that include building activities in the Netherlands.

3.2 Representativeness

Experts on land development projects in the Netherlands could argue that there are at least two potential limitations using these land servicing accounts in comparison to all other land servicing accounts. First, one can argue that the costs and revenues of those land accounts are inaccurate because they are appraised values – at least partly – instead of real prices. However, this is valid for land servicing accounts in general. Moreover, land servicing accounts in our dataset have been drawn up relatively close to the final stage of the land development project, just before the start of the actual building. Prior to the adoption of the development plan, a number of costs have already been made (e.g. research costs) and will therefore not change anymore.

A second, though related, critique might be that land servicing accounts of development plans might coexist with other 'real' or 'shadow' land servicing accounts, which remain hidden from the public. This might be the case for land acquisition 'costs' which in the system of the planning act are estimated land values instead of real land prices, even

¹⁷ The old spatial planning act from 1965 was replaced.

when the land has already been bought. However, it is hard to assess whether this leads to an under- or overestimation of land assembly costs; that depends on the timing of land acquisition. The closer land assembly took place before the recent global financial crisis, the more likely it is that actual land prices are higher than the estimated residual values and vice versa. Other than the land acquisition costs there is no reason to assume that there are 'shadow' accounts that would differ a lot from the ones that are publicly available. The law provides checks and balances to provide as accurate figures of costs and revenues as possible.

Due to the specific nature of each development project, we expect the sample to deviate from the total population of land servicing accounts in three ways. First, we expect that the development plans concern sites which contain a relatively large number of landowners. Because both public and private parties in general favour bilateral and voluntary development agreements over development plans (PBL, 2012), they will only use the latter when the former cannot be achieved. Therefore, it is very likely that on average there are relatively many landowners involved. With on average 32 landowners (see section 3.3), the sample does indeed seem to be biased in terms of landowners. Secondly, we expect that the development plans in the dataset concern relatively large areas. This is related to the first argument: the larger the plan area, the more landowners it will have, the more difficult it will be to establish a development agreement on cost recovery. Looking at the average size of the development projects in the dataset, which is almost 60 hectares (see section 3.3), it does indeed appear that the sample consists of relatively large sites. Third, we expect that all contributions in order to cover the costs of large infrastructure works to be relatively low, because of the fact that there are strict formal limitations to the extent to which these costs can be recovered from developers. In that sense, in bilateral agreements there is more freedom as to what to recover from developers.

Unfortunately, it is not possible to test these expectations empirically on all development sites in the Netherlands, since these variables are not available for the all land accounts. However, it is possible to shed some light on the representativeness of the dataset, by comparing the geographic distribution of land-use plans combined with development plans on the one hand with all land-use plans that allow for building on the other. In order to test the geographical representativeness we distinguished between three geographic parts in the Netherlands, which are commonly used: the Randstad, the intermediate zone and the peripheral zone (Van Oort, 2004)¹⁸. By using the *goodness-of-fit* test we estimated whether the geographic distribution of the sample differs from the total population in a statistically significant way. This is the case¹⁹. There is a slight overrepresentation of locations in the Randstad, the economic core of the Netherlands where the biggest Dutch cities are, including Amsterdam, Rotterdam, Utrecht and The Hague. This might indeed indicate that there is an overrepresentation for larger sites, since major (re)developments tend to be primarily located in that part of the country. This is not problematic, rather on the contrary, since these locations are in the heart of public-policy and scholarly attention (Flyvbjerg, Bruzelius & Rothengatter, 2003; Oosterlynck *et al.*, 2011).

¹⁸ Van Oort distinguishes these on the basis of a geographic gravity model.

¹⁹ Chi-square: 13,155 (p: 0.001).

3.3 Operationalisation of variables

On basis of the literature review, a number of location features have been derived that, in theory, influence the costs and revenues of land development (section 2). The first feature is 'location' within the Netherlands. To capture the impact of this feature, we looked into regional economic differences. For regional economic differences are expected to have a significant influence on the development of real estate values. Viewed from a residual valuation perspective, this should have a noticeable effect on land servicing accounts. Therefore we took into account the size of the regional economy, in terms of the gross regional product per capita (at a NUTS 2 level). The average gross regional product is € 34,333 per capita (standard deviation: € 6.325).

With respect to the variable 'zoning', we distinguished between mixed-use zones, residential zones and industrial estates (including offices), based on the dominant land use on a site. This has been determined on the basis of plan documents. Mixed-use areas mainly concern integrated land development projects on central locations. The sample contains 34 residential areas (38.2%), 26 business or industrial areas (29.2%) and 29 mixed-use areas (32.6%).

In this research, the share of land which is released for (real estate) development – these rest is public space – is used as a proxy to measure density²⁰. The argument is like this: the greater the share of space for real estate development, the higher the revenues and the lower the costs. This should have a positive effect on the financial feasibility of land development. The remaining part consists of public space and infrastructure. The average percentage of land released for development is 53.5% (standard deviation: 18%).

To assess whether economies of scale occur, with respect to costs for land servicing and costs concerned with the planning process, we take into account the size of the plan area, measured in hectares. The average size of the plan areas is 59.2 hectares (standard deviation: 92.6 hectares).

In the previous section we explicitly distinguished between three different types of site-specific constraints. First, we made a distinction between greenfield and brownfield land. In the case of greenfield sites, land use changes from vacant land to a built use²¹. On a brownfield site, however, there is a change from one built land-use to another. The attribution to greenfield and brownfield has been done on the basis of plan documents and aerial photographs. This leads to 31 brownfield sites (34.8%) and 58 greenfield sites (65.2%).

Second, we wanted to look at the effect of the soil on the land servicing costs. A GIS analysis of soil maps has been made to attribute a soil type to a plan area. We have distinguished between two categories: peat and clay soil on the one hand and sand soil and urban land on the other. Peat and clay soil often coincide with low altitude – in

²⁰ The floor-space index (FSI) would have been a superior proxy for density. However, there were no data available to construct this index for all plans. Other measures, such as the number of houses per hectare, are not suitable for all land uses.

²¹ Except for agricultural land.

many cases these soil types are below sea level – which may be considered to have a large impact on the costs associated with elevating and draining the land compared to sand soil and urban land. There are 24 cases of peat and clay soil in the sample (27%). The remaining 65 cases concern sand soil and urban land (73%).

The third site-specific constraint is the number of landowners as a proxy for the fragmentation of landownership. Information on this was gathered in the underlying plan documents and, if not available, via the Dutch land registry (*Kadaster*). The average number of landowners (at the point of adoption of the land-use and development plan) in a plan area is 31.8 (standard deviation: 50.7).

In section 2, we introduced our selection of costs and revenues that have been subject to further statistical analysis. These are: land assembly costs, land servicing costs, plan-making and process costs, costs of infrastructure works and the land revenues. Table 3.2 presents descriptive statistics of these items.

Table 3.2: Descriptive statistics of the dependent variables (per square metre)

Costs and revenues	N	Average	Minimum	Maximum	SD	Skewness
Balance (excluding gap funding) ²²	88	-20.18	-583.91	142.65	93.67	-3.751
Land revenues	89	132.13	0.00	554.10	102.28	1.940
Land assembly costs	89	76.63	1.97	702.04	98.90	3.885
Land servicing costs	76	44.27	0.10	178.44	37.21	2.119
Plan-making and process costs	78	15.92	0.05	75.26	12.63	2.055

3.4 Method

In the next section, the relation between location features and the costs and revenues of land development projects will be discussed. To this end, we use multivariate linear regression analyses. Because the dependent variables are measured in euros per square meter, *ordinary least squares* (OLS) regressions are appropriate. One condition for such analyses is that there is no ‘multicollinearity’. We checked this by using the variance inflation factor (VIF). In general, a value lower than 5 is acceptable. In our case, the highest VIF is 2.4. Therefore, based on this condition in all models all independent variables that have been derived from the literature could be included.

We estimated five regression models, with five different dependent variables (table 4.1)²³. To correct the results for heteroskedasticity, the models have been estimated with robust (White) standard errors. This means the variables have been corrected for vertical outliers. In addition, two control variables have been included. The first concerns a dummy variable to control for the fact that some land accounts use nominal

²² The external funding has been deducted because including it would conceal the ‘real’ financial gap and the effect location features have on that.

²³ Land assembly costs, land servicing costs, costs of infrastructure works, plan-making and process costs and land yields.

values for costs and revenues while other use net-present values. The second concerns year dummies to control for differences in the time value of money which results from the fact that the development plans and land servicing accounts have been adopted in different years (2009 and 2010).

Table 4.1: Results of regression analyses

Variables	(1) Balance (excluding gap funding)	(2) Land revenues	(3) Land assembly costs	(4) Land servicing costs	(5) Plan-making and process costs
Brownfield (0/1)	36.16* (18.92)	-49.09* (25.14)	-52.37** (23.16)	-20.36** (9.224)	-8.718*** (2.893)
GRP per capita	0.000811 (0.00103)	0.00181 (0.00138)	0.000913 (0.00135)	-0.000226 (0.000624)	4.48e-05 (0.000205)
Peat and clay soil (0/1)	3.143 (14.63)	-8.993 (18.49)	-8.059 (16.26)	0.790 (8.319)	-2.277 (3.084)
Residential zoning (0/1)	14.76 (20.52)	-7.551 (30.05)	-14.30 (20.68)	-12.60 (10.48)	-0.844 (3.195)
Industrial zoning (0/1)	4.519 (17.70)	-58.76** (26.36)	-42.28* (24.23)	-21.17* (10.79)	-4.648 (3.392)
Share of space for real estate development	51.17 (39.05)	21.11 (64.85)	25.34 (40.60)	-49.22** (23.29)	-14.40* (7.648)
Size of the plan area	-0.0403 (0.151)	-0.172 (0.215)	-0.0380 (0.238)	-0.0874 (0.0612)	-0.0375 (0.0247)
Number of land owners	-1.003*** (0.230)	0.726*** (0.273)	1.344*** (0.358)	0.208 (0.260)	0.121 (0.112)
Constant	-71.76 (52.05)	110.1 (75.93)	56.88 (55.05)	102.9*** (24.59)	29.40*** (8.217)
<i>Control variables</i>					
Nominal value (0/1)	8.005 (14.25)	-31.47 (19.09)	-21.39 (20.32)	-12.68** (6.056)	-2.648 (2.480)
Year 2010 (0/1)	-3.143 (17.07)	14.49 (23.32)	7.696 (17.58)	3.110 (7.895)	2.196 (2.729)
Observations	71	72	72	70	70
Adjusted R ²	0.355	0.262	0.413	0.333	0.367

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4 Results

The results of the regression analyses are presented in Table 4.1. They are discussed in the same order as we used in the introduction of the hypotheses in section 2.

Contextual factors

In section 2 we stated that the closer a location is towards the economic centre of a country, the higher the rents. We hypothesised that higher rents in the economic centre, following the residual approach, would lead to higher land revenues and higher land assembly costs. Therefore it is surprising to find that no significant positive correlation can be found between land revenues and the gross regional product per capita. The same goes for the relation between land assembly costs and the gross regional product. An explanation might be that the regional scale is too rough a level to measure distance-decay effects of land rents, since it does not account for potentially large intraregional differences. We will come back to this later.

Zoning

We suggested that land-use zoning affects costs and revenues in general. We indeed observe that land revenues and land assembly costs of industrial estates are significantly lower than those of mixed-use zones and residential areas. Second, we expected that land servicing costs and plan-making and process costs of residential and mixed-use zones would be higher than of industrial estates because of higher quality requirements with regard to residential and mixed-use areas. Our hypothesis regarding land servicing costs can indeed be confirmed; contrary to our hypothesis on plan-making and process costs. In other words, public spaces in residential and mixed-use areas are more expensive than in industrial areas, but it does not take more effort (i.e. transaction costs) to get these public spaces up to standard.

Density requirements

Unlike our hypothesis, the results do not confirm that land revenues and land assembly costs increase with an increase in density. Or at least not in the way that we measured density, that is, as the share of land dedicated for real estate or housing development. The reason might be that greater shares of public space increase the value of real estate, and therefore of land. In other words, the value increase that results from the positive effects of public space compensates – in terms of land value – for the smaller share of land that is available for real estate and housing development. On the other hand, our hypothesis that land servicing costs are higher with an increase in the share of public space is confirmed.

Size of the plan area

Based on mainstream economic thinking, we expected ‘economies of scale’ to occur with regard to land servicing costs and plan-making and process costs. However, the results do not show any statistically significant relationship between the size of a plan area and the land servicing and process costs (per square meter). This might have to do with the fact that at a certain point – a certain size - development projects get a span of control that is too big, which leads to diseconomies of scale.

Greenfield or brownfield

The assumption that developing brownfield sites is more costly and less profitable than greenfield sites has been stated often. And indeed, it is largely confirmed by our data. First, the costs of plan-making and the process costs are indeed higher, likely because of the involvement of a great number of stakeholders on brownfield sites than on greenfield sites. Second, brownfield sites have, as expected, higher land revenues, land assembly costs and a worse financial balance, as compared to greenfield sites. As argued before, the difference might occur due to the relatively high use value – compared to the residual value of the new land use – of land on brownfield sites. In addition, brownfield sites are usually closer to the urban centre than greenfield sites; following the logic of the bid-rent curve, this proximity is likely to give rise to land values. Our third hypothesis has not been confirmed. We expected land servicing costs to be lower on brownfield sites than on greenfield sites. However, this is not the case, rather the contrary. A possible explanation might be that the potential benefits of making use of existing facilities (e.g. roads and sewerage systems) are outweighed by the relatively high soil remediation costs on brownfield sites.

Physical geographic constraints

Another site-specific factor that has been taken into account is the suitability of the site for building. Because, in theory, these constraints might limit housing supply, house prices might be positively affected by them. Our results, however, show no significant relationship between soil type and land servicing costs.

Number of landowners

Unlike our expectation, the plan-making and process costs – transaction costs involved with deliberating and negotiating with actors – do not increase when the number of landowners in a certain plan area increase. Apparently, the complexity of locations is influenced more by the brownfield/greenfield divide than by the number of landowners.

On the other hand, we find that the number of landowners is strongly and positively associated with other costs and revenues on the land servicing account. The relation between the number of landowners and the land assembly costs is stronger than with land revenues. This results in a problematic financial feasibility of projects as the number of landowners in the plan area increases. As we suggested earlier, the number of landowners might not only be considered a proxy for land ownership structures, but to some extent also as a proxy for location relative to the economic centre of an urban area. In addition, use values closer to the centre are likely to be closer to or to exceed the residual value of the new land use, which poses problems for the financial feasibility.

5 Reflections on land development

In this paper we used a unique dataset to make a quantitative analysis of how location features are related to the financial side of land development projects. Many of the relationships turned out to be as we expected. For instance, the financial differences between brownfield and greenfield sites are in line with what is written about the financial feasibility and the progress of the redevelopment of brownfield sites (Adams & Watkins, 2002). The most striking deviation from the expected pattern is the fact that there are no economies of scale. Larger sites do not economise on costs, probably because potential scale advantages are eliminated – due to the greater number of landowners and other stakeholders involved in many large-scale projects – by the large span of control of larger sites. This is interesting in a public-policy context, since governments and developers use the ‘scale argument’ for the advocacy of these large-scale projects or ‘megaprojects’. However, this needs to be seen in the light of a sample of land development projects that is biased towards the larger and more complex projects. The possible effect of a larger span of control on scale advantages also calls for a reflection on the way public agencies make their land-policy decisions (with regard to e.g. compulsory purchase and scoping) to affect the number of stakeholders involved in projects.

Another important observation is that land-use zoning does affect land assembly costs and land revenues, but has no effect on the financial balance. What can we learn from this? The research results demonstrate the working of the use of residual valuation as a land appraisal method. It is a method that maximises land values. However, this does not only have an effect on revenues, but also on the (land assembly) costs. Hence, there is no or hardly an effect of location factors on the financial result of land development (Table 4.1). Although a widely accepted method to determine land values, the value-maximising mechanism of the residual value method has its drawbacks. The result of residual valuation is that early in the development process, initial land owners capitalise on value increases that are expected to be realised at the end of the process. This is not problematic in cases of market growth, which occurred in many countries earlier in the first decade of this century. In that situation, actual land revenues often outweigh the initially estimated revenues. The difference leads to a positive financial result which can be captured by the developing party, who then has an incentive to continue and complete the development process. However, in a deteriorating market, we see the reverse. Because of a residual calculation, and maximisation of the land values, expected land revenues often turn out to be higher than actual revenues at the end of the process. This leads to financial deficits, and therefore to delay, postponement and abolition of development projects.

This also has implications for ‘value capturing’, a land policy that has received renewed attention recently (e.g. Van der Krabben & Needham, 2008; Calavita & Mallach, 2010). One could distinguish between two forms. In the first form value is captured with no specific purpose other than the purpose of making sure that value increases that are caused by public-policy decisions end up in the public purse. The English betterment tax was an example of this type of value capturing. The second type dedicates the value increase specifically to another land use. The most commonly mentioned example is the capturing of value increases of real estate because of infrastructure

development and dedicated to cost recovery of the latter. This is where value capturing and cost recovery meet. In many land development projects, especially the larger and more integrated ones, value capturing takes place implicitly during plan-making. Commercial real estate and owner-occupied housing are often developed alongside less profitable land uses such as green spaces, infrastructure and affordable housing. The latter types of land uses are feasible because of the value of the former. However, capturing value for these less- or non-profitable land uses early in the process, especially when the value is maximised due to residual valuation and in relation to the before-mentioned positive and negative leverage effects due to market dynamics, might negatively impact on the financial feasibility of a land development project as a whole. This is something we must take into consideration, especially at times when markets teach us (once again) that the adage of 'the only way is up' is a false premise.

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