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A game theory approach to the analysis of land and property development processes

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ABSTRACT

Land and property development processes obviously can be seen as a social situation in which the interaction of individuals or groups of individuals is one of the essential elements. To study and understand social situations, it is important to analyse how the decisions of actors are interrelated and how those decisions result in outcomes. In this paper, we propose a game theoretical modelling approach to analyse it. Hence, the objective of the paper is to investigate the usefulness as well as the limitations of game theoretical modelling for analysing and predicting the behaviour of actors in decision-making processes with respect to the development of land and property. For that purpose, we have developed game models for the case study of the development of a greenfield residential location in the Netherlands with respect to the implementation of new Dutch legislation on cost recovery.

Our study demonstrates that game theory could help us to identify the key strategic decisions of land and property development projects by showing the different payoffs for stakeholders of their chosen strategies and selecting the equilibrium in which all stakeholders involved are best of. We also found many limitations of using game theory in our case study especially regarding the assumptions underlying the model. However, we conclude that game theoretical modelling can be a useful decision support tool in spatial planning, because it provides a way to think about the complexity of strategic interaction and, in particular, about the conflicting structure of collective decision-making processes.

1. Introduction

Land and property development processes obviously can be seen as social situations in which the interaction of individuals or groups of individuals is one of the essential elements (Goodchild and Munton, 1985; Adams and May, 1991; Adams et al., 1985, 1988). To study and understand social situations, it is important to analyse the decisions of actors and how they are interrelated and to analyse how those decisions result in outcomes.

Decision-making processes, especially with respect to land and property development, are, almost by definition, complex processes (Alexander, 1965; Byrne, 2003; De Roo, 2004). First, different groups of actors or stakeholders are involved (e.g., landowners, property developers, various municipal departments, investors, end users and real estate agents) and they respond to each other's strategies differently and also with different rationalities. Second, the utility functions of most of the stakeholders involved are usually based on more than one goal. Financial aspects are of course very relevant to decision-making, but the same goes for abstract themes like spatial quality and the wish to continue cooperation after completion of the project. These utility functions probably vary for each stakeholder. Third, many studies have demonstrated the strong link between the institutional context and market processes which in the end may change the stakeholders' strategies (Healey, 1992; Van der Krabben and Lambooy, 1993; Keogh and D'Arcy, 1999; Adams et al., 2005; Buitelaar, 2007). And fourth, there is interdependency among stakeholders' decisions in which the decision of one stakeholder will influence or be affected by the decision of other stakeholders.

This complexity issue is taken in this paper as the starting point for the analysis of decision-making in land and property development. The interactions among stakeholders in land and property development processes can be investigated by case study analysis. However, one of the disadvantages of this approach is the limited number of successful cases. Moreover, using case studies analysis could bear some difficulties regarding the influence of unique factors on the results and hence it would lead to the difficulties of generalization of the insights in behaviour of stakeholders. An alternative research approach is to use more experimental settings for analysis. This approach offers the opportunity to study behavioural

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aspects in relation to responses on controlled stimuli. Simulation and gaming tools have often been used in experiments with real players to analyse decision-making processes in land and property development (see e.g., Devisch et al., 2005; Havel and Viitanen, 2007; Devisch, 2008). In this paper, alternatively, we propose a game theoretical modelling approach. Hence, the objective of the paper is, in the above context, to investigate the usefulness as well as the limitations of game theoretical modelling for analysing and predicting the behaviour of actors in decision-making processes with respect to the development of land and property. Compared to gaming experiments, game theoretical modelling potentially offers the advantage to select the best possible outcomes of a game, i.e. the equilibriums. Moreover, we will argue in this paper that game theory is able to conceptualise the structure of relations between actors in land and property development, which in the end may lead us to a better understanding about the land and property development process. This may support, for instance, the choice of development models in the context of the institutional-economic environment. On the other hand, we also know from earlier studies that many underlying assumptions in game theory contain limitations that could reduce the applicability of the results.

To investigate the usefulness of game theoretical modelling with respect to collective decision-making in land and property development processes, we have developed a game model for the case study of the development of a greenfield residential location in the Netherlands. In this case study, we analyse the strategic behaviour of private developers and municipalities with respect to the implementation of new Dutch legislation on cost recovery (the Land Development Act, issued July 1st, 2008). The focus in the case study on the Land Development Act follows from our assumption that the new legislation not only affects the strategies of the actors involved, but also the interrelationships between the actors (Korthals Altes, 2006; Van Dinteren et al., 2008). The game model will thus be employed to analyse the effects of the actors' changing strategies on both the outcomes of each other's strategies and on the equilibriums that can be achieved.

The structure of this paper is as follows. Section 2 provides an introduction to game theory and a discussion of the supposed advantages as well as limitations of applying game theory to urban planning and land and property development studies. Section 3 discusses then how game theory actually works. In Sections 4 and 5 we use game theory to construct a model with respect to greenfield residential location development in the Netherlands. Section 4 presents a brief description of the land development process for residential use in the Netherlands, introducing the stakeholders, their strategies and the institutional context in which they operate. In Section 5 the modelling analysis is carried out. It will show the outcomes of the game model, both *before* and *after* the implementation of the new legislation on cost recovery. Finally, Section 6 discusses the usefulness of game theory for modelling land and property development processes and suggests the next steps for further analysis.

2. Why game theory?

Game theory is a theory of interdependent decision-making in which the decision-makers involved have conflicting preferences and the outcome of their decisions cannot be determined by one party or actor only. The roots of game theory derive from decision theory (Myerson, 1991). However, there is a clear distinction. Decision theory usually analyses decision-making processes from one player's point of view, while game theory emphasizes its analysis in the interaction among many players. Because game theory focuses on situations in which interactions and interdependency play a role, it can be seen as an extension of decision theory.

The term 'game theory' stems from the resemblance of collective decision-making situations to well-known parlour games like chess, poker, and monopoly (Aumann, 1989). Because of its focus on conflicting preferences, game theory is often defined as a theory of conflict (Myerson, 1991; Luce and Raiffa, 1957). Aumann has even proposed to speak of 'Interaction Decision Theory' instead of Game Theory, since the former name more accurately describes the content and focus of the theory (Myerson, 1991). Modern game theory began in the 1920s with the work of Borel (1921) and Von Neumann (1928). But it was after the seminal work of Von Neumann and Morgenstern (1944) that game theory triggered an outburst of interests, especially among mathematicians and economists, and started to flower as a field of study. Since then, game theory has been profoundly influencing other fields in natural science, such as biology, physics, and computer science, as well as social science, including anthropology, psychology, sociology, politics, and philosophy (Kreps, 1990; Colman, 1999; Hargreaves Heap and Varoufakis, 2004). The increased attention to game theory especially in social science is based on the idea that it can provide solid micro-foundations for the study of collective decision-making processes and structures and social change (Elster, 1982; Aumann and Hart, 1992). Furthermore, game theory has the potential to improve our understanding of social interactions in general and interactive decision-making in particular. One important example is the game theoretical model of the prisoners' dilemma which has been one of the most prominent analytical foundations for the understanding of problems of collective action (Hardin, 1971, 1982; Ostrom, 2000).[1]

With respect to land and property development processes, the applications of game theory so far are limited in number (Berkman, 1965; Mu and Ma, 2007). The lack of attention is perhaps understandable because land and property development and spatial planning are characteristically very much *context-driven*. The issues of pluriformity, complexity and interdependency have become much more important in urban societies and, accordingly, in current planning literature (Healey, 1992; Taylor, 1998; Needham, 2007). Modelling those processes, so it is sometimes argued, makes no sense, because the interactions of the actors involved are undeniably too complex and so much dependent on the case-specific circumstances. To argue in favour of modelling land and property development processes in simplified models may then seem to be odd. However, we will argue otherwise. This is supported by a review of the analytical tools for studying land and property development processes by Ball et al., which considers game theory as a promising methodology in this field of research (Ball et al., 1998; Ball, 1998).

Game theoretical modelling indeed implies, like any modelling exercise, a simplification and abstraction from the real world. However, in some disciplines, for instance in economics, the translation of the real world into a formal model is very much accepted and appreciated. Mathematical approaches to the analysis of complex situations have evolved through time as a very significant field of study.

[1] The study of collective actions has been introduced in the classical work of Olson: *The Logic of Collective Action* (Olson, 1965). Olson's analysis of collective action focuses particularly on the problem of public goods provision. According to Olson, there is a natural tendency for people with shared interests to act together in pursuit of those interests. However, there is sometimes a problem of congruence between individual interests and group interests which is not well explained in Olson's work. As discussed by Hardin (1971, 1982), using the game theoretical model of the Prisoners' Dilemma the divergence of individual interest and group interest can be clearly explained. For more information about collective action and game theory (see e.g., Hardin, 1971, 1982; Ostrom, 2000, 1990; Olson, 1965; Oliver, 1993).

Being aware of the limitations to modelling exercises of complex situations, there are some good reasons to look at the possibilities of game theory as a decision support tool for the analysis of land and property development. First, one of the benefits of using game theory is that the construction of a model of complex land and property development requires to define very precisely the assumptions about the complex reality underlying the model (see Section 5). In line with that, as a formal model, game theory allows us to see exactly how the conclusions of a model follow from its assumptions. Of course, the assumptions can and should be discussed, but the outcome of game theoretical modelling can be described very precisely. In addition, formal modelling also creates a logical structure for an argument and its accumulation. The logical structure of a model allows a modeller to add to it or rub out something from it to derive new conclusions and leads to new insights or the clarification of a problem. Moreover, sensitivity analysis can be carried out in order to examine the robustness of the model. There are many different ways to define issues and arguments in urban planning or land and property development. However, without the rigour of a formal model, we might fail to generalize such argument to other situations. And moving away from complexity by trying to make a more general structure of arguments may also contribute to increase the transferability of planning and development strategies internationally.[2]

Second, many have criticized the notion of rational or payoff maximizing players underlying game theory, which assumes complete information for each player. However, recent contributions to game theory seem to offer new opportunities to increase its applicability. In the last decade game theory has been capable of developing more realistic decision-making models, including bounded rationality models, models taking account of emotions and intuitive decision-making, models with incomplete information and models with asymmetric information positions. In this respect, game theory is leaving its mathematical heritage and is becoming more and more a behavioural theory of decision-making and has lead to much experimentation in game theory (see e.g., Camerer, 2003; Camerer et al., 2004). Applications of game theory to spatial planning can take advantage of that. In this paper, however, we stick to the more traditional game theoretical methods. The advantage of this approach is that it structures the situations to be studied in a simple and clear way. As a first step, it therefore raises our understanding of the decision problems at stake. In a later stage, it may be refined and extended into a more sophisticated or realistic model.

Third, results of earlier studies show that it is possible to test and validate empirically the outcomes of game theoretical modelling. In this respect, we refer to good results of earlier research (van Deemen, 2006). Validating the preferences of the stakeholders involved and testing the outcomes of the games to be played can help to increase the applicability of the outcomes of games in a more general way.

3. How does game theory work?

This section provides a brief introduction to how game theory actually works. Since the main objective of the paper is to investigate the usefulness of game theoretical modelling for the analysis of land and property development processes, only the basic concepts of game theory are explained here, including *games*, *players*, *strategies*, *outcomes* and *payoffs* and *solution concepts*.[3]

3.1. Games

Any game consists of two parts, namely a descriptive part which describes the game under scrutiny, and a solution part which describes or predicts the outcomes given the description of the game. This two-component approach can be compared with a mathematical problem, e.g., in linear algebra. We then have a set of equations describing the problem and, subsequently, we try to find a solution of the system of equations. In game theory we describe a collective decision-making situation as a game and try to find its solutions. This analogy of game theory with linear algebra elucidates another important point in game theory. In linear algebra, a system of equations may have one solution, many solutions or no solution at all. The same is true for games. Basically, three descriptive frameworks for the games are distinguished: games in *strategy form*, games in *coalition form* or *characteristic form* and games in *extensive form*. These three formats have already been constructed by Von Neumann and Morgenstern (1944). In the case study in this paper (Section 5) we model the decision-making processes as a game in extensive form. In this way, we will arrive at a detailed picture of the structure of land and property development processes and the possible outcomes of this structure. It is assumed that players decide sequentially, as in playing chess. The first player makes a move, the second one responds and so on. The whole game can be structured by means of a so-called game tree. This can be seen as a graphical representation of the strategic interactions of the players in Fig. 1.

Trees are defined in terms of *nodes* and *branches*. The nodes in the tree represent the decisions made by a player, while the branches represent the moves or alternative actions for a player to choose from. The branches end in different decision nodes at which other players can make a decision and so on until an outcome is arrived at and the game ends. The nodes representing these outcomes are called *end nodes*. Note that a game tree, usually, will have many end nodes. The node at with the first player makes his decision is called the *initial node* or also the *root* of the game. So, a game in extensive form is a sequence of decisions with respect to possible actions, made by the players in succession.

It is possible to transform games in extensive form into games in strategic form. However, games in extensive form are usually more detailed. Conversions into strategic form games therefore lead to a loss of information which in most cases is difficult to repair. The strategic form game, based on the game in extensive form, gains in more abstraction and hence in the loss of detailed information. In principle, it is also possible to move from games in strategy form to games in coalition form. Again, information will be lost when increasing the level of abstraction. According to Myerson (1991), games in extensive form usually offer the most richly structured way to describe the structure of game situations, although sometimes it could seem too complicated. When the game is showed in detail, this may hinder the analysis, because the fundamental issues are obscured. The strategic or normal form is offering a simpler construction and, conceptually, it gives more convenience for purposes of general analysis. Therefore, sometimes it is necessary to represent the game in both extensive and normal form.

[2] Several authors have addressed the problem of the limited international transferability of planning and development strategies and instruments (e.g., Dolowitz, 1998; Dolowitz and Marsh, 2000; Salskov-Iversen, 2006; Bulmer et al., 2007; Dolowitz and Medearis, 2009).

[3] General introductions to game theory include (Aumann, 1989; Luce and Raiffa, 1957; Carmichael, 2004; Dixit and Skeath, 2004).

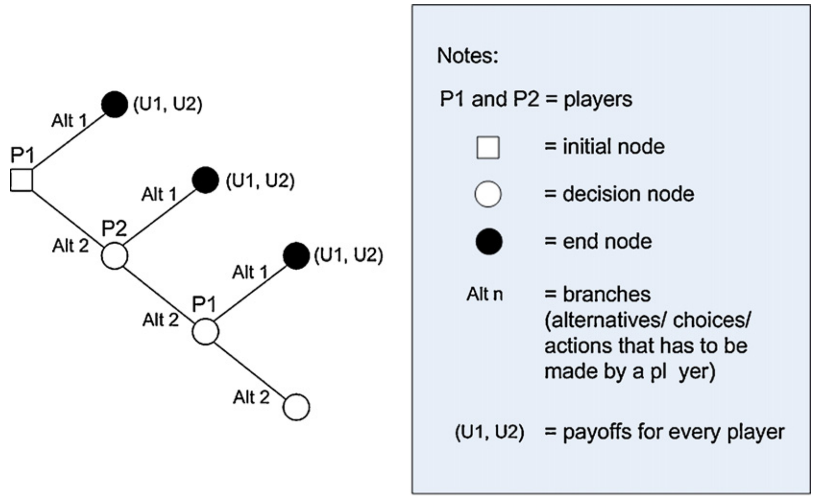

Fig. 1. Game tree.

3.2. Players

In a game, players are the decision makers. If a player exactly knows where he stands in the game tree, then we speak of *perfect information*. If a player does not know where he is in the tree, he can still estimate the probability that he is at a certain node. We then speak of *imperfect information*. In this situation, he does not know the moves made in a previous stage by other players. A player is a primitive term that has to be linked to an empirical domain in order to get any meaning. In the case study in Sections 4 and 5, players are interpreted as stakeholders involved in the process of land and property development in the Netherlands.

3.3. Strategy

A strategy can be defined as a contingent plan of actions. It stipulates a priori how the player will act when a move is made by another player. Players are supposed to be able to choose from a set of different strategies. There is a similarity between a strategy in game theoretical terms and the business meaning of strategy. The strategic management literature (see e.g., Ansoff, 1979) contains a variety of definitions of the concept strategy, but most definitions have in common that a strategy contains long-term goals and objectives, as well as a plan how to attain them. In game theory, players also aim at a goal, namely utility maximization, and adopt a plan how to achieve this in their strategy. The essence of game theory is that each player makes his own selection of a strategy, but the overall result depends on the choices of all. So each player only partially controls the outcome of a game.

3.4. Outcome and payoff

In any game, a clear distinction has to be made between the concepts of *outcome* and *payoff*. An outcome is a social or physical state which may result from the behaviour of the players or a complete set of strategic selections in the game. In fact, it is the decision, if any, arrived at by the players collectively. The payoff of an outcome for a player is the value of that outcome for the player. Different players will, in general, value outcomes differently and, consequently, will have different preferences over the set of outcomes. The players' preferences over outcomes are represented by means of expected utility functions or, as they are called in game theory, by payoff functions. These presumed differences in individual preferences and hence in the players' payoff functions make the notion of conflict very important in game theory. It is because of this reason that game theory sometimes is called a theory of conflict (Luce and Raiffa, 1957; Jones, 2000). The individual payoff functions that assign values to outcomes vary across individuals. The best outcome for one player may be the worst for the other. The basic question therefore is how to solve games given these different conflicting payoff functions.

3.5. Solution concepts

There are several solution concepts for game theory.[4] However, it is the concept of *Nash Equilibrium* (NE) that is certainly most frequently applied (Aumann, 1985). An NE can be defined as a profile of selected strategies – one strategy for each player – in which no player has an incentive to deviate from his selected strategy. The strategy selected by any player is a best response to the strategies chosen by all the other players. Note the complexity of the concept: each player selects a best response to any other individual strategy selected. Hence, Nash equilibrium is a situation of best responses toward each other, one strategy for each player. 'Best' hereby means that deviating from the response will not lead to an increase in payoff. Nash equilibrium need not be unique. Many games have multiple Nash equilibriums. Therefore, in the theory of games in strategic and extensive form much attention has been paid to refinements of the NE concept. A frequently used refinement for games in extensive form with perfect information is the notion of subgame perfect equilibrium (SPE). A subgame of an extensive form game is a part of the game that as such can be considered as a game on its own. It corresponds with a sub-tree in the game tree. An SPE is an NE for every subgame in an extensive form game. Clearly, an SPE is always an NE, but not conversely, hence there may be Nash equilibriums which are not subgame perfect. Therefore, an SPE is a stronger solution concept than an NE. An SPE can be found by using the backward induction method. This method starts the searching process after equilibriums at the end of the tree in a sub-tree. Rolling back through the several sub-trees

[4] The variation of solution concepts for game theory mainly ensues based on the different types of game that are played in different situations. *Nash Equilibrium* is the most common solution concept to be applied in Non-cooperative games. While in cooperative games such concepts like *the core*, *the stable set* (also known as the *von Neumann–Morgenstern solution*) and *Shapley value* are the most important solution concepts. For more information (see e.g., Aumann, 1989; Luce and Raiffa, 1957; Carmichael, 2004; Dixit and Skeath, 2004).

to the root of the tree and analysing for equilibriums lead to a SPE. It is a backward reasoning method starting at the endnodes of the tree.

All the concepts that have been discussed in this section will be applied in the case study in the next two sections.

4. Case study: residential land development in the Netherlands

The main goal of the case study is to investigate the potential usefulness of game theoretical modelling in supporting decision-making processes regarding the strategies to choose for land and property development. Our case study concerns the game theoretical modelling of greenfield residential land development in the Netherlands. Compared to, for instance, the transformation of brownfield locations into residential use, the number of stakeholders is usually limited, which helps us to use it as a clear study case. Moreover, the choice for this case study allows us to pay attention to the impact of new legislation on the strategies of the stakeholders and, consequently, on the outcome of the game. This will demonstrate the usefulness of game theoretical modelling, when estimating the effects of changes in the institutional context.[5]

4.1. Municipal strategies for greenfield residential land development in the Netherlands

First, we must define the possible strategies for the municipalities to develop a greenfield location for residential use within the Dutch context.[6] The municipality usually takes the initiative for greenfield residential developments. To make sure that the plan is implemented, municipalities often decide to take part in the land development process (Needham, 2006). This approach is called *active land policy* and is referred to as the *public development model*, which means that the municipality acquires all the land to be developed, services the land, readjusts the parcels into building plots suitable for the desired development and after that releases them to builders/developers and end users (Van der Krabben and Needham, 2008). This public development model is also often used in situations that private developers have already acquired land on the location with the intention to build houses. The private developers usually agree to sell their unserviced land to the municipality without trying to make profits. In return, they hold a building claim to the municipality that guarantees them the first right to buy the serviced land, against prices that have been agreed upon before they sold the unserviced land. This model is usually referred to as the *building claim model*. This approach excludes competitors from the development and ensures the private developer a high-quality location for profitable housing development (Korthals Altes, 2006; Needham and Verhage, 1998; Boelhouwer, 2005).[7]

An often used alternative development strategy to the public land development model is a land development model based on a public private partnership between the municipality and some of the private developers that have acquired land on the location. The advantage of this model for both the public and the private actors is that they can share financial risks and expertise. In this model, the public and private stakeholders involved establish a joint venture land development company which takes over the role of the municipality in the public development model. This joint venture company will come to an end, as soon as all building plots are sold. The shareholders in this joint venture generally agree not to make any profits, but to accept that only the costs of land development will be covered by the sale of building plots. In turn, the private developers will have the first right to buy serviced building plots, against prices that may be below market value, depending on the negotiations between the municipality and the private developer. To support the development strategy of the joint venture company, the municipality usually agrees to use its land policy tools, if necessary, including the possibility of a pre-emption right and expropriation powers.

The above models of public or public private residential land development usually work well for most municipalities in the Netherlands. However, the active involvement of municipalities in the land development process is not without risks. Sometimes land development processes will result in financial losses for the stakeholders involved, for instance because of a drop in the demand for housing and, subsequently, the demand for land. Therefore, although the development models above are commonly used for greenfield residential developments, still alternative approaches or models are in use as well. One of them is known as a local government strategy based on facilitating land policy. In this model, location development is carried out by one or more private developers, without any interference of the municipality in the land development process. The instruments of land acquisition are not pro-actively used in this model. The municipality initiates the development by issuing a land use plan, but is not involved in the actual development of the location. One reason for municipalities to choose this strategy is to reduce land development risks. In practice, this development model is often used for office or retail development in the Netherlands, but hardly ever for residential development.

Another strategy for the municipality is to form a joint venture land development company with one or more private developers that do not own any land on the location, despite the fact that other private developers do own parts of the location and have the legal right to develop it. The intention of this joint venture company will be then to acquire the remaining land on the location, supported by the municipal land policy tools. The private developer participating in the joint venture land development company will usually be offered a building claim or the first right to buy the serviced land that is owned by the joint venture. The motivation for the municipality to choose this strategy might be that the expertise of the selected developer is believed to be better than the expertise of the land-owning private developers; or, the negotiations with the land-owning developers have failed because of financial reasons.[8] The motivation for the private developer to participate is, again, not primarily the profitability of land development, but the chance to buy the serviced land to develop houses. In this situation, private developers would usually also accept low or no profits at all from land development, as long as their participation in the land development process will guarantee them to buy

[5] Note that the case study, in its present form, is primarily meant for scientific goals. The results are only of limited use for strategic advice to the stakeholders involved, due to the empirical restrictions to the game (see Section 5).

[6] For more information about the Dutch residential land market and residential policies we refer to, among others (Korthals Altes, 2006; Needham, 2007; Verhage, 2002).

[7] It is hard for the municipality to refuse cooperation with the private developers that have already acquired land. According to Dutch law, landowners that can prove that they have the skills to carry out the planned development have the legal right to do this. In this situation they cannot be expropriated by the municipality.

[8] The municipality may consider this strategy in a situation that part of the land on the development location has been already acquired by private developers, while a substantial part of the land is still in the hands of the original owners and has to be acquired by the joint venture development company. This will guarantee the developer participating in the joint venture company that he will still have sufficient development opportunities on the locations that will be acquired by the joint venture company.

Table 1
Land development strategies.

Land development strategy	Initial situation on the land market	Acquisition of agricultural land	Servicing and reparcelling the land	Acquisition of building plots
Active land policy by the municipality				
(1) Public land development	Original owners	Municipality acquires all land	Municipality	Private developers buy numerous building plots End user buys single building plot
(2) Building claim model	Private developers with intentions to build houses	Municipality acquires all land	Municipality	Private developers with building claim buy building plots
(3)Public private partnership model	Original owners	Joint venture company (including land-owning private developer)	Joint venture company	Private developers with building claim buy building plots
	Private developers with intentions to build houses	Joint venture company (excluding land-owning private developers)		
Facilitating land policy by the municipality				
(4) Private land development model	Original owners	Private developers; End users	Private developers; end users	End users buy building plots; end users already own building plots

building plots against 'acceptable' prices which is to be negotiated beforehand.

A final strategy for the municipality might be to acquire all land on the location and sell it directly to the *end user* (the individual household), offering the end user to construct its own house. In this paper we leave aside this approach, because municipalities do not often use it for residential development (though it is the regular development model for industrial estates). They prefer to cooperate with professional private developers, because they aim at the integrated development of the location. Moreover, it is much easier for municipalities to sell the serviced land to a limited number of private developers instead of to thousands of individuals. Besides, as we explained before, in many cases municipalities do not have a choice, because private developers acquired all land.

Table 1 summarises the different land development strategies that are available for municipalities.

4.2. The New Land Development Act and its impact on land and property development

The main reason for adopting an active land policy with respect to the development of greenfield sites (public or public private partnership model) is that municipalities can exert more influence on the spatial development process compared to the situation in which they adopt a facilitating land policy. Moreover, municipalities will also have an opportunity to gain some profits from the development even though it is not their main purpose. In some situations, however, it appeared to be impossible for the municipality to acquire all land. Some of the land-owning private developers did not agree with the public or public–private model and aimed for private development of the part of the location that is owned by them. Some of them also refused to contribute to the costs of plan-related infrastructure and public space development (Needham, 2007). They are considered as *free riders*.[9] Municipalities were lacking the legal tools to require a financial contribution to plan-related costs (cost recovery) from those free riders. This has resulted, for some municipalities, in serious problems with cost recovery of public investments in public land development processes. To put it in game theoretical terms, the payoff for the municipality of some outcomes decreased substantially. For that reason, the Dutch Cabinet decided recently (per 1 July, 2008) to introduce new legislation for cost recovery of public investments, for example, costs of servicing the land, road infrastructure and open space. Under the new Land Development Act, all landowners that take part in the (re)development can be forced, if necessary, to contribute to plan-related costs. This Land Development Act is expected to provide more flexibility to municipalities with respect to location development and to make it 'easier' for municipalities to (re)develop both greenfield and brownfield locations (Van Dinteren et al., 2008).[10] Even when municipalities do not own land, the private landowners can be forced to contribute to the costs of public investments. In principle, the new legislation guarantees them the same development result, either with active or with facilitating land policy.

The consequence of this is that the positions of the stakeholders in the land development game have changed. The municipalities have gained power in the negotiation processes, while the power of the private developers has decreased. Results of recent studies (Korthals Altes, 2006; Van Dinteren et al., 2008; Needham, 2007), on the other hand, show that under the old regime most private developers even without legislation agreed to contribute to plan-related costs, because they expect to benefit from it since a higher quality of the location leads to higher housing prices. In the game that will be constructed in the next section we will be able to show to what extent the changes in legislation may result in other payoffs for the stakeholders and other equilibriums.

5. Game construction

5.1. Framework for the game

For this study, we have restricted ourselves to the analysis of a game in extensive form or a game tree analysis. By using a solution concept for the game, the steady-state situation can be found to find the best strategy for all players, i.e. the equilibrium of the game. This will allow us to compare the outcome of complex decision-making

[9] This started in the 1990s, after the national government had launched a nationwide policy to develop a substantial number of large residential greenfield locations (the so-called VINEX locations). The unexpected effect of this policy was that private developers started to acquire land at the VINEX locations (while they had not shown any interest in acquiring land before). The private developers' strategies led to the building claim model and, in some situations, to free rider problems. For more information about the development of VINEX locations (see e.g., Korthals Altes, 2006).

[10] A short introduction in English to the Dutch Land Development Act can be found on www.vrom.nl/pagina.html?id=2706&sp=2&dn=7198.

in actual projects with the best outcome of the game for all players. Here we will discuss the basic elements to construct a game tree, including: *players*, *strategies* and *payoffs*.

5.1.1. Players

In line with our discussion in Section 4, we identify four different stakeholders, i.e. players for the game:

(1) the municipality (M),
(2) a property developer who has not acquired land (PD),
(3) a property developer who has acquired land (PL),
(4) and the original landowner (LO) which usually a farmer.

In reality, the process of land and property development involves more actors, such as the national government, the province, pressure groups, landowners and/or developers in other competing locations, but we only consider those four in our game, because they are the crucial stakeholders in this process. Furthermore, in real situations – on large development locations – there is usually more than one PD, LO and PL. However, for the sake of simplification, we have assumed here a small location with only the four stakeholders.

Note that, although in Section 4 we have mentioned the joint venture company as one of the stakeholders in land and property development, we do not consider it as one of the players. We consider this joint venture company – which is expected to have a zero profit (or, in game theoretical perspective: zero payoff) – just as a tool of the municipality and the private developers to maximize their utility functions. It also should be noted that we distinguish between property developers who have acquired land and those who have not, because we assume that strategies of both stakeholders will be different.

5.1.2. Strategies

In the game we constructed, the strategies are derived from the different land development strategies that are available for each stakeholder (see Section 4.1). It is important to notice that almost in every game, strategic interactions of players consist of a mixture of both conflicts and common interests. It implies that players are not only trying to compete with each other but may also cooperate or reach agreements to form a coalition in order to maximize their total benefits. In our model, a coalition takes place when the municipality and the property developers decide to implement a joint venture company to service the land. However, we leave aside the costs of forming coalitions in the land development game, though it could be a consideration for the players in assessing the payoff of the game, especially when the joint venture is not functioning as it should be.

5.1.3. Payoffs

In the game model presented here we have estimated the payoffs at interval level for every possible outcome in the game. In order to do that, we first conceptualised the goal of land and property development process in three sub-goals that are in line with payoff maximization, which are (1) the financial result of the development process, (2) the spatial result or the spatial quality that will be achieved, and (3) the period of time in which the plan will be implemented ('the sooner, the better'). However, the relevance of these three different payoffs varies for the different players. For the municipality, 'spatial quality' and 'time' are believed to be more important than 'financial result', while for the property developers this is likely to be vice versa. These differences are expressed in different weights to these three sub-goal features for every player (total weight of 100% for all three features together). Every player will make an assessment to all outcomes with respect to those three sub-goals based on its preferences. For this assessment, every player will use different variables based on their preferences and reflect the relevance of those variables with respect to each of the three sub-goals of land and property development. These variables are shown in Table 2.[11]

Table 2
Variables for outcomes assessment.

Players	Variables
Municipality (M)	(1) Implemented plan (2) Giving building claim to PL (3) Public land development model (4) Property market conditions (5) Establishing a joint venture company (6) Buying agricultural land
Property developer (PD)	(1) Opportunity to develop properties (2) Having building claim (3) Property market conditions (4) Selling serviced land (5) Buying serviced land (6) Buying agricultural land
Property developer with land (PL)	(1) Opportunity to develop properties (2) Having building claim (3) Property market conditions (4) Selling unserviced land (5) Selling serviced land (6) Risk of servicing the land (7) Buying serviced land
Landowner (LO)	(1) Land sold (2) Property market conditions (3) Land buyer (4) Cost of selling (5) Future occupancy of the land

To be able to calculate the payoff of all outcomes for each player, we first scored all variables above. The variables have been valued by scores from 0 to 10. Value 10 means that a particular variable is very relevant to achieve a particular sub-goal and value 0 means completely the opposite. In this valuation, negative values have also been taken into account to show that a particular variable may be considered to have a negative impact on one of the sub-goals. The valuation of each variable is multiplied by the weight of each feature of the sub-goal, resulting in a weighted score to all indicators (Appendix A).

Within the context of this game, those variables are jointly responsible for the way each player assesses the different outcomes. For example, with respect to variable 1, for M outcomes that have led to the implementation of the plan will be assessed better than outcomes that have not led to the implementation of the plan. With respect to variable 2, outcomes that are based on the building claim model will be assessed less than outcomes that are not, because M will expect that in this building claim model PL will be able to negotiate a better financial result. Regarding variable 3, outcomes based on a public land development strategy are assessed better than outcomes based on a private land development strategy. With respect to variable 4, property market conditions are expected to influence the outcome as well. Outcomes that are based on a joint venture model, as in variable 5, are assessed better than outcomes that are not based on a joint venture model. And, finally, with respect to variable 6, it is assumed that outcomes that are

[11] Our estimations are based on our own experiences in this field and earlier research (Van Dinteren et al., 2008). They are believed more or less to represent the general opinion about the strategies of the stakeholders. As has been mentioned in the previous section, the payoffs have not been validated. We believe this is acceptable in the context of this paper, considering the main purpose of the case study (namely to analyse the usefulness of this approach).

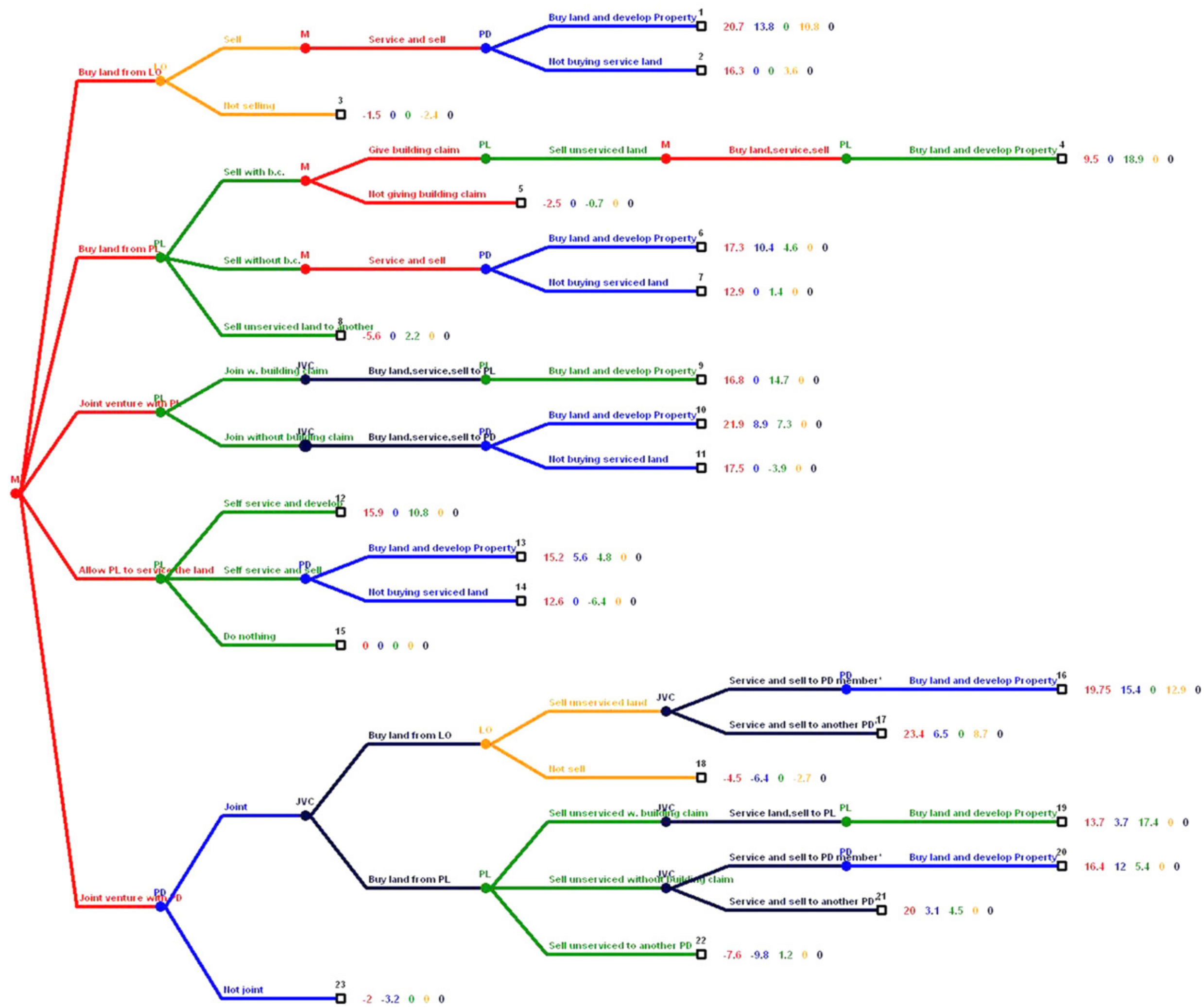

Fig. 2. Game in extensive form—land and property development process for residential use in the Netherlands under old regulation.

based on the strategy of M to buy agricultural land from LO are assessed better than strategies to buy land from other players. The end score that results from this exercise is the payoff for M. We have used a similar line of argument for the other players.

We applied the game for the case of greenfield residential land development within the institutional context of the Dutch planning system, more specifically under the regime before and after the implementation of the new Land Development Act. Since this new legislation has been implemented only very recently, we do not know yet the stakeholders' strategies under the new regime. However, there is some empirical evidence supporting our estimations of the payoffs of the possible outcomes under the new regime from the ex-ante evaluation of the new law (Van Dinteren et al., 2008). We have explored the game tree to analyse the differences with respect to the stakeholders' strategic behaviour regarding the development process under the old planning regime and the new one. Additionally, we have predicted the subgame perfect equilibrium in accordance with both games and find out whether they deviate or not. The game we constructed is a static game and we assume perfect information.

5.2. The game models

The structures of the game under the old and the new planning regime are presented respectively in Figs. 2 and 3. The structures of both games are identical, because the available strategies for all stakeholders are the same under both conditions. However, players' perceptions of the expected utility of the outcomes of land and property development processes are different, due to the introduction of the new Land Development Act. The new legislation is expected to lead the stakeholders to choose different strategies. The differences between both games are visible in the payoff systems which express the players' expected utility on the game outcomes.

In the games we constructed, the municipality (M) is the initiator of the game, i.e. the first mover at the root of the game tree, because in the Netherlands the municipality usually takes the initiative for land and property development in the Netherlands (Needham, 2007, 2006). As we explained in Section 3, the municipality can choose between a public land development model and a private land development model. The public land development model either involves the municipality as public land developer or a public private joint venture company (together with private developer). Based on this condition, five different moves can be constructed for M from the root of the game tree. Four of them are within the public land development model and one strategy is based on the private land development model. When M decides to choose a development strategy for the location based on the public land development model, two moves can be considered: to buy land from LO or to buy land from PL. Other possible moves are to establish a joint venture company, either with PD or with PL. The

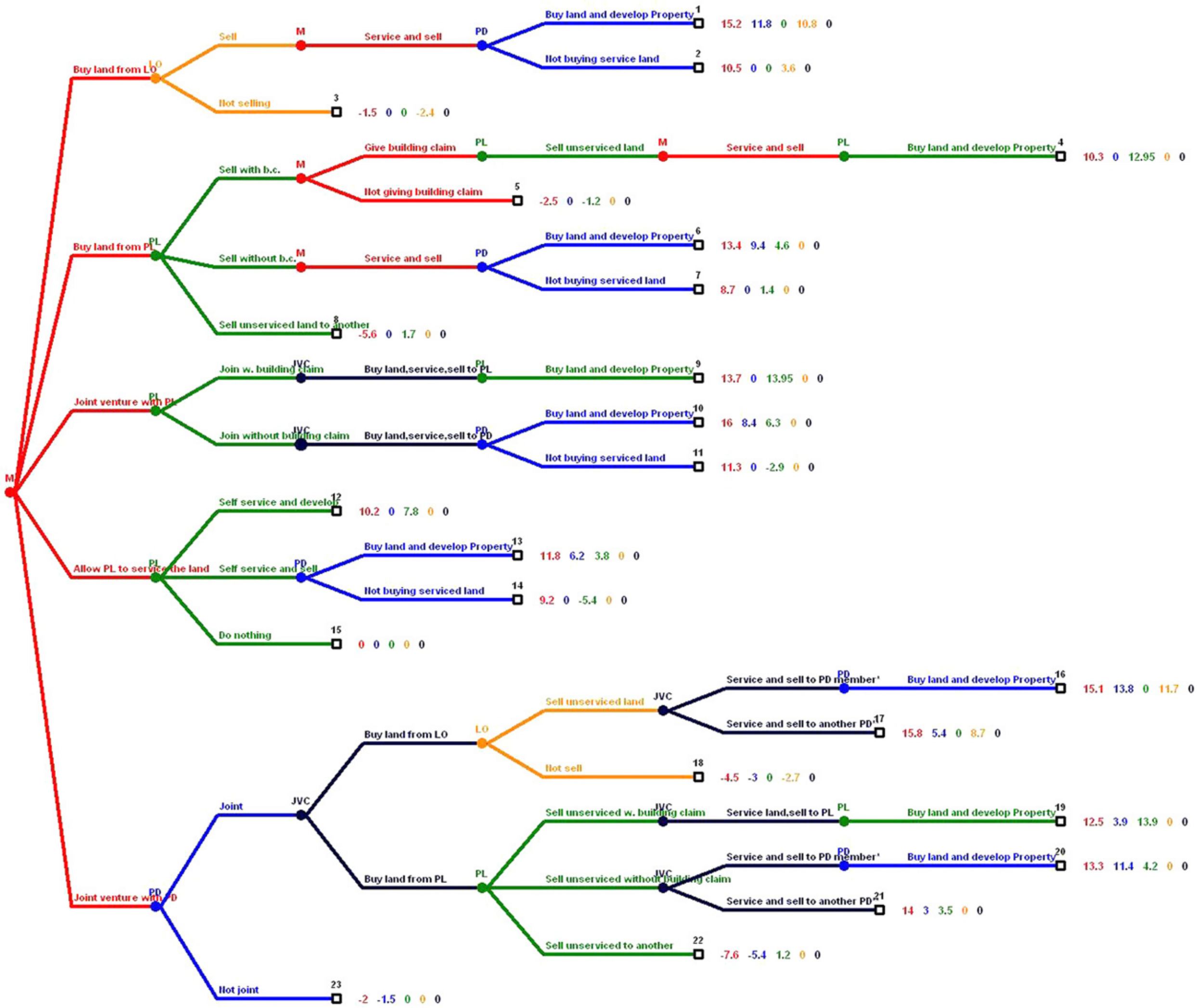

Fig. 3. Game in extensive form—land and property development process for residential use in the Netherlands under new regulation.

final potential move of M is based on the private land development model, if M decides to allow PL to develop the land. Sequentially, based on these five different moves by M, the other players will respond and decide to take their moves. For instance, suppose M chooses to buy land from LO in the first move, then LO will have the chance to respond. At its decision node, LO can choose either to sell the land to M or not. Suppose LO decides not to sell its land (and M decides not to make use of its expropriation powers), the game will end at this point. And suppose that LO chooses to sell its land to M, and then M will service the land and sell the building plot(s) to PD. At this point, PD will have to respond: it may decide to buy the building plots or refuse to buy. Both decisions will lead to different end points or *terminal nodes* as the outcome of the game. Note that in this game, PD and PL do not have the choice to refuse buying the serviced land, either from M or the joint venture company, after M has decided to grant them a building claim, because the building claim model also includes the obligation for PD or PL to buy the serviced land.

PL and PD might decide to establish a joint venture company with other property developers. However, this is considered only as a matter of strengthening or increasing their capacity and capability with respect to land development. The strategy of such a joint venture company will then be similar to the strategy of the individual property developer PL or PD. That is why we put this alternative aside from PD's and PL's choices of actions. The other alternative we put aside from PD's strategy is to acquire land (most likely from LO or PL), because if PD would like to do this, it will then follow the same behaviour as PL. At the same time, it shows the boundaries of our model as we did not take into account how and when PL acquired its land.

5.3. Findings

In our models, both under old and new regulation, we found 23 different outcomes at which the game could end. In specifying the outcomes of the game, we take into account that the final financial project results as well as the strategies of the players depend on the economic situation of the housing market. The explanation for this is that the increase of the demand for housing under favourable market conditions will result in higher housing prices, which at the same time will increase land prices as well.[12] Therefore, favourable market conditions on the housing market will result in more profitable land development, while bad market conditions will result in less profitable land development. In the game we constructed, the

[12] Land prices for housing are generally calculated from the residual of the housing price minus the construction costs.

housing market conditions are unknown or uncertain. For that reason, we incorporated 'nature' (or: the economy) as a chance player in the model and assigned a symmetric probability for good and bad market conditions to it.[13] The payoff under favourable market conditions is obviously higher than under poor market conditions. However, this probability leads to uncertainty when we analyse the best strategy for the players, because the market conditions cannot be influenced by the player. In order to reduce the uncertainty, we calculated the expected value for the particular outcomes which are under the probability condition.

The payoff structure for both games shows the preferences of the players with respect to every outcome of the game. Fig. 2 shows that under the old regime, outcome 17 is the most preferable one for M, because M will have the highest payoff from it (payoff: 23.4). Fig. 3 shows, however, that outcome 10 is the most preferable for M under the new regime (payoff: 16). The least preferable outcome for M, both under the old and the new regime, is outcome 22 (payoff: −7.6 in both situations).

The outcome with the highest payoff for M under the old regime emerges from a strategy that starts from M's decision to establish a joint venture company with PD. The joint venture company then buys land from LO. Subsequently, the joint venture company will service the land and sells the serviced land to PD. M's position in the negotiations in a joint venture company with PD will be better compared to a joint venture company with PL, because PD has no building claim. With this strategy, M will be able both to implement its plan and to maximize its profits from the sale of serviced land. Although we argued before that M does not aim at profit maximization in providing building plots, it does not mean that they do not benefit from the financial result, because this will give M an opportunity to cover the negative financial results of other projects. The other advantage of this strategy is that it will give M the opportunity to share development risks with PD with respect to land development in the joint venture company.

Under the new regime, outcome 17 does not give the highest payoff for M anymore. Instead, the highest payoff for M under the new regime is given by outcome 10 that emerges when M decides for the strategy to establish a joint venture company with PL, while afterwards the serviced land is sold to PD. The explanation for this is that under the new regime M's position in the negotiations with PL to contribute to the costs of land development has improved. M can refuse a joint venture with PL, but instead force PL to pay for all costs that are necessary to service the land (including for instance infrastructure and the development costs of recreational areas outside the development scheme). If PL refuses this, M may decide to expropriate PL (under certain conditions). Since both M and PL know this can happen, PL might decide to cooperate with M, even under less favourable conditions. In this strategy, there can still be a financial profit from the sale of serviced land to PD. Though this explains why (in this situation) the payoff for M is high, it is unlikely (but not impossible) that this strategy will occur very often, because PL would usually refuse to participate in the joint venture company with M. Instead PL may decide to sell the unserviced land to any interested party.

Furthermore, the lowest payoff to M emerges from a strategy that started in the same way as outcome 17. However, despite of acquiring land from LO, the joint venture company that is established with PD acquires land from PL. Outcome 22 turns up when PL refuses to sell its land to the joint venture company, but instead to PD. If this situation would occur, M's plan for land development will not be implemented. Moreover, both M and PD will have to pay for the costs of establishing the joint venture company. Therefore, this outcome gives not only the lowest payoff for M, but also for PD. Again, it is unlikely that it occurs, because there will probably be a contractual agreement between M and PD, as partners in the joint venture company, not to acquire land on their own.

In contrast, the highest payoff for PD both under the old and the new regime is given by outcome 16. Although the outcome with the highest and the lowest payoff do not change for PD under the old and the new regime, the payoffs under the new regime are less compared with the old regime. Under the old regime, the best payoff for PD is 15.4, while under the new regime it is 13.8. Similar to outcome 17, outcome 16 also emerges from the establishment of a joint venture company between M and PD. However, outcome 16 emerges from a situation in which PD buys the serviced land from the joint venture company, while in outcome 17 it is sold to another party.

For PL, the highest payoffs under the old and new regime are in different outcomes. Under the old regime, outcome 4 is the highest payoff for PL (18.9); under the new regime the highest payoff changes to outcome 9 (13.2). Outcome 14 means the lowest payoff for PL, both under the old and the new regime (respectively −6.4 and −5.4). Outcome 4 emerges from a strategy that starts from M's decision to buy unserviced land from PL and PL sells the land with a condition that M grants a building claim to PL. However, under the new regulation, it is better for PL to respond to M's strategy that starts from M's decision to establish a joint venture company with PL (and to grant PL a building claim).

Finally for LO, it is found that, both under the old and the new regime, outcome 16 has the highest payoff (respectively 12.9 and 11.7). Outcome 18 gives the lowest payoff for LO (−2.7 both under the old and the new regime).

Table 3 gives a summary of the maximum and minimum outcome for each player.[14]

The payoff structures of all players show that every player has different preferences with respect to the possible outcome of the game, both under the old and the new regime. This could lead to a conflict situation. For the solution, we analysed the steady state of the game by looking for the subgame perfect equilibrium (SPE) using a backward induction method. The result is outcome 1 in which each player's strategy is an optimal response to the other player's strategies. Recall that any SPE is an NE, so that no player has an incentive to deviate. This outcome emerges from the strategy that started from M's decision to buy land from LO. Subsequently, M services the land and sells it to PD. This equilibrium is found for both games, which means that there is no change in equilibrium of the game after the introduction of the new regulation. However, the payoffs in the SPE under the new regime are lower than under the old one.

Obviously, the payoff structure at SPE is lower than every player's best payoff. Particularly, PL's payoff is low, but PL holds no position to negotiate for a better payoff with the other stakeholders. It proves that in this game we can find more than one NE.

[13] We assume that the market conditions are uncertain because they depend on many variables; some of them could be exogenous. Because of its uncertainty, we assign the probability of 0.5 for the emerging of good market and 0.5 for the emerging of bad market. The term of "A symmetric probability" refers to this equal probability. The issue of 'market conditions' in our model mainly serves to illustrate that this type of exogenous factors (that influence the players' strategies) can be included in game theoretical modeling.

[14] Note that, in general, the payoffs under the new regime are lower than under the old regime. It means that for the players, the importance of such strategies to achieve their development goals under the new regulation is less than under the old regime.

Table 3
Maximum and minimum payoffs for stakeholders.

Stakeholder	Old regime				New regime			
	Maximum		Minimum		Maximum		Minimum	
	Outcome number	Payoff	Outcome number	Payoff	Outcome number	Payoff	Outcome number	Payoff
M	17	23.4	22	−7.6	10	16	22	−7.6
PD	16	15.4	22	−9.8	16	13.8	22	−5.4
PL	4	18.9	14	−6.4	9	13.2	14	−5.4
LO	16	12.9	18	−2.7	16	11.7	18	−2.7

Table 4
Payoffs at SPE.

Player	Payoff	
	Old regime	New regime
M	20.7	15.2
PD	13.8	11.8
PL	0	0
LO	10.8	10.8

However, these NEs are not credible or, in other words, they are not subgame perfect. Therefore they cannot be considered as the final solution for the game. Table 4 summarises the payoffs for each stakeholder at SPE both under the old and the new regime.

The game theoretical modelling in this case study leads to the conclusion that the new regulation will not result in an alternative equilibrium outcome. Though the position of the municipality in the negotiation process, in contrast to the other players' positions, has improved under the new regulation, it would nevertheless be wise for the municipality to continue with the same development strategy as before. This is in line with the outcome of the results of the ex-ante evaluation of the impact of the new regulation (Van Dinteren et al., 2008). It is also in line with the objectives of the new legislation. As we explained in Section 4, the intention of the new legislation is not to change development practices, but to offer municipalities a safety net in the rather exceptional cases that free riding private developers/landowners do not want to contribute to the municipality's land development costs.

6. Conclusion

By making use of game theory, we have analysed stakeholders' strategic behaviour in land and property development processes. To investigate the usefulness of game theory for modelling decision-making processes in land and property development processes, we have built a game theoretical model of a typical greenfield residential development in the Netherlands concerning the implementation of new Dutch legislation on cost recovery. Our study has demonstrated that game theory helps to identify the key strategic decisions to be made in this type of development projects, shows the different payoffs, in relative terms, for stakeholders of their chosen strategies and enables to select the equilibrium situations in which all stakeholders are best of. However, we are also aware that the case study, in its present form, still contains many limitations. In this final section we discuss the problems that must still be solved to increase the attractiveness of game theory for decision support with respect to land and property development.

First, as long as the strategies of the stakeholders in the model are not based on empirical data, the usefulness of the outcomes for decision support is only limited. However, it is certainly possible to validate the preferences of the stakeholders, for instance by making use of stated preference techniques. Moreover, the outcomes of the game can also be tested by playing the game with real stakeholders or experts in a laboratory situation.

Second, initially game theory assumes that the players possess complete information about the strategies of the other players. This assumption underlies our model as well. It implies that each player knows the strategies and the payoff functions of the other players. Unfortunately, in practice, stakeholders do usually not hold complete information about the strategies and payoff functions of the other players. Moreover, stakeholders may withhold information for strategic use. This reduces of course the usefulness of the outcomes of the model as presented here. However, games with *incomplete* information (the strategies or payoff functions of one or more players are unknown or partially known), *imperfect* information (a player does not know for sure where he stands in the game) or *asymmetric* information (some players are better informed than others) are more and more studied, especially in microeconomics. An alternative approach which applies to games in strategy form is to repeat a game several times through time. This will give the players the opportunity to learn and to adapt their strategies accordingly. This is also meaningful in the case of incomplete information: starting with incomplete information in the beginning of the game, the players will collect information during repeatedly playing the game. They then will be able to learn rationally and update their conjectures about the other players' strategies and payoff functions by observing the other players' behaviour. Even in the case of conflicting optimal strategies of the stakeholders, repeated games would give the stakeholders the opportunity to adjust their strategies to the strategies of other stakeholders. Fudenberg and Levine (1993) and Kalai and Lehrer (1993) revealed that rational learning in repeated games eventually can lead the game to reach the equilibrium.

Another limitation regarding game theory is its notion of rationality with respect to the behaviour of the players. This notion also underlies our model. Of course, the assumption that individuals act perfectly rational may never match a real-life situation. However, recent developments and experimentation in game theory pay more attention to behavioural aspects of the player, including bounded rationality, emotions and intuitive decision-making. It can be used in further research to increase the reliability of the model.

Finally, the application of game theoretical modelling to complex decision-making processes like in land and property development processes, involves, by definition, the simplification of reality in the model. There are much more coincidental events involved and much more linkages between types of actors (e.g., informal relations between stakeholders) and mixed types of actors in reality. One example of this simplification problem is the path dependency of the tree. In our model, we have assumed that the municipality will start the tree, but it is also possible in a real-life situation that other stakeholders will start the tree which will probably lead to different outcomes. Although we believe that more complexity can be built in, game theoretical models – like any other model – are always an abstraction of reality. However, these presumed weaknesses can also be seen as strength, as modelling exercises are often used in other research fields as decision support tools. In general, models coerce the accuracy of argument. Models force the modellers to be explicit in expressing the assumptions, and in arriving at conclusions by deduction. They have to show how a particular conclusion derives from certain assumptions. The game models in this paper are able to capture the logic of the process of land and property development.

Furthermore, models help us to discipline and formalize intuition. Intuition, undoubtedly, is central to any understanding, including in modelling. However, intuition alone is not reliable. Although the results of many models agree with our intuition, not all intuitions can be supported by models. Game theoretical modelling can be one of the tools for exploring the strategic logic of situations. It forces us to be specific about the characteristics of conflicting situations.

The specific advantage of game theory in formal modelling is its focus on strategic interaction and conflict in collective decision-making processes. It naturally leads us to consider the individual strategic decisions and their interdependency in relation to collective outcomes. In addition, game theory provides a way to think about the complexity of strategic interaction and, in particular, about the conflicting structure of collective decision-making processes. When the game is constructed, the choices of the players and their consequences are specified as demonstrated in this study. That specification is a representation of a conflicting structure. Different players want different things, opt for different outcomes. A game tree is an expression of rules about how to play a game and structures in this way the conflict among the players. Different sets of rules will, ceteris paribus, lead to different games and hence to different structuring of social conflict. This structural variation in games may help us understand the consequences of social conflict in collective decision-making processes. In sum, we strongly believe that game theory, compared to alternative modelling techniques, offers a promising approach for modelling land and property development processes, because it takes account of the complexity of the process and the assumptions in the model can be validated empirically.

Appendix A.

Old regulation	Aspects of preference	Relevance to achieve goals with respect to						Total score (weighted)
		Spatial quality		Financial aspects		Time process		
		Score	Weighted score (50%)	Score	Weighted score (30%)	Score	Weighted score (20%)	
Municipality (M)	Plan's implemented	10	5	4	1.2	4	0.8	7
	Plan's not implemented	0	0	0	0	0	0	0
	No building claim	4	2	7	2.1	4	0.8	4.9
	Building claim to PL	0	0	−7	−2.1	−4	−0.8	−2.9
	Building claim to JV member	0	0	0	0	−1	−0.2	−0.2
	Active policy	3	1.5	6	1.8	6	1.2	4.5
	Passive policy w/prop. dev't	2	1	3	0.9	0	0	1.9
	Passive policy without prop. dev't	1	0.5	3	0.9	−1	−0.2	1.2
	Good market	2	1	8	2.4	4	0.8	4.2
	Bad market in active policy	0	0	−5	−1.5	0	0	−1.5
	Bad market in passive policy	0	0	0	0	0	0	0
	Serviced land unsold in active policy	0	0	−10	−3	0	0	−3
	Serviced land unsold in passive policy	−1	−0.5	0	0	0	0	−0.5
	Join service with PL	2	1	6	1.8	7	1.4	4.2
	Join service with PD	2	1	6	1.8	5	1	3.8
	Alone	1	0.5	−3	−0.9	0	0	−0.4
	Land from LO	2	1	5	1.5	4	0.8	3.3
	Land from PL	2	1	−3	−0.9	−1	−0.2	−0.1

Old regulation	Aspects of preference	Relevance to achieve goals with respect to						Total score (weighted)
		Spatial quality		Financial aspects		Time process		
		Score	Weighted score (30%)	Score	Weighted score (50%)	Score	Weighted score (20%)	
Property developer (PD)	Develop property	3	0.9	10	5	4	0.8	6.7
	No property	0	0	0	0	0	0	0
	Have building claim	2	0.6	10	5	4	0.8	6.4
	No building claim	0	0	0	0	0	0	0
	Good market (with property)	2	0.6	10	5	6	1.2	6.8
	Good market (no property)	2	0.6	8	4	4	0.8	5.4
	Bad market (with property)	−2	−0.6	−10	−5	−6	−1.2	−6.8
	Bad market (no property)	0	0	0	0	0	0	0
	Selling serviced land to PL without B.C.	0	0	8	4	0	0	4
	Selling serviced land to PL with B.C.	0	0	2	1	0	0	1
	Serviced land unsold	0	0	−8	−4	0	0	−4

Appendix A (*Continued*)

Old regulation	Aspects of preference	Relevance to achieve goals with respect to						Total score (weighted)
		Spatial quality		Financial aspects		Time process		
		Score	Weighted score (50%)	Score	Weighted score (30%)	Score	Weighted score (20%)	
	Buy serviced land from M	1	0.3	6	3	2	0.4	3.7
	Buy serviced land from JV	1	0.3	3	1.5	2	0.4	2.2
	Buy serviced land from PL	0	0	−3	−1.5	2	0.4	−1.1
	Buy raw land from LO	0	0	6	3	2	0.4	3.4
	Buy raw land from PL	0	0	0	0	0	0	0
Property developer with land (PL)	Develop property	3	0.9	10	5	4	0.8	6.7
	No property	0	0	0	0	0	0	0
	Have building claim	2	0.6	10	5	4	0.8	6.4
	No building claim	0	0	0	0	0	0	0
	Good market (with property)	2	0.6	10	5	6	1.2	6.8
	Good market (no property)	2	0.6	8	4	4	0.8	5.4
	Bad market (with property)	−2	−0.6	−10	−5	−6	−1.2	−6.8
	Bad market (no property)	0	0	0	0	0	0	0
	Very bad market (serviced land unsold)	0	0	−1	−0.5	0	0	−0.5
	Selling unserviced land to PD	0	0	6	3	2	0.4	3.4
	Selling unserviced land to JV	0	0	5	2.5	2	0.4	2.9
	Selling unserviced land to JV w/b.c.	0	0	5	2.5	1	0.2	2.7
	Selling unserviced land to M	0	0	3	1.5	2	0.4	1.9
	Selling serviced land	0	0	8	4	2	0.4	4.4
	Serviced land unsold	0	0	−8	−4	2	0.4	−3.6
	No risk in servicing land	0	0	5	2.5	2	0.4	2.9
	Risk sharing in servicing land	0	0	0	0	1	0.2	0.2
	Risk taker in servicing land	0	0	−5	−2.5	1	0.2	−2.3
	Buying serviced land from M	0	0	5	2.5	2	0.4	2.9
	Buying serviced land from JV	0	0	2	1	2	0.4	1.4
	Unsuccesful negotiation w/M	0	0	−2	−1	−1	−0.2	−1.2
	Unsuccesful negotiation w/JV	0	0	−4	−2	−1	−0.2	−2.2

Old regulation	Aspects of preference	Relevance to achieve goals with respect to						Total score (weighted)
		Spatial quality		Financial aspects		Time process		
		Score	Weighted score (30%)	Score	Weighted score (50%)	Score	Weighted score (20%)	
Landowner (LO)	Land sold	0	0	10	6	0	0	6
	Good market	0	0	8	4.8	0	0	4.8
	Selling land to JVC	0	0	3	1.8	2	0.6	2.4
	Negotiation w/M	0	0	3	1.8	3	0.9	2.7
	Selling land to PD w/B.C.	0	0	3	1.8	0	0	1.8

New regulation	Aspects of preference	Relevance to achieve goals with respect to						Total score (weighted)
		Spatial quality		Financial aspects		Time process		
		Score	Weighted score (50%)	Score	Weighted score (30%)	Score	Weighted score (20%)	
Municipality (M)	Plan's implemented	10	5	4	1.2	4	0.8	7
	Plan's not implemented	0	0	0	0	0	0	0
	No building claim	2	1	3	0.9	2	0.4	2.3
	Building claim to PL	0	0	−2	−0.6	−1	−0.2	−0.8
	Building claim to JV member	0	0	0	0	0	0	0
	Active policy	2	1	2	0.6	2	0.4	2
	Passive policy w/prop. dev't	1	0.5	2	0.6	0	0	1.1
	Passive policy without prop. dev't	0	0	2	0.6	−1	−0.2	0.4
	Good market	2	1	8	2.4	4	0.8	4.2
	Bad market in active policy	0	0	−3	−0.9	0	0	−0.9
	Bad market in passive policy	0	0	0	0	0	0	0
	Serviced land unsold in active policy	0	0	−10	−3	0	0	−3
	Serviced land unsold in passive policy	−1	−0.5	0	0	0	0	−0.5
	Join service with PL	2	1	3	0.9	3	0.6	2.5
	Join service with PD	2	1	3	0.9	1	0.2	2.1

Appendix A (*Continued*)

New regulation	Aspects of preference	Relevance to achieve goals with respect to						Total score (weighted)
		Spatial quality		Financial aspects		Time process		
		Score	Weighted score (50%)	Score	Weighted score (30%)	Score	Weighted score (20%)	
	Alone	1	0.5	−2	−0.6	0	0	−0.1
	Land from LO	2	1	3	0.9	2	0.4	2.3
	Land from PL	2	1	−1	−0.3	−1	−0.2	0.5

New regulation	Aspects of preference	Relevance to achieve goals with respect to						Total score (weighted)
		Spatial quality		Financial aspects		Time process		
		Score	Weighted score (30%)	Score	Weighted score (50%)	Score	Weighted score (20%)	
Property developer (PD)	Develop property	3	0.9	10	5	4	0.8	6.7
	No property	0	0	0	0	0	0	0
	Have building claim	2	0.6	4	2	2	0.4	3
	No building claim	0	0	0	0	0	0	0
	Good market (with property)	2	0.6	10	5	6	1.2	6.8
	Good market (no property)	2	0.6	8	4	4	0.8	5.4
	Bad market (with property)	−2	−0.6	−10	−5	−6	−1.2	−6.8
	Bad market (no property)	0	0	0	0	0	0	0
	Selling serviced land to PL without B.C.	0	0	7	3.5	0	0	3.5
	Selling serviced land to PL with B.C.	0	0	1	0.5	0	0	0.5
	Serviced land unsold	0	0	−7	−3.5	0	0	−3.5
	Serviced land from M	1	0.3	4	2	2	0.4	2.7
	Serviced land from JV	1	0.3	2	1	2	0.4	1.7
	Serviced land from PL	0	0	−1	−0.5	0	0	−0.5
	Buy raw land from LO	0	0	4	2	2	0.4	2.4
	Buy raw land from PL	0	0	0	0	0	0	0
Property developer with land (PL)	Develop property	3	0.9	10	5	4	0.8	6.7
	No property	0	0	0	0	0	0	0
	Have building claim	2	0.6	4	2	4	0.8	3.4
	No building claim	0	0	0	0	0	0	0
	Good market (with property)	2	0.6	10	5	6	1.2	6.8
	Good market (no property)	2	0.6	8	4	4	0.8	5.4
	Bad market (with property)	−2	−0.6	−10	−5	−6	−1.2	−6.8
	Bad market (no property)	0	0	0	0	0	0	0
	Very bad market (serviced land unsold)	0	0	−1	−0.5	0	0	−0.5
	Selling unserviced land to PD	0	0	4	2	2	0.4	2.4
	Selling unserviced land to JV	0	0	3	1.5	2	0.4	1.9
	Selling unserviced land to JV w/b.c.	0	0	3	1.5	0	0	1.5
	Selling unserviced land to M	0	0	1	0.5	2	0.4	0.9
	Selling serviced land	0	0	6	3	2	0.4	3.4
	Serviced land unsold	0	0	−6	−3	2	0.4	−2.6
	No risk in servicing land	0	0	2.5	1.25	1	0.2	1.45
	Risk sharing in servicing land	0	0	2.5	1.25	2	0.4	1.65
	Risk taker in servicing land	0	0	−5	−2.5	1	0.2	−2.3
	Buying serviced land from M	0	0	2	1	2	0.4	1.4
	Buying serviced land from JV	0	0	1	0.5	2	0.4	0.9
	Unsuccessful negotiation w/M		0	−1	−0.5	−1	−0.2	−0.7
	Unsuccessful negotiation w/JV	0	0	−2	−1	−1	−0.2	−1.2

Appendix A (*Continued*)

New regulation	Aspects of preference	Relevance to achieve goals with respect to						Total score (weighted)
		Spatial quality		Financial aspects		Time process		
		Score	Weighted score (10%)	Score	Weighted score (60%)	Score	Weighted score (30%)	
Landowner (LO)	Land sold	0	0	10	6	0	0	6
	Good market	0	0	8	4.8	0	0	4.8
	Selling land to JVC	0	0	3	1.8	2	0.6	2.4
	Negotiation w/M	0	0	3	1.8	3	0.9	2.7
	Selling land to PD w/B.C.	0	0	1	0.6	0	0	0.6

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