Land Use Policy 47 (2015) 66–77

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Negotiation issues in forming public–private partnerships for brownfield redevelopment: Applying a game theoretical experiment

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ARTICLE INFO

Article history:
Received 24 February 2014
Received in revised form 8 March 2015
Accepted 27 March 2015

Keywords:
Brownfield redevelopment (BR)
Public–private partnership (PPP)
Game theory
Fuzzy Delphi method (FDM)

ABSTRACT

The redevelopment of a brownfield can provide a range of societal, environmental but also economic benefits for a number of entities. In the Netherlands (and elsewhere), public–private partnerships are common practice for such projects, because of two main reasons. First, limitations to public funding have led governments to invite the private sector into various long-term arrangements for capital-intensive projects. Second, a comprehensive approach for the whole brownfield area may be more efficient and profitable, compared to piecemeal development via interventions by individual owners. This article investigates, with respect to brownfield redevelopment, the interaction behavior of two key parties in forming partnerships: the municipality and a private developer. It is assumed that, apart from their mutual interest to redevelop the brownfield area, they will have different interests as well. In order to indicate their specific interest and the negotiation outcome regarding the forming of a public private partnership, this paper makes use of an experimental game theory approach. Three specific negotiation issues were analyzed in our research: a building claim, future land use and reparcelling of the land. In addition, this paper suggests an eight-step procedure to conduct a game theoretical experiment. A survey was conducted in order to gather the required data for the experiment. The data have been used to estimate the payoffs variations between the two key parties in the mentioned negotiation games. Finally, by comparing sub game perfect Nash equilibrium generated game outcomes and direct expected outcomes of respondents, this paper experimentally proves that the game theoretical analysis provides a valid representation of a real world brownfield redevelopment negotiation within the Dutch institutional-economic context. The outcome of the experiment confirms the Dutch tradition of public private partnerships in urban development practice, with public and private bodies willing to share financial risks and returns in these projects.

Introduction

Several definitions for a brownfield can be found in the literature (CABERNET, 2002; Yount, 2003). This paper uses the following: "A brownfield site is any land or premises which has previously been used or developed and is not currently fully in use, although it may be partially occupied or utilized. It may also be vacant, derelict or contaminated. Therefore, a brownfield site is not available for immediate use without intervention" (Alker et al., 2000). Numerous authors (Carroll and Eger Iii, 2006; Chen et al., 2009; De Sousa, 2002; Ganser and Williams, 2007; Lange and McNeil, 2004a,b; Wang et al., 2011) have argued that the redevelopment of a brownfield can provide a range of economic, social, and environmental benefits. Leaving brownfields unmanaged brings a potential loss of economic opportunities to the community in which they are located.

In most cases, a brownfield redevelopment (BR) seeks a form of partnership. A public private partnership (PPP) is a concept frequently used in development practice (Koppenjan and Enserink, 2009) although a uniform definition is still lacking (Weihe, 2005). PPPs are particularly useful when circumstances are not favorable for a piecemeal development via interventions by individual owners (Grimsey and Lewis, 2002). In such cases a comprehensive integrated approach, with private owners/developers collaborating with the responsible public authorities, may be more efficient and profitable. Another important reason for the establishment of a PPP can be limitations to public funding available, making a public sector-led redevelopment impossible. This has led

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http://dx.doi.org/10.1016/j.landusepol.2015.03.018
0264-8377/

local governments to invite the private sector into various long-term arrangements for capital-intensive real estate development projects.

Forming a PPP can be problematic as a consequence of differences in goals amongst potential partners. The existing literature addresses the general diversification of goals and interests by providing various typologies of potential parties (Coiacetto, 2001; Hieminga, 2006). The preferences of the potential parties involved in BR may vary substantially. It is also possible that the self-interest of an individual decision-maker can be heavily influenced by the other parties that are present in a certain decision moment. Providing more insight into these interactions may be of help when forming new public–private coalitions for BR. This paper introduces concepts of game theory in order to improve the understanding of the interactions among two key decision-makers in forming PPP for a BR project: the municipality and a private developer.

Game theory has been applied in many fields of research, but only few applications can be found in urban development practice. Most game-theoretical applications with respect to urban development focus on negotiations, applying game-theoretical concepts with regard to the interaction of players. Samsura et al. (2010, 2013) and Samsura and van der Krabben (2011, 2012) have used game theory to model negotiation processes with respect to value capturing in land and property development. In addition, pricing strategies with respect to land use have been modeled with help of game-theoretical concepts (Forester, 1987; Ma et al., 2007; Martínez and Henríquez, 2007; Mu and Ma, 2007; Sibdari and Pyke, 2010; Wu et al., 2014; Zellner et al., 2009). Modeling this kind of negotiations has proved to be able to generate practical advice. For example, Pfrang and Witting (2008) have demonstrated how lease contract negotiations can be smoothened and how a social environment between the tenant and the landlord can be cultivated.

Regarding the application of game theory with respect to decision-making processes for BR, analyzing negotiations may be useful to decide how to allocate cost and benefits in brownfield redevelopment negotiations (Liang et al., 2008; Wang et al., 2007, 2011), to compare the costs and benefits of BR and greenfield development, in order to support BR with effective policies (Liang et al., 2008), and to evaluate the potential conflict in engaging public opinion in redevelopment processes (Tam and Thomas, 2011; Tam et al., 2009). Most applications, however, refer to improving decision-making processes in establishing various partnerships (Blokhuis et al., 2012; Sounderpandian et al., 2005; Walker et al., 2008; Wang et al., 2008; Yousefi et al., 2007, 2010). Ultimately, the latter research helps to develop decision-support tools, clarifies interests, identifies tradeoffs, recognizes party satisfaction, and generates optimal solutions, preparing a decision maker to optimally benefit from the negotiation (e.g. Yousefi et al., 2010) Although game theory can help to negotiate favorable conditions related to different partnerships types, little attention so far has been put on isolated negotiable issues in forming a PPP for a BR project. This paper elaborates on three specific issues in these negotiations (building claim, future land use and reparcelling the land; see Section 'Defining the institutional-economic context of the game') and aims to contribute to the further development of game-theoretical approaches to urban development practice by suggesting a formal procedure for applying a game-theoretical experiment.

Classical game theory has been largely criticized due to the notion of a homo economicus, a completely rational decision-maker (e.g. Camerer, 2003; Raiffa, 2002). Therefore, instead of using a classical game-theoretic approach, this paper provides the findings based on experimental game theory results. Rather than only modeling the outcome of the negotiations, the games have been experimentally tested. Usually, an experiment consists of several phases: description of the game environment, the assumptions underlying the game, and estimation of players' preferences. This experiment introduces an eight-step procedure. First, the game is set in a proper institutional-economic environment. This phase has been divided into five separate steps: (1) selecting a game class – cooperative vs. non-cooperative and conflict vs. common interest; (2) selecting a game form – strategic vs. strategic; (3) selecting a game solution concept; (4) describing the institutional-economic context of the game, here it is important to mention that the study was conducted in the Netherlands; (5) designing the game conditions within the game set environment. Further (6), two different types of games have been assumed (ultimatum and bargaining game) for specific negotiation issues in forming PPP for BR. In addition, both games are experimentally validated by a survey among BR experts. The players in both games are a public party and a private party. In the remaining of the paper, these two parties are referred to as a municipality (M) and a developer (D). To estimate the respondents' preferences (7), a standard phase in game theoretical experiments, the fuzzy Delphi method (FDM) with similarity aggregation method (SAM) has been applied. (8) Finally, the experiment ends with the analysis of the outcomes.

To collect the data for validating the results an on-line survey tool is used (*Berg Enquête System© 2007*).

The experiment explores whether the self-prediction of the respondents about the game outcome corresponds to the game-theoretical predictions. This provides insight in the suitability of the application of game theory in predicting real-world actor behavior concerning BR projects. In addition, based on the outcomes of the analyses, interventions can be designed and through them, various policies may be considered. The eventual new policies would aim at supporting the cooperation between relevant parties, thus reducing the number of conflicts and stimulating the actual implementation of BR projects.

This paper first explains the basic elements of a game tree and argues for the implementation of game theoretical experiments in forming PPP for BR projects (Section 'Game theory applications in forming PPP for a BR project'). Further, Section 'Designing games over negotiation issues in forming PPP for a BR project' explains the eight-step procedure of conducting a game theoretical experiment for an urban development project. Section 'Data collection and respondents characteristics' reports on the data collection technique and the background of respondents that are used for the game theoretical experiment. Section 'Game experiment results' summarizes the empirical results of validated game trees and estimated game outcomes. Finally, Section 'Conclusions' concludes on the importance of using rigorous procedural steps of conducting a game theoretical experiments and the contribution that such experiments can provide to represent real world brownfield redevelopment negotiation.

Game theory applications in forming PPP for a BR project

Often, in urban development the outcome of a decision-making process does not only depend on individual choice but is also influenced by choices made by other decision-makers. Game theory is a suitable theory to test the behavior of interactive decision-making situations (e.g. Neumann et al., 1944). Even more, game theory assumes that decision-making is always interdependent; game theory mainly aims to provide a better understanding of situations in which decision-makers interact (Colman, 1995; Osborne, 2004; Rasmusen, 2007; Shoham and Leyton-Brown, 2009; Stengel, 2008).

A decision-maker – a player in game-theoretical terminology – has to think ahead and is assumed to devise a strategy based