

Fair shares? Advancing land economics through cooperative game theory

Article

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1 **Fair shares? Advancing land economics through cooperative game**
2 **theory**

3

4 **Abstract**

5 Site consolidation is a perennial issue in the study of land economics. The emergence in many
6 contexts of policies that follow variations on 'land readjustment' represent a common way for
7 policy makers to overcome the barriers to wholesale redevelopment. In several important respects
8 the nature of the problems that land readjustment seeks to confront are best thought of as
9 questions in cooperative game theory. In this contribution we seek to explore the underpinning
10 logic of land-readjustment using fundamental concepts in cooperative game theory: the Shapley
11 value and the Core. In addition, we present results of an experiment on coalition and value
12 distribution in four European countries. Our results shed light on a range of important practical
13 issues for the policy ranging from the conditions under which development might be self-initiated
14 to coalition stability, and to the value of an animating agency such as urban planning.

15

16 Introduction

17 Site consolidation is a perennial issue in the study of land economics. In many contexts around
18 the globe wholesale urban transformation is hindered by multiple ownership of often small,
19 contiguous parcels of land that would ideally be considered together as a coherent whole for
20 redevelopment purposes. The corresponding power accorded to one unwilling seller to ‘hold out’,
21 either for pecuniary or sentimental reasons, has resulted in delay and sometimes prevention of
22 development becoming a hallmark of urban planning in some contexts, such as the UK (Cheshire
23 and Sheppard, 2005; Nathan and Overman, 2011; White, 2014; Adams et al., 2017) and Norway
24 (Falleth and Nordahl, 2017; Falleth et al., 2011, Nordahl and Eika, 2017). In response some
25 nations have begun to experiment with new policy responses designed to overcome what is in
26 effect a collective action problem and catalyse the development process. In many parts of the
27 world the first choice for policy makers has been variations on land readjustment where the
28 promise of a corresponding uplift in land values associated with site consolidation and subsequent
29 planning consent, it is hoped, should provide an incentive for cooperative behaviour between
30 landowners (Adams et al., 2001; Turk, 2008; van der Krabben and Jacobs, 2013; van der Krabben
31 and Heurkens, 2015; Nordahl and Falleth, 2011). At root this approach turns on some important
32 economic concepts/assumptions. Firstly, for land readjustment to work it would be essential that
33 individual landowners are able to decode what cooperative action – the willingness to pool their
34 asset with those of their neighbours – would mean for them as individuals. Secondly, we would
35 ideally need to know if the viability of the approach is in any way dependent upon the various
36 potential roles for the state, for example, as a holding agency to guarantee a fair pooling and
37 subsequent distribution of assets. On this second point it would be desirable to know under what
38 conditions individual landowners might be able to reach a solution themselves without the
39 requirement for the state to referee the process. Any evidence on this would speak directly to the
40 wider question of the degree to which self-organisation can be prompted by policy design and, by
41 extension, if self-organisation is a realistic and viable vision of an achievable urban policy yet to
42 come (Boonstra and Boelens, 2011; de Roo, 2016; Moroni, 2015; Portugali, 2000, 2011;
43 Swyngedouw and Moulaert, 2010; Zhang and de Roo, 2016).

44 On these important questions we have only clues. The degree to which such cooperative
45 outcomes, particularly those that imply some form of self-organisation, are likely to result from
46 variations on the land readjustment formula is an open question upon which there is a paucity of
47 research. For example, the fundamental issue of the degree to which the apportionment of land
48 holdings to be returned to landowners accords with a shared or broadly consensual interpretation

49 of what would constitute ‘fair shares’ is a centrally important issue. Moreover the degree to which
50 cooperative action depends upon the existence of a mutually binding trust between stakeholders
51 is also under-researched.

52 In this paper we aim to use cooperative game theory to explore these questions of how collective
53 agreement over the pooling and reallocation of an asset, in this case land holdings, might proceed.
54 To explore these questions, we first use a thought experiment in which, rather than the state
55 assigning values for compensation payments on a case by case basis, landowners and developers
56 do this collectively based upon their own expectations of what the surplus subsequently to be
57 shared might be. Using Shapley values to illustrate how the process might work in theory we hope
58 to show that under very specific conditions a self-determined solution would be theoretically
59 possible. In taking this approach we hope to illustrate in theoretical terms what some of the
60 implied differences might be between urban planning systems that allow for some degree of self-
61 organisation compared to those where a state or para-state agency, such as an urban development
62 corporation, plays an active economic role either as regulator or broker. Secondly we present
63 empirical evidence from a recent JPI-funded project, *SIMS City: Testing new tools for value capture*,¹
64 which seeks to explore the degree of trust present amongst actors who are at the core of the
65 redevelopment process across varying national contexts (Li et al 2019).

66 **Land readjustment policy: history, context and mechanics**

67 Land readjustment has been used in a wide variety of international contexts across the globe,
68 although it has been particularly popular in Europe and South East Asia. If a specific geographic
69 origin can be found the principal candidate is Japan where an early version of the approach was
70 employed following the Tokyo earthquake of 1923 and in the reconstruction of Japanese cities
71 following the Second World War (Larsson, 1997). More recently land readjustment has been used
72 in varying contexts within mainland China (Li and Li, 2007), and Hong Kong (Yau, 2012) as well
73 as Australia, where it is known as ‘land pooling’, Israel, and South Korea. In Europe, the idea has
74 gained most currency in the north of the continent where it can be witnessed in urban planning
75 policies enacted in nations such as Germany, France, the Netherlands, Norway and Sweden (Turk,
76 2008). Nevertheless, the potential for land readjustment to act as a vehicle for urban
77 transformation in extreme settings – such as post-conflict Japan – has moved the World Bank to

¹ Details of this JPI-funded project can be found at <https://jpi-urbaneurope.eu/project/simscity-valuecap>

78 advocate the policy as a measure that might have some traction in developing countries (Doebele,
79 2007).

80 The core principle of land readjustment is that it enables the consolidation of separately held,
81 adjacent plots into a new configuration more amenable to wholesale development. In a typical
82 model of urban land readjustment, private property rights are temporarily transferred to a public
83 development agency that proceeds to assemble and re-parcel the site – often into a greater number
84 of smaller units – before installing infrastructure and thus raising the value of each individual plot.
85 Property rights are subsequently returned to the original landowners. The upfront costs incurred
86 by the state (through the public development agency) are designed to be recovered by the sale of
87 new additional plots created by the process. Compensation to the original landowners, whose
88 cooperation is essential to the process as a whole, comes through the enhancements to their
89 (typically reduced) land holdings resulting from the creation of fully serviced sites complete with
90 planning consent (van der Krabben and Needham, 2008).

91 Variations on the model include scenarios in which no new plots are created, landowners cover
92 the costs of the redevelopment themselves from the subsequent anticipated increase in the value
93 of their holdings and where a public use (e.g. a municipal building, green space) may also be
94 incorporated with private holdings in the allocation and re-allocation of holdings (Needham, 2007;
95 van der Krabben and Needham, 2008). In the UK, Adams et al (2001) draw inspiration from
96 urban land readjustment in proposing the ‘urban partnership zone’ as a way of tackling the barrier
97 sometimes posed to redevelopment by one or more landowners obstructing development. In such
98 circumstances, urban land readjustment has been valued for its potential to build the recovery of
99 infrastructure costs into the development process thus providing an automatic way of capturing
100 the uplift in land values associated with the granting of planning consent and obviating the need
101 for any form of *ex post* development levy (such as that discussed in Lord, 2009). From this
102 perspective, land readjustment is a policy tool that may be used to address situations where, “the
103 boundaries of the rights to land ownership or land use may impede the desired use of the area as
104 a whole” (Needham, 2007: 115).

105 To date the effectiveness (or otherwise) of urban land readjustment has largely been judged
106 inductively on the basis of experience. As a result conclusions are in many instances predicated
107 on conjecture and circumstantial evidence regarding what might or might not work in various
108 contexts, thus making context potentially the most salient variable. However, the underlying
109 principles upon which urban land readjustment are based – the division of an asset between a small
110 number of self- and collectively-interested agents speaks very closely to a common theoretical

111 question in game theory – an increasingly popular way of thinking about such questions (Lord,
112 2009, 2012; Samsura et al., 2010, 2015). In this contribution we seek to explore one of the most
113 fundamental questions relating to how coalitions might decide on what constitutes ‘fair shares’
114 within the process by which individual assets are collectivised and then returned, subdivided, to
115 their original owners.

116 **Cooperative game theory**

117 When considered in the abstract the questions with which land readjustment deals in practice can
118 be understood as analogous to those that are routinely explored in cooperative game theory. This
119 branch of game theory explicitly sets out to understand group decision making and is therefore
120 distinct from the best known examples – such as the prisoners’ dilemma and the ultimatum game
121 – that seek to explore the microeconomics of decision making under non-cooperative conditions
122 (for a thorough treatment of the differences between cooperative and non-cooperative game
123 theory see, e.g., Osborne and Rubinstein, 1994). For cooperative game theory the aim is to
124 investigate the conditions under which some form of cooperative action might be necessary and
125 the outcomes that might follow. There is, therefore, a clear point of tangency between the goals
126 of cooperative game theory and the specifics of land readjustment policies.

127 In relation to the specific question of site consolidation and subsequent reallocation we have a set
128 of issues that can very neatly be codified as a problem in cooperative game theory. Our asset, the
129 full potential site, is pooled, subdivided and then returned to the original landowners in modified
130 form. The anticipated spur to the initial cooperative act is the prospective incentive that the
131 holding that will be returned from the land (remediated, consolidated with its neighbouring plots,
132 possibly serviced by infrastructure and with planning consent provided) will be of enhanced value
133 compared to the asset that the individual landowner had initially submitted to the pool.

134 The predictions of cooperative game theory would suggest that each individual landowner will
135 evaluate the degree to which their outcome is acceptable not on the basis of the uplift in value that
136 pertains to their land holding *per se* but as a function of the relative redistribution of the asset *as a*
137 *whole* between the group *as a whole* (Young, 1988). This concept, called the Shapley value after its
138 founder Lloyd Shapley, allows us to theorise and predict the behaviour of individual economic
139 agents when confronted with a collective asset that must be divided amongst them relative to their
140 marginal contribution to its creation (Shapley, 1953; Roth, 1988; Winter, 2002). Applied to a public
141 policy question such as a land-readjustment exercise we can use this theoretical framework to
142 explore the degree to which cooperation might be sustained over the full duration of the

143 pooling/reallocation process and the conditions under which a self-organised solutions might be
144 possible and those where a state/regulatory referee might be required.

145 To explore this range of questions we propose a thought experiment. This method of thinking
146 about a problem in the abstract is the most common method of analysis in much of Western
147 philosophy, particularly the analytic tradition, and those disciplines, such as game theory, which
148 follow this lead. Thought experiments allow us to conceive of a problem in terms of its first
149 principles. Common examples include *Schrödinger's Cat* (Schrödinger, 1935) where we are invited
150 to think about the conditions under which we might claim certainty of knowledge and Hardin's
151 (1968) *Tragedy of the Commons* which posits varying outcomes as a result of individual and collective
152 actions. Many thought experiments have had enduring appeal as devices to extrapolate from the
153 abstract to the material world (e.g. Cole et al., 2014; Feeny et al., 1990; Ostrom, 1990).

154 The following thought experiment allows us to explore the foundational issues in land
155 readjustment by formulating a simple game that mirrors the interactions that land readjustment
156 creates. Although in simplified form we have just three participants, the results provide insights
157 into fundamental mechanics of this approach to redevelopment and point to important lessons
158 for policy design. Likewise, although our experiment is restricted to just three players the
159 experiment can be extrapolated for any number of participants.

160 **Rethinking land readjustment using Shapley Values**

161 Consider a situation where three participants have the opportunity to redevelop a site as a whole.
162 In keeping with the terminology of game theory, let the participants be labelled players 1, 2, and
163 3, respectively. In practical terms, they can be either landowners or developers. Suppose each
164 player on their own cannot start any project and hence the “worth” of coalitions of a single player
165 is normalised to 0. That is, in the language of cooperative game theory, the characteristic function
166 v has the value

$$167 \quad v(\{1\}) = v(\{2\}) = v(\{3\}) = 0.$$

168 When two players collaborate, a small redevelopment project becomes possible. However, only
169 when all three players work together, can they realise the full potential of the site. Specifically, let
170 the value of all potential coalitions be defined as:

$$171 \quad v(\{1,2\}) = 300, v(\{1,3\}) = 350, v(\{2,3\}) = 400 \text{ and } v(\{1,2,3\}) = 900.$$

172 We note that to reflect the possibility that the players may differ in their endowments/capabilities,
173 we have allowed the value of two-player coalitions to be different. Note also that the union of any

174 two sets of players is always worth no less than the sum of the two individual sets or, in game
175 theoretical terms, our land readjustment game is ‘superadditive’.

176 We now first apply the concept of the Shapley value to this cooperative game which determines
177 each player’s fair payoff in the efficient grand coalition, $N=\{1,2,3\}$. The Shapley value is defined
178 by players’ average marginal contribution over possible coalition formations. In the table below
179 we find for each player their marginal contribution in each permutation of the grand coalition. In
180 the first column we list the 6 possible orderings of the grand coalition. In the second column we
181 record player 1’s marginal contribution in each ordering - player 1’s added worth to the coalition
182 formed by all players *preceding* her. For example, in the permutation (2,3,1), player 1 contributes to
183 the coalition {2,3} by increasing the worth of the coalition from $v(\{2,3\})$ to $v(\{2,3,1\})$, i.e., from
184 400 to 900. In the ordering (3,1,2), player 1’s marginal contribution is $v(\{3,1\}) - v(\{3\}) = 350 - 0$
185 $= 350$. Similarly, in columns 3 and 4 we record marginal contributions of players 2 and 3,
186 respectively.

187

188

TABLE ONE ABOUT HERE

189

190 The Shapley value - defined as a player’s *average* marginal contribution over the permutations - are
191 thus 270, 300, and 325 for players 1, 2, and 3 respectively. Let Sb_i denote player i ’s Shapley value
192 payoff in this land adjustment game. We have $Sb_1 = 270$, $Sb_2 = 300$, and $Sb_3 = 325$. In this solution,
193 the three players efficiently and fairly divide the total value from the land adjustment project: the
194 maximum total value is realised and players who contribute more receive more.

195 The Shapley value represents one important interpretation of a fair division of the grand coalition’s
196 worth. Intuitively, each player is rewarded by their average marginal contributions to other
197 coalitions. Notably, the Shapley value is the only value that satisfies a set of simple and intuitive
198 axioms. For instance, Young (1985, 1988) demonstrates that the Shapley value is the only solution
199 that satisfies axioms of efficiency, symmetry and the “marginality principle”. The efficiency axiom
200 means that the worth is fully divided, and symmetry requires that the payoffs to any two players
201 should be the same whenever they make exactly the same marginal contributions. A value satisfies
202 the marginality principle if a player receives the same payoffs in two different games of the same
203 set of players whenever the player makes the same marginal contributions in the two games. These
204 three axioms characterise the Shapley value.

205 A more intuitively compelling argument in favour of a Shapley value to solve a land readjustment
 206 dilemma is perhaps the balanced contributions property. Suppose ψ is an arbitrary value or division
 207 rule. Imagine that player 2 is able to say to player 1: “give me more of the proceeds of the
 208 development or I will leave the coalition, causing you to obtain only $\psi_1(\{1,3\})$ rather than the
 209 larger payoff of $\psi_1(\{1,2,3\})$. This will mean that you lose the positive amount $\psi_1(\{1,2,3\}) - \psi_1$
 210 $(\{1,3\})$.” We call this an *Objection* of player 2 against player 1. If, on the other hand, player 1 can
 211 say to player 2 that “it is true that if you leave then I will lose, but if I leave then you will lose at
 212 least as much: $\psi_2(\{1,2,3\}) - \psi_2(\{2,3\}) \geq \psi_1(\{1,2,3\}) - \psi_1(\{1,3\})$ ”, then we say player 1 has a
 213 *counter-objection* to player 2’s objection. Note that in our example the Shapley value, $Sb_1(\{1,2,3\}) -$
 214 $Sb_1(\{1,3\}) = 275 - 175 = 100$ while $Sb_2(\{1,2,3\}) - Sb_2(\{2,3\}) = 300 - 200 = 100$. Thus, under the
 215 Shapley value player 2 does have an objection against player 1 but player 1 also has a counter-
 216 objection to player 2’s objection against player 1. Therefore, there is the potential that the
 217 objection and counter-objection that the two players have against one another will nullify each
 218 other and act as a principle for sustained mutual cooperation between the two players: the presence
 219 of an objection and counter-objection mean that neither player has any incentive to withdraw from
 220 the coalition.

221 Another type of objection involves a threat which proceeds as follows. A player may say to another,
 222 “give me more or I will persuade the other players to exclude you from the game, causing me to
 223 obtain more than my current payoff.” Under these circumstances a counter-objection requires the
 224 player being threatened to be able to respond that “it is true that if you exclude me then you will gain,
 225 but if I exclude you then I will gain at least as much”.

226 Theoretically, the Shapley value is the only division rule or value that satisfies the balanced
 227 contributions property which requires that for every objection of any player i against any other
 228 player j there is a counter-objection available to player j .

229

230 **The Core**

231 Although theoretically appealing, in naturally occurring situations it is not obvious that the Shapley
 232 value will always prevail.² One of the most well-known disadvantages of the Shapley value is that

² For example, Williams (1988) reports empirical tests of cooperative game solution concepts with observations taken from naturally occurring markets and concludes that empirical results support the theory of the core in general and the “equal propensity to disrupt” solution concept in particular. On the other hand, the Shapley value and the nucleolus received weaker empirical support.

233 it ignores the stability of the grand coalition. Would the players in real life situations be willing to
234 form the grand coalition given the particular way the Shapley value divides the worth of the grand
235 coalition?

236 It could be expected that the grand coalition would be stable when there exists no smaller subset
237 of players who can make a Pareto improvement for themselves.³ Formally, the grand coalition is
238 stable, or, in other words, the players will want to form the grand coalition if and only if the payoff
239 profile is drawn from a set called *the Core* of this coalitional game. In the above land readjustment
240 game, a payoff vector x where $\sum_{i \in N} x_i = v(N)$ is in the core of the coalitional game if and only if
241 for every subset S of the grand coalition, N , $\sum_{i \in S} x_i \geq v(S)$.⁴ That is, the core of this game consists
242 of all individual payoffs $x_1, x_2, x_3 \geq 0$ such that:

243
$$x_1 + x_2 + x_3 = 900,$$

244
$$x_1 + x_2 \geq 300,$$

245
$$x_1 + x_3 \geq 350, \text{ and}$$

246
$$x_2 + x_3 \geq 400.$$

247 Intuitively, the core rules out payoff profiles under which one or more players as a coalition can
248 make a profitable deviation.⁵ For all payoff profiles in the core, we can be confident that the
249 grand coalition is stable.

250 The core of the above land readjustment game is clearly non-empty. Indeed, one can
251 straightforwardly verify that the Shapley value payoff profile, $x_1 = 270$, $x_2 = 300$, and $x_3 = 325$, is
252 in the core of this game. In general, however, there is no guarantee that the core of a coalitional
253 game is non-empty or unique.

254 In this land readjustment game, the grand coalition is stable with the allocation of the Shapley
255 value. However, the same can be verified for many other payoff profiles. In particular, the equal

³ A Pareto improvement for a group of players is a change in allocation that benefits at least one player without hurting any other players in the group.

⁴ For a formal, textbook treatment, see, e.g., Osborne and Rubinstein (1994).

⁵ This is analogous to the concept of Nash equilibrium in noncooperative games where, however, only unilateral individual deviations are considered.

256 division of the worth of the grand coalition, $x_1 = 300$, $x_2 = 300$, and $x_3 = 300$, is also in the core of
257 this game. This allocation is of particular interest because it has been long argued in the
258 literature that humans often exhibit a preference for equal division.

259

260 **Is an equal split a plausible outcome?**

261 When it comes to dividing a surplus among a group of participants, it has long been recognised
262 that individuals do not behave purely selfishly as the standard economic theory would predict
263 (Güth and Tietz, 1990; Bolton et al, 1998; Engle, 2011; Güth and Kocher, 2014). As a workhorse
264 model in behaviour economics, the Dictator Game has been widely implemented and tested,
265 mostly in laboratory experiments, where, in the most simplistic form, one player is given a certain
266 amount of money to be divided between themselves and one other player. The standard economic
267 theory would predict that the first player, the dictator, will keep everything for themselves and leave
268 nothing for the other player. However, based on observations in more than a hundred dictator
269 game experiments published in the span of 25 years, Engel (2011) reports that on average the
270 dictator gives out more than 28% of the money which highlights that there are important and
271 significant concerns in the subjects' preferences other than their own materialistic payoff.

272 Closely related to the dictator game is the Ultimatum Game where the first player proposes a
273 division and the other player can either accept it or reject it. The division is implemented only
274 when the second player accepts the offer. Otherwise, both players receive nothing. While the
275 standard economic theory predicts that the receiver will accept any offers, it has been wildly
276 established that individuals will reject a proposed division if they perceive it as unfair. Indeed, the
277 receivers usually accept all offers above 50% (for themselves) and their acceptance rate decreases
278 and quickly approaches zero for offers below 20% (Güth and Kocher, 2014). There is by now a
279 large volume of evidence that allows us to claim that in such experiments the *equal split* offer is an
280 extremely robust phenomenon (Dawes et al, 2007; Fehr et al, 2008). Such observations
281 demonstrate that people will take into account the interests of others, are sensitive to norms of
282 cooperation, and may have other concerns. Theoretically, Fehr and Schmidt (1999) offers a
283 compelling treatment of fairness that reconciles seemingly contradicting observations and the
284 standard economic theory.

285 From the foregoing discussion we have two possible predictions for how a land readjustment game
286 might proceed. The Shapley value is the only division rule that satisfies the balanced contributions
287 property where each player's outcome is related to their contribution to the coalition. If the worth

288 of the grand coalition is allocated *in any other way* than in strict accordance with the principles of
289 the Shapley value, then there can exist objections to which there is no counter-objection.
290 However, the Shapley value is not the only allocation that is conducive to the formation of the
291 grand coalition. Indeed, the grand coalition is stable under any allocation in the core of the game.
292 In particular, a rival allocation – an equal split - is in the core of the game and may represent an
293 intuitively appealing solution as indicated in many published experiments in the literature.

294 In what follows we present the results of an experiment on coalition and value distribution
295 conducted in four European countries. The experiments examine the tendency for participants to
296 form a grand coalition and the manner in which they agree how value should be distributed. In
297 so doing we seek to explore empirically participants' preferences for how a consolidated land asset
298 should be split.

299 **Experiment design, analysis and results**

300 Illuminating as theories are to the fundamental thinking of how a land readjustment game might
301 proceed, only empirical evidences can speak of their validity. On the other hand, as it is challenging
302 to collect observational data in real-world situations that allow us to investigate the working of a
303 cooperative process, we opt to designing and running experiments involving subjects who play the
304 roles in a land readjustment game. In addition, a carefully designed experiment can help avoid the
305 usual problems associated with observational data such as endogeneity issues.⁶ To this end, an
306 experiment that mirrors our theoretical exposition was designed (set out in Appendix A) and run
307 in four European national settings: Belgium, the Netherlands, Norway and the UK.⁷ Participants
308 were student volunteers drawn from cognate programmes in urban planning, architecture and
309 economic geography. This method of finding participants rather than through a random set of
310 experiment subjects was to ensure that participants had some grounding in the subject area and
311 could readily comprehend the nature of the questions being posed.

312 The design of the experiment was for groups comprising three subjects to assume the position of
313 three developers - A, B, and C – who own three contiguous parcels of land. The scenario then

⁶ For a more thorough discussion on experimental methods in Economics, see, e.g., Smith (2010). Experiments are also gaining popularity as a research apparatus in studies of land use policies. See, e.g., Banerjee et. al. (2015) and Tanaka (2007) among others.

⁷ The students came from University of Liege in Belgium, Nijmegen University in the Netherlands, Norwegian University of Life Sciences in Norway and Liverpool University in England. The number of groups varies as a result of number of students in the classes in the different countries.

314 described a situation where the local municipality invited the three developers to develop a plot as
315 a whole with the condition that a coalition of at least two developers was required to undertake
316 the project (to encourage wholesale over piecemeal development). Due to different capacities, and
317 in line with our theoretical example, the possible coalitions have different net payoffs as follows.

- 318 • 300 million (national currency) if developer **A and B** develop the area together
- 319 • 350 million (national currency) if developer **A and C** develop the area together
- 320 • 400 million (national currency) if developer **B and C** develop the area together
- 321 • 900 million (national currency) if developer **A, B, and C** develop the area together
- 322

323 The coalition parties will then divide the payoff as they see fit. The subjects had 15-25 minutes to
324 make a coalition and a distribution of the payoff. After an experimenter introduced the experiment
325 to the subjects, they were given a handout with the assignment text, an answer sheet, and a short
326 survey. The experimenter also assigned the A, B, or C role to each student.⁸

327 It might be expected that each group should be able to reach the formation of a grand coalition as
328 the structure of the game means payoffs are high enough to make every participant better off than
329 they could hope to be in any smaller coalition. This proved to be the case. From 92 groups only
330 3 did not form a grand coalition. As [Figure 1 Table 2](#) shows there was significant variation amongst
331 nations with respect to which distribution was favoured. In the Netherlands the even split was
332 strongly preferred by a majority of participants. A similar outcome prevailed in Belgium.
333 However, in Norway participants had a marginal preference for the Shapley value with a simple
334 majority choosing this approach. However, in the UK the strength of preference for the Shapely
335 value was much stronger with a large majority preferring this method of allocating the proceeds
336 of the land readjustment game.

337 **FIGURE ONE ABOUT HERE**

338 In the game, the Shapley value is 275, 300 and 325 million to A, B and C respectively. None of
339 the groups who did not choose an even distribution chose the exact Shapley distribution.
340 However, 26 of the 92 groups (28 %) reached distributions similar to the Shapley prediction

⁸ We note that due to logistical challenges the subjects in our experiment are non-financially-incentivised. However, we believe psychological incentives can potentially act as a reward medium that ensures incentive-compatibility and hence non-financially-incentivised decision making can also be effective in shedding light on our research questions. For example, Camerer and Hogarth (1999) review 74 experimental studies which study the effect of different monetary incentives, including zero monetary incentives, and find the modal result is no effect on mean performance (though variance is usually reduced by higher payment). More recently, DellaVigna and Pope (2018) also demonstrate the effectiveness of psychological incentives in experiments.

341 (hence ‘Shapley-like’), with the player in position A receiving less than the player in position C,
342 and B somewhere in between. Of the seven groups that reached other results, three formed
343 pairs, three failed to reach any agreement in the allotted time, and one group formed a grand
344 coalition with a distribution of 400, 100, and 400.

345 **FIGURE TWO ABOUT HERE**

346 In the subsequent questionnaire all but five of the players that achieved the grand coalition
347 thought that the distribution was unfair: The three players who distributed 400, 100, 400 all
348 agreed it was unfair, plus two of the “A developers” who received a smaller share. Most of the
349 other A developers who received less than 300 saw it as reasonable for the others to earn more,
350 as their participation contributed more to the project.

351 The game set out above illustrates the conditions under which a (small) collection of interests,
352 which otherwise may not work together, might assemble into a functioning coalition. The
353 alignment of individual payoffs with the corresponding contribution made by each member of the
354 coalition to that coalition points to ways of both initiating development and ensuring stability
355 across the group of interested parties through the full duration of the development process.

356 We anticipated that if we could establish a reallocation to all interested parties that implies payoffs
357 that accord with the principles of the Shapley value, we would have created a settlement that is
358 stable and mutually incentivises cooperative action such as would be necessary to realise wholesale
359 redevelopment. However, the experiments indicated that, particularly in some national settings, a
360 distribution based upon an even split was preferred. This finding chimes with that of Li et al.,
361 (2019) that ‘culture’ may be an important variable in explaining variations in outcomes in these
362 national comparisons. The experiments indicated, firstly, that all participants saw the value of a
363 grand coalition but, secondly, that participants in different nations then differed with regard to
364 how they chose to share the asset: in Belgium and the Netherlands an even distribution was
365 generally preferred even though the parties contributed unevenly in the first place; in the UK and
366 Norway outcomes that balanced outcome and input, close to the Shapley value, were more routine.

367 The fact that the equal split was a popular choice for many participants, particularly in some
368 national settings, may be a reflection of the fact that all participants were, *ex ante*, symmetric. The
369 subjects were randomly assigned to one of the three developer roles with equal chances.
370 Correspondingly, the equal split may have been incentivised in these experiments following the
371 parallel arguments that rationalise equal split outcomes in ultimatum game experiments discussed
372 earlier in this paper. Nevertheless, the popularity of the equal split outcome is an interesting

373 phenomenon and may point to norms of practice or heuristics that are culturally and behaviourally
374 inscribed into different understanding of what constitutes ‘fair shares’. Further research would be
375 valuable on how enduring these arrangements are: economic theory would suggest that in
376 circumstances where a coalition is required to hold together, division rules which deviate from the
377 Shapley value may be unstable as any design that deviates from the Shapley value represents an
378 arrangement that has the potential for objections and counter-objections.

379 What remains is the question of whether we would arrive at a different outcome to the self-
380 organised solutions discussed in this research if an informed broker had ‘nudged’ the players
381 towards a different allocation (such as the Shapley distribution). In the example set out above just
382 three players are included – we did not include a role for any state or quasi-state agency which
383 might be able to broker a deal between landowners and developers as this would be inconsistent
384 with our test of what happens under self-organisation. In our analysis the results are clear: in some
385 circumstances (or national settings) our instincts to be cooperative and even-handed mean that we
386 may be able to form a grand coalition and harmonise to an equal split when left to our own devices,
387 but this is potentially unstable. When we have planning law and (well-informed) institutions to
388 implement that law a different allocation may prevail that differs from the self-organised solution
389 but may be more stable. The implications of this finding suggest the desirability of further research
390 on this issue in other national settings where a statutory actor is an essential player – for example
391 in land tenure systems where development rights in land are nationalised, such as China.

392 **Conclusion**

393 In recent years a huge amount of academic attention has been devoted to ‘mechanism design’ –
394 using the principles of game theory and behavioural economics to develop new insights into a
395 whole range of public policy questions (Börger, 2015; Chetty, 2015; Hu et al., 2016). In our
396 example, a properly designed planning ‘mechanism’ could be instituted to be played non-
397 cooperatively which could implement the grand coalition and the division of surplus defined by
398 the Shapely value. To illustrate how such an observation might be translated into mechanism
399 design, Pérez-Castrillo and Wettstein (2001) offer a bidding mechanism in which players first bid
400 to become the “proposer” and then the proposer makes a proposal to each of the other players.
401 If the proposal is accepted by all the other players, the proposer forms the grand coalition, collects
402 the value generated and makes the proposed payments to the rest of the players. If the proposal is
403 rejected, the proposer will be on their own and the rest of the players play the bidding mechanism
404 again. The authors show that in the subgame perfect equilibria of this bidding mechanism the net
405 payoff of every player is his/her own Shapley value. Relatedly, Serrano and Vohra (1997) explore

406 mechanisms that are motivated by the concept of the core and possess the property that their non-
407 cooperative equilibrium outcomes coincide with the core.

408 Much greater research on mechanism design in relation to planning questions is required. In
409 particular more work is required that speaks to the central importance of planning institutions in
410 animating markets – especially those that relate to/depend upon the natural environment
411 (Bromley, 2014, 2016; North, 1990, 1995; Ostrom, 2005). In the case of our specific thought
412 experiment the behavioural complexities of real estate markets are well-noted (Brzezicka and
413 Wisniewski, 2014; Evans, 1991; Jackson and Watkins, 2008; Pavlidis et al., 2016; Roberts and
414 Henneberry, 2007). Although we could expand the game to encompass a greater number of
415 players across a larger coalition with similar theoretical results, the degree to which the behavioural
416 economics of strategy might affect outcomes remains a very salient question. For example,
417 signalling strategies or the emergence of shifting, or nested, coalitions of actors (partition games)
418 might make a different outcome more likely in practice. Within this real world context there would
419 almost certainly be a need for an agency, such as a development corporation or urban planning, as
420 a formal statutory function that might make the ‘state of the world’ described by the Shapley value
421 a reality. This type of activity would correspond to the idea of urban planning as a ‘market maker’
422 (Lord et al., 2015) – the type of economic agency that can, if suitably well-informed, encourage
423 outcomes, such as coordinated self-organisation. Defining and applying Shapley values to guide
424 the design of land readjustment policies might be one such role a market making planning agency
425 could explore although we are sorely in need of further applied research on how such approaches
426 might work out in practice.

427

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433

434

435 **Appendix A**

436 Coalition Game for Area Development

437 A municipality would like to develop an area by inviting developers to plan and carry out the development
438 process. Three private land developers, A, B, and C are interested in the project. The municipality will only
439 give a development permit if the development is carried out through a coalition or a joint-venture initiative
440 of at least two developers because by doing this, they can make a better project and create more value for
441 the area. Therefore, if no coalition is formed (by at least 2 developers), no value will be created, and
442 everybody will get nothing. Due to differences in the capacity of the developers, the value created from the
443 joint venture will differ according to the members of the coalition. The expected values from the
444 development are:

- 445 • nothing if developer A, B, or C develops the area alone
- 446 • 300 million kroner if developer A and B develop the area together
- 447 • 350 million kroner if developer A and C develop the area together
- 448 • 400 million kroner if developer B and C develop the area together
- 449 • 900 million kroner if developer A, B, and C develop the area together

450 *Note:*

- 451 • If 2 developers agree to make a coalition/joint venture, the value they create will only be divided
452 between them, while the third player will get nothing.

453

454 Your Task:

455 You are developer (A/B/C), sitting together with (A/B/C) and (A/B/C). Please negotiate with each other,
456 what coalition are you going to form, and how are you going to divide the value created by the coalition
457 among the coalition members?

458

459

460 **When you have decided on a coalition and a distribution, please turn over the page.**

461 Answer sheet (all three players fill in the same):

462 • Circle the coalition you formed

463 ○ (A, B)

464 ○ (A, C)

465 ○ (B, C)

466 ○ (A, B, C)

467 ○ None

468

469 • Distribution of created values:

470 ○ A: _____ kroner

471 ○ B: _____ kroner

472 ○ C: _____ kroner

473

474 Questionnaire (fill in individually):

475 1. Please explain the motivation of your decision (in forming or not forming a coalition)

476

477 2. Do you think that you have distributed the created value in a fair way among the members of the
478 joint venture, and why do you think so? Please also explain what, in your opinion, is the fair
479 distribution if you think you have not distributed the value in a fair way.

480

481 3. Years of completed university/college education

482 4. Gender:

483 5. Age:

484 6. Do you work outside of the university?

485 a. No

486 b. Yes, but not related to planning or development

487 c. Yes, with development or urban planning in the private sector

488 d. Yes, with development or urban planning in the public sector

489 7. Income:

490 a. Less than 200,000 kroner a year

- 491 b. 200,000 – 500,000 kroner a year
- 492 c. More than 500,000 kroner a year
- 493 8. Type of education
- 494 a. ByReg
- 495 b. Eiendomsutvikling
- 496 c. Eiendomsfag
- 497 d. Other (please specify):
- 498

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