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Duality in land rental problems

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Abstract

Land rental problems describe situations where one tenant demands land from several lessors. The way lessors rent their land can be seen as equivalent to a bankruptcy problem. We extend the idea of self-duality in bankruptcy problems to land rental problems. We provide a complete characterization of the family of rules that satisfy self-duality. Moreover, self-duality is enough to assure the proportional land share among lessors. Adding other reasonable properties, we pick up a single rule.

Keywords: Self-duality; land rental problems; bankruptcy problems; proportional rule

1. Introduction

Duality is an important concept in mathematics which usually implies the involution operation, i.e. given x and its dual y , then the dual of y is x . Even though duality has different interpretations depending on the area, we focus on the interpretation in bankruptcy problems [11], which is consequently extended to a land rental problem context.

A land rental problem involves several lessors and a single tenant, who needs to rent land, but less than all land that is owned by the lessors. The main question is knowing how much land each lessor should rent and the price per unit of land [12, 16]. We follow the same cooperative approach as [16] with different properties, apart from the so-called “standard for two”; the classes of rules we obtain are different, even though the proportional sharing for land arises in both studies. The approach and results in [12] are different, but the motivation of land acquisition is similar.

Bankruptcy problems are situations where a group of agents (N) have some claims ($c \in \mathbb{R}_+^N$) that sum up to more than some particular estate (E), i.e. $\sum_{i \in N} c_i > E$. A bankruptcy rule is a way to share the total estate among the claimants. For each claimant, her share can be seen either as an award of part of her claim or as a loss of the other part.

The self-duality principle in bankruptcy problems [1] states that the criterion used to grant awards should coincide with the one used to grant losses. Many important rules in the context of bankruptcy problems satisfy self-duality, for example, the proportional rule [20, 7, 8, 6], the Talmud rule [2], the Contested Garment principle [4], and the reverse Talmud rule [19]. For a survey, we refer to [13, 15, 10].

We extend the idea of self-duality to land rental problems. The lessors can be seen as claimants in a bankruptcy problem. Lessors’ claims are the land they own, and the estate is the amount of land that the tenant needs. Moreover, land renting problems have other elements to take into account, as for example the fact that the tenant is also an agent (see [3] for another extension of bankruptcy problems in which the estate

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