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General equilibrium with nonconvexities and money

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Abstract

In a general-equilibrium economy with nonconvexities, there are sunspot equilibria with good welfare properties; sunspots can ameliorate the effects of the nonconvexities. For these economies, we show that agents act *as if* they have quasi-linear utility functions. We use this result to construct a new model of monetary exchange along the lines of Lagos and Wright, where trade occurs in both centralized and decentralized markets, but instead of quasi-linear preferences we assume general preferences but with indivisible labor. This suggests that modern monetary theory is more robust than one might have thought. It also constitutes progress on the classic problem of integrating monetary economics and general-equilibrium theory.

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1. Introduction

We study nonconvex economies, in particular economies in which some goods are indivisible. We have two major goals. First, extending Shell and Wright [32], we show that in the presence of indivisibilities there exist *sunspot equilibria* without the usual assumptions needed to generate such equilibria in convex economies, and that these equilibria have good welfare properties because sunspots allow "convexification," similar to the way lotteries work in the indivisible labor

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economy of Rogerson [29]. [1] Second, we emphasize something not appreciated in the existing literature on nonconvexities, sunspots, and lotteries: in these economies, as long as the optimizing choices of agents are interior, then they act *as if* they have quasi-linear preferences.

It is true that it has been noted previously of the Rogerson model that, when labor is indivisible, under certain additional assumptions that include additive separability between consumption and leisure, agents act as if utility is linear in leisure. Our result is more general. The fact that for more general specifications of underlying preferences agents act as if they have quasi-linear preferences is useful for a variety of reasons. For one thing, it means that, for the divisible goods in the economy, wealth effects vanish. This has many implications, including the law of demand (the demand for each of the divisible goods is unambiguously decreasing in its own price). Here we will emphasize the usefulness of these results for monetary theory.

A model of monetary exchange with micro-foundations based on search theory has been developed by Lagos and Wright [20], hereafter LW. The LW model is tractable because it gets around the problem of having to keep track of the distribution of money holdings as a state variable. It works by allowing agents to trade periodically in centralized markets (CMs), where they can adjust their cash positions by buying and selling other goods, as well as sometimes forcing them to trade in decentralized markets (DMs), where money is essential. If agents have quasi-linear utilities then, given interior solutions, they all take the same amount of money out of the CM, and hence the distribution of money entering the DM is degenerate. This makes the framework relatively easy to analyze, and hence one can extend and apply it in a number of ways. [2]

Although for some questions one would obviously like to allow for endogenous non-degenerate distributions of money holdings, it is useful to have a benchmark without this complication, and to this extent the LW model is helpful. One might object, however, that quasi-linear utility is very special. Our results show that one does not actually need quasi-linearity: for general preferences, as long as some goods are indivisible, and again given interior solutions, all agents take the same amount of money out of the CM. Thus, we provide an alternative set of assumptions that leads to a simple model of monetary exchange with explicit micro-foundations. [3]

We make an effort to describe the CM in the model in a fairly general way—there are few restrictions other than those in standard general-equilibrium (GE) theory. This generality comes at little cost, and shows that modern monetary theory is not as special as one might think based on previous presentations (in earlier discussions of the LW model, e.g., the CM has a single consumption good, agents are homogeneous, and so on). Indeed, our CM looks much like the

[1] A sunspot equilibrium is one in which extrinsic uncertainty (a random variable with no impact on preferences, endowments, or technologies) affects the allocation. In strictly convex economies, sunspot equilibria are necessarily inefficient, because random allocations are dominated by the average allocation. When some goods are indivisible, however, the average may not be feasible. For some recent papers on nonconvexities, lotteries, and sunspots, see Prescott and Shell [26] and papers cited therein, Garratt et al. [12,13], and Kehoe et al. [16].

[2] LW provide examples and references to other applications. An alternative approach is provided by Shi [34]. Faig [10] tries to integrate the two models, and gives some results related to those derived below. For models that are less tractable, precisely because one has to keep track of the relevant distribution, see Green and Zhou [14], Zhou [40], Molico [23], Camera and Corbae [6], Taber and Wallace [36], or Zhu [41,42]. Earlier search-based models, such as Kiyotaki and Wright [17,18], Aiyagari and Wallace [1], Shi [33], or Trejos and Wright [37], were also very simple, but only because they avoided the issue by assuming agents could only hold $m \in \{0, 1\}$ units of money. In this symposium, Zhu [43] uses the births and deaths in an overlapping-generation economy to provide relatively simple dynamics.

[3] We usually interpret the indivisible good as labor. Although this is not necessary for any of the results, it is a common interpretation in macroeconomics. In addition to Rogerson [29], a sample of well-known papers adopting the indivisible labor model includes Hansen [15], Cooley and Hansen [8], and Christiano and Eichenbaum [7]. Some more recent examples include Sargent and Ljungqvist [31].