Search cost, trading strategies and optimal market structure

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Abstract

The theory of Walrasian equilibrium yields a set of prices at which the aggregate competitive demand for each commodity equals its aggregate competitive supply. However, even at equilibrium prices the theory of competitive equilibrium does not explicitly offer explanation regarding the manner in which trades are actually executed. This paper considers a model where trade takes place in a decentralized fashion and examines in a dynamic game-theoretic framework, the role of social institution of money and markets in facilitating exchange. The steady state Nash equilibrium derived in the paper demonstrates how, depending on the level of transaction costs associated with a market setup (synonymously, trading posts to exchange possible pairs of goods) appropriate monetary trade emerges, which like a hub and spoke network (Starr and Stinchcombe, 1999) makes some markets non-functioning and in equilibrium only the markets having trade through the medium of exchange continue to exist. However, despite the obvious advantages of a market setup in reducing search costs, pure random search for a complementary trading partner (as considered by Ostroy and Starr, 1974; Kiyotaki and Wright, 1989; and others) prevails in many economies, especially, in many developing economies. This paper models this feature of developing economies by introducing differences in transaction costs across agents and shows why sustainable equilibria might exist exhibiting random search for certain commodities even in the presence of established markets.

Accepted 12 February 2012

Keywords: Trading post
Market less trade
Steady state Nash equilibrium

1. Introduction

Money is an essential intermediary in the process of exchange. Even in a competitive setup where aggregate demand equals aggregate supply for each commodity, lack of a double coincidence of wants at the individual level can create serious problems in attaining one desired bundle of goods (Ostroy and Starr, 1990). The earliest recognition of the problem came in Menger (1892) and later Hicks (1967) posed the problem in the context of a Walrasian economy (Walras, 1954). In recent times the celebrated papers of Ostroy and Starr (1974, 1990) and Kiyotaki and Wright (1989) examined the question of which commodity can be the best choice as a medium of exchange in terms of transaction costs like time or storage cost. In the framework considered by Kiyotaki and Wright (1989) there are different types of goods in terms of storage cost and three types of agents with specialized production and consumption for goods. Agents are assumed to be randomly searching for trading partners in order to achieve the good s/he finally wishes to consume by exchanging either directly or indirectly the good s/he produces. In the process of indirect exchange an agent may accept a good not because s/he wishes to consume it but because it can be exchanged for a good s/he finally demands. Such a commodity then serves the purpose of a medium of exchange.

In addition to a medium of exchange, which facilitates the process of exchange, market institutions also smoothen the transaction process by acting as a meeting ground for the buyers and sellers. Recognizing the role of markets in the process of exchange, some authors theoretically examined the coexistence of money and markets as facilitators of exchange (see Howitt 2005; Rajeev 1997, 1999; Rajeev and Dasgupta, 2007; Starr 2002; Starr and Stinchcombe, 1999). The market setup considered in the literature consists of trading posts for different possible pairs of commodities and is visited by the demanders and suppliers of the goods concerned. However, notwithstanding the obvious advantages of a market setup where buyers and sellers of a particular good can meet separately (as against a pure random search for a matching trading partner amongst all agents in the economy) market less trade is also commonly observed in developing economies. For example, at any traffic signal stop, one is surrounded by vendors peddling their wares. Hawkers of various commodities, ranging from perishable goods like fish or vegetables to non-food items, call
out in residential areas in search for a potential trading partner. In other
words, though a market setup can reduce the search cost to a great ex-
tent, random search persists even for the commodities having estab-
lished markets. Literature is generally silent about why one may
observe such a phenomenon.

In the present paper we make an attempt to explain the simulta-
neous existence of monetary trade through pure random search and
market specialization as a solution of a dynamic game problem. The
problem is posed in a simple three-good economy characterized by
complete absence of mutual coincidence of wants amongst the agents with
flexible trading rules. More precisely, trade can take place either in
a trading post setup (equivalently in markets to exchange different
pairs of goods) or, through pure random search (market less setup).
Though it is appropriate to incorporate flexible price regimes (see
Kiyotaki and Wright (1993)), we abstain from doing so in this exercise
as the purpose here is to show that even with pre-determined market
clearing prices, monetary trade can be indispensable and market less
trade can coexist in equilibrium with specialized markets, even though
the latter seems to reduce transaction costs.

Equilibrium here is a steady state Nash equilibrium involving
the optimal trading strategies of agents engaged in a process of exchange. The
paper recognizes the fact that in addition to time or storage costs,
there may be additional resources necessary for one to be engaged in
trade through a market setup. These may include taxes payable, rentals
or power charges and so on. Initially we consider an economy with dif-
ferent types of agents characterized by their excess demand and supply,
but agents belonging to a particular type are assumed to be identical.
Later in Section 2.3 we relax this assumption. The kind of economy we
consider later has different types of agents who are not only character-
ized by their excess demands and supplies but also by their resource
constraints. For example, one group of agents may be constrained by
financial resources to participate in a market setup, while the other
group within the same type may have inherited (or otherwise endowed
with) wealth, which may be used as collateral for acquiring capital nec-
cessary to participate in a trading post or equivalently, market setup. This
is captured in the model by incorporating a cost for participating in a
market setup, measured in terms of instantaneous disutility, which is
higher for the resource-constrained agents. This leads to the possibility
that the people who are more constrained with respect to financial
resources (than with respect to time) may prefer to go in for random
search. However, this need not imply that a meaningful steady state
Nash equilibrium will necessarily exist. We show that feasible parametric
restrictions can be obtained under which such an equilibrium exists.
The important question that arises is why such an equilibrium is not
common in a developed economy. This is possibly due to the fact that
even a resource-constrained agent (in a developed nation) has suffi-
cient funds or receives adequate financial support, either Government
or private, to be able to participate in a market setup. In other words,
not relative deprivation, but absolute level of poverty seems to matter.
It is interesting to note however that the equilibrium we derive is Pareto
non comparable to the one characterized by complete marketized trade.

Given this background the next section describes the basic framework
under consideration. Section 3 looks at the possible equilibrium stra-
gies under different trading arrangements. A concluding section follows
thereafter. Appendix A provides the technical details.

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market setup, measured in terms of instantaneous disutility, which is
captured in the model by incorporating a cost for participating in a
trading post setup (equivalently in markets to exchange different
commodities). As soon as a type k agent acquires good k s/he consumes it
and produces one unit of k*. Each good can be stored at a cost, but an
agent’s capacity to store is restricted to one unit only. Let \( b_{kn} \) denote
the cost (in terms of instantaneous disutility) to the type k agents of
storing good c. It is assumed that \( 0 < b_{k1} < b_{k2} < b_{k3} \) for all k.

For a type k agent, let \( U_t^k \) denote the instantaneous utility from
consumption of good k, \( L_t^k \) instantaneous disutility of producing k* and
\( \beta \in (0, 1) \) is the common discount factor. Thus, a type k agent’s
discounted life time utility is given as

\[
E \left[ \sum_{t=0}^{\infty} \beta^t \left( I_{t\sigma}(t)U_t^k - I_{t\sigma}(t)k - I_{t\sigma}(t)b_{kc} \right) \right]
\]

where \( I_{t\sigma}(t) \) is a random indicator function with

\[
I_{t\sigma}(t) = 1, \text{ if a type } k \text{ agent consumes good } k \text{ in period } t = 0, \text{ otherwise.}
\]

Similarly,

\[
I_{t\sigma}(t) = 1, \text{ if a type } k \text{ agent produces good } k^* \text{ in period } t = 0, \text{ otherwise.}
\]

In each period, agents are randomly matched with each other in
pairs and exchange of goods takes place when it is mutually agree-
able. It is assumed that the net utility of consuming plus producing,
\( u_k = U_k - L_k \) is large enough for agents not to want to drop out of
the economy. This may be ensured through the following sufficient condi-
tion introduced by Kiyotaki and Wright (1989).

\[
u_k > (b_{k1} - b_{k3})/(1 - \beta), \text{ for all type } k \text{ agents and commodities } c.
\]

Under this basic framework Kiyotaki and Wright (1989) estab-
lished that there exist two types of pure strategy steady state Nash
equilibria. A steady-state Nash equilibrium is a set of trading strategies
\( \{S_k\} \), one for each type k, together with a steady state distribution
of inventories \( \pi \) (which gives the proportion of type k agents with
good c which in turn determines probability of meeting a type k agent
with good c) that satisfies the following conditions:

(i) each individual k chooses \( S_k \) to maximize his/her expected
discounted life time utility given the best strategies of others
and the distribution \( \pi \); and

(ii) given \( S_k, \pi \) is the resulting steady state distribution.

The two types of equilibria established are,

(1) Fundamental equilibrium: where good 1 (the good with the lowest
storage cost) is the unique medium of exchange and type 2
traders who produce good 3 (that is, the good with the highest
storage cost) and consume good 2 are the middlemen (i.e., who
go through two-stage indirect trade using good 1 as a medium
of exchange). Others go through direct barter of exchanging
their production good against their consumption good (directly).

(2) Speculative equilibrium: where both goods 1 and 3 are acting as
media of exchange. Type 1 traders (who consume good 1 and

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\[a \text{ See Kiyotaki and Wright (1989).} \]
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