Specialization and the Effects of Transactions Costs on Equilibrium Exchange

James Dolmas

and

Joseph H. Haslag

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JAMES DOLMAS AND JOSEPH H. HASLAG*

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ABSTRACT. In this paper, we examine economies in which there are fixed costs associated with executing trades of differentiated goods. When traders exchange units of the home goods for another household's consumption good, the results uphold the conventional wisdom–it does not matter who pays the transactions cost. However, when we introduce fiat money into the environment, the results demonstrate that it does matter who pays. Our results demonstrate that when members of the household specialize, bearing the transaction cost s can yield different equilibrium outcomes.

Transactions costs have long played an important role in motivating why people value fiat money. Baumol (1952) and Tobin (1956) established a "demand" for fiat money based on the presence of transactions costs. In both cases, agents must pay a fixed fee to change from interest-bearing bonds to non-interest-bearing fiat money. Saving (1971) built on this tradition by developing the shopping-time model in which agents' money balances are inversely related to one's effort devoted to shopping. Since shopping uses time that could otherwise be spent enjoying leisure (or producing), fiat money is valuable. More recently, Schreft (1992) examined economies in which agents balance transactions costs associated with using credit against eroding purchasing power associated with using fiat money.

The purpose of this paper is to ask whether who bears the transactions costs will affect equilibrium outcomes. By definition, the direct incidence of the transaction cost is borne either by the buyer or the seller. Our read of the conventional wisdom is that the incidence is irrelevant.

In this paper, we develop a general equilibrium model to study these issues. Our economy consists of households that are located along a unit circle, each endowed with a specific good. Preferences are defined over the entire range of endowment goods, providing an incentive for trade. More importantly preferences are symmetric. We examine two means of executing trades. In the first case, trades are executed by exchanging units of the endowment goods. In this model, it does not matter whether the buyer or the seller bears the direct burden of the transaction fee. This result confirms the conventional wisdom. In this economy, both seller and shopper are acquiring commodities. In the second case, fiat money is introduced. Here, a generally accepted medium of exchange highlights specialization within the household. The seller's job is to maximize the quantity of fiat money available for purchasing the endowment good. In contrast, the shopper maximizes utility by paying the transaction fee to acquire a measure of the different commodities that are available. As such, specialization leads to equilibrium allocations that differ depending upon whether the seller bears the transactions cost or whether the shopper bears the transactions cost.

Department of Economics, Southern Methodist University and Reserach Department, Federal Reserve Bank of Dallas, respectively. The authors wish to thank Greg Huffman, Evan Koenig, and Marci Rossell for helpful comments on earlier drafts of this paper. The views expressed herein do not necessarily represent those of the Board of Governors of the Federal Reserve System nor the Federal Reserve Bank of Dallas.

1. THE ENVIRONMENT

The model is a modified version of Townsend's economy in which infinitely-lived households are spatially separated. Time is discrete and indexed by $t = 0, 1, 2, \ldots$. The physical environment can be interpreted as a group of households, each living at a specific point on an atoll. The locations on the atoll are indexed by i. The location index is important because each location produces a different commodity. The circumference of the atoll is normalized to one so that $i \in [0, 1]$. With households indexed by location on this atoll, the greatest distance, in absolute value, is between points on opposite sides of the atoll. There is a large number of households at each location. Each household is endowed with a finite quantity of the home-location's goods, denoted by $e(i)$. These endowment goods spoil at the end of the period in which the endowment is received.

Preferences are identical across households and across locations. The momentary utility function is represented by

$$U_t = \left[\int_0^1 [c(i)]^\alpha di \right]^{1/\alpha}$$

In general, these preferences satisfy standard conditions; that is, U is strictly concave and satisfies the Inada conditions. Indeed, the essential feature exhibited by these preferences is that all goods are gross substitutes. Symmetric preferences makes the analysis substantially more tractable. For one thing, we can conduct our analysis for a representative household without loss of generality.

The household consists of two agents—a seller and a shopper.[1] At the center of the atoll is a trading center, hereafter referred to as the marketplace. It is costless to move from one's home location to the marketplace. In addition, shoppers costlessly meet with sellers. Trade occurs if the shopper offers some of the home-location's endowment good to a seller from location i and the seller accepts. Here, the matching technology is trivial. We assume for simplicity that the shopper visits the sellers in sequential order; that is, a location-0 shopper visits location-ε, where ε is some infinitesimally smaller number greater than zero, then location-$(\varepsilon + \varepsilon)$, etc.

So far, spatial separation is meaningless. To incorporate the feature that households live at different locations, we include a fixed cost, payable in the units of trader's home good, that accompanies each trade. For the preferences described above, sellers would always accept goods from every location. However, when a seller and shopper agree to trade, we assume that one has less information about the nature of the goods being traded. As such, the less-informed trader will pay a fixed fee to verify that trade is according to the terms of the contract. If the shopper bears the verification cost, offers for some location's goods may not occur because the fee is "too expensive." Similarly, the seller may refuse to trade with some shoppers for the same reason. Spatial separation has meaning in this environment through this verification cost. We assume that the fee, paid in units of the home-location's goods, is an increasing function of the distance between locations: "closer" neighbors require fewer resources to verify trades as compared with households that are located further away. Let the verification cost function be denoted $a(|i - j|)$, where $|i - j|$ denotes (the absolute value of) the distance between location i and location j. Note that $|i - j|$ is taken as the minimum distance from location i;

[1] The seller-shopper pair is analogous to the worker-shopper pair developed in Lucas and Stokey (1983). As in the Lucas-Stokey framework, the key feature is that the pair cannot perfectly coordinate their activities to overcome trading frictions.

hence when $|i-j| > \frac{1}{2}$, then for $i > j$ ($j > i$), the minimum distance is $|i-1| + |0-j|$ ($|j-1| + |0-i|$). Thus, the shortest distance between any two locations is necessarily less than $\frac{1}{2}$. Then, the verification cost is formalized as $a(0) = 0$, $a'(.) > 0$, and $a''(.) \geq 0$. With preferences symmetric across goods from different locations, the Inada conditions imply that households will be willing to trade some of the home-good for goods from other locations. Because the verification costs are increasing in the distance, the household's problem is to decide what range of goods from other locations to consume. Moreover, with symmetric preferences and increasing fixed costs, a shopper from, say, location 0, will only visit kiosks from locations where $i \in [0, 1/2]$. The shopper need only cover half of the locations because the location-0 seller will be visited by shoppers from locations $i \in [1/2, 1]$ at a lower transaction cost.

In this paper, we investigate whether it matters if the shopper or the seller pays the transaction costs. The different assumptions are seemingly innocuous in terms of affecting equilibrium outcomes. In the next section, we present a case in which the equilibrium is identical regardless of whether the shopper or the seller pays the transactions fee.

2. USING ENDOWMENT GOODS AS PAYMENT

In this section, we consider trades in which the seller and shopper exchange units of their endowment good. There are two options, either the seller or buyer can pay the verification costs. With symmetric preferences, verification costs will be the same across households. With a large number of household at each location, each seller and shopper will take the prices as given. Symmetric preferences further implies that relative prices will equal unity. Correspondingly, we can discuss the problem from the perspective of a representative household located at $i = 0$, without loss of generality.

2.1. I: 'Seller' bears verification cost.

Let S_t denote the set of locations that the shopper executes a trade.[2] Let S_t' denote the set of 'visitors' with whom the seller will execute a trade. It is probably worth mentioning again, for home location denoted 0, the potential set of visitors will come from the range, $i \in [1/2, 1]$.

Suppose that the seller bears the cost of verifying the payment. Thus, exchanging with traders in the set S_t' incurs a cost—borne in units of the home endowment—of

$$A(S_t') = \int_{S_t'} a(i)\, di.$$

Suppose all relative prices are unity and that the households at each location take these relative prices as given. It is fairly straightforward to rule out the case in which the household gives the shopper the entire endowment. At first glance, this approach would mean that the household would pay zero verification costs. However, if every household took this strategy, then the economy would see no trade. The shopper could visit all the kiosks, but sellers at each location would have nothing to trade. The equilibrium, therefore, would be autarkic. The preferences with the Inada conditions ensure that seller's will pay some verification to acquire goods from other locations.

Suppose that the location-0 seller pays the fixed cost to trade with location$-i$ shopper and location$-j$ shopper for $i \neq j$. One implication of this setup is that with unit relative prices, the shopper will trade for the same amount of location$-i$ good and location$-j$ good. Let c_t denote the pair's uniform consumption of goods from locations $i \in S_t$, and

[2] Note that the seller-shopper pair views the set of available markets as given.

c'_t denote the (also uniform) offer of goods to traders from $i \in S'_t$. The household's budget constraint is

$$e_t - A(S'_t) \geq c_t \mu(S_t) + c'_t \mu(S'_t). \tag{1}$$

It is straightforward to argue that $S_t \cap S'_t = \emptyset$. This is not too argue that $S_t = [0, 1/2]$, the range could be smaller. But the argument does guarantee that a location-0 shopper, for example, will visit location-i seller while a location-i shopper is visiting a location-0 seller. Substituting eqn.(1) into the momentary utility function yields the following,

$$U_t = \left[(c_t)^\alpha \mu(S_t) + (c'_t)^\alpha \mu(S'_t)\right]^{1/\alpha}. \tag{2}$$

The household takes the set S_t as given. Momentarily, suppose that S'_t is taken as given as well. Optimal choices of c_t and c'_t clearly satisfy

$$c_t = c'_t,$$

and the budget constraint gives

$$c_t = \frac{e_t - A(S'_t)}{\mu(S_t) + \mu(S'_t)}.$$

Because the goods cannot be stored, the household's infinite-horizon program with time-additive preferences is equivalent to series of one-period static problems. Each can be solved separately. For location–0, then suppose that S_t is an interval $[0, s_t]$ and S'_t is an interval $[s'_t, 0]$, so that the household maximizes

$$U_t = \left(e_t - \int_0^{s'_t} a(i)\, di\right) [s_t + s'_t]^{\frac{1-\alpha}{\alpha}}.$$

The utility maximizing choice of s'_t, given s_t, is determined by the first-order condition—

$$-a(s'_t)[s_t + s'_t]^{\frac{1-\alpha}{\alpha}} + \frac{1-\alpha}{\alpha}\left(e_t - \int_0^{s'_t} a(i)\, di\right)[s_t + s'_t]^{\frac{1-\alpha}{\alpha}-1} = 0,$$

or

$$a(s'_t)[s_t + s'_t] = \frac{1-\alpha}{\alpha}\left(e_t - \int_0^{s'_t} a(i)\, di\right). \tag{3}$$

A symmetric, competitive equilibrium consists of a given size endowment, a given range, s, covered by the household's shopper such that: (i) the household's seller will trade with shoppers over the range s' that solve the household maximization problem (equation (2)); (ii) and markets clear at each date; that is, $e_t(i) - \int_0^{s'_t} a(i)\, di = \int_{s'_t}^{s_t} c(i) di$. In a symmetric equilibrium, $s_t = s'_t$ and, s_t satisfies

$$s_t a(s_t) = \frac{1-\alpha}{2\alpha}\left(e_t - \int_0^{s_t} a(i)\, di\right).$$

Note that the trading range here is $2s_t$. Consumption then satisfies

$$c_t = \frac{e_t - \int_0^{s_t} a(i)\, di}{2s_t} \tag{4}$$

on each segment of length s_t.

2.2. II: 'Shopper' bears the verification cost. We use the same notation as before. Now, suppose that the verification cost depends on the range of locations visited by the shopper, S_t. The household, therefore, maximizes utility by selecting the range of locations that the shopper will visit, taking the range of places visiting the seller, S_t', as given. The budget constraint is now

$$e_t - A(S_t) = c_t \mu(S_t) + c_t' \mu(S_t').$$

Again, with $S_t \cap S_t' = \varnothing$, the momentary utility function is

$$U_t = \left[(c_t)^{\alpha} \mu(S_t) + (c_t')^{\alpha} \mu(S_t')\right]^{1/\alpha}. \tag{5}$$

As before, given the trading sets S_t and S_t', optimal consumption choices clearly set $c_t = c_t'$, so that utility in terms of S_t is again

$$\begin{aligned} U_t &= c_t \left[\mu(S_t) + \mu(S_t')\right]^{1/\alpha} \\ &= \left(e_t - A(S_t)\right)\left[\mu(S_t) + \mu(S_t')\right]^{\frac{1-\alpha}{\alpha}}. \end{aligned}$$

Suppose (again) that $S_t = [0, s_t]$ and $S_t' = [s_t', 0]$. Then

$$U_t = \left(e_t - \int_0^{s_t} a(i)\, di\right)\left[s_t + s_t'\right]^{\frac{1-\alpha}{\alpha}}.$$

The first-order condition for an optimal choice is, not surprisingly,

$$a(s_t)\left[s_t + s_t'\right] = \frac{1-\alpha}{\alpha}\left(e_t - \int_0^{s_t} a(i)\, di\right) \tag{6}$$

Thus, as before, in a symmetric equilibrium with $s_t = s_t'$, we obtain the household's optimal range of goods over which to trade given by the following condition:

$$s_t a(s_t) = \frac{1-\alpha}{2\alpha}\left(e_t - \int_0^{s_t} a(i)\, di\right)$$

and

$$c_t = \frac{e_t - \int_0^{s_t} a(i)\, di}{2 s_t},$$

which is identical to equation (4). Thus, the analysis shows that for the two versions of this model economy, the household maximizes utility by choosing the same consumption bundle–that is, the same level of consumption from each location and the same range of locations with which to trade. The seller-pays economy is equivalent to the shopper-pays economy. This is a general feature of economies in which exchange is a trade of endowment goods for endowment goods.[3]

[3]Suppose that the transactions costs are borne according to the following rule: the seller pays $\alpha a(i)$ and the shopper pays $(1-\alpha)a(i)$, for $0 \le \alpha \le 1$. It is fairly straightforward to show that the results, in terms of range of goods consumed (s) and the quantity of each good consumed (c) would be identical for any α.

3. USING FIAT MONEY AS PAYMENT

In this section, we consider an environment in which there is a store of value. Suppose there is a good, call it fiat money, which is an intrinsically useless, noncounterfeitable piece of paper. We assume that there is a constant stock of fiat money in the economy. As in exchanges in which the endowment goods are used as payment, we assume that verification costs are present. We consider the same two cases: either the shopper pays a fixed fee to verify that the goods satisfy the conditions of the trade or the seller pays a fixed fee to verify that the fiat money is indeed the generally acceptable medium of exchange.

In this economy, the separation of the shopper-seller pair at the central market presents a timing issue. The seller must offer the home-good for cash, bring the cash back to the home location, and give the shopper the proceeds for next-period's market activity. *De facto* a cash-in-advance condition arises.

3.1. I. Seller bears the verification costs. Formally, let S_t denote the set of markets to which shopper carries money (again, the shopper's direction is strictly one way). Consider our representative household as coming from location 0. The household takes the locations that will accept the shopper's cash as given. Let S_t' denote the set of shoppers from whom location-$0's$ seller will accept cash in exchange for the home good. Verifying the currency of traders in a set S_t' incurs a cost $A(S_t') = \int_{S_t'} a^M(i)\,di$, which comes out of the pair's endowment of the home good. We assume that $a^M(0) = 0$, $a^{M\prime}(.) > 0$, and $a^{M\prime\prime} \geq 0$.[4]

Let m_t denote the pair's real cash balances at the start of period t, and let c_t denote the shopper's uniform purchase of goods $i \in S_t$. Then the following constraint holds: $c_t\mu(S_t) \leq m_t$, which is essentially the cash-in-advance constraint. Note that $\mu(S_t)$ and m_t are quantities that the household takes as given at the start of t. Assuming that the constraint holds with strict equality, utility is then

$$
\begin{aligned}
U_t &= \left[c_t^\alpha \mu(S_t)\right]^{1/\alpha} \\
&= \left[m_t^\alpha \mu(S_t)^{1-\alpha}\right]^{1/\alpha}.
\end{aligned}
\tag{7}
$$

How do household's cash balances evolve? Given, S_t', the pair sells

$$
m_{t+1} = e_t - \int_{S_t'} a^M(i)\,di \tag{8}
$$

units of its endowment—*i.e.*, all of its endowment, less verification cost—in exchange for money. Let p_t denote the quantity of fiat money exchanged for one unit of the consumption good. Relative prices are constant so that p_t is the price level for goods from each location.[5] With fiat money as the acceptable medium of exchange, the seller will choose S_{t-1}' to maximize utility. Substituting (8) into the household utility function yields

[4] We exclude the possibility of trade through barter. In a series of papers, most notably, Kiyotaki and Wright (1991) discuss conditions when barter is too expensive to coincide with fiat money as a means of payment.

[5] See Cole and Stockman (1992), who argue that symmetry across preferences and production opportunities is sufficient to guarantee that relative prices would be unity in an economy with differentiated products. Effectively, unit relative prices eliminate arbitrage opportunities. Our case is simpler than theirs becuase we restrict production opportunities.

the following efficiency condition

$$[U_t]^{1/\alpha-1}(e_t - \int_{S'_{t-1}} a^M(i)\,di)^{\alpha-1}[-a^M(S'_{t-1})] = 0 \tag{9}$$

According to equation (9), the household's optimal program requires that $a^M(S'_{t-1}) = 0$.[6] Thus, the optimal strategy is to sell the household's endowment for fiat money. The household takes from the right-hand (seller) and gives to the left-hand (shopper). This is because the seller can sell *any amount* of the home good at p_t dollars per unit on *any* S'_t. Thus, the household will seek to acquire sufficient fiat money balances by the least expensive means possible. That is, the seller will sell an amount approaching e_t on a set $S'_t = \varnothing$—*i.e.*, vend the whole endowment on themselves. In a stationary symmetric equilibrium, $S' = S$, leaving the shopper with an vanishingly small set of locations to exchange the money for consumption goods.[7]

The preceding problem highlights what it means for fiat money to serve as a generally acceptable medium of exchange. The problem seems to be the combination of having the person who accepts money in exchange for goods bearing the verification cost and the idea of money as generalized purchasing power—*i.e.*, indifference as to the identity (or home goods) of the bearer.

If I take as given the markets in which I can use money—and all the relative prices are one, and my preferences treat all these goods identically—then I take my real balances at the start of the period and spend them uniformly on this set. Whose money do I *accept*? I accept money in this economy in order to have it to spend next period. Absent the verification cost a^M—ignoring it for a moment—I would offer my endowment to anyone with cash. When the cost $\{a^M(i)\}$ is present, if I can sell $e - \int_{S'} a^M(i)\,di$ for $p_t\left(e - \int_{S'} a^M(i)\,di\right)$on any set S', then I'd want to make S' vanishingly small. If I can sell at most c' to each $i \in S'$, then I have no choice of S' really—I choose S' to maximize $p_t c'_t \mu(S'_t)$ subject to

$$e_t - \int_{S'_t} a^M(i)\,di \geq c'_t \mu(S'_t)$$

—*i.e.*, I just set S'_t so that $e_t - \int_{S'_t} a^M(i)\,di = c'_t \mu(S'_t)$.

In the next section, we show that the range of goods consumed by the household will differ if the one who offers money for goods bears the cost.

3.2. II: Shopper bears the verification cost.

Now, suppose that the shopper bears cost of verifying the goods received satisfy the conditions for trade. The household takes the set, S'–the set of visitors from whom the pair will accept cash for units of the home good, as given. In addition, the household starts the period with a quantity of real balances , denoted m_t. The household chooses S_t—what markets to carry cash to—so as to maximize lifetime utility subject to the constraints

$$e_t - \int_{S_t} a^M(i)\,di = x_t,$$

[6] Of course, $e_t - \int_{s_{t-1}} a^M(i)di = 0$ would also satisfy the first-order condition for the household's problem. This would correspond to a case in which the household uses its entire endowment to cover verification costs. Consumption would equal zero, and utility would equal zero. Clearly, the case in which $a^M(S'_{t-1}) = 0$ yields greater utility to the household.

[7] The money market clearing condition requires that $m_t = e_t - \int_{s_{t-1}} a^M(i)di$ or equivalently $M_t = p_t(e_t - \int_{s_{t-1}} a^M(i)di)$ where M denotes the households, nominal quantity of fiat money balances.

$$\frac{p_{t-1}x_{t-1}}{p_t} = m_t = c_t\mu\left(S_t\right),$$

Within period utility, given S_t and m_t is

$$U_t = \left[m_t^{\alpha}\mu\left(S_t\right)^{1-\alpha}\right]^{1/\alpha}.$$

We then have the following dynamic program

$$v\left(m_t;\mathbf{z}_t\right) = \max_{S_t}\left[m_t^{\alpha}\mu\left(S_t\right)^{1-\alpha}\right]^{1/\alpha} + \beta v\left(m_{t+1};\mathbf{z}_{t+1}\right) \tag{10}$$

subject to

$$m_{t+1} = \left(e_t - \int_{S_t} a^M\left(i\right)di\right).$$

Assuming $S_t = [0, s_t]$, an interval in the direction of travel from zero to some s, the problem is

$$v\left(m_t;\mathbf{z}_t\right) = \max_{s_t}\left[m_t^{\alpha}s_t^{1-\alpha}\right]^{1/\alpha} + \beta v\left[\left(e_t - \int_0^{s_t} a^M\left(i\right)di\right);\mathbf{z}_{t+1}\right].$$

The first-order condition is

$$\frac{1-\alpha}{\alpha}U_t^{1-\alpha}m_t^{\alpha}s_t^{-\alpha} = \beta\frac{p_t}{p_{t+1}}a^M\left(s\right)v_1\left(m_{t+1};\mathbf{z}_{t+1}\right) \tag{11}$$

and the envelope condition is

$$v_1\left(m_t;\mathbf{z}_{t+1}\right) = U_t^{1-\alpha}m_t^{\alpha-1}s_t^{1-\alpha}. \tag{12}$$

Combining these, and updated the envelope conditions by one period, we have

$$\frac{1-\alpha}{\alpha}U_t^{1-\alpha}m_t^{\alpha}s_t^{-\alpha} = \beta a^M\left(s_t\right)U_{t+1}^{1-\alpha}m_{t+1}^{\alpha-1}s_{t+1}^{1-\alpha}. \tag{13}$$

In a steady state equilibrium, this reduces to

$$\frac{1}{\beta}\left(\frac{1-\alpha}{\alpha}\right)m = sa^M\left(s\right). \tag{14}$$

Note that the range of goods the household consumes in this case is s, not $2s$. We also have $m = cs$, and in equilibrium c must satisfy

$$c = \left(e - \int_0^s a^M\left(i\right)di\right)/s, \tag{15}$$

since a measure s of agents visit each location i and consume c units of the endowment from that location. Thus, a symmetric, steady state equilibrium is characterized by

$$\frac{1}{\beta}\left(\frac{1-\alpha}{\alpha}\right)\left(e - \int_0^s a^M\left(i\right)di\right) = sa^M\left(s\right). \tag{16}$$

Thus, comparing equation (16) with the equilibrium outcome associated with equation (9), it is obvious that with fiat money it matters who pays the verification costs. In short, the presence of fiat money and transactions costs do not necessarily imply a consistent set of outcomes.

Is one monetary equilibrium better than another? The shopper-borne transaction fee permits the shopper to trade cash for the home commodity. However, the optimizing conditions indicate that the household will prefer to spend some of their endowment on non-home commodities. This follows from the Inada conditions on preferences, despite the presence of fixed transactions costs.

4. Summary and conclusion

In this paper, we specify a simple general equilibrium model with differentiated goods in which traders face a fixed fee to acquire certain good. Transactions costs are distinguished by whether they are borne by the seller or the shopper. We then ask whether the incidence of the transactions costs matters. Our two main results are:

(i) in pure exchange economies–i.e. ones in which endowment goods are exchanged for endowment goods–the incidence does not matter;

(ii) in monetary economies, the incidence does matter in the sense that households will consume a wider range of the differentiated products when the shopper bears the transaction costs than when the seller pays the transaction fee.

We believe that result (i) characterizes the conventional wisdom. As long the households are identical, trade with a fixed transactions cost will not affect the equilibrium outcome regardless of who bears the fee. As such, our findings offer insight into the consequences of generally acceptable medium of exchange on specialization. Fundamentally, differences in equilibrium trades arise in a monetary economy because of the way in which a household divides its functions. Members of the household can indeed specialize in a monetary economy. Specifically, the seller's chief role is to acquire fiat money, while the shoppers chief function is to directly acquire the goods that will maximize the household's utility. In a way, the seller is removed from the activity that directly affects the household's utility. As such, specialization leads to different versions of the household's problem, depending on who bears the transaction cost. Taking the locations that the shopper can trade with as given, the seller will maximize real fiat money balances by minimizing the loss of the endowment good through paying the fixed verification costs. The shopper, however, will bear some fixed verification costs. The difference is that fiat money is a generally acceptable medium of exchange that permits household member to specialize. In the exchange economy, the seller and shopper are really serving the same role, trading endowment goods for endowment goods.

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