COMPETITIVE PRICE ADJUSTMENT TO CHANGES IN THE MONEY SUPPLY

by

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ABSTRACT

This model applies the analysis of competitive price adjustment in Eden [1981], to the case in which changes in the money supply are the only source of uncertainty. It is shown that, if the possible changes in the money supply are not large the economy will exhibit a positive relationship between money and output but no involuntary unemployment. If the possible changes in the money supply are large the economy will exhibit a positive relationship between money and employment, allowing for involuntary unemployment.

I. Introduction

Consider the problem of a seller who has to advertise a price for his product in the presence of costly information about demand. He can costlessly observe the prices advertised by other sellers in his neighborhood, and he can also spend some resources to find out the actual demand. If the price advertised by other sellers in the neighborhood (the market price) is always based on updated information, the seller will never invest in information gathering and will always follow the market. Therefore, to maintain incentive to collect information, there must be a positive probability that the price advertised in a given neighborhood will not be based on updated information. In an economy composed of many such neighborhoods, we will therefore have some neighborhoods which advertise a price that is based on updated information (informed neighborhoods) and some which advertise a price that is based on "old" information (uninformed neighborhoods). The implications of this general result are discussed in Eden (1981) for the case in which real shocks cause the fluctuations in demand. Here I consider the case in which changes in the money supply are the source of uncertainty.

Sellers form rational expectations with respect to demand and with respect to the probability that the price advertised by other sellers in their neighborhood is based on updated information. In equilibrium sellers are indifferent between buying and not buying information about demand conditions. They use a mixed strategy to make this choice. Sellers who did not buy the information advertise the price which is optimal under the initial prior. A seller who buys the information and advertises a different price will be identified as informed and will be followed by all the sellers in his neighborhood. Thus, information about demand is a local public good, and a neighborhood is informed if at least one seller in the neighborhood has bought the information.

The price advertised in uninformed neighborhoods is optimal under the initial prior with respect to demand conditions. This price will also be optimal for some level of the money supply -- call it the anticipated level. Thus, uninformed and informed neighborhoods advertise the same price when the anticipated money supply actually occurs. When the actual money supply is different from the anticipated level, the informed sector will realize the return on the investment in information, will face a higher real price, and will expand production. If the money supply is above its anticipated level, the uninformed sector will produce and sell its normal output. In this case, we will observe a positive relationship between money and total output. If the money supply is below its anticipated level, the uninformed will not be able to sell at their advertised price. If these uninformed sellers realize that they have made a mistake, and if there is not enough time to transmit a new price to the buyers, they may decide to quit working. Thus, in the case in which the money supply is below its anticipated level, we may observe involuntary unemployment.

As in Lucas (1972), we can have a positive effect of money on output under rational expectations. Here, however, this effect does not require real shocks; it does not require the assumption that transactions costs prohibit trade among neighborhoods (islands in Lucas' model); and it does not require the assumption that information about the current money supply is prohibitively expensive. It requires the substitution of the auctioneer by a market mechanism in which firms are price setters, and it requires some lag in transmitting advertised prices to the buyers. As in the Keynsian model, we can have prices which are "too high" and, during the time it takes to transmit new prices, we can have involuntary unemployment. Here, however, prices are endogenous rather than historically given.

To make this paper self-contained, I summarize, in section II, the part of Eden (1981) which describes the process of advertising prices in a particular neighborhood under the assumption that expectations are exogenously given.

I then consider, in section III, an equilibrium analysis in which expectations are determined in equilibrium and study the effects of money on output and employment. A brief discussion of the assumptions and the implications is provided in section IV.

II. The Sellers' Problem

The question of who will gather the information necessary for announcing equilibrium prices is a public good problem which, in the Walrasian model, is avoided by using the artificial entity of the auctioneer. The public good aspect of the problem emerges when there is a unique optimal price which would be announced on the basis of "old" information shared by all participants. If a single firm buys "new" information and updates its price, all firms which are aware of this revised price will rightly think that it is based on "new" information and will therefore follow the lead. The firm that updates the price therefore provides that public good which in the Walrasian model is provided by the auctioneer.

The question is: Which firm will undertake the function of the auctioneer? The suggested solution is that all firms will adopt a mixed strategy in which they undertake this function and buy information with a certain probability. It is argued that to maintain an incentive to buy information there must be a strictly positive probability that no one will buy information and, therefore, the price advertised in a particular market will not always reflect updated information. (See Grossman and Stiglitz [1976, 1980] for a similar argument in a Walrasian setting.)

I start with a simple single period model in which there are n identical firms (sellers); each will have a given supply of one unit of a non-storable good at the end of the period. The good is valueless to sellers, and there are no transaction costs associated with the selling of the good. The n sellers are located in a neighborhood (to be defined later); and since there are many such neighborhoods in the economy, the aggregate demand that the single neighborhood (the group of the n sellers) faces is highly elastic. (We may think of the international demand from the point of view of a small country.) I shall actually assume that the aggregate demand is infinitely elastic at a random price θ, where θ may take two values: θ_1 or θ_2 ($\theta_2 > \theta_1$) with equal probability of occurrence, as in Figure 1. It is assumed that all sellers maximize expected profits.

Before the opening of the market (Saturday) each seller can buy information, at the cost of x dollars, about the actual realization of θ. Then, sellers place advertisements which state the dollar price of their merchandise in the local newspaper. The newspaper is then published and sellers may costlessly observe the prices advertised by other sellers in their neighborhood. Based on this observation, they may wish to revise their prices. In this case, they will place new advertisements and a new issue of the newspaper will appear. The process comes to an end when no one wishes to make a further revision of his price. The final issue of the newspaper is circulated all over the economy. It is assumed that the above process does not take real time, and the final issue appears at the beginning of the period (Sunday). It takes one period to transmit information about final prices to buyers all over the economy. At the end of the period (Friday), actual trading takes place at the final prices. (The assumption that actual transactions take place at the final or equilibrium prices is also used by Walras. Here, however, sellers replace the auctioneer in determining the final prices.)

The good must be sold at the end of the period. Otherwise, it will evaporate. This constraint does not allow enough time for buyers to engage in an extensive search and, therefore, it is impossible to sell the good without advertising a price in the newspaper. It is also assumed that it is impossible to buy information about the realization of θ after the first issue of the local newspaper appears. The assumption of a lag in transmitting information about prices to buyers implies that during the period sellers cannot change prices.

The payoff matrix for the individual seller is:

	$\theta = \theta_1$	$\theta = \theta_2$	expected profit
$p = \theta_1$	θ_1	θ_1	θ_1
$p = \theta_2$	0	θ_2	$\theta_2/2$

Table 1

where p is the seller's final price, and the expected profits are calculated on the basis of the prior distribution of θ.

I start by analyzing the case in which $\theta_2 < 2\theta_1$. Thus, on the basis of the prior distribution of θ, it is optimal to announce the lower price θ_1. The seller's main problem is whether to buy the information about the realization of θ. As a first step for solving this problem, I shall characterize a Nash strategy 1/ with respect to the behavior of sellers after the opening of the market (i.e., after the decision whether to buy the information was already made).

Claim 1: The following is a Nash strategy: (a) if you have bought the information and observed $\theta=\theta_i$, advertise the price $\theta_i (i=1,2)$; (b) if you have not bought the information, advertise the price θ_1 unless you observe that the price θ_2 has been advertised. In this case, advertise the price θ_2.

To prove this claim, note that θ_2 will be announced if and only if someone has actually observed $\theta = \theta_2$. If no one has observed $\theta = \theta_2$, then the assumption that $\theta_2 < 2\theta_1$ implies that it is optimal to announce θ_1. Note that the final price is the same for all the n sellers.

Armed with Claim 1, we can compute the expected profit when buying and when not buying the information. If seller j buys the information, he will announce the observed realization θ_i. The expected profit in this case is

(1) $$r_j = \theta_2/2 + \theta_1/2 - x = \bar{\theta} - x,$$

where x is the price of information and $\bar{\theta}$ is the expected value of θ. If seller j does not buy the information, he may still reap the benefits if some other seller buys the information.

Assume that seller j believes that other sellers buy information independently of each other, each with probability q. The subjective probability that no other seller will buy the information is thus

(2) $$(1-q)^{n-1}.$$

Since Claim 1 implies that the final price is the same for all sellers, $\bar{\theta}$ is the expected revenue if at least one seller has bought the information (this will occur with probability, $1-[1-q]^{n-1}$). And θ_1 is the revenue if no one has bought the information (this will occur with probability $[1-q]^{n-1}$). The expected profits of seller j when he does not buy the information are thus

(3) $$R_j = [1-(1-q)^{n-1}]\ \bar{\theta} + \theta_1(1-q)^{n-1}.$$

Finally, if seller j decides to buy the information with probability q_j his expected profit will be

(4) $$\pi_j(q_j,q) = q_j r_j + (1-q_j)R_j.$$

Taking a partial derivative of (4) leads to:

(5) $$\frac{\partial \pi_j}{\partial q_j} = (\bar{\theta} - \theta_1)(1-q)^{n-1} - x.$$

$(\bar{\theta} - \theta_1)$ is the increase in expected revenue that each seller will experience if at least one seller buys the information. I shall therefore refer to this term as the collective value of information per seller (CVI). When this term is multiplied by the probability that no other seller will buy the information, we get the increase in expected revenue that an individual seller will experience if he buys the information or the private value of information (PVI). (Note that PVI $\leq$ CVI.) The derivative (5) tells us that when the private value of observing θ is greater than the cost of doing so,

$(\partial\pi_j/\partial q_j > 0)$, the seller will choose $q_j = 1$. When PVI < x the seller will choose $q_j = 0$ and when PVI = x the seller will be indifferent with respect to the choice of q_j.

To characterize an equilibrium in this environment I shall define the probability q* to be a Nash solution if given $q_i = q^*$ for all $i \neq j$, $q_j = q^*$ is optimal for seller j, where j = 1, ..., n. The possible Nash solutions are:

(6) $\qquad$ if CVI < x, then q* = 0

(7) $\qquad$ if CVI $\geq$ x, then $q^* = 1 - (\frac{x}{CVI})^{1/(n-1)}$

where CVI = $\bar{\theta} - \theta_1$. Substituting (6) into (5) leads to $\partial\pi_j/\partial q_j < 0$ for all j, and substituting (7) into (5) leads to $\partial\pi_j/\partial q_j = 0$ for all j, thus q* is optimal from the point of view of all sellers. Note that under (7), q* goes to zero when n goes to infinity. Thus, the typical seller is uninformed.[2/]

The probability that no one will buy the information is given by

(8) $\qquad (1-q^*)^n = \min[(\frac{x}{CVI})^{n/(n-1)}, 1]$,

and is strictly positive.[3/] Thus, the final price in a given neighborhood does not always reflect updated information. This result requires only a positive cost for obtaining information about changes in demand. It does not require any restrictions on the magnitude of this cost. The intuition is that a strictly positive probability of a "market failure" is required to maintain an incentive to buy information. Therefore, this result seems to be quite general and model free. The general result, rather than the specific details of the calculation of the above probability, provides the basis for the macro discussion in section III.

In the case where $\theta_2 \geq 2\theta_1$, it is optimal under the prior distribution of θ to advertise θ_2 rather than θ_1. Therefore

Claim 2: When $\theta_2 \geq 2\theta_1$, then the following is a Nash strategy: (a) if you have bought the information and observed $\theta = \theta_i$, advertise the price $\theta_i (i=1,2)$; (b) if you have not bought the information, advertise the price θ_2 unless you observe that the price θ_1 has been advertised. In this case, advertise the price θ_1.

To prove this claim, note that θ_1 will be announced if and only if someone has actually observed $\theta = \theta_1$. If no one has observed $\theta = \theta_1$, then the assumption that $\theta_2 \geq 2\theta_1$ implies that it is optimal to announce θ_2.

The probability q* can be calculated in a way which is similar to the calculations for the case $\theta_2 < 2\theta_1$. In general, I shall refer to the case in which on the basis of the prior distribution of θ it is optimal to advertise the lower price ($\theta_2 < 2\theta_1$, in the above example) as regime A and to the case in which on the basis of the prior it is optimal to advertise the higher price as regime B.

III. Equilibrium

The above analysis allows for a single seller to have a noticeable influence on the probability distribution of the final price. For example, the distribution will be different if he buys the information with certainty, since in this case the final price which is advertised by all the n sellers will always be based on updated information.

This departure from the usual interpretation of competitive environment led to a model in which sellers are located in many markets or neighborhoods (Eden [1981]). Each seller can observe the prices which were advertised in his own neighborhood before he commits himself to a final price, but he can observe the final prices which were advertised in other neighborhoods only after he is committed to a final price. Thus, each neighborhood is an information network rather than a geographical location. The individual seller may effect the distribution of the final price only in his own neighborhood. Since each neighborhood is small relative to the entire economy, the individual's influence on the economy-wide distribution of final prices is negligible. In this sense, a model with many information networks (neighborhoods) describes a competitive environment. The many neighborhoods assumption also simplifies the analysis, since it implies that the demand from the point of view of each neighborhood is infinitely elastic. (This is the assumption which is used in section II. For the analysis of a case of downward sloping demand curve, see appendix 2 in Eden [1981].)

Here I will use this set-up to study the real effects of money on output and employment. The purpose is to show that depending on the choice of a parameter that governs the evolution of the money supply, the model can produce two regimes. Under regime A, it can generate a positive relationship between money and output, but no involuntary unemployment. Under regime B, it can generate a positive relationship between money and employment, allowing for involuntary unemployment. I shall provide an informal discussion. For a more rigorous analysis in the context of an overlapping generations model, see Eden (1980).

There are N identical buyers. (In the above-mentioned overlapping generations model, buyers are members of the old generation.) N is large and will be treated as a real number. At the beginning of period t, each buyer holds M_{t-1} dollars. At the end of period t (Friday), each buyer may get a transfer payment of $(\alpha-1)M_{t-1}$ dollars, $(\alpha>1)$. It is assumed that either all buyers get a transfer payment or no one gets it. The probability of a transfer payment is 1/2. Thus, the money supply at the end of period t, NM_t, is either $NM_t = NM_{t-1}$ or $NM_t = \alpha NM_{t-1}$. It is assumed that changes in the money supply are the only source of uncertainty and that at the beginning of period t, the probability distribution of M_t is known. Further, it is possible to buy information about the realization of M_t at the beginning of the period (Saturday). This may be done by "bribing" a politician to let you know whether a transfer payment is being planned.[4/]

At the end of the period, buyers exchange some or all of their nominal balances for a single consumption good. The demand of each buyer is given by

(9) $$d(P_t, M_t)$$

where P_t is the dollar price of consumption and M_t is his holdings of nominal balances. It is assumed that (9) is homogeneous and we can therefore define

(10) $$D(P_t/M_t) \equiv d(P_t/M_t, 1).$$

There are H identical producer-sellers. (In the overlapping generations model, it is assumed that sellers are members of the young generation.) H is large and will be treated as a real number. There is a one period lag in production, and production decisions are made at the beginning of the period. It is assumed that if the seller knows (with certainty) that he will sell at his advertised price P_t, and he knows (with certainty) that the realization of the money supply is NM_t, he will produce

(11) $$s(P_t, M_t)$$

units of consumption. It is assumed that s( ) is homogeneous and we can therefore define

(12) $$S(P_t/M_t) \equiv s(P_t/M_t, 1).$$

It is further assumed that under conditions of uncertainty the seller will use all the information which is available to him at the beginning of the period to compute some (weighted) average, $\overline{P_t/M_t}$, and supply according to

(13) $$S(\overline{P_t/M_t}).$$

Thus, $\overline{P_t/M_t}$ is a certainty equivalent. It will also be referred to as a "real" price. I shall use $P_t/\overline{M}$ to denote the average of P_t/M_t when the seller is certain that he will sell at his advertised price, but is uncertain with respect to a money supply. In this case, $\overline{M}$ is some average of M_{t-1} and αM_{t-1}.

The specification in (13) assumes that some average of P_t/M_t is a sufficient statistic for the purchasing power of P_t dollars in the future. This is true, for example, in the overlapping generations model which is used in Eden (1980). In this model, individuals live for two periods, work in the first period, and consume only in the second period. Members of the old generation get the transfer payment in proportion to their holdings of nominal balances. Since in equilibrium the old generation spends all its money, one who holds 1% of the current money supply will be able to buy, on average, 1% of future output. It is also assumed that the money supply is serially independent and, therefore, in equilibrium, output is serially independent. Thus, evaluating $1 as a percentage of the current money supply is a sufficient statistic for its purchasing power in the future.

The sellers are distributed over many neighborhoods, n sellers per neighborhood. The number of sellers in each neighborhood, n, is large. Each seller can observe the prices which are advertised in his neighborhood at the beginning of the period (Sunday), before he commits himself to a final price. There is a one period lag in transmitting information about prices to buyers and to sellers in other neighborhoods. (Thus, each seller must advertise a final price at the beginning of the period.) Sellers make production decisions after observing the final price in their neighborhood (Monday) and take it into account when computing the "real" price. At the end of the period, information about prices (all over the economy) is costless. Transactions are costless. Buyers are served on a first-come, first-served basis, and there is no rationing for those who actually get served. Thus, whenever there is more than one price, all buyers will try to buy at the cheapest price, but typically not all of them will succeed.[5/]

In equilibrium, each seller views the aggregate demand that his neighborhood faces as infinitely elastic at a price, P_t, which is contingent on the money supply, and is given by

(14) $$P_t = P_1, \text{ if } M_t = M_{t-1}; \text{ and}$$
$$P_t = P_2, \text{ if } M_t = \alpha M_{t-1}.$$

At the beginning of the period (Saturday), it is possible to buy information about the realization of the (end of period) money supply. Given (14), the process of advertising prices is carried out in each neighborhood separately in the way which is described in the previous section (where here P_i plays the role of θ_i). The Nash strategy which characterizes this process dictates to each seller to buy the information about the realization of M_t with some probability, q^*. The probability that no one in a given neighborhood will buy the information is given by

(15) $$1-\mu = (1-q^*)^n.$$

Thus, $1-\mu$ is the fraction of uninformed neighborhoods (where a neighborhood is uninformed if no one of its n sellers has bought the information). Since we have a large number of neighborhoods, I shall use the law of large numbers and assume that μ is non-random. I shall also assume that information is not prohibitively expensive and therefore $0 < \mu < 1$.

I shall start from regime A in which (α is not large and, therefore) on the basis of the equilibrium expectations (14) it is optimal to advertise the lower price P_1. (This case is analogous to the case $\theta_2 < 2\theta_1$ in section II.) Under this regime, the Nash strategy is similar to the one in Claim 1. It implies that P_1 will be advertised if either no one in the neighborhood has bought the information or someone has bought it and observed $M_t = M_{t-1}$. Therefore, when $M_t = M_{t-1}$, all neighborhoods (informed and uninformed) will advertise the price P_1, but only the sellers who have bought the information will know the realization of M_t. Since when n is large (7) implies that q^* is small, the fraction of sellers who have actually bought the information is negligible. We can therefore assume that almost all sellers will use some average, $\overline{M}$, of M_{t-1} and αM_{t-1} as a deflator and will supply a total of $HS(P_1/\overline{M})$. The supply of the informed sector is thus $\mu HS(P_1/\overline{M})$ and the supply of the uninformed sector is $(1-\mu)HS(P_1/\overline{M})$.

It is assumed that P_1 clears the market for the case $M_t = M_{t-1}$. Thus, $HS(P_1/\overline{M}) = ND(P_1/M_{t-1})$; the informed sector satisfies the demand of μN buyers and the uninformed sector satisfies the demand of $(1-\mu)N$ buyers. This is illustrated by Figure 2, where Q_o^u is the quantity supplied by the uninformed sector and Q_o^I is the quantity supplied by the informed sector.

Note that market clearing rationalizes the sellers' expectations with respect to the demand that each neighborhood will face when $M_t = M_{t-1}$. In particular, since there are many neighborhoods, the sellers in each neighborhood will not be able to sell at $P > P_1$, and will be able to sell all their supply at the price P_1.

When $M_t = \alpha M_{t-1}$, informed neighborhoods will advertise P_2 while uninformed neighborhoods will advertise P_1. The uninformed sector will supply the same quantity as before; but since their price in terms of percentage of M_t is now lower $(P_1/\alpha M_{t-1} < P_1/M_{t-1})$, each buyer will demand a larger quantity. The number of buyers that the uninformed sector will satisfy, N^*, is therefore smaller than before (i.e., $N^* < (1-\mu)N$). This is illustrated by Figure 3. The remaining N-N* buyers will have to go to the informed sector and buy at the higher price.

At the beginning of the period, sellers in the informed sector know that $M_t = \alpha M_{t-1}$, since P_2 is advertised only if someone has observed this realization. The informed sector will therefore supply $\mu HS(P_2/\alpha M_{t-1})$ units. It is assumed that P_2 clears the residual market; that is, $(N-N^*)D(P_2/\alpha M_{t-1}) = \mu HS(P_2/\alpha M_{t-1})$ as in Figure 4. This assumption rationalizes the sellers' expectations with respect to the demand in the case $M_t = \alpha M_{t-1}$. In particular, since there are many informed neighborhoods, each individual neighborhood will not be able to sell at $P > P_2$, but will be able to sell its entire supply at P_2.

Thus, the above is a description of equilibrium in the sense that expectations are correct and agents do not have an incentive to deviate from the equilibrium strategy. In particular, uninformed sellers do not have an incentive to become informed. (A formal definition of equilibrium is attempted in Eden [1980, 1981].)

To show that the output of the informed sector is higher when $M_t = \alpha M_{t-1}$, note that market clearing for the case $M_t = M_{t-1}$ implies

(16) $$Q_o^I = \mu ND(P_1/M_{t-1}) = \mu HS(P_1/\overline{M}).$$

Homogeneity implies that

(17) $$Q_o^I = \mu ND(\alpha P_1/\alpha M_{t-1}) = \mu HS(\beta/\alpha M_{t-1})$$

where $\beta = \alpha P_1 \frac{M_{t-1}}{\overline{M}}$. Since $\frac{M_{t-1}}{\overline{M}} < 1$, it follows that $\beta < \alpha P_1$. Thus, Q_o^I will be supplied at a price which is less than αP_1 (Figure 4). Since $N-N^* > \mu N$, Q_o^I will be demanded at a price which is higher than αP_1. Therefore, the intersection of supply and demand is at $Q_1^I > Q_o^I$.

To get some further insight, let us consider Figure 5 in which the "real" price, P/M, is plotted on the vertical axis. When $M_t = M_{t-1}$ almost all the suppliers are not sure about the realization of the money supply and they deflate by $\bar{M} > M_{t-1}$. Therefore, they see a lower real price than the buyers. This discrepancy is eliminated when $M_t = \alpha M_{t-1}$ and the suppliers in the informed sector are able to infer the realization of the money supply. Thus, even if the informed sector faced the same real demand, the equilibrium quantity would increase (to Q'). The increase from Q' to Q_1^I is due to the spillover from the uninformed sector, which leads to an increase in the real demand.

To sum up, the production of the uninformed sector does not depend on the realization of the money supply, while the production of the informed sector is higher when $M_t = \alpha M_{t-1}$. This implies a positive relationship between money and total production.

Regime B is defined as the case in which (the parameter α is large and therefore) on the basis of the equilibrium expectations (14), it is optimal for uninformed sellers to advertise the higher price P_2. This case is analogous to the case $\theta_2 \geq 2\theta_1$ in section II, and the relevant Nash strategy is stated by Claim 2. It implies that when $M_t = \alpha M_{t-1}$, all neighborhoods advertise P_2, and almost all sellers will not be able to infer the realization of M_t.6/ The typical seller will therefore expect to get either a real price of $P_2/\alpha M_{t-1}$ or zero. He will supply $S(\emptyset P_2/\alpha M_{t-1})$ units, where $0<\emptyset<1$ and $(1-\emptyset)$ are the weights that he uses to compute the average real price.7/ The equilibrium solution for the case $M_t = \alpha M_{t-1}$ is described by Figure 6, where the informed sector produces q_o^I and the uninformed sector produces q_o^u. When $M_t = M_{t-1}$, the uninformed sector will not be able to sell at the price P_2, and the informed sector will therefore face the entire demand. The price P_1 should therefore satisfy $ND(P_1/M_{t-1}) = \mu HS(P_1/M_{t-1})$ as in Figure 7. Again, homogeneity can be used to show that q_o^I will be supplied at a price which is lower than P_2/α and will be demanded at a price which is higher than P_2/α. Therefore, the equilibrium output in the informed sector must increase (i.e., $q_1^I > q_o^I$).

Also in this regime the increase in output in the informed sector occurs when (ex post) the uninformed sector makes a mistake. The reasons for the increase in output are also similar: (a) the sellers can infer the realization of the money supply; this eliminates the discrepancy between the real price that the sellers act upon and the real price paid by the buyers; and (b) there is an increase in real demand due to the inability of the uninformed sector to sell at its advertised price. Both reasons are illustrated in Figure 8, where the real price, P/M, is plotted along the vertical axis.

However, under regime B, when the uninformed sellers make a mistake, they do not sell at all. Therefore, the effect of money on the total amount sold is ambiguous and depends, in general, on the elasticities of supply and demand and the cost of information.

A slight change in the assumptions of the model can generate involuntary unemployment. If, for example, sellers in uninformed neighborhoods learn at some point during the period that they have made a mistake in advertising the high price, but they do not have enough time to transmit a new price to the buyers, they will quit working. In the case of storable goods, it is also fairly easy to see how regime B can be used to generate involuntary inventories.

Discussion and Conclusions

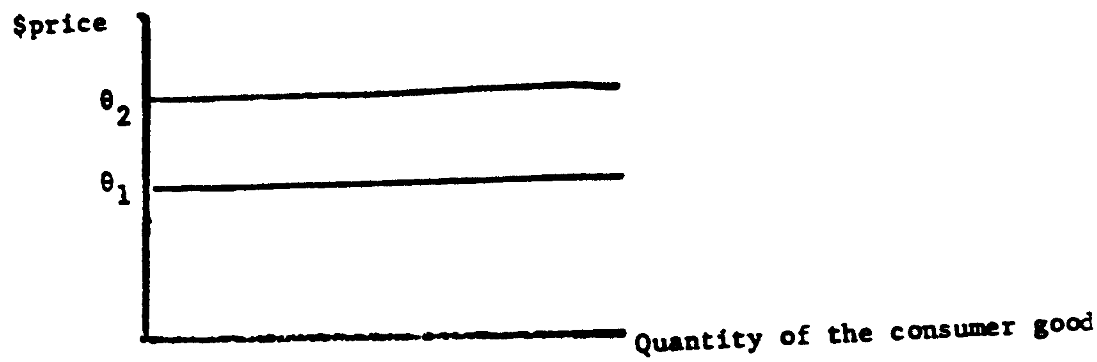
The model applied the result that the price advertised in a particular market (neighborhood) cannot always be based on updated information to the case in which the source of uncertainty is in changes in the money supply. To summarize, I define the anticipated money supply as the level which is implicitly assumed by uninformed sellers when they advertise their price (i.e., M_{t-1} under regime A and αM_{t-1} under regime B). Further, I define normal output as the output which corresponds to the anticipated level of the money supply. Then, if the money supply is different from its anticipated level, the informed sector will realize the return on information and face a higher real price. This will lead to an increase in production. If the money supply is above its anticipated level, the uninformed sector will sell its normal output (regime A). If the money supply is below its anticipated level, the uninformed sector will not sell at all (regime B). The effect of money on total output is thus positive under regime A and ambiguous under regime B. The second regime can be used for constructing models of involuntary unemployment in which the effect of money on employment is positive.

The equilibrium concept uses rational expectations. Given these expectations, agents cannot do better than following the equilibrium strategy with respect to advertising prices. In particular, *ex ante*, uninformed sellers cannot do better by becoming informed. The equilibrium concept does not use an auctioneer.

It seems that the above analysis is some mixture of Lucas (1972) and the Keynesian model. As in Lucas' model, we can have a positive effect of money on output under rational expectations. Here, however, this effect does not require real shocks, it does not require the assumption that transaction costs prohibit trade between different neighborhoods (islands in Lucas' model), and it does not require the assumption that information about the current money supply is prohibitively expensive. It requires the substitution of the auctioneer by a market mechanism in which sellers, in setting prices, face the choice between following the price advertised in their neighborhood and buying information about changes in demand. It requires some lag in transmitting advertised prices to the buyers. Thus, there is an element of price rigidity. It also requires a strictly positive, but not prohibitive, cost for information about the future (end of period) money supply. As in the Keynesian model, we can have (under regime B) prices which are "too high" and, during the time it takes to transmit new prices, we can have involuntary unemployment. Here, however, prices are endogenous rather than historically given.

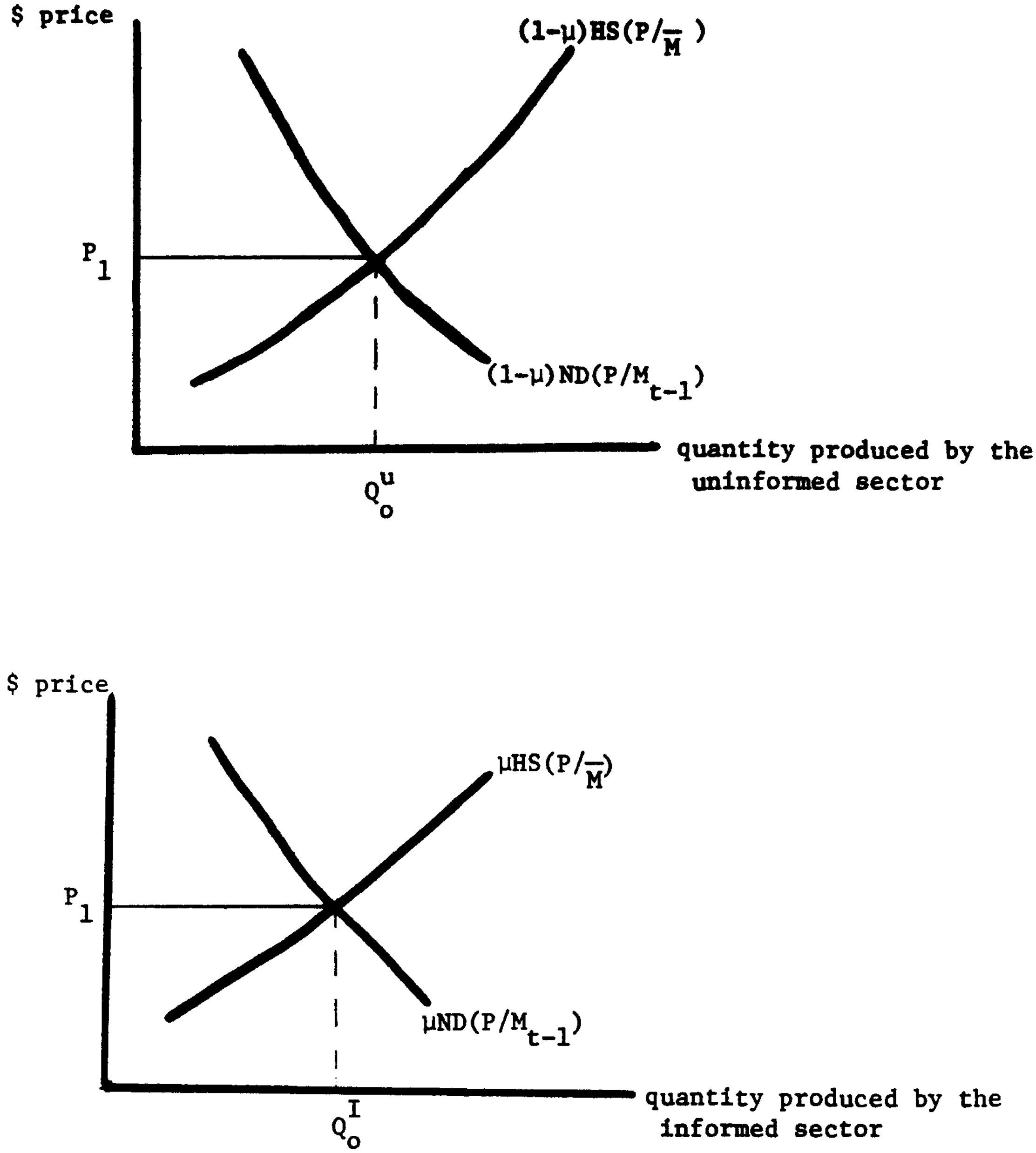
Although the theory is not fully developed, a few implications may be noted at this early stage. The theory implies that the normal output in the economy (the output which is produced when the actual money supply is equal to its anticipated level) is less than the quantity that will be produced when there is no uncertainty about the money supply. The reason is that, in their production decision, sellers take into account the possibility that they may be advertising the "wrong" price although they are, in fact, advertising the "correct" price. This is illustrated in Figures 5 and 8 where the normal output in the informed sector, q_o^I, is less than the output which corresponds to the intersection of supply and demand. This result seems to be in the spirit of Friedman (1977) rather than Barro (1977, 1978).[8/] The theory also implies a positive correlation between the variability of prices and the absolute deviation of the money supply from its anticipated level. This is in line with the findings of Vining and Elwertowski (1976). Another implication is the existence of a correlation between some measure of income distribution and the absolute deviation of the money supply from its anticipated level. In particular, although *ex ante* all are roughly the same, in informed neighborhoods sellers will get a larger share of the pie whenever the money supply is different from its anticipated level.

Finally, it is interesting to note that nothing in the basic argument is specialized to the fact that changes in the money supply are the source of the uncertainty. If the source is in some real disturbance to demand (as in Eden [1981]), we will still have the informed sector producing more and getting a higher payoff whenever the level of the disturbance is different than its anticipated level. (Similarly, when the level of the disturbance is above its anticipated level, the uninformed will produce their normal output, and when it is below the anticipated level they will not be able to sell.) Thus, the theory may be able to account for the so-called "real" business cycles. Whether most business cycles are caused by monetary or real shocks is, of course, an empirical issue.



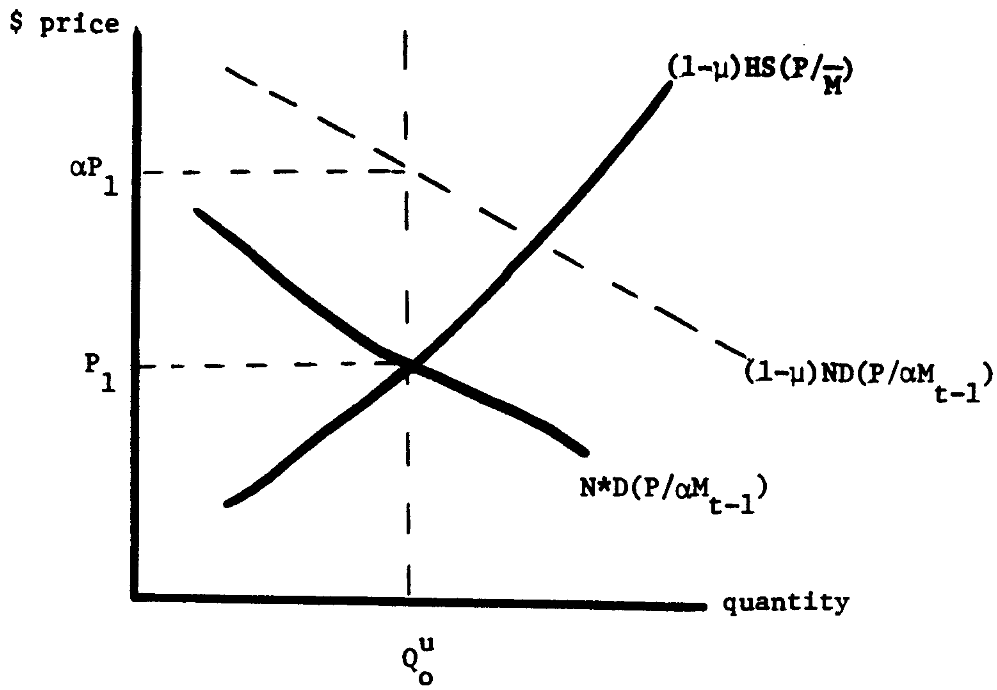
The demand from the point of view
of a small neighborhood.

Figure 1



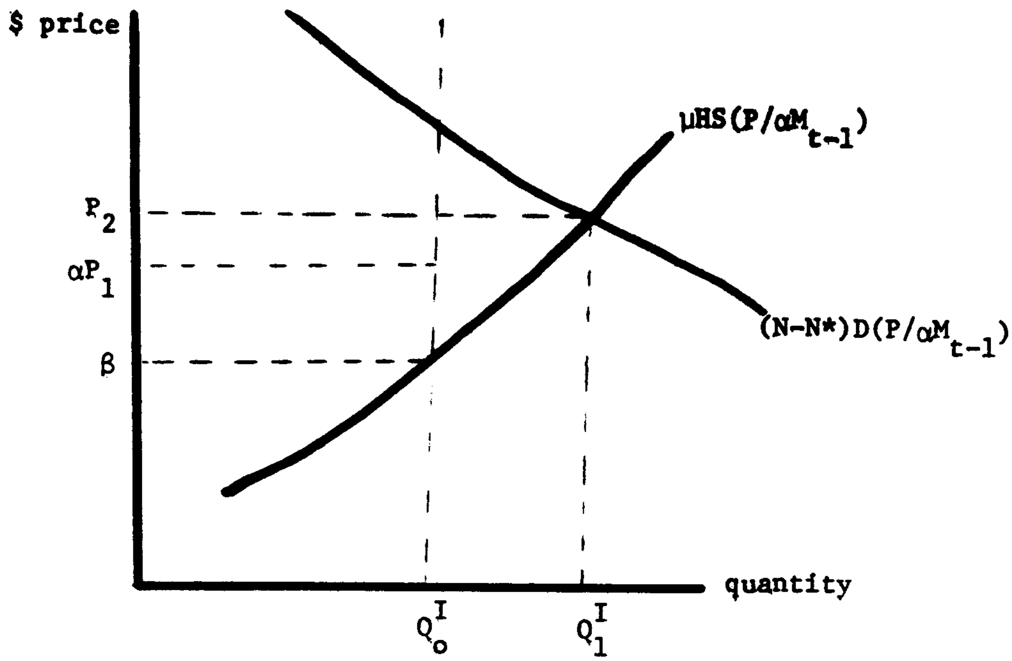
Regime A: equilibrium solution when $M_t = M_{t-1}$.

Figure 2



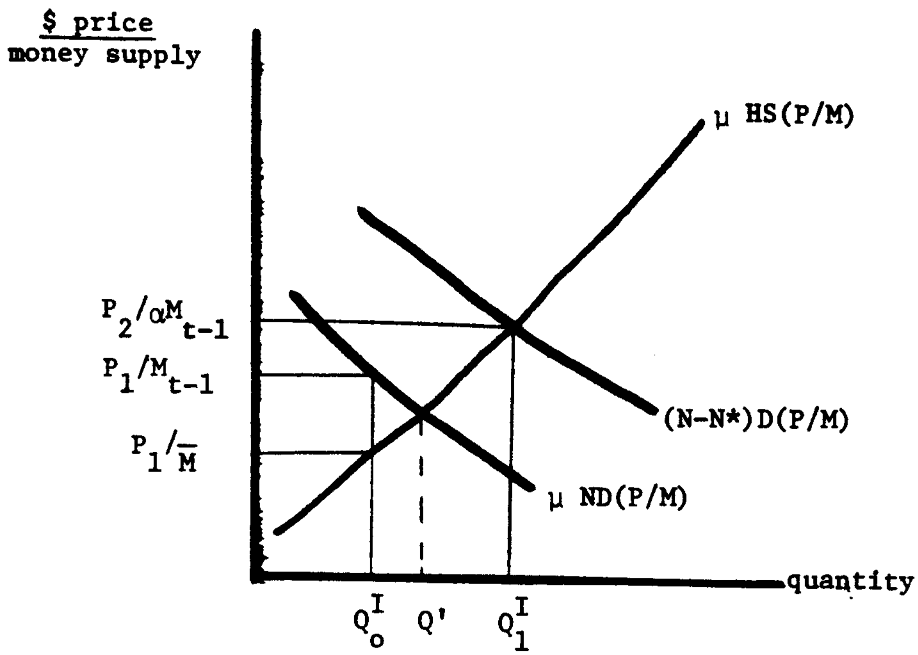
Regime A: equilibrium solution for the uninformed sector when $M_t = \alpha M_{t-1}$

Figure 3



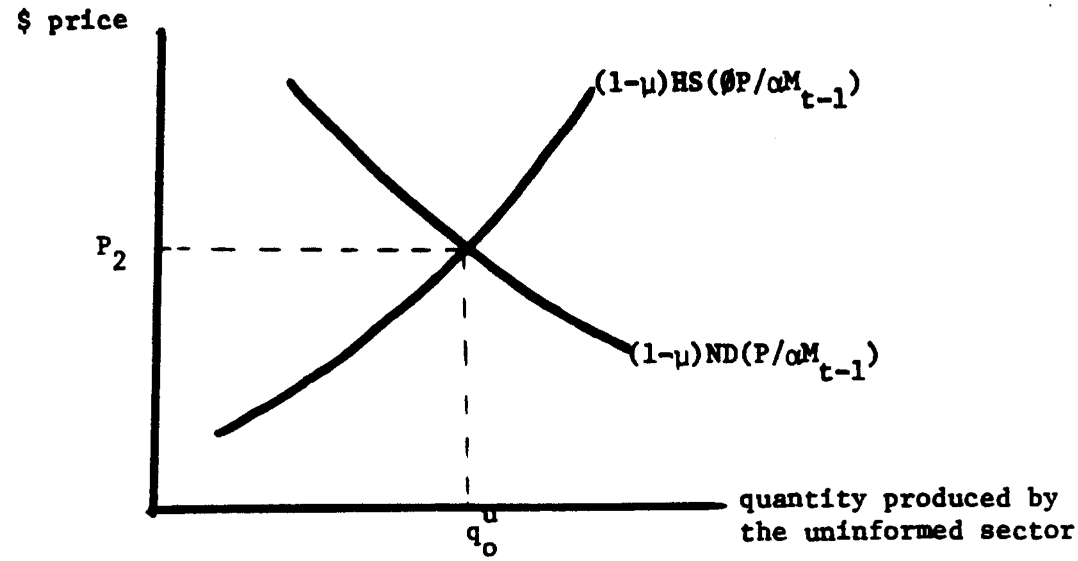
Regime A: equilibrium solution for the informed sector when $M_t = \alpha M_{t-1}$

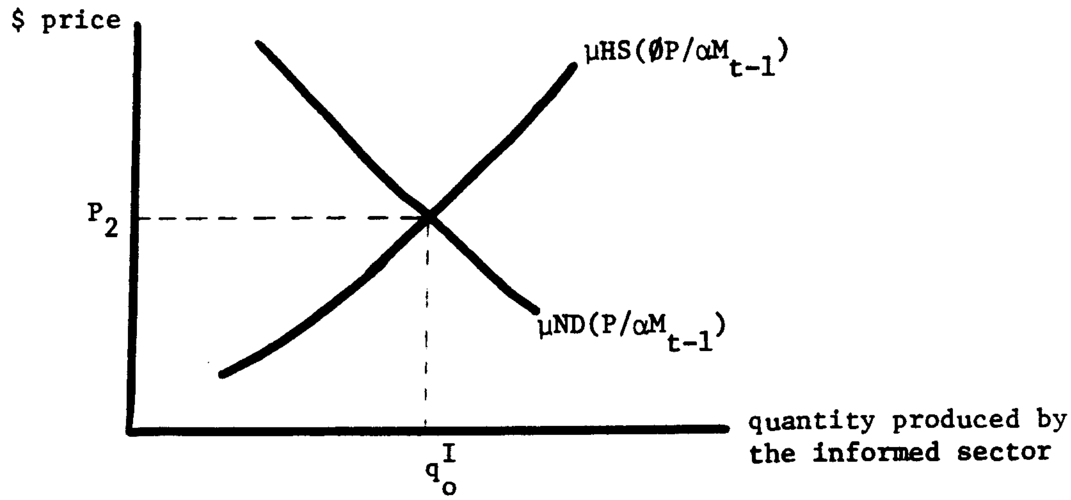
Figure 4



Regime A: Equilibrium solution for the informed sector in terms of "real" prices. Q_o^I is produced when $M_t = M_{t-1}$ and Q_1^I is produced when $M_t = \alpha M_{t-1}$.

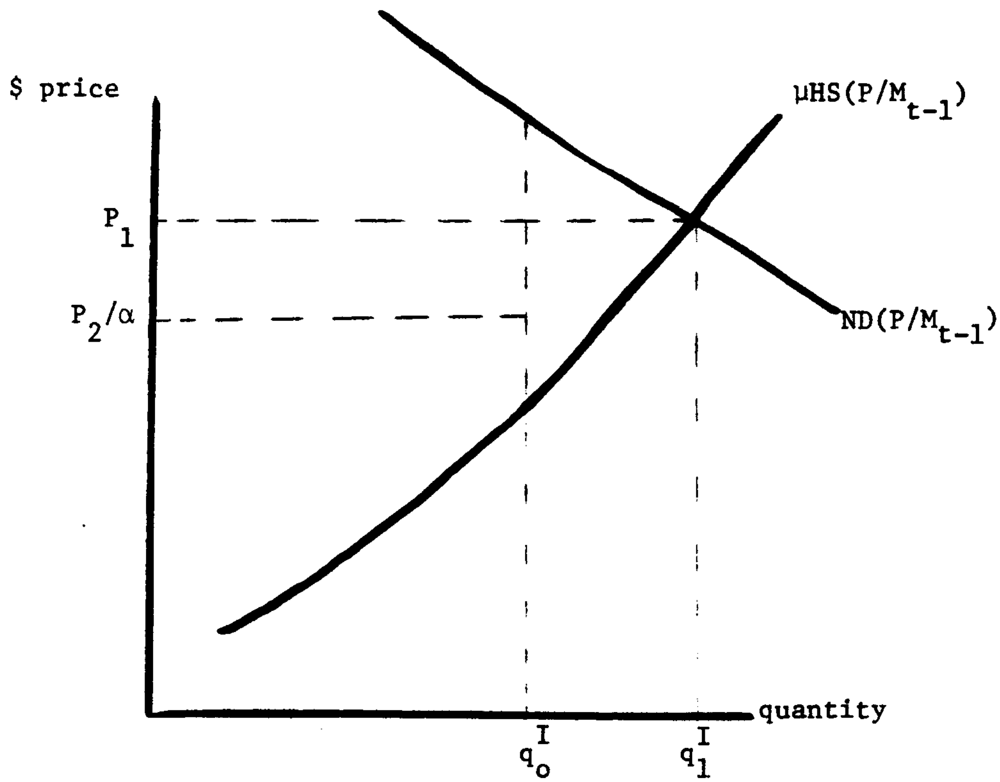
Figure 5





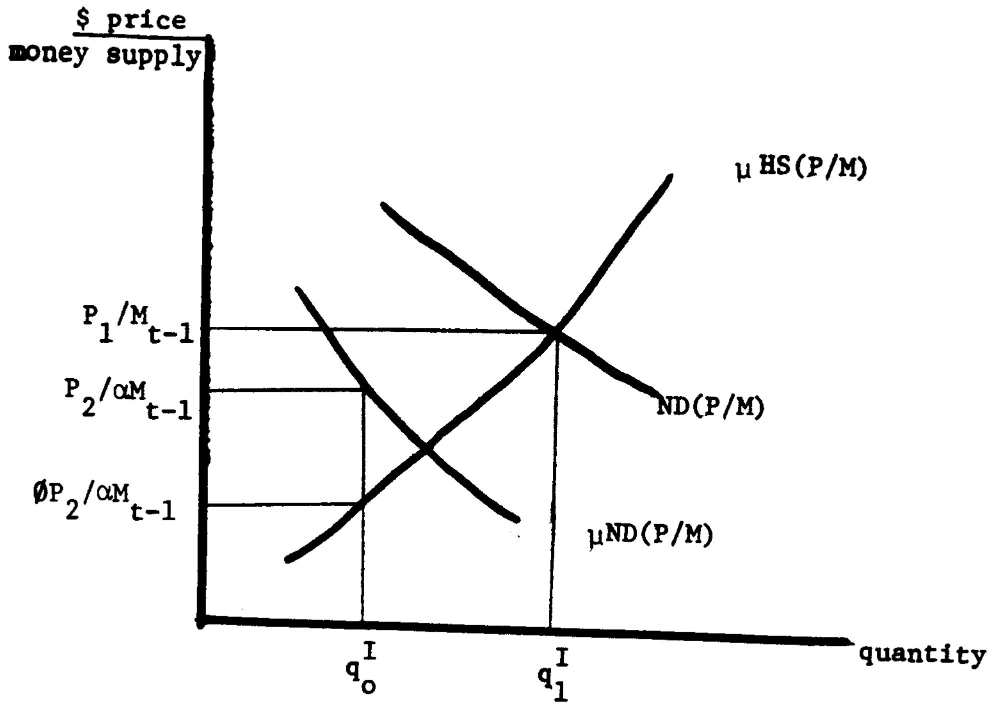
Regime B: equilibrium solution when $M_t = \alpha M_{t-1}$

Figure 6



Regime B: equilibrium solution for the informed sector, when $M_t = M_{t-1}$

Figure 7



Regime B: equilibrium solution for the informed sector in terms of "real" prices. The quantity q_o^I is produced when $M_t = \alpha M_{t-1}$ and the quantity q_1^I is produced when $M_t = M_{t-1}$.

Figure 8

FOOTNOTES

1/ If all other sellers follow a Nash strategy, it is optimal for the individual seller to do the same.

2/ For a similar result in a different model, see Barro (1979).

3/ Under (6) the probability in (8) is unity. Under (7) this probability is strictly positive and when n goes to infinity, it approaches the limit x/CVI.

4/ It is more realistic to assume that by investing resources you can get a signal rather than the actual realization. I do not expect that the basic result will be sensitive to this modification.

5/ It is assumed that some random mechanism determines who will actually buy at the cheapest price. A more complete model may use differential search costs.

6/ Since q* is small, most sellers in any neighborhood will not observe M_t directly. They will not know whether P_2 was advertised because no one in their neighborhood has bought the information, or because someone has actually observed $M_t = \alpha M_{t-1}$.

7/ In the case of risk neutrality, $\emptyset$ is the probability that $M_t = \alpha M_{t-1}$ given that the final price in the neighborhood is P_2.

8/ See Leijonhufvud (1980) for a more general discussion on the effect of random money supply on (normal) output.

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