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Price Contracts, Output, and Monetary Disturbances

I. Introduction

The notion that prices are somewhat sticky in a downward direction and that output is determined by demand and not directly by supply play prominent roles in "Keynesian" macroeconomics. Yet the rationale for sticky prices has proved elusive. Indeed, the language of "sticky prices" is loaded: rather than asking about the consequences of sticky prices, it would be better to ask about the consequences of specific circumstances which lead people to *choose* to trade at prices that have particular characteristics (or responses to exogenous disturbances).[1] Many macroeconomic models simply assume that prices are sticky without investigating the causes of that stickiness. However, there are examples in which the same circumstances that cause prices to be sticky are known also to cause people to alter their other choices, e.g., about quantity-determination, in such a way as to change the equilibrium.[2]

One expects this to be a general phenomenon: if restrictions are imposed that prevent people from trading at certain prices, the restrictions also motivate people to alter their behavior so as to minimize the effects on their own welfare. People will choose to consume different quantities of other goods or leisure (as in the literature on "effective demand"). In a world of uncertainty, people will also choose different portfolios of assets

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[1]Having said this, I will revert to the usual language in order to avoid semantic disputes.

[2]See for example Barro (1976).

in response to these restrictions, because the restrictions change the probability distribution of the real returns to assets. Contractual arrangements can be thought of as assets and subjected to asset-pricing formulas. A desire to rationalize sticky prices and determine the effects of various disturbances in their presence was one of the motivating forces behind the development of the recent literature on contracts following Baily (1974) and Azariadis (1975).[3] Most of the literature on contracts, however, employs real models in which money and nominal prices play no role.

This paper develops a model in which money plays a critical role in transactions—using a cash-in-advance constraint[4]—and in which households would like to insure against fluctuations in the real value of their nominal money balances. But explicit insurance markets to accomplish this task are unavailable. Contracts between buyers and sellers are shown to be a partial substitute for these insurance markets. Specifically, the paper presents an example with contracts that (a) specify nominal prices that do not vary in proportion to changes in the money supply, (b) involve variations in output when the money supply changes, and (c) dominate spot market equilibrum in terms of households' expected utility. In the example, a fall in the money supply produces a smaller percentage fall in nominal prices and a fall in output. Though prices are, in that sense, partly sticky in a downward direction, they are not sticky in an upward direction.

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[3]Stiglitz (1984) provides a critical survey of that literature. Also see Rosen (1985).

[4]See Clower (1967) and Lucas (1980). Kohn (1981) and (1984) surveys the constraint from historical perspective and discusses the recent abundance of research making use of the constraint.

Section II of the paper presents the model and examines spot market equilibrium. Section III discusses determination of output and prices under the specified contracts and examines the effects of monetary disturbances. Section IV contains some further comments.

II. Spot Market Equilibrium in a Simple Monetary Model

Consider an economy with a continuum of households indexed by their point-of-origin along the (0, 1) interval. Household move costlessly to locations on the (1, 2) interval, where all trades take place. Each household is a price-taker and maximizes discounted expected utility of consumption and leisure over its two-period life.

$$(1) \quad E[U(c) + W(1 - L) + \beta U(c') + \beta W(1 - L')]$$

where c and c' are first- and second-period consumptions, and L and L' are labor supplies. Assume $\beta \in (0, 1)$ and that, for constant r and R,

$$(2a) \quad U(c) = \frac{c^{1-r}}{1-r}$$

and

$$(2b) \quad W(1 - L) = \frac{-k}{1+R} L^{1+R}.$$

One unit of labor produced one unit of the consumption good. Workers never consume their own output (perhaps because of social taboo or because of some physical impossibilities such as that of a person watching—live—a sporting event in which he participates). I also assume that each seller has a representative sample of the population as his customers.

The budget constraint facing each household is

$$(3) \quad M + \tau + P(L-c) - M' - \alpha' q = 0$$

where

M = nominal money held at the beginning of the period, before transfers

τ = nominal lump-sum transfer payment of money received at the beginning of the period

α' = vector of (non-money) financial assets at the end of the period

q = vector of nominal prices of (non-money financial assets

P = price of goods in period one

M' = money holdings at the end of period one

In addition to the budget constraint, each household faces a cash-in-advance constraint of the form

$$(4) \quad M + \tau \geq Pc.$$

In the second period, there is an analogous budget constraint and cash-in-advance constraint

$$(5) \quad M' \geq P'c'$$

where P' is the nominal price of goods in the second period.

The model involves an artificial "final period" problem common to finite horizon monetary models. To deal with this problem, I assume that a perfectly enforced law required people to work an exogenously determined L' hours in the second period, and to sell the output for money.

Any attempt to obtain real effects of changes in the money supply must rely on some real disturbance that is proximately associated with the monetary change (to avoid real effects of a costless currency reform). One natural candidate for a real change associated with a monetary change is a wealth redistribution. Transfer payment financed by new money may not be distributed in proportion to money balances; open market purchases redistribute wealth from money-holders to people whose future tax liabilities are reduced by the fall in government debt; expansion of bank reserves at a below-market discount rate redistributes wealth from taxpayers to the recipients of the subsidized loans. In order for these channels of wealth redistribution to operate, capital markets must be incomplete (or costly to trade in) since otherwise individuals could perfectly hedge against such redistributions. The magnitudes of these wealth redistributions, however, are small empirically and seem unable to account for the phenomena we want to explain.[5]

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[5] One reaction to the small magnitude of the wealth redistribution caused directly by a monetary expansion is to seek a more indirect relation. Grossman, Hart, and Maskin (1983) argue that because a large fraction of assets are held in the form of nominal debt, and because of these and other nominal contracts, monetary changes can produce substantial wealth

Even if monetary changes are associated with wealth redistributions, additional elements of a model are required to explain changes in aggregate output. If tastes are characterized by parallel linear income expansion paths, then a wealth redistribution does not affect even relative prices. Aggregate output may be unaffected even if shifts in relative supplies and demands alter the composition of production. Real mobility costs of labor in this situation could produce a temporary reduction in output and employment in response to a change in the composition of demand. Alternatively, some other explanation such as the asymmetry in optimal labor contracts when workers and firms are differently informed, studied by Grossman, Hart, and Maskin (1983), could be invoked to explain a temporary reduction in output following a shift in the composition of demand.

An alternative channel for real changes associated with monetary disturbances, which does not rely on wealth redistributions, has been discussed by Grossman and Weiss (1983), Rotemberg (1984), and Krugman, Persson, and Svensson (1982). If demand is constrained by liquidity, then monetary disturbances that differentially affect individuals' liquidity can alter the composition of demand and supply. It seems plausible that effects

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redistributions through changes in the price level. They do not, however, explain the existence of these nominal contracts. King and Haubrich (1984) assume that the variance of the distribution of wealth is positively correlated with monetary growth, without specifying the mechanism leading to this correlation (which could reflect an endogenous component of money growth).

of monetary disturbances on liquidity may be substantially larger than the small direct effects on wealth distribution.[6]

Money supply changes will affect liquidity in this model, and the effects will differ across households. Let there be two types of households, in equal number, indexed by j and k. Type j households receive the transfer (or

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[6] In the Grossman and Weiss paper and the Rotemberg papers, monetary disturbances redistribute both liquidity and wealth. Individuals visit financial markets at staggered intervals, as in Jovanovic's (1981) steady state general equilibrium extension of the Baumol-Tobin model, and an open market purchase redistributes wealth from people not currently trading in financial markets ("at the bank") to people who are doing so. The wealth redistribution takes the form of (i) a greater inflation tax on the former group, who currently hold more money than the latter group, and (ii) a change in the time-path of the real interest rate (and capital, in Rotemberg's model) which affects the groups differently because of their different time paths of borrowing and lending. A redistribution of wealth, alone, may not affect aggregate output, the price level, or real interest rates. But the open market purchase also raises the price level and reduces the real money balances of people not currently in financial markets. Since money is required to buy consumption goods, this places a more severe liquidity constraint on demand by the group. The group's current consumption falls by more, as a result of this fall in liquidity, than it would if only wealth were affected. The group with higher wealth (those at financial markets) increases its consumption demand, but by less than the fall in demand by the other group. The fall in aggregate consumption demand (given output, which depends on the predetermined capital stock) leads to an increase in the capital stock (in Rotemberg's model) and a fall in the real interest rate. The price level initially rises less than proportionately to the money stock because of the increased demand of money by the wealthier group (while the less wealthy, liquidity constrained group exhausts its money holdings).

In Krugman, Persson, and Svensson (1982), an exogenous real disturbance increases the wealth of lucky consumers and decreases the wealth of unlucky consumers. But lucky consumers are initially unable to increase their consumption as much as they would if they were not liquidity constrained by their (predetermined) cash balances. Unlucky consumers are not liquidity constrained: they reduce consumption and hold some unspent cash balances. A reduction in the rate of monetary expansion (through lump-sum transfers to all individuals, which cannot be used for current consumption) raises the rate of return on money holding and so leads unlucky consumers to reduce current purchases and save more money for future purchases. This reduction in spending and associated increase in money demand lowers the current price level and, therefore, makes the liquidity constraint on lucky consumers less severe.

pay the tax) τ when the first period begins. Type k households do not receive a transfer or pay a tax. Before the first period begins, it is impossible to determine whether a household is of type j or type k. Moreover, households are effectively able to conceal their type ex-post (unless they choose behavior that reveals it).

Equilibrium in the second period is straightforward. Only (5) constrains consumption, so $c'^{i} = M'^{i}/P'$, where i = j, k. But goods market equilibrium in the second period implies

$$(6) \quad 2L' = c'^{j} + c'^{k},$$

so

$$(7) \quad P' = \frac{M'^{j}+M'^{k}}{2L} \equiv \frac{M^{s}}{2L'}$$

and

$$(8) \quad c'^{i} = 2L' \frac{M'^{i}}{M^{s}} .$$

This period-two equilibrium makes assets other than money worthless in period two, so $\alpha' = 0$.

Households choose c, L and M' to maximize (1) subject to (3)-(5) where t = 0 for k households, so

$$(9) \quad W_1(1 - L) = \beta \frac{2L'P}{M^{s}} U_1 \left[\frac{2L'}{M^{s}} (M + \tau - Pc + PL)\right]$$

$$(10) \quad = U_1(c) - \gamma P$$

Let L^* be the solution to

$$(11) \quad L^* W_1(1 - L^*) = \beta L' U_1(L'),$$

which in the case of (2) is

$$(11') \quad L^* = \left[\frac{\beta}{k} L'^{1-r}\right]^{\frac{1}{1+R}}.$$

Define

$$(12) \quad \omega = 1 + \frac{\tau}{M}, \qquad \omega^i = \begin{cases} \omega & \text{if } i = j \\ 1 & \text{if } i = k, \end{cases}$$

and note that $M^s = M(1 + \omega)$.

Suppose $\gamma^j > 0$, $\gamma^k > 0$. This is guaranteed by

$$(13a) \quad U_1\left[2L^* \frac{\omega}{1+\omega}\right] > W_1(1 - L^*)$$

$$(13b) \quad U_1\left[2L^* \frac{1}{1+\omega}\right] > W_1(1 - L^*),$$

which in the case of (2) reduce to

$$(13') \quad \left[\frac{1+\omega}{2\omega^i}\right]^{r(1+R)} > \beta^{r+R} k^{1-r} L'^{(1-r)(r+R)}, \quad i = j, k.$$

Then $y^j > 0$, $y^k > 0$, $L^j = L^k = L^*$ given in (11'), consumption are

$$(14a) \quad c^j = \frac{2L^* \omega}{1+\omega}$$

$$(14b) \quad c^k = \frac{2L^*}{1+\omega},$$

and

$$(15) \quad P = \frac{M^s}{2L^*}.$$

Expected utility is

$$(16) \quad EU = \frac{1}{2} U\left[\frac{2L^* \omega}{1+\omega}\right] + \frac{1}{2} U\left[\frac{2L^*}{1+\omega}\right] + W(1 - L^*) + \beta U(L') + \beta W(1 - L').$$

Note that the last two terms in (16) are exogenous, and that if the exogenous second-period labor supply L' is set so that L' = L, then (11') implies $L = (\beta/K)^{1/(r+R)}$ and (13') reduces to $((1 + \omega)/2\omega^i)^r > \beta$ which is satisfied for $\beta < 1$ and sufficiently small t, i.e., for

$$(13'') \quad 2\beta^{(1/r)} - 1 < \omega < (2\beta^{1/r} - 1)^{-1}.$$

Despite the liquidity contraints on households' consumption choices and the differential effects on liquidity across households of a change in the money supply, (15) implies that the price level is proportional to the money supply. Relative consumption of type j versus type k households is altered by changes in the money supply as shown by (14), but (11') shows that total output is independent of the money supply. This last result is specific to the two-period example and would change if the horizon were longer. However, the two-period example simplifies the results below on contracts.

III. Price-Contracts with Demand-Determined Output

The spot-market equilibrium is inefficient because households are unable to pool the risk involved in the transfers. If this risk were partly—but not fully—pooled, so that "lucky" households make a payment to "unlucky" households, then the partial insurance arrangements through which these payments are made could be interpreted as a non-neutral effect of money. With imperfect insurance, lucky households will be net purchasers of goods from unlucky households. Because the insurance involves payment from lucky to unlucky households, this payment could be interpreted as part of the price paid by lucky households for goods purchased from unlucky households. The gross price—including these payments—would exceed the spot market price. In the absence of insurance arrangements, households can be made better off by alternative institutional arrangements. For example, suppose buyers and sellers are bound by contracts that specify a price P_1 for the first N units of the good that a household purchases, and a price $P_2 > P_1$ for subsequent units. By appropriate choice of P_1, P_2, and N, one can achieve allocations arbitrarily close to the full-insurance allocation. (Choose N to be the full-insurance spot market price, and make P_2 arbitrarily large. The transfer payments—or unassessed taxes—then have arbitrarily small real value.)

In this paper, I restrict the set of potential contracts to fall within the set in which (a) a price function q is unrelated to the amount a household purchases, and (b) output is demand-determined. Denote output under the contracts by X. The price q is a function of the money supply (and other exogenous variables) and only this function q is to be chosen.

Households live in sets called "neighborhoods" in the (1, 2) interval. A neighborhood is defined by a contract between households and the indentity of the households involved. An "equal rights" law, enforced perfectly and costlessly by the government, requires all (identical, except for place-of-origin on the (0, 1) interval) households in a neighborhood to be treated identically in the contract. Neighborhoods can be treated as sets of points between adjacent rational numbers, so there are infinitely many neighborhoods. An exogenous probability distribution assigns possible contracts to neighborhoods on the (1, 2) interval. Households may move costlessly between neighborhoods before the first period begins.

Within each neighborhood, households sell to one another. The contract defining the neighborhood requires households to buy and sell at the neighborhood price q(n), with sales determined by demand. Obviously, the price must be equal in every neighborhood in which households choose to locate. Moreover, households will choose to locate in the neighborhood(s) with the highest expected utility per household.

Given the contract, each household in a neighborhood chooses c to maximize

$$(1') \quad U(c) + W(1 - X) + \beta U\left[\frac{2L'}{M^S}(M + \tau + qX - qc)\right] + \beta W(1 - L')$$

subject to given X (to be determined below) and

$$(4') \quad M + \tau \geq qc.$$

Letting γ be the multiplier on (4'), c satisfies

$$(17) \quad U_1(c) = \frac{2L'q}{M^s}\,\beta U\left[\frac{2L'}{M^s}(M + \tau + qx - qc)\right] + \gamma q$$

where $\tau = 0$ for a k-household, as before.

Make the provisional assumption that $\gamma^j > 0$, $\gamma^k > 0$. (The conditions that guarantee this are discussed below.) Then $c^j = \frac{M+\tau}{q}$ and $c^k = \frac{M}{q}$, so output under the contract is

$$(18) \quad X = \frac{2M+\tau}{2q}$$

for each household. Expected utility under the contract is

$$(19) \quad EU^c = \frac{1}{2}\,U\left[\frac{M+\tau}{q}\right] + \frac{1}{2}\,U\left[\frac{M}{q}\right] + W\left[1 - \frac{2M+\tau}{2q}\right],$$

where exogenous utility in the second period has been ignored. A change in the contractual price affects expected utility by

$$(20) \quad \frac{\partial EU^c}{\partial \frac{1}{q}} = \frac{M+\tau}{2}\,U_1\left[\frac{M+\tau}{q}\right] + \frac{M}{2}\,U_1\left[\frac{M}{q}\right] - \frac{2M+\tau}{2}\,W_1\left[1 - \frac{2M+\tau}{2q}\right].$$

Evaluating (20) at the spot market price, q = P, and using (11) one obtains (where c^j and c^k are given by (14))

$$(21)\quad \left.\frac{\partial EU^c}{\partial \frac{1}{q}}\right|_{q=p} = q\left\{\frac{1}{2}\,[c^jU_1(c^j) + c^kU_1(k^k)] - \beta L'U_1(L')\right\}$$

$$= \frac{q}{2}\left[\frac{M+\tau}{q}\right]^{1-r} + \frac{q}{2}\left[\frac{M}{q}\right]^{1-r} - \beta L'^{\,1-r}.$$

If L' is chosen so that L' = L then (21) is

$$(22)\quad \frac{M^{1-r}q^r}{2(1+\omega^{1-r})}\left[1 - \beta 2^r\,\frac{(1+\omega)^{1-r}}{1+\omega^{1-r}}\right].$$

which is positive if transfers are sufficiently small in absolute value, because $\beta < 1$.[7] So if $r < 1$, $\beta < 1$, $L' = L$, and $|\frac{t}{M}|$ is small, a contractural equilibrium with $q < P$ (i.e., contract price smaller than the spot market price would have been) and output demand-determined, dominates spot market equilibrium in terms of expected utility. Note that, because output is demand-determined under the contract, $C \lesseqgtr L$ as $q \gtreqless P$.

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[7] If $r < 1$ and $\beta = 1$ then (28) is zero for $\tau = 0$ and negative for all $\tau \neq 0$. (28) is minimized at $\frac{\tau}{M}$ such that

$$\left[\frac{M+\tau}{M+\frac{\tau}{2}}\right]^{-r} = \frac{1}{\beta},$$

which implies $\tau = 0$ if $\beta = 1$.

Now consider the socially optimal q within this set of contracts. If $\gamma^j > 0$ and $\gamma^k > 0$ then an optimum requires, using (20), that

$$(23)\quad \omega U_1(\omega m) + U_1(m) = (1 + \omega)W_1(1 - \frac{m}{2}(1 + \omega))$$

where

$$(24)\quad m \equiv \frac{M}{q}$$

and where $\frac{m(1+\omega)}{2} = X$ is output per capita. Using (2), (23) implies

$$(25)\quad q = M\left[\frac{k(1+\omega)^{1+R}}{2^R(1+\omega^{1-r})}\right]^{\frac{1}{r+R}}$$

$$= M^s\Omega^{\frac{1}{r+R}}$$

where

$$(26)\quad \Omega \equiv \frac{k(1+\omega)^{1-r}}{2^R(1+\omega^{1-r})}.$$

Because households can costlessly choose any neighborhood in the (1, 2) interval in which to trade, they will choose the neighborhood with the contractual price that most closely approximates (25).

Now return to the provisional assumption that $\gamma^j > 0$, $\gamma^k > 0$. From (17), this implies

$$\gamma^i q = (c^i)^{-r} - \frac{\beta}{X} L'^{1-r}$$

$$= \left[\frac{M+\tau^i}{q}\right]^{-r} - \beta \frac{2q}{M^s} L'^{1-r}$$

is positive. At the optimal q given in (25), this implies

$$\left[\frac{\omega^i}{1+\omega}\right]^{-r} \Omega^{\frac{r-1}{r+R}} > 2\beta L'^{1-r}.$$

In particular, suppose L' is chosen so that L' = X. Then

$$\gamma^i q = \Omega^{\frac{r}{r+R}}\left[\left(\frac{1+\omega}{\omega^i}\right)^r - 2^r\beta\right]$$

which is positive if and only if (13") is satisfied. Therefore, if transfers are small enough to satisfy (13") a contractual equilibrium with price q given by (25) and demand-determined output,

$$(27) \quad X = \frac{1}{2}\Omega^{\frac{-1}{r+R}},$$

yields higher expected utility than the spot market equilibrium with (14), (15), and (11').

While the spot market equilibrium price P is unit elastic in the money supply, the contractual price q in (26) is not. The elasticity of q with respect to the money supply, $M^s = 2M + \tau$, for given initial money M, is[8]

$$(28)\quad \epsilon(q,\ M^s) = (r + R)^{-1}\left[1 + R - (1 - r)\ \frac{\omega^{1-r} + \omega^{-r}}{\omega^{1-r} + 1}\right],$$

which equals unity only at $\omega = 1$, i.e., when $\tau = 0$. If $r < 1$ and $\omega > 1$ (or $r > 1$ and $\omega < 1$) then (29) exceeds unity, while if $r < 1$ and $\omega < 1$ (or $r > 1$ and $\omega > 1$) (28) is less that one. In fact, if $r < 1$,

$$(29)\quad \frac{q}{P} = 2^{\frac{r}{r+R}}\ \beta^{\frac{1}{1+R}}\ L'^{\frac{1-r}{1+R}}\ k^{\frac{1-r}{(r+R(1+R)}}\ (1+\omega)^{\frac{1-r}{r+R}}\ (1+\omega^{1-r})^{\frac{-1}{r+R}}$$

takes a minimum value at $\omega = 1$. So if the coefficient of relative risk aversion is less than one, contractual prices are "sticky" in a downward direction but rise with a greater than unit elasticity with an increase in the money supply. Changes in the money supply raise the ratio of the contract price to the spot market price (that would prevail without

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[8]Given M, $d\ln M^s = d\ln(1+\omega)$,

so $$\frac{d\ \ln\ q}{d\ \ln\ M^s} = 1 + \frac{1}{r+R}\left[1 - r - \frac{d\ \ln(1+\omega^{1-r})}{d\ \ln(1+\omega)}\right].$$

But $$\frac{d\ \ln(1+\omega^{1-r})}{d\ \ln(1+\omega)} = \left[\frac{1+\omega}{1-\omega^{1-r}}\right](1-r)\omega^{-r},$$ so (28) follows.

contracts) and thereby reduce output. Notice that if $\omega = 1$ and L' is chosen so that $L^* = L'$ as in (11'), then (29) reduces to $\beta^{1/(r+R)} < 1$, so $q < P$ and output under contracts exceeds spot market equilibrium output.

The relation between the contractual price and the money supply, for small changes in the money supply, is illustrated in Figure 1 for the case of relative risk aversion less than one. The price falls less than proportionately with decreases in the money supply and rises more than proportionately with increases in the money supply. This price behavior with demand-determined output provides a second-best insurance arrangement. This insurance works in the following way. Consider a fall in the money supply through lump-sum taxes paid by type-j households. Because type-j households lose wealth, their desired expenditure falls; because they are liquidity-contrained, desired expenditure falls by the full amount of the fall in liquidity, i.e., by the full amount of the increase in taxes. Suppose the reduction in the money supply is x%; conjecture (falsely) that nominal prices also fall by x%. In that case, type-j households reduce expenditure by x% (their nominal money balances fall by 2x% while nominal money holdings of other households are unaffected). The assumption that transfer payments are small in absolute value implies that type-k households, who gain x% in real money balances due to the fall in prices, remain liquidity constrained. The purpose of this assumption is to simplify the example by ensuring that type-k households increase current expenditures by the full x%. If nominal prices fall by less than x%, then type-j households lose more than x% on their real balances: their nominal balances fall by 2x% and prices fall by less than x%; similarly, type-k households would gain less than x% on their real balances. Because all money is spent in this liquidity-contrained example, these losses in real balances are losses in consumption. If prices fall by (x - e)%, for 0 < e < x, rather than x%, then compared to the case which prices fall by x%, type-j household consume e% less and type-k households consume e% less. Because type-k households consume more then type-j households (who paid the tax), the absolute fall in consumption by type k households is larger than that of type-j households. If the degree of relative risk aversion is less than one, type-k households lose more utility than do type-j households from lower consumption. But if consumption is lower, because real balances are lower, then production (which is demand-determined) will also be lower. Lower production implies less labor supply and more leisure. Because all households work the same amount, they all gain the same amount of utility from additional leisure. On net, then, utility is redistributed from "lucky" type-k households who did not have to pay the tax to "unlucky" type-j households who paid the tax. Prices fall less than proportionately with money and output falls.

Similarly, if the money supply increases by x% through transfers to type-j households (that increase their money holdings by 2x%), nominal prices rise by more than x%. Starting from a situation in which nominal prices have risen by x%, further increases in prices reduce real balances and consumption by all households. With the degree of relative risk aversion smaller than one, this reduces utility of the "lucky" type-j households more than it reduces utility of "unlucky" type-k households. But all households gain equal utility from the reduction in labor supply that accompanies the fall in real balances and consumption demand. Consequently, a rise in nominal prices that is greater in percentage terms than the increase in the money supply redistributes utility from the lucky to the unlucky households. With relative risk aversion less than one, nominal prices exhibit some downward (but not upward) stickiness, and, as in Grossman, Hart, and Maskin (1983), changes in the money supply reduce output.

The level of nominal prices reflects the fact that there are two distortions in the model. First, as long as the rate of inflation exceeds the negative of the discount rate, real money balances fall short of Friedman's optimal quantity of money. As in Aschauer (1981), this takes the form of suboptimal labor supply and output in equilibrium. Second, uncertainty about the identity of taxpayers or transfer recipients creates risk that would be diversifiable if capital markets were complete. The level of contractual prices is lower, when the tax/transfer is zero and the degree of relative risk aversion less than one, than the level of prices in the spot market equilibrium. Because output is demand determined, this raises output above its spot market equilibrium value and offsets the first distortion. The optimal contract sets prices so that real money balances are lower if the tax or transfer is nonzero; this is required for the partial insurance arrangement that tends to offset the second distortion.[9]

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[9] King and Haubrich (1984) develop a rather different model in which price contracts play an insurance role. In simplified form, their model has two kinds of individuals, A and B. The distortion of wealth across B-people is random and unobservable (or at least uninsurable) while the variance of this distribution is random and observable (perhaps with error). People in group A sell insurance to people in group B against the contingency of a high variance. If the variance turns out to be low, B pays A an insurance premium while if the variance turns out to high, B collects an insurance payment from A. In the latter situation, A is less wealthy than otherwise. King and Haubrich assume people in group A have variable labor supply while those in B do not (they are retired), so the fall in A's wealth leads to an increase in

IV. Conclusions

The paper has presented an example of an economy in which incomplete asset markets create incentives for buyers and sellers to sign contracts that specify a price function different from the spot market equilibrium price function. The price function can exhibit downward stickiness in nominal prices and lead to nonneutral effects of money on real output. Three key elements of the model are the transactions role of money, fluctuations that differ across households in the value of nominal money balances, and the inability of households to insure directly.

As in Grossman and Weiss (1983), a change in the money supply in either direction not only redistributes wealth but affects the liquidity of some consumers. The inability of households to diversify the risk of money supply changes creates a role for contracts with nonneutral effects of money.

The model is not developed from first principles. Instead, it seeks to take one step toward that end starting from macroeconomic models that postulate sticky prices. Usually, sticky prices are a source of inefficiency in a model, and monetary disturbances have real effects because of this inefficiency. Ordinarily, households would prefer to be able to adjust

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labor supply and output. Given a fixed velocity of money, this reduces the price level. They also assume that the variance of the wealth distribution is positively correlated with monetary growth (which is neutral if the variance is fixed). States of the world with high money growth are associated, therefore, with high output and with prices that rise less than proportionately to money. A fall in the money supply is associated with a smaller variance of the wealth distribution in group B and with higher wealth for A people, so output is lower and prices fall by less than the money supply.

prices instantaneously in those models, and price stickiness must be rationalized—usually implicitly—on the ground that changing prices has some cost. The example in this paper, in contrast, begins with an inefficiency due to incomplete asset markets and the nature of monetary disturbances. Households can increase expected utility by entering into contracts in which nominal prices are somewhat sticky in a downward direction and output is demand-determined. Further research will be required to develop the ideas in this example further, to include an explanation based on first principles for the absence of an explicit insurance market in the risk caused by taxes and transfers, and to consider a broader range of possible contracts and alternative choices for households. The goal of this paper has been much more modest—to develop a specific example in which households would have an incentive to enter into trades with sticky nominal prices and in which real output is affected by monetary disturbances.

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