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MONETARY POLICIES AND THE OVERSHOOTING OF FLEXIBLE
PRICES: IMPLICATIONS FOR AGRICULTURAL POLICY

by

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1. Introduction

Since Schuh's famous paper, the effects on the agricultural sector of exchange rates in particular and monetary and fiscal policies in general have been a subject of much interest and controversy in agricultural economics. The extent to which these factors affect the agricultural sector is still not resolved. Some studies (e.g. Chambers and Just, Dunmore and Longmire) find monetary factors to be important, while others (e.g. Batten and Belongia) disagree.

Part of the difficulty in reconciling the different conclusions available in the literature is that no common model underlies these studies. However, if monetary or fiscal policies are to be considered important forces in determining agricultural market conditions, a theoretical framework must be developed in which this proposition can be evaluated. Reasons must be advanced, for instance, as to why there are important spillover effects--macroexternalities, if you will--from these policies. Otherwise, empirical analyses which purport to show significant real effects of exchange rates, inflation, etc., lack the theoretical background against which results can be judged.

In this paper, we focus on monetary policy and discuss a model of price and exchange rate dynamics in which these macroexternalities are present. It begins with the exchange-rate overshooting model of Dornbusch, in which exchange rate changes in response to money growth can exceed, or overshoot, their long-run equilibrium values. Unlike the Dornbusch model, in which all real sector prices are fixed, agricultural

prices are assumed to be flexible, and we focus on the importance of this assumption for the agricultural sector. The model is consistent with rational expectations and asset market equilibrium at every point in time, and with the long-run neutrality of money. As in Dornbusch, flexible prices overshoot their long-run equilibrium. Thus, unanticipated changes in the growth rate of the money supply can be shown to change the relative price of agricultural products in the short run, thus representing either a tax or a subsidy to agricultural producers due to the short-run non-neutrality of money. The paper's contribution can therefore be viewed as identifying one set of conditions sufficient for monetary policy to cause real effects in the agricultural sector, and examining some factors affecting the extent of overshooting.

The model adopts a "fix-price, flex-price" framework, to use the terms originating with Hicks. Previous studies using this framework include Okun and Van Duyne. Agricultural prices, because those goods are homogeneous, frequently traded, and storable, are assumed to be flexible and governed by instantaneous commodity arbitrage. Non-agricultural prices, on the other hand, are more often differentiated products, with contracting, less rapidly disseminated information, and imperfect competition as possible causes of less rapid price adjustment. Price adjustment therefore occurs through instantaneous commodity arbitrage in the flex-price agricultural markets, while fix-price, non-agricultural markets respond gradually to changes in aggregate demand. The model permits testing propositions about the short-run effects of monetary policy within the agricultural sector. This is because market clearing and flexible prices in the non-food sector, and thus, short-run neutrality of money, are not ruled out, but appear as special cases.

Long-run neutrality of money is accepted by most economists, and the focus in macroeconomics appears to have shifted to the short run. Indeed, Gordon (1981), in his survey of price adjustment, considers the short-run inertia of prices to be the main point of contention between proponents (auction market theorists) and critics (disequilibrium theorists) of the policy ineffectiveness proposition. While theoretical support for gradual price adjustment has lagged, some empirical evidence is available to support the hypothesis. Rotemberg, Mussa, and others have recently proposed "sticky" price schemes which lend some theoretical foundation, based on costly adjustment of prices or other impediments to flexibility, without requiring apparent irrationality of either firms or workers.

The paper proceeds as follows. First, our overshooting model is developed. Next, we consider the factors affecting the degree of overshooting and some empirical evidence. The paper concludes with a discussion of the implications for agricultural policy.

2. Overshooting in Flexible Price Markets

The overshooting model was developed by Dornbusch to explain variability in flexible exchange rates, following the breakdown of the fixed-rate system in the early seventies. In his model, all prices were assumed to be sticky, adjusting less rapidly than the prices of assets (other currencies). This can cause exchange rate changes in response to changes in the money supply which are greater than the long-run outcome.

Frankel (1977) used the overshooting model to combine competing theories of exchange rate determination. His analysis of the dollar-

deutschemerk exchange rate provided support for the overshooting hypothesis, as does a later study by Meese. Other generalizations of the Dornbusch model are given by Mussa and Obstfeld and Rogoff.

Also, evidence on Purchasing Power Parity presented by Frenkel and Isard lends some support. Both of those authors found evidence that individual country price levels do not obey Purchasing Power Parity because of stickiness of prices. Isard pointed out that commodity arbitrage is likely to work only for primary, homogeneous commodities. Other support for price stickiness can be found in Gordon (1981,1982) and Rotemberg.

A simple example illustrates the overshooting concept for a pure exchange economy. Consider two goods markets, say, food (a flex price market) and widgets (a fix price market). When a doubling of the money supply occurs in the presence of perfect price flexibility, doubling of both the food and widget prices follows. This corresponds to money neutrality. The doubling of the price level leaves real money balances unchanged from their initial level, and equilibrium quantities of food and widgets are also unchanged.

The flexibility of prices is the key. With short-run fixity in the price in the widget market, such an adjustment is prevented. In fact, after a doubling of the money supply, if only the food price has doubled, there is excess demand for widgets and excess supply of money balances. The continuing effort of agents to rid themselves of money balances in excess of what they would prefer to hold guarantees further food price increases.

Of course, prices at the farm level fit this example much better than retail food prices, as the latter include the costs of marketing and processing inputs. These inputs may make retail food behave more like fix-price goods. Farm prices are much more flexible, and are the concern of our study and of agricultural policy, so for the sake of the example, we treat food as the flex-price good. Also, it is important to remember that food prices are flexible so long as they remain above levels at which they are supported by agricultural policy. Feed grains and wheat, for instance, are only flex-price goods when prices are above the loan rates at which their prices are supported. This downward-inflexibility turns out to have some interesting implications which are pursued later in the paper.

The extent to which the food price rises beyond twice its initial level is the overshooting of the flexible food price in response to the monetary expansion. Then, as the widget price rises, the food price will fall, eventually restoring the initial relative prices. Thus, money is still neutral in the long run, but the sticky price assumption leads to relative price changes during the adjustment period.

3. Factors Affecting the Degree of Overshooting

The preceding discussion omits an important factor, the interest rate. If the quantity of money demanded responds positively to decreases in the interest rate, then the food price does not have to rise as much to restore equilibrium in the three markets. This is due to the fact that, if interest rates fall due to a liquidity effect after the increase in real balances, excess demand does not have to exist in the money market.

However, the lower interest rate will cause capital flows into more profitable investments. As long as capital mobility exists, the change in the money supply does not represent a stable equilibrium even if the money market clears. This observation suggests that a more general model is necessary to understand the overshooting concept.

Our generalization of the overshooting model is presented in this section. Both foreign assets and agricultural commodities are treated as flexible-price goods. Frankel (1984) and Frankel and Hardouvelis have previously included commodities in the Dornbusch model by substituting commodity prices for that of the foreign currency. Because the dependence of agriculture on both interest rates and exchange rates is of interest, we include both commodities and foreign assets.

First, we assume that uncovered interest parity holds, which requires that

$$i - i^* = x,$$

where i and i^* are domestic and foreign nominal interest rates and x is the expected depreciation of the domestic currency. This expectation, in turn, is assumed to be a function of the extent to which the exchange rate (domestic currency per foreign currency units) deviates from its long-run equilibrium level:

$$x = \theta (\bar{e} - e).$$

θ is directly related to the flexibility of non-agricultural prices. It ranges from zero (fixed prices) to one (perfectly flexible prices).

An equilibrium condition in the money market is expressed in natural logarithms:

$$m - q = \lambda y - \lambda i$$

where m denotes the nominal money supply, q the price level, y income, and i the interest rate. All are measured in logarithms except the interest rate. Purchasing power parity is assumed to hold for the agricultural commodity:

$$e = P_a - P_a^*$$

If each price P_a is expressed in logarithms, the assumption that the foreign price is one allows this expression to be rewritten as

$$e = P_a.$$

Note that this is simply a choice about the units in which to express the price of the agricultural commodity. The home country is assumed to be a price-taker on the world market, so that P_a^* is exogenously determined.

The domestic price level is Q , and its natural logarithm q appears in the money-market equilibrium condition. Initially, let Q be a Cobb-Douglas price index so that

$$q = \alpha P_n + (1 - \alpha) P_a,$$

or

$$q = \alpha P_n + (1 - \alpha) e,$$

where P_n is the natural logarithm of the fix-price good. The money

market equilibrium condition can therefore be expressed as

$$m - \alpha P_n - (1 - \alpha) e = \delta y - \lambda i.$$

Combining the uncovered interest parity assumption and the expected depreciation of the currency, the money market equilibrium condition becomes

$$m - \alpha P_n - (1 - \alpha) e = \delta y - \lambda [\theta(\bar{e} - e) + i^*].$$

This expression summarizes equilibrium in financial asset markets.

A long-run version of the expression for asset market equilibrium, one in which money supply is taken to be at its long-run equilibrium level, is

$$\bar{m} - \alpha \bar{P}_n - (1 - \alpha) \bar{e} = \delta y - \lambda i^*.$$

Note that the expected depreciation of the currency is now zero.

Combining the last two expressions, and expressing the nominal interest rate differential ($i - i^*$) as expected depreciation or appreciation of the home currency,

$$m - \alpha P_n - (1 - \alpha) e = -\lambda \theta (\bar{e} - e) + \bar{m} - \alpha \bar{P}_n - (1 - \alpha) \bar{e}.$$

where $y = \bar{y}$ is assumed for convenience. By taking $m = \bar{m}$, as well, we find that

$$e - \bar{e} = -\alpha [(1 - \alpha) + \lambda \theta]^{-1} (P_n - \bar{P}_n).$$

The equilibrium exchange rate deviates from its long-run equilibrium rate (\bar{e}) by an amount proportional to the deviation of the price in the

fix-price sector from its long-run equilibrium level. The proportion is increasing in α and decreasing in λ and θ .

The persistence of expected appreciation or depreciation does not mean that unexploited profits exist. The expected capital gain or loss on bonds denominated in the home currency will be consistent with both the uncovered interest parity assumption (1) and with the rate of return available through storing commodities. For instance, when the domestic interest rate falls below the foreign rate, following an increase in money growth, the currency depreciates instantly as the prices of foreign assets are bid up. The more the interest rate falls, the greater this immediate overshooting response of the exchange rate must be. Depreciation continues until the expected revaluation plus the (lower) nominal interest rate just equals i^* , the rest-of-world interest rate. Then expected depreciation falls over time as the fix-price P_n moves toward its long-run equilibrium and i returns to i^* .

In addition, there is no advantage to holding commodities instead of currencies. Frankel (1984) and Frankel and Hardouvelis develop this latter point in more detail, but a brief summary is in order. To compensate the holders of grain inventories for foregoing present consumption, the grain price must rise at the interest rate in between harvests, once convenience yields, storage costs, and a risk premium are accounted for. If an unanticipated growth in the money supply occurs, so that the liquidity effect causes a fall in the interest rate, a better return is available for storing grain than dollars, and investors compete to hold grain inventories. This causes an immediate jump in the price of grain, so that an asset market equilibrium of equal rates of

return is restored. All commodity prices are therefore expected to rise at the now lower interest rate.

Recall that we took P_a to be equal to the exchange rate, by normalizing the rest-of-world price of agricultural output. This means that there is an equivalent amount of overshooting in the agricultural goods markets. Also, note that the proportion by which e deviates from \bar{e} is increasing in α or decreasing in $(1 - \alpha)$, so this illustrates the importance of the number of fix-price markets. As the share of fix-price markets rises, the extent of deviation of e from \bar{e} is greater, and as that share falls, it is less.

Both e and P_a overshoot their long-run equilibrium levels in a manner directly related to deviation of P_n from its long-run equilibrium level. The upshot is that there are relative price changes during the adjustment period. This is a source of macroexternalities. In the short-run, relative price changes occur so that, after monetary growth, there is a period in which agriculture is subsidized; conversely, after a contraction, the change in relative prices acts as a tax on agriculture, until the fix-price has fully adjusted.

We conducted a simple test of the importance of overshooting by examining the sensitivity of prices to anticipated money growth. We estimated money growth using a fairly ad hoc mechanism which we treat as the reaction function of monetary authorities. As in the series of studies by Barro and in the recent paper by Enders and Falk, predicted values from this regression (MFIT) are treated as anticipated money growth. Fitted residuals are thought of as unanticipated money growth.

The anticipated money growth rate was used to explain the price level response in the fix- and flex-price sectors of the economy. The rate of change of the non-food Consumer Price Index (CPINF) is taken as the growth rate of prices in fix-price markets, while a calculated growth rate of the U.S.D.A. Index of Prices Received by Farmers (FOODINF) was used to measure growth in flex prices. See Lombra and Mehra and Belongia and King for regressions using the food component of the Consumer Price Index.

To explain variation in these rates of change, we used as independent variables our anticipated money growth variable, distributed lags of the gap between potential and actual income (INCGAP), oil-price inflation (OILINFL) and the differential of wage and productivity growth rates (WPRODIF), and a lagged dependent variable. The following equations were estimated using instrumental variables

$$\begin{aligned} \text{FOODINF} &= 1.891 + 0.0319 \text{ FOODINF} - 0.188 \text{ WPRODIF} + 0.00003 \text{ OILINFL} \\ &\quad (2.608) \quad (0.128) \quad (0.308) \quad (0.0238) \\ &\quad + 0.0286 \text{ INCGAP} + 1.641 \text{ MFIT} \\ &\quad (0.0113) \quad (1.319) \\ \text{CPINF} &= 0.0117 + 0.356 \text{ CPINF} + 0.070 \text{ WPRODIF} + 0.0115 \text{ OILINFL} \\ &\quad (0.321) \quad (0.144) \quad (0.044) \quad (0.0039) \\ &\quad + 0.003 \text{ INCGAP} + 0.329 \text{ MFIT} \\ &\quad (0.0014) \quad (0.169) \end{aligned}$$

Comparing the coefficients across the two equations, we see that the lagged dependent variable has a large and significant coefficient in the non-food inflation equation compared to the food equation. In addition, anticipated money growth causes a much greater response in food inflation than for non-agricultural goods. In fact, the estimated coef-

efficient exceeds one, corresponding to overshooting of food prices following money growth. In contrast, the coefficient in the other equation is significantly less than one, indicating sluggish response to anticipated money growth. Presumably, this is because some of the factors causing stickiness of non-food prices, say contracts, were already in place in the preceding quarter. These results support our assumption that prices in the non-food sectors adjust more sluggishly than food prices, to changes in money growth. Coupled with the theoretical model, this provides a basis for assuming that there are spillover effects from monetary policy changes in U.S. agriculture.

4. Summary and Conclusions

To this point, we have developed a theoretical overshooting model and provided some empirical support. The model is sufficient to produce short-run effects on agriculture from monetary policy. Factors affecting food price overshooting were shown to be the share and number of fix-price markets, the speed of adjustment of those prices, and the interest elasticity of money demand.

Conditions in the eighties have been consistent with the model's predictions. The Federal Reserve has chosen not to allow money to grow to monetize the federal deficit. Real interest rates and the value of the dollar have been high and relative prices of farm products have been low. In the overshooting model, this can be attributed, in part, to the tight monetary policy pursued by the Federal Reserve. Previously insulated from high borrowing costs through interest subsidies, this effect is magnified, since agricultural borrowers now find themselves competing for credit with other borrowers at higher rates than forecast a decade

ago.

Without a price floor, the falling relative price of farm products is simply a "tax" on agriculture. However, downward inflexibility of prices causes some of the tax to show up as unexpected increases in costs of maintaining price supports and the farmer-owned reserve. At the same time, agricultural policy has been under increasing attack for its unacceptably large budget costs.

Insulation from these spillover effects of monetary policy would improve the stability of the agricultural sector. Whatever one's view of agricultural intervention, if agricultural programs were modified to incorporate the effects of macroeconomic policies, resulting budget costs could be less, as well. This would be an example of the "conditional policy" approach suggested by Just and Rausser, in which policies are designed to be self-adjusting in accordance with the prevailing conditions.

Factors which affect overshooting merit further research. We showed that increases in the number of goods with flexible prices reduce the degree of overshooting. Government policies affecting price flexibility in other sectors, such as trade barriers, should be studied to determine their effects on agriculture.

The notion of spillover effects from monetary policy, in the way they are defined in our model, is a useful concept. It remains to be shown, however, how macroexternalities can be used to demonstrate that the exchange rate is a major factor explaining declining agricultural exports. In our formulation, commodity arbitrage is assumed, so the

price of U.S. grain should not vary solely because the exchange rate changes. Instead, it will be necessary to motivate why it serves as a separate factor in explaining export demands; some justification is needed for assuming that Purchasing Power Parity fails.

One possibility does fit the overshooting framework --the downward inflexibility of supported prices. If grain prices fall to support levels as they overshoot downwards, this can lead to substitution to other suppliers, provided those countries undersell the U.S. This departure from commodity arbitrage can only be justified to the extent that foreigner suppliers cannot either sell grain to the U.S. government at the support price, or displace domestic grain which is then sold to the government. It is, however, consistent with results showing food prices moving up by only the amount of money growth, rather than overshooting their long-run level, along with the exchange rate. If food prices do not overshoot, while the exchange rate does, then prices do turn against U.S. exporters when the dollar is appreciating. Again, this requires that commodity arbitrage is imperfect. It does serve to justify the exchange rate as a separate regressor in export demand equations, and indicates just what must be assumed in order to construct models with that specification.

Another possibility we are studying stems from the currency substitution hypothesis of MacKinnon. This hypothesis emphasizes foreign reactions to changes in U.S. money growth. Namely, in their efforts to sustain the dollar value of their currencies, foreign governments allow their money supplies to grow or contract along with the dollar. If this causes a change in income abroad, then there will be a change in the

demand for U.S. exports. This suggests that studies finding a significant effect of the exchange rate on exports may be picking up the effect of foreign income, rather than any effects due to the exchange rate itself. Empirical evidence concerning the currency substitution hypothesis in general, and its importance for the agricultural sector in particular, has yet to be examined in sufficient detail.

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