Sluggish Price Adjustments and the Effectiveness of Aggregate Demand Policies at the Sectoral Level

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A. E. Research Series No. 94-13

August, 1994

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ABSTRACT

The theoretical part of this study demonstrates that if nominal prices adjust sluggishly, the anticipated aggregate demand policies will affect the real economic variables at the *sectoral level*, though they may be neutral at the *aggregate level*. The empirical analysis tests the policy ineffective proposition on real farm output by using monetary policy alone, and monetary and fiscal policies jointly, as aggregate demand policies. The U.S. agricultural sector is chosen for this study because it is inundated with government price-fixing policies that impart imperfect flexibility to prices. The empirical results corroborate the theoretical findings, i.e., the anticipated aggregate monetary and fiscal policies do have significant effects on farm output and, thus, do not support the neutrality proposition. Examination of a specific sector sheds light in understanding the nature of the market and in ascertaining the reasons for the cause of the nonneutrality.

J.E.L Classification: E63.

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I. INTRODUCTION

The policy ineffectiveness proposition[1] elucidates that real economic variables respond only to unanticipated movements in the aggregate demand policies, but do not respond to anticipated policies associated with the systematic feedback rules. Since this proposition was spearheaded by Lucas (1972, 1973) in the early 1970s, it has been hotly debated in the macroeconomics literature, and numerous theoretical and empirical studies have flourished either supporting or refuting this proposition. Theoretical studies that supported this proposition include, among others, Barro (1976), Sargent and Wallace (1975, 1976), McCallum (1977, 1978, 1979), McCallum and Whitaker (1979), and Hercowitz (1981). Theoretical studies that rejected this hypothesis are Fischer (1977), Phelps and Taylor (1977), Canzoneri (1978), Blinder (1981, 1982), Gordon (1982), and Blinder and Mankiw (1984). On the empirical verification of this proposition, studies that provided evidence supporting this proposition include Barro (1977, 1978), and Barro and Rush (1980). Empirical studies that cast doubt on this hypothesis encompass Mishkin (1982a, 1982b), Gordon (1979, 1982), Laumas and McMillin (1984), and Glick and Hutchison (1990).

One of the essential ingredients employed in the theoretical studies in invalidating this hypothesis is imperfect flexibility of prices (Phelps and Taylor, 1977).[2] For instance, even McCallum (1980), a proponent of this hypothesis, acknowledged that because of sticky-prices, it is "difficult to sustain the position that the policy ineffectiveness proposition is applicable to the U.S. economy." Gordon (1980), a critic of this proposition, asserted that neutrality of anticipated aggregate demand policies would be valid if market prices are freely flexible, but the presence of administered prices and imperfect flexibility of prices would invalidate this hypothesis.

The studies cited above examined the neutrality proposition at the aggregate level, though the original models developed by Lucas and Barro were based on microfoundations of supply and demand functions of large numbers of disaggregate markets. Investigation of this proposition at the disaggregate level received scant attention, particularly in the theoretical developments. For instance, Duca (1987) noted that although most modern economies are comprised of markets with different degrees of wage-price stickiness, most studies do not attempt to analyze how different sectors respond to policy actions. Theoretical and empirical analyses of this hypothesis at the disaggregate level are needed because, as elucidated by Blinder and Mankiw (1984), aggregate level tests can obscure the true impacts of the anticipated aggregate demand policies in a specific sector. This is because the aggregate level test results may net out the differing impacts of the anticipated components of the aggregate demand policies at the sectoral level. Impacts may differ across sectors because the underlying structure of the individual sector may vary, and each sector may experience a differing degree of price flexibility. Also, examination of a specific sector would allow us to study the nature of the market structure in that sector and ascertain reasons for the cause of nonneutrality. The agricultural sector provides a unique case for testing the Macro Rational Expectation (MRE) hypothesis because the U.S. agricultural industry, as noted in Devadoss and Choi (1991) and Wright (1985), is inundated with government price-fixing policies such as price support programs that restrict movements of commodity prices.

The purpose of this study is to examine the MRE hypothesis at the sectoral level by injecting three new contributions. First, the theoretical innovation of this study is, in contrast to earlier studies that rejected the neutrality hypothesis at the *aggregate* level, to demonstrate that this hypothesis does not hold at the *sectoral level*. A theoretical model is developed using the localized-market framework of rational expectation models put forward by Barro (1976) and Hercowitz (1981) to show that if market prices adjust sluggishly then anticipated monetary policies do influence the real economic activities at the *sectoral level*. This result is appealing particularly because the theoretical underpinnings of this hypothesis as indicated by the models of Lucas and Barro were built upon supply and demand functions of numerous sectors. The development of the theoretical model and the illustration of the nonneutrality of monetary policy constitute section II.

The neutrality of fiscal policy is also a controversial subject in the macroeconomics literature. For instance, McCallum and Whitaker (1979) have shown that under rational expectation framework with flexible prices and wages, systematic components of fiscal policies are ineffective in influencing the real output. In contrast, Canzoneri (1978) demonstrated theoretically that a coordinated fiscal policy along with monetary policy will influence the real output. In section III, we discuss how the theoretical model developed in section II can be modified to include the fiscal policy and show that the anticipated fiscal policy stimulus also influences the real economic variables.

The second contribution of this study is the empirical test of the MRE hypothesis[3], both the neutrality and rationality propositions, at the *sectoral level*. The agricultural sector was chosen for this study because of its unique characteristics of government administered prices that impart imperfect flexibility to prices. Specifically, MRE hypothesis is tested on real farm output using the joint estimation procedure developed by Mishkin (1982a).

The third contribution of this study is inclusion of *fiscal policy stimulus* in addition to monetary policy in the empirical testing of this hypothesis at the *sectoral level*. Recent empirical studies have emphasized the importance of simultaneous inclusion of monetary and fiscal policies in examining the policy ineffectiveness proposition. For instance, Glick and Hutchison (1990) note that exclusion of either monetary or fiscal policy in the neutrality test, because of the interactions between them, will lead to the omitted variable problem and cause biased coefficient estimates. In light of their findings, first, MRE hypothesis is tested on real farm output with monetary policy as the aggregate demand variable. Second, both monetary and fiscal policies are included simultaneously in testing the MRE hypothesis. The results show that perceived monetary policy has significant effects on real farm output. Also, when monetary and fiscal policies are included simultaneously, the anticipated components of both of these policies are important determinants of real farm output.

The explanation of joint estimation methodology, policy forecasting equations, and empirical results of MRE hypothesis constitute the subsections of section IV. The final section concludes with summary and policy implications.

II. THEORETICAL MODEL

The object of this section is to develop a theoretical model by incorporating gradual price adjustments in the partial information-localized market framework of rational expectation model to show that perceived money growth does influence the real economic variables.

According to the partial-information rational expectations model formulated by Hercowitz (1981), which is a modified version of the model developed by Barro (1976), the economy is comprised of numerous markets indexed by z. Agents in each market have full information about the relevant aggregate variables with one-period lag, and current information of local market price, $P_t(z)$. Market participants do not know the current prices in other markets. The key elements of this model are individuals possessing incomplete current information and making supply and demand decisions by responding to relative prices as they are locally perceived. Because of the lack of information, participants are not able to differentiate between the aggregate and market-specific shocks. As a result, individuals misinterpret unanticipated aggregate shocks that cause changes in relative prices as market-specific shocks and, in turn, respond by changing their demand and supply behavior to these shocks, which leads to real effects of unperceived aggregate shocks. However, anticipated money growth is perceived by agents in all markets as economy-wide effects and results in price changes in all markets. Consequently, anticipated money growth does not affect the relative prices and real economic variables.

The point of departure of this study is to incorporate sluggish price adjustments in this imperfect information model and demonstrate that not only unanticipated, but also anticipated, aggregate demand shocks have effect on real variables. Sluggish price adjustments capture the various degree of price stickiness caused by long-term sales contracts and government administered prices, which are widely prevalent in many markets.

As in Hercowitz (1981), the log-linear form of supply and demand functions for commodity z are represented as:

$$y_t^s(z) = \alpha^s(z)[P_t(z) - EP_t] + \varepsilon_t^s(z), \qquad \alpha^s(z) > 0, \qquad (1)$$

$$y_t^d(z) = -\alpha^d(z)[P_t(z) - EP_t] + [M_t - EP_t] + \varepsilon_t^d(z), \qquad \alpha^d(z) > 0, \qquad (2)$$

The operator E denotes the expectation conditional on all the available information in market z. P_t is the log of economy-wide aggregate price. The supply of commodity z, $y_t^s(z)$, depends on the perceived relative price in that market. The demand for commodity z, $y_t^d(z)$, depends on the perceived relative price and aggregate shocks, $M - EP_t$. The stochastic disturbances $\varepsilon_t^s(z)$ and $\varepsilon_t^d(z)$ capture relative supply and demand shifts, respectively. It is assumed that the excess demand shifter, $\varepsilon_t(z) \equiv \varepsilon_t^d(z) - \varepsilon_t^s(z)$, is independent and normally distributed with mean zero and variance σ_ε^2.

Prices in a market may move sluggishly because factors such as adjustment costs, sales contracts, government price support policies, and decentralized planning, can prevent prices from instantaneous adjustment. As in McCallum (1978), price sluggishness emulates partial adjustment formula:

$$P_t(z) - P_{t-1}(z) = \gamma(z)[P_t^*(z) - P_{t-1}(z)], \qquad 0 < \gamma(z) \leq 1 \tag{3}$$

where $P_t^*(z)$ is the market clearing price at which supply is equal to demand. The range of $\gamma(z)$ from zero to one implies that the degree of price flexibility varies across markets. Markets with $\gamma(z)$ values closer to zero have more rigid prices. On the other hand, markets with $\gamma(z)$ values closer to one have fairly flexible prices. Values of $\gamma(z)$ equal to one, of course, imply perfectly flexible prices. It should be pointed out that sluggish price adjustments are not incompatible with the rational expectation approach. As elucidated by Gordon (1982), economic agents realize the price inertia, and thus, take this into account, along with other relevant past information, in forming the expectations rationally.

To complete the model, the growth rate of money supply, comprising systematic and random components, is specified as:

$$M_t - M_{t-1} \equiv \Delta M_t \equiv m_t = g_t + u_t \tag{4}$$

where g_t and u_t are anticipated and unanticipated growth rates of money supply at time t, respectively. Thus, g_t is the expected money supply growth based on all economy-wide information shared by agents in all markets. Consequently, g_t is the same in all the markets.

The random component, u_t is taken to be generated by a temporally independent white noise process with mean zero and variance σ_u^2. However, the posterior expectation of unanticipated money supply depends on local market price, $P_t(z)$, and thus, it varies across markets.

Since $P_t^*(z)$ is defined as the market clearing price at which supply in (1) is equal to demand in (2), the solution for price $P_t^*(z)$, after substituting for M_t from equation (4), can be written as:

$$P_t^*(z) = [1 - \lambda(z)]EP_t + \lambda(z)[M_{t-1} + g_t + u_t + \varepsilon_t(z)] \quad (5)$$

where $\lambda(z) = \dfrac{1}{\alpha^s(z) + \alpha^d(z)}$. Substituting $P_t^*(z)$ in the price adjustment equation (3), we get

$$P_t(z) = (1 - \gamma(z))P_{t-1}(z) + \gamma(z)[1 - \lambda(z)]EP_t + \gamma(z)\lambda(z)[M_{t-1}+ g_t+ u_t+ \varepsilon_t(z)]. \quad (6)$$

This price equation is not a reduced-form equation since EP_t appears in (6).

Next, price is determined as a function of exogenous variables by using the method of undetermined coefficients. By utilizing the model's log linearity, a reduced-form solution for the aggregate price is conjectured as:

$$P_t = \Pi_1 P_{t-1} + \Pi_2 M_{t-1} + \Pi_3 g_t + \Pi_4 u_t \quad (7)$$

where Πs are unknown parameters. The aggregate price is determined by its own lag and the current money supply, which, as in (4), consists of M_{t-1}, g_t, and u_t. The lagged aggregate price enters P_t equation because the partial adjustment assumption entails that individual market price depends on its lag price (see eqn. (6)). By realizing that M_{t-1} and g_t are fully perceived at time t, whereas the posterior expectation of u_t is conditional on market-specific information, the expected aggregate price can be written as:

$$EP_t = \Pi_1 P_{t-1} + \Pi_2 M_{t-1} + \Pi_3 g_t + \Pi_4 Eu_t. \quad (8)$$

The key to the formation of the aggregate price expectations is the computation of Eu_t conditional on the market-specific information, $P_t(z)$. The conditional expectations of u_t are calculated, in effect, by linearly projecting u_t on $P_t(z)$. That is,

$$Eu_t|P_t(z) = [\frac{\sigma_u^2}{\sigma_u^2 + \sigma_\varepsilon^2}][u_t + \varepsilon_t(z)]. \tag{9}$$

Substituting (9) into (8), we find that

$$EP_t = \Pi_1 P_{t-1} + \Pi_2 M_{t-1} + \Pi_3 g_t + \Pi_4[\frac{\sigma_u^2}{\sigma_u^2 + \sigma_\varepsilon^2}][u_t + \varepsilon_t(z)]. \tag{10}$$

The expected aggregate price from (10) is plugged into the market-specific price in (6) to obtain

$$\begin{aligned} P_t(z) = {} & [1-\gamma(z)]P_{t-1}(z) + \gamma(z)[1-\lambda(z)]\{\Pi_1 P_{t-1} + \Pi_2 M_{t-1} + \Pi_3 g_t + \Pi_4[\frac{\sigma_u^2}{\sigma_u^2 + \sigma_\varepsilon^2}][u_t + \varepsilon_t(z)]\} \\ & + \gamma(z)\lambda(z)[M_{t-1} + g_t + u_t + \varepsilon_t(z)]. \end{aligned} \tag{11}$$

The general price is obtained by averaging $P_t(z)$ across all markets[4]

$$\begin{aligned} P_t = {} & [(1-\gamma)+\gamma(1-\lambda)\Pi_1]P_{t-1} + [\gamma(1-\lambda)\Pi_2+\gamma\lambda]M_{t-1} + [\gamma(1-\lambda)\Pi_3+\gamma\lambda]g_t \\ & + [\gamma(1-\lambda)\Pi_4\frac{\sigma_u^2}{\sigma_u^2 + \sigma_\varepsilon^2} + \gamma\lambda]u_t. \end{aligned} \tag{12}$$

Noting that equations (12) and (7) are equal, the four Π coefficients are determined by matching corresponding terms in the two equations. The resulting solution is

$$\Pi_1 = \frac{1-\gamma}{1+\lambda\gamma-\gamma}, \quad \Pi_2 = \frac{\lambda}{\lambda+\frac{1}{\gamma}-1}, \quad \Pi_3 = \frac{\lambda}{\lambda+\frac{1}{\gamma}-1}, \text{ and } \Pi_4 = \frac{\gamma(\sigma_u^2+\sigma_\varepsilon^2)}{[\gamma+\frac{1}{\lambda}(1-\gamma)]\sigma_u^2+\frac{\sigma_\varepsilon^2}{\lambda}}. \tag{13}$$

These Π coefficients are substituted into (11) to obtain the market price $P_t(z)$ and into (7) or (12) to obtain the aggregate price, P_t:

$$P_t(z) = [1-\gamma(z)]P_{t-1}(z) + \gamma(z)\frac{(1-\lambda(z))(1-\gamma)}{1+\lambda\gamma-\gamma}P_{t-1} + \gamma(z)\frac{[\lambda+\lambda(z)(\frac{1}{\gamma}-1)]}{\lambda+\frac{1}{\gamma}-1}[M_{t-1} + g_t]$$
$$+ \gamma(z)\frac{[\gamma+\gamma(z)\lambda(z)\frac{(1-\gamma)}{\lambda}]\sigma_u^2 + \frac{\lambda(z)}{\lambda}\sigma_\varepsilon^2}{[\gamma+\frac{1}{\lambda}(1-\gamma)]\sigma_u^2 + \frac{\sigma_\varepsilon^2}{\lambda}}[u_t + \varepsilon_t(z)]. \tag{14}$$

$$P_t = \frac{1-\gamma}{1+\lambda\gamma-\gamma}P_{t-1} + \frac{\lambda}{\lambda+\frac{1}{\gamma}-1}[M_{t-1} + g_t] + \frac{\gamma(\sigma_u^2 + \sigma_\varepsilon^2)}{[\gamma+\frac{1}{\lambda}(1-\gamma)]\sigma_u^2 + \frac{\sigma_\varepsilon^2}{\lambda}}u_t. \tag{15}$$

Important results in eqns. (14) and (15) can be readily interpreted. When prices move sluggishly (i.e., $0 < \gamma(z) < 1$ and thus $0 < \gamma < 1$), they do not adjust instantaneously to the changes in M_{t-1} and g_t. Consequently, movements in M_{t-1} and g_t are not fully captured by $P_t(z)$ and P_t, and thus, the coefficients of M_{t-1} and g_t are less than one in both $P_t(z)$ and P_t equations.[5] If $\gamma(z)$ and γ are set to one, i.e., prices are perfectly flexible, the coefficients in eqns. (14) and (15) will simplify. Particularly, the coefficients of M_{t-1} and g_t will become one and the ensuing results will be identical to eqns. (11) and (12) in Hercowitz (1981).[6] In this case, prices will change equiproportionately in response to perceived movements in money supply growth. However, as captured in eqns. (14) and (15), if prices adjust gradually, they will not change proportionately in response to perceived movements in money growth.

Since the partial adjustment assumption eqn. in (3) implies that $P_t(z)$ is weighted average of lag price $P_{t-1}(z)$ and market clearing price $P_t^*(z)$ with weights equal to $(1-\gamma(z))$ and $\gamma(z)$, respectively, $P_{t-1}(z)$ enters the $P_t(z)$ equation with the coefficient of $(1-\gamma(z))$, and the rest of the arguments have the weight $\gamma(z)$. $P_t(z)$ also depends on aggregate lag price that reflects the effects of price sluggishness in other markets. The aggregate price also depends on the lag price.

The relative price, the difference between the market price and the economy-wide aggregate price, is determined by subtracting (15) from (14) as:

$$
\begin{aligned}
P_t(z) - P_t = {} & [1-\gamma(z)]P_{t-1}(z) + \frac{(1-\gamma)[\gamma(z)(1-\lambda(z))-1]}{1+\lambda\gamma-\gamma}P_{t-1} \\
& + \frac{\gamma(z)[\lambda+\lambda(z)(\frac{1}{\gamma}-1)]-\lambda}{\lambda+\frac{1}{\gamma}-1}[M_{t-1} + g_t] \\
& + \frac{[\gamma(z)\gamma+\gamma(z)\lambda(z)\frac{(1-\gamma)}{\lambda}-\gamma]\sigma_u^2 + [\frac{\gamma(z)\lambda(z)}{\lambda}-\gamma]\sigma_\varepsilon^2}{[\gamma+\frac{1}{\lambda}(1-\gamma)]\sigma_u^2 + \frac{\sigma_\varepsilon^2}{\lambda}}u_t \\
& + \frac{[\gamma(z)\gamma+\gamma(z)\lambda(z)\frac{(1-\gamma)}{\lambda}]\sigma_u^2 + \frac{\gamma(z)\lambda(z)}{\lambda}\sigma_\varepsilon^2}{[\gamma+\frac{1}{\lambda}(1-\gamma)]\sigma_u^2 + \frac{\sigma_\varepsilon^2}{\lambda}}\varepsilon_t(z).
\end{aligned}
\tag{16}
$$

The results for relative prices in (16) can be interpreted as follows. The systematic part of monetary policy, g_t, does influence the relative price. This result occurs because the magnitude of adjustments of $P_t(z)$ and P_t in response to movements in g_t differs, because of the varying degree of price stickiness across markets, and thus, relative price $(P_t(z) - P_t)$ is not neutral to the systematic component of the monetary policy. It should be observed that nonneutrality of the systematic part of monetary policy occurs even though g_t is contained in the information set, and therefore agents take this information into account in forming the expectations. Note that if $\gamma(z) < (>) \gamma$, i.e., the price in market z is less (more) flexible than the aggregate price, then g_t will have a negative (positive) effect on the relative price of market z.[7]

The unsystematic part of the money growth, u_t, also affects the relative price. This is because the random component of monetary policy is not contained in the agents' information set and, thus, not captured in the price expectations. As a result, the unperceived money growth affects relative price. If $\gamma(z)$ and γ are equal to one, it can be readily verified that the relative price will be influenced only by the random components of monetary policy and market-specific excess demand shocks, $\varepsilon_t(z)$. And, the coefficients of u_t and $\varepsilon_t(z)$ will also be simplified.

The next step is to derive reduced-form equations for output supply and demand. To do that, first we need to solve for EP_t by plugging the value of Π coefficients in (13) into (10). Then, the resulting expression for EP_t along with $P_t(z)$ are substituted in the supply and demand functions to obtain the reduced-form equations for supply and demand:

$$
\begin{aligned}
y_t^s(z) = {} & \alpha^s(s)[1-\gamma(z)]P_{t-1}(z) + \alpha^s(z)\frac{(1-\gamma)[\gamma(z)(1-\lambda(z))-1]}{1+\lambda\gamma-\gamma}P_{t-1} \\
& + \alpha^s(z)\frac{[\gamma(z)[\lambda+\lambda(z)(\frac{1}{\gamma}-1)]-\lambda]}{\lambda+\frac{1}{\gamma}-1}[M_{t-1} + g_t] \\
& + \alpha^s(z)\frac{[\gamma(z)\gamma+\gamma(z)\lambda(z)\frac{(1-\gamma)}{\lambda}-\gamma]\sigma_u^2 + \frac{\gamma(z)\lambda(z)}{\lambda}\sigma_\varepsilon^2}{[\gamma+\frac{1}{\lambda}(1-\gamma)]\sigma_u^2 + \frac{\sigma_\varepsilon^2}{\lambda}}[u_t + \varepsilon_t^d(z)] \\
& + \frac{[\gamma+\frac{1-\gamma}{\lambda}]\sigma_u^2 - \alpha^s(z)[\gamma(z)\gamma+\gamma(z)\lambda(z)\frac{(1-\gamma)}{\lambda}-\gamma]\sigma_u^2 + \frac{1-\alpha^s(z)\gamma(z)\lambda(z)}{\lambda}\sigma_\varepsilon^2}{[\gamma+\frac{1}{\lambda}(1-\gamma)]\sigma_u^2 + \frac{\sigma_\varepsilon^2}{\lambda}}\varepsilon_t^s(z).
\end{aligned}
\tag{17}
$$

$$
\begin{aligned}
y_t^d(z) = {} & -\alpha^d(z)[1-\gamma(z)]P_{t-1}(z) + \frac{-\alpha^d(z)(1-\gamma)[\gamma(z)(1-\lambda(z))-1] - (1-\gamma)}{1+\lambda\gamma-\gamma}P_{t-1} \\
& + \frac{(\frac{1}{\gamma}-1)-\alpha^d(z)[\gamma(z)[\lambda+\lambda(z)(\frac{1}{\gamma}-1)]-\lambda]}{\lambda+\frac{1}{\gamma}-1}[M_{t-1} + g_t] \\
& + \alpha^d(z)\frac{[\gamma(z)\gamma+\gamma(z)\lambda(z)\frac{(1-\gamma)}{\lambda}-\gamma]\sigma_u^2 + \gamma\sigma_u^2 + \frac{\gamma(z)\lambda(z)}{\lambda}\sigma_\varepsilon^2}{[\gamma+\frac{1}{\lambda}(1-\gamma)]\sigma_u^2 + \frac{\sigma_\varepsilon^2}{\lambda}}\varepsilon_t^s(z) \\
& + \frac{\frac{1-\gamma}{\lambda}\sigma_u^2 - \alpha^d(z)[\gamma(z)\gamma+\gamma(z)\lambda(z)\frac{(1-\gamma)}{\lambda}-\gamma]\sigma_u^2 + \frac{1-\alpha^d(z)\gamma(z)\lambda(z)}{\lambda}\sigma_\varepsilon^2}{[\gamma+\frac{1}{\lambda}(1-\gamma)]\sigma_u^2 + \frac{\sigma_\varepsilon^2}{\lambda}}[u_t + \varepsilon_t^d(z)].
\end{aligned}
\tag{18}
$$

Note that supply is not equal to demand because as a result of gradual price adjustment the actual price is not equal to the equilibrium price. If $\gamma(z)$ and γ are set to one, the reduced-form supply and demand will be identical and equal to equilibrium output, and also only the unperceived component of the money supply growth will influence the output, confirming the policy ineffectiveness proposition.

However, if the prices adjust sluggishly, supply and demand are influenced by anticipated money growth, and the policy ineffectiveness proposition is invalidated. The unperceived monetary policy also affects relative prices and output. This is because the random component of the money growth u_t is not contained in the information set, and economic agents cannot differentiate the impact of u_t from the demand shocks ($\varepsilon_t^d(z)$), which also explains why u_t and $\varepsilon_t^d(z)$ have common coefficients in (17) and (18). Because of the gradual adjustment of prices, output supplied and demanded also depend on lagged prices.

In the reduced-form supply equation, if $\gamma(z)$ is less (greater) than γ, the effect of the systematic component of monetary policy would be negative (positive). Thus, when we aggregate the output of all the sectors, the anticipated monetary policy may be neutral at the aggregate level because the positive and negative effects at the sectoral levels may offset each other. This result corroborates the findings of Blinder and Mankiw (1984), who noted that the aggregate level evaluation of demand shocks can present a false picture of the disaggregate level impacts.

III. NONNEUTRALITY OF FISCAL POLICY

Laumas and McMillin (1984) provided empirical evidence in support of the nonneutrality of anticipated fiscal policy on *aggregate real output*. In their empirical study, Glick and

Hutchison (1990) provided strong justifications for inclusion of fiscal policy in testing the policy ineffectiveness proposition. Their arguments can be succinctly summarized: (a) real economic variables are affected by both monetary and fiscal policies; (b) to the extent the anticipated or unanticipated monetary and fiscal policies are related, exclusion one of these variables will bias the estimated coefficients;[8] and (c) monetary and fiscal policies may respond simultaneously through feedback rules and exhibit covariation to a common shock such as unemployment changes. Glick and Hutchison (1990) provided empirical evidence of nonneutrality at the *aggregate level* when fiscal policy is tested separately, but found only components of monetary policies, but not of fiscal policies, to be significant when anticipated and unanticipated monetary and fiscal policies are tested jointly. They also noted that fiscal policy may be neutral at the *aggregate level*, "but may nonetheless have significant effects on the composition of output."

On the theoretical developments, McCallum and Whitaker (1979) have shown that in the context of rational expectation models with flexible prices and wages, systematic components of fiscal policies are ineffective in influencing output. However, the built-in stabilizer feature of the fiscal policy, which automatically responds to current economic shocks, may affect output. Canzoneri (1978) has also theoretically demonstrated that policy conclusions of rational expectation models might be misleading because of the exclusions of systematic and random components of fiscal policy in the analysis. He concluded that a coordinated monetary and fiscal policy will influence the output.

The theoretical analysis of the section II can be readily modified to include fiscal policies and show that the anticipated fiscal stimulus, like the anticipated monetary policy, also affects the real economic variables. More specifically, eqn. (7) can be modified to conjecture that aggregate price also depends on anticipated and unanticipated components of fiscal policy, and the rest of the analysis is carried out as before. The end results are that not only unanticipated, but also anticipated, fiscal policy influences the real economic variables at the *sectoral level*.

IV. EMPIRICAL ANALYSIS

The strategy of the empirical analysis is to test the MRE hypothesis of monetary policy separately, and of monetary and fiscal policies simultaneously. First, the joint estimation procedure used to estimate the farm output and policy forecasting equations is discussed. Second, the policy feedback rules for money growth and fiscal policy are estimated and discussed. Third, the MRE hypothesis of monetary policy separately, and monetary and fiscal policies jointly, is tested on farm real GNP.

Joint Estimation Procedure

The framework for testing the policy MRE hypothesis involves the estimation of the system of policy forecasting equations and reduced-form output equations. Previous studies by Barro (1977, 1978) used a two-step procedure to test the money neutrality proposition. In this procedure, the money forecasting equation is estimated by using ordinary least squares (OLS), and the predicted and residual series from this regression are used, respectively, as the perceived and unperceived money supply growth in the output equation, which is also estimated by OLS. Pagan (1984) has shown that the two-step procedure is biased against the acceptance of policy ineffectiveness proposition. Also, Mishkin (1982a) notes that the two-step procedure ignores possible covariances between the parameters across the money growth and output equations. If the covariances between these parameters are nonzero, then the estimates obtained from the two-step procedure are not efficient, and the test statistics will render invalid inferences. Furthermore, the two-step procedure does not allow one to explicitly test the rationality proposition. In light of these statistical problems, Mishkin (1982a) developed a joint estimation procedure for testing the MRE hypothesis. This procedure estimates the money forecasting equation and the output equation as a joint nonlinear system. This procedure, unlike the two-step procedure, can be used to test both the neutrality and rationality propositions.[9] In the current study, Mishkin's joint estimation procedure is used.

The specifications used to forecast the monetary and fiscal policies are, respectively, given by the following equations:

$$MG_t = X_{t-1}\psi + u_t \tag{19}$$

$$FP_t = Z_{t-1}\zeta + v_t \tag{20}$$

where MG_t and FP_t are the actual money growth and fiscal policy measure in t, X_{t-1}, and Z_{t-1} are the vectors of macroeconomic variables pertinent to forecasting MG_t and FP_t, respectively, ψ and ζ are coefficient vectors, and u_t and v_t are disturbance terms assumed to be generated by a temporally independent white noise and thus uncorrelated with independent variables. The policy forecasting equations are used to decompose the dependent variable into the anticipated and unanticipated components. The predicted values represent the anticipated policy measures and the residuals the unanticipated measures. Thus, the anticipated money growth denoted as MG_t^a is equal to $X_{t-1}\psi$, and the unanticipated money supply growth, MG_t^u, is equal to $MG_t - X_{t-1}\psi = u_t$. Similarly, the anticipated fiscal policy, FP_t^a, is equal to $Z_{t-1}\psi$, and the unanticipated fiscal policy, FP_t^u, is equal to $FP_t - Z_{t-1}\psi = v_t$.

If the neutrality proposition holds, then the real output will depend only on unanticipated policy measures, and the output equation can be written as:

$$y_t(z) = c + \sum_{i=0}^{n} \delta_i(MG_{t-i} - X_{t-1-i}\psi) + \sum_{i=0}^{n} \phi_i(FP_{t-i} - Z_{t-1-i}\zeta) + \varepsilon_t(z) \tag{21}$$

where $y_t(z)$ is the log of farm real GNP, $\varepsilon(z)$ is the error term, n is the number of lags, c is the intercept term, and δ and ϕ are the coefficients.

However, as shown in the theoretical section, under the sluggish price movements, the output will depend on both the anticipated and unanticipated policy measures. Thus, for the purpose of empirical analysis, the output supply (17) derived in section II can be written, with the inclusion of fiscal policy measures, as:[10]

$$y_t(z)=c+\sum_{i=0}^{n}\delta_i(MG_{t-i}-X_{t-1-i}\psi^*)+\sum_{i=0}^{n}\beta_i(X_{t-1-i}\psi^*)+\sum_{i=0}^{n}\phi_i(FP_{t-i}-Z_{t-1-i}\zeta^*)+\sum_{i=0}^{n}\theta(Z_{t-1-i}\zeta^*)+\varepsilon_t(z) \quad (22)$$

where $\psi = \psi^*$ and $\zeta = \zeta^*$, β and θ are the coefficients of anticipated monetary and fiscal policies, respectively. Equations (19), (20), and (21) constitute the most constrained system, whereas equations (19), (20), and (22) with $\psi = \psi^*$ and $\zeta = \zeta^*$ not imposed constitute the most unconstrained system of the model.

Since the joint estimation procedure allows for covariances between parameters across equations (i.e., "information crossovers" between the forecast and output equations), the estimates of ψ, ζ, δ, β, ϕ, and θ are efficient, and the test statistics are also valid.

Tests of joint hypothesis, i.e., joint tests of the rationality and the neutrality propositions, are conducted by constructing a likelihood ratio statistic from the constrained system in equations (19), (20), and (21) and the unconstrained system in equations (19), (20), and (22) with $\psi = \psi^*$ and $\zeta = \zeta^*$ not imposed. Tests of monetary neutrality only, under the maintained hypothesis of rationality, are analyzed by computing the likelihood ratio statistic where the constrained system is (19), (20), and (21) and the unconstrained system is (19), (20), and (22) with $\psi = \psi^*$ and $\zeta = \zeta^*$ imposed. Finally, the rationality proposition, without maintaining the neutrality, is tested by examining the likelihood ratio statistic where the constrained system is (19), (20), and (22) with $\psi = \psi^*$ and $\zeta = \zeta^*$ imposed and the unconstrained system is (19), (20), and (22) with $\psi = \psi^*$ and $\zeta = \zeta^*$ not imposed. The joint hypothesis, neutrality, and rationality propositions are tested by estimating the appropriate constrained and unconstrained systems. From the estimated results of the corresponding constrained and unconstrained systems, the likelihood ratio statistic is constructed as:

$$2N\,[\log(SSR^c) - \log(SSR^u)], \tag{23}$$

where SSR^c is the sum of squared residuals from the constrained system, SSR^u is the sum of squared residuals from the unconstrained system, and N is the number of observations in each equation. The test statistic is asymptotically distributed as $\chi^2(q)$ under the null hypothesis, where q is the total number of restrictions imposed.

Monetary and Fiscal Policy Forecasting Equations

The first step in testing the MRE hypothesis is to estimate the forecasting equations for monetary and fiscal policies. The predicted values from these equations are defined as anticipated policy measures, and the residuals are used as unanticipated measures. The anticipated and unanticipated policy components are used as explanatory variables in the farm real GNP equation in testing MRE hypothesis. Mishkin (1982a) points out, in specifying the policy forecasting equations, that an atheoretical statistical model is superior to the one implied by the economic theory because exclusion of any useful information based on theoretical grounds in predicting the policy actions is not appropriate. Furthermore, the atheoretical approach prevents a search for the alternative specifications to generate particular results expected by the researcher. This approach is undertaken by, among others, Laumas and

McMillin (1984) and Glick and Hutchison (1990). Following these studies, the specifications of the monetary and fiscal policy feedback rules are based on the notion that agents use all the available and pertinent macroeconomic information in predicting the policy actions. In particular, we use Glick and Hutchison's specifications in estimating the money growth (MG) and fiscal policy (FP) forecasting equations. The fiscal policy measure is generated by deflating the change in the real middle-expansion trend ***budget surplus*** with potential GNP.[11] This measure of fiscal policy is independent of the particular position of business cycle, and thus, is abstracted from the automatic stabilizing feature of the fiscal policy (Laumas and McMillin, 1984). The explanatory variables used in these specifications include: lagged values of money growth, fiscal policy measures, unemployment rate (UN), percentage change in the GNP deflator (INF), and change in the three-month treasury bill rate (RTB).

In the money growth forecasting equation, the lagged values of the money growth equation capture the persistence effects not explained by other variables. Sargent and Wallace (1975, 1981) and Barro (1977) have posited that government deficits have accelerated the money growth. Thus, lagged values of FP are included to help predict the money supply growth. The lagged values of unemployment in the money growth equation reflect the counter-cyclical response of monetary policy to the unemployment rate. The lagged values of inflation and the treasury bill rate capture the policy changes pursued by the Fed in response to inflationary pressures and interest rate changes, respectively. The same set of variables are used to explain the federal governments fiscal policy actions. Following Glick and Hutchison (1990), a common lag length of seven for each variable in both the equations is selected, and all the explanatory variables are retained irrespective of their joint or individual significance.[12]

Quarterly data are used for the empirical analysis. Data for GNP deflator, government expenditure, revenues, and farm sector real GNP are collected from the National Income and Product Accounts of the United States and various issues of the Survey of the Current Business published by the U.S. Department of Commerce. The data for the M1-money supply and the three-month treasury bill rate are obtained from the St. Louis Federal Reserve Bank. The unemployment rate is collected from the International Financial Statistics. The data period used for the estimation of policy forecasting equations runs from 1954:1 to 1990:4.

The estimated results for the policy forecasting equations are presented in table 1. Since both the equations contain variables other than the lagged dependent variables, the observational equivalence problem expounded by Sargent is not encountered. The results of an F-test, which is carried out under the null hypothesis that seven coefficients of the individual policy response variables are jointly zero, are reported in table 2.

The difference between the policy forecasting equations in this study and those of Glick and Hutchison (1990) is in the time period. Glick and Hutchison estimate over the period 1961:1-1985:4, whereas our time period is longer, i.e., 1954:1-1990:4. Comparisons of F-statistics results reveal that the longer period in our study led to a higher level of significance in most of the variables. In the money forecasting equation, lagged money growth, unemployment, and interest rates are key determinants of money supply in both the studies; however, they are more strongly significant in the current study. The inflation variable is not significant in both the studies. The fiscal policy measure was not significant in Glick and Hutchison's study, but is significant in the current study. The significance of the fiscal policy measure might be attributed to the fact that during the 1950s money supply responded rapidly to government budget increases (Barro, 1977). In the fiscal policy equation, all the variables play important roles in predicting government budget; whereas in Glick and Hutchison only unemployment and inflation are significant, and the other three variables contributed little in predicting anticipated fiscal policy stimulus. Notably, interest rate is not significant in Glick and Hutchison's study, but is highly significant in the current study. It should be observed that unemployment is a strong predictor of both monetary and fiscal policy indicating that the interaction effects between monetary and fiscal stimulus are caused by a common shock, i.e., unemployment. The estimated values of DW statistics indicate absence of serial correlation in both the equations.

Analysis of Farm Output

The empirical results of the MRE hypothesis tests and the impacts of the anticipated and unanticipated monetary and fiscal policy measures on farm output are the focus of this subsection. The farm output equation is jointly estimated with the forecasting equations as explained previously. The time period of the output equation estimation is 1954:1 to 1990:4.[13] The farm output equation is estimated using a polynomial distributed lag (PDL) with a fifth-order polynomial and an endpoint constraint. Earlier studies found that the test results are affected by the lag length (the value of n in equations (21) and (22)) of the anticipated and unanticipated policy measures (Gordon, 1979, and Mishkin, 1982a, 1982b). For instance, Mishkin opts for a longer lag by noting that exclusion of relevant variables will result in invalid test statistics; in contrast, inclusion of irrelevant variables will at worst only decrease the power of tests and expound rejections even more telling, but will not yield incorrect test statistics. In light of this suggestion, we estimate the model with a lag length of 20. This lag length is also in line with the recent experiences of the impacts of the macro policies on the farm sector. For example, the tight monetary policy and budget deficit problems which began in the early 1980s had continued effects on the farm sector, and led to mid and late 1980s recession in the agricultural economy (Devadoss, et al., 1990). Timmer, Falcon, and Pearson (1983) provide an excellent discussion of the transmission mechanisms of the impacts of macro policies on agriculture (also see, Timmer, 1984).

The likelihood ratio test results presented in table 1 show that the MRE hypothesis is strongly rejected both in the monetary policy model and monetary and fiscal policy model.[14] The joint hypothesis of rationality and neutrality is rejected at the 1 percent level in both the models. Further tests were conducted to ascertain whether the rejection of the joint hypothesis is due to neutrality or rationality constraints. Separate tests of rationality and neutrality indicate that both are not supported in both models.

Rejection of the rationality proposition in the agricultural sector is not surprising because not all farmers use rational expectations in making their production decisions. In some markets, for example the chicken market where a high level of vertical integration exists, farmers who have education skills and ready access to information may use rational expectations in their production decisions. However, not all farmers are equipped with the necessary education skills and the information network to readily access all the available information in forming rational expectations and making production decisions. Also, because of the disperse and isolated location of farms, information reaches farmers with considerable time lag. Furthermore, the U.S. agriculture is heavily influenced by the demand and supply conditions in the world market. Agricultural export companies may know the changes in the demand and supply conditions in the world market. However, farmers, who are the producers, in general do not have good knowledge of the developments in the world market. In summary, not all farmers are adequately equipped to operate under rational expectations.

Rejection of the neutrality proposition (at the 1 percent level) provides evidence that contemporaneous and lagged anticipated aggregate demand policies, both monetary and fiscal, do matter in effecting the farm output. The reasons why neutrality is not supported can be understood by closely examining the movements of farm output prices in the farm sector. Conventional wisdom would suggest that agricultural commodity prices are perfectly flexible. However, many farm programs in the United States are designed to stabilize prices of primary agricultural commodities such as feed grains and wheat through buffer stock programs. For example, the price stabilization programs such as the loan rates and Farmer Owned Reserve (FOR) programs stabilize the nominal prices of agricultural commodities within the lower and upper price bounds. Specifically, the loan rates program provides downside price protection, whereas the FOR program limits the upward movements of prices (Wright, 1985). Thus, these programs restrict the movements of agricultural commodity prices. Consequently, these programs, by imparting some rigidity to the commodity prices, cause these prices to adjust sluggishly and limit the response of nominal prices to any exogenous shocks such as aggregate demand shocks (also see Just and Chambers, 1987). For example, Rausser et al. (1986) note that there is an asymmetry in the effect of macro policy on agricultural markets because of U.S. agricultural policies that support prices for major commodities. Also, Bessler (1984) concludes that agricultural prices do not adjust faster than industrial prices to money supply shocks.[15]

Sluggishness in nominal prices is expected to cause large movements in relative prices. As shown in the section II, the anticipated money growth will influence the real output if prices do not adjust instantaneously. The test results in table 3, which indicate a strong rejection of neutrality proposition, provide the empirical evidence to substantiate that the systematic macro policies do affect the real farm output. A deeper understanding of the test results in table 3 can be accomplished by studying the estimated output equations, which are discussed next.

Table 4 reports the results of the effects of unanticipated policy measures on farm output, obtained from nonlinear joint estimation of the policy forecasting equation and the output equation. Specifically, model 4.1 is the result of nonlinear joint estimation of the money growth equation (19) and the output equation (21) with unanticipated monetary policy only by imposing cross-equation restrictions that ψ is equal in both the equations. Model 4.2 is the result of nonlinear joint estimation of the monetary and fiscal policy forecasting equations (19) and (20) and the output equation (21) by imposing cross-equation restrictions that ψ is equal in (19) and (21) and ζ is equal in (20) and (21). The joint nonlinear estimates of ψ of model 4.1 and ψ and ζ of model 4.2, and those models that follow, are available from the author upon request.

The results of both the models indicate that the fit of the equations is good as reflected by the significance of many of the estimated coefficients and high explanatory power of the unanticipated, both monetary and fiscal, policy variables. The signs of all the estimated coefficients, except δ_0 in model 4.1, of unanticipated monetary policy in model 4.1 and in model 4.2 are negative, and consequently, the sums of these coefficients are also negative. Except for δ_0 in model 4.1 and δ_0 and δ_{20} in model 4.2, all the estimates of unanticipated money growth are significant. The significance of the estimated coefficients of longer lags indicate the appropriateness of including 20 lags in the model. Most of the significant estimates of unanticipated fiscal policy measures in model 4.2 are negative, and sums of the coefficients are also negative. The negative impacts of the unanticipated policy measures are related to the output price stickiness imparted by U.S. commodity price stabilization programs. The commodity prices, because of their sluggishness, do not adjust freely to aggregate demand shocks, creating unfavorable relative prices, which causes the farm output supply to decline.

Despite the significant effects of unanticipated macro policy stimulus, the policy ineffectiveness proposition is not supported, as shown by the neutrality test results. A closer examination of the estimates of the farm output equation with anticipated and unanticipated policy measures provides further insights into the neutrality rejections. Table 5 presents the estimated results of the farm output equation with inclusions of anticipated policy measures as additional explanatory variables. Specifically, model 5.1 is the result of nonlinear joint estimation of the money forecasting equation (19) and the output equation (22) with unanticipated and anticipated money growths only, by imposing cross-equation restrictions that ψ is equal in both the equations. Model 5.2 is the result of nonlinear joint estimation of the monetary and fiscal policy forecasting equations (19) and (20) and the output equation (22) by imposing cross-equation restrictions that ψ is equal in (19) and (22) and ζ is equal in (20) and (22). The results indicate that the model fits the data well as reflected by the relatively high R^2.

In model 5.1, as one would expect from the results of likelihood ratio tests in table 3, many of the anticipated money growth coefficients are significant. The estimated coefficients of anticipated money growth are negative in the first few quarters and positive in the remaining quarters. The negative impacts of the anticipated money supply growth in the early quarters may be related to the stickiness of commodity prices. As demonstrated in the theoretical section, the anticipated money supply growth will have negative impacts on real output if commodity prices are less flexible than the aggregate prices. U.S. farm programs by imparting rigidity to the commodity prices make them less flexible than the aggregate prices. For nominal movements associated with the currently anticipated portion of money growth, the producer is caught in relatively rigid price adjustments, and cannot totally escape the significant negative impacts, but makes the adjustments possible (such as reduced input use) to confine the negative

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impacts to a relatively short period. Thus, the anticipated money growth impacts are negative and short-lived. On the other hand, the unanticipated monetary impacts in all the quarters are negative as in the model 4.1. This result occurs because the unanticipated shocks by nature are unexpected, and farmers operating in long and rigid production cycles are not able to adjust their production decisions instantaneously to any surprises. The rigid production cycle, combined with sluggish price adjustments, cause the commodity supply to respond negatively to unanticipated monetary policy.

In model 5.2, the anticipated and unanticipated fiscal policy measures are included in addition to the monetary policy measures. The effects of anticipated monetary policy are somewhat similar to the results in model 5.1 in that the impacts are negative in the first few quarters and positive in the latter quarters. Similarly, the anticipated government structural deficit (surplus) has negative (positive) impacts in the first few quarters and positive (negative) impacts in the latter periods. Both the unanticipated monetary and fiscal policy stimulus continue to have negative impacts on the farm output.

As pointed out by Glick and Hutchison (1990), anticipated and unanticipated monetary and fiscal policies are interrelated and should be included simultaneously in testing the policy ineffectiveness proposition. This interaction is evident from the comparison of results of models 5.1 and 5.2. Once, the fiscal policy measures are included, the unanticipated money growth becomes less significant, i.e., compared to 19 significant coefficients in model 5.1, only four coefficients are significant in model 5.2. The anticipated money growth, though, continues to be significant in model 5.2, but by five fewer significant coefficients than in model 5.1.

In model 5.1, it is evident that the anticipated money growth is the sole aggregate demand variable responsible for the neutrality rejection. However, in model 5.2, it is not readily apparent whether anticipated monetary and fiscal policies contributed, if at all, individually for neutrality rejections. In order to ascertain whether each of these anticipated policies contributed in rejecting the neutrality proposition, further tests were conducted by estimating additional equations. More specifically, equation (22) with restrictions all β_i are zero was estimated to test anticipated monetary policy alone matters, and equation (22) with restrictions all θ_i are zero was estimated to test anticipated fiscal policy alone matters. The likelihood ratio statistic for the neutrality tests of anticipated monetary policy alone is 38.37, which is significant at the 1 percent level. Similarly, for the anticipated fiscal policy, the likelihood ratio statistic is 39.32, which is also significant at the 1 percent level. From these test statistics, we can conclude that both anticipated monetary and fiscal policies contributed individually in rejecting the neutrality proposition. These results are different from Glick and Hutchison's findings that when anticipated and unanticipated monetary and fiscal policies are included, fiscal policies do not have significant impacts on *aggregate real GNP*. However, they correctly conclude by noting that fiscal policy stimulus may have neutral effects on aggregate real variable, but may yet have significant effects on the components of aggregate variable.

It should be emphasized that, as elaborated in the theoretical section, the neutrality at aggregate level does not necessarily imply that the hypothesis holds at the disaggregate level also because of the differences in the structure of the markets and differing degree of price flexibility across sectors. Thus, the empirical results provide evidence to the theoretical findings.

V. SUMMARY AND IMPLICATIONS

According to the policy ineffectiveness proposition, only the unanticipated aggregate demand policies have impacts on real economic variables, and the anticipated policy measures have no real impacts. This study demonstrates theoretically if nominal prices adjust sluggishly, then the anticipated aggregate demand policies will affect the real economic variables at the *sectoral level.* Also, examination of a specific sector sheds light in understanding the nature of the markets and in ascertaining the reasons for the cause of the nonneutrality. To provide empirical support to the theoretical findings, the MRE hypothesis was tested on real farm output by using monetary policy alone, and monetary and fiscal policies jointly, as aggregate demand policies. The test procedure involves a joint estimation of real farm output and policy forecasting equations.

The results reveal that the MRE hypothesis is strongly rejected. Separate tests of neutrality and rationality hypotheses are also unfavorable in supporting these hypotheses. The estimated output equations show that the anticipated aggregate demand policies do have significant effects on farm output and, thus, do not support the neutrality hypothesis. The implication of this result is that since the agricultural sector is influenced by anticipated macroeconomic policies, analysis of agricultural market dynamics should take these effects into account. Also, the farm policy decision makers should consider the macroeconomic shocks in formulating price support and storage policies. This is particularly important in view of the increased integration between the farm and nonfarm sectors (see Timmer, 1986, pp. 120-125). Thus, the macroeconomic disturbances are vital to agricultural policy developments. These results support the view of Modigliani (1977) who, in his American Economic Association presidential address, argued against the policy ineffectiveness proposition and supported active stabilization policy.

Table 1. Systematic Component of Money Growth and Fiscal Policy Equations.

Explanatory Variables	Money Growth Coefficient Estimates	Money Growth t-statistics	Fiscal Policy Coefficient Estimates	Fiscal Policy t-statistics
Constant	0.063	0.31	-0.172	-0.50
MG_{t-1}	0.518[c]	5.71	0.123	0.80
MG_{t-2}	0.264[c]	2.62	0.192	1.13
MG_{t-3}	-0.189[a]	-1.93	-0.028	-0.17
MG_{t-4}	0.146	1.46	-0.380[b]	-2.25
MG_{t-5}	-0.037	-0.36	0.669[c]	3.82
MG_{t-6}	0.096	0.95	-0.423[b]	-2.45
MG_{t-7}	-0.052	-0.61	0.126	0.87
FP_{t-1}	-0.133[c]	-2.51	-0.332[c]	-3.69
FP_{t-2}	0.105[a]	1.82	-0.054	-0.55
FP_{t-3}	0.071	1.27	-0.063	-0.67
FP_{t-4}	-0.061	-1.14	-0.068	-0.74
FP_{t-5}	0.058	1.13	0.005	0.06
FP_{t-6}	0.041	0.88	0.015	0.18
FP_{t-7}	-0.009	-0.20	-0.060	-0.83
UN_{t-1}	-0.563[c]	-2.89	-0.429	-1.30
UN_{t-2}	1.043[c]	2.95	0.471	0.79
UN_{t-3}	-0.351	-0.92	0.367	0.57
UN_{t-4}	0.011	0.03	0.220	0.36
UN_{t-5}	-0.430	-1.27	-0.606	-1.06
UN_{t-6}	0.374	1.16	0.403	0.74
UN_{t-7}	-0.055	-0.30	-0.360	-1.16
INF_{t-1}	0.040[c]	0.37	0.303[a]	1.65
INF_{t-2}	-0.056	-0.51	-0.326[a]	-1.75
INF_{t-3}	0.087	0.80	-0.395[b]	-2.12
INF_{t-4}	0.024[b]	0.21	0.206	1.10
INF_{t-5}	-0.089	-0.85	-0.276	-1.56
INF_{t-6}	-0.020	-0.19	-0.254	-1.40
INF_{t-7}	0.126	1.19	0.143	0.80
RTB_{t-1}	-0.675[c]	-8.17	-0.108	-0.78
RTB_{t-2}	0.076	0.69	0.207	1.11
RTB_{t-3}	0.189	1.62	-0.100	-0.51
RTB_{t-4}	-0.257[b]	-2.14	0.583[c]	2.90
RTB_{t-5}	0.192	1.50	0.045	0.21
RTB_{t-6}	-0.063	-0.53	0.334[a]	1.61
RTB_{t-7}	-0.056	-0.54	-0.472[c]	-2.71
$R/\bar{R}^2$	0.88/0.64		0.55/0.43	
DW	2.03		2.02	

Coefficients significant at the 10%, 5%, and 1% levels are denoted by a, b, and c, respectively.

Table 2. F-Statistics of the Explanatory Variables in the Money Growth and Fiscal Policy Equations

Explanatory Variables	Money Growth		Fiscal Policy	
	F-Statistics	Significance Levels	F-Statistics	Significance Levels
MG_{t-i}	12.73	(0.00)	3.37	(0.00)
FP_{t-i}	2.49	(0.02)	2.24	(0.04)
UN_{t-i}	2.49	(0.02)	2.21	(0.04)
INF_{t-i}	0.40	(0.90)	3.18	(0.00)
RTB_{t-i}	13.31	(0.00)	3.00	(0.01)

The F-statistics test the null hypothesis that the coefficients on the seven lagged values of each of these variables are equal to zero.

Table 3. Likelihood Ratio Tests of Macro Rational Expectation Hypothesis.

	Monetary Policy	Monetary and Fiscal Policies
	Likelihood Ratio Statistics	Likelihood Ratio Statistics
Joint Hypothesis	$\chi^2(39)=230.88^*$	$\chi^2(71)=416.55^*$
Neutrality	$\chi^2(5) = 34.80^*$	$\chi^2(10) = 63.71^*$
Rationality	$\chi^2(34)=196.08^*$	$\chi^2(67)=406.47^*$

The likelihood ratio statistic is computed as $2N[\log(SSR^c)-\log(SSR^u)]$, where SSR^c and SSR^u are the sum of squared residuals from the constrained and unconstrained systems, respectively, and N is the number of observations in each equation.

* significant at 1% level.

Table 4. Nonlinear Estimates of Effects of Unanticipated Policy Measures on Farm Output.

Unanticipated Monetary Policy Model 4.1	Unanticipated Monetary and Fiscal Policies Model 4.2	
C = 4.165(0.062)**	C = 4.158(0.057)**	
δ_0 =0.4E−4(0.01)	δ_0 =−0.005(0.008)	ϕ_0 =−0.031(0.006)**
δ_1 =−0.017(0.009)*	δ_1 =−0.023(0.008)**	ϕ_1 =−0.036(0.005)**
δ_2 =−0.029(0.01)**	δ_2 =−0.031(0.010)**	ϕ_2 =−0.039(0.007)**
δ_3 =−0.039(0.01)**	δ_3 =−0.032(0.011)**	ϕ_3 =−0.039(0.008)**
δ_4 =−0.047(0.011)**	δ_4 =−0.032(0.012)**	ϕ_4 =−0.038(0.008)**
δ_5 =−0.054(0.012)**	δ_5 =−0.033(0.014)**	ϕ_5 =−0.035(0.009)**
δ_6 =−0.060(0.013)**	δ_6 =−0.036(0.015)**	ϕ_6 =−0.031(0.009)**
δ_7 =−0.066(0.014)**	δ_7 =−0.042(0.016)**	ϕ_7 =−0.025(0.009)**
δ_8 =−0.071(0.014)**	δ_8 =−0.050(0.017)**	ϕ_8 =−0.019(0.009)*
δ_9 =−0.076(0.015)**	δ_9 =−0.060(0.017)**	ϕ_9 =−0.012(0.009)
δ_{10}=−0.080(0.015)**	δ_{10}=−0.071(0.017)**	ϕ_{10}=−0.005(0.009)
δ_{11}=−0.083(0.015)**	δ_{11}=−0.081(0.017)**	ϕ_{11}=0.002(0.009)
δ_{12}=−0.085(0.016)**	δ_{12}=−0.089(0.017)**	ϕ_{12}=0.008(0.009)
δ_{13}=−0.084(0.016)**	δ_{13}=−0.093(0.017)**	ϕ_{13}=0.013(0.009)
δ_{14}=−0.082(0.015)**	δ_{14}=−0.093(0.017)**	ϕ_{14}=0.017(0.009)*
δ_{15}=−0.077(0.014)**	δ_{15}=−0.087(0.016)**	ϕ_{15}=0.019(0.009)*
δ_{16}=−0.069(0.014)**	δ_{16}=−0.075(0.015)**	ϕ_{16}=0.020(0.009)*
δ_{17}=−0.059(0.013)**	δ_{17}=−0.059(0.014)**	ϕ_{17}=0.019(0.009)*
δ_{18}=−0.046(0.012)**	δ_{18}=−0.040(0.012)**	ϕ_{18}=0.016(0.008)*
δ_{19}=−0.032(0.01)**	δ_{19}=−0.021(0.010)*	ϕ_{19}=0.012(0.007)
δ_{20}=−0.016(0.007)*	δ_{20}=−0.006(0.007)	ϕ_{20}=0.006(0.004)
$\sum_{i=0}^{20} \delta_i$=−1.172(0.224)**	$\sum_{i=0}^{20} \delta_1$=−1.058(0.223)**	$\sum_{i=0}^{20} \phi_i$=−0.178(0.127)**
R^2=0.755 SE=0.091	R^2=0.862	SE=0.067

Note: Model 4.1 is estimated using the system (19) and (21) by imposing cross-equation constraints that ψ is equal in both the equations. Note that in Model 4.1 the unanticipated fiscal policy is excluded from (21). Model 4.2 is estimated using the system (19), (20), and (21) by imposing constraints ψ is equal in (19) and (21), and ζ is equal in (20) and (21). The asymptotic standard errors for coefficients are given in parentheses.

*significant at 5% level
** significant at 1% level

Table 5. Nonlinear Estimates of Effects of Anticipated and Unanticipated Monetary and Fiscal Policies on Farm Output.

Monetary Policy Model 5.1	Monetary and Fiscal Policies Model 5.2	
$C = 3.824(0.093)^{**}$		$C=3.923(0.066)^{**}$
$\delta_0=-0.010(0.010)$	$\delta_0=-0.006(0.009)$	$\phi_0=-0.032(0.006)^{**}$
$\delta_1=-0.019(0.007)^{*}$	$\delta_1=-0.019(0.011)$	$\phi_1=-0.029(0.007)^{**}$
$\delta_2=-0.023(0.008)^{**}$	$\delta_2=-0.026(0.015)$	$\phi_2=-0.027(0.011)^{*}$
$\delta_3=-0.023(0.008)^{**}$	$\delta_3=-0.022(0.018)$	$\phi_3=-0.024(0.013)^{*}$
$\delta_4=-0.022(0.008)^{**}$	$\delta_4=-0.012(0.019)$	$\phi_4=-0.022(0.015)$
$\delta_5=-0.020(0.008)^{*}$	$\delta_5=-0.001(0.021)$	$\phi_5=-0.020(0.016)$
$\delta_6=-0.018(0.008)^{*}$	$\delta_6=0.009(0.022)$	$\phi_6=-0.017(0.018)$
$\delta_7=-0.017(0.009)^{*}$	$\delta_7=0.015(0.021)$	$\phi_7=-0.015(0.018)$
$\delta_8=-0.018(0.009)^{*}$	$\delta_8=0.018(0.020)$	$\phi_8=-0.013(0.018)$
$\delta_9=-0.019(0.009)^{*}$	$\delta_9=0.016(0.018)$	$\phi_9=-0.011(0.017)$
$\delta_{10}=-0.022(0.009)^{*}$	$\delta_{10}=0.010(0.016)$	$\phi_{10}=-0.009(0.016)$
$\delta_{11}=-0.025(0.009)^{**}$	$\delta_{11}=0.002(0.015)$	$\phi_{11}=-0.007(0.015)$
$\delta_{12}=-0.028(0.009)^{**}$	$\delta_{12}=-0.008(0.015)$	$\phi_{12}=-0.006(0.014)$
$\delta_{13}=-0.032(0.010)^{**}$	$\delta_{13}=-0.019(0.016)$	$\phi_{13}=-0.005(0.013)$
$\delta_{14}=-0.034(0.010)^{**}$	$\delta_{14}=-0.028(0.017)$	$\phi_{14}=-0.004(0.013)$
$\delta_{15}=-0.036(0.011)^{**}$	$d_{15}=-0.035(0.018)^{*}$	$\phi_{15}=-0.003(0.013)$
$\delta_{16}=-0.036(0.011)^{**}$	$\delta_{16}=-0.038(0.018)^{*}$	$\phi_{16}=-0.003(0.012)$
$\delta_{17}=-0.034(0.012)^{**}$	$\delta_{17}=-0.037(0.017)^{*}$	$\phi_{17}=-0.003(0.012)$
$\delta_{18}=-0.029(0.012)^{*}$	$\delta_{18}=-0.032(0.015)^{*}$	$\theta_{18}=-0.002(0.010)$
$\delta_{19}=-0.022(0.010)^{*}$	$\delta_{19}=-0.022(0.012)$	$\phi_{19}=-0.002(0.009)$
$\delta_{20}=-0.012(0.007)$	$\delta_{20}=-0.011(0.008)$	$\phi_{20}=-0.001(0.005)$
$\sum_{i=0}^{20}\delta_i=-0.497(0.139)^{**}$	$\sum_{i=0}^{20}\delta_i=-0.235(0.171)$	$\sum_{i=0}^{20}\phi_i=-0.255(0.175)$
$\beta_0=0.007(0.008)$	$\beta_0=-0.003(0.010)$	$\theta_0=0.015(0.009)$

Table 5. Nonlinear Estimates of Effects of Anticipated and Unanticipated Monetary and Fiscal Policies on Farm Output (cont'd.).

Monetary Policy Model 5.1	Monetary and Fiscal Policies Model 5.2	
β_1=-0.003(0.004)	β_1=-0.009(0.010)	θ_1=0.029(0.014)*
β_2=-0.006(0.004)	β_2=-0.013(0.011)	θ_2=0.034(0.018)*
β_3=-0.006(0.004)	β_3=-0.015(0.011)	θ_3=0.033(0.021)
β_4=-0.003(0.004)	β_4=-0.015(0.010)	θ_4=0.028(0.023)
β_5=0.001(0.003)	β_5=-0.014(0.010)	θ_5=0.020(0.025)
β_6=0.005(0.003)	β_6=-0.012(0.010)	θ_6=0.012(0.027)
β_7=0.008(0.004)*	β_7=-0.009(0.010)	θ_7=0.004(0.027)
β_8=0.011(0.004)**	β_8=-0.005(0.009)	θ_8=-0.004(0.026)
β_9 = 0.013(0.004)**	β_9 = 0.0002(0.009)	θ_9=-0.009(0.025)
β_{10}=0.014(0.004)**	β_{10}=0.006(0.008)	θ_{10}=-0.014(0.023)
β_{11}=0.016(0.004)**	β_{11}=0.012(0.008)	θ_{11}=-0.017(0.022)
β_{12}=0.017(0.005)**	β_{12}=0.018(0.008)*	θ_{12}=-0.019(0.022)
β_{13}=0.019(0.005)**	β_{13}=0.025(0.008)**	θ_{13}=-0.020(0.022)
β_{14}=0.022(0.005)**	β_{14}=0.030(0.008)**	θ_{14}=-0.021(0.022)
β_{15}=0.025(0.005)**	β_{15}=0.035(0.008)**	θ_{15}=-0.021(0.021)
β_{16}=0.028(0.006)**	β_{16}=0.038(0.008)**	θ_{16}=-0.020(0.019)
β_{17}=0.030(0.006)**	β_{17}=0.039(0.008)**	θ_{17}=-0.019(0.016)
β_{18}=0.030(0.006)**	β_{18}=0.036(0.009)**	θ_{18}=-0.018(0.013)
β_{19}=0.027(0.006)**	β_{19}=0.030(0.008)**	θ_{19}=-0.014(0.009)
β_{20}=0.018(0.005)**	β_{20}=0.018(0.006)**	θ_{20}=-0.009(0.006)
$\sum_{i=0}^{20}\beta_i$=0.272(0.066)**	$\sum_{i=0}^{20}\beta_i$=0.191(0.047)**	$\sum_{i=0}^{20}\theta_i$=-0.031(0.247)
R^2=0.766 S.E.=0.007	R^2=0.881	S.E.=0.004

Note: Model 5.1 is estimated using the system (19) and (22) by imposing cross-equation constraints that ψ is equal in both equations. In model 5.1 the fiscal policy is excluded from (22). Model 5.2 is estimated using the system (19), (20),and (22) by imposing constraints that ψ is equal in (19) and (22), and ζ is equal in (20) and (22). The asymptotic standard errors for coefficients are given in parentheses.

*significant at 5% level.
**significant at 1% level.

ENDNOTES

1. This proposition is also known in the macroeconomics literature as Macro Rational Expectation (MRE) hypothesis (Modigliani, 1977; Mishkin, 1982a), Monetary Neutrality Proposition (Lucas, 1972; Barro, 1976), and Natural Rate Hypothesis (Sargent, 1973). These terms are used interchangeably in this study.

2. Other elements used in discrediting this hypothesis are long-term nominal wage contracts (Fischer, 1977), and inventory adjustments (Blinder, 1982).

3. Mishkin (1982a) demonstrated that MRE hypothesis can be decomposed into the rationality and neutrality tests and developed a methodology, which he termed as the joint estimation procedure because the policy forecasting equation and the real economic variable equation are jointly estimated, to test the MRE hypothesis and also rationality and neutrality separately.

4. The averages of $\gamma(z)$ and $\lambda(z)$ are denoted by γ and λ, respectively. The average of $\varepsilon_t(z)$ is zero.

5. To show that the coefficient of M_{t-1} and g_t is less than one in the $P_t(z)$ equation, we need to assume $\gamma(z) = \gamma$ and $\lambda(z) = \lambda$.

6. It should be pointed out that the coefficients in (14) and (15) and the following equations are written such that if $\gamma(z)$ and γ are equal to one, it can be readily seen that the ensuing results are identical to those in Hercowitz (1981, p. 334).

7. To show this result, we need to assume $\gamma(z) = \gamma$ and $\lambda(z) = \lambda$.

8. The interrelatedness of the fiscal and monetary policies has been highlighted by Sargent and Wallace (1975, 1981) by demonstrating that an increase in deficits causes higher money supply. Empirical evidence for this correlation has been provided by Hamburger and Zwick (1981), Levy (1981), Allen and Smith (1983), and Grier and Neiman (1987). Glick and Hutchison (1990) compute the extent of the bias and also discuss the possibility of misleading conclusions arising from the omitted variables problem.

9. Mishkin (1983) provides a more detailed discussion of the methodology by clearly documenting the estimation procedures and various steps involved in testing the MRE hypothesis.

10. Following previous studies, the output equation is specified as a function of only anticipated and unanticipated policy measures, and the lagged market price, general price, and money stock are not included.

11. Data for the real middle-expansion budget surplus was calculated by deflating the difference between the nominal receipts and expenditures by the GNP deflator. The potential GNP was generated from the predicted values from the regression of the log of real GNP on a

constant and a time trend with first-order autocorrelation correction.

12. Glick and Hutchison (1990) provide an elaborate justification for the choice of a common seven lag length and retaining all the explanatory variables.

13. Though the raw data starts at 1947:1, because of the long lags of anticipated and unanticipated policy measures in the farm output equation and the additional seven lags in the policy forecasting equation, the starting period for the estimation is 1954:1.

14. The MRE hypothesis of fiscal policy alone was also tested. The test results showed no evidence of acceptance of this hypothesis. The details of these results are available upon request.

15. See Bessler, Barnett, and Thompson (1983) for causality of money supply and commodity prices.

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