PLACE IN RETURN BOX to remove this checkout from your record.
TO AVOID FINES return on or before date due.

DATE DUE	DATE DUE	DATE DUE
~~[illegible]~~ ~~[illegible]~~		

THE IMPACTS OF U.S. FISCAL POLICIES ON AGRICULTURE

BY

Young Chan Choe

A DISSERTATION

Submitted to

Michigan State University

in partial fulfillment of the requirements

for the degree of

DOCTOR OF PHILOSOPHY

Department of Agricultural Economics

1991

ABSTRACT

THE IMPACTS OF U.S. FISCAL POLICIES ON AGRICULTURE

By

Young Chan Choe

Macroeconomists have different opinions on how fiscal policy affects the economy in general. Not surprisingly, these different views have also resulted in wide disagreements on how fiscal policies affect agriculture. Schuh (1981, 1983) and Barclay and Tweeten (1988), following the Keynesian hypothesis, have argued that an increase in the federal deficit causes unfavorable conditions for the farm economy by decreasing farm prices. On the other hand, Belongia and Stone (1985) and Batten and Belongia (1986) have rejected any possible connection between the federal deficit and farm prices, based on a New Classical macroeconomic model. Applying the neo-Keynesian differential price adjustment, Rausser (1985) and Rausser, Chalfant, Love and Stamoulis (1986) have argued that the federal deficit, due to sticky industrial prices, has the same short run impact on the farm economy as tight monetary policy, which implies a decrease in farm prices. Just and Chambers (1987) also applied the neo-Keynesian hypothesis, but considered farm prices as sticky as a result of price supports.

This study attempts to resolve these differing views with a detailed empirical analysis of the effects of U.S. fiscal policies on agriculture. Minimally restricted time series

models, in the form of vector autoregressions and error correction models, are used so that alternative theories of how agriculture responds to fiscal policies can be tested rather than imposed a priori. Results support the arguments of Rausser (1985) and others that the federal deficit decreases farm prices in the short run without affecting industrial prices. Thus, the farm economy suffers a cost price squeeze in the short run. However, farm prices move back to their long run equilibrium price level after an initial fiscal shock, reaching equilibrium after about two or three years. Thus, no long run changes in the relative position between farm prices and industrial prices are detected. The short run impact of the federal deficit occurs mainly through its effects on interest rates and the exchange rate.

Results from simulating the model over a five year period suggest that spending reductions are the most desirable form of deficit reduction from the general macroeconomic perspective, as spending reductions have little impact on total output or the general price level. A tax increase results in a slump in both the macroeconomy and the farm sector. Monetization of the deficit favors the farm sector initially because there is a short run increase in farm prices. However, monetization does not affect the relative price of farm and industrial goods in the long run, and induces inflation and a decrease in real output after its initial expansionary effects.

ACKNOWLEDGEMENTS

I wish to express my sincere appreciation to my major professor, Dr. Robert J. Myers, for his valuable guidance and counseling throuout author's graduate program and thesis writing. My special thanks also go to Professors Glenn L. Johnson, Lindon J. Robison, James F. Oehmke, and Richard T. Baillie, for their interest, ideas, and comments on the research. I would like to extend my gratitude to the Department of Agricultural Economics for continued financial support. Extra special thanks go to my parents for providing this opportunity and my wife, Hye Sun Lee, for her love.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Agricultural economists have paid considerable attention to the macroeconomics of agriculture since Schuh (1974) first considered the exchange rate as an important factor affecting the farm economy. Most attention has focused on exchange rates and the effects of monetary policy on agriculture (Shei and Thompson, 1981; Chambers and Just, 1981; Belongia and King, 1983; Rausser, 1985; Orden, 1983, 1986). Recently, however, the U.S. economy has experienced large federal budget deficits and a number of agricultural economists have tried to relate the depressed farm economy in the early 1980s to these deficits (Schuh, 1981, 1983, 1984b; Rausser, 1985; Rausser, Chalfant, Love, and Stamoulis, 1986; Belongia and Stone, 1985; Batten and Belongia, 1986; Just and Chambers, 1987).

Schuh (1981, 1983, 1984a, 1984b) discussed some potential effects of fiscal policy on agriculture. The federal deficit, in his view, tends to increase interest rates and hence the exchange rate. Agriculture, an export oriented sector, will suffer from the resulting reduction in exports, prices, and income. Schuh's conjecture brought immediate responses from the agricultural economics profession. Barclay and Tweeten (1988) supported Schuh's conjecture. Their simulation analysis resulted in a negative impact of the federal deficit on farm exports and prices through increased interest rates and exchange rates. Rausser, Chalfant, Love, and Stamoulis (1986) supported the conjecture only in the short run, with no long run impact from fiscal policy. On the other hand, Just and Chambers (1987) claimed in their theoretical work that the federal deficit stimulates the farm economy. However, Belongia and Stone (1985), and Batten and Belongia (1986) found no evidence of causality from federal deficit changes to agriculture in their empirical work.

Controversy over the effects of federal budget deficits on agriculture implies varying policy recommendations under the current huge deficit regime. Just and Chambers (1987) argued for a reduction of government spending in other sectors as the most favorable approach to agriculture for reducing the federal deficit. Alternatives were a monetary expansion and a tax increase. Belongia and Stone (1986) argued that focusing attention on deficit reduction measures diverts attention from more fundmental changes required in farm commodity programs. However, Rausser, Chalfant, Love, and Stamoulis (1986) argued for the dominance of macroeconomic policies over farm policies in influencing the farm economy in short run. The role of farm policies is confined only to reducing instability in farm prices and not to providing incentives for overallocation of resources to agricultural production. They suggest that frequent use of sectoral policies only brings more instability in the farm economy. Barclay and Tweeten (1988) defined optimal policy as a balanced budget and payment position, keeping no interest rate differentials between foreign and domestic economies.

This study considers some issues surrounding the impact of fiscal policy on agriculture. The primary objective is to test empirically the different explanations of how the federal deficit affects agriculture. Attention will be given to the significance and the persistence of federal deficit changes on farm prices. The mechanisms through which the impact of federal deficit changes get transferred to agriculture will also be considered.

The second objective of the study is to provide broad guidelines for policy under current economic conditions. The effects of changes in government spending, taxation, and monetization of the deficit on agriculture are examined. The performance of different deficit reduction policies will be considered against the alternative of maintaining the status quo.

Three different models, the simultaneous equations model (SEM), the rational expectations model (REM), and the vector autoregression model (VAR), have been used in empirical macroeconomic policy analysis. In this paper, the VAR model pioneered by Sims (1980) is used rather than a SEM or a REM model. VAR models employ only minimal restrictions on the dynamics of the variables being investigated, where other models incorporate large numbers of overidentifying restrictions on the model structure. Tests of stationarity, cointegration, and structural changes will be applied to selected data to assist in specification of the reduced form VAR model. Then, the relations between contemporaneous variables will be used to identify the structural form VAR.

Given certain identification restrictions, impulse response functions and decompositions of forecast error variance can be used to identify how fiscal policy affects agriculture. Forecasts under the current economic structure will provide a base projection for the time path of each variable in the system. Finally, alternative time paths for each variable under different policy scenarios will be simulated and compared to the base projection.

In the next chapter, the role of fiscal policies in agriculture will be stressed by looking at key summary statistics. Then, the major issues and controversies surrounding fiscal policies and agriculture will be discussed by reviewing the current literature. Chapter III provides details of the methods employed herein. In chapter IV, variables are defined and stationarity of data will be checked. In chapter V, an empirical model is fitted to data for the selected variables and the impact of fiscal policy on agriculture will be traced out. Given these estimation results, chapter VI identifies alternative policy measures for reducing the current federal budget deficit and compares them through simulation analysis. Chapter VII will provide a brief summary of findings and conclude the study with a few suggestions for future research.

CHAPTER II

ISSUES AND CONTROVERSIES

Budget deficits in the United States became a major issue for economists when they rose to an average of $206.7 billion per year between 1982 and 1986. Deficits, which fluctuated through the 1970s, suddenly grew to alarming levels in the 1980s (see Figure 1). At the same time, agriculture experienced a prolonged recession. The price of farm products decreased by an average of 2% per year in the early 1980s and real net farm income declined by 15% per year. Furthermore, the value of farm exports fell by an average 8% per year between 1980 and 1986 (see Figure 2).

Recently, a number of agricultural economists have tried to relate the depressed farm economy in the early 1980s to the growing federal budget deficits (Rausser, 1985; Belongia and Stone, 1985; Just and Chambers, 1987). However, their explanations are controversial and little has been done to test alternative theories empirically. Before turning to empirical tests, however, it is important to get a better perspective on the theoretical relationship between fiscal policies and the farm economy. To this end, the current status of macroeconomic theories on fiscal policy is first summarized. Then, the impact of fiscal policies on agriculture will be discussed within the context of these macroeconomic theories.

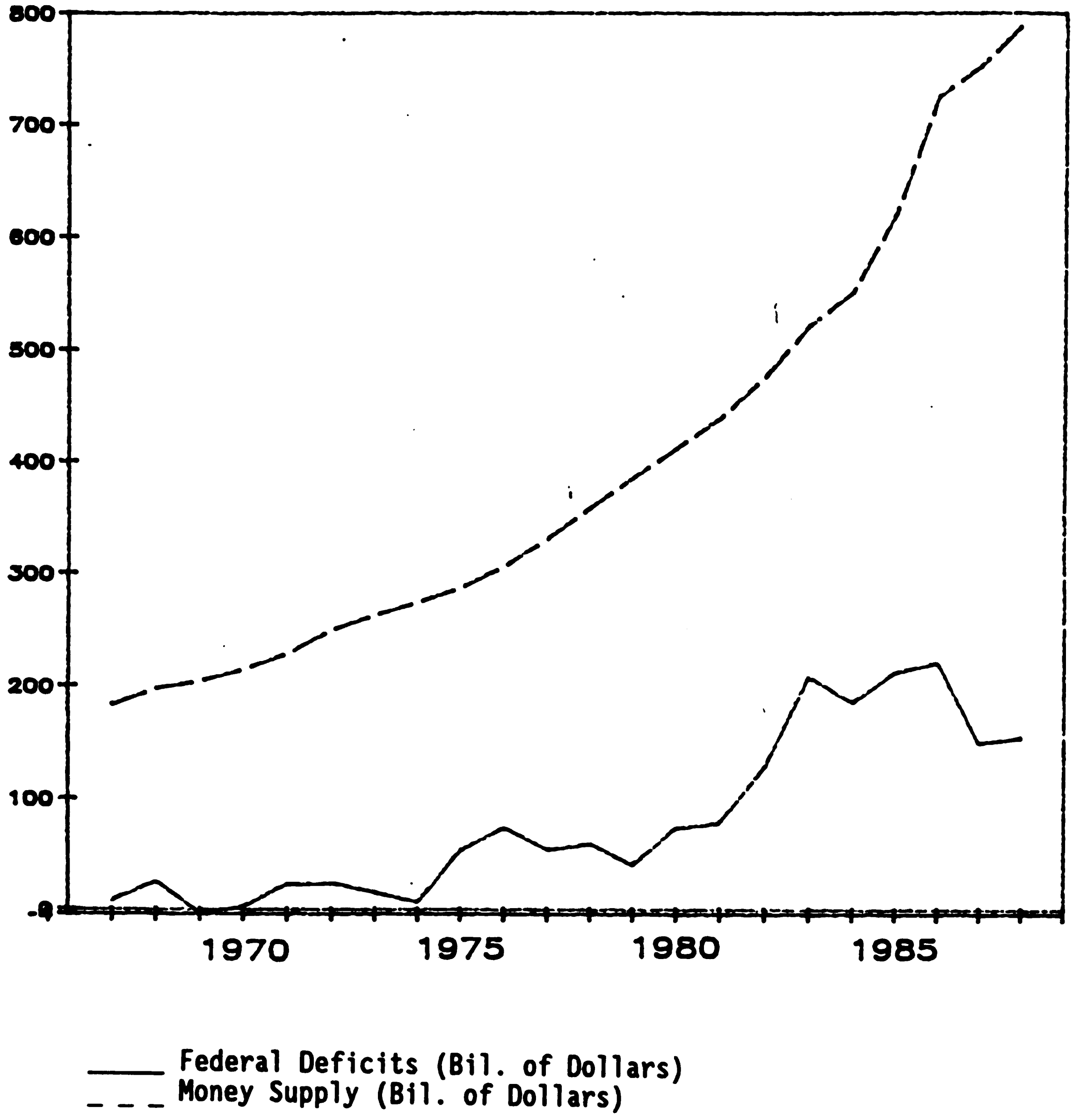


Figure 1. Federal Deficit and Money Supply

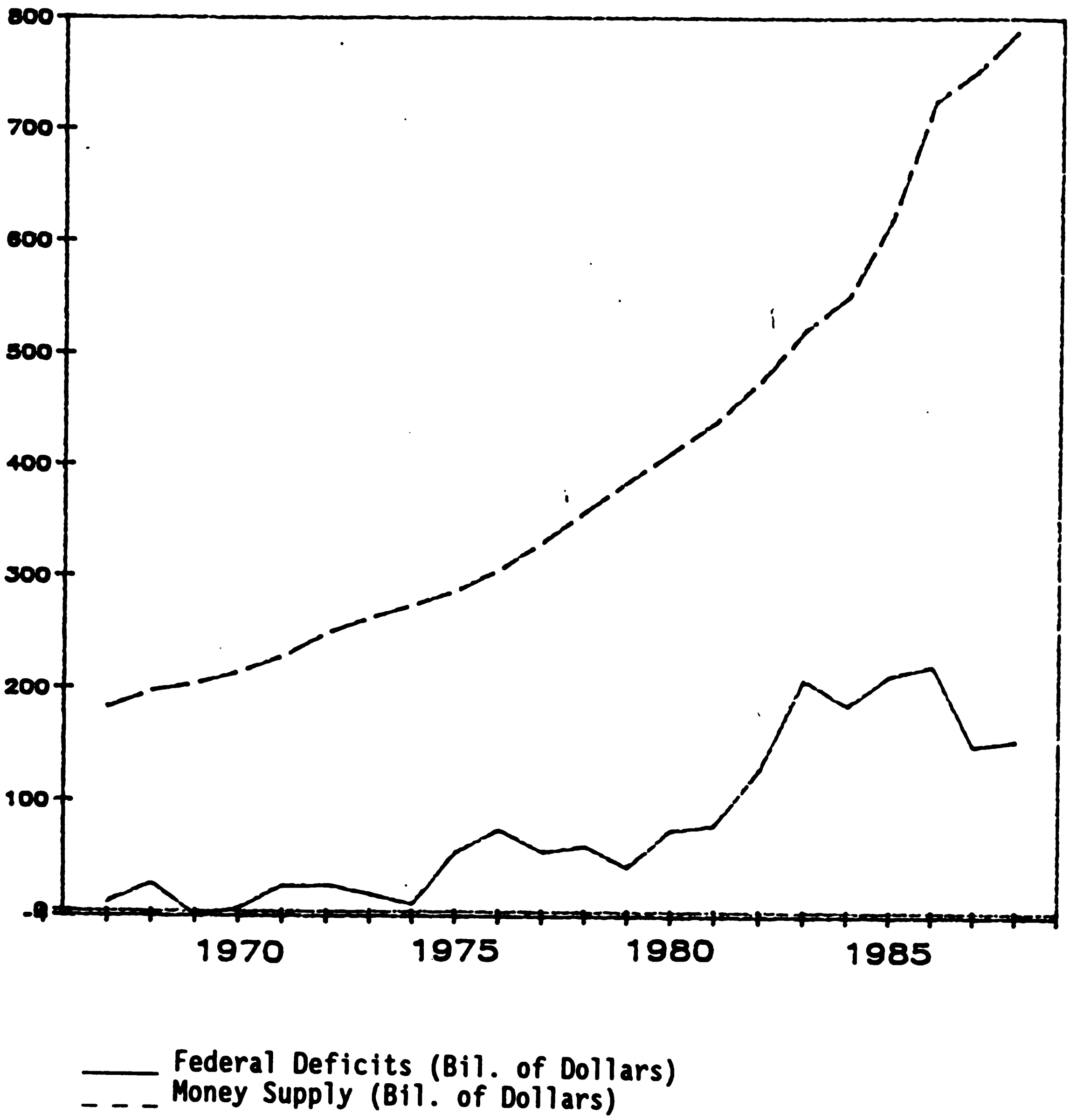
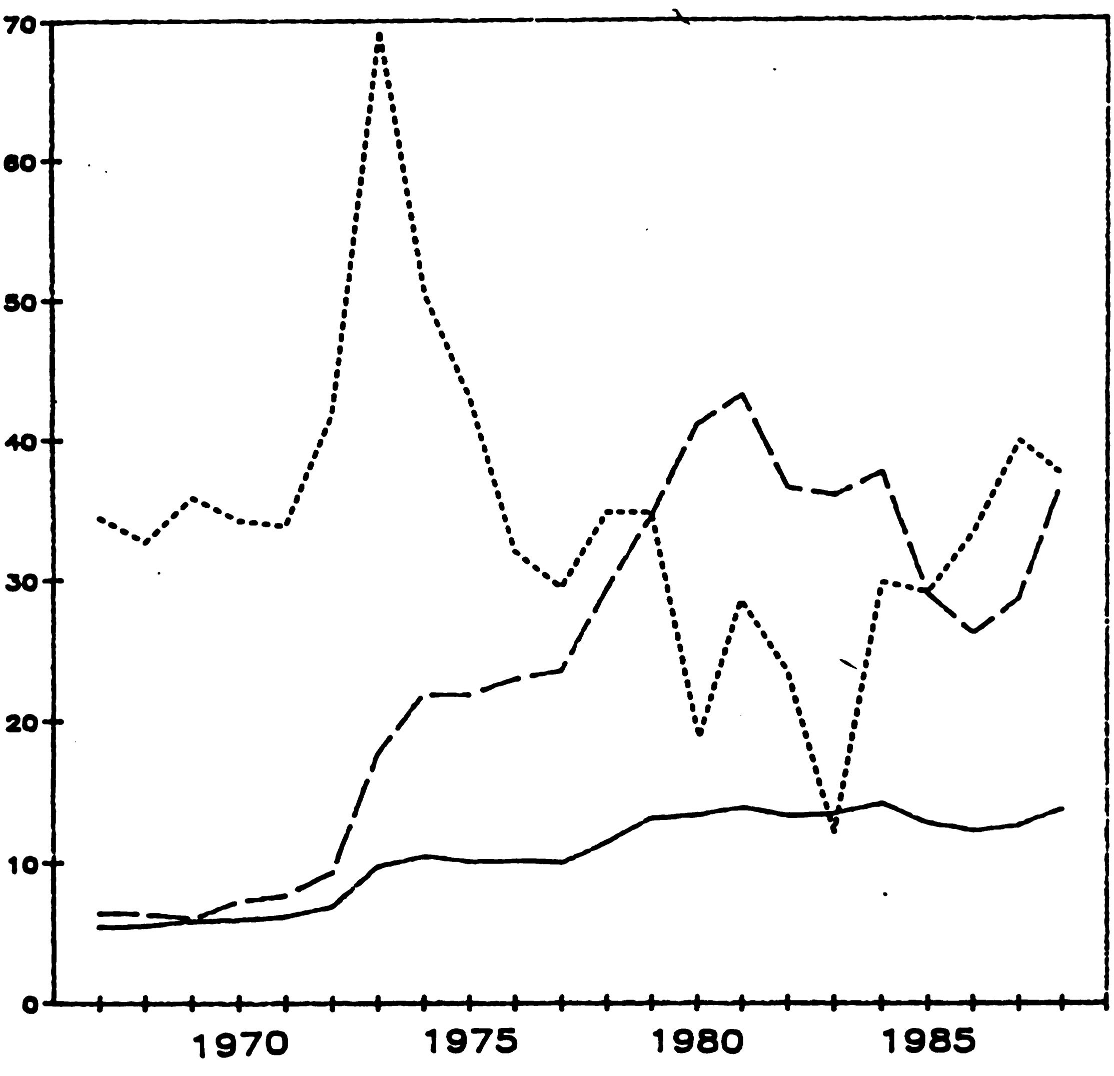


Figure 1. Federal Deficit and Money Supply



_____ Farm Prices (Index of Prices Received by Farmers, 1977=10)

__ __ Agricultural Exports (Mil. of Dollars)

_ _ _ Real Farm Income (Bil. of 1982 Dollars)

Figure 2. Farm Price, Export, and Income

1. Fiscal Policy in the Keynesian Paradigm

In a Keynesian economy, an expansionary fiscal policy (increase in government expenditure or reduction in taxes) shifts the IS curve out from IS_0 to IS_1 (Figure 3). This causes equilibrium output to increase from Y_0 to Y_1 and the price level to increase from p_0 to p_1. The real money stock, M^S/P, decreases because of higher prices causing the LM curve to move up to LM_1. The interest rate increases from r_0 to r_2 and investment drops, pulling the output level back to Y_2. Overall, the output, price, and interest rate of the economy are all increased in both nominal and real terms. Tight fiscal policy (decrease in government expenditure or increase in taxes) will move each of these variables in the opposite direction.

While increasing government expenditure can help to produce an initial economic boom, different ways of financing the expenditure have different effects in a Keynesian economy. Following Branson (1979) and Canto and Rapp (1982), the federal government has three distinct alternatives to finance increased expenditure. First, the government can increase taxes. A tax increase obviously will offset the initial stimulative effect of government spending by shifting the IS curve back towards the origin.

Second, the government expenditure can be financed by selling bonds to the public. The resulting increase in federal

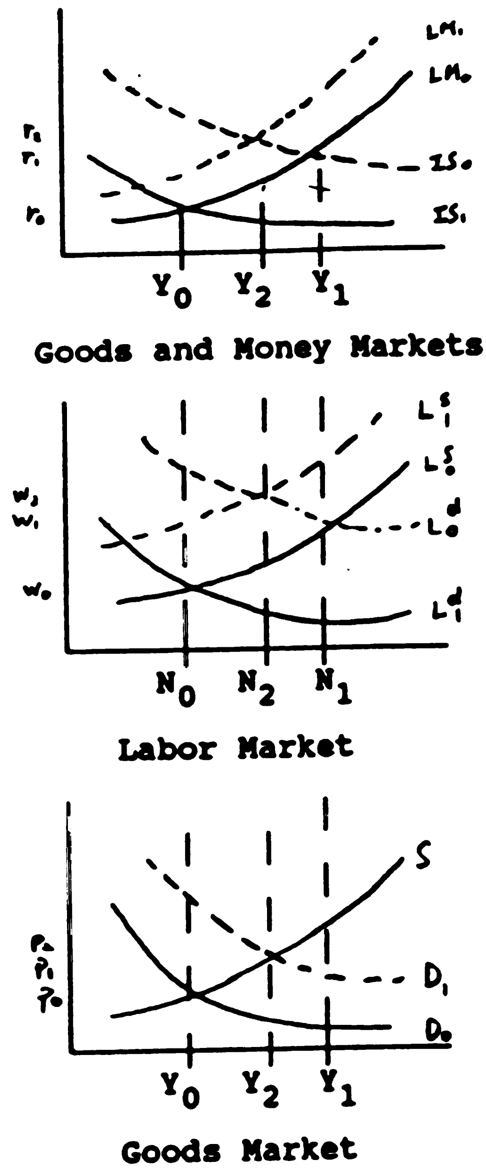


Figure 3. Fiscal Policy in the Keynesian Paradigm

debt bids up interest rates, thus choking private investment and reducing income. The high interest rates also will induce inflows of foreign capital which will bid up the value of dollar. The strong dollar makes exports more expensive and imports cheaper. Exports will fall and imports will expand. High interest rates also induce a release of commodity stocks to the market, because interest costs are an important component of the total costs of carrying stocks. Thus, the supply of commodities shifts to the right. All of these effects partially offset the stimulative effect of the IS shift caused by increased government spending.

Third, the government can finance the deficit by selling bonds to the monetary authority. The deficit in this case is financed by additional money creation which shifts the LM curve out. This causes a decrease in interest rates, an increase in income, and an increase in the price level. In this case, secondary effects reinforce the initial expansionary effect on the economy. This method is frequently referred to as "monetization" of the deficit.

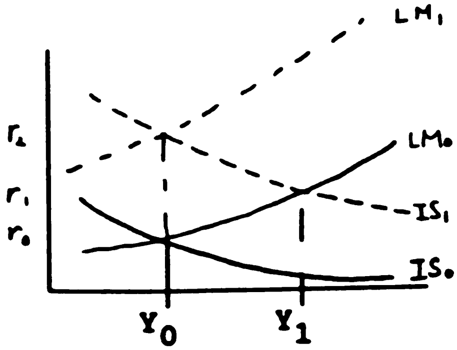
Although the effect of increased government expenditure with monetization is always expansionary in a Keynesian economy, it is not always true that increased government expenditure will be expansionary without monetization. Tobin (1969) argued that non-monetized deficits are still expansionary, because the magnitude of the initial expansionary effect is greater than the magnitude of the offsetting secondary contractionary effect. Brunner and Meltzer (1972) and Blinder and Solow (1973) argued not only that debt financed government expenditure is expansionary, but also that it is more expansionary than monetization of the expenditure. They show that higher incomes offset higher interest payments and hence stabilize the economy. However, Silber (1970) argues for the reverse case that non-monetized deficits are not expansionary.

The Keynesian paradigm is based on the disequilibrium assumption that markets do not always clear immediately, due to stickiness or slow adjustment processes in the labor market. Both the size of the budget and the method of financing the expenditure affect real output and prices in the economy (Tobin, 1969; Brunner and Meltzer, 1972; Tobin and Buiter, 1974; Blinder and Solow, 1973; CEASM, 1978; Branson, 1979; Feldstein, 1982).

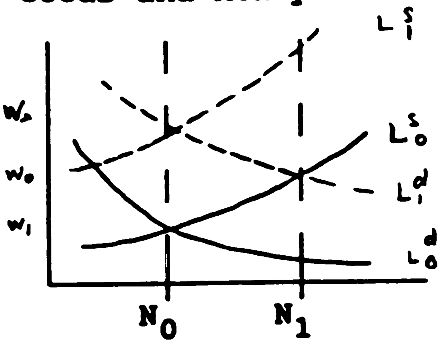
2. Fiscal Policies in the New Classical Paradigm

Tatom (1985) described ex-ante crowding out and the permanent income hypothesis as two important theoretical considerations from classical economics. Carlson and Spencer (1975) defined crowding out as a steady state government spending multiplier (changes of nominal income by a unit change in government spending given a constant money supply) of near zero. Canto and Lapp(1982) defined crowding out as a government expenditure multiplier of less than one and full crowding out as a multiplier of zero. If a fiscal policy action is largely offset by direct private sector responses, it fails to stimulate total economic activity. In this case, the private sector is said to have been "crowded out" by the government action.

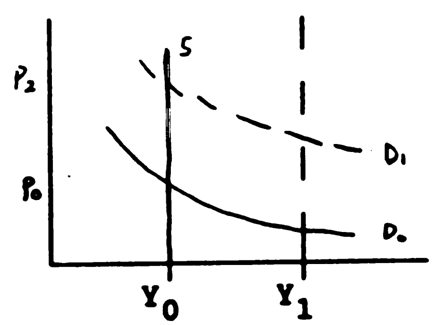
Three different explanations for crowding out phenomena are distinguished by Blinder and Solow (1973). First, crowding out occurs as the LM curve moves back toward the origin after an expansionary fiscal policy. As shown in Figure 4, the IS curve shifts up to IS_1 from IS_0 with an expansionary fiscal policy. At the initial price level P_0, demand for output rises to Y_1. This is shown as a shift in the demand curve to D_1 in the goods market, generating an excess demand gap of $Y_1 - Y_0$ which forces price to rise. However the price increase is fully anticipated by agents and output stays at the natural rate, Y_0. In the financial market, the price increase reduces the real level of money stock (M_S/P) and, hence, moves the LM curve up to LM_1. This raises interest rates further to r_2 and reduces investment and consumption, which result in a decline in income to the original level. Overall, the expansionary fiscal policy actions are offset or crowded out. The policy affects nominal variables but not real variables, thus leaving the equilibrium of the economy unaffected. The general price level and interest rates are increased by the same proportion. But real income and real interest rates remain at the original



Goods and Money Markets



Labor Market



Goods Market

Figure 4. Fiscal Policy in the New Classical Paradigm

level. By the same reasoning, tight fiscal policy has no effect on real variables either.

Second, crowding out occurs as the IS curve moves back toward the origin. As shown in Figure 4, the shift in the IS curve from IS_0 to IS_1 with an expansionary fiscal policy raises the interest rate. Private investment will be decreased until there is no more upward pressure on the interest rate. The stimulative effect of the expansionary fiscal action is exactly offset by the decreased investment and the IS curve moves back to the original level, IS_0.

Finally, crowding out occurs as government policy actions are largely offset by direct private sector responses before they can affect the economy. Tatom (1985) believed that this type of crowding out can occur regardless of the methods of financing the government expenditure. A debt financed government expenditure induces an offsetting change in private investment, and a tax financed expenditure has a displacement effect on private consumption. Therefore, fiscal policy doesn't change the path of the economy. Aggregate demand (income), interest rate, and the price level are not affected by the fiscal action (p.10, Tatom, 1985).

The permanent income hypothesis defines consumption expenditures to be a function of permanent income, which is a constant fraction of current assets and expected total future earnings discounted back to the current time (Friedman, 1957). Under the permanent income hypothesis, variations in personal saving have a large cyclical component due to transitory income changes which don't have any effect on an agent's consumption plan. The permanent income hypothesis can also be applied to the government budget constraint, which indicates that the present value of current and future government expenditures must equal the present value of taxes. Debt financed government expenditure must be paid, if not at present, then sometime in the future. Households perceive and discount the increased government borrowing as a future tax liability. Any transitory increase in income caused by a tax cut will be saved to pay future taxes. Thus, any change in the tax scheme or the government debt is offset by an equal change in private saving, leaving agents' consumption plans unchanged. The shifts between taxation and government borrowing affect the timing of the tax collection and the components of personal income, but not aggregate wealth. The method of financing government expenditure is irrelevant to the real economy in the case of lump sum taxes. This hypothesis, known as the Ricardian proposition, is concerned with the ineffectiveness of shifts between taxes and government borrowing. (Ricardo, 1951; Crouch, 1972; Barro, 1974, 1978a; Boothe and Reid, 1989).

However, there is also another explanation for the effect of financing government expenditure on the economy: debt financed government expenditure doesn't affect the real economy but causes a monetary expansion. This hypothesis is sometimes called "the monetarist paradigm" because of the emphasis on monetary factors. In a monetarist framework, there is a tendency for the Federal Reserve to control interest rate movements by conducting monetary policy. When government deficits place upward pressure on interest rates, the Federal Reserve tries to reduce the effect of the deficit on interest rates by printing money. The monetary expansion will cause inflation but not affect the real economy, by the same arguments discussed in the case of fiscal expansion. The monetarist paradigm implies that the shifts between the monetization and nonmonetization of government deficit do not affect the real economy, but cause a monetary expansion. (Hamburger and Zwick, 1981; Fusfeld, 1982; Protopapadakis and Siegel, 1984).

Although the Ricardian hypothesis is only concerned with the financing decision of the government, some scholars have related it to the size of the government budget. For example, Feldstein (1982) argued that the Ricardian equivalence theorem implies irrelevance of not only the method of financing, but also the size of government expenditures.

In contrast to the Keynesian paradigm, the classical paradigm is based on a market clearing (or equilibrium) assumption with price and wage flexibility. Neither the size of the budget nor the method of financing government expenditures affect the real economy.

3. Fiscal Policies in the Neo-Keynesian Paradigm

Andrews and Rausser (1986) described the evolution of the Neo-Keynesian paradigm as follows;

> Traditional Keynesians in a quandary to develop a rival to the natural rate hypothesis, turned to the fixed-flex price model first proposed by Means and expanded it to explain how stagflation can be generated from exogenous supply shocks. These modifications of the traditional Keynesian sticky price model have converged into a competing paradigm known as the Neo-Keynesian school. (p.414)

The main characteristic of the Neo-Keynesian paradigm is the heterogeneity in the economy. It contains both Walrasian auction markets (flexible price sector) and nonclearing customer markets (fixed price sector). Although the reasons for sticky prices in the short run are not completely understood, some justifications have been proposed based on the optimizing behavior of agents. Search costs (information costs) due to imperfect information (Okun, 1975); transaction costs (management costs) due to price setting and delivery lags (Blinder, 1982; Carlton, 1978, 1979, 1980); implicit wage contracts due to the uncertain environment (Taylor, 1979, 1980); and asymmetric information (Stiglitz, 1984) are various candidates for Neo-Keynesian microfoundations.

The Neo-Keynesian view does not deny money neutrality and the natural rate of employment in the long run, but emphasizes the short run responses to a shock to the economy. Due to the heterogeneity of markets, fiscal policy as well as monetary policy leads to changes in the relative price between auction and customer markets, even under rational expectations. The price of the flexible sector overshoots its long run equilibrium level while the price of the other sector change little during the transition period. The rate of temporary overshooting depends on the size of the auction sector and the speed of the adjustment. Real output, employment, and the rate of interest will also be affected by the differential price movement. After the adjustment period, the price of inflexible sector responds and the price of flexible sector moves back to its long run equilibrium level (Chambers, 1984; Frankel, 1984; Rausser, 1985; Stamoulis, Chalfant and Rausser, 1985, 1987; Andrews and Rausser, 1986; Rausser, Chalfant, Love, and Stamoulis, 1986).

The impact of fiscal policy in the Neo-Keynesian paradigm can be contrasted to the results from other paradigms by using a macroeconomic model. To measure the fiscal policy effect, let

(1) $$M - p = \phi y - \delta r \qquad (\phi,\ \delta > 0)$$

and

(2) $$y = \alpha - \beta\,[r - (p^e - p)] + \mu G \qquad (\beta,\ \mu > 0)$$

be the equations for LM and IS curves respectively, where M is the log of the nominal money supply, p is the log of the overall price level, y is the log of total output, r is the short term nominal interest rate, p^e is the log of the expected price, and G is the fiscal policy action. Expectations are formed based on the long run equilibrium paths of economy.

Both monetary and fiscal actions are governed by feed back rules

(3) $G = f(\Omega) + \epsilon_G$

and

(4) $M = g(\Omega) + \epsilon_M,$

where Ω is an information set available at the previous time period and ϵ_G and ϵ_M represent the random part of G and M, respectively.

There are two different goods in the model, flexible price goods with the price p_f in log form, and fixed price goods with the price p_n in log form. The flexible price goods are homogenous and storable. Their expected earnings from speculative storage are assumed to be equal to storage costs s plus the interest cost r;

(5) $p_f^e - p_f = s + r$,

and the overall price level is an average of fixed sector price with weight τ and flexible sector price with weight

$1-\tau$;

(6) $p = \tau p_n + (1-\tau)p_f$.

Substituting equation (2) into equation (1) yields

(7) $M - p = \phi\alpha - \phi\beta[r - (p^e - p)] + \phi\mu G - \delta r$.

By substituting in equations (5) and (6) and rearranging, equation (7) becomes

(8) $$M - (1-\phi\beta)[\tau p_n + (1-\tau)p_f]$$
$$= \phi\alpha + \phi\beta p^e + \phi\mu G - (\phi\beta+\delta)(p_f^e - p_f - s).$$

Taking expectations will generate the long run version of equation (8):

(9) $$M^e - (1-\phi\beta)[\tau p_n^e + (1-\tau)p_f^e]$$
$$= \phi\alpha + \phi\beta p^e + \phi\mu G^e - (\phi\beta + \delta)(p_f^e - p_f^e - s)$$

and subtraction of equation (9) from equation (8) yields

(10) $$(M - M^e) - (1-\phi\beta)\tau(p_n - p_n^e) - (1-\tau+\tau\phi\beta+\delta)(p_f - p_f^e)$$
$$= \phi\mu(G - G^e).$$

Rearranging terms in equation (10) gives

$$(11)\quad p_f = p_f^e - \frac{\tau(1-\phi\beta)}{(1-\tau+\tau\phi\beta+\delta)}(p_n - p_n^e) - \frac{\phi\mu}{(1-\tau+\tau\phi\beta+\delta)}(G - G^e) + \frac{1}{(1-\tau+\tau\phi\beta+\delta)}(M - M^e).$$

By taking expectation of equations (3) and (4), $G^e=f(\Omega)$ and $M^e=g(\Omega)$ are obtained. Thus, equation (11) becomes

$$(12)\quad p_f = p_f^e - \frac{\tau(1-\phi\beta)}{(1-\tau+\tau\phi\beta+\delta)}(p_n - p_n^e) - \frac{\phi\mu}{(1-\tau+\tau\phi\beta+\delta)}\epsilon_G + \frac{1}{(1-\tau+\tau\phi\beta+\delta)}\epsilon_M.$$

The derivative of (12) with respect to G^e is then

$$(13)\quad \frac{dp_f}{dG^e} = \frac{dp_f^e}{dG^e} - \frac{\tau(1-\phi\beta)}{(1-\tau+\tau\phi\beta+\delta)}\left(\frac{dp_n}{dG^e} - \frac{dp_n^e}{dG^e}\right) - \frac{\phi\mu}{(1-\tau+\tau\phi\beta+\delta)}\frac{d\epsilon_G}{dG^e} + \frac{1}{(1-\tau+\tau\phi\beta+\delta)}\frac{d\epsilon_M}{dG^e},$$

where $d\epsilon_M/dG^e = d\epsilon_G/dG^e = 0$ with the rational expectation assumption.

If the fixed sector prices do not respond to the expected fiscal shock ($dp_n/dG^e = 0$), then equation (13) reduces to

$$(14)\quad \frac{dp_f}{dG^e} = \frac{dp_f^e}{dG^e}\left(1 + \frac{\tau(1-\phi\beta)}{1-\tau+\tau\phi\beta+\delta}\right) > \frac{dp_f^e}{dG^e},$$

assuming both prices go back to their long run equilibrium path after the short period of adjustment ($dp_f^e/dG^e = dp_n^e/dG^e = dp^e/dG^e$). Therefore, flexible sector prices overshoot their long run equilibrium path during the adjustment period. Equation (13) shows that if one price does not deviate from its long run equilibrium path, then the other price would keep its long run equilibrium path as well. In this case, fiscal policy should be neutral to all sectors of the economy. The more flexible sectors (the smaller is τ) the economy has, the less overshooting occurs. With $\tau = 0$, no overshooting occurs and the prices are always in equilibrium(the Neoclassical economy). The more fixed sectors (the bigger is τ) the economy has, the more overshooting occurs and the longer it lasts. The effect of an expected government policy shock on any particular sector will depend on the flexibility of the economy (the value of τ) and will be left as an empirical question. Rausser (1985) views the agricultural sector as flexible, and Just and Chambers (1987) view it as fixed.

4. Empirical Tests of the Effects of Fiscal Policy

The contrast between different schools of thought in explaining the effects of fiscal policy on the economy can be addressed by looking at the experience during the 1970s and 1980s. From 1981 to 1986, the U.S. inflation rate declined by 22.1% per year while the rate of interest remained very high. The U.S. exchange rate rose consistently by an average of 10.6% per year between 1980 and 1985 (see Figure 5). U.S. federal budget deficits grew over 28.3% per year on average between 1979 and 1986 (see Figure 1). If we look only at annual statistics for those years, the association between deficits and macroeconomic variables appears to strongly support the Keynesian model.

Yet, when the 1960s and the 1970s are examined, a different picture emerges. Between 1969 and 1972, U.S. federal deficits increased continuously, from a $3.2 billion surplus to $23.4 billion deficit. During that time, U.S. exchange rates and interest rates fell consistently. The interest rate also remained quite low averaging 5.39% per year. The inflation rate remained stable over the period except for a short fall in 1972. Moreover, no particular pattern is found in the relationship between the federal deficit and other macroeconomic variables between 1972 and 1979. Thus, it is difficult to draw conclusions based on the annual statistics. Such a narrow focus necessarily raises questions about the

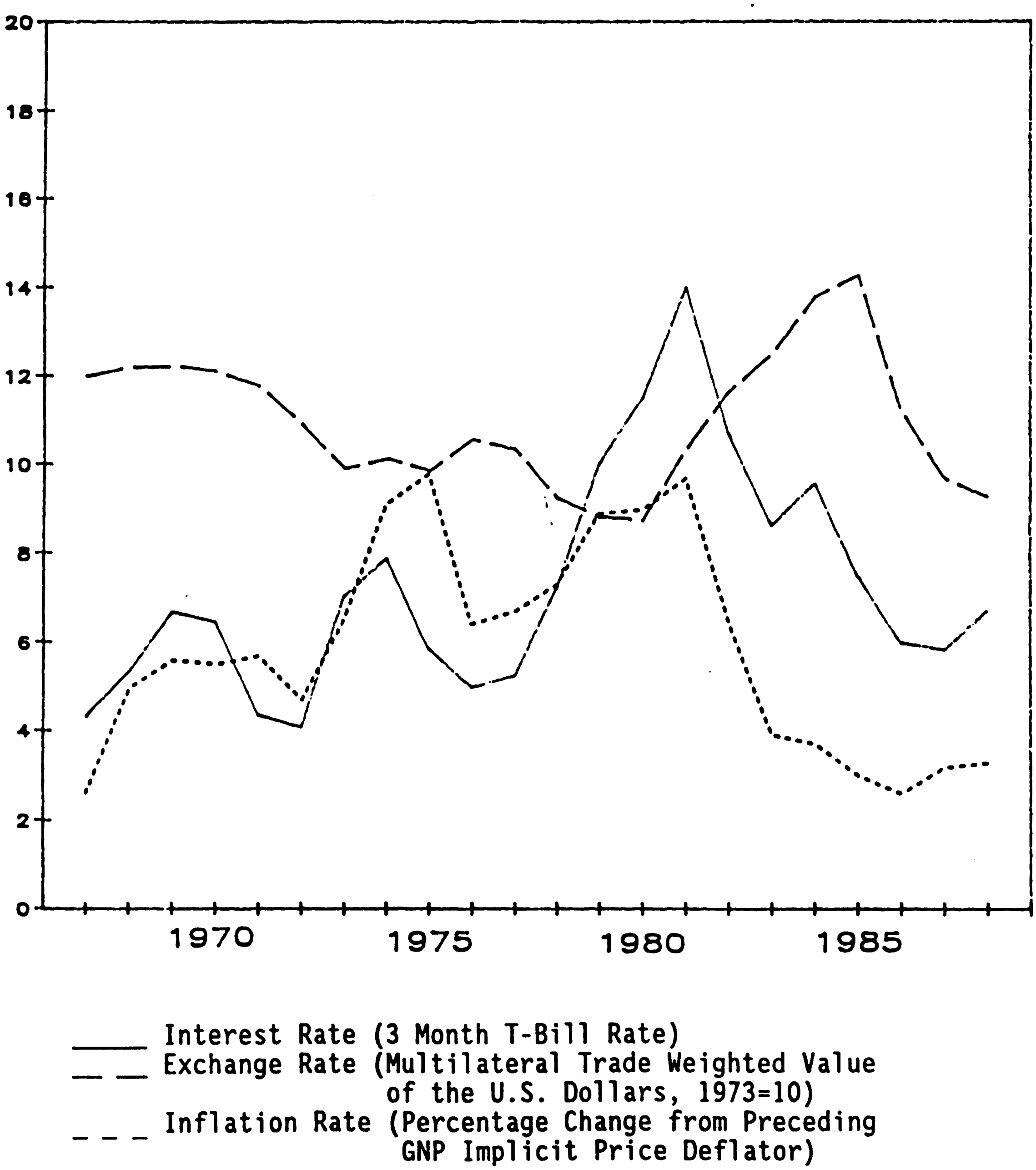


Figure 5. Interest Rate, Exchange Rate, and Inflation rate

generality of the presumed relationships.

Numerous scholars have tried to test empirically the different propositions. Gramlich (1971) and Framm and Klein (1973), in support of the Keynesian view, found a significant impact of government expenditure increases on real income. On the other hand, Keran (1969) and Batten and Thoronton (1984) supported the classical view of crowding out and found no impact of government spending changes on real income. Carlson (1982) supported the Ricardian hypothesis and found neither government expenditures nor deficits affect income, even in nominal terms

Similar controversies were found in the relationship between the federal budget deficit and financial variables (interest rates, the exchange rate, and inflation). Feldstein and Eckstein (1970), Makin (1983), and Cohen and Clark (1984) supported the Keynesian view that the budget deficit has a positive impact on real interest rates. Frankel (1984), in support of Neo-Keynesian view, found a positive impact in the short run. However, Belongia and Stone (1985) didn't find any relationship between real interest rates and the federal deficit, supporting the classical view. Canto and Rapp (1982) didn't find any relationship even with the nominal interest rate. Carlson (1982) and Evans (1986, 1987) supported the Ricardian hypothesis and found neither government expenditures nor budget deficits cause changes in interest rates, either in nominal or real terms. Plosser (1982) supported the

Ricardian view but rejected ex-ante crowding out. He found that federal budget deficits have no impact on nominal interest rates, but that a balanced budget increase has impacts on interests rate in both nominal and real terms.

In the case of exchange rates and the deficit, Hutchinson and Throop (1985) found a positive relationship and Cohen and Clark (1984) found a negative relationship. However, Belongia and Stone (1985) and Batten and Belongia (1986) didn't find any relationship.

In the case of inflation (or money supply) and the deficit, Rausser (1985) estimated a temporary price decrease in the flexible good sector caused by a non-monetized deficit. Niskanen (1978), Dornbush and Fisher (1981), McMillin and Beard (1982), and Protopapadakis and Siegel (1984) all supported the Ricardian equivalence theorem. The government deficit appeared not to have any impact on inflation (or money supply) in their estimation. Barro (1977, 1978a, 1978b) also supports the Ricardian proposition that the budget deficit has no impact on the real economy, but found that government expenditure increases stimulate money growth and inflation. Barr (1979) supported the monetarist view by finding a positive relationship between the general price level and budget deficits. Hamburger and Zwick (1981) also found that both government expenditure and the deficit are responsible for monetary expansion. Hamburger and Zwick (1982) and Allen and Smith (1983) supported the monetarist hypothesis by finding an impact of the budget deficit on money supply, but didn't find any causality from government spending to the money supply.

The conflicting empirical evidence makes the issue of fiscal policy impacts on macroeconomic variables an unresolved puzzle. This tends to place macroeconomics in a state of disarray (Grossman, 1980; Fusfeld, 1982; Barro, 1984). Bell and Kristol (1981) refer to this disarray as a "crisis in economic theory". Not surprisingly, these different macroeconomic theories have resulted in an wide disagreement in studies on how macroeconomic policies affect agriculture.

5. Fiscal Policies and Agriculture

Traditionally, agricultural economists have devoted most of their attention to microeconomic issues because the classical economic paradigm applies to agricultural markets better than anywhere else (Frankel, 1984). However, attention has gradually turned to macroeconomic issues after Schuh (1974) argued for the important role of a macroeconomic variable, the exchange rate, in economic fluctuations in agriculture. Most of the attention so far has focused on monetary policy impacts on agriculture through macroeconomic variables, such as the inflation rate, interest rates, and the exchange rate (Shei and Thompson, 1981; Chambers and Just, 1981; Rausser, 1985; Orden, 1986).

Schuh (1981) turned his attention to another dimension of macroeconomic policy, namely fiscal policy. Schuh (1983) in his testimony to the U.S. Congress argued that the federal budget deficit, as well as the tight monetary policy, causes unfavorable conditions for the farm economy. The government deficit, in his view, tends to increase real interest rates and hence the exchange rate. Decreases in agricultural exports, prices, and incomes follow because agriculture is an export oriented sector. Schuh (1984a) later emphasized this view by stating that "a more nearly balanced federal budget probably would do as much as anything to improve our agricultural export performance" (p.246).

Schuh's initial work was nothing more than an extension of the Keynesian paradigm to the farm economy and it received immediate response from a number of researchers. Belongia and Stone (1985) and Batten and Belongia (1986) criticized the Keynesian view of fiscal policy impacts on agriculture. Though a negative relationship between the real exchange rate and agricultural exports was found in their empirical analysis, neither money nor the federal deficit caused changes in real interest rates and exchange rates. They concluded that "attributions of the decline in farm exports to monetary policy or the deficit are difficult to support empirically and still may be regarded, at this late date, only as conjecture" (p.427, Batten and Belongia).

Barclay and Tweeten (1988) supported Schuh's conjecture by finding a negative impact of federal deficit increases on agricultural exports and prices. An increase in interest rates and an appreciation of the U.S. dollar caused by an increase in the federal deficit is found to be a major mechanism for the impact.

Rausser (1985) looked at the issue differently. He found that the speed of price adjustment to any shock in the monetary variables (money supply, interest rate, and exchange rate) is much faster in the case of agricultural goods compared to industrial goods. Chambers (1985) and Bredahl (1985) related the differential price adjustment to the stylized facts that U.S. agriculture has; (a) highly inelastic demand and supply, (b) low income elasticities of demand, (c) high competition, (d) rapid technological change, (e) asset fixity, (f) variability in supply due to weather, and (g) foreign agricultural policy. Rausser found that nonmonetization of the federal deficit has the same effect on the economy as tight monetary policy does. It depresses farm prices through its deflationary impact on the general price level. Rausser, Chalfant, Love, and Stamoulis (1986) also supported the short run responses of agricultural prices due to fiscal deficit changes. However, the neutrality of the economy is supported in the long run. They argued that agricultural prices follow a new long run equilibrium path after a short adjustment period. Thus, the relative price of agricultural goods to industrial goods remains stable in the long run.

Recently, Just and Chambers (1987) developed a theoretical model to explain the relationship between the farm economy and budget deficits. They compared the performance of three alternative ways to reduce the current budget deficit: expenditure reduction, monetary expansion, and a tax increase. Their model appears to be the first theoretical model dealing directly with fiscal policy impacts on agriculture. Again, the differential price adjustment scheme is used in their model, but the direction is just the opposite to Rausser and others. Farm prices are believed to be fixed due to government intervention, and industrial prices are allowed to be flexible. Therefore, any inflationary policy causes a "cost-price squeeze" in agriculture by increasing industrial prices relative to farm prices. Expansionary fiscal policy hurts the farm economy as much as expansionary monetary policy, where financing the expenditure by borrowing (or a tax) stimulates it. The results are derived from a comparative static analysis with a multi-period equilibrium condition in the government budget. However, the model has many weaknesses, and so far it lacks empirical support to validate its results.

Thus far, the current literature dealing with fiscal policy impacts on agriculture have been discussed. The empirical model by Rausser (1985) and the theoretical model by Just and Chambers (1987) have been described as Neo-Keynesian models. The empirical works by Belongia and Stone

(1985) and Batten and Belongia (1986) fit the classical paradigm. Papers by Schuh (1981, 1983) and Barclay and Tweeten (1988) fit the Keynesian paradigm.

To reduce the current huge federal deficit, Just and Chambers argued that a government expenditure reduction would have the most beneficial effects for agriculture. Belongia and others argued that focusing attention on deficit reduction measures diverts attention from more fundamental changes required in farm commodity programs since budget deficits do not have impacts on agriculture. However, Rausser and others argued for the dominance of macroeconomic policies over farm policies in affecting the farm economy in the short run. They confined the role of farm policies to reducing instability of farm prices and not providing incentives for over-allocation of resources to agricultural production. Frequent use of farm policy would hurt the farm economy by causing more overshooting to macroeconomic policy shocks later. Barclay and Tweeten defined optimal policy as a balanced budget and international account with zero differential between domestic and foreign interest rates. No particular solutions for reducing the current budget deficit are described in their simulation study.

CHAPTER III

MODELS AND RESEARCH METHODS

As discussed in the previous section, wide disagreement exists regarding the effects of fiscal policy on agriculture. Three different approaches to empirical macroeconomic modeling can be distinguished: the simultaneous equations model (SEM); the rational expectation model (REM); and the vector autoregression model (VAR). In this section, comparisons of these models will be made and the selection of the VAR approach for this analysis will be justified. Some recent developments in time series analysis also will be discussed and taken into account to establish an improved VAR procedure. The methods applied in this paper will be introduced at the end of the section.

1. Models Used in Empirical Macroeconomics

1.1. The Traditional Simultaneous Equations Model

The SEM often has been referred as "Keynesian macroeconometrics" because it is widely used in the empirical macroeconomic analysis of Keynesian Models (Cooley and Leroy, 1985). The SEM tends to be large scale, taking account of many behavioral relations between macroeconomic variables.

A system of g stochastically dependent equations can be represented generally as

$$(15) \qquad A(L)y_t = B(L)e_t,$$

where y_t is a (gx1) vector of g macroeconomic variables at time t and e_t is a (gx1) vector of disturbance terms. It is assumed that $E(e_t)=0$ and $E(e_t e_s')=\Omega$ for t=s, and 0 for $t \neq s$. Ω is a diagonal matrix, implying no contemporaneous correlation among the error terms across the equations.

Assuming B(L)=I for simplicity gives

$$(16) \qquad A(L)y_t = e_t$$

with $A(L) = \sum_{j=0}^{p} A_j L^j$ where the A_js are (gxg) matrices of autoregressive parameters and L is the lag operator. The model is assumed to be stable and all the roots of the characteristic equation $|A(L)|=0$ lie outside the unit circle. The SEM usually distinguishes exogenous and endogenous variables based on economic theory. By redefining A(L) and y_t, the structural form of SEM is represented as

$$(17) \qquad \begin{bmatrix} A_{11}(L) & A_{12}(L) \\ 0 & A_{22}(L) \end{bmatrix} \begin{bmatrix} w_t \\ x_t \end{bmatrix} = \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix},$$

where $A_{11}(L)$ is a [(g-k)x(g-k)] matrix, $A_{12}(L)$ is a [(g-k)xk] matrix, and $A_{22}(L)$ is a (kxk) matrix of A(L) elements. The 0 is an [kx(g-k)] matrix of zeros. w_t is a [(g-k)x1] vector of observations on the endogenous elements of y_t and x_t is a (kx1) vector of observations on the exogenous part of the y_t variables. e_{1t} is a [(g-k)x1] vector of disturbance terms for the w_t equations and e_{2t} is a (kx1) vector of disturbance terms for the x_t equations. $A_{11}(L)$, $A_{12}(L)$, and $A_{22}(L)$ are assumed to have the orders p, q, and r, respectively, which are not necessarily the same.

The corresponding reduced form is

$$(18) \quad w_t = - A_{11}^{-1}(L)A_{12}(L)x_t + A_{11}^{-1}(L)e_{1t}.$$

Numerous a priori restrictions are used to identify the parameters of the behavioral equations. Zero or equality restrictions are often applied to $A_{11}(L)$ and $A_{12}(L)$ to exclude variables from a specific equation. Restrictions on the lag structure and the error structure are also used. The predictive power of the model depends on the credibility of the restrictions.

The problems associated with the SEMs are now well known. The traditional model uses many restrictions which often cause over-identification. Some restrictions are based on controversial aspects of economic theory and not tested empirically. The SEM has a weakness for policy analysis because its structure may not be invariant to policy changes. The parameters of the behavioral equations usually do not account for any policy caused structural changes. Such a change is likely to occur since any change in policy affects the agent's decision rules by changing their views of the future. Finally, the errors across the equations are likely to be related since they are produced by the same decision making process.

1.2. The Rational Expectations Model

The REM considers the agent's views on the future seriously since these views affect the optimizing behavior of economic agents. With inclusion of the expected values of endogenous variables, the structural form of REM is represented as

$$
\begin{aligned}
(19) \qquad A_{11}(L)w_t + \phi w_t^e + A_{12}(L)x_t &= e_{1t} \\
A_{22}(L)x_t &= e_{2t},
\end{aligned}
$$

where ϕ is an (gxg) matrix of parameters and w_t^e is expectation of w_t formed in period t-1; that is, $w_t^e = E[w_t | w_\tau, x_\tau, \tau<t]$. By taking conditional expectations,

$$
(20) \quad w_t^e = -(A_{11,0}+\phi)^{-1} \left[\sum_{i=1}^{p} A_{11,i}w_{t-i} + A_{12,0}x_t^e + \sum_{i=1}^{q} A_{12,i}x_{t-i}\right]
$$

and

$$(21) \quad x_t^e = -A_{22,0}^{-1} \sum_{i=1}^{r} A_{22,i} x_{t-i}.$$

Substituting equations (20) and (21) into (19) yields

$$(22) \qquad \bar{A}_{11}(L) w_t + \bar{A}_{12}(L) x_t = e_t$$

and the reduced form equation is

$$(23) \quad w_t = - \bar{A}_{11}^{-1}(L) \bar{A}_{12}(L) x_t + \bar{A}_{11}^{-1}(L) e_{1t}.$$

The REM produces the same type of reduced form as the SEM (compare equation (18) with (23)), but the rational expectation hypothesis implies restrictions on the parameters which can be tested. To identify the system from the final form estimation, the REM uses cross equation restrictions on parameters and the orthogonality between e_t and x_τ ($\tau<t$) assuming the error terms are not correlated with past information. The restrictions representing the optimal decision rules of agents are also used.

The advantage of the REM, compared to the SEM, is that the structure of the REM is invariant to policy changes. The agent's views of the future and his decision rules are already taken account in the parameters of structural form and final form equations. Therefore, the parameters do not depend on changes in policy rules, unless the policy makers have more information than agents. However, REMs have not been successful for macroeconomic forecasting. The restrictions on parameters often fail to be consistent with empirical data.

1.3. "Unconstrained" Vector Autoregressions

Resistance to the use of a priori restriction used in the SEM, and the poor empirical performance of the REM, have led some economists to turn their attention to unconstrained VARs. Sims (1980, 1986) originally applied this method to identify the effects of government policy on macroeconomic variables. The structural form VAR can be represented by equation (16), the same form used in the SEM. However, the block exogeneity restrictions are removed from A(L) and all variables are treated as endogenous.

The reduced form equations for the VAR are

$$(24) \qquad y_t = \sum_{s=1}^{p} C_s y_{t-s} + u_t,$$

where $C_s = A_0^{-1}A_s$ and $u_t = A_0^{-1}e_t$. $E(u_t u_t') = A_0^{-1}\Omega A_0' = M$.

VAR models tend to be small scale. Restrictions used to specify VARs are based on statistical properties of the data. Economic theory has a role in variable selection, but not in restricting the structure of the system. To recover the system from the reduced form equation, the VAR utilizes the relation between the structural disturbance e_t and the reduced form disturbance u_t. The VAR generally assumes that the behavioral shocks are mutually orthogonal (i.e., Ω is diagonal). Hence, if the estimated reduced form covariance matrix M is diagonal, then the reduced form equation is identified (i.e., A_0=I). In any other case, a (gxg) matrix R, subject to $R'R = M^{-1}$, is selected to remove the contemporaneous correlation between the error terms. Then, $E(Ru_tu_t'R') = RE(u_tu_t')R' = MM^{-1} = I$.

Identifying A_0 with R and premultiplying the reduced form equation by it recovers the system. Though various matrices could satisfy the conditions for R, a unique lower triangular matrix with positive elements exists for a given variable order in the system. This method, known as the Choleski factorization, or triangularization, restricts the system to be recursive. The present values of variables appear recursively in the left hand side of equation (16), following the same order given in Ω. A particular orthogonal order must have a sound theoretical and statistical justification.

With no exogenous variables in the system, a policy shock to the economy cannot be identified by traditional methods. Various nontraditional methods are applied. First, the moving average parameters are often used to identify the effects of a policy shock on the system. The estimated reduced form equation (24) is transformed to its moving average representation

$$(25)\quad y_t = \sum_{s=0}^{\infty} D_s u_{t-s},$$

by either inversion or successive substitution. The moving average parameters represent the net effect of a particular shock to economy, assuming no additional shocks occur. The moving average parameters, D_s are often called the impulse response weight or dynamic response weight.

Second, a decomposition of variance for the forecast of future values of variables into components due to particular shocks provides information on the sources of unpredictable fluctuations.

Finally, the significance of a variable in a forecast of the other variables provides a criteria for causality (Granger, 1969; Sims, 1972). If all the lags of a variable are significant in a forecast of the current values of the other variable, but not vice versa, causality runs from the first variable to the second variable. Insignificance of lags of both variables in the forecast of a variable implies no relation between two variables. Hsiao (1981), using the same idea, used Akaike's (1969) final prediction error (FPE) for the significance criteria.

The VAR approach has been criticized on a number of grounds. First, the selection of the variables are arbitrary, depending on the researcher's interests. Therefore, the VAR approach may not be consistent with the optimal behavior of agents. Rather they reveal the statistical correlations between the selected variables. Omitted variables could be a problem of VAR model (Mount, 1989). Second, policy changes are sometimes not random as the VAR approach assumes. Third, many VAR studies specify the model arbitrarily. Different lag length and different orderings of variables might cause different results (Saunders, 1988; Orden and Fackler, 1989). Fourth, U.S. macroeconomic data usually fail to satisfy the stationarity condition. The VAR model with levels, in this case, might not be appropriate for empirical tests (Engle and Granger, 1987; Mount, 1989). Fifth, U.S. macroeconomic data often show nonconstant variances conditional on past information. The existence of conditional heteroscadasticity doesn't affect consistency of the estimator, but causes a loss of efficiency (Engle, 1982; Engle and Bollerslev, 1986). Sixth, VAR models are often criticized for their high parameter to observation ratio (Zellner, 1981; Hsiao, 1979). With all variables treated endogenously, the number of lags are heavily constrained by the number of observations. Nickelsburg (1985) found poor performance and underfitting of the lag selection criteria in the case of small samples for VARs. Finally, in the case of unprecedented large movements in policy instruments, it is doubtful that the linear structure of the model would remain fixed (Mazon, 1985; Bessler and Kling, 1989; Todd, 1989).

2. Extensions of the VAR Approach

Numerous studies have adopted the VAR approach in empirical macroeconomic analysis after the mid 1970s. Recently, several papers have considered the critics of the VAR approach seriously and tried to improve performance in various ways.

2.1. Identifying Contemporaneous Correlations

As discussed, identification of the VAR system and causality tests rely on contemporaneous relations between variables (i.e., the structure of A_0). Though a recursive order for A_0 is often used, many researchers have criticized this approach. Cooley and Leroy (1985) argued the restriction was nothing more than imposing the same prior exclusion restrictions used in the SEM approach. Leamer (1985) didn't find any reason why A_0 has to be triangular. They also argued against the VAR type causality test for policy analysis. Cooley and Leroy discredited the VAR approach for policy analysis by saying that

> "In the absence of prior predeterminedness restrictions, such interpretations are completely unjustified ... , for an intervention in policy variables to have clear meaning, an exogeneity assumption is needed. Such an assumption is, as we have noted, not testable in the absence of prior restrictions. We conclude that VAR models are not useful for analyzing interventions either in parameters or in variables." (p.301-303)

Several recent papers responded to this argument. Blanchard and Watson (1984), Sims (1986), Bernanke (1986), and Orden and Fackler (1989) introduced a two step procedure to estimate the contemporaneous correlation matrix, A_0, rather than using the arbitrary Choleski factorization. The relations between the reduced form and structural form covariances are used in estimation. Applying the variance operator to $u_t = A_0^{-1}e_t$, the relationship can be represented as

(26) $\Omega = A_0 M A_0'$

The reduced form equation (24) and it's covariance M are estimated first. Then, the structural form covariance is recovered from equation (26). With g variables in the system, the

number of distinct covariances in M is g(g+1)/2. Since Ω has only g components (recall that Ω is diagonal), the system is just identified if A_0 has g(g-1)/2 unknown parameters. A lower triangular matrix A_0, hence, satisfies the condition for the just identified system. However, neither simultaneity nor over (under) identification restrictions have to be precluded.

Though Orden and Fackler (1989) justify the recursive structure by delays in agent's reaction to the policy shock, due to information lags and adjustment costs, they argue that simultaneity is a more likely choice. Blanchard and Watson (1984), Bernanke (1986), and Orden and Fackler have all emphasized the role of theory in pinning down the initial structure for the system. Blanchard and Watson had eight contemporaneous parameters in their four variable VAR. They used outside information to estimate the parameters and the variances of the first equation. The findings are used to estimate the parameters and variances for the other equations sequentially. Bernanke called this model "quasi triangular" since the equations are ordered in such a way that the i-th equation has exactly i-1 unknown parameters and the estimated residuals from equation 1 through i-1 is used as the instruments to solve the i-th equation.

Bernanke, in his over-identified model, found a way to avoid the quasi triangularity assumption. To use up a degree of freedom from over identification, he allowed an error term to appear in other equations as well as the equation for its own variable. Orden and Fackler, however, used the FIML estimation procedure. Recently, Blanchard and Quah (1989) used a block exogeneity restriction on the parameters of a moving average representation to identify a system.

Considering the factors above, it can be said that the VAR approach tries to place minimal identification restrictions for any given analysis. Indeed, the restrictions are based solely on the contemporaneous interactions among the variables.

2.2. Considerations of Structural Change

Schuh (1976) highlighted a change in the macroeconomic environment in 1973 when the U.S. government adopted a flexible exchange rate system. Many economists have also been concerned with the effect of 1980 Monetary Decontrol Act on the economy (Saunders, 1988). Chambers and Just (1986) have expressed concern over models which do not take account of structural changes. Though the VAR approach catches the dynamic response of the economy without a priori restrictions, an unprecedented large movement in the economy may not allow the linear structure of the VAR model to remain fixed.

Separation of the sample might be a solution to this problem. Saunders (1988) used this approach and ran two different VAR models to check the consistency between data before and after the 1980 monetary regime change. However, division of the sample period reduces the number of observations significantly, and hence causes a degrees of freedom problem.

Mazon (1985) introduced a dummy variable into a VAR model to account for a structural changes in the economy. Loss in the degrees of freedom is negligible in this case. If the dummy variables solely reflect the structural change, their effect on the economy can also be traced through a variance decomposition procedure. To show this, consider a dummy variable in the reduced form equation (24). The equation becomes

$$\text{(27)} \qquad y_t = \sum_{s=1}^{p} C_s' y_{t-s} + \alpha DV_t + u_t,$$

where DV_t = a (gx1) vector of dummy variables which has 0 values for the period before and 1 after the structural change has occured. The corresponding moving average representation will be

$$\text{(28)} \qquad y_t = \sum_{s=0}^{\infty} D_s' u_{t-s} + \beta DV_t.$$

The decomposition of variance in forecasts of future expected values of y_t can be used to examine the effect of a structural change in the economy. The appearance of the dummy variable in the system will likely affect the parameters of both the autoregressive and the moving average parameters if it is significant.

Although the magnitude of the effect of the dummy variable is well represented by the differences in base projection, its statistical significance is not easily derived since there is no asymptotic distribution theory available for the decomposition. Mazon used the Monte Carlo Integration method developed by Kloek and Dijk (1978) to compute the first and the second moment for the posterior distribution of the decomposition[1].

2.3. Unit roots

Thus far, the time series model is assumed to be stable (i.e., all the roots of the characteristic equation $|A(L)|=0$ lie outside unit circle). Recently, numerous scholars have investigated the stationarity properties of macroeconomic data (Nelson and Plosser, 1982; Schwert, 1987). When the data are generated by nonstationary processes, the autoregressive polynomial $A(L)$ is not invertible. Therefore, the moving average representation (25) cannot be obtained and causality tests based on impulse response weights cannot be justified. Phillips and Durlauf (1986) found that OLS produces consistent estimates but that they are not asymptotically normally distributed. Therefore, approximate maximum likelihood estimators for the VAR parameters will be difficult to obtain. Furthermore, test statistics are not easily found (Sims, Stock and Watson, 1990).

Several techniques have been developed to test for stationarity. Most commonly, the likelihood ratio test by Dickey and Fuller (Fuller, 1976; Dickey and Fuller, 1979,

[1]One hundred random samples are drawn from the posterior distribution of the VAR coefficients, assumed to be Normal-Inverse Wishart (Zellner, 1971). The historical decompositions are generated for each draw and the first moment and standard errors are computed with the one hundred sample historical decompositions.

1981) and Stock and Watson (1986, 1988) are used. Both tests are based on the significance of the parameter α_0 in the OLS regressions

$$(29) \quad \Delta y_t = \mu + \beta t + \alpha_0 y_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta y_{t-i} + e_t$$

where $\Delta y_t = y_t - y_{t-1}$. Critical values are reported in Fuller (1976) for the DF test and Stock and Watson (1988) for the SW test. The same methods are used for testing larger numbers of unit roots in economic time series by replacing Δy_t with appropriately differenced series in the test equation.

However, Sen (1986) found that these methods lack power. Dickey and Pantula (1987) provide a test for multiple unit roots, which starts with a large number of unit roots and tests downwards. To test three unit roots in the AR(3) model

$$(30) \quad y_t = \sum_{j=1}^{3} \phi_j y_{t-j} + e_t,$$

Dickey and Pantula reparameterized (30) to get

$$(31) \quad \Delta^3 y_t = \pi_1 y_{t-1} + \pi_2 \Delta y_{t-1} + \pi_3 \Delta^2 y_{t-1} + e_t.$$

The appropriate null hypothesis for testing the i-th unit will be H_i where

H_3: $\pi_1 = \pi_2 = \pi_3 = 0$

H_2: $\pi_1 = \pi_2 = 0, \quad \pi_3 < 0$

H_1: $\pi_1 = 0, \pi_2 < 0$

and alternative hypotheses are H_2, H_1, and

H_0: $\pi_1 < 0$,

respectively. Test statistics used in the DP test will be same as the DF test statistics and the equations also can be augmented by introducing lagged dependent variables, as in the DF test when auto-correlation appears in the error terms.

Though the DF test is widely used for economic time series, weaknesses of the test are also well recognized. First, the test ignores the possibility that the true data generating process may have MA terms as well as AR terms. Schwert (1987, 1988) and Lee and Schmidt (1990) found low power for the DF test in the presence of MA errors in a process. Too many rejections in the case of negative MA errors and too few rejections in case of positive MA terms are experienced. Second, critical values of the DF test are not valid when the nuisance parameters μ and β appear in a process (Schmidt, 1988; Nankervis and Savin, 1985; Evans and Savin, 1984). The meaning of the nuisance parameters depends on whether or not the unit root is true. Under the null hypothesis, μ represents a deterministic time trend and β represents a quadratic time trend. Under the alternative hypothesis, μ represents deterministic level and β represents a deterministic time trend.

Phillips and Perron (PP) developed a test to solve the first problem by allowing a wide variety of weakly dependent and heterogeneously distributed time series (Perron, 1986; Phillips, 1987; Phillips and Perron, 1988). The test statistics are corrected by using Newey and West (1987) type error covariance corrections and are valid under autocorrelation or conditional heteroscadasticity of the errors. The PP unit root test considers following three OLS regression equation.

$$(32) \quad y_t = \bar{\mu} + \bar{\beta}(t - n/2) + \bar{\alpha} y_{t-1} + \bar{u}_t$$

$$(33) \quad y_t = \mu^* + \alpha^* y_{t-1} + u_t^*$$

$$(34) \quad y_t = \alpha' y_{t-1} + u_t'.$$

The test procedure starts with the null hypothesis

$$H_0^1\colon \bar{\mu} = \bar{\beta} = 0 \text{ and } \bar{\alpha} = 1,$$

with the test statistic $Z(\Phi_2)$. If the first null hypothesis is rejected, then test the second null hypothesis

H_0^2: $\bar{\beta} = 0$ and $\bar{\alpha} = 1$

with the test statistic $Z(\Phi_3)$. If H_0^2 is also rejected, then test the third null hypothesis

H_0^3: $\bar{\alpha} = 1$

with test statistic $Z(t_{\bar{\alpha}})$. Rejection of H_0^3 implies no unit root and acceptance of H_0^3 implies a unit root in the series.

The trend and drift terms are also important. If H_0^1 and H_0^2 cannot be rejected, then the procedure develops into a more powerful test with equation (33). The new null hypothesis will be

H_0^4: $\mu^* = 0$, $\alpha^* = 1$

and the test statistic will be $Z(\Phi_1)$. Rejection of H_0^4 will lead one to the individual unit root test of the hypothesis

H_0^5: $\alpha^* = 1$

with the test statistic $Z(t_{\alpha^*})$. Acceptance of H_0^4 will lead one to estimate equation (34) and the individual unit root test will be done with the hypothesis

H_0^6: $\alpha' = 1$.

The test statistic will be $Z(t_{\alpha'})$. No trend and no drift terms will be included in the series. The test statistics $Z(t_{\bar{\alpha}})$, $Z(t_{\alpha^*})$ and $Z(t_{\alpha'})$ are defined in Appendix B and have the Dickey Fuller τ, τ_μ, and τ_τ distributions respectively. Critical values for PP test are also included in Appendix B.

Schmidt and Phillips (1989) developed a test valid with the nuisance parameters. They modified a unit root test based on Bhargava's (1986) parameterization. The Schmidt-Phillips (SP) unit root test starts with OLS regression equation

$$(35)\quad \Delta y_t = \psi + \phi \bar{S}_{t-1} + \xi_t \quad (t = 2, \ldots. n),$$

where

$$\bar{S}_{t-1} = y_{t-1} - \mu + \beta(t-1)$$
$$\mu = \text{mean } \Delta y = (y_n - 1)/(n-1)$$
$$\beta = y_1 - \mu.$$

The nuisance parameter μ and β can easily be estimated by

$$(36)\quad \Delta y_t = \mu + \beta t + e_t.$$

The test statistic is the usual t statistic for ϕ and its critical values appear in Appendix C. The test equation can be augmented with lagged dependent variables when autocorrelation is present. In that case, the test statistic will be the ratio of the t statistic to a discount factor ρ, where

$$\rho^2 = \sigma_\epsilon^2/\sigma^2$$

$$\sigma_\epsilon^2 = \lim n^{-1} E(\Sigma e_t^2)$$

$$\sigma^2 = \lim n^{-1} E(S_n^2)$$

and

$$S_n^2 = (\Sigma e_j)^2.$$

The meaning of the nuisance parameters μ and β in the SP test does not depend on whether the unit root hypothesis is true or not.

2.4. Cointegration and Error Correction Models

While individual macroeconomic time series data have often shown stationarity after first differencing (Stock and Watson, 1986, 1989; Engle and Granger, 1987; Kunst, 1989; Haslag and Slottje, 1989), it is also believed that many nonstationary series have a tendency to move together in the long run. If economic variables are linked by a long run equilibrium relationship, a linear combination of the variables should not drift too far apart over time and need not be differenced. This relationship, termed as cointegration by Granger (1981), reduces the number of unit roots to be fewer than the number of variables.

As an example, consider two nonstationary time series y_{1t} and y_{2t} in y_t, which are stationary after differencing d times. If there exists a linear combination $z_t = \alpha' y_t$ which reveals stationarity after differencing b(<d) times, the two series are said to be cointegrated of order d, b, denoted CI(d,b). The (gxh) coefficient matrix α is called as cointegrating vector and the combination z_t is called as error correction term (Engle and Granger, 1987). z_t has expected value of zero and any nonzero value represents a deviation from the long run equilibrium relationship.

The existence of cointegration implies a restriction on multivariate time series models. To show this, consider d=b=1 for the reduced form VAR equation (24). Taking the first difference, equation (24) becomes

$$(37) \qquad \Delta y_t = \sum_{s=1}^{p-1} \Delta\Gamma_s y_{t-s} + \Gamma_p y_{t-p} + u_t,$$

where $\Gamma_s = - I + c_1 + c_2 + \ldots + c_s$. Therefore, the VAR with levels will only be appropriate when Γ_p has full rank g. If Γ_p has zero rank, Δy_t is stationary. In any other case, Γ_p has rank h with 0<h<g and can be represented as

$$(38) \qquad - \Gamma_p = \pi\alpha',$$

where π is dimensioned as (gxh) with rank h. Equation (24) now becomes

$$(39) \qquad \Delta y_t = \sum_{s=1}^{p-1} \Delta\Gamma_s y_{t-s} - \pi\alpha' y_{t-p} + u_t,$$

or equivalently

$$(40) \qquad \Delta y_t = \sum_{s=1}^{p-1} \Delta\Gamma_s y_{t-s} - \pi z_{t-p} + u_t.$$

These equations are called an error correction model (ECM) since they contain the error correction term, z_t. The error correction term represents adjustment of the economy to a disequilibrium in one period ($z_t \neq 0$). π represents the speed of adjustment and α represents the long run relationship between the variables (Engle and Granger, 1987). The VAR model with levels, in this case, is inefficient since it ignores the restrictions on Γ_p. The VAR model with first differences will be over differenced and misspecified by falsely restricting $\Gamma_p = 0$. The parameters, π and α, also provide a basis for identifying the contemporaneous correlations where long run interpretations of VARs are varying with different specifications.

An ECM is consistent with economic theory satisfying long run equilibrium as well as allowing for short run dynamic adjustments. Thus, ECMs produce accurate forecasts of responses to disequilibrium shocks over reasonable horizons (Hendry, 1986; Nickell, 1985).

Several measures are available to test for cointegration and to estimate the cointegrating vectors. The two step method of Engle and Granger (1987) is based on the autocorrelation function of OLS residuals and focuses exclusively on a bivariate system. Engle and Yoo (1987) found that the critical values of the augmented Dickey-Fuller test used by Engle and Granger increase with the number of variables in the system. Although Engle and Granger argued for the efficiency of the two step estimation method in the two variable cointegration case, the properties of the least square estimators are dubious when there are more than two variables. Stock (1987) showed that the least square estimators are biased and not asymptotically normally distributed.

Stock and Watson (1986, 1989) developed a test based on the principal component estimators. Though the test is applicable to a system with more than two variables, Engle (1987) discredited the test since it is not based on likelihood theory. Hoffman and Rasche (1989a) are also skeptical of the method. They argued that inference from the SW test is highly sensitive to arbitrary lag length specifications in the structure used to estimate the principal components. Also, the available critical values generated by numerical simulation may not be applicable to a wide range of variables.

A consistent maximum likelihood estimation procedure has been established by Johansen (1988, 1989) and Johansen and Juselius (1988, 1989) by using moments and cross moment matrices of the residuals from auxiliary regressions. In equation (38), the rank of the matrix Γ_p, h<g, determines the number of cointegrating vectors in the system y_t. To test H_0: at most h cointegration vectors, a maximum likelihood test statistic

$$(41) \quad LR = -2\ln Q = -n \sum_{i=h+1}^{g} \ln(1-\lambda_i) \approx \sum_{i=h+1}^{g} n\lambda_i(n)$$

is used, where λ_i are the g-h smallest eigenvalues of

$$(42) \quad |\lambda S_{pp} - S_{p0}S_{00}^{-1}S_{0p}| = 0,$$

where

$$(43) \quad S_{ij}' = i/n \sum_{t=1}^{n} r_{it}r_{jt}'. \qquad (i,j=0,p)$$

r_{0t} and r_{pt} are obtained by OLS regressions:

$$(44) \quad \Delta y_t = \sum_{i=1}^{p-1} a_i \Delta y_{t-i} + r_{0t}$$

and

$$(45)\quad y_{t-p} = \sum_{i=1}^{p-1} a_i \Delta y_{t-i} + r_{pt}.$$

The log likelihood test statistic is asymptotically distributed as $c \cdot \chi_{(f)}$ where $c=.85-.58/f$ and $f=2(g-h)^2$. Selected fractiles are given in Appendix D.

The cointegrating vector α and parameter for the error correction term π are obtained as

$$\pi = -S_{0p}\alpha$$

and

α = eigenvectors of (42) corresponding to the largest h eigen values.

Johansen's estimator has better properties than least squares, since it takes accounts the error structure of the underlying process.

2.5. Restrictions on Cointegrating Vectors

Though the interpretation for the error correction term is forward straight for a two variable system, it is not as easy for systems with more than two variables. When there exist more than two variables in a cointegration equation, certain restrictions on π and α might be needed for interpretations to make sense. Johansen (1989), Johansen and Juselius (1988, 1989) introduced a linear restriction procedure to simplify the parameters to find useful inference from the cointegration relations. They also established a full information maximum likelihood method to estimate the simplified inferable parameters and to test the linear restrictions on parameters. To test H_0: $\alpha = \theta\phi$ where θ is a (gxs) and ϕ is a (sxh) matrix, the likelihood statistic

$$(46)\quad LR = -2\ln Q = n \sum_{i=1}^{h} \ln(1-\lambda_i^*)/(1-\lambda_i)$$

is used, where λ_i^* are the h largest eigenvalues obtained by solving

$$(47)\quad |\lambda\theta' S_{pp}\theta - \theta' S_{p0}S_{00}^{-1}S_{0p}\theta| = 0.$$

The restricted parameters, α^* and π^* are obtained as

α^* = eigenvectors of (47) corresponding to the largest h eigenvalues

and

$\pi^* = -S_{0p}\alpha^*$.

The restriction, H_0:$K'\alpha = 0$, can also be tested by a Wald test statistic

$$(48)\quad W = n\,tr[(K'\pi'(S_{00}-\alpha\alpha')^{-1}\pi K)(K'\mu\mu'K)^{-1}]$$

where μ is the eigenvectors of (42) corresponding to smallest (g-h) eigenvalues. The test statistic is distributed as $\chi_{(g-s)h}$.

2.6. Error Regressive Models

When more than two components are introduced into the system y_t, there exists a possibility of more than one cointegration relationship, each representing an equilibrium for different variables. For example, a cointegration equation representing the money market equilibrium condition may not include all the goods market variables, and vice versa. In this case cointegration between variables can be used to reduce the dimension of the system y_t. Consider two error correction terms z_1 and z_2 in equation (40), each representing a deviation from equilibrium in market 1 and market 2 respectively. The ECM is still applicable with the two different error correction terms as follows

$$(49)\qquad \Delta y_t = \sum_{s=1}^{p-1} \Delta\Gamma_s y_{t-s} + \pi_1 z_{1,t-p} + \pi_2 z_{2,t-p} + u_t.$$

Alternatively, it is also possible to formulate the time series regression by treating the error correction terms z_1 and z_2 as a reconstructed variable. z_1 will reflect any deviation of the variables of market 1 and z_2 will reflect any deviation of the variables of market 2 from their long run equilibrium. The VAR with two stationary variables z_1 and z_2 can be represented as

$$(50) \qquad z_t = \sum_{s=1}^{p} \mathring{A}_s z_{t-s} + \vartheta_t,$$

where $z_t' = [z_{1,t} \quad z_{2,t}]$, and is referred to an error regressive model (ERM) in this study. Though the dimension of the system y_t is reduced significantly, the ERM is still capable of capturing any movement of a variable in y_t which causes deviations from the equilibrium relationship.

The ERM has several benefits over the ECM. First, the ERM saves the degrees of freedom by reducing the size of system. Thus, improvement in model fitting and performance is anticipated, especially in cases when only a small sample is available. Second, the structural form can be easily identified in the case of an ERM due to reduced dimensionality. For the previous example, there are only two just identified contemporaneous structures possible, either $z_{1,t}$ before $z_{2,t}$ or $z_{2,t}$ before $z_{1,t}$ in the orthogonal order.

The ERM also has disadvantages. There is a loss of information and it is not easy to detect causes of the disequilibrium movement in z_t. Therefore, it is also difficult to find the impact of any individual series in z_t on other variables, as well as short run interactions among the z_t. For this reason, the VAR or the ECM would be natural choices if one is interested in dynamic interactions between individual series. However, the result from the ERM can serve as a preliminary analysis. With the improved statistical performance of the ERM, a VAR analysis consistent with the ERM will provide confidence for researchers, especially when there are many possible choices in the model specification.

With cointegration in time series data, the ECM and the ERM generate stationary models. The parameter π provides an ordering of contemporaneous variables in structural identification. VARs in differenced variables suffer misspecification and VARs in levels underestimate the parameters near the unit circle, though they are consistent (Engle and Yoo, 1987). With the ECM, improved asymptotic properties are achieved for estimators and tests (Sims, Stock, and Watson, 1990). Although cointegration between macroeconomic variables has been found in some foreign data (Robertson and Orden, 1989; Kunst, 1989), it is not pervasive in U.S. data. Stock and Watson (1989) found no cointegration between money, income, price, and the interest rate. Engle and Granger (1987) found cointegration between consumption and income. But they rejected cointegration between wages and prices, and between GNP and money.

3. Methods Used in This Study

This study adopts the VAR approach developed by Sims. Although the VAR approach has some disadvantages, as discussed above, its strengths for empirical analysis are well known. Sims (1980) justifies use of the VAR approach in cases of no sound theoretical model by saying that "...when adequate structural models do not exist; as is often the case in aggregate macroeconomic work, VAR modeling is a useful strategy for obtaining empirical evidence on competing theories." Myers, Piggott, and Tomek (1991) had more reasons to use the VAR approach; that is,

> "... VAR models are relatively simple to specify and estimate. Only a minimal set of just-identifying restrictions is employed and no restrictions are placed on the parameters of the reduced form. ... given the uncertainty surrounding the underlying economic structure of the market, the unrestricted reduced form VAR provides flexibility which allows the model to be consistent with a wide range of alternative economic structures."

Analysis will begin with unit root tests. If unit roots are found, further tests will be conducted to find whether cointegration exists. The maximum likelihood methods developed by Johansen will be applied to test and estimate the cointegration relations. Estimates of a cointegrating vector α will indicate long run relationships between variables and generate error correction terms z_t. A reduced form ERM model will be estimated based on the findings, and several contemporaneous structures will be imposed to identify the structural form. Statistical performance and theoretical consistency will be considered to choose a final model for the analysis. Then, the impact of fiscal policy on farm prices relative to industrial prices will be traced out based on impulse response weights. Decomposition of forecast error variances will provide a further measure of the impact.

Sensitivity of the ERM interpretations will be analyzed with respect to different model specifications. Sensitivity against different lag orders and different contemporaneous structures will be checked first. Sensitivity analysis will also be performed against different types of model, ECM and VAR in both levels and first differences. For the ECM estimation, a z_t series representing the long run equilibrium relationships between variables will be unrestricted and its component variables will be included individually. The parameters for the error correction term will then serve as another criteria for identification. With all monetary variables included, the impulse response weights and the error decomposition will provide a measure of the impact of fiscal policies on agriculture.

Finally, a policy option to tackle the current budget deficit will be drawn based on the findings. The policy option will be compared to other policy scenarios in a simulation study.

CHAPTER IV

PRELIMINARY ANALYSIS

1. Variables and Data

The Federal deficit (D) and farm prices (F) are natural choices for variables considered here to pursue the study's objectives. The Federal deficit is also broken down into its two component parts, federal government spending (G) and tax revenue (T). Real output of the economy (Y) and industrial prices (P) are included to represent quantity and price variables for domestic goods markets; real money stock (M) and interest rate (R) represent quantity and price for domestic financial markets. The exchange rate variable (X) enters into the model to represent the international sector.

D is measured by the federal budget deficit ($ bil.) divided by nominal GNP ($ bil.) to remove any impact of inflation, size of economy, and business cycle fluctuations (Belongia and Stone, 1985). Similar measures are used in other empirical studies (Barro, 1978a, 1978b; Hamburger and Zwick, 1981; McMillin and Beard, 1982; Protopapadakis and Siegel, 1984). Similarly, G is measured by the ratio of the federal government expenditures ($ bil.) over nominal GNP and T is measured by the ratio of the federal government receipts ($ bil.) over the nominal GNP. Nominal M1 ($ bil.) is deflated by the GNP implicit price deflator (1982=100) to define M and the three month treasury bill rate is used for R. X is measured by the multilateral trade weighted value of the U.S. dollar (march 1973=100). Y is measured by nominal GNP divided by the GNP implicit price deflator. The implicit price deflators for GNP by farm and nonfarm sectors are used for F and P respectively.

Quarterly data from 1948:3 to 1989:3 are used for the analysis (see Appendix A for sources). The indexes are seasonally adjusted except for the interest rate and the exchange rate. All variables, except D, are expressed in natural logarithms to stabilize their variances (Kunst, 1989). Plots of each series are provided in Figure 6.

2. Unit Root Tests

Several measures are used to test for stationarity in each series. Dickey-Fuller (DF) test and Stock-Watson (SW) tests are applied and the results are reported in Table 1 for the first unit root and Table 2 for the second unit root. Lag lengths for the test equations for each series are selected based on several criteria (FPE, AIC, SC and LR)[2] and appear in the last row of the tables. The first unit root is rejected in series G, T and D at the .05 level in both tests. The

---

[2]FPE: Final Prediction Error Criteria by Hsiao (1981).
AIC: Akaike Information Criteria by Akaike (1969)
SC : Schwartz Criteria by Schwartz (1978)
LR : Likelihood Ratio Test by Sims (1980)

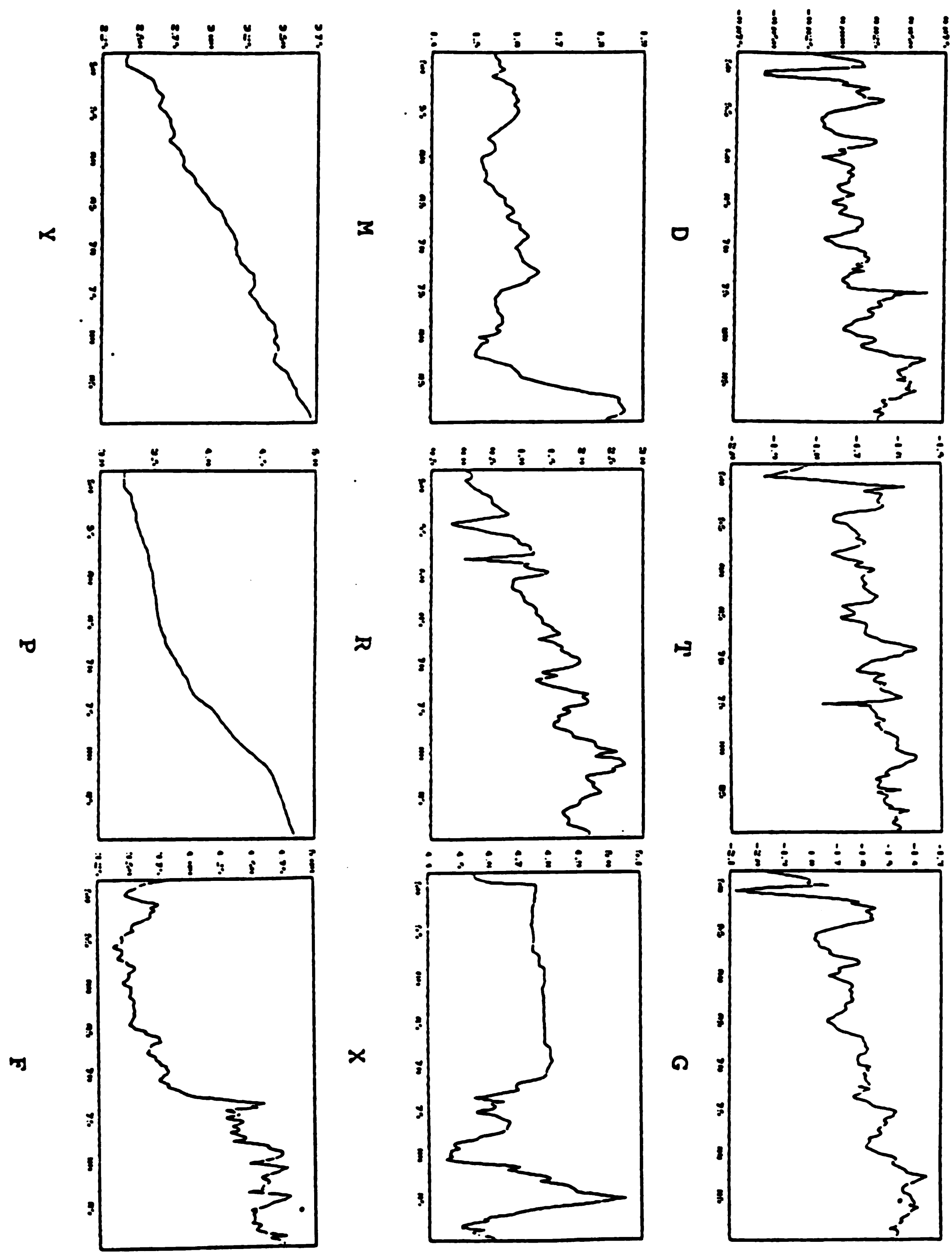


Figure 6. Plots of Each Series

Table 1. Results of DF Test for One Unit Root

Hypothesis	Series								
	Y	M	P	F	R	X	G	T	D
Unit Root(β_1=0)[a]									
DF	-2.06	-.38	-1.44	-2.96	-3.17*	-2.91	-4.48***	-4.85***	-5.47***
SW	-6.90	-.36	-.87	-11.97	-16.97	-9.62	-27.84**	-36.95***	-41.19***
Deterministic Trend[b] (β_0=0, given β_1=0)	1.92*	-.25	1.65	3.12***	2.51**	-1.62	3.48***	2.80**	3.99***
Drift[b] (μ=0, given β^1=0)	2.25**	.47	1.58	2.88***	.85	2.95***	-4.39***	-4.80***	-2.11***
Number of Lags	0	0	3	0	3	1	1	2	2

Reject the null hypothesis of unit root at .10 for *, .05 for ** and .01 for ***.
Distribution of test statistic follow Dickey and Fuller for a and t for b.

Table 2. Results of DF Test for Two Unit Roots

Hypothesis	Series								
	Y	M	P	F	R	X	G	T	D
Unit Root(β_1=0)[a]									
DF	-8.51***	-17.02***	-3.33*	-12.58***	-6.62***	-6.86***	-8.28***	-8.48***	-7.99***
SW	-101.51***	-209.09***	-41.29***	-160.72***	-119.63***	-103.25***	-132.10***	-155.34***	-128.93***
Deterministic Trend[b] (β_0=0, given β_1=0)	-.69	.05	1.00	.74	-.52	-.81	-.47	-.68	.00
Drift[b] (μ=0, given β^1=0)	3.36***	-.06	1.64	-.07	.87	.76	.72	.88	.09
Number of Lags	0	0	2	0	2	1	1	1	1

Reject the null hypothesis of unit root at .10 for *, .05 for ** and .01 for ***.
Distribution of test statistic follow Dickey and Fuller for a and t for b.

second unit root is rejected in all series at any significance level by the SW test. It is also rejected by the DF test at any level of significance for all but the P series where it is rejected only at the .10 level. The results suggest that all the series except the fiscal measures contain a unit root. And the fiscal variables, G, T and D, are stationary in levels.

Dickey-Pantula (DP) test result appears in Table 3 for the third unit root and Table 4 for the second unit root. As expected, both units roots are rejected in all series at any significance level, except for the P series. The second unit root for P is rejected only at the .10 level. The results from the DP test affirm the results by the DF and SW tests.

Phillips-Perron (PP) unit root test also provide results consistent with the DF and SW tests, except for the D series, as shown in Table 5. A structural change in the mid 1970's for the D series, as evident in Figure 1, might be responsible for this anomalous result.

As shown in Table 6, the Schmidt-Phillips (SP) test had similar results to the DF and SW tests. Except for the fiscal variables, all series contain a unit root at any level of significance. However, the unit root is rejected in G only at the .10 level and in T at the .05 level.

Overall, it is reasonable to say a unit root is evident in all series except the fiscal variables. Inspection of the autocorrelations for the levels given in Table 7 and the first

Table 3. Results of DP Test for Three Unit Roots

Hypothesis	Series								
	Y	M	P	F	R	X	G	T	D
Third Unit Root τ_{μ}	-19.03***	-17.08***	-14.38***	-20.99***	-12.49***	-10.99***	-14.14***	-12.00***	-13.04***
Number of Lags	0	0	1	0	2	3	1	2	1

Significant at .10 for *, .05 for ** and .01 for ***.

Table 4. Results of DP Test for Two Unit Roots

Hypothesis	Series Y	M	P	F	R	X	G	T	D
Second Unit Root τ_μ	-6.40***	-7.29***	-3.22*	-9.40***	-11.13***	-5.58***	-7.04***	-7.46***	-7.62***
Number of Lags	0	0	1	0	0	1	1	1	3

Significant at .10 for *, .05 for ** and .01 for ***.

Table 5. Results of PP Test for One Unit Root

Test Statistics	Series								
	Y	M	P	F	R	X	G	T	D
$Z(\Phi_2)$	17.35***	1.87	31.48***	3.72	3.89	2.51	5.94**	5.64**	2.50
$Z(\Phi_3)$	3.39	1.56	6.20**	5.02	5.28	3.75	8.42***	8.28***	3.49
$Z(t\bar{\alpha})$	-2.45	-.25	-1.51	-2.96	-3.16*	-2.49	-3.99***	-3.99***	-2.61
$Z(\Phi_1)$	21.65***	1.41	42.31***	.59	2.60	2.31	4.53*	5.78**	1.39
$Z(\alpha^*)$	-1.08	.59	2.61	-.35	-2.03	-2.14	-2.84*	-3.33**	-1.49
$Z(\alpha')$	6.22	1.59	8.99	.98	-.28	.91	-1.60	-.69	-.87
# Neway-West Lags	2	1	3	0	3	1	1	0	2

Significant at .10 for *, .05 for ** and .01 for ***.

Table 6. Results of SP Test for One Unit Root

Hypothesis	Series								
	Y	M	P	F	R	X	G	T	D
Unit Root τ	-1.00	-.72	-1.21	-1.04	-2.05	-2.61	-2.75*	-3.30**	-4.65***
Number of Lags	1	1	2	0	3	1	1	0	1

Significant at .10 for *, .05 for ** and .01 for ***.

Table 7. Autocorrelations of Level Series

	Series								
	Y	M	P	F	R	X	G	T	D
r_1	.980	.969	.985	.983	.961	.956	.938	.889	.902
r_2	.960	.927	.969	.964	.911	.889	.865	.774	.773
r_3	.939	.875	.953	.946	.877	.808	.798	.646	.640
r_4	.917	.816	.937	.929	.839	.718	.737	.520	.529
r_5	.896	.751	.920	.909	.797	.625	.686	.395	.455
r_6	.874	.682	.904	.893	.751	.532	.645	.293	.419
r_7	.853	.611	.887	.880	.710	.435	.621	.219	.402
r_8	.833	.539	.870	.866	.688	.334	.572	.160	.382
r_9	.814	.467	.852	.853	.667	.242	.513	.136	.367
r_{10}	.796	.393	.835	.842	.638	.153	.457	.118	.352
r_{11}	.778	.320	.818	.832	.613	.071	.407	.120	.298
r_{12}	.762	.251	.801	.822	.598	.005	.380	.104	.272
r_{13}	.745	.189	.783	.814	.586	-.053	.368	.097	.261
r_{14}	.729	.134	.765	.804	.571	-.097	.374	.123	.271
r_{15}	.713	.085	.747	.791	.551	-.136	.385	.154	.294
r_{16}	.696	.039	.729	.780	.533	-.164	.400	.199	.330
r_{17}	.680	-.003	.710	.770	.523	-.179	.421	.232	.357
r_{18}	.664	-.040	.692	.755	.511	-.181	.437	.259	.373
r_{19}	.648	-.073	.673	.741	.491	-.169	.448	.279	.370
r_{20}	.633	-.100	.654	.726	.473	-.153	.456	.299	.355

differenced series in Table 8 does not contradict these results. The results are also consistent with other empirical studies[3].

3. Cointegration Tests

Though a unit root is found in each component variable of y_t, except fiscal variables, the number of unit roots in the system can be reduced if the nonstationary variables are cointegrated. The Johansen and Juselius method is applied to test the existence of long run equilibrium relationships among the six nonstationary variables, M, R, Y, P, X, and F.

Test equations (44) and (45) are estimated first. The lag p-1 is selected based on statistical criteria appearing in Table 9. Among the information criteria, Lutkepohl (1982) supported the use of the Schwartz Criterion with his simulation study. This criterion was minimized for a lag length of zero. The zero lag model seems underfitted using Sim's (1980) modified likelihood ratio test. This test suggests two or seven lags.

The test statistics for cointegration are given in Table 10. Three cointegrating vectors are found with seven lags and four cointegrating vectors with two lags. Three cointegrating

---

[3]Nelson and Plosser (1982) found a unit root in output, price, interest rate, and money series with annual data. Stock and Watson (1986, 1989) found a unit root in the series with quarterly data. Similar results are obtained by Hoffman and Rasche (1989a, 1989b) and Plosser (1986).

Table 8. Autocorrelations of First Differenced Series

	Series Y	M	P	F	R	X	G	T	D
r_1	.381	.374	.566	.019	.175	.327	.226	-.007	.209
r_2	.232	.113	.598	-.043	-.269	.167	.013	.054	.044
r_3	.014	-.122	.528	.026	.073	.129	-.006	-.052	-.092
r_4	-.098	-.022	.396	-.019	.092	.131	-.117	-.028	-.191
r_5	-.109	.140	.441	-.122	.077	.113	-.191	-.167	-.222
r_6	-.058	.102	.352	-.050	-.069	.046	-.086	-.042	-.105
r_7	-.028	-.010	.379	.069	-.320	.086	-.061	-.006	-.118
r_8	-.085	-.021	.354	-.073	-.005	-.089	-.080	-.119	-.106
r_9	-.098	.090	.381	-.116	.139	-.053	.037	.011	.004
r_{10}	-.005	.190	.338	.082	-.063	-.086	.112	.021	.196
r_{11}	-.009	.123	.236	-.021	-.146	-.171	-.130	.005	-.065
r_{12}	-.102	.173	.365	-.141	-.045	-.117	-.066	-.083	-.039
r_{13}	-.092	-.076	.263	.079	.020	-.156	-.105	-.119	-.099
r_{14}	-.115	.013	.293	.173	.056	-.041	-.107	-.031	-.084
r_{15}	-.065	.013	.299	-.134	-.034	-.104	.018	-.091	-.051
r_{16}	.033	.040	.243	-.007	-.121	-.139	-.001	.059	.086
r_{17}	.070	-.048	.321	.072	.016	-.135	-.007	.054	.027
r_{18}	.081	-.054	.294	-.036	.119	-.173	.082	.026	.124
r_{19}	.026	-.118	.287	-.037	-.049	-.100	.089	.012	.073
r_{20}	.027	-.058	.275	.070	-.073	-.091	.065	.034	.115

Table 9. Lag Selection for ΔM, ΔR, ΔY, ΔP, ΔX, and ΔF

Lag Length p-1	Criteria FPE ($\times 10^{20}$)	AIC	SC	$\chi^2(36)^1$	Sig. Level
0	.7830	-46.30^{v}	-46.30^{v}		
1	.8421	-45.86	-45.86	570.72	.0000***
2	.5697	-45.89	-44.53	72.76	.0000***
3	.4485	-45.76	-43.73	46.24	.1179
4	.3500	-45.65	-42.94	47.45	.0960*
5	.2115	-45.79	-42.40	55.36	.0206**
6	.1471	-45.79	-41.72	51.44	.0459**
7	.0974	-45.84	-41.09	56.64	.0156**
8	.0646	-45.88	-40.46	46.20	.1188
9	.0476	-45.83	-39.73	41.80	.2333
10	.0253	-46.09	-39.31	62.26	.0042***
11	$.0165^{v}$	-46.16	-38.70	47.63	.0930*

1.Likelihood ratio statistics to test H_0: Lag length of p-2 vs. H_a: Lag length of p-1.
2.H_0 is rejected at 10% level for *, at 5% for ** and at 1% for ***.
3.v indicates minimum value for each information criteria.

Table 10. JJ Test Results for M, R, Y, P, X, and F

H_0		$-2\ln Q$	
h	m	Two lags	Seven lags
0	6	124.10***	154.52***
1	5	76.73***	100.93***
2	4	52.52***	58.64***
3	3	30.04***	22.81
4	2	11.91	5.95
5	1	1.48	.43

***: Reject the null hypothesis at .01 level.

vectors are also found with five or more lags and four cointegrating vectors with other lags. Thus, at least three long run equilibrium relationships are evident among the six nonstationary variables.

Although a cointegrating vector may describe an equilibrium among all variables in a system, it is also plausible that only a subset of the variables are significant in the cointegration. In this case, the dimension of the cointegrating vector must be reduced. The bigger the system is, the more possibilty of reduction in the dimension of cointegrating vector. To simplify the cointegrating vector, the Johanson and Juselius test is applied to all possible combinations of two variables among the six nonstationary variables. However, no cointegration is found in any two variable combination. This results in moving to a test on three variable combinations.

Among the various possible three variable combinations, Hoffman and Rasche (1989a, 1989b) have shown that the long run money demand function, a linear combination of M, Y and R, is a strong candidate.

4. Money Market Equilibrium

The long run money demand function, known as the LM curve or portfolio balance schedule, has received much attention from macroeconomists (Meltzer, 1963; Chow, 1966; Poole, 1970, 1988; Goldfeld, 1973). The portfolio balance schedule is represented as

$$(51)\quad \alpha_M M_t + \alpha_Y Y_t + \alpha_R R_t = e_{Mt}.$$

The Johansen and Juselius method is applied to test the existence of a long run equilibrium relationship among the three variables. Two, four or seven lags are adopted for the cointegration test equations based on lag selection criteria reported in Table 11. The test statistics for cointegration are given in Table 12. The estimated eigenvalues and eigenvectors are presented in Table 13 with parameter matrices. One cointegration is found at the .05 significance level and the long run money demand equation is established as equation (51). The coefficients, α_M, α_Y, and α_R are obtained from the first column in α vector in Table 13 and are significant by the Wald test. The LM equation is more familiar after normalization as

$$(52)\quad M_t = \alpha_Y^N Y_t + \alpha_R^N R_t.$$

Estimated values for α_Y^N, ranging from -.71 to -1.29, suggest that the equilibrium real income elasticity of money demand with respect to real balances is unity as many macroeconomists conjecture. To test H_0: $\alpha_M = -\alpha_Y$ or $\alpha_Y^N = 1$, a likelihood ratio test statistic, equation (46), and Wald test statistic,

Table 11. Lag Selection for ΔM, ΔY, and ΔR

Lag Length p	Criteria FPE ($x10^9$)	AIC	SC	$\chi^2(9)$[1]	Sig. Level
0	.1129	-22.90	$-22.90^{\vee}$		
1	.1171	-22.79	-22.62	28542.00	.0000***
2	.0912	-22.97	-22.63	43.46	.0000***
3	.0854	-22.96	-22.45	16.21	.0626*
4	.0783	-22.98	-22.30	19.98	.0180**
5	.0736	-22.97	-22.12	14.29	.1125
6	.0675	$-23.98^{\vee}$	-21.96	7.29	.6074*
7	.0603	-23.02	-21.83	17.67	.0392**
8	.0556	-23.03	-21.67	6.39	.7002
9	.0554	-22.96	-21.43	6.36	.7035
10	.0503	-22.98	-21.28	14.44	.1074
11	$.0469^{\vee}$	-22.98	-21.11	13.51	.1409

1.Likelihood ratio statistics to test H_0: Lag length of p-1 vs. H_a: Lag length of p.
2.H_0 is rejected at 10% level for *, at 5% for ** and at 1% for ***.
3.$\vee$ indicates minimum value for each information criteria.

Table 12. JJ Test Results for M, Y, and R

H_0		$-2\ln Q$		
h	m	Two lags	Four lags	Seven lags
0	3	29.85***	32.58***	28.35**
1	2	6.55	9.52	12.50*
2	1	1.44	2.68	2.55

Reject the null hypothesis at .01 level for ***, at .05 level for **, and at .10 level for *.

Table 13. Eigenvalues and Eigenvectors for M, Y, and R

Two lags

		Eigenvalues λ	
	.13	.03	.01
		Eigenvectors V (=α)	
M	14.15	-10.87	9.51
Y	-10.10	4.58	2.37
R	5.38	-.75	-.94
		$-S_{0p}V$ x 1000 (=π)	
M	1.64	-1.18	.16
Y	3.10	.72	.21
R	21.99	1.67	-9.91

Four lags

		Eigenvalues λ	
	.13	.04	.02
		Eigenvectors V (=α)	
M	14.01	13.83	11.01
Y	-11.54	-5.30	1.65
R	6.23	1.15	-.28
		$-S_{0p}V$ x 1000 (=π)	
M	.94	1.35	.50
Y	2.37	-.78	.69
R	37.59	.49	-7.44

Seven lags

		Eigenvalues λ	
	.10	.06	.02
		Eigenvectors V (=α)	
M	9.00	24.77	6.43
Y	-11.59	-9.23	4.11
R	6.79	3.74	-.84
		$-S_{0p}V$ x 1000 (=π)	
M	-.83	1.76	.02
Y	1.55	.63	.77
R	30.01	9.41	-6.13

equation (48), are used. Results are provided in Table 14 with corresponding eigenvalues and eigenvectors. Both tests failed to reject the unitary income elasticity hypothesis. The long run LM equation (52) with the restriction is reestimated as

$$(53)\quad M_t = Y_t + \alpha_R^* R_t + Z_{Mt}$$

with α_R^* having values -.55 for two and four lags and -.58 for seven lags.

The results are quite consistent with Hoffman and Rasche (1989a) who found the interest rate elasticity is -.53 for four lags and -.56 for seven lags with monthly data from 1953 to 1987. However, Stock and Watson (1989) didn't find cointegration between these monetary variables. The results are not sensitive to other lag specifications. One cointegration with the unitary income elasticity is also accepted with three lags, five, six and eight lags. Estimates of the interest rate elasticity in the restricted money demand equation were -.56 for three, six and eight lags and -.58 for five lags.

Based on the cointegration results, three variables in the LM equation can be merged into a synthetic time series $Z_{Mt} = M_t - Y_t - \alpha_R^* R_t$, which represents deviations from the long run money market equilibrium. In Figure 7, the actual balance and the equilibrium balance of money are plotted with $\alpha_R^* = -.55$. Z_{Mt} is represented by the vertical differences

Table 14. Test Results for the Velocity Restriction

Two lags			
Eigenvalues λ^*	.12		.03
Eigenvectors V (M & Y)	9.51		5.42
(R)	5.28		1.24
Test for the Velocity Restriction:		$\chi^2(1)$	1.81
		N	1.52
Implied Interest Elasticity of Velocity			-.55 (.03)
Four lags			
Eigenvalues λ^*	.13		.03
Eigenvectors V (M & Y)	11.03		5.53
(R)	6.06		1.23
Test for the Velocity Restriction:		$\chi^2(1)$	.53
		N	.82
Implied Interest Elasticity of Velocity			-.55 (.02)
Seven lags			
Eigenvalues λ^*	.10		.03
Eigenvectors V (M & Y)	12.58		8.03
(R)	7.20		2.48
Test for the Velocity Restriction:		$\chi^2(1)$	.14
		N	.58
Implied Interest Elasticity of Velocity			-.58 (.05)

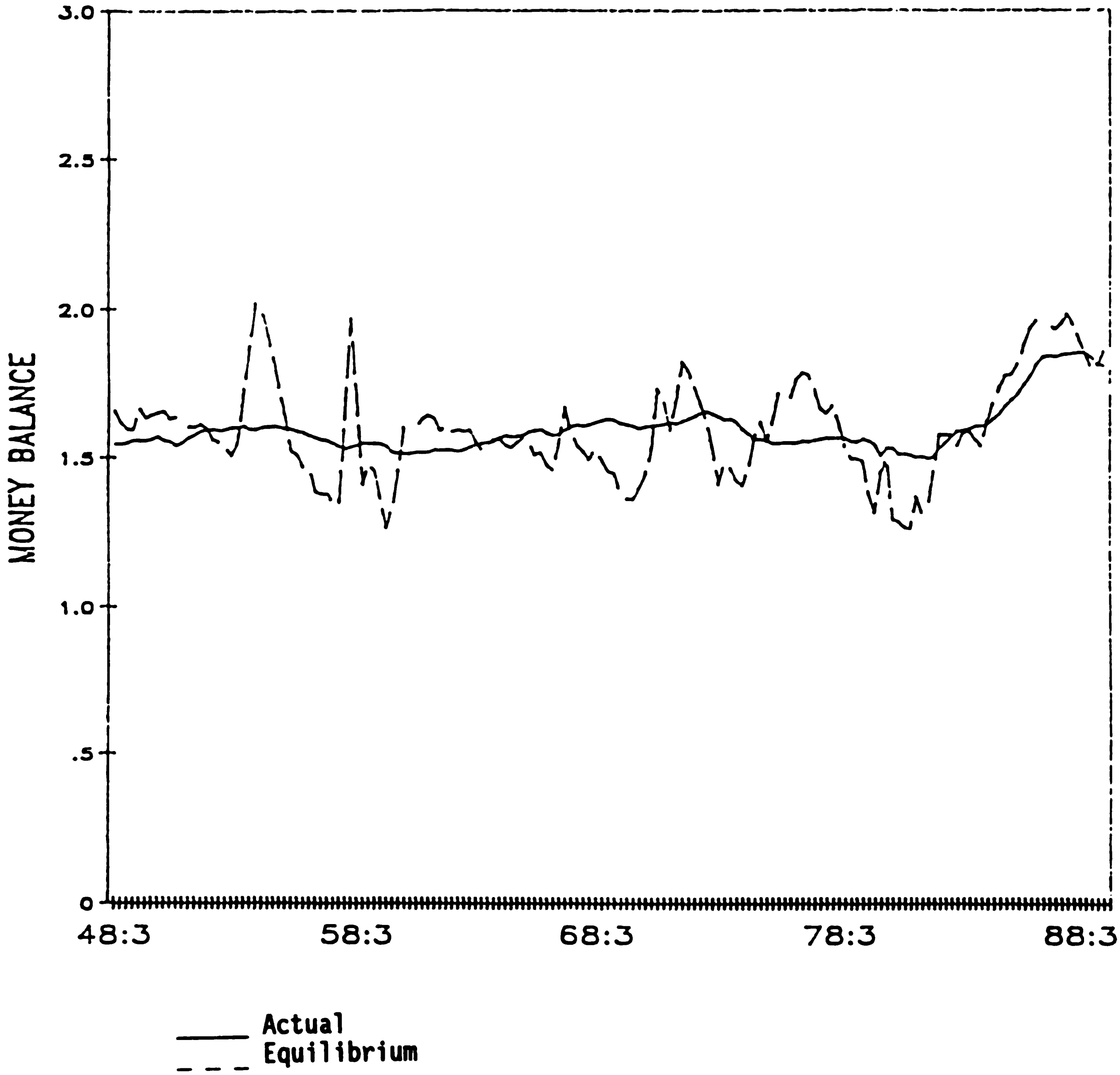


Figure 7. Actual and Equilibrium Real Money Balances

between them. Any changes in M, Y and R will be directly reflected in Z_M.

5. Exchange Rate Equilibrium

Unlike the long run money demand function, equilibrium among P, F and X, has not been studied yet. The rationale for the long run equilibrium relationship can be derived from the PPP (Purchasing Power Parity) equation which can be written as

$$(54) \quad X_t = \alpha_0 + \alpha_1(Q_t - Q_t^*) + u_t.$$

Q_t, and Q_t^* denote, respectively, the domestic and foreign aggregate price indices. To maintain the terms of trade the constant, α_1 must be unity.

Because PPP tends to be rejected empirically when applied to aggregate price indices (Frenkel, 1981; Branson, 1981; Batten Belongia, 1984), many scholars have replaced the aggregate price indices with prices of specific commodity groups. Protopapadakis and Stall (1983) have termed this the LOP (Law of One Price). Frenkel (1981) disaggregated the general price indice into prices of traded goods and non-traded goods, and Isard (1977) disaggregated into manufacturing goods and primary goods.

In its strictest form, the LOP implies α_0=0 and α_1=1 in

(54) where Q_t denotes disaggregated prices. The result can be obtained with competitive behavior in the market; instantaneous adjustment of prices and the exchange rate; a high degree of homogeneity between products; and no trade barriers and transportation costs. Though it is difficult to find a commodity to fit all of these conditions, Isard (1977), Protopapadakis and Stall (1983), Jabara and Schwartz (1987), and Ardeni (1989) considered agricultural goods as the best possible candidate. Empirical tests of the LOP for agricultural goods have produced mixed results, depending on the commodity, time periods and countries used in the analysis (Jabara and Schwartz, 1987; Ardeni, 1989).

To test the LOP in agricultural goods, the PPP equation (54) is expressed as

$$(55) \quad X_t = \alpha_0 + \alpha_1(F_t - F_t^*) + u_t.$$

The aggregate price level is assumed to be an index of industrial prices with weight β and farm prices with weight $1-\beta$ (domestic), and β^* and $1-\beta^*$ (foreign):

$$(56) \quad Q = \beta P + (1-\beta)F$$

and

$$(57) \quad Q^* = \beta^* P^* + (1-\beta^*)F^*.$$

Subtracting (57) from (56) and rearranging terms yields

$$(58)\quad F - F^{*} = (Q - Q^{*}) + \beta(F - P) - \beta^{*}(F^{*} - P^{*}).$$

Substituting equation (58) into equation (55) yields

$$(59)\quad X_t = \alpha_0 + \alpha_1\beta(F_t-P_t) - \alpha_1\beta^{*}(F_t^{*}-P_t^{*}) + \alpha_1(Q_t-Q_t^{*}) + u_t.$$

When the aggregate price indices in the domestic and foreign countries have a long run equilibrium relationship (ie., $F_t^{*}-P_t^{*} = Z_{1t}$) and the relative price index between sectors abroad remain stable in the long run (ie., $Q_t-Q_t^{*} = z_{2t}$), the third and the fourth terms in right hand side of (59) can be replaced with stationary error processes. Thus, equation (59) becomes

$$(60)\quad X_t = \alpha_{0,t}' + \alpha_1\beta(F_t-P_t) + u_t'$$

or, more generally,

$$(61)\quad X_t = \alpha_{0,t}' + \alpha_F\beta F_t - \alpha_P\beta P_t + u_t'.$$

For the U.S. economy, the weight of farm prices in the aggregate price index is considered to be near zero[4]. With

---

[4]For the last three decades, the weight of farm prices on aggregate price index (GNP implicit price deflator) remained less than .045.

β=1, equation (61) becomes

$$(62)\quad \alpha_X X_t + \alpha_P P_t - \alpha_F F_t = e_{Xt},$$

where $\alpha_X=1$, $\alpha_P=\alpha_F=\alpha_1$, and $e_{Xt}=\alpha'_{0,t}=u'_t$. Therefore, the LOP holds if $\alpha_P=\alpha_F=\alpha_X=1$.

The Johansen and Juselius method is applied to test the existence of a long run equilibrium relationship among the three variables. A dummy variable is introduced into the test equation to take account of differences in the volatility of the exchange rate before and after the 1973 exchange rate system change. Two lags are adopted for the cointegration test based on lag selection criteria reported in Table 15. The test statistics for cointegration are given in Table 16. The estimated eigenvalues and eigenvectors are presented in Table 17 with parameter matrices. One cointegration is found at the .05 level and the long run equilibrium relationship is established as equation (62).

The coefficients, α_X, α_P, and α_F are obtained from the first column in α vector in Table 17 and found significant by the Wald test. To test the LOP hypothesis, H_0: $\alpha_X = \alpha_P = \alpha_F$, the likelihood ratio and Wald tests are used. The test results, provided in Table 18, fail to reject the equality restriction. Thus, the long run equilibrium equation (62) is written as

Table 15. Lag Selection for ΔX, ΔP, and ΔF

Lag Length p	Criteria FPE ($x10^9$)	AIC	SC	$\chi^2(9)$[1]	Sig. Level
0	.1283	-22.78	-22.77^{v}		
1	.1331	-22.67	-22.50	56.91	.000***
2	.1202	-22.70	-22.36	23.54	.005***
3	.1167	-22.65	-22.14	9.75	.371
4	.1101	-22.64	-21.96	15.58	.076*
5	.0879	-22.79	-21.94	13.42	.144
6	.0840	-22.76	-21.74	12.42	.191
7	.0860	-22.67	-21.47	4.15	.901
8	.0645	-22.88	-21.52	26.90	.001***
9	.0615	-22.85	-21.32	11.46	.246
10	.0512	-22.97	-21.26	17.43	.042**
11	.0452^{v}	-23.02^{v}	-21.14	19.60	.021**

1.Likelihood ratio statistics to test H_0: Lag length of p-1 vs. H_a: Lag length of p.
2.H_0 is rejected at 10% level for *, at 5% for ** and at 1% for ***.
3.v indicates minimum value for each information criteria.

Table 16. JJ Test Results for X, P, and F

H_0		$-2\ln Q$		
h	m	Two lags	Four lags	Eight lags
0	3	34.71***	42.52***	28.63**
1	2	10.34	15.10**	10.80
2	1	.03	.52	.28

Reject the null hypothesis at .01 level for ***, at .05 level for **, and at .01 level for *.

Table 17. Eigenvalues and Eigenvectors for X, P, and F

Two lags

		Eigenvalues λ	
	.14	.06	.00
		Eigenvectors V (=α)	
X	-5.79	-10.22	1.09
P	-4.47	5.57	.90
F	5.61	-5.01	5.87
		$-S_{0p}V \times 1000$ (=π)	
X	-6.80	-3.84	.22
P	-1.70	.39	-.05
F	3.31	-13.76	-.44

Four lags

		Eigenvalues λ	
	.16	.09	.00
		Eigenvectors V (=α)	
X	10.33	-8.05	.88
P	2.91	7.14	-1.00
F	-4.02	-8.33	-6.41
		$-S_{0p}V \times 1000$ (=π)	
X	7.24	-3.82	-.91
P	1.73	.91	.11
F	4.67	-14.74	2.13

Eight lags

		Eigenvalues λ	
	.11	.07	.00
		Eigenvectors V (=α)	
X	17.70	7.84	2.99
P	-6.67	7.26	1.62
F	6.82	-8.26	-10.22
		$-S_{0p}V \times 1000$ (=π)	
X	5.22	3.16	-.54
P	-.28	1.05	.11
F	15.45	-4.72	1.35

Table 18. Test Results for the Exchange Rate Restriction

Two lags			
Eigenvalues λ^*	.14		
Eigenvectors V	5.01		
Test for the LOP Restriction:		$\chi^2(1)$	.78
	$(\alpha_X = \alpha_P)$	N	.43
	$(\alpha_X = -\alpha_F)$	N	.06
	$(\alpha_P = -\alpha_F)$	N	.87

(63) $F_t = P_t + X_t + Z_{Xt}$

which is called the exchange rate equilibrium equation.

However, the credibility of the LOP hypothesis relies on the stability of relative prices between sectors in other countries and the stability of the aggregate price ratio between countries. The results are also quite sensitive to lag length. As shown in Table 16, two cointegrations are found with four lags at the .05 significance level and different signs for the cointegrating vector are found with eight lags. However, the four and eight lag models are not considered for the cointegration test because lags from three to seven are rejected strongly by the likelihood ratio test.

Based on the cointegrating relationship, three variables in the exchange rate equilibrium equation can be merged into a synthetic time series $Z_{Xt} = F_t - P_t - X_t$, which represents deviations from the long run exchange rate equilibrium. In Figure 8, the actual and the equilibrium farm prices are plotted. Z_{Xt} is represented by the vertical differences between them. Any changes in X, P and F will be directly reflected in Z_X.

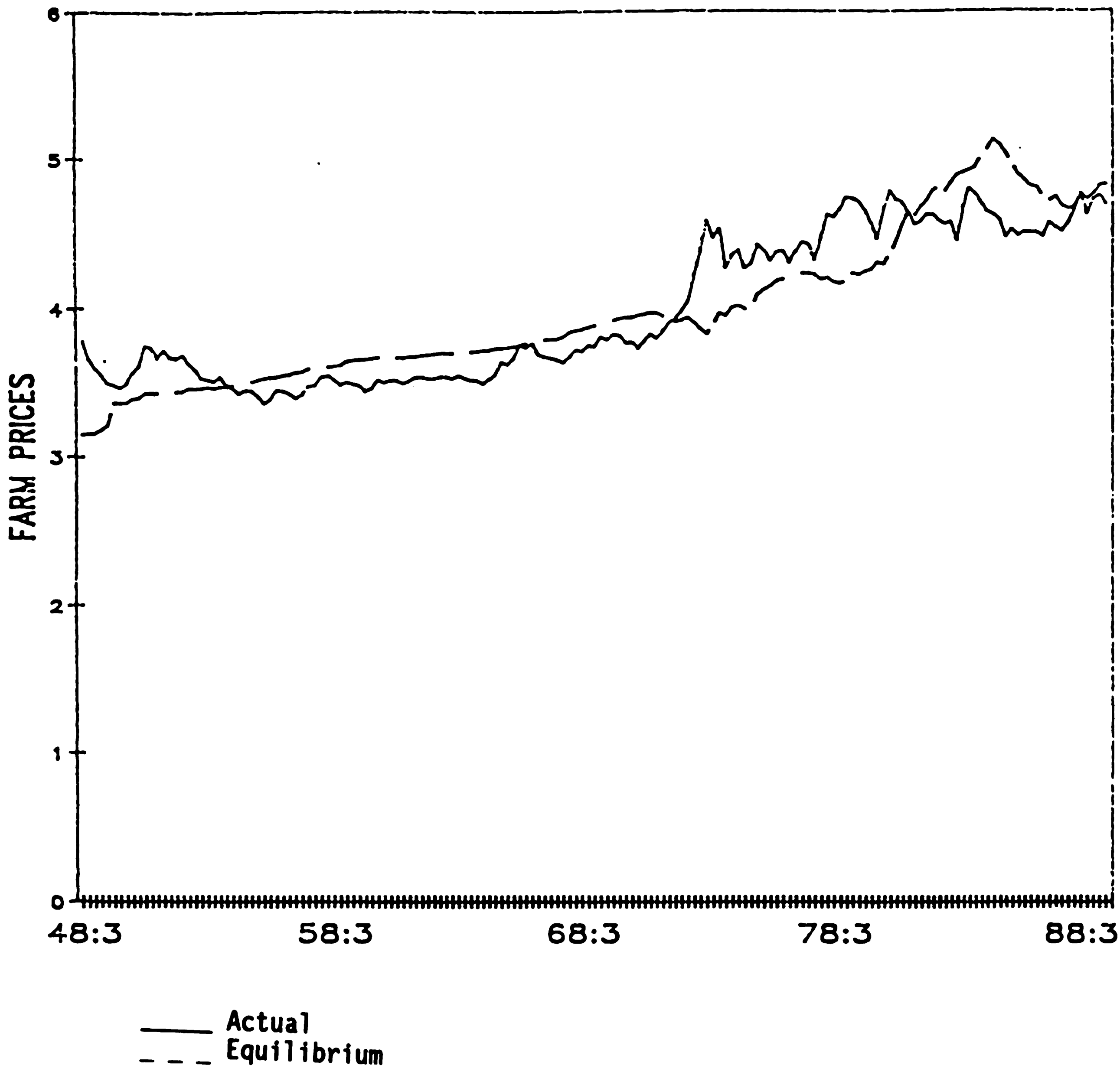


Figure 8. Actual and Equilibrium Farm Prices

CHAPTER V

A VAR MODEL OF FISCAL POLICY IMPACTS ON AGRICULTURE

1. Reduced Form Specification

As discussed in chapter III, cointegration between variables can be used to restrict the VAR in the form of an ECM, or to reduce number of variables in the form of ERM. The appropriate form for an ERM will be equation (50) with three stationary variables D_t, Z_{Mt}, and Z_{Xt}. Three lags were chosen for the reduced form on the grounds of statistical tests reported in Table 19.

Possible structural changes during the estimation period are considered following Chambers and Just (1986) and Saunders (1988). To test the significance of a structural change in 1973 due to the exchange rate regime change, and in 1979 due to the Monetary Decontrol Act, the reduced form ERM is estimated for two separate sample periods, before and after the structural changes. Chow tests of the structural changes are then applied. As shown in Table 20, the structural change in 1973 has important effects on D and Z_X. The structural change in 1979 is only evident in the D equation. When the impact of the 1973 structural change is removed by introducing a dummy variable, the 1979 structural change is no longer visible. Therefore, it is believed that a structural change occurred in 1973, but not in 1979. The results are not

Table 19. Lag Selection for ΔD, ΔZ_M, and ΔZ_X

Lag Length p	Criteria FPE $(x10^8)$	AIC	SC	$\chi^2(9)^1$	Sig. Level
0	.1941	-20.06	$-20.06^{\vee}$		
1	.2012	-19.95	-19.78	1856.12	.000***
2	.1583	-20.12	-19.78	44.24	.000***
3	.1405	-20.17	-19.66	26.37	.002***
4	.1303	-20.17	-19.49	16.90	.050*
5	.1285	-20.11	-19.26	8.03	.531
6	.1166	-20.13	-19.12	17.05	.048**
7	.1125	-20.10	-18.91	10.40	.319
8	.0844	-20.31	-18.96	26.89	.001***
9	.0737	$-20.38^{\vee}$	-18.85	15.48	.078*
10	.0738	-20.30	-18.61	5.41	.797
11	$.0647^{\vee}$	-20.36	-18.50	21.12	.012**

1.Likelihood ratio statistics to test H_0: Lag length of p-1 vs. H_a: Lag length of p.
2.H_0 is rejected at 10% level for *, at 5% for ** and at 1% for ***.
3.∨ indicates minimum value for each information criteria.

Table 20. Test Results for Structural Change

Statistics	Distribution	Equation		
1973		D	Z_M	Z_X
HS[1]	F(53,89)	.746	.563	2.167***
CHOW	F(13,135)	3.665***	.566	2.472***
1979				
HS[1]	F(29,113)	.419	.501	1.888***
CHOW	F(10,142)	2.230**	1.402	1.287

1. Test of homoscadasticity is performed by comparing the variances between two different sample periods.
2. The null hypothesis of homoscadasticity or no structural change is rejected at .05 level for ** and at .01 level for ***.

sensitive to the number of lags.

The 1973 structural change is also identified in the historical decomposition of D as shown in Table 21. The structural change had positive impact on D implying an increased federal budget deficit was created by the change. No evidence of the structural changes was found in Z_M and Z_X using historical decomposition of these variables (Tables 22 and 23).

Though the three variable ERM has advantages over the seven variable ECM in model fitting and identification, it is difficult to investigate the impact of fiscal policies on farm and nonfarm prices using the ERM. The responses of P and F to a shock in D will be reflected in movement of Z_{Xt} and is not easily identified. Replacing Z_{Xt} with its component variables turns the system into a five variable ERM and makes it possible to detect any impact of fiscal variables on the farm and nonfarm sectors.

With two stationary variables, D and Z_M, and one cointegrating vector among the nonstationary variables, X, P and F, the number of unit roots contained in the system should be no more than two. As shown in Table 24, two unit roots are found by the Johansen and Juselius test. Two lags are selected for estimation of the test equation based on likelihood ratio tests criteria shown in Table 26. The results remained the same with three lags through eight lags. The reduced form ERM is estimated based on these results. The fiscal variable D_t

Table 21. Historical Decomposition of D

TIME	(1) ACTUAL	(2) PROJECT w/ DV73	(3) PROJECT w/o DV73	(4) D	(5) FORECAST ERROR DUE TO Zm	(6) Zx	(7) DV73	(8) S.E. for DV73
1974:1	0.00309	0.01328	0.00487	-0.01020	0.00000	0.00000	0.00841	0.00196 *
1974:2	0.00726	0.01853	0.00230	-0.00965	-0.00112	-0.00049	0.01623	0.00377 *
1974:3	0.00531	0.02403	0.00074	-0.01924	-0.00146	0.00197	0.02329	0.00518 *
1974:4	0.01543	0.02602	-0.00242	-0.00867	-0.00026	-0.00166	0.02844	0.00586 *
1975:1	0.03083	0.02713	-0.00472	0.00161	0.00241	-0.00032	0.03186	0.00601 *
1975:2	0.06402	0.02787	-0.00567	0.02979	0.00517	0.00119	0.03354	0.00589 *
1975:3	0.03976	0.02847	-0.00537	0.00594	0.00565	-0.00030	0.03384	0.00577 *
1975:4	0.03921	0.02878	-0.00446	0.00863	0.00242	-0.00062	0.03324	0.00574 *
1976:1	0.03108	0.02895	-0.00330	0.00121	0.00051	0.00041	0.03226	0.00580 *
1976:2	0.02759	0.02917	-0.00207	-0.00212	0.00023	0.00031	0.03124	0.00593 *
1976:3	0.03059	0.02949	-0.00088	0.00363	-0.00079	-0.00174	0.03037	0.00605 *
1976:4	0.03081	0.02989	0.00015	0.00496	-0.00257	-0.00147	0.02974	0.00615 *
1977:1	0.02064	0.03030	0.00095	-0.00557	-0.00379	-0.00030	0.02936	0.00622 *
1977:2	0.02133	0.03071	0.00152	-0.00202	-0.00508	-0.00228	0.02919	0.00628 *
1977:3	0.02555	0.03110	0.00192	0.00284	-0.00669	-0.00170	0.02918	0.00636 *
1977:4	0.02473	0.03144	0.00219	0.00287	-0.00894	-0.00065	0.02925	0.00644 *
1978:1	0.02250	0.03174	0.00238	0.00154	-0.01109	0.00030	0.02936	0.00653 *
1978:2	0.01134	0.03199	0.00252	-0.00576	-0.01196	-0.00292	0.02947	0.00662 *
1978:3	0.01057	0.03219	0.00264	-0.00913	-0.01095	-0.00153	0.02955	0.00670 *
1978:4	0.00862	0.03235	0.00275	-0.01342	-0.00999	-0.00033	0.02960	0.00679 *
1979:1	0.00405	0.03248	0.00286	-0.01696	-0.00942	-0.00205	0.02962	0.00687 *
1979:2	0.00242	0.03259	0.00298	-0.01874	-0.00855	-0.00287	0.02961	0.00695 *
1979:3	0.00786	0.03268	0.00309	-0.01508	-0.00680	-0.00294	0.02959	0.00703 *
1979:4	0.01107	0.03275	0.00319	-0.01143	-0.00521	-0.00503	0.02956	0.00709 *
1980:1	0.01414	0.03282	0.00329	-0.00817	-0.00526	-0.00526	0.02953	0.00715 *
1980:2	0.02414	0.03288	0.00337	0.00257	-0.00507	-0.00624	0.02951	0.00718 *
1980:3	0.02743	0.03294	0.00345	0.00129	-0.00131	-0.00548	0.02949	0.00721 *
1980:4	0.02387	0.03298	0.00351	-0.00128	0.00120	-0.00903	0.02947	0.00724 *
1981:1	0.01591	0.03303	0.00356	-0.01070	-0.00066	-0.00575	0.02946	0.00726 *
1981:2	0.01630	0.03306	0.00361	-0.01230	-0.00103	-0.00343	0.02946	0.00727 *

* :significant at .05 level.

(1) is for actual values for D. (2) is for base projections and (3) for projections set with DV73=0. Thus, the difference, (2)-(3), produces (7), forecast errors of D due to DV73. (4), (5), and (6) are forecast errors of D due to D, Zm, and Zx, respectively. The actual value (1) can be recovered by the sum of projected value and forecast errors, that is, (3)+(4)+(5)+(6)+(7). (8) is for the standard errors of forecast error due to DV73.

Table 22. Historical Decomposition of Zm

TIME	(1) ACTUAL	(2) PROJECT w/ DV73	(3) PROJECT w/o DV73	(4) FORECAST ERROR DUE TO D	(5) Zm	(6) Zx	(7) DV73	(8) S.E. for DV73
1974:1	-0.5659	-0.6527	-0.6688	0.0000	0.0868	0.0000	0.0161	0.0197
1974:2	-0.5335	-0.6610	-0.6896	0.0090	0.1172	0.0014	0.0286	0.0426
1974:3	-0.5435	-0.6510	-0.6764	0.0199	0.0891	-0.0015	0.0254	0.0563
1974:4	-0.6169	-0.6579	-0.6706	0.0335	0.0147	-0.0072	0.0127	0.0603
1975:1	-0.7383	-0.6772	-0.6769	0.0366	-0.0967	-0.0010	-0.0003	0.0606
1975:2	-0.7950	-0.6926	-0.6822	0.0230	-0.1302	0.0049	-0.0104	0.0603
1975:3	-0.7282	-0.7004	-0.6818	-0.0148	-0.0160	0.0029	-0.0185	0.0598
1975:4	-0.8105	-0.7054	-0.6801	-0.0290	-0.0803	0.0043	-0.0253	0.0588
1976:1	-0.9039	-0.7112	-0.6810	-0.0204	-0.1804	0.0082	-0.0302	0.0579
1976:2	-0.8824	-0.7171	-0.6841	-0.0100	-0.1604	0.0052	-0.0331	0.0578
1976:3	-0.8901	-0.7220	-0.6877	-0.0041	-0.1646	0.0006	-0.0343	0.0582
1976:4	-0.9504	-0.7257	-0.6911	-0.0074	-0.2206	0.0033	-0.0346	0.0589
1977:1	-0.9655	-0.7290	-0.6945	-0.0142	-0.2271	0.0048	-0.0345	0.0596
1977:2	-0.9605	-0.7322	-0.6979	-0.0080	-0.2223	0.0020	-0.0343	0.0602
1977:3	-0.9059	-0.7353	-0.7012	0.0010	-0.1764	0.0048	-0.0341	0.0606
1977:4	-0.8363	-0.7380	-0.7040	-0.0010	-0.1059	0.0087	-0.0340	0.0609
1978:1	-0.8170	-0.7405	-0.7065	-0.0074	-0.0736	0.0044	-0.0340	0.0611
1978:2	-0.8438	-0.7427	-0.7086	-0.0088	-0.0941	0.0019	-0.0342	0.0612
1978:3	-0.7832	-0.7447	-0.7104	-0.0003	-0.0523	0.0141	-0.0343	0.0613
1978:4	-0.7046	-0.7465	-0.7119	0.0121	0.0049	0.0249	-0.0345	0.0613
1979:1	-0.6738	-0.7480	-0.7133	0.0234	0.0255	0.0253	-0.0347	0.0614
1979:2	-0.6768	-0.7494	-0.7145	0.0339	0.0130	0.0258	-0.0349	0.0613
1979:3	-0.6567	-0.7505	-0.7156	0.0437	0.0229	0.0272	-0.0350	0.0613
1979:4	-0.5515	-0.7516	-0.7165	0.0481	0.1255	0.0264	-0.0350	0.0613
1980:1	-0.4997	-0.7524	-0.7174	0.0462	0.1811	0.0254	-0.0350	0.0613
1980:2	-0.6753	-0.7532	-0.7182	0.0414	0.0133	0.0233	-0.0350	0.0612
1980:3	-0.6970	-0.7539	-0.7189	0.0292	0.0086	0.0191	-0.0350	0.0612
1980:4	-0.4919	-0.7545	-0.7195	0.0182	0.2223	0.0221	-0.0350	0.0612
1981:1	-0.5053	-0.7550	-0.7201	0.0160	0.1951	0.0387	-0.0349	0.0611
1981:2	-0.4840	-0.7554	-0.7206	0.0252	0.2014	0.0449	-0.0349	0.0611

(1) is for actual values for Zm. (2) is for base projections and (3) for projections set with DV73=0. Thus, the difference, (2)-(3), produces (7), forecast errors of Zm due to DV73. (4), (5), and (6) are forecast errors of Zm due to D, Zm, and Zx, respectively. The Actual value (1) can be recovered by the sum of projected value and forecast errors, that is, (3)+(4)+(5)+(6)+(7). (8) is for the standard errors of forecast error due to DV73.

Table 23. Historical Decomposition of Zx

TIME	(1) ACTUAL	(2) PROJECT w/ DV73	(3) PROJECT w/o DV73	(4) FORECAST ERROR DUE TO D	(5) Zm	(6) Zx	(7) DV73	(8) S.E. for DV73
1974:1	-4.0387	-4.0827	-4.0906	0.0000	0.0000	0.0440	0.0080	0.0181
1974:2	-4.2910	-4.1519	-4.1662	-0.0002	-0.0142	-0.1247	0.0144	0.0377
1974:3	-4.2567	-4.2164	-4.2365	0.0004	-0.0157	-0.0250	0.0201	0.0564
1974:4	-4.2347	-4.2706	-4.2924	0.0036	-0.0190	0.0513	0.0218	0.0712
1975:1	-4.3351	-4.3163	-4.3347	0.0078	-0.0213	-0.0053	0.0184	0.0829
1975:2	-4.3212	-4.3587	-4.3698	0.0127	-0.0168	0.0416	0.0111	0.0920
1975:3	-4.2743	-4.3985	-4.4010	0.0135	-0.0181	0.1288	0.0026	0.0994
1975:4	-4.3471	-4.4338	-4.4283	0.0070	-0.0276	0.1074	-0.0054	0.1057
1976:1	-4.4419	-4.4640	-4.4518	-0.0062	0.0033	0.0251	-0.0122	0.1116
1976:2	-4.4170	-4.4900	-4.4725	-0.0122	0.0212	0.0640	-0.0174	0.1176
1976:3	-4.4179	-4.5125	-4.4916	-0.0129	0.0235	0.0841	-0.0210	0.1237
1976:4	-4.5143	-4.5323	-4.5093	-0.0099	0.0462	-0.0183	-0.0230	0.1299
1977:1	-4.4549	-4.5495	-4.5256	-0.0067	0.0756	0.0256	-0.0238	0.1361
1977:2	-4.4018	-4.5644	-4.5406	-0.0062	0.0944	0.0743	-0.0238	0.1422
1977:3	-4.4140	-4.5774	-4.5541	-0.0061	0.1187	0.0510	-0.0233	0.1482
1977:4	-4.5136	-4.5889	-4.5662	-0.0032	0.1372	-0.0587	-0.0227	0.1538
1978:1	-4.3388	-4.5990	-4.5771	-0.0006	0.1518	0.1090	-0.0220	0.1591
1978:2	-4.1927	-4.6079	-4.5866	-0.0005	0.1676	0.2481	-0.0213	0.1640
1978:3	-4.1786	-4.6158	-4.5950	-0.0015	0.1812	0.2575	-0.0208	0.1685
1978:4	-4.1168	-4.6226	-4.6023	-0.0015	0.1767	0.3305	-0.0203	0.1725
1979:1	-4.0598	-4.6286	-4.6086	0.0014	0.1729	0.3945	-0.0200	0.1762
1979:2	-4.1107	-4.6338	-4.6141	0.0057	0.1705	0.3469	-0.0197	0.1796
1979:3	-4.1206	-4.6384	-4.6189	0.0104	0.1644	0.3429	-0.0194	0.5775
1979:4	-4.2057	-4.6423	-4.6231	0.0150	0.1497	0.2720	-0.0192	0.1854
1980:1	-4.2979	-4.6457	-4.6268	0.0184	0.1214	0.2080	-0.0189	0.1878
1980:2	-4.4539	-4.6487	-4.6300	0.0193	0.1038	0.0718	-0.0187	0.1901
1980:3	-4.2440	-4.6513	-4.6328	0.0176	0.1101	0.2795	-0.0185	0.1922
1980:4	-4.1904	-4.6535	-4.6353	0.0137	0.0739	0.3755	-0.0182	0.1941
1981:1	-4.3345	-4.6554	-4.6374	0.0070	0.0263	0.2877	-0.0180	0.1958
1981:2	-4.4590	-4.6571	-4.6393	0.0010	0.0308	0.1663	-0.0178	0.1974

(1) is for actual values for Zx. (2) is for base projections and (3) for projections set with DV73=0. Thus, the difference, (2)-(3), produces (7), forecast errors of Zx, due to DV73. (4), (5), and (6) are forecast errors of Zx due to D, Zm, and Zx, respectively. The actual value (1) can be recovered by the sum of projected value and forecast errors, that is, (3)+(4)+(5)+(6)+(7). (8) is for the standard errors of forecast error due to DV73.

Table 24. JJ Test Results for D, Z_M, X, P, and F

H_0		-2lnQ
h	m	
0	5	117.46***
1	4	65.77***
2	3	25.93**
3	2	8.82
4	1	.10

**: Reject the null hypothesis at .05 level.
***: Reject the null hypothesis at .01 level.

Table 25. Eigenvalues and Eigenvectors for D, Z_M, X, P, and F

Two lags

		Eigenvalues λ	
	.27	.22	.10
		Eigenvectors V ($=\alpha$)	
D	-.60	-.56	-.00
Z_M	.57	-.50	.52
X	-.31	-.14	.65
P	-.17	.65	.55
F	.43	.05	-.01
		$-S_{0p}V \times 1000$ ($=\pi$)	
D	-2.79	-1.88	-1.11
Z_M	2.51	-15.03	18.42
X	-2.39	6.59	3.48
P	-1.34	1.48	.58
F	6.72	-4.45	5.30

Three largest eigenvalues and corresponding eigenvectors and π vectors are appeared.

Table 26. Lag Selection for ΔD, ΔZ_M, ΔX, ΔP, and ΔF

Lag Length p	Criteria FPE ($x10^{16}$)	AIC	SC	$\chi^2(25)^1$	Sig. Level
0	.3843	-37.80	-37.80^v		
1	.4084	-37.49	-37.02	371.35	.000***
2	.2600	-37.70	-36.76	82.12	.000***
3	.2176	-37.64	-36.22	34.52	.097*
4	.1882	-37.54	-35.65	32.37	.147
5	.1180	-37.76	-35.40	49.59	.002***
6	.0990	-37.69	-34.86	32.48	.145
7	.0645	-37.88	-34.57	51.42	.001***
8	.0398	-38.12	-34.34	55.13	.000***
9	.0322	-38.08	-33.44	30.02	.223
10	.0231	-38.17	-33.44	39.68	.031**
11	.0178^v	-38.19^v	-32.99	29.64	.238

1. Likelihood ratio statistics to test H_0: Lag length of p-1 vs. H_a: Lag length of p.
2. H_0 is rejected at 10% level for *, at 5% for ** and at 1% for ***.
3. v indicates minimum value for each information criteria.

will be replaced by its component variables, G_t and T_t in a following section.

Table 27 provides summary statistics for the two lag reduced form ERM. R^2s for the equations indicate a significant proportion of the variation in dependent variables is explained by the model. The statistics are obtained after the model has been reparameterized to get an equivalent VAR in levels. The Z_M equation had the lowest R^2, as anticipated, since it includes movement of three variables. The D and P equations showed weak serial correlations based on Ljung-Box Q statistics. The Ljung-Box Q statistics on squared error terms, which are asymptotically equivalent to a LM test for conditional heteroscedasticity, could not reject ARCH type errors, except in the X series. However, it is not clear how VAR methods, such as impulse response analysis, can be applied with ARCH errors. No theoretical or empirical work has been done in this area. Instead, OLS is applied and is consistent (Engle, 1982). Overall, the summary statistics for the OLS estimator imply that the ERM provides reasonably robust statistical results.

2. Structural Form Identification

The reduced form is identified as the structural form if the off-diagonal elements of the covariance matrix are zero. However, the LM test rejected the null hypothesis of no

Table 27. Summary Statistics for Five Variable ERM

Stat's	Dist'n	D	Z_M	X	P	F
		Dependent Variable				
R^2		.884	.781	.941	.999	.983
DW		2.09	1.87	2.01	2.15	2.02
AC	$\chi^2(20)$	36.12**	27.71	17.90	37.03**	18.74
ARCH	$\chi^2(20)$	97.88***	61.92***	28.38	89.02***	38.30***

**: significant at .05 level.
***:significant at .01 level.

contemporaneous correlation at the .05 level (see Appendix E). Therefore, Fackler's (1988) maximum likelihood estimation method is applied to identify the structural form.

A recursive order of D-P-X-F-Z_M is considered and estimated as shown in Table 28. This order allows for the most possible influence of the federal deficit on other variables. D is placed first in the order because the budget is set in a long term perspective. Furthermore, fiscal policy affects goods markets and money markets within a quarter because agents adjust to a perceived policy changes quickly. This order also allows effects from the goods market to the money market within a quarter, assuming a more flexible money market than goods market. Farm prices are ordered after industrial prices, thus indicating farm prices are more flexible, as Rausser (1985) has argued. Z_M is ordered last in the order because the interest rate in Z_M is much more sensitive than goods market prices. X is placed between P and Z_M, since the exchange rate equation reflects conditions of both goods and financial markets. A recursive order of D-Z_M-P-X-F can also be used if the money supply in Z_M is considered as a policy variable, as discussed in the next section.

Estimates of π in Table 25 support the recursive order, except for D and P. An order of P-D-X-F-Z_M is suggested by the speed of adjustment parameter and this order will be discussed in a following chapter.

A positive contemporaneous coefficient for D in the P,

Table 28. Estimates of Contemporaneous Parameters in D-P-X-F-Z_M Recursive Structure

Dep. Var.	Explanatory Variables					S.E.
	D	P	X	F	Z_M	
D						.0071
P	.279 (.054)					.0049
X	.462 (.319)	.579 (.432)				.0267
F	2.687 (.718)	1.591 (.971)	-.247 (.176)			.0598
Z_M	1.799 (.779)	1.263 (1.018)	-.290 (.184)	-.007 (.082)		.0622

Standard errors for the parameters are in parenthesis.

X and F equations is expected because excess demand in the goods market, caused by a federal deficit, induces inflationary pressure. A positive coefficient for P in the F equation is also expected because inflation in the industrial sector induces inflationary pressure in the farm sector. The coefficient for P in the X equation is not significant. The negative contemporaneous coefficient of X in the F equation is expected, as indicated by Schuh (1974, 1976). Direct interpretations of the other parameters is difficult since Z_M consists of three different variables. The coefficient of D in the F equation is much bigger than in the P equation, supporting the assumption of flexible farm prices and fixed industrial prices.

3. Dynamic Responses and Forecast Error Variance Decomposition

To detect dynamic responses of variables to the fiscal policy shock, the reduced form ERM is reparameterized to its equivalent VAR in levels. The response of each variable over six year periods to a one standard deviation shock to each of the variables are shown in Figure 9.

A positive shock to the D results in a disturbance in the money market equilibrium as well as an increase in X. A sharp decrease in F follows, causing a temporary cost price squeeze in agriculture. F then increases back towards its long run equilibrium level as P starts to decrease towards the new

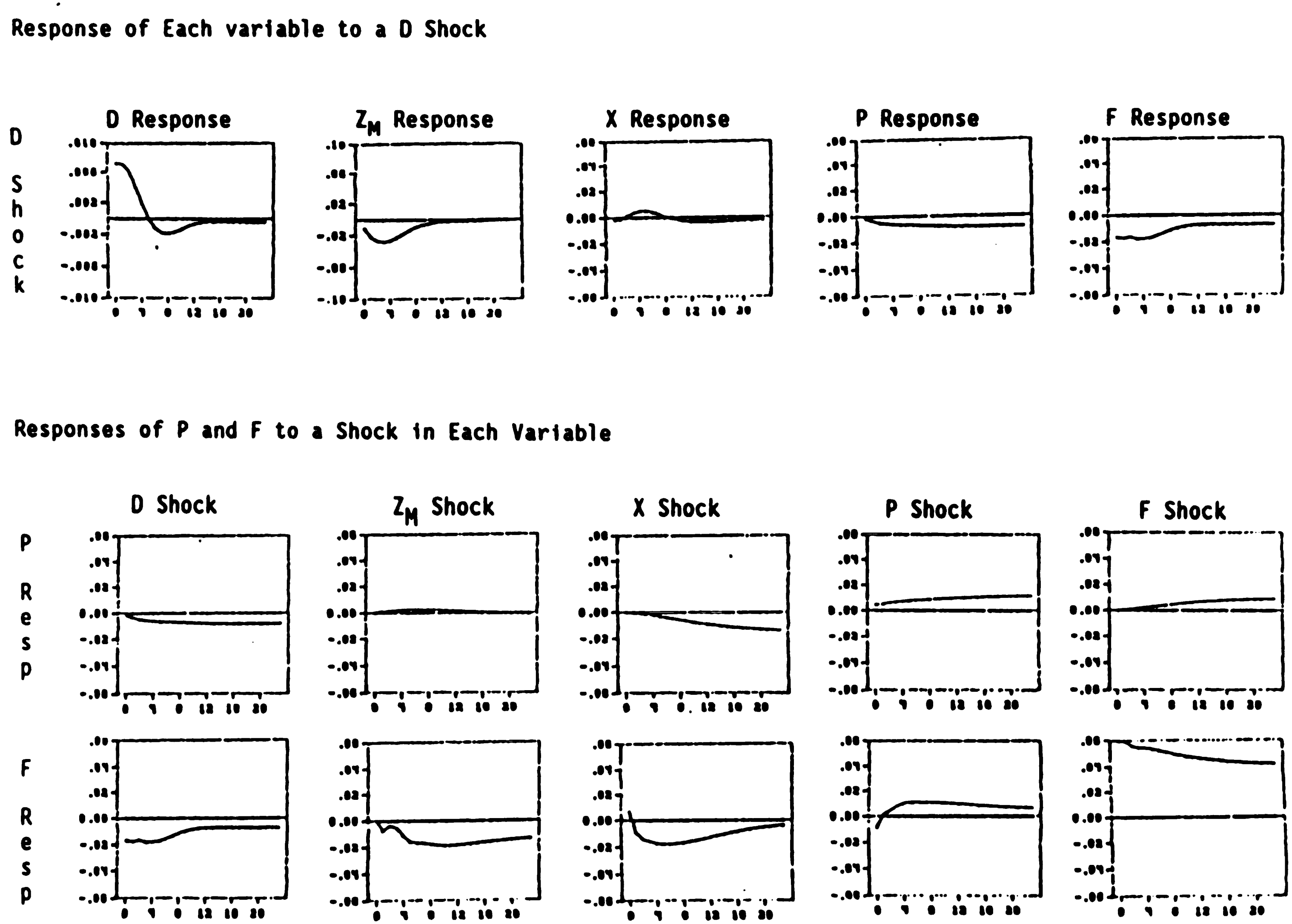


Figure 9. Impulse Response Function by ERM with D-P-X-P-Z_M

equilibrium. It takes about 2-3 years for the exchange rate and both prices to reach equilibrium. Thus, the long run equilibrium relationship among the three variables are obtained.

A positive shock to P induces an increase in P and a decrease in F initially. F then increases rapidly for a year and reaches a new equilibrium with P after 2-3 years. A positive shock to the money market equilibrium reduces F and a positive shock to F increases F without affecting P very much. A positive shock in X decreases F initially and then decreases P later. Responses of F are quicker and larger than responses of P to any shock in the economy.

The impulse responses support the fixed industrial prices-flexible agricultural prices paradigm discussed by Rausser. The federal deficit brings a temporary cost price squeeze in the farm economy which remains about 2-3 years. No long run price squeeze is found. The exchange rate as well as money market variables seem to be responsible for transferring the policy shock to farm prices.

The fixed industrial prices-flexible agricultural prices paradigm is also supported by the decomposition of forecast error variance. As shown in Table 29, The forecast error variances in F are bigger than those in P. Own shocks explain a relatively large proportion of the forecast error variance for each series. The effect of D on F is immediate and steady whereas the effect of Z_M on F takes time.

Table 29. Decomposition of Forecast Error Variance

Forecast Error Variance in	Quarters Ahead	Shocks to				
		D	Zm	X	P	F
P	4	0.757	0.094	0.059	1.380	0.078
		(31.98)	(3.96)	(2.50)	(58.27)	(3.29)
	8	2.546	0.392	0.702	3.894	0.666
		(31.05)	(4.78)	(8.56)	(47.49)	(8.12)
	12	4.813	0.603	2.869	7.360	2.152
		(27.04)	(3.39)	(16.12)	(41.35)	(12.09)
	16	7.493	0.669	7.016	11.673	4.550
		(23.86)	(2.13)	(22.34)	(37.17)	(14.49)
	20	10.253	0.674	12.962	16.624	7.607
		(21.31)	(1.40)	(26.94)	(34.55)	(15.81)
F	4	11.633	1.048	6.029	1.625	131.544
		(7.66)	(.69)	(3.97)	(1.07)	(86.62)
	8	21.771	10.736	18.443	6.268	242.664
		(7.26)	(3.58)	(6.15)	(2.09)	(80.92)
	12	25.187	24.550	27.736	10.534	336.736
		(5.93)	(5.78)	(6.53)	(2.48)	(79.28)
	16	27.161	36.956	32.667	13.713	419.060
		(5.13)	(6.98)	(6.17)	(2.59)	(79.15)
	20	29.149	46.328	34.669	15.939	494.105
		(4.70)	(7.47)	(5.59)	(2.57)	(79.67)

Numbers in parenthesis are proportions of variance in % terms.
Actual Variances x 10,000 are used for easy comparison.

4. Sensitivity Analysis

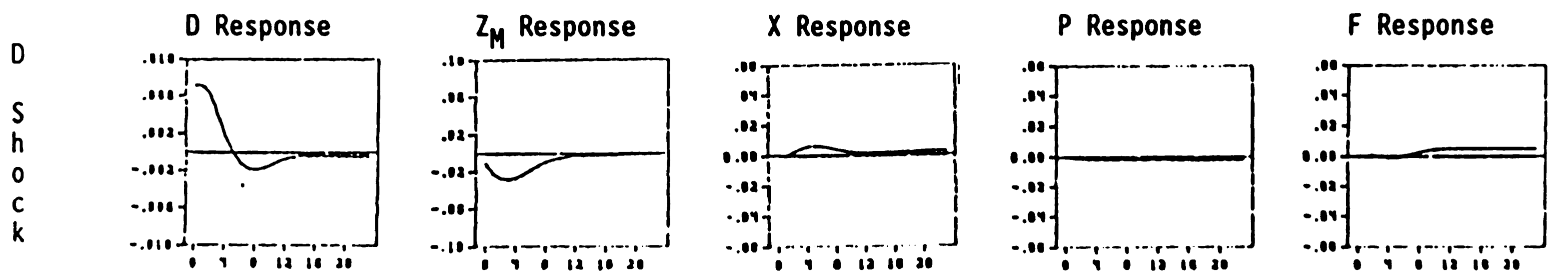
4.1. Structural Identification

To investigate the question of whether the results are robust to alternate identifications, other structural forms are estimated. A recursive order of D-F-P-X-Z_M is considered first. This order allows the most possible influence of the agricultural sector on other sectors of the economy. Industrial prices are believed to adjust faster than farm prices, following Just and Chambers (1987). The impulse response functions remained virtually the same as before. Thus, overshooting of F and sluggish adjustment of P are supported by these results.

Other recursive orders tried include D-Z_M-P-X-F and P-D-X-F-Z_M. The first order allows the money market to contemporaneously affect the goods market, as well as more flexible F than P and the second order is implied by the speed of adjustment parameter. Various other recursive orders, which often don't have any natural economic justification, were also tried. The results remained virtually the same unless D is ordered after F.

With D ordered after F, the impulse response function displayed a positive response of F after about two years to a positive shock in D, as illustrateded in Figure 10. P doesn't respond to the shock. The result is not consistent

Response of Each variable to a D Shock



Responses of P and F to a Shock in Each Variable

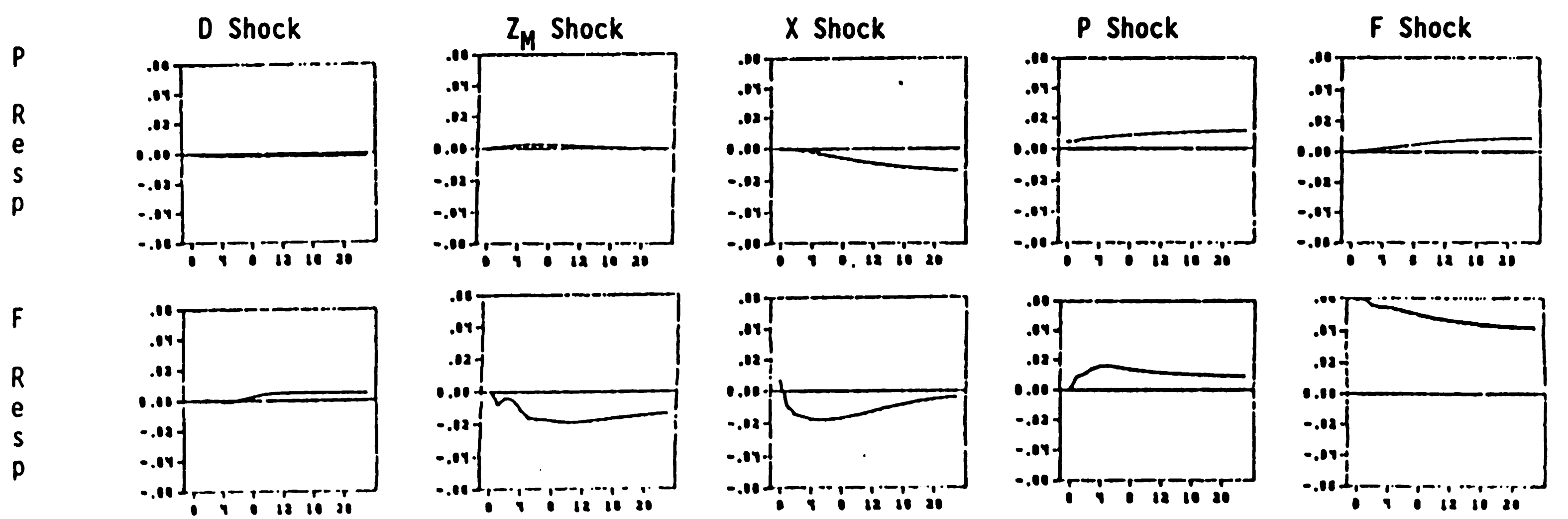


Figure 10. Impulse Response Function by ERM with F-D-P-X-Z_M

with the discussions of chapter II. Furthermore, it is hard to believe that the federal government takes an expansionary fiscal policy within a quarter whenever there is inflationary pressure in farm prices, as implied by the positive contemporaneous parameter estimates of F in the D equation. Hence these structures are not considered appropriate.

Various simultaneous structural forms are also considered. Simultaneity between farm prices and industrial prices is considered first. The maximum likelihood estimates appearing in Table 30, gave similar results as the recursive structures. Both price variables have positive contemporaneous impacts on the other price, but the impact of F on P is much larger than the impact of P on F. The impulse responses under this structure remained the same as in Figure 9. Allowing for the simultaneity between the prices in other structures produced similar impulse responses.

Simultaneity between P and Z_M is also considered, but the contemporaneous parameter estimates have different signs from the previous section and unrealistically large values for some values as well as explosive impulse responses.

In summary, the implications drawn by the recursive structure, D-P-X-F-Z_M, remain quite stable over various structural forms.

Table 30. Estimates of Contemporaneous Parameters in a Simultaneous Structure

Dep. Var.	Explanatory Variables					S.E.
	D	Z_M	X	P	F	
D						.0071
Z_M	1.952 (.749)			1.442 (1.015)		.0627
X	.358 (.330)	-.053 (.033)		.501 (.491)		.0265
P	.279 (.092)				.000 (.032)	.0049
F	2.683 (1.525)		-.247 (.176)	1.576 (4.934)		.0598

Standard errors for the parameters are in parenthesis.

4.2. Lag Order

Three, four and eight lags are considered for the reduced form ERM estimation. As discussed before, the number of cointegrating vectors among the variables remained the same as in the two lag model. Although more cyclical movements are added with more lags, the impulse response functions are quite similar to Figure 9. Thus, implications drawn by the two lag ERM remained stable.

4.3. Model Specification

Replacing Z_M with its component variables turns the system in a seven variable ECM. As shown in Table 31, four cointegrating relationships at the .01 level and five cointegrating relationships at the .05 level are found by the Johansen and Juselius test. Though the results are not very sensitive to the number of lags and cointegrating relationships, a three lag ECM with four cointegrating relationships provides the most consistent impulse response function.

Keeping the recursive structure D-P-X-F-Z_M, as used in the ERM, an order of D-M-P-Y-X-F-R is recommended to identify the structural form ECM. According to estimates of the π matrix shown in Table 32, R has bigger values in the speed of adjustment parameter than any other, followed by F and X.

Table 31. JJ Test Results for D, M, R, Y, P, X, and F

H_0		-2lnQ
h	m	
0	7	206.54***
1	6	145.79***
2	5	92.63***
3	4	51.83***
4	3	28.37**
5	2	11.28
6	1	.01

Reject null hypothesis at .05 level for ** and .01 for ***.

Table 32. Eigenvalues and Eigenvectors for D, M, R, Y, P, X, and F

	Eigenvalues λ			
	.31	.28	.22	.14
	Eigenvectors V $(=\alpha)$			
D	-10.60	-97.62	-45.12	56.31
M	9.39	-6.42	10.64	-4.17
R	4.58	-2.41	-4.44	-2.03
Y	-4.57	5.79	12.66	7.42
P	-7.86	-1.35	-3.34	-7.56
X	-5.15	10.45	-3.57	5.96
F	4.86	4.99	-.96	5.75
	$-S_{0p}V$ x 1000 $(=\pi)$			
D	.29	-2.93	.71	1.67
M	3.06	-1.31	1.16	-.97
R	15.22	4.88	-39.43	5.40
Y	2.39	.49	-2.11	-.69
P	-2.56	-.25	-.79	-.84
X	-3.90	4.56	3.34	3.50
F	2.90	15.12	-3.67	5.98

Four largest eigenvalues and corresponding eigenvectors and π vectors are appeared.

However, it is not obvious how to order the other variables based on the adjustment parameters. The policy variables M are assumed to have a slower response than Y and P on the grounds that agents adjust to a perceived policy change quickly where as the monetary authority has a more complicated decision process. Among the policy variables, M is believed to be more flexible than D since the Federal Reserve Board sets monetary targets more frequently than the annually set government budget.

To detect the dynamic responses of variable to the fiscal policy shock, the reduced form ECM is reparameterized to its equivalent VAR in levels of the variables. The impulse response functions from the recursive ECM provide very similar implications to the ERM analysis. As shown in Figure 11, a positive shock in D leads to a sharp decrease in F, leaving the farm economy in a temporary cost price squeeze. F then starts to increases towards its long run equilibrium level. Both prices reached the same equilibrium level after about 2 years. The response of F is much bigger than the response of P to any shock in the economy. Again Rausser's fixed industrial prices-flexible agricultural prices paradigm is supported.

As expected, an increase in R and X has strong and permanent negative impacts on F. An increase in Y and M induces a temporary overshooting of farm prices which vanishes after about two years. A positive shock to P causes a decrease

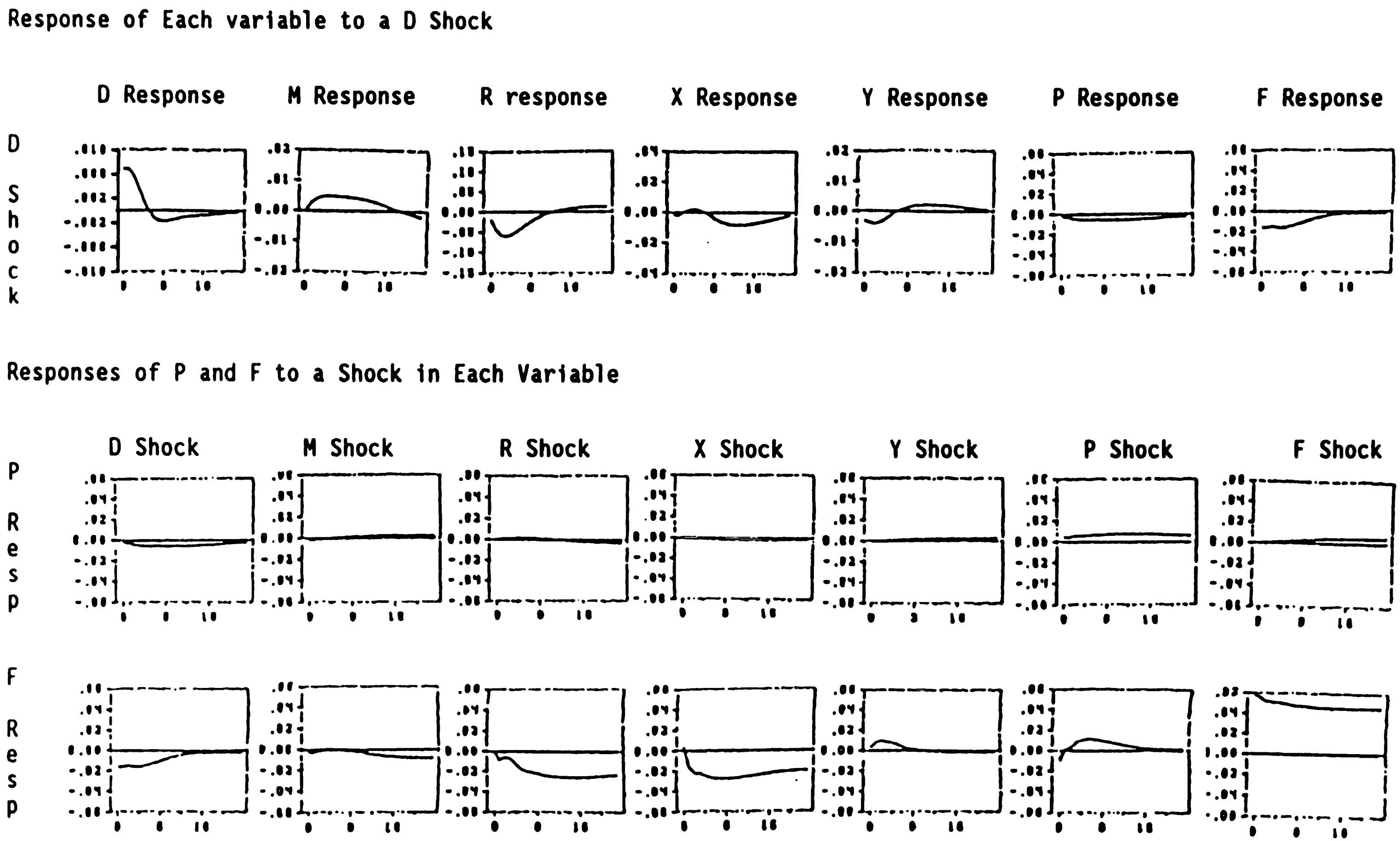


Figure 11. Impulse Response Function by Seven Variable ECM

in F for very short periods. The cost price squeeze is removed when F quickly overshoots and then returns to its long run equilibrium level. A positive shock in F resulted in a favorable situation for the farm economy.

Though many scholars (Schuh, 1981, 1983, 1984a, 1984b; Rausser, 1985; and Barclay and Tweeten, 1988) have argued that interest rates are a major transmital mechanism of macroeconomic policy shocks to the economy, the interest rate responds to the policy shock much differently than expected. R falls as the federal deficit increases. Increased money supply after the fiscal shock may be the main cause. As the monetarists (Hamburger and Zwick, 1981, 1982; Allen and Smith, 1983) have argued, monetization of the deficit is evident in the impulse response function. When increased federal deficit puts pressure on the interest rate and hence decreases output and farm prices, the monetary authority tries to remove the pressure by increasing the money supply. Interest rates, which have the largest speed of adjustment among any of the variables, immediately fall in response to a monetary shock. Farm prices start to increase right after the shock. After about 2-4 quarters, the exchange rate decreases and output increases. Thus, farm prices would have fallen further, as a result of the higher interest rates and exchange rates, without the monetization.

Shocks to the financial variables (R and X) dominate shocks to the policy variables (D and M) in their effects on farm prices. However, there was no single dominant factor affecting farm prices in the ECM, besides its own shock.

A VAR in levels produced impulse responses quite similar to the ECM, but the VAR with first differences had different impulse responses.

The impulse responses with seven variable VAR models were quite sensitive to the lags selected. The ECM with lags two, four, six, seven or eight were tried, but failed to generate a consistent response function. Thus, it is verified that VAR analysis becomes more sensitive to the number of lags selected as the number of variables increases.

5. Implications from the Analysis

A number of implications can be drawn regardless of the models, structural forms, lag orders and specifications that have been considered.

First, a consistent result on the impact of the federal deficit on prices has been found. Farm prices are reduced sharply due to an unexpected increase in the federal deficit, while industrial prices respond only gradually. This results in a cost price squeeze on the farm economy. However, both prices moved toward and reach a long run equilibrium level after about 2-3 years.

Second, farm prices are found to be more responsive to compared to industrial prices. The results support the fixed industrial prices-flexible agricultural prices paradigm suggested by Rausser and others.

Third, the interest rate and the exchange rate are major transmital mechanisms for fiscal shocks to the farm economy. Expansionary monetary policy after a federal deficit increase causes interest rates to fall. However, the interest rate and the exchange rate have a substantial negative impact on the farm prices and respond significantly to policy shocks.

Thus, the continuous increases in federal deficits in the 1980's appear to have a significant negative impact on agriculture through their impacts on the macroeconomic variables.

VI. COMPARISON OF DEFICIT REDUCTION POLICIES

Three broad options are considered for reducing the deficit. As discussed in Just and Chambers (1987), these are reduction in government spending, a tax increase, and monetization. Recently, the U.S. government has attempted to undertake tight monetary policy with spending reductions to cut the federal deficit. The policy is likely to be changed in the near future as the Bush administration is considering a tax increase. In this chapter, some of the effects of each option will be examined using the econometric model developed earlier.

1. Impact of Deficit Reduction Options on Agriculture

To compare the impact of the three policy alternatives on the economy, fiscal variables G and T are introduced into the ECM. By replacing D with G and T, the model now consists of eight variables. As list in Table 33, five cointegrating vectors are detected at the .01 level. The reduced form ECM is estimated and reparameterized to its equivalent VAR in levels. A recursive order G-T-M-P-Y-X-F-R is established to identify the structural form. G is placed before T since T is more variant to economic conditions. This is also supported by the error correction parameter matrix π, appearing in Table 34.

The ECM produced impulse responses that are consistent with models in the previous section. As shown in Figure 12, all three

Table 33. JJ Test Results for G, T, M, R, Y, P, X, and F

H_0		-2lnQ
h	m	
0	8	245.08***
1	7	176.39***
2	6	121.10***
3	5	81.48***
4	4	52.64***
5	3	24.76**
6	2	7.66
7	1	.08

Reject null hypothesis at .05 level for ** and .01 for ***.

Table 34. Eigenvalues and Eigenvectors for G, T, M, R, Y, P, X, and F

	Eigenvalues λ				
	.35	.29	.22	.16	.16
	Eigenvectors V $(=\alpha)$				
G	-5.60	18.16	-11.23	9.88	-3.00
T	5.29	-21.02	8.94	-8.28	-23.77
M	9.08	6.57	-7.10	-6.18	-3.52
R	4.02	2.07	-5.29	-1.91	.73
Y	-3.71	-4.46	14.55	8.05	-3.19
P	-7.84	.55	-3.22	-7.55	2.78
X	-4.86	-10.25	-1.54	5.46	1.70
F	5.26	-4.03	-.04	6.19	3.46
	$-S_{0p}V \times 1000$ $(=\pi)$				
G	.02	12.32	-.14	6.69	-1.17
T	-1.67	-3.49	-2.57	.25	-7.63
M	3.25	1.32	.61	-1.23	-.75
R	12.89	-12.00	-37.98	5.32	2.44
Y	2.14	-.97	-2.32	-.39	-1.83
P	-2.70	.08	-.68	-.83	-.30
X	-3.75	-3.80	3.93	3.49	-3.83
F	2.18	-12.09	-3.31	7.71	-2.59

Five largest eigenvalues and corresponding eigenvectors and π vectors are appeared.

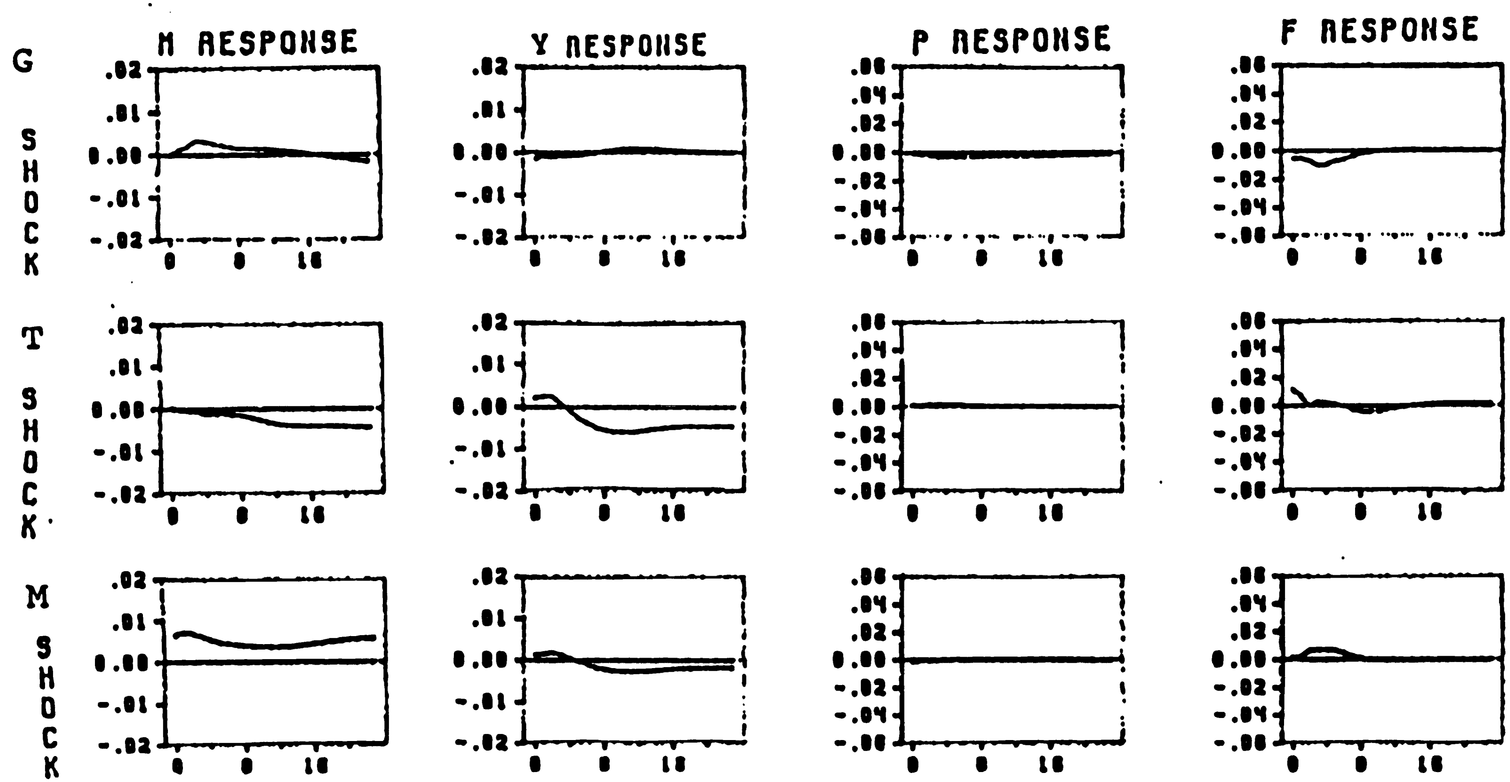


Figure 12. Impulse Response Function by Eight Variable ECM

policy measures have similar impacts on output, increasing it initially but decreasing it after about a year. Among the policy alternatives, a spending reduction has the least impact and tax increase has the most impact on output. All three options have a similar impact on farm prices, increasing initially but eventually decreasing to their long run equilibrium level. Spending reductions and monetization induce farm prices to be stabilized at the equilibrium after about two years. All the policy measures, especially monetization, have little impact on industrial prices.

As Tatom (1985) and Just and Chambers (1987) suggest, the spending reduction seems the most favored deficit reduction policy. It provides the most stable environment for both the macroeconomy and agriculture, while tax increases contribute to unstable economic conditions.

2. Policy Simulations

The implications drawn in previous section rely on economic conditions at hand. A simulation study bearing current economic conditions is set to compare how the economy will evolve under different policy scenarios. A base projection is set for 1991-1995 periods using the eight variable ECM. Simulated projections are, then, drawn under each different policy option and compared to the base projection. The reduced form ECM is used for projections.

In Figures 13-15, base projections for output, nonfarm prices and farm prices were compared with the projected time paths of the

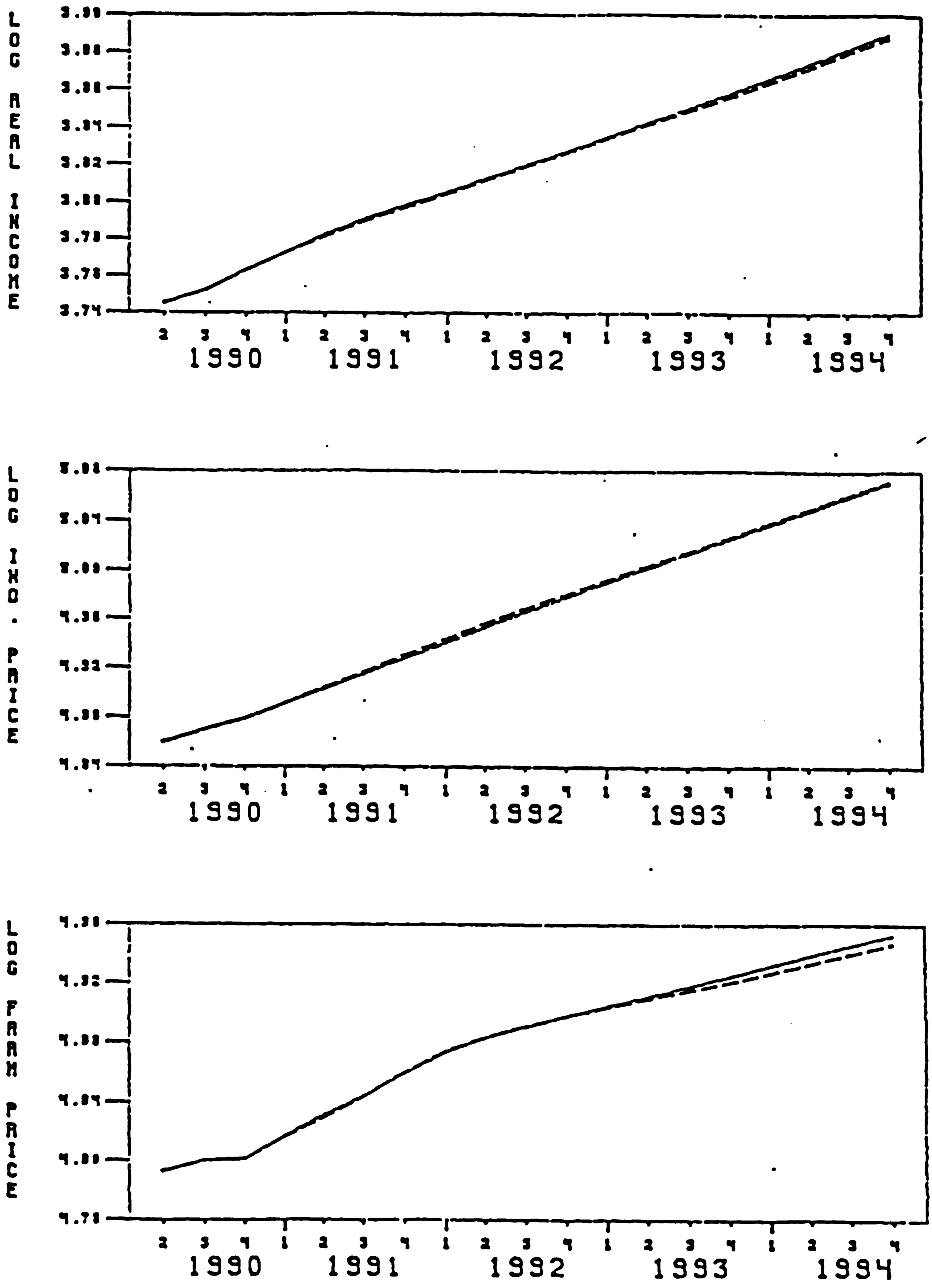


Figure 13. Effects of Spending Reduction

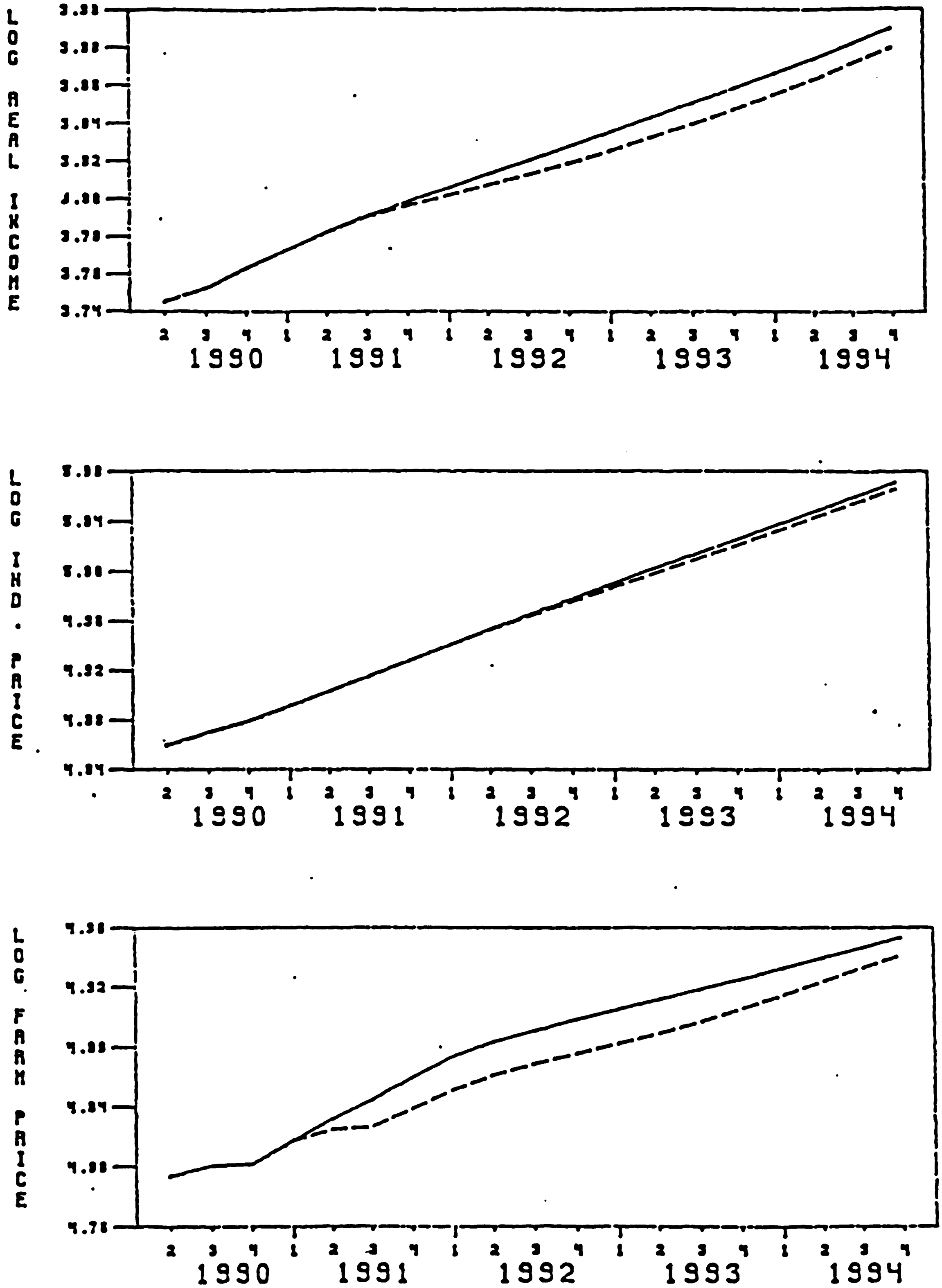


Figure 14. Effects of Tax Increase

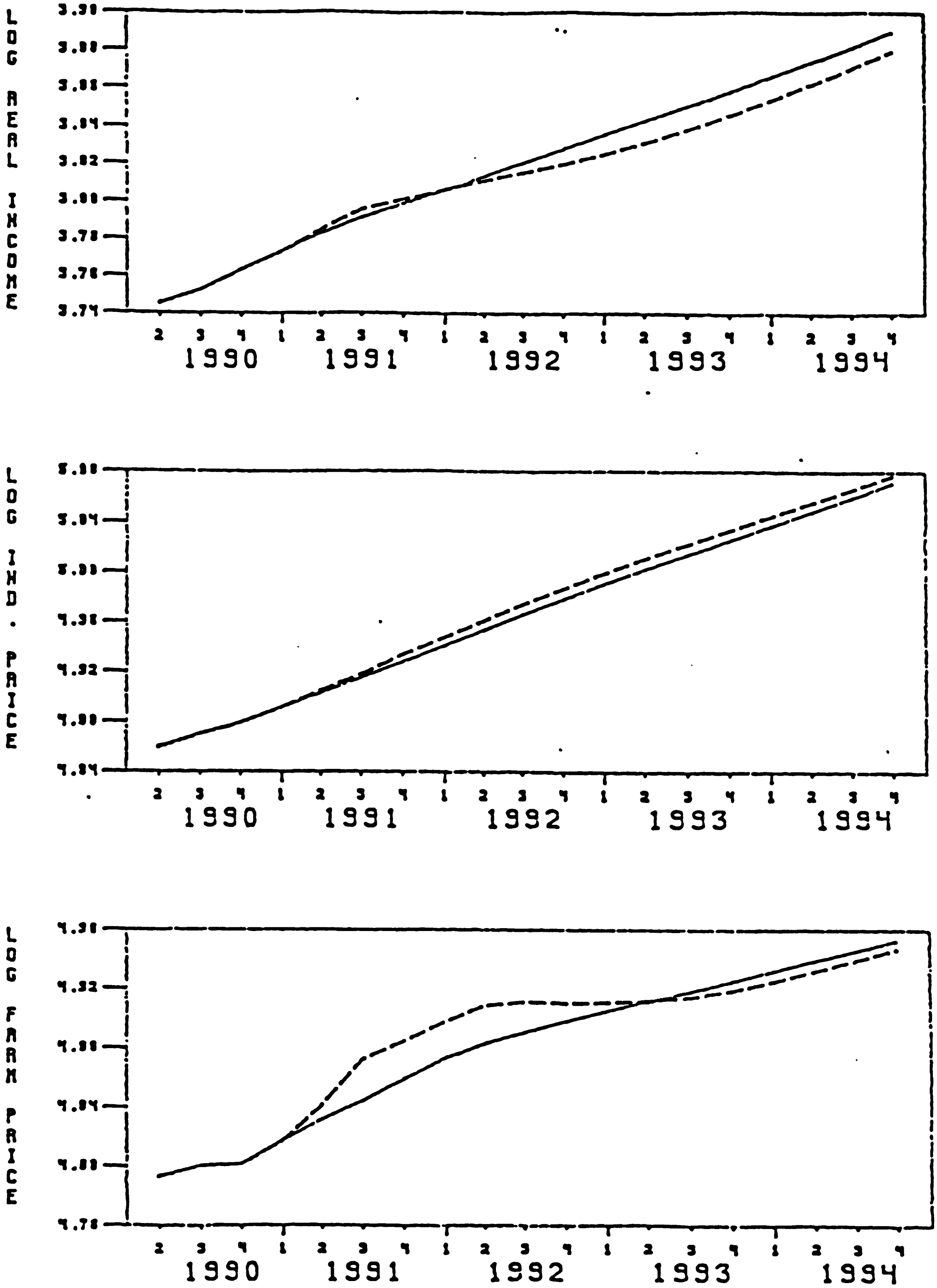


Figure 15. Effects of Monetization

variables under different policy options. Three options are considered: a 5% increase in the money supply, a 5% reduction in spending, and a 5% increase in taxes, all occuring in 1991. As shown in Figure 13, no significant impacts are found in each of the projected time paths as a result of a spending reduction. A 5% tax increase resulted in a depressed farm sector as shown in Figure 14. Though its impact on industrial prices are minimal, a large decrease in output and farm prices occur. A 5% increase in the money supply increases industrial prices little, as shown in Figure 15. However, the policy is favorable to the farm sector since it initially increases farm prices considerably. Farm prices then move back to their normal level, after the first quarter of 1993. The policy also lifts the output of the economy a small amount in the second and third quarter of 1991, but decreases output for the rest of the period.

The simulation study thus suggests that a spending reduction is the most favored option for tackling the current deficit. A monetary expansion would mostly favor the farm sector. A tax increase is the least favored policy. A recession in both the farm and nonfarm economy could be expected with this option.

VII. SUMMARY AND CONCLUSION

Macroeconomists have different opinions on how fiscal policy affects the economy. The different macroeconomic views have also resulted in wide disagreements on how fiscal policies affect agriculture. Schuh (1981, 1983) and Barclay and Tweeten (1988), following the Keynesian hypothesis, argued that an increase in the federal deficit causes unfavorable conditions for the farm economy by increasing interest rates and the exchange rate. This leads to decreases in agricultural exports, prices, and income. Others, following the neoclassical model, disagree with this Keynesian explanation. Belongia and Stone (1985) and Batten and Belongia (1986) rejected any possible connection between the federal deficit and the farm economy. Applying the neo-Keynesian differential price adjustment, Rausser (1985) and Rausser, Chalfant, Love and Stamoulis (1986) supported Schuh's conjecture partly. They argued that the federal deficit, due to sticky industrial prices, has the same short run impact on the farm economy as tight monetary policy, which decreases farm prices. However, they also supported the neutrality argument in the long run. Just and Chambers (1987) also used the neo-Keynesian idea, but considered farm prices as sticky, because of farm programs. Their results were just the opposite to Rausser's in the short run.

The main objective of this study is to evaluate the different explanations of deficit effects on agriculture using the VAR analysis pioneered by Sims (1980). Modifications are made on the

VAR model because of unit roots and structural changes found. A unit root is evident in all series except the fiscal variables. The long run money balance (LM) and exchange rate equilibrium, established with Johansen and Juselius cointegration tests, play an important role in the modification. A structural change in the federal budget deficit variable, found by Chow Test and Mazon's Simulation method, is also considered in the reduced form ERM estimation.

The LM test rejected the null hypothesis of no contemporaneous correlations between reduced form error terms. A sequential ordering is established based on the priors and the maximum likelihood method by Fackler is used to identify the structural form ERM.

The results from the impulse response analysis suggest a substantial impact of the federal deficit on farm prices in the short run. A sharp decrease in farm prices occurs as a result of an increase in the federal deficit, leaving the farm economy in a cost price squeeze. However, the price decrease remains only in the short run. Farm prices move back to the long run equilibrium price level after the initial shock and reach equilibrium after about two or three years. Thus, no long run changes in the relative position between farm prices and industrial prices are detected. The short run impact of the federal deficit occurs mainly through its impact on interest rates and the exchange rate, as conjectured by Schuh and others.

The results are quite consistent with the results of Rausser and others using a fixed industrial price and flexible farm price model. Rausser's explanation is also supported by the quick and substantial movement in farm prices due to other changes in the macroeconomic environment, including the money supply.

The decomposition of forecast error variances also supports the fixed industrial prices and flexible farm prices. The forecast error variances for farm prices are much bigger than those for industrial prices, regardless of shocks in the economy.

Results are not very sensitive to the type of structural form applied. Various recursive and simultaneous structures were applied, but the impulse responses remained stable. The impulse responses also remained stable with the ECM and the VAR in levels when lags for the models are selected based on the ERM. The VAR in first differences performed poorly.

The impulse responses were not sensitive to different lag structures in the ERM. Since more variables are included in the ECM and the VAR, results become more sensitive to the number of lags in these model. The lag selection criteria also didn't work well in that case, as Nickelsburg (1985) and Hsiao (1979) have verified. Thus, the number of lags for large systems are selected based on consistency in performance compared to the small ERM model. As the number of variables increases, the results from the VAR with levels become closer to those of the ECM.

An eight variable ECM is estimated to compare three policy alternatives for reducing the budget deficit: a spending reduction, a tax increase and monetization. A tax increase has big negative impacts on real output while a spending reduction has minimal impacts.

Results from simulation over the next five years confirmed this conclusion. A spending reduction scheme does not have much impact on output and prices in the simulation. A tax increase results in a big slump in the macroeconomy and the farm sector. The simulation also identified that monetization is a favorable option for the farm sector since it initially increases farm prices considerably. However, the monetization option induces a decrease in real output after its initial expansionary impact on the economy has disappeared. It also induces inflation for the economy. Thus, the simulation experiment suggests that a spending reduction is the most favored option for tackling the current budget deficit and a tax increase is the least favored option.

The implications drawn from the VAR analysis have certain limitations. Results are only credible where no further structural changes are expected. With the U.S. economy now experiencing the unprecedented triple digit federal deficit, the results might be different from these simulated, since the linear structural relationship of time series analysis may not catch the structural changes. Other farm indicators including export and income must be included to draw a better picture on how fiscal policies affect farm economy.

Appendices

Appendix A

Data Sources

Table 35. Data Sources

Variable	Period	Source
R	1948	Federal Reserve Bulletin
	1949 - 1970	Banking and Monetary Statistics
	1971 -	Treasury Bulletin
		Annual Statistical Digest
X	1948 - 1966	International Financial Statistics[1]
	1967 - 1978	Federal Reserve Bulletin[2]
	1979 -	Annual Statistical Digest
		Federal Reserve Bulletin
GNP (nominal)	1948 - 1982	The National Income and Product Accounts of the United States
	1983 -	Survey of Current Business
Implicit Price Deflator for GNP	1948 - 1982	The National Income and Product Accounts of the United States
	1983 -	Survey of Current Business
P	1948 - 1982	The National Income and Product Account of the United States
	1983	Survey of Current Business
F	1948 - 1982	The National Income and Product Account of the United States
	1983	Survey of Current Business
Federal Tax Receipts	1948 - 1982	The National Income and Product Account of the United States
	1983	Survey of Current Business
Federal spendings	1948 - 1982	The National Income and Product Account of the United States
	1983	Survey of Current Business
Federal	1948 - 1982	The National Income and Product

(continued)

Table 35 (Cont'd).

Variable	Period	Source
Deficit		Account of the United States
	1983	Survey of Current Business
M1	1948 - 1960	Federal Reserve Bulletin[3]
	1961 - Jun. 89	Citibank Data Base 1990
	Jul. 89 -	Federal Reserve Bulletin

Data obtained from the sources are most updated version and selected issues for the source publications are used unless notified. XR, IR, and M1 data are created by average of three momthly data.

1. Generated by the formula in Federal Reserve Bulletin Aug. 1978 issue (p. 700)
2. Data from Aug. 1978 issue of the Bulletin.
3. Data from Oct. 1969 issue of the Bulletin.

Appendix B

Definition and Critical Values for Phillips-Perron Test Statistics

The test statistics are defined by

$$Z(t_{\bar{\alpha}}) = (S_u/S_{nl})t_{\bar{\alpha}} - (1/2S_{nl})(S_{nl}^2 - S_u^2)[n^{-2}\Sigma(y_{t-1} - \bar{Y}_{-1})^2]^{-1/2}$$

$$Z(t_{\alpha^*}) = (S_u/S_{nl})t_{\alpha^*} - (1/2S_{nl})(S_{nl}^2 - S_u^2)[n^{-2}\Sigma(y_{t-1} - \bar{Y}_{-1})^2]^{-1/2}$$

$$Z(t_{\alpha'}) = (S_u/S_{nl})t_{\alpha'} - (n^3/4(3D_y)^{1/2}S_{nl})(S_{nl}^2 - S_u^2)$$

$$Z(\Phi_1) = (S_u^2/S_{nl}^2)\Phi_1 - (1/2S_{nl}^2)(S_{nl}^2 - S_u^2)\{n(\alpha^* - 1) - 1/4(S_{nl}^2 - S_u^2)[n^{-2}\Sigma(y_{t-1} - \bar{Y}_{-1})^2]^{-1}\}$$

$$Z(\Phi_2) = (S_u^2/S_{nl}^2)\Phi_2 - (1/3S_{nl}^2)(S_{nl}^2 - S_u^2)[n(\alpha' - 1) - (n^6/48D_y)(S_{nl}^2 - S_u^2)]$$

$$Z(\Phi_3) = (S_u^2/S_{nl}^2)\Phi_3 - (1/2S_{nl}^2)(S_{nl}^2 - S_u^2)[n(\alpha' - 1) - (n^6/48D_y)(S_{nl}^2 - S_u^2)]$$

where

$$t_{\bar{\alpha}} = (\bar{\alpha} - \alpha)\{\Sigma(y_{t-1} - \bar{Y}_{-1})^2\}^{1/2}/\bar{S}$$

$$t_{\alpha*} = (\alpha^* - \alpha)\{\Sigma(y_{t-1} - \bar{Y}_{-1})^2\}^{1/2}/S^*$$

$$t_{\alpha'} = (\alpha' - \alpha) \;/\; (S'^2 C_3)^{1/2}$$

$$\Phi_1 = (2S^{*2})^{-1}\{nS_0^2 - nS^{*2}\}$$

$$\Phi_2 = (3S'^2)^{-1}(nS_0^2 - nS'^2)$$

$$\Phi_3 = (2S'^2)^{-1}(nS_0^2 - n(\bar{y}_0 - \bar{Y}_{-1})^2 - nS'^2)$$

$$\alpha^* = \Sigma(y_t - \bar{Y}_0)y_{t-1}/\Sigma(y_{t-1} - \bar{Y}_{-1})^2$$

$$\alpha' = (\Sigma y_{t-1}^2)^{-1}\Sigma y_t y_{t-1}$$

$$\mu^* = \bar{Y}_0 - \alpha^*\bar{Y}_{-1}$$

$$\bar{Y}_{-i} = n^{-1} \sum_t y_{t-i} \qquad (i=0,1)$$

and $\bar{S}$, S^* and S' are the standard errors of regression (32), (33) and (34), respectively.

S_0 is S' when $\alpha' = 1$. S_u^2 is a consistent estimator of σ_u^2 = lim $n^{-1}\Sigma$ $E(u_t^2)$ and S_{nl}^2 is a consistent estimator of σ^2 =lim n^{-1} $E(S_n^2)$ under the appropriate null hypothesis, where $s_n = \Sigma u_t$. n represents the number of observations. The consistent estimation of σ^2 concerns the appropriate choice of truncation lag parameter. Though the choice will be an empirical matter, Perron (1986) recommended to inspection of the sample autocorrelation of first differenced data. In this paper, the LR in first differences is used together with the recommendation. C_i is the (i,i) element of the matrix $(Y'Y)^{-1}$ and D_y denotes the determinant of the (Y'Y) which is represented as

$$D_y = (n^2(n^2-1)/12)\ \Sigma y_{t-1}^2 - n(\Sigma t y_{t-1})^2 + n(n+1)\ \Sigma t y_{t-1}\ \Sigma y_{t-1} \\ -(n(n+1)(2n+1)/6)\ (\Sigma y_{t-1})^2.$$

The critical values for the test statistics are presented as

Table 36. Critical values for PP Test Statistics

Test Statistics	Percentiles			
	10%	5%	2.5%	1%
$Z(\Phi_2)$	4.03	4.68	5.31	6.09
$Z(\Phi_3)$	5.34	6.25	7.16	8.27
$Z(t_{\bar{\alpha}})$	-3.12	-3.41	-3.66	-3.96
$Z(\Phi_1)$	3.78	4.59	5.38	6.43
$Z(\alpha^*)$	-2.57	-2.86	-3.12	-3.43
$Z(\alpha')$	-1.62	-1.95	-2.23	-2.58

Appendix C

Critical Values for Schmidt-Phillips Test Statistics

Table 37. Critical Values for SP Test Statistics

n	Percentiles			
	10%	5%	2.5%	1%
25	-2.85	-3.18	-3.50	-3.90
50	-2.80	-3.11	-3.39	-3.73
100	-2.77	-3.06	-3.32	-3.63
200	-2.76	-3.04	-3.30	-3.61
500	-2.76	-3.04	-3.29	-3.59
1000	-2.75	-3.02	-3.28	-3.58
2000	-2.75	-3.02	-3.27	-3.56

Appendix D

Critical Values for Johansen-Juselius Cointegration Test Statistics

Table 38. Critical Values for JJ Test Statistics

h	m	percentiles		
		5%	2.5%	1%
g-8	8	154.3	159.4	165.2
g-7	7	103.1	120.0	112.7
g-6	6	78.1	82.0	86.6
g-5	5	57.2	60.3	63.9
g-4	4	38.6	41.2	44.5
g-3	3	23.8	26.1	28.5
g-2	2	12.0	13.9	15.6
g-1	1	4.2	5.3	5.3

Appendix E

LM Test of contemporaneous Correlation

The LM statistic for testing H_0: $\Omega=I$ against H_1: $\Omega\neq I$ is given by

$$\lambda_{LM} = n \sum_{i=2}^{g} \sum_{j=1}^{i-1} \rho_{ij}^2$$

where

$$\rho_{ij} = \frac{\sigma_{ij}^2}{\sigma_{ii}\sigma_{jj}}.$$

The test statistic is distributed as χ^2 with g(g-1)/2 degree of freedom. In the five variable ERM estimated in Chapter V, the value of the LM test statistic was 48.55508 which is significant at the .01.

Bibliography

BIBLIOGRAPHY

Akakike, Hizotogu. "Fitting Autoregressive Models for Prediction." Annals of Institute of Statistical Mathematics. 1969. pp.243-247.

Allen, Stuart and Michael Smith. "Government Borrowing and Monetary Accommodation." J. Monetary Econ. 12(1983):605-616.

Andrews, Margaret S. and Gordon C. Rausser. "Some Political Economy Aspects of Macroeconomic Linkages with Agriculture." Amer. J. Agr. Econ. 68(1986):413-417.

Ardeni, Pier Giorgio. "Does the Law of One Price Really Hold for Commodity Prices?" Amer. J. Agr. Econ. 71(1989):661-669

Baillie, R. T. "Commodity Prices and Aggregate Inflation: Would A Commodity Price Rule be Worthwhile?" Econometrics and Economic Theory Pap. No. 8808. Dept. of Econ. Mich. State Univ. E. Lansing. MI. April. 1989.

Baillie, R.T. and Tim Bollerslev. "The Message in Daily Exchange Rates: A Conditional Variance Tale." J. of Business and Econ. Stat. 7(1989):295-307.

Baillie, R. T. and Robert J. Myers. "Modeling Commodity Price Distribution and Estimating the Optimal Future Hedge." J. Applied Econometrics. Forthcoming. 1991.

Barclay, Tom and Tweeten, Luther. "Macroeconomic Policy Impacts on United States Agriculture: A Simulation Analysis." Agricultural Economics. 1(1988):291-307.

Barr, Wallace. "Inflation, Agriculture, and the Food Economy: Discussion." Amer. J. Agr. Econ. 61(1979):909-911.

Barro, Robert J. "Are Government Bonds Net Wealth?" J. Polit. Econ. 82(1974):1095-1117.

Barro, Robert J. "Unanticipated Money Growth and Unemployment in the United States." Amer. Econ. Rev. 67(1977):101-115.

Barro, Robert J. "Comment from an Unconstructed Ricardian." J. Monetary Econ. 4(1978a):569-581.

Barro, Robert J. "Unanticipated Money, Output, and the Price Level in the United States." J. Polit. Econ. 86(1978b): 549-580.

Barro, Robert J. Macroeconomics, 2nd. New York: John Wiley & Sons. 1984.

Barro, Robert J. Macroeconomics, 3rd. New York: John Wiley & Sons. 1987.

Batten, Dallas S. and Michael T. Belongia. "Monetary Policy, Real Exchange Rate and U.S. Agricultural Exports." Amer. J. Agr. Econ. 68(1986):422-427.

Batten, Dallas S. and Daniel L. Thoronton. "How Robust Are the Policy Conclusions of the St. Louis Equation?: Some Further Evidence." Fed. Res. Bank of St. Louis Rev. (1984: June/July):26-32.

Bell, Daniel and Irving Kristol. The Crisis in Economic Theory. New York: Basic Books Inc. 1981.

Belongia, Michael T. "The Impact of Inflation on the Real Income of U. S. Farmers: Discussion." Amer. J. Agr. Econ. 67(1985):398-399.

Belongia, Michael T. and Richard A. King. "A Monetary Analysis of Food Price Determination." Amer. J. Agr. Econ. 65(1983):131-135.

Belongia, Michael T. and Courtenay C. Stone. "Would Lower Federal Deficits Increase U. S. Farm Exports?" Fed. Res. Bank of St. Louis Rev. (Nov. 1985):5-19.

Bera, A. K. and C. M. Jarque. "Model Specification Tests: A Simultaneous Approach." J. Econometrics. 20(1982):59-82.

Bernanke, Ben S. "Alternative Explanations of the Money-Income Correlation." Carnegie-Rochester Conference Series on Public Policy. 25(1986):49-100.

Bessler, David A. and John L. Kling. "The Forecast and Policy Analysis." Amer. J. Agr. Econ. 71(1989):503-506.

Bhargava, A. "On the Theory of Testing for Unit Roots in Observed Time Series." Rev. of Econ. Studies. 52(1986): 369-384.

Bisignanno, Joseph. "Fiscal Deficits and Exchange Rate: A Look at Recent Policy Assertions and Their Theoretical and Empirical Support." Fed. Res. Bank of San Francisco. Working Pap. No. 85-04, June 1985.

Blanchard, O. J. and M. W. Watson. "Are All Business Cycles Alike?" Paper Presented at Conference on Business Cycles. Nat. Bur. Econ. Res. Puerto Rico. Mar. 22-25. 1984.

Blanchard, O. J. and Danny Quah. "The Dynamic Effects of Aggregate Demand and Supply Disturbances." Amer. Econ. Rev. 79(1989):655-673.

Blinder, Alan S. "On the Monetization of Deficits." Working Pap. Series, No. 1052. Nat. Bur. Econ. Res. Dec. 1982.

Blinder, Alan S. and Robert M. Solow. "Does Fiscal Policy Matter?" J. Public Econ. 2(1973):319-337.

Blinder, Alan S. and Robert M. Solow. "Analytical Foundations of Fiscal Policy." in Alan S. Blinder and Robert M. Solow, ed., The Economics of Public Finance, pp. 3-15. The Brookings Institution, 1974.

Board of Governors of the Federal Reserve System. Annual Statistical Digest. Washington, D.C. selected issues.

Board of Governors of the Federal Reserve System. Banking and Monetary Statistics, 1941-1970. Washington, D.C. 1976.

Board of Governors of the Federal Reserve System. Federal Reserve Bulletin. Washington, D.C. selected issues.

Bollerslev, Tim. "Generalized Autoregressive Conditional Heteroskedasticity." J. Econometrics 31(1986):307-327.

Bollerslev, Tim. "A Conditional Heteroskedastic Time Series Model for Speculative Prices and Rates of Return." Rev. of Econ. and Stat. 69(1987):542-547.

Bollerslev, Tim, Robert F. Engle and J. M. Wooldridge. "A Capital Asset Pricing Model with Time Varying Covariances." J. Polit. Econ. 96(1988):116-131.

Boothe, Paul M. and Bradford G. Reid. "Asset Returns and Governments Budgets In a Small Open Economy: Empirical Evidence for Canada." J. Monetary Econ. 23(1989):65-77.

Box, George E. P. and Jenkins, Gwilym M. Time Series Analysis Forecasting and Control. Holden-Day, San Francisco. 1970.

Box, George E. P. and Pierce, David A. "Distribution of Residual Autocorrelations in Autoregressive-Integrated Moving Average Time Series Models." J. Amer. Stat. Ass. 65(1970):1509-1526.

Box, George. E. P. and G. C. Tiao. "A Canonical Analysis of Multiple Time Series Models." Biometrika. 64(1977):355-365.

Bredahl, Maury E. "The Effects of Inflation on the Welfare and Performance of Agriculture: Discussion." Amer. J. Agr. Econ. 67(1985):400-401.

Branson, William H. Macroeconomic Theory and Policy. 2nd. Harper & Row. New York. 1979.

Branson, William H. "The Collapse of Purchasing Power Parities during the 1970's by Frenkel: Comments." European Econ. Rev. 16(1981):161-171.

Brown, W. W. and G. J. Santoni. "Unreal Estimates of the Real Rate of Interest." Fed. Res. Bank of St. Louis Rev. (Jan. 1981):18-26.

Brunner, Karl and Allan H. Meltzer. "Money, Debt, and Economic Activity." J. Polit. Econ. 80(1972):951-977.

Buchanan, J. M. and R. Wagner. Democracy in Deficit: The Political Legacy of Lord Keynes. Academic Press. New York. 1978.

Buiter, William. "Deficits, Crowding Out and Inflation: The Simple Analytic." Working Pap. No. 1078. Nat. Bur. Econ. Res. Feb. 1983.

Bureau of Economic Analysis. Business Statistics. U.S. Department of Commerce. Washington, D.C. selected issues.

Bureau of Economic Analysis. Survey of Current Business. U.S. Department of Commerce. Washington, D.C. selected issues.

Burger, Albert E. "The Implementation Problem of Monetary Policy." Fed. Res. Bank of St. Louis Rev.(Mar. 1971):20-30

Canto, Victor A. and Donald Rapp. "The Crowding Out Controversy: Arguments and Evidence." Fed. Res. Bank of Atlanta Rev. (Aug 1982):33-37.

Carlson Keith M. "The Mix of Monetary and Fiscal Policies: Conventional Wisdom vs. Empirical Reality." Fed. Res. Bank of St. Louis Rev. (Oct. 1982):7-21.

Carlson, Keith M. and Roger W. Spencer. "Crowding Out and Its Critics." Fed. Res. Bank of St. Louis Rev. (Dec. 1975):2-17.

Carlton, Dennis W. "Market Behavior with Demand Uncertainty and Price Inflexibility." Amer. Econ. Rev. 68(1978):571-587.

Carlton, Dennis W. "Contracts, Price Rigidity, and Market Equilibrium." J. Polit. Econ. 87(1979):1034-1063.

Carlton, Dennis W. "Modeling Price Rigidity or Predicting the Quality of the Good that Clears the Market." Working Pap. No. 503. Nat. Bur. Econ. Res. July 1980.

CEASM (Council of Economic Advisers Staff Memorandum). "Financing a Federal Deficit." Ronald L. Teigen, ed. Readings in Money, National Income, and Stabilization Policy. 4th. R.D. Irwin. Homewood, Ill. 1978. pp.277-279.

Chambers, Robert G. "Interrelationships between Monetary Instruments and Agricultural Commodity Trade." Amer. J. Agr. Econ. 63(1981):934-941.

Chambers, Robert G. "Agricultural and Financial Market Interdependence in the Short Run." Amer. J. Agr. Econ. 66(1984):12-24.

Chambers, Robert G. "Credit Constraints, Interest Rates, and Agricultural Prices." Amer. J. Agr. Econ. 67(1988):12-24.

Chambers, Robert G. and Richard E. Just. "Effects of Exchange Rate Changes on U.S. Agriculture: A Dynamic Analysis." Amer. J. Agr. Econ. 63(1981):33-46.

Chambers, Robert G. and Richard E. Just. "A Critique of the Exchange Rate Treatment in Agricultural Trade Models: Reply." Amer. J. Agr. Econ. 68(1986):994-997.

Chow, G. C. "Tests of Equality Between Sets of Coefficients in Two Linear Regressions." Econometrica. 28(1960):591-605.

Chow, G. C. "On the Long-Run and Short-Run Demand for Money." J. Polit. Econ. 74(1966):111-131.

Christ, Carl F. "A Short-Run Aggregate-Demand Model of the Interdependence and Effects of Monetary and Fiscal with Keynesian and Classical Interest Elasticities." Amer. Econ. Rev. 57(1967):434-443.

Christ, Carl F. "A Simple Macroeconomic Model with a Government Budget Restraint." J. Polit. Econ. 76(1968):53-67.

Cohen, Darrel and Peter B. Clark. "The Effects of Fiscal Policy on the U.S. Economy." Staff Studies No. 136. Board of Governors of the Fed. Res. Sys., Jan. 1984.

Cooley, Thomas F. and Stephen F. LeRoy. "Atheoretical Macroeconometrics: A Critique." J. Monetary Econ. 16 (1985):283-308.

Corrigan, E. Gerald. "The Measurement and Importance of Fiscal Policy Changes." Fed. Res. Bank of New York Monthly Rev. (June 1970):133-145.

Crouch, Robert L. Macroeconomics. Harcourt Brace Jovanovich Inc. 1972.

Crouhy-Veyrac, L., M. Crouhy, and J. Melitz. "More about the Law of One Price." European Econ. Rev. 18(1982):325-44.

Cullison, William E. "Money, the Money Base, and Nominal GNP." Fed. Res. Bank of Richmond Economic Rev.(May/ June, 1982):3-13.

Davis, Richard G. "How Much Does Money Matter? A Look at Some Recent Evidence." Fed. Res. Bank of New York Monthly Rev. (June 1969):119-131.

Dickey, David A. and Wayne A. Fuller. "Distribution of the Estimators for Autoregressive Time Series with a Unit Root." J. Amer. Stat. Ass. 74(1979):427-431.

Dickey, David A. and Wayne A. Fuller. "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root." Econometrica. 49(1981):1057-1072.

Dickey, David A. and Sastry G. Pantula. "Determining the Order of Differencing in Autoregressive Processes." J. Business and Econ. Stat. 5(1987):455-461.

Diebold, F. X. and M. Nerlove."The Dynamics of Exchange Rate Volatility: A Multivariate Latent Factor ARCH Model." J. Applied Econometrics. 4(1989):1-21.

Dobson, William D. "Effects of the Macroeconomic Environment on 1985 Farm Legislation." Annual Ag. Outlook Conference. USDA. Washington, D. C. Dec. 3-5. 1984. pp.48-58.

Dornbush, Rudiger. "Expectations and Exchange Rate Dynamics." J. Polit. Econ. 84(1976):1161-1176.

Dornbush, Rudiger and Stanley Fisher. "Budget Deficits and Inflation." M. June Flanders and Assaf Razin, ed. Development in an Inflationary World. Academic Press. New York. 1981.

Dornbush, Rudiger and Stanley Fisher. Macroeconomics(3rd.). McGraw-Hill Book Co. New York. 1984.

Dwyer, Gerald. "Inflation and Deficits." Economic Inquiry. 20(1982):315-329.

Engle, Robert F. "Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of United Kingdom Inflation." Econometrica. 50(1982):987-1007.

Engle, Robert F. "On the Theory of Cointegrated Economic Time Series." mimeo. 1987.

Engle, Robert F. and Tim Bollerslev. "Modeling the Persistence of Conditional Variances." Econometric Rev. 5(1986):1-50.

Engle, Robert F. and C. W. J. Granger. "Cointegration and Error Correction: Representation, Estimation, and Testing." Econometrica. 55(1987):251-276.

Engle, Robert F., C.W.J. Granger, and Dennis Kraft. " Combining Competing Forecasts of Inflation Using a Bivariate ARCH Model." J. Econ. Dynamics and Control. 8(1984):151-65.

Engle, Robert F., David M. Lilien, and Russell P. Robins. "Estimating Time Varying Risk Premia In the Term Structure: the ARCH-M Model." Econometrica. 55(1987):391-407.

Engle, Robert F. and B. S. Yoo. "Forecasting and Testing in Co-integrated Systems." J. Econometrics. 35(1987):143-159.

Evans, G. B. A. and N. E. Savin. "Testing for Unit Roots: 1." Econometrica. 49(1981):753-779.

Evans, G. B. A. and N. E. Savin. "Testing for Unit Roots: 2." Econometrica. 52(1984):1241-1270.

Evans, Paul. "Is the Dollar High Because of Large Budget Deficits?" J. Monetary Econ. 18(1986):227-249.

Evans, Paul. "Do Budget Deficits Raise Nominal Interest Rate: Evidence from Six Countries." J. Monetary Econ. 20(1987):281-300.

Evans, Paul. "Interest Rates and Expected Future Budget Deficits in the United States." J. Polit. Econ. 95 (1987):34-58.

Fackler, P. F. "Vector Autoregressive Techniques for Structural Analysis." Working Pap. No. 113. Dept. of Econ. and Business. N. C. State Univ. Raleigh. N. C. 1988.

Feldstein, Martin S. "Government Deficits and Aggregate Demand." J. Monetary Econ. 9(1982):1-20.

Feldstein, Martin S. and Otto Eckstein. "The Fundamental Determinants of the Interest Rate." Rev. of Econ. and Stat. 52(1970):363-375.

Framm, Gary and Lawrence R. Klein. "A Comparison of Eleven Econometric Models of the United States." Amer. Econ. Rev. 63(1973):385-393.

Frank, de Leeuw and Thomas M. Holloway. "The High Employment Budget: Revised Estimates and Automatic Inflation Effects." Survey of Current Business. (April 1982):21-23.

Frankel, Jeffery A. "Commodity Prices and Money: Lessons from International Finance." Amer. J. Agr. Econ. 66(1984):560-566.

Frankel, Jeffery A. "Expectations and Commodity Price Dynamics: Overshooting Model." Amer. J. Agr. Econ. 68(1986):344-348.

French, K.R., G.W. Schwert and R.E. Stambaugh. "Expected Stock Returns and Volatility." J. Finan. Econ. 19(1987):3- 29.

Frenkel, Jacob A. "The Collapse of Purchasing Power Parities During the 1970's." European Econ. Rev. 16(1981):145-165.

Friedman, Milton. A Theory of the Consumption Function. Princeton Univ. Press. 1957.

Friedman, Milton. "A Monetary Theory of Nominal Income." J. Polit. Econ. 79(1971):323-337.

Friedman, Milton. "Comments on the Critics." J. Polit. Econ. 80(1972):906-50.

Fuller, Wayne A. Introduction to Statistical Time Series. Wiley. New York. 1976.

Fusfeld, Daniel R. The Age of the Economist. 4th. Scott, Foresman and Co. Glenview. Ill. 1982.

Goldfeld, Stephen. "The Demand for Money Revisited." Brookings Pap. Econ. Act. (1973):577-638.

Gramlich, Edward M. "The Usefulness of Monetary and Fiscal Policy as Discretionary Stabilization Tools." J. Money, Credit and Banking. 3(1971):506-532.

Granger, C. W. J. "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods." Econometrica. 37(1969):24-36.

Granger, C. W. J. "Some Properties of Time Series Data and Their Use in Econometric Model Specification." J. Econometrics. 16(1981):121-130.

Grossman, Herschel I. "Rational Expectations, Business Cycles, and Government Behavior. " Rational Expectations and Economic Policy. edited by Stanley Fisher. Nat. Bur. Econ. Res. Chicago. 1980.

Hafer, R. W. "Selecting a Monetary Indicator: A Test of the New Monetary Aggregates." Fed. Res. Bank of St.Louis Rev. (Feb. 1981):12-18.

Hafer, R. W. "Money, Debt, and Economic Activity." Fed. Res. Bank of St. Louis Rev. (Jun/July 1984):18-25.

Hamburger, Michael J. and Burton Zwick. "Deficits, Money, and Inflation." J. Monetary Econ. 7(1981):141-150.

Hamburger, Michael J. and Burton Zwick. "Deficits, Money, and Inflation: Reply." J. Monetary Econ. 10(1982):279-283.

Haslag, Joseph H. and Daniel J. Slottje. "Macroeconomic Policy and Income Inequality: An Error-Correction Representation." Working Pap. No. 8909. Fed. Res. Bank of Dallas. June 1989.

Hendry, D. F. "Econometric Modelling with Cointegrated Variables: An Overview." Oxf. Bull. Econ. Stat. 48(1986): 201-212.

Hoffman, Dennis and Robert H. Rasche. "Long-Run Income and Interest Elasticities of Money Demand in the United States." Working Pap. No. 2949. Nat. Bur. Econ. Res. 1989a.

Hoffman, Dennis and Robert H. Rasche. "The Demand for Money in the U.S. during the Great Depression: Estimates and Comparisons with the Post War Experience." Unpublished Working Pap. Nat. Bur. Econ. Res. Dec. 1989b.

Hsiao, Cheng. "Autoregressive Modeling of Canadian Money and Income Data." J. Amer. Stat. Ass. 74(1979):353-560.

Hsiao, Cheng. "Autoregressive Modeling and Money-Income Causality Detection." J. Monetary Econ. 7(1981):85-106.

Hsieh, D. A. "The Statistical Properties of Daily Foreign Exchange Rates: 1974-1983." J. Internat. Econ. 18 (1988):129-146.

Hutchinson, Michael M. and Adrian W. Throop. "U.S. Budget Deficits and the Real Value of the Dollar." Fed. Res. Bank of San Francisco Econ. Rev. (Nov. 1985):26-43.

Isard, Peter. "How Far Can We Push the Law of One Price?" Amer. Econ. Rev. 67(1977):942-48.

Jabara, C. L., and N. E. Schwartz. "Flexible Exchange Rates and Commodity Price Changes: The Case of Japan." Amer. J. Agr. Econ. 69(1987):580-90.

Johansen, Sören. "Statistical Analysis of Cointegration Vectors." J. Econ. Dynamics and Control. 12(1988): 231-254.

Johansen, Sören. "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models." Preprint 3. Inst. of Math. Stat. Univ. of Copenhagen. Jan. 1989.

Johansen, Sören and Katarina Juselius. "Hypothesis Testing for Cointegration Vectors with an Application to the Demand for Money in Denmark and Finland." Preprint 2. Inst. of Math. Stat. Univ. of Copenhagen. Feb. 1988.

Johansen, Sören and Katarina Juselius. "The Full Information Maximum Likelihood Procedures for Inference on Cointegration with Applications." Preprint 4. Inst. of Math. Stat. Univ. of Copenhagen. Jan. 1989.

Just, Richard E. and Robert G. Chambers. "Deficits and Agriculture: An Alternative Parable." Working Pap. No. 87-08. Dept. of Agr. and Resource Econ. Univ. of Maryland. July. 1987.

Keran, Michael W. "Monetary and Fiscal Influences on Economic Activity: The Historical Evidence." Fed. Res. Bank of St.Louis Rev. (Nov. 1969):5-24.

Keran, Michael W. "Monetary and Fiscal Influences on Economic Activity: The Foreign Experience." Fed. Res. Bank of St.Louis Rev. (Feb. 1970):16-28.

Kloek, T. and H. K. Van Dijk. "Bayesian Estimates of Equation System Parameters: An Application of Integration by Monte Carlo." Econometrica. 46(1978):1-20.

Kochin, Levis A. "Are Future Taxes Anticipated by Consumers?" J. Money Credit and Banking. 6(1974):385-394.

Kormend, Roger C. "Government Debt, Government Spending, and Private Sector Behavior." Amer. Econ. Rev. 73(1983):994-1010.

Kunst, Robert M. "Cointegration in a Macro Economic System: Sensitivity and Prediction." Working Pap. Institute for Advanced Studies. Vienna. Austria. 1989.

Leamer, Edward E. "Vector Autoregressions for Causal Inference?" Carnegie-Rochester Conference Series on Public Policy. 22(1985):255-304.

Lee, Junsoo and Peter Schmidt. "Unit Root Tests With ARMA errors." unpublished Working Pap. Dept. of Econ. Michigan State Univ. E.Lansing. MI. March. 1990.

Leonall C. Andersen and Jerry L. Jordan. "Monetary and Fiscal Policy Actions: A Test of Their Relative Importance in Economic Stabilization." Fed. Res. Bank of St. Louis Rev. (Nov. 1968):11-24.

Ljung, G.M. and G.E.P. Box. "On A Measure of Lack of Fit in Time Series Models." Biometrika. 65(1978):297-303.

Lutkepohl, H. "Comparison of Criteria for Estimating the Order of a Vector Autoregressive Process." Working Pap. No. 8207. Fachbereich Wirtschaft-swissenschaften. Universitat Osnabruck. 1982.

Makin, John H. "Real Interest, Money Surprises, Anticipated Inflation and Fiscal Deficits." Rev. of Econ. and Stat. 65(1983):374-384.

Mazon, Cristina. "The Impact of Government Policy on the U.S. Steel and Cigarette Industries." Unpublished Ph.D Dissertation. Dept. of Econ. Univ. of Minn. Minn. 1985.

McCurdy, T. and I. G. Morgan. "Tests of the Martingale Hypothesis for Foreign Currency Futures with Time Varying Volatility." Internat. J. of Forecasting. 3(1987):131-148.

McMillin, Douglas W. and Thomas R. Beard. "Deficits, Money, and Inflation: Comment." J. Monetary Econ. 10(1982): 273-277.

Meltzer, Allan. H. "The Demand for Money: the Evidence from the Time Series." J. Polit. Econ. 71(1963):219-246.

Milhoj, "A Conditional Variance Model for Daily Deviations of An Exchange Rate." J. of Business and Econ. Stat. 5(1988):99-103.

Mount, Timothy D. "Policy Analysis with Time Series Econometric Models: Discussion." Amer. J. Agr. Econ. 71(1989):507-508.

Myers, Robert J., R. R. Piggott, and William G. Tomek. " Estimating Sources of Fluctuations in the Australian Wool Market: An Application of VAR Methods." Amer. J. Agr. Econ. Forthcoming. 1991.

Nankervis, J. C. and N. E. Savin. "Testing the Autoregressive Parameters with t Statistics." J. Econometrics. 27(1985):143-161.

Nelson, Charles R. and Charles I. Plosser. "Trends and Random Walks in Macroeconomic Time Series: Some Evidence and Implications." J. Monetary Econ. 10 (1982):139-162.

Newey, W. K. and K. D. West. "A Simple Positive Definite Heteroskedasticity and Autocorrelation Consistent Covariance Matrix." Econometrica. 55(1987):703-708.

Nickell, S. "Error Correction, Partial Adjustment and All That: An Expository Note." Oxf. Bull. Econ. Stat. 47 (1985):119-129.

Nickelsburg, Gerald. "Small Sample Properties of Dimensionality Statistics for Fitting VAR Models to Aggregate Economic Data: A Monte Carlo Study." J. Econometrics. 28(1985):183-192.

Niskanen, William. "Deficits, Government Spending, and Inflation." J. Monetary Econ. 4(1978):591-602.

O'Driscall, G. P. "The Ricardian Nonequivalence Theorem." J. Polit. Econ. 85(1979):207-210.

Okun, Arthur. "Inflation: Its Mechanics and Welfare Costs." Brookings Pap. on Econ. Act. (1975):351-401.

Orden, David. "Capitol Flows, the Exchange Rate, and Goods Markets in a Neoclassical Trade Model: Towards a Framework for Evaluating Monetary Aspects of Agricultural Trade." Paper Presented at Canada/U.S. International Agricultural Trade Research Consortium. Ontario. Canada. June 24. 1983.

Orden, David. "Agriculture, Trade, and Macroeconomics: the U.S. Case." J. Policy Modeling. 8(1986):27-51.

Orden, David. and P. F. Fackler. "Identifying Monetary and Other Macroeconomic Impacts on Agricultural Prices in VAR Models." Amer. J. Agr. Econ. 71(1989):495-502.

Ott, Mack. "Money, Credit, and Velocity." Fed. Res. Bank of St. Louis Rev. 64(1982):21-34.

Perron, Pierre. "Trends and Random Walks in Macroeconomic Time Series: Further Evidence from a New Approach." unpublished. Dept. of Econ. Universite' de Montre'al. Oct. 1986.

Phillips, P. C. B. "Time Series Regression with A Unit Root." Econometrica. 55(1987):277-301.

Phillips. P. C. B. and S. N. Durlauf. "Multiple Time Series Data and Their Use in Econometric Model Specification." Rev. Econ. Stud. 53(1986):473-495.

Phillips, P. C. B. and Pierre Perron. "Testing for a Unit Root in Time Series Regression." Biometrika. 75(1988):334-346.

Plosser, Charles I. "Government Financing Decisions and Asset Returns." J. Monetary Econ. 9(1982):325-352.

Poole, W. "Wither Demand for Money?" Brookings Pap. on Econ. Act. (1970):485-500.

Protopapadakis, Aris A. and Jeremy J. Siegel. "Government Debt, the Money Supply, and Inflation: Theory and Evidence for Seven Industrialized Economies." Working Pap. No. 84-4, Fed. Res. Bank of Philadelphia. Aug. 1984.

Protopapadakis, Aris A. and H. R. Stoll. "Spot and Futures Prices and the Law of One Price." J. Finance. 38(1983):1431-1455.

Rausser, Gordon C. "Macroeconomics and U.S. Agricultural Policy." Bruce L. Gardner. ed. U.S. Agricultural Policy: The 1985 Farm Legislation. American Enterprise Institute for Public Policy Research. Washington D.C. 1985.

Rausser, Gordon C., James A. Chalfant, H. Alan Love, and Kostas G. Stamoulis. "Macroeconomic Linkages, Taxes, and Subsidies in the U.S. Agricultural Sector." Amer. J. Agr. Econ. 68(1986):399-412.

Ricardo, D. "Funding System." in v.4 of P. Sraffa. ed. The Works and Correspondence of David Ricardo. Cambridge Univ. Press. Cambridge. England. 1951.

Robertson, John and David Orden. "A Vector Error-Correction Model of Money and Price Dynamics in New Zealand." Working Pap. Dept. Agri. Econ. Virginia Tech. Blacksburg. Virginia. Sept. 1989.

Runkle, D. E. "Vector Autoregressions and Reality." J. of Business and Econ. Stat. 5(1987):437-442.

Said, S. E. and D. A. Dickey. "Testing for Unit Roots in Autoregressive-Moving Average Models of Unknown Order." Biometrika. 71(1984):599-608.

Santoni, G. J. and Courtenay C. Stone. "Navigating Through the Interest Rate Moraces: Some Basic Principles." Fed. Res. Bank of St. Louis Rev. (Mar. 1981):11-18.

Sargent, Thomas J. and Neil Wallace. "Some Unpleasant Monetarist Arithmetic." Fed. Res. Bank of Minneapolis Quarterly Rev. 5(1981):1-17.

Saunders, Peter J. "Causality of U.S. Agricultural Prices and the Money Supply: Further Empirical Evidence." Amer. J. Agr. Econ. 70(1988):588-596.

Schmidt, Peter. "Dicky-Fuller Tests with Drift." Econometrics and Economic Theory Pap. No. 8717. Dept. of Econ. Mich. State Univ. E. Lansing. MI. 1988.

Schmidt, Peter and P. C. B. Phillips. "Testing for a Unit Root in the Presence of Deterministic Trends." unpublished. Dept. of Econ. Mich. State Univ. E. Lansing. MI. Oct. 1989.

Schuh, G. E. "The Exchange Rate and U.S. Agriculture." Amer. J. Agr. Econ. 56(1974):1-13.

Schuh, G. E. "The New Macroeconomics of Agriculture." Amer. J. Agr. Econ. 58(1976):802-811.

Schuh, G. E. "The Global Macroeconomic Environment of U. S. Food and Agricultural Policy." Food Security in Hungry World. 1981.

Schuh, G. E. "U.S. Agricultural Policy in An Open World Economy." Testimony to Congress. 1983.

Schuh, G. E. "Future Directions for Food and Agricultural Trade Policy." Amer. J. Agr. Econ. (1984a):242-247.

Schuh, G. E. "Trade and Capital Market Linkages As Components of The Domestic Farm Policy Environment." Annual Agr. Outlook Conference. (1984b):59-66. USDA. Washington, D.C.

Schwert, G. William. "Effects of Model Specification on Tests for Unit Roots in Macroeconomic Data." J. Monetary Econ. 20(1987):73-103.

Schwert, G. William. "Tests for Unit Roots: A Monte Carlo Investigation." J. Business and Econ. Stat. 7(1988):147-159.

Seater, John J. "Are Future Taxes Discounted." J. Money, Credit and Banking. 14(1982):377-389.

Sen, D. L. "Robustness of Single Unit Root Test Statistics in the Presence of Multiple Unit Roots." unpublished Ph.D Dissertation. Dept. of Statistics. North Carolina State Univ. 1986.

Sen, D. L. and D. A. Dickey. "Symmetric Test for Second Differencing in Univariate Time Series." J. of Business and Econ. Stat. 5(1987):463-473.

Shei, Shun Yi and Robert Thompson. "Inflation and Agriculture: A Monetarist Structuralist Synthesis." Mimeo. Dept. of Agr. Econ. Purdue Univ. West Lafayette, Indiana. sept. 1981.

Silber, William L. "Fiscal Policy in IS-LM Analysis: A Correction." J. Money, Credit and Banking. 2(1970):461-472.

Simon, Herbert A. "Causal Ordering and Identifiability." in William C. Hood and Tjalling C. Koopmans, ed., Studies in Econometric Method. Cowles Foundation. 1953.

Sims, C. A. "Money Income and Causality." Amer. Econ. Rev. 62 (1972):540-552.

Sims, C. A. "Macroeconomic and Reality." Econometrica. 48(1980):1-48.

Sims, C. A. "Are Forecasting Models Usable for Policy Analysis?" Fed. Res. Bank of Minneapolis Quarterly Rev. 10(1986):1-16.

Sims, C. A. "Models and Their Uses." Amer. J. Agr. Econ. 71(1989):489-494.

Sims, C. A., J. H. Stock, and M. W. Watson. "Inference in Linear Time Series Models with Some Unit Roots." Econometrica. 58(1990):113-144.

Spanos, A. Statistical Foundations of Econometric Modelling. Cambridge Univ. Press. Cambridge. 1986.

Stamoulis, Kostas G., James A. Chalfant, and Gordon C. Rausser. "Monetary Policies and Overshooting of Flexible Prices: Implications for Agricultural Policy." Selected Pap. Presented at Amer. Agr. Econ. Ass. Annual Meeting. Ames, Iowa. 1985.

Stamoulis, Kostas G., James A. Chalfant, and Gordon C. Rausser. "Monetary Policy and Relative Farm Prices." Univ. of Ill. at Urbana Champaign and Univ. of Cal. at Berkeley. unpublished. 1987.

Stiglitz, Joseph. "Theories of Wage Rigidity." Working Paper. Nat. Bur. Econ. Res. Sept. 1984.

Stock, J. H. "Asymptotic Properties of Least Squares Estimators of Cointegrating Vectors." Econometrica. 55 (1987):1035-1056.

Stock, J. H. and M. W. Watson. "Does Real GNP Have a Unit Root?" Economic Letters. 22(1986):147-151.

Stock, J. H. and M. W. Watson. "Testing for Common Trends." J. Amer. Stat. Ass. 83(1988):997-1107.

Stock, J. H. and M. W. Watson. "Interpreting the Evidence on Money-Income Causality." J. Econometrics. 40(1989):161-181.

Tatom, John A. "A Perspective on the Federal Deficit Problems." Fed. Res. Bank of St. Louis. (June/July 1984):5-17.

Tatom, John A. "Two Views of the Effects of Government Budget Deficits in the 1980's." Fed. Res. Bank of St. Louis. (Oct. 1985):5-16.

Taylor, John. "Staggered Wage Setting in a Macro Model." Amer. Econ. Rev. 69(1979):109-113.

Taylor, John. "Aggregate Dynamics and Staggered Contracts." J. Polit. Econ. 88(1980):

Teigen, Ronald L. "A Critical Look at Monetarist Economics." Fed. Res. Bank of St. Louis Rev. (Jan. 1972):10-25.

Theil, H. and J. C. G. Boot. "The Final Form of Econometric Equation Systems." Rev. of the Internat. Stat. Ins. 30 (1962):136-152.

Thompson, Robert L. "U.S. Macroeconomic Policy and Agriculture." Paper Presented at Univ. Consortium for Agricultural Trade Research Conference. July 24-29. 1986. Tahoe City. California.

Tobin, James. "A General Equilibrium Approach to Monetary Theory." J. Money, Credit and Banking 1(1969):15-29.

Tobin, James. "Friedman's Theoretical Framework." J. Polit. Econ. 80(1972):852-863.

Tobin, James. "The Wrong Mix for Recovery." Challenge.(May/ June 1982):25.

Tobin, James and William Buiter. "Long Run Effects of Fiscal and Monetary Policy on Aggregate Demand." Cowles Foundation Discussion Pap. No. 384. 1974.

Todd, Richard M. "Policy Analysis with Time Series Econometric Models: Discussion." Amer. J. Agr. Econ. 71(1989):509-510.

Tweeten, Luther. "Impact of Federal Fiscal-Monetary Policy on Farm Structure." Southern J. Agri. Econ. 15(1983):61-68.

Tweeten, Luther. Farm Policy Analysis. Westview Press. Boulder. Colorado. 1989.

Vela, R. P., D. W. Wichern, and G. C. Reinsel. "A Note on Nonstationarity and Canonical Analysis of Multiple Time Series Models." J. Time Series Analysis. 8(1987):479-487.

Wallis, Kenneth F. "Multiple Time Series Analysis and the Final Form of Econometric Models." Econometrica. 45 (1977):1481-1498.

Weintraub, Robert E. "Deficits: Their Impact on Inflation and Growth." Staff Study for the Subcommittee on Monetary and Fiscal Policy of the Joint Economic Committee, GPO, July, 1981.

Yohe, William P. "The 'Crowding Out' of Private Expenditures by Fiscal Policy Actions." Fed. Res. Bank of St. Louis Rev. (Oct. 1970):12-24.

Zellner, Arnold. "The Current State of Business Econometrics." Mimeo. Univ. of Chicago. Ill. 1981.

Zellner, Arnold. An Introduction to Bayesian Inference in Econometrics. New York: John Wiley & Sons. 1971.