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THE OVERSHOOTING HYPOTHESIS: ARE AGRICULTURAL EXPORTS MORE SENSITIVE?

by

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ABSTRACT

A seven-variable macroeconomic-agricultural VAR was used to test the overshooting hypothesis for agriculture, specifically that growth in agricultural exports are more sensitive to changes in monetary variables such as the money supply and exchange rates. No significant effects from macroeconomic variables were found to growth in either agricultural or nonagricultural exports. The effects that were found suggests that, if anything, growth in nonagricultural exports overshoot relative to growth in agricultural exports.

Key Words: overshooting, vector autoregresssion, flexprice-fixprice, agricultural exports, macroeconomic linkages.

THE OVERSHOOTING HYPOTHESIS: ARE AGRICULTURAL EXPORTS MORE SENSITIVE?

Over forty years ago, Schultz (1945, p. 214) argued that business fluctuations in the nonfarm sector of the U.S. were the major cause of farm income instability. Shuh (1974) later suggested that exchange rates are important determinants of agricultural exports for the U.S. More recently, it has been argued that effects of monetary policy are transmitted to the agricultural sector via exchange rates due to the so-called overshooting phenomenon.

In a two sector economy with fix-flex prices, a shock can cause prices in the flexprice sector to "overshoot" since those in the fixprice sector are not allowed to adjust freely. Several economists (e.g., Bessler 1984; Chambers 1984, 1985; Devados and Meyers 1987; Frankel 1984, 1986; Jabara and Schwartz 1987) have suggested that, in the U.S., agriculture is the flexprice sector while manufacturing is the fixprice sector. The argument is that, for example, an appreciation of the dollar relative to other currencies causes prices in agriculture to rise relative to nonagricultural prices and causes agricultural exports to fall relatively more than nonagricultural exports. The opposite would result from a depreciation of the dollar. Indeed, overshooting in agriculture is the basic underlying assumption for several important agricultural sector models (e.g., Rausser et al. 1986; Shei and Thompson 1988; Stamoulis and Rausser 1988).

Dornbusch (1976) developed a two-sector model in which asset market prices adjusted faster than goods market prices leading to the exchange rate overshooting its equilibrium level in response to a shock in the system. However, when allowing for short-term adjustments in output, he showed the possibility of the exchange rate undershooting its equilibrium level. Obstfeld (1986) reminds us that, even with fix-flex prices, exchange rate theory gives no unambiguous predictions about overshooting. Additionally, he warns against "sweeping assertions that flexible prices necessarily overshoot in economies where some prices are rigid in the short run. Even if...the exchange rate overshoots in response to some shock, empirical analysis would be needed to establish whether agricultural prices do the same." Stamoulis and Rausser (1988, p. 165) also recognize that the question of overshooting agricultural prices must be answered empirically.

Whether or not agricultural prices overshoot causing agricultural exports to decline relative to nonagricultural exports as a result of monetary shocks and exchange rate movements is an empirical question. Although several studies have found a relationship between exchange rates and domestic agricultural and nonagricultural prices, and others between exchange rates and agricultural exports, strong empirical support for the overshooting hypothesis for agriculture is lacking (Stamoulis and Rausser 1988, p. 185). As the overshooting hypothesis is one of relative effects, curiously no one has looked at the relative effects of monetary policy, fiscal policy, and exchange rates on agricultural and nonagricultural exports.

This paper reviews the empirical evidence for or against macroeconomic effects on agriculture. Next, a seven-variable macroeconomic-agricultural vector autoregression (VAR) system is presented and used to test the relative effects of macroeconomic shocks on the growth of agricultural and nonagricultural exports. Finally, conclusions are drawn.

Empirical Literature

Prior to Chambers and Just (1981), few if any empirical studies supported Shuh's exchange rate hypothesis (e.g., Greenshields 1974; Johnson et al. 1977). Using SDR's (special drawing rights) as a proxy for the exchange rate, Chambers and Just concluded they had found significant support for Shuh's hypothesis based on their structural model and its reduced form.[1]

As an exchange rate is a monetary variable, other researchers hypothesized that the exchange rate was only one and perhaps not the most important avenue for monetary effects on agriculture. Batten and Belongia (1986) found exchange rates to be an important determinant of agricultural trade flows but not as important as income effects of importing countries. Chambers (1984) using a VAR found a connection between the money supply (M1) and net agricultural exports. Orden (1986) expanded Chamber's analysis to include additional monetary variables (money supply (M1), the real interest rate, the exchange rate and the general price level) and found that the exchange rate and the interest rate

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[1]Only one of three parameter estimates on SDR's in the three export equations in the structural model had a standard error less than half the size of the parameter. Of the three export equations in the reduced-form model, none of the parameter estimates on SDR's had standard errors less than half its size.

explained the largest proportion of forecast-error variance for agricultural exports. Others (e.g., Bessler and Babula 1987) found little support that exchange rates determined agricultural export flows.

Several studies looked at the effects of money supply changes on agriculture. Noted among these are Barnett et al. (1981), Chambers (1981), Orden (1986), and Saunders (1987). Barnett et al. found strong evidence that the money supply had causality effects on agricultural prices although Saunders, updating their study and changing the lag length of the variables, found no causal relationship between money supply and agricultural farm prices. Chambers found a causal relationship between money supply and net agricultural exports, and Orden found a small but persistent effect of a money supply innovation on agricultural prices but not on agricultural exports.

Recent literature on macroeconomic linkages to agriculture stresses fixprice-flexprice models such as those based on Hicks (1974). These studies include those by Bessler (1984), Chambers (1984), Devados and Meyers (1987), and Jabara and Schwartz (1987). Hicks' argument was that some markets are flexprice (prices determined by supply and demand) while others are fixprice (those not directly or instantaneously determined by supply and demand). Although both sectors are characterized by stocks, in fixprice markets actual stocks may be greater (or less) than desired stocks; in the flexprice sector, actual stocks always equal desired stocks. It is the accumulation of undesired stocks that buffers the fixprice markets from supply-and-demand conditions. In flexprice markets, since undesired (desired) stocks are released (absorbed), their prices may fall (rise) more than would be the case without transactions involving stocks. The costs of holding stocks are important in the decision to hold, accumulate or sell stocks in flexprice markets, and these costs are greatly influenced by the interest rate. Note that fixprices are not necessarily fixed as they can indeed go up or down and are generally influenced by the prices of flexprice goods.[2]

Of the four studies mentioned directly above, only Devados and Meyers 1987 found evidence that agricultural prices responded more than nonagricultural prices to monetary shocks. Chambers did not include nonagricultural prices in his model so did not test relative flexibility between agricultural and nonagricultural prices. Bessler with Brazilian data rejected that agricultural prices adjusted faster

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[2]Hicks (p. 29) suggested that, with flexible exchange rates, "foreign goods as a whole become flexprice, not fixprice, goods".

than nonagricultural prices to monetary shocks. Using Japanese data, Jabara and Schwartz (p. 589) concluded, based on their results, that "agricultural commodity prices may not be as flexible as commonly perceived."

Empirical Analysis

As stated above, no empirical evidence strongly supports the overshooting hypothesis for agriculture. The paucity of empirical studies that test this hypothesis for agriculture is striking. To date no studies have attempted to test the relative effects of exchange rate, monetary, and fiscal shocks on agricultural and nonagricultural exports.

The analysis that follows is based on monetary theory and a seven variable VAR system. The data are quarterly starting from the first quarter of 1971 and ending in the third quarter of 1988. The five macroeconomic variables are the three-month average of real interest rates (i) for U.S. Treasury Bills, change in real gross national product ($G\dot{N}P$) deflated by the change in the Personal Consumption Expenditure Index (PCE), the real trade-weighted exchange rate (e) U.S. versus the world, change in the money supply ($\dot{m}$), and the balance of the Federal budget divided by nominal GNP (F). The other two variables are growth in agricultural ($A^{\cdot}X$) and nonagricultural exports ($N^{\cdot}X$). Data on $G\dot{N}P$, i, F, $A^{\cdot}X$ and $N^{\cdot}X$ are from the U.S. Department of Commerce, <u>Survey of Current Business</u> and <u>U.S. Business Statistics</u>, various issues. $\dot{m}$ is the monetary base (i.e. growth in the money in circulation adjusted for current reserve requirements of banks) from the Federal Reserve Bank of St. Louis. The real exchange rate (e) was obtained from the Federal Reserve Bank of Dallas. All variables are lagged five periods.

VAR analysis is generally well-known with canned programs such as RATS available for analysis on microcomputers (Doan and Litterman 1984). Due to space limitation, readers unfamiliar with or interested in VAR methodological and technical issues are referred to either Bessler (1984), Ford (1986), or Orden (1986).

Our particular model is estimated under the following ordering: F, $\dot{m}$, i, $G\dot{N}P$, e, $N^{\cdot}X$, and $A^{\cdot}X$. Except for placing F first, our ordering follows from usual monetary theory. By placing F first, we are suggesting that fiscal policy has causal effects on how the Federal Reserve Bank (FEDS) acts, i.e. on the money supply. A loose fiscal policy (spending more than tax revenues) would put pressure on the FEDS to tighten money supply growth. If $\dot{m}$ actually decreases, this will cause interest rates to increase which in turn causes growth in G$\dot{N}$P to decline. The rise in i puts upward pressure on the exchange rate (foreign currency/domestic currency) although a fall in G$\dot{N}$P puts downward pressure on e.[3] Assuming e rises and overshoots its equilibrium level, this puts downward pressure on both $A^{\bullet}X$ and $N^{\bullet}X$. According to the overshooting hypothesis for agriculture, $A^{\bullet}X$ should decrease relative to $N^{\bullet}X$ when e appreciates and increase relative to $N^{\bullet}X$ when e depreciates.

As typical of VAR, each of the seven variables was regressed on their lagged values and all other lagged variables in the system. Granger causality tests results are reported in Table 1. This test restricts a set of parameter estimates to be zero and compares sums of squared errors between the restricted and nonrestricted model. Test values 2.59 or above show that the restricted variables added explanatory power for the variability of the current variable (left-hand variable) over and beyond that of the other included variables. Results show that F, i, G$\dot{N}$P, and $A^{\bullet}X$ have significant effects on F, although F is not shown to have an effect on these variables. G$\dot{N}$P affects $\dot{m}$ but $\dot{m}$ does not affect G$\dot{N}$P. Real interest rates are affected by $\dot{m}$, i, and G$\dot{N}$P but not vice versa. Exchange rates are strongly affected by past exchange rates but by no other variables. No strong effects by any system variables are found to significantly affect $N^{\bullet}X$ or $A^{\bullet}X$.

In addition to Granger Causality tests, one can also test whether two or more sets of lagged variables significantly added explanatory power over the other included sets of lagged variables. To tests for the effects of macroeconomic variables as a whole on growth of nonagricultural and agricultural exports, the parameters on all macroeconomic variables were restricted to zero in the two equations for $N^{\bullet}X$ and $A^{\bullet}X$. The results clearly indicate that the macroeconomic variables had no additional significant explanatory power for $N^{\bullet}X$ or $A^{\bullet}X$ over past values of $N^{\bullet}X$ and $A^{\bullet}X$. The F-values for both $N^{\bullet}X$ (0.91) and $A^{\bullet}X$ (0.57) are much smaller that the critical F-value (α = .05) of 1.99. Thus the null hypothesis that all parameters on macroeconomic variables are zero can not be rejected at any conventional probability level.

[3]As Chambers (1984) points out, the rise in i also increases storage costs which encourages a release of stocks and an increase in agricultural exports. However the same may hold for nonagricultural stocks and exports.

Table 1. Granger causality tests results from a seven-variable macroeconomic-agricultural VAR, 1972:2-1988:2.

Lagged variables	Current variables						
	F	$\dot{m}$	i'	$G\dot{N}P$	e	N'X	A'X
F	6.95**	1.73	.96	.75	.40	.81	.37
$\dot{m}$	1.05	1.61	2.65*	1.22	.53	1.25	.43
i	2.75*	2.22	27.35	1.68	1.05	.34	.13
$G\dot{N}P$	3.82**	2.60*	3.73*	.23	.77	.42	.80
e	2.54	1.12	1.07	.78	78.71**	1.6	.46
N'X	1.63	2.17	1.82	2.21	.42	.98	1.27
A'X	3.13*	.54	.38	1.28	1.11	1.15	.85

* Test value is above critical value for $\alpha = .05$ showing evidence that parameters of this group are not all equal to zero.

** Test value is above critical value for $\alpha = .01$ showing strong evidence that parameters in this group are not all equal to zero.

Impulse-response analysis shows the effects on the system from an exogenous shock to one of the system's variables (Ford 1986). The analysis is based on a moving average transformation of the VAR model, and the effects of a shock to the system are traced out through time by comparing the model's shocked time path to that of the expected unshocked time path. Impulse-response analysis was performed where the size of the shock in all cases was one-standard deviation of the variable being shocked. Further, the effects of the exogenous shocks can be decomposed and the portions of the forecast variance can be attributed to particular variables in the system. The results of the decomposition analysis is reported in Table 2.

In all cases, most of the forecast-error variances (FEV) in the first period were explained by own-shock innovations. This was particularly true for F, $\dot{m}$, GNP, e, and N'X, where over 90 percent of the FEV of these variables in the first period was due to own-shocks. Own-shocks in i explained almost 75 percent of its FEV while that of A'X explained almost 66 percent. Although own-shocks explained relatively less of A'X's FEV than that of the other variables in the first period, by the 24th quarter own-shocks in A'X explained relatively more of its FEV than own-shocks did for all other variables except $\dot{m}$.

In the first four periods, FEV of N'X was mostly explained its own shocks, with A'X explaining the next largest proportion. By the 24th quarter, innovations in N'X still explained over one-third of its FEV followed by 17 percent for $\dot{m}$, 14 percent for i, and 11 percent for A'X.

Except for F, innovations in the macroeconomic variables explained little of the FEV of A'X. The proportion explained by F remained relatively steady throughout all 24 periods at about 11 percent. All other innovations in macroeconomic variables explained less than 10 percent of FEV of A'X except for $\dot{m}$ (11 percent) starting in period 17 (not reported in Table 2). Innovations in N'X explained approximately 13 percent of A'X's FEV in period one and just over 20 percent in the 24th quarter.

Finally, step-response functions were calculated for all seven system variables. Step-response functions show the response of endogenous variables to a one time, permanent change in the system and are obtained by summing impulse responses over a designated number of time periods (24 quarters in our case). Further, to show the relative effects on N'X and A'X of exogenous shocks to the

Table 2. Summary results of decomposition analysis from a seven-variable macroeconomic-agricultural VAR, 1972:2-1988:2.

Forecast error in	Period	Triangularized innovations						
		F	$\dot{m}$	i	$G\dot{N}P$	e	N•X	A•X
F	1	100.0[a]	.0	.0	.0	.0	.0	.0
	2	56.5	.2	10.5	7.3	10.5	3.9	11.1
	3	38.2	4.7	7.2	20.0	15.7	3.1	11.0
	4	31.5	6.4	5.9	17.9	21.4	2.9	14.0
	8	23.4	6.9	10.3	14.1	26.1	5.9	13.3
	16	14.0	14.4	21.6	17.3	15.9	5.6	11.2
	24	13.1	15.4	20.7	17.2	14.5	9.5	9.7
$\dot{m}$	1	4.9	95.1	.0	.0	.0	.0	.0
	2	8.0	67.0	.3	18.1	6.2	.1	.4
	3	18.2	51.9	1.9	17.5	6.2	.2	4.1
	4	16.0	46.5	3.5	15.5	5.6	1.3	11.5
	8	13.4	43.8	4.4	17.2	6.1	3.6	11.5
	16	13.8	42.6	4.8	17.3	5.8	3.6	12.1
	24	14.0	42.5	5.0	16.9	5.8	3.7	12.1
i	1	14.8	10.7	74.5	.0	.0	.0	.0
	2	20.2	8.7	59.3	9.5	2.0	.0	.1
	3	12.0	6.3	44.5	25.9	8.0	.2	3.1
	4	8.6	4.4	41.3	28.8	6.6	.2	10.2
	8	5.7	14.7	36.2	25.4	8.1	1.0	8.9
	16	6.7	20.9	29.8	19.3	10.2	5.5	7.7
	24	6.2	20.3	27.8	19.0	13.9	5.3	7.4
$G\dot{N}P$	1	2.3	3.4	.4	93.8	.0	.0	.0
	2	10.0	2.6	6.3	65.3	.1	12.5	3.2
	3	17.3	4.4	9.0	50.0	3.7	10.6	5.2
	4	13.9	3.3	10.6	39.0	6.0	8.8	18.5
	8	14.8	5.1	9.9	39.7	5.8	7.3	17.3
	16	13.5	9.2	9.3	35.9	6.9	8.9	16.2
	24	13.4	9.9	9.3	35.6	7.0	8.8	16.2
e	1	.3	7.3	.2	.6	91.6	.0	.0
	2	.7	12.0	.1	3.8	81.2	.6	1.5
	3	.5	12.5	.1	8.9	74.5	.4	3.3
	4	.5	15.0	.5	11.0	69.6	.3	3.1
	8	.8	14.0	1.8	23.2	55.4	1.6	2.0
	16	.9	9.3	10.8	32.6	36.1	7.9	2.5
	24	1.4	11.5	14.8	29.3	29.5	10.5	3.1
N•X	1	1.6	1.2	.1	4.2	.0	92.9	.0
	2	6.6	2.9	2.5	3.3	.6	71.7	12.3
	3	6.0	3.7	4.7	3.3	5.3	65.1	11.9
	4	7.4	4.8	4.5	3.4	5.6	62.7	11.6
	8	10.0	10.5	11.5	4.6	5.8	46.3	11.3
	16	8.6	17.2	13.7	4.8	9.1	36.0	10.6
	24	8.8	17.4	13.7	4.8	9.2	35.6	10.5
A•X	1	12.0	3.4	.3	1.6	3.5	13.1	66.0
	2	10.7	7.1	.3	1.7	6.6	16.5	57.1
	3	10.7	6.5	1.8	1.5	7.0	16.0	56.5
	4	10.2	6.3	1.8	3.1	7.7	17.4	53.6
	8	10.8	7.0	4.0	2.8	9.1	21.2	45.2
	16	10.5	10.5	5.6	2.6	8.8	20.9	41.0
	24	10.5	10.9	5.6	3.0	8.8	20.7	40.4

[a]Values indicate percentages of forecast error variance.

system's variables, their step response functions were normalized by division of the size of the variance error at period one. Results of shocks to F, $\dot{m}$, i, and e on N^*X and A^*X are shown in Figures 1-4. Growth in agricultural exports reacted more negatively to the total effect of a one-time shock to F than did growth in nonagricultural exports (Figure 1), with N^*X reacting positively in the first period before reacting negatively (but never by a larger percentage than A^*X). For a one-time shock in $\dot{m}$, particularly in the short run, N^*X reacted more than A^*X (Figure 2). A^*X reacts more negatively in period one and then positively for the next seven periods before responding negatively thereafter. N^*X responds positively from period one through 13 before responding negatively. Although the lasting effect to A^*X is slightly more negative than that of N^*X, in the short run, N^*X respond more than did A^*X to a shock in $\dot{m}$. In response to a one-time shock in i, A^*X and N^*X responded similarly in the first eight quarters (Figure 3). Thereafter, the negative effect on N^*X is consistently more than that on A^*X. Finally, to the question of whether or not shocks in e caused A^*X to overreact relative to N^*X, the answer is clearly that they did not (see Figure 4). In the first 11 quarters, there is essentially no appreciable difference in the short-run reaction of N^*X and A^*X to a one-time permanent exogenous shock to e. By period 11, almost all the effects to A^*X have dissipated while those of N^*X turned positive and continued to grow positively at a decreasing rate.

Conclusions

A seven variable (five macroeconomic variables and growth in nonagricultural and agricultural exports) VAR system was used to empirically test the overshooting hypothesis that monetary variables such as the money supply and exchange rates affect growth in agricultural exports relatively more than growth in nonagricultural exports. Granger causality tests showed no significant effect of macroeconomic variables on the growth of agricultural or nonagricultural exports. Additionally, F-tests showed that the macroeconomic variables taken as a whole did not significantly add to the explanatory power of the variability in growth of agricultural or nonagricultural exports over the explanatory power of these variables themselves.

Decomposition analysis as well as step-response functions showed that growth in agriculture exports did not respond to shocks in monetary variables more than nonagricultural exports. In fact, it was growth in nonagricultural exports that was relatively more sensitive to shocks in the money supply,

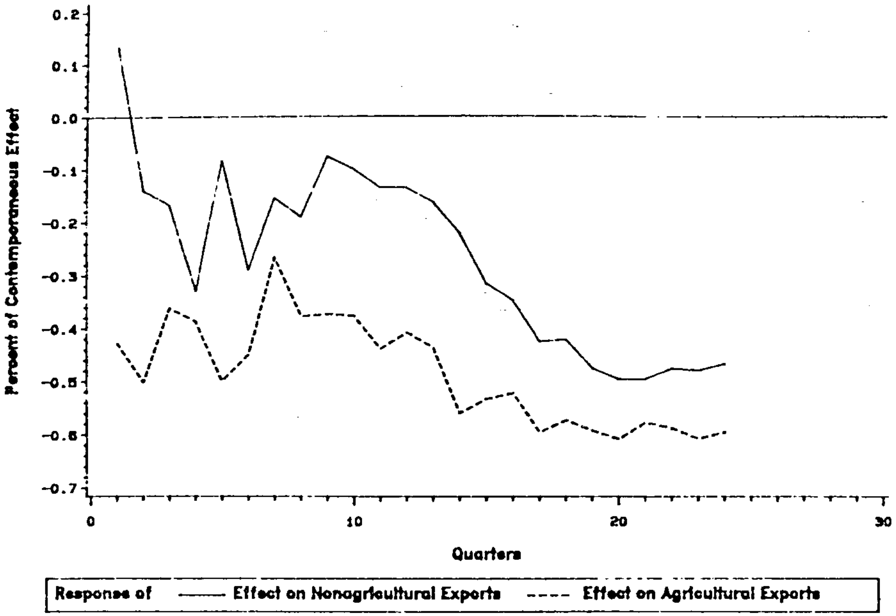

Figure 1: Total Effect of Fiscal Shock on Exports

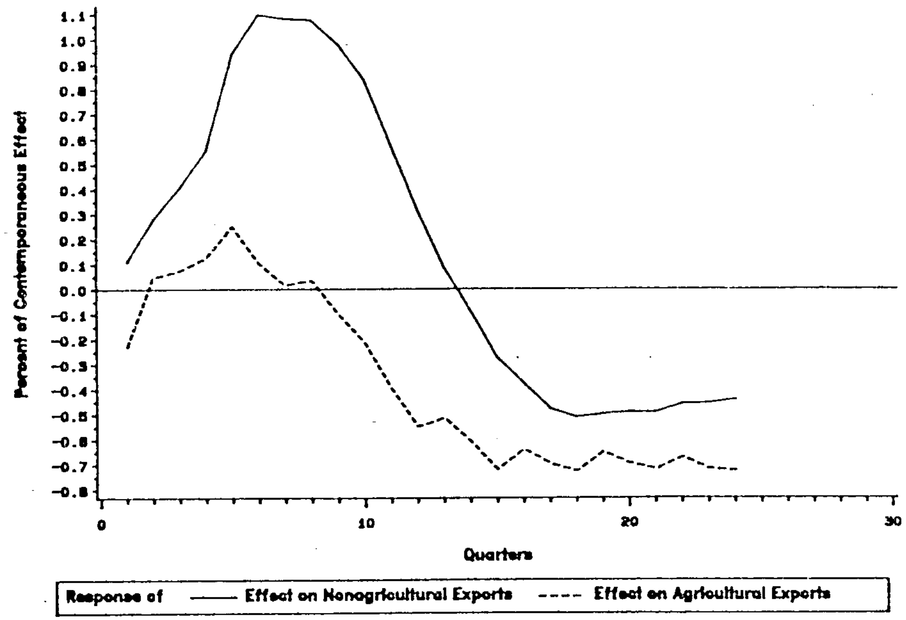

Figure 2: Total Effect of Monetary Shock on Exports

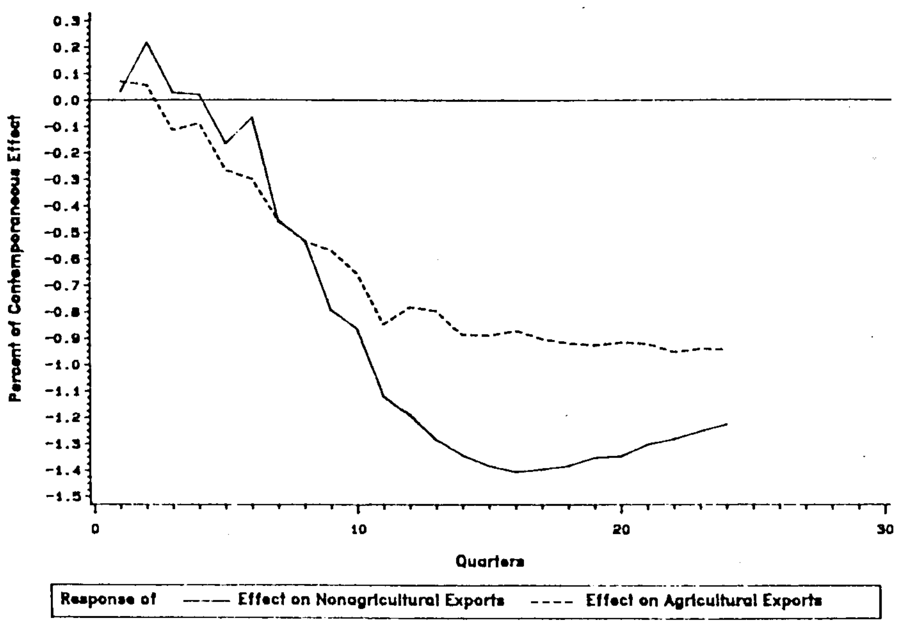

Figure 3: Total Effect of Interest Shock on Exports

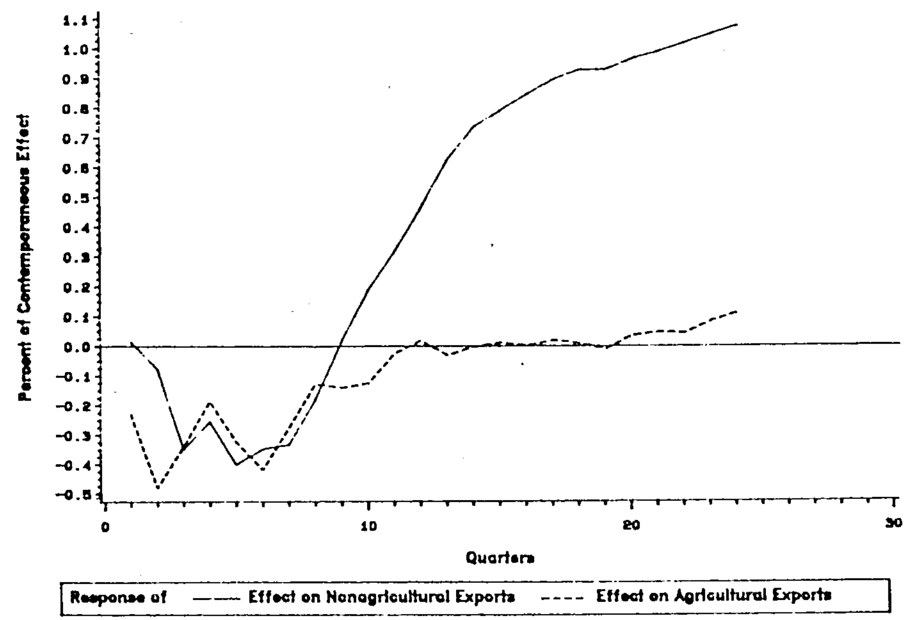

Figure 4: Total Effect of Exchange Rate Shock on Exports

interest rates and exchange rates. For shocks in fiscal policy, growth in agricultural exports was relatively more sensitive.

Based on the results of this paper and those of the more recent empirical literature on flexprice-fixprice economies and the overshooting hypothesis for agriculture, we want to echo those warnings by Obstfeld. Unless growth in agricultural exports does indeed react more negatively (positively) to exchange rate appreciations (depreciations) than does growth in nonagricultural exports, caution should be used when interpreting results of models that are based on the flexprice-fixprice or overshooting hypotheses for agriculture.

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