Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA

AN INVESTIGATION OF THE EFFECT OF
MONETARY FACTORS ON AGRICULTURE

Robert G. Chambers and Richard E. Just

AN INVESTIGATION OF THE EFFECT OF MONETARY FACTORS ON AGRICULTURE

by

Robert G. Chambers and Richard E. Just*

AN INVESTIGATION OF THE EFFECT OF MONETARY FACTORS ON AGRICULTURE

I. Introduction

Since the appearance of Schuh's (1974) paper on the effect of exchange rates on the agricultural sector of the economy, there has been a heightened interest in the impact of monetary factors on agriculture. At the same time, the monetary approach to the balance of payments and exchange rate determination has received increasing attention in the international economics literature. To date, however, very few attempts (e.g., Shei, 1978) have been made to incorporate the theoretical concepts of the monetary approach into empirical models of agricultural activity. The purpose of this paper is to construct an econometric model that recognizes this linkage specifically. The model is then subjected to simulation analysis to determine the effect of key monetary variables on the agricultural sector. It is found that the impacts of movements of such monetary variables as the interest rate and the level of the money supply on the agricultural sector can be quite significant. For instance, the results suggest that the dynamic response of agricultural prices and exports to a decrease in the money supply is eventually elastic. Further, it is found that such antiinflationary policies as a contraction of the money supply could seriously affect the competitive position of the U. S. agricultural sector in the world market.

II. The Model

The econometric model developed in this paper is a three-block recursive model. The agricultural block contains models of the wheat, corn, and soybean markets. The aggregate export block contains a model of the current

account net of the value of wheat, corn, and soybean exports. The final block is a reduced-form model of exchange rate determination.

The exchange rate determination model is based on the fundamental hypothesis that the balance of payments is a major determinant of the exchange rate. There are at least four basic theoretical approaches to the analysis of the balance of payments: the elasticities approach, the Keynesian multiplier approach, the absorption approach, and the monetary approach. The first three approaches treat the balance of payments as a real phenomenon and focus attention on the balance of trade (i.e., balance on current account) while the monetary approach emphasizes that the balance of payments is essentially a monetary phenomenon and should be analyzed as such. The monetary approach is of primary importance here since this paper focuses on the effect of monetary variables on the agricultural sector. The model developed below, however, is sufficiently general to recognize the impact that nonmonetary variables have on exchange rate determination.

III. The Agricultural Model¹

The agricultural model consists of separate market blocks for the wheat, corn, and soybean markets. Since the market model for each commodity has essentially the same structure, a brief exposition of the general model used in each case suffices.

Domestic Disappearance

The general domestic disappearance equation is

$$D_t = D(P_t, M_t, POP_t, Z_t), \quad (1)$$

where D_t is domestic disappearance at time t , P_t is a vector of prices

at time t , M_t is income at time t , POP_t is population at time t , and Z_t is a vector of other predetermined variables that affect disappearance.

Inventories

Inventories are hypothesized to have a direct relationship with the market price and population that can be expressed as

$$I_t = I(P_t, POP_t), \quad (2)$$

where I_t is inventory at time t and P_t is own market price at time t .

It is assumed that $\partial I_t / \partial P_t < 0$.

Exports

The agricultural export demand functions, the specification of which has been discussed elsewhere by Chambers and Just (in press), follow:

$$X_t = X(Ee_t, EP_t, M_t^*), \quad (3)$$

where Ee_t is the expected exchange rate, EP_t is the expected market price of the commodity and M_t^* is a variable(s) reflecting international market conditions. Expectations are represented by distributed lag structures in the estimated model.

Production

The production equation, based on work done by Houck and Ryan (1972), is

$$PR_t = PR(SP_t, LP_t), \quad (4)$$

where PR_t is production at time t , SP_t is the support price, and LP_t is the average price of the commodity for the previous year. To account for the quarterly nature of the model, an indicator variable is utilized so that the effective production equation is

$$\delta PR_t = \delta PR (SP_t, LP_t), \quad (5)$$

where $\delta = 1$ for the quarter when harvest occurs and $\delta = 0$ otherwise. Using this procedure allows for systems estimation of the production equation.

Price Determination

The identity which closes the system equates total supply with total disappearance:

$$D_t + X_t + I_t = PR_t + I_{t-1}. \quad (6)$$

Price is, of course, determined implicitly by this identity. However, since the domestic disappearance equations are most appropriately estimated in per capita terms, thus introducing a significant nonlinearity into the system, a specific price determination equation obtained (in principle) by solving (6) is used. In general, the resulting equation is of the form

$$P_t = P (Ee_t, POP_t, M_t, M_t^*, Z_t). \quad (7)$$

IV. Exchange Rate Determination

As suggested above, the exchange rate determination model basically follows the monetarist approach. The fundamental assumption of the model is that the exchange rate responds to disequilibrium in the balance of payments. To explain why it does not move to clear the balance of payments, it should be noted that, at present, the floating rate regime is characterized by regulated floating of rates with governmental policy playing a key role in exchange rate determination. Specifically, suppose that the national government has at every point in time some desired level for the exchange rate that is a function of the overall balance of payment⁵, i.e.,

$$De_t = h (BOP_t), \quad (8)$$

where De_t is the desired exchange rate at time t . To relate the unobservable desired exchange rate to observable phenomena, a Nerlovian partial adjustment process may be specified to obtain

$$\Delta e_t = bh (BOP_t) - be_{t-1} \quad (9)$$

where b is the factor of adjustment.

To complete the model of exchange rate determination, equation (2) is integrated into a modified version of a model originally suggested by Kouri and Porter (1974).² The model can be written as:

$$r_t = r (C_t, r_t^d) \quad (10)$$

$$M_t^d = M^d (r_t, M_t, \tilde{P}_t) \quad (11)$$

$$BOP_t = BOC_t + C_t = \Delta R_t \quad (12)$$

$$M_t^S = D_t + R_t \quad (13)$$

$$M_t^S = M_t^d \quad (14)$$

$$\Delta e_t = bh (BOP_t) - be_{t-1} \quad (15)$$

where

r_t = market rate of interest

C_t = balance on capital account

r_t^d = discount rate

M_t^d = money demand

R_t = international reserves

$\tilde{P}_t$ = general price level

M_t = income.

Equation (10) hypothesizes that the market rate of interest is determined by the level of the capital account and governmental policy as reflected by the discount rate. Equation (11) is a simple money demand function which hypothesizes that money demanded at time t is a function of the general price level, the market rate of interest, and income. The latter is essentially identical in nature, though not necessarily in functional form, to money demand functions specified in Fränkel (1976) and Magee (1976).³ Equation (12) is a reflection of the accounting identity between the change in reserves and the components of the balance of payments. Equation (13) recognizes the two components of the money supply—domestic credit creation (D) and international reserves (R). As was originally intended by Kouri and Porter (1974), this model is used to provide an explanation of international capital movement and, as such, C_t is considered as endogenous while BOC_t and, indeed, the whole real portion of the economy (therefore, $\tilde{P}_t$ and M_t) are considered as exogenous.

The jointly dependent variables of the exchange rate model are M^d , M^s , R , D , r , and e . Since the actual coefficients of the money demand relationship and the interest rate equation are of little intrinsic interest in the present study, the model, as outlined above, can be solved to obtain a reduced form expression for the exchange rate,

$$\Delta e_t = h^1 (BOC_t, D_t, \tilde{P}_t, r_t^r, e_{t-1}, M_t). \quad (16)$$

Since the topic of interest in the present study is not the money market per se but, rather, the money market's effect on the exchange rate and on the agricultural portion of the model, this reduced form of the model adequately captures the effects of interest in the context of the model in (10) through (15).

V. Aggregate Exports

The aggregate export block of the model consists of two behavioral equations and an identity. The two equations apply to the nonagricultural balance of trade and the nongrain balance of trade. The nongrain balance of trade is defined as the balance of trade for all agricultural goods and services exclusive of wheat, corn, and soybeans. These quantities are then related to the overall balance on current account by an identity.

The equation for the nonagricultural balance of trade is a straightforward extension of empirical models developed by Prachowny (1969), Leamer and Stern (1976), and Rhomberg and Boisseneault (1965); thus, little further explanation is given here. The equation can be written as

$$BNA_t = BNA (P_t, Ee_t, M_t), \quad (17)$$

where BNA_t is the balance of nonagricultural trade, P_t is the general price level in the United States, M_t is U. S. income, and Ee_t is the expected exchange rate at time t .

Similarly, the model for the balance of nongrain trade can be written as

$$BNG_t = BNG (PF_t Ee_t, M_t), \quad (18)$$

where BNG_t is the balance of nongrain trade and PF_t is the price level of agricultural commodities. The identity that closes the system is

$$BOC_t = BNA_t + BNG_t + NGX_t, \quad (19)$$

where BOC_t is the balance on current account and NGX_t is the value of net exports of wheat, corn, and soybeans.

VI. Structural Estimates of the Agricultural Model

The model is estimated using quarterly U. S. data for 1969 through mid-1977. Two-stage least-squares (2SLS) methods were selected so as to reduce vulnerability to structural misspecification. The results are presented in table 1. The model as a whole appears to fit quite well as evidenced by the associated R^2 statistics. The signs of all coefficients correspond to *a priori* expectations with the *possible* exception of the income variable in the wheat disappearance equation.

VII. Reduced-Form Estimates of Agricultural Model

The 2SLS-derived reduced-form estimates for the disappearance and inventory equations are reported in table 2. (The derived reduced-form equations for price, exports, and production are identical to those reported in table 1.)

VIII. The Exchange Rate and Aggregate Exports Model

The exchange rate block was estimated by ordinary least squares (OLS), and the aggregate export block was estimated by Zellner's seemingly unrelated regression (SUR) method using quarterly data for 1969 through mid-1977. The exchange rate model was estimated as an inverted V lag function

Table 1. Structural Estimates of the Agricultural Model^a

$$(1) \quad PWD_t = .5903 - .0331 WP_t + .1745 PWDL_t + .7218 FALL_t + .2480 SPR_t + .1830 WINT_t - .00995 PDI_t$$

(3.05) (-1.79) (1.07) (11.32) (4.93) (2.05) (-.37)

[-.0999]

$$R^2 = .85 \quad D.W. = 1.87$$

$$(2) \quad PCD_t = 3.9193 - .0972 CP_t + .0867 PCDL_t + 1.8382 WINT_t - .3890 FALL_t + 1.3353 SPR_t$$

(3.62) (-.58) (.49) (3.67) (-.90) (3.63)

[-.041]

$$R^2 = .58 \quad D.W. = 1.93$$

$$(3) \quad PSD_t = 1.0095 - .0151 SP_t - .1281 PSDL_t - .4642 FALL_t + .2676 WINT_t + .1201 SPR_t + .0410 PDI_t$$

(4.88) (.75) (-.72) (-6.49) (2.19) (1.53) (.89)

[-.074]

$$R^2 = .80 \quad D.W. = 1.94$$

$$(4) \quad PWI_t = -.3700 - .1238 WP_t + .8112 PWIL_t + 6.9271 FALL_t + .3286 WINT_t + .1520 SPR_t$$

(.38) (-.98) (5.72) (19.84) (.50) (.39)

[-.059]

$$R^2 = .95 \quad D.W. = 1.50$$

$$(5) \quad PCI_t = 2.8954 - .7761 CP_t + .5280 PCIL_t - 2.1634 FALL_t + 17.7171 WINT_t + 1.6958 SPR_t$$

(1.22) (-2.57) (3.84) (-2.34) (11.41) (1.58)

[-.136]

$$R^2 = .97 \quad D.W. = 1.90$$

(Continued on next page.)

TABLE 1--continued.

$$(6) \quad \text{PSI}_t = -.6163 - .0124 \text{SP}_t + .7374 \text{PSIL}_t + .2693 \text{FALL}_t + 4.9308 \text{WINT}_t + .2680 \text{SPR}_t$$

(1.39) (-.41) (6.32) (1.13) (15.39) (1.08)
 [-.023]

$$R^2 = .96 \quad \text{D.W. } 1.62$$

$$(7) \quad \text{WX}_t = 1069.227 + .1711 \text{WXL}_t - 25.5301 \text{WPL}_t - 168.3109 \text{SDRL}_t - 291.0083 \text{SDRL2}_t - 234.9038 \text{SDRL3}_t$$

(3.23) (.98) (-1.06) (-.323]

$$- .4224 \text{FREIGHT}_t - .3880 \text{THPW}_t - 3.9697 \text{WSTOCKW}_t + 2.8138 \text{FALL}_t + 30.5640 \text{WINT}_t$$

(-.13) (-.82) (-1.55) (.07) (1.16)

$$+ 8.3747 \text{SPR}_t + 40.4965 \text{DUMMYRW}_t$$

(.33) (1.25)

$$R^2 = .71 \quad \text{D.W. } = 1.89$$

$$(8) \quad \text{CX}_t = 1630.503 + .3023 \text{CXL}_t - 2.3973 \text{CPL}_t - 708.1718 \text{SDRL}_t - 438.3735 \text{SDRL2}_t - 230.4020 \text{SDRL3}_t$$

(2.53) (1.87) (-.06) [-.023]

$$- 84.2801 \text{SDRL4}_t - 3.6525 \text{FREIGHT}_t - 13.5047 \text{WSTOCKC}_t + 192.3354 \text{FALL}_t + 131.7562 \text{WINT}_t$$

(-1.41) (-1.98) (2.43) (2.65)

$$+ 93.5157 \text{SPR}_t$$

(2.01)

$$R^2 = .75 \quad \text{D.W. } = 1.92$$

(Continued on next page.)

TABLE 1--continued.

$$(9) \quad SX_t = 272.8937 + .3079 SXL_t - 2.8233 SPL_t - 49.0192 SDRL_t - 59.6700 SDRL2_t - 55.0504 SDRL3_t$$

(1.36) (1.90) (-.60) [-.116]

$$- 35.1534 SDRL4_t - .5238 FREIGHT + 1.3950 NONUSS - 35.4799 FALL_t + 62.5027 WINT_t$$

(-.45) (.19) (3.23) (4.33)

$$+ 5.7928$$

(.51)

$$R^2 = .71 \quad D.W. = 1.76$$

$$(10) \quad WPR_t = 4.5989 + 127.1766 WAP_t + 713.7696 WSP_t$$

(.23) (4.15) (14.95)

$$R^2 = .98 \quad D.W. = 2.00$$

$$(11) \quad CPR_t = .1004 + 269.4454 CAP_t + 3338.69$$

(.00) (2.48) (20.64)

$$R^2 = .99 \quad D.W. = 2.00$$

$$(12) \quad SBPR_t = .7833 + 55.2132 SAP_t + 463.7191 SSP_t$$

(.06) (3.97) (16.09)

$$R^2 = .99 \quad D.W. = 2.00$$

(Continued on next page.)

TABLE 1--continued.

$$(13) \quad WP_t = 6.8914 + .4226 WPL_t - 5.2904 SDRL_t + .3428 PWDL_t - .2318 PWIL_t + .1270 FALL_t$$

(2.88) (3.33) (-2.52) (.47) (-2.26) (.35)

[-1.786]

$$+ 1.2144 WINT_t + .8280 SPR_t + .2493 DUMMYRW_t - .0042 THPW_t + .0021 WXL_t$$

(2.17) (3.36) (1.01) (.99) (1.35)

$$R^2 = .92 \quad D.W. = 1.99$$

$$(14) \quad CP_t = 3.4480 + .6641 CPL_t - 3.4156 SDRL_t + .0634 PCDL_t + .2243 FALL_t + .0305 WINT_t + .0382 SPR_t$$

(3.44) (7.85) (-3.81) (1.44) (2.10) (.24) (.42)

[-1.511]

$$R^2 = .94 \quad D.W. = 1.94$$

$$(15) \quad SP_t = 6.5345 + .8584 SPL_t - 7.0344 SDRL_t + .2464 PSDL_t - .1229 PSIL_t + .0209 SXL_t + .0851 FALL_t$$

(1.20) (4.71) (-1.25) (.28) (-.31) (4.06) (.13)

[-1.341]

$$+ .1957 WINT_t - .6262 SPR_t - .0708 FREIGHT_t - .1719 NONUSS_t$$

(.16) (-.83) (-1.60) (.72)

$$R^2 = .87 \quad D.W. = 1.77$$

^aThe t statistics are reported in parentheses and elasticities in brackets.

Table 2. Reduced-Form Estimates of Agricultural Model and Estimates of Exchange Rate and Aggregate Export Models³

-
- (1) $PWD_t = .3614 + .1629 PWDL_t + .0077 PWIL_t - .0001 WXL_t - .0140 WPL_t - .0099 PDI_t$
 $+ .1758 SDRL_t + .7176 FALL_t + .1428 WINT_t + .2206 SPR_t + .0001 THPW_t - .0083 DUMMYRW_t$
 $[\text{.179}]$
- (2) $PCD_t = 3.5806 + .0804 PCDL_t - .0663 CPL_t + .3410 SDRL_t - .4111 FALL_t + 1.8351 WINT_t + 1.3314 SPR_t$
 $[\text{.064}]$
- (3) $PSD_t = .9044 - .1322 PSDL_t + .0019 PSIL_t - .0003 SXL_t - .0136 SPL_t + .0422 PDI_t + .1115 SDRL_t$
 $[\text{.104}]$
 $- .4655 FALL_t + .2641 WINT_t + .1298 SPR_t + .0011 FREIGHT_t + .0027 NONUSS_t$
- (4) $PWI_t = -1.2232 - .0423 PWDL_t + .8402 PWIL_t - .0003 WXL_t - .0521 WPL_t + .6524 SDRL_t + 6.9121 FALL_t$
 $[\text{.104}]$
- (5) $PCI_t = .2082 - .0489 PCDL_t + .5292 PCIL_t - .5122 CPL_t + 2.6344 SDRL_t - 2.3300 FALL_t + 17.7070 WINT_t$
 $[\text{.204}]$
 $+ 1.6578 SPR_t$
- (6) $PSI_t = -.6984 - .0028 PSDL_t + .7396 PSIL_t - .0002 SXL_t - .0098 SPL_t + .0804 SDRL_t + .2696 FALL_t$
 $[\text{.028}]$
 $+ 4.9310 WINT_t + .2743 SPR_t + .0008 FREIGHT_t + .0020 DUMMYRW_t$
-

(Continued on next page.)

Table 2--continued.

$$\begin{aligned}
 (7) \quad SDR_t = & .302515 + .723764 \, SDRL_t + .00000014 \, BOC_t + .00000028 \, BOCL_1 + .00000028 \, BOCL_2_t \\
 & [3.9898] \\
 & + .00000014 \, BOCL_3_t - .000457189 \, CREDIT_t - .00258441 \, RD_t + .00108307 \, WHSP_t + .00113492 \, DI_t \\
 & [1.80778] \quad [-.573982] \quad [1.65516] \quad [.712973] \\
 & + .0125208 \, FALL_t + .00820270 \, WINT_t - .0058055 \, SPR_t \\
 & [1.56556] \quad [1.04417] \quad [-.614378]
 \end{aligned}$$

$$R^2 = .9584973$$

$$\begin{aligned}
 (8) \quad BNA_t = & 1,2709.63 + .546426 \, BNAL_t - 8.987662 \, WHSP_t - 5.975050 \, DI_t - 6,931.58 \, SDRL_t \\
 & [1.4103] \quad [3.71174] \quad [-.1667] \quad [0.7371] \quad [-.9365] \\
 & - .569.328 \, FALL_t - 505.0467 \, WINT_t - 1,715.205 \, SPR_t \\
 & [-1.7981] \quad [-.6611] \quad [-2.0172]
 \end{aligned}$$

$$R^2 = .6227$$

$$\begin{aligned}
 (9) \quad BNG_t = & 1,112.640 + .0944370 \, BNGL_t - 5.4568 \, WHSPF_t + 1.296313 \, DI_t - 1,712.932 \, SDRL_t \\
 & [.48475] \quad [.58220] \quad [0.7062] \quad [1.2956] \quad [0.89277] \\
 & - 338.4915 \, FALL_t + 236.8159 \, WINT_t + 67.25294 \, SPR_t \\
 & [-2.159] \quad [1.4212] \quad [.4308]
 \end{aligned}$$

$$R^2 = .47632$$

$$\begin{aligned}
 (10) \quad BOC_t = & 1,3822.27 + .546426 \, BNAL_t + .0904337 \, BNGL_t - 8.987662 \, WHSP_t - 5.4568 \, WHSPF_t \\
 & - 4.684707 \, DI_t - 8,644.49 \, SDRL_t - 1,907.8195 \, FALL_t - 268.2308 \, WINT_t - 1,647.9521 \, SPR_t
 \end{aligned}$$

(Continued on next page.)

Table 2--continued.

Variable	Definition	Unit	Source
SDR_t	Special drawing rights/ dollar exchange rate		IFS
CREDIT	Domestic credit	billion dollars	
RD_t	Discount rate at New York Federal Reserve		BS, SCB
$WHSP_t$	Wholesale price index, 1967 = 100		BS, SCB
DI_t	Disposable income	billion dollars	BS, SCB
BOC_t	Balance on trade	billion dollars	BS, SCB
FALL, WINT, SPR	Seasonal indicators		
L indicates lag values, e.g., $SDRL_t = SDR_{t-1}$			

^aElasticities are reported in brackets.

Sources:

- IFS International Monetary Fund, International Financial Statistics. Washington, D. C., 1969-1977.
- BS U. S. Department of Commerce, Bureau of Economic Analysis, Business Statistics, 1969-1975.
- SCB _____. Bureau of Economic Analysis, Survey of Current Business, 1969-1977.

of the balance on current account. Several other lag structures were considered; but the present one provides the best statistical results consistent with theoretical considerations. The equation for the overall balance on current account was obtained by derived reduced form using the identity in (19) and the estimates of (17) and (18) given by SUR.

The estimated aggregate export model presumes that aggregate exports respond to the wholesale price level in the United States, foreign and domestic consumers' expectations about the exchange rates, and the level of income in the United States.⁴ All signs, with the possible exception of the income variable in the nongrain equation, conform to *a priori* theoretical expectations. Note, however, that the income variable in the equation for the overall balance on current account has the sign suggested by *a priori* theoretical reasoning. Although the results for the aggregate export sector are relatively poorer than those for either the exchange rate model or the agricultural model, it should be noted that such results are not unusual in studies of such an aggregate nature. Furthermore, the method of simulation employed below minimizes the importance of the relatively poor fit encountered in the aggregate export block.

IX. The Influence of Money Supply on the Agricultural Economy

To measure the importance of the linkage between the monetary and agricultural sectors, two simulations are undertaken. The results of the first, reported in table 3, examine the effect on the agricultural sector of a sustained 1 percent decrease in the money supply beginning in 1972 III. The results suggest significant impacts. For example, a relatively major impact of decreasing money supply is observed in the inventory variables for the agricultural blocks. By the end of the simulation period, per capita

TABLE 3

Effects of a Sustained Decrease in Money Supply by 1 Percent
Beginning in 1972 III

Period	Price			Inventories		
	Wheat	Corn	Soybeans	Wheat	Corn	Soybeans
	cents per bushel			bushels per person		
1972 III	0	0	0	0	0	0
IV	- 1.5	- 1.0	- 2.0	.002	.007	.001
1973 I	- 3.3	- 2.3	- 5.4	.006	.021	.001
II	- 5.2	- 3.7	- 9.9	.010	.039	.002
III	- 7.0	- 5.1	-15.3	.018	.060	.003
IV	- 8.1	- 6.3	-21.2	.025	.079	.005
1974 I	- 9.9	- 7.3	-27.3	.032	.099	.006
II	-11.1	- 8.2	-33.2	.039	.116	.009
III	-12.0	- 9.0	-38.7	.047	.130	.011
IV	-12.8	- 9.0	-43.6	.054	.142	.013
1975 I	-13.5	- 9.6	-47.9	.061	.153	.015
II	-14.1	-10.1	-51.6	.067	.163	.016
III	-14.5	-10.5	-54.7	.072	.169	.018
IV	-14.9	-10.9	-57.3	.077	.175	.021
1976 I	-15.3	-11.1	-59.6	.082	.180	.022
II	-15.6	-11.3	-61.4	.079	.184	.024
III	-15.9	-11.5	-63.0	.088	.186	.023
IV	-16.2	-11.7	-64.4	.091	.185	.025
1977 I	-16.4	-11.9	-65.6	.095	.194	.027
II	-16.8	-12.2	-66.8	.097	.188	.027
Maximum per- centage change	-7.0	-5.1	-13.7	2.7	10.1	2.1
Period	Exports			Disappearance		
	Wheat	Corn	Soybeans	Wheat	Corn	Soybeans
	million bushels			bushels per person		
1972 III	0	0	0	0	0	0
IV	- .5	- 2.0	- .1	.001	.001	.001
1973 I	- 1.3	- 5.2	- .4	.002	.002	.002
II	- 2.6	- 8.8	- .7	.002	.004	.002
III	- 3.8	-12.2	- 7.2	.003	.005	.002
IV	- 4.2	-14.9	- 1.3	.003	.007	.003
1974 I	- 4.6	-17.1	- 1.4	.004	.008	.004
II	- 4.9	-18.7	- 1.4	.005	.009	.005
III	- 5.1	-20.1	- 1.4	.005	.010	.005
IV	- 5.2	-21.2	- 1.3	.005	.010	.006
1975 I	- 5.3	-22.0	- 1.2	.006	.011	.005
II	- 5.5	-22.6	- 1.2	.006	.012	.007
III	- 5.5	-23.1	- 1.1	.006	.012	.008
IV	- 5.5	-23.5	- 1.0	.006	.012	.008
1976 I	- 5.5	-23.9	- .9	.006	.013	.008
II	- 5.5	-24.2	- .9	.007	.013	.009
III	- 5.5	-24.8	- .8	.006	.013	.009
IV	- 5.6	-24.7	- .8	.007	.012	.009
1977 I	- 5.6	-25.0	- .8	.007	.013	.009
II	- 5.7	-25.4	- .8	.007	.013	.010
Maximum per- centage change	-3.7	-9.7	-3.4	1.3	.4	2.1

(Continued on next page.)

Period	Production			
	Wheat	Corn	Soybeans	
	million bushels			
1973	- 3.2	- 8.1	- 4.5	
1974	-11.6	-20.6	-16.7	
1975	-16.5	-28.0	-27.3	
1976	-19.1	-30.7	-33.3	
Maximum percentage change	-.9	-.5	-2.6	
Period	Exchange rate	Nongrain agricultural balance of trade	Balance on current account	
	special drawing rights per dollar	million dollars		
1972 III	.0027	0	0	
IV	.0048	- 4.8	- 24.1	
1973 I	.0064	- 8.6	- 52.4	
II	.0076	-11.9	- 80.8	
III	.0086	-14.3	-106.0	
IV	.0093	-16.1	-126.5	
1974 I	.0099	-17.5	-143.8	
II	.0104	-18.7	-158.0	
III	.0108	-19.5	-169.2	
IV	.0111	-20.4	-178.5	
1975 I	.0113	-21.0	-185.5	
II	.0115	-21.4	-191.9	
III	.0116	-21.7	-196.0	
IV	.0117	-22.0	-199.7	
1976 I	.0119	-22.1	-202.9	
II	.0120	-22.5	-205.5	
III	.0122	-22.7	-207.9	
IV	.0123	-22.9	-210.3	
1977 I	.0125	-23.3	-212.9	
II	.0127	-23.8	-216.8	
Maximum percentage change	1.4			

inventories of wheat rise by 18 million bushels (.09 bushels per capita), corn inventories by 38 million bushels (.19 bushels per capita), and soybean inventories by 6 million bushels (.03 bushels per capita). Exports of these three commodities, on the other hand, are lower as a result of the upward pressure on the exchange rate. Corn exports, for instance, ranged as much as 25 million bushels lower while wheat and soybean exports responded relatively less--around 5 million bushels and 2 million bushels, respectively. Furthermore, the eventual increase in corn and wheat exports represents more than a 1 percent change; i.e., the dynamic response of the exports of these commodities appears to be elastic with regard to the money supply.

Turning to impacts on production, wheat impacts continue to grow until 1976--four years following the change in money supply--where production drops by about 20 million bushels or a little less than 1 percent. By 1976, both corn and soybean production fall by more than 30 million bushels as a result of the decrease in money supply.

Apparently, this response in production of these three crops can be linked directly to falling prices for the respective commodities. Wheat price falls as much as 17 cents per bushel, corn as much as 12 cents, and soybean price as much as 60 cents. All of these represent significantly more than 1 percent declines so that, again, the eventual response of the three agricultural commodity prices to a decrease in the money supply is elastic.

Turning to the aggregate export block and the exchange rate determination model, the decrease in the money supply causes the exchange rate to appreciate which, in turn, causes a downturn in the level of the balance of trade for nonagricultural items, nongrain items, and the current account in general. By the end of the sample period, the balance on current account

deteriorates by a little less than a half billion dollars while the balance of nongrain trade falls by approximately \$24 million . Hence, the simulated contraction of the money supply by appreciating the exchange rate worsens the competitive position of the United States in the world market. At the same time, there is a shift from exports to domestic consumption of the three agricultural commodities examined; the increase in domestic consumption, however, is not sufficient to compensate for the decrease in exports. Consequently, domestic agricultural prices are seriously deflated.

X. The Influence of Interest Rates on the Agricultural Economy

A similar investigation of the effects of varying interest rates in the general economy is reported in table 4. Response, however, appears to be less drastic for all agricultural commodities. For instance, wheat exports decline by, at most, 4 million bushels; corn, by 9 million bushels, and soybeans, by about 1 to 2 million bushels as a result of a sustained .5 percent decrease in interest rates. Correspondingly, prices are not affected as drastically and, as a result, production remains a good bit higher. The largest fall in prices is about 6 cents per bushel for wheat, about 4 cents per bushel for corn, and about 24 cents per bushel for soybeans. It should be noted that all of these represent a fairly inelastic response. While the exchange rate improves, as a result of the steady rise in demand for money following the fall in interest rates, the balance on current account steadily declines but not by as much as was the case for the decrease in the money supply. By the end of the simulation period, the level of the current account is about \$150 million lower than it was before the simulated fall in the interest rate, while the balance of nongrain trade falls by about

TABLE 4

21.

Effect of a Sustained Decrease in the Interest Rate by 1/2 Percent
Beginning in 1972 III

Period	Price			Inventories		
	Wheat	Corn	Soybeans	Wheat	Corn	Soybeans
	cents per bushel			bushels per person		
1972 III	0	0	0	0	0	0
IV	-.7	-.4	-.9	.001	.003	.0001
1973 I	-1.5	-1.1	-2.5	.003	.010	.0004
II	-2.4	-1.7	-4.6	.005	.017	.0008
III	-3.2	-2.3	-6.9	.008	.028	.001
IV	-3.8	-2.3	-9.5	.011	.036	.002
1974 I	-4.3	-2.8	-12.0	.014	.043	.003
II	-4.6	-3.2	-14.2	.017	.049	.004
III	-4.9	-3.5	-16.3	.020	.054	.005
IV	-5.1	-3.7	-18.0	.022	.058	.006
1975 I	-5.3	-3.9	-19.4	.025	.061	.006
II	-5.4	-4.0	-19.5	.026	.063	.007
III	-5.5	-4.0	-21.3	.028	.064	.008
IV	-5.6	-4.1	-21.9	.030	.066	.008
1976 I	-5.6	-4.1	-22.5	.031	.066	.009
II	-5.7	-4.2	-22.8	.032	.068	.009
III	-5.7	-4.2	-23.1	.033	.068	.010
IV	-5.7	-4.2	-23.3	.034	.067	.010
1977 I	-5.8	-4.2	-23.4	.034	.069	.010
II	-5.8	-4.2	-23.5	.035	.060	.010
Maximum percentage change	-2.4	-1.8	-5.1	1.0	3.8	.9

Period	Exports			Disappearance		
	Wheat	Corn	Soybeans	Wheat	Corn	Soybeans
	million bushels			bushels per person		
1972 III	0	0	0	0	0	0
IV	-.2	-.2	-.1	.001	.0004	.0001
1973 I	-.6	-1.4	-.2	.001	.001	.0003
II	-1.2	-4.1	-.4	.001	.002	.0006
III	-1.6	-5.5	-.5	.001	.002	.001
IV	-1.9	-6.6	-.6	.002	.003	.001
1974 I	-2.0	-7.3	-.6	.002	.004	.002
II	-2.1	-7.8	-.6	.002	.004	.002
III	-2.1	-8.2	-.5	.002	.004	.002
IV	-2.1	-8.4	-.5	.002	.004	.003
1975 I	-2.1	-8.5	-.5	.002	.004	.003
II	-2.0	-8.6	-.4	.002	.004	.003
III	-2.0	-8.6	-.4	.002	.004	.003
IV	-2.0	-8.6	-.3	.002	.004	.003
1976 I	-2.0	-8.7	-.3	.002	.004	.003
II	-2.0	-8.7	-.4	.003	.005	.003
III	-1.9	-8.7	-.3	.002	.005	.003
IV	-1.9	-8.6	-.3	.003	.005	.003
1977 I	-1.9	-8.6	-.3	.003	.005	.003
II	-1.9	-8.6	-.3	.003	.005	.003
Maximum percentage change	-1.3	-3.6	-1.5	.5	.2	.7

(Continued on next page.)

Table 4--continued.

Period	Production			
	Wheat	Corn	Soybeans	
	million bushels			
1973	-1.5	- 3.6	- 2.1	
1974	-4.5	- 8.8	- 7.2	
1975	-6.5	-10.7	-11.0	
1976	-7.0	-11.2	-12.5	
Maximum percentage change	-.3	-.2	-1.0	
Period	Exchange rate	Nongrain agricultural balance of trade	Balance on current account	
	special drawing rights per dollar	million dollars		
1972 III	.0012	0	0	
IV	.0022	-2.3	- 11.2	
1973 I	.0028	-4.0	- 24.3	
II	.0033	-5.1	- 36.3	
III	.0036	-6.3	- 46.7	
IV	.0038	-6.9	- 54.6	
1974 I	.0040	-7.3	- 60.5	
II	.0041	-7.6	- 64.6	
III	.0041	-7.7	- 67.4	
IV	.0041	-7.8	- 69.3	
1975 I	.0042	-7.8	- 70.4	
II	.0041	-7.9	- 71.2	
III	.0041	-8.0	- 71.8	
IV	.0041	-7.9	- 72.3	
1976 I	.0041	-7.9	- 72.1	
II	.0041	-7.9	- 72.2	
III	.0041	-7.9	- 72.1	
IV	.0042	-7.9	- 72.1	
1977 I	.0041	-7.9	- 72.0	
II	.0041	-7.9	- 72.0	
Maximum percentage change	.5			

\$8 million. The perceived interest rate effect, while relatively smaller than the effect of decreasing the money supply, is fairly significant.

XI. Conclusions and Implications

The foregoing simulation studies suggest some striking evidence about the largely unexplored relationship between the agricultural and monetary sectors. Noting that the exchange rate itself is a monetary variable and that previous studies such as Chambers and Just (in press); Konandreas, Bushnell, and Green (1978); and Fletcher, Just, and Schmitz (in press) show the importance of exchange rates for agriculture, it is clear that fluctuation in monetary variables affects the agricultural sector. While the results in this paper suggest that these effects can be large—indeed, elastic—one must bear in mind that the agricultural markets in this model are only linked to the monetary sector through the exchange rate determination process. With little doubt, the effects reported here would be magnified if other linkages were specified. For example, the level of the discount rate and the corresponding level of interest rates determine to a large extent the amount farmers borrow to finance either the purchase of new land and equipment or the actual planting of crops. Such effects, coupled with those noted through the exchange rate, may be too large to be ignored and may, in fact, magnify considerably the results obtained here.

The magnitude of the effects due to altering the money supply also suggests that policy action, such as open market operations and speculation in international currency markets, can have a heavy impact on the agricultural sector. In light of recent increasing manipulation of the money supply, these results raise some serious considerations regarding related effects on

price stability in the agricultural sector. Furthermore, the results suggest that the burden of restrictive monetary policy may be unusually great for agricultural producers. Ordinarily, one would expect such a policy to lead to a general decline in prices and, at least in the short run, to increased demand for products. Producers should, therefore, in the short run benefit from such action. The results of this paper indicate that, indeed, price does fall and that domestic demand rises; however, the upward pressure on the exchange rate seriously affects the competitive position of U. S. exports in international markets. For sectors like agriculture that are heavily dependent on the export market, this effect could be substantial.

REFERENCES

- Artus, Jacques R., "Exchange Rate Stability and Managed Floating," IMF Staff Papers 23 (July 1976), 312-333.
- Chambers, Robert G., "An Econometric Investigation of the Effect of Exchange Rate and Monetary Fluctuation on U. S. Agriculture," unpublished Ph.D. dissertation, University of California, Berkeley, 1978.
- Chambers, Robert G., and Richard E. Just, "A Critique of Exchange Rate Treatment in Agricultural Trade Models," American Journal of Agricultural Economics (in press).
- Fletcher, Stanley M., Richard E. Just, and Andrew Schmitz, "The Impact of Exchange Rates and Other Factors on North American Wheat Export Demand" in G. C. Rausser (ed.), World Food Crisis: Issues and Policy Alternatives (Amsterdam: North Holland Publishing Company, in press).
- Frankel, Jacob A., "A Monetary Approach to the Exchange Rate: Doctrinal Aspects and Empirical Evidence," Scandinavian Journal of Economics 78 (1976), 200-224.
- Hodjera, Zoran, "Alternative Approaches to the Analysis of International Capital Movements: A Case Study of Austria and France," IMF Staff Papers 23 (Nov. 1976), 598-623.
- Houck, J. P., and M. E. Ryan, "Supply Analysis for Corn in the United States: Impact of Changing Government Programs," American Journal of Agricultural Economics 54 (May 1972), 184-191.
- Kouri, Pentti, and Michael Porter, "International Capital Flows and Portfolio Equilibrium," Journal of Political Economy 82 (May/June 1974), 443-467.

- Konandreas, Panos, Peter Bushnell, and Richard Green, "Estimation of Export Demand Functions for U. S. Wheat," Western Journal of Agricultural Economics 3 (July 1978), 39-49.
- Leamer, Edward S., and Robert M. Stern, Quantitative International Economics (Boston: Allyn and Bacon, 1970).
- Magee, Stephen P., "The Empirical Evidence on the Monetary Approach to the Balance of Payments," American Economic Review 66 (May 1976), 163-170.
- Prachowny, Martin F. J., A Structural Model of the U. S. Balance of Payments (Amsterdam: North-Holland Publishing Co., 1969).
- Rhomberg, Rudolf R., and Lorette Boissenault, "The Foreign Sector" in J. Duesenberry, G. Fromm, L. R. Klein, and E. Kuh (eds.), The Brookings Quarterly Econometric Model of the United States (Chicago: Rand-McNally, 1965).
- Schuh, G. Edward, "The Exchange Rate and U. S. Agriculture," American Journal of Agricultural Economics 56 (1974), 1-13.
- Shei, Shun-Yi, "The Exchange Rate and United States Agricultural Markets: A General Equilibrium Approach," unpublished Ph.D. dissertation, Purdue University, May 1978.
- Tsiang, S. C., "The Monetary Theoretic Foundation of the Modern Monetary Approach to the Balance of Payments," Oxford Economic Papers 29 (Nov. 1977), 319-338.

FOOTNOTES

*Ohio State University at Columbus and University of California, Berkeley, respectively. Giannini Foundation Paper No.

¹See Chambers (1978) for a more detailed derivation of the model and a discussion of the underlying assumptions.

²Hodjera (1976) and Artus (1976) have recently estimated variants of the original model.

³S. C. Tsiang (1977) has recently provided a criticism of the appropriateness of such a specification for an aggregate money demand equation. He presents some limited empirical evidence and some heuristic arguments for the inclusion of the volume of trade in the money demand function. However, the model presented above has been validated in a number of studies and, lacking any strong verification of Tsiang's arguments, it is felt that the specification of (11) is acceptable. It should also be noted that, since only a reduced-form exchange rate equation shall be dealt with, our model yields an identical specification of the exchange rate equation as would be obtained by using Tsiang's money demand function.

⁴An attempt was made to incorporate several different distributed lag structures with poor results; the resulting model was not stable.