THE IMPACT OF DEVALUATION ON U.S. AGRICULTURAL EXPORTS

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The 1971 and 1973 official devaluations of the U.S. dollar have often been cited as a pivotal cause for the enormous price rises in agricultural products in 1972 and 1973. This article presents two studies that test the hypothesis that exchange rate changes have a significant effect on the demand for U.S. agricultural exports. The first is a cross-sectional study of the demand for U.S. agricultural exports by major U.S. trading partners in 1971-73. The second looks at the exchange rate changes of other countries and their demand for five agricultural commodities imported from the United States as well as the world during 1954-69. Both studies support the thesis that the special circumstances present in the agricultural sector negate the effects of exchange rate changes on the demand for U.S. agricultural exports.
Keywords: Devaluation, exchange rates, agricultural demand.

Many explanations have been offered for the pressure on farm supplies which led to exceptionally large increases in farm prices in 1972-73. These include the following:

- Rising incomes in the developed countries led to increased meat consumption and therefore increased import demand for feed grains;
- Crop shortfalls in the USSR and the People's Republic of China caused unprecedented increases in world import demand and depleted grain reserves to an unprecedented low point because supplies of U.S. agricultural commodities were not able to expand rapidly in the short run;
- Two devaluations of the dollar reduced U.S. agricultural export prices initially and further increased the demand for U.S. agricultural products.

In this article I shall test the validity of only one of these explanations—the recent dollar devaluations.

The first devaluation had its immediate roots in the August 15, 1971, announcement by the United States which temporarily suspended the sale of gold for dollars. As a practical and immediate result, many countries announced that their currencies would float vis-a-vis the dollar. For most of the larger customers for U.S. agricultural exports, their currencies immediately floated upwards (that is, appreciated) vis-a-vis the dollar. In December 1971, representatives of the 10 largest members of the International Monetary Fund signed an agreement realigning their currencies. As a result, the dollar was devalued 8.57 percent vis-a-vis gold and against currencies of all other countries who chose to preserve their currencies' relationship with gold. In February 1973, after a precipitous downturn in the value of the dollar in exchange markets, the United States announced that it would unilaterally devalue the dollar again. These two devaluations by the United States broke a 27-year period of generally fixed exchange rates between the United States and its major trading partners. Thus these two actions represent a major break with past U.S. exchange rate policy.

It has usually been hypothesized that, as a result of the two devaluations of the dollar, demand for U.S. agricultural exports has increased. At the same time, supply, in the form of existing reserves or unutilized capacity, could not respond fast enough to prevent a price rise. This resulting price rise contributed to already existing world as well as U.S. inflationary pressures.

In this article, I attempt to establish whether the two devaluations significantly affected the quantity of U.S. agricultural exports. That is, was the response of U.S. trading partners significant enough to involve a measurable shift in their import demand? The intent is not to explain the level of U.S. agricultural trade or the increase in U.S. prices as a result of the two devaluations, but to measure the possible impact on the quantity demanded.

The two steps taken to test the hypothesis form the body of the article. First, cross-sectional data among countries during a fixed time period are examined to see if variations in exchange rates during this period explain the distribution of U.S. exports and imports among trading partners. Second, past exchange rate changes in other countries are examined to determine if changes in these rates explain variations in imports over time, both from the world and the United States. Finally, implications are drawn for agricultural trade from exchange rate theory.

A CROSS-SECTIONAL ANALYSIS OF TWO U.S. DEVALUATIONS

The method used in this cross-sectional analysis was ordinary least squares regression with a stepwise procedure[1] of eight variables for two commodities (wheat and

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[1] The equation with the highest R^2 as well as the highest F statistic, when all independent variables were significant at the 5-percent level, was chosen as the best step equation. If this criterion could not be met, the last equation was chosen. The stepwise algorithm used starts with all the independent variables in the regression and drops out those not considered significant.

corn) and seven variables for one commodity (soybeans) across 21 different countries (15 countries for wheat, 13 for corn, and 15 for soybeans[2]). These countries imported 54, 67, and 92 percent of the U.S. exports of wheat, corn, and soybeans, respectively, in 1972.[3] Concessional sales were not included. Changes in quantity between 1971 and 1972 and between 1971 and 1973 were measured. The effect on commodity prices was not examined. To do so would be exceedingly difficult because of the task of sorting out the factors of domestic and foreign inflation and the exchange rate. Such a task would be complicated further by the fact that a devaluation can result in a rise in the general price level as well as the agricultural price level.

Selection of Independent Variables

To ascertain which factors most influenced the variability of U.S. exports in these two periods, the following independent variables, which have often been mentioned as causal factors, were specified as indices with 1971 as the base year:

- Exchange rate changes: the change in the U.S. dollar vis-a-vis the currency of each country included in the study. These were calculated from mid-1971 to mid-1972 and from mid-1971 to mid-1973. The dollar depreciated or appreciated at a different rate vis-a-vis each country's currency during this period (X_1).
- Per capita income growth: an index of increase in per capita income to current dollars in the importing countries (X_2).
- Population growth: an index of increase in population growth of the importing countries (X_3).
- Consumer price index for the economy as a whole. This variable was chosen to learn whether the overall increases in the importing country's consumer price index significantly affected the quantity of its imports as demand spilled over into the foreign sector (X_4).
- Foreign supplies: production and stocks of wheat and corn of the importing countries in the study. These supplies were summed to arrive at an index of foreign supplies. Data limitations precluded the use of this variable for soybeans (X_5).
- Expected export quantities: United States. The trend of quantities exported from the United States to these 21 countries from 1961 to 1973 1972, and 1973 were divided by actual exports for 1971 and an index calculated (X_6). This variable and variable 7 were included to detect whether agricultural exports were on-trend. Should these variables prove not to be foremost in importance we can more readily believe that factors unique to 1972-73, as defined by the set of other variables, significantly affected exports.
- Expected export quantities: rest of the world. The trend of quantities exported from the entire world to these countries in 1961-73 was determined. The expected quantities minus those expected for the United States were divided by actual exports minus actual U.S. exports for 1971, and an index was calculated (X_7).
- Actual exported quantities: United States. The commodities imported from the rest of the world were the dependent variables, and the commodities exported from the United States became the independent variable (X_8).
- Actual imported quantities: rest of the world. The commodities exported from the United States were the dependent variables, and the commodities exported from the rest of the world became the independent variable (X_9).

These variables were regressed on the following variables: The difference in the quantities of wheat, corn, or soybeans exported from the United States between 1972 and 1971 (Y_{1i}) and between 1973 and 1971 (Y_{2i}); and, the difference in the quantities of wheat, corn, or soybeans exported from the rest of the world between 1972 and 1971 (Y_{2i}) and between 1973 and 1971 (Y_{4i}).

The choice of independent variables may appear unorthodox since some of them, particularly per capita income and population, are correlated. However, the purpose of this analysis is not to build a model explaining U.S. agricultural exports, but simply to look at the significance of one variable—the exchange rate. This variable is not correlated to any of the others. The correlations of population with per capita income and of expected U.S. exports with expected rest-of-the-world exports may have increased the R^2 somewhat. But such correlations did not affect the measure of the significance of the main variable, the exchange rate.[4]

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[2] Countries used in cross-sectional analysis and commodities imported by each (W=wheat, C=corn, S=soybeans) are: Belgium-CS; Brazil-W; Canada-S; Denmark-S; France-S; Israel-S; Italy-WCS; Japan-WCS; Korea-WC; Mexico-WC; Netherlands-WCS; Norway-WCS; Portugal-WCS; Spain-WCS; Sweden-WCS; Taiwan-S; U.S.S.R.-W; United Kingdom-WCS; Venezuela-W; West Germany-WCS; and Yugoslavia-WC;

[3] Most other sizable exports of wheat were noncommercial.

[4] The problem of multicollinearity would be crucial in a model-building exercise that seeks to explain the level of U.S. agricultural trade, but it is not crucial to the present analysis. Further, the stepwise procedure eliminates one of the correlated variables without detracting from analysis of the exchange rate variable. Whether or not the exchange rate variable continues to be statistically significant or not and whether or not it is one of the first few variables to be eliminated, one can still state with certainty that this variable either is or is not important in explaining the variability of U.S. agricultural exports of wheat, corn, or soybeans from 1971 to 1973. The problem of multicollinearity should also be reduced by using first differences. Each independent variable for equations 1 and 3 is the difference between that variable's value in 1972 and its value in 1971 and, in equations 2 and 4, the difference between the value in 1973 and the value in 1971.

Analysis of Equations for Selected Commodities

Wheat. The statistical significance and explanatory power of each wheat equation for the eight independent variables together is consistently good (table 1).[5] The lowest R^2 is 72 percent while the other three are 89, 95, and 86 percent. The trend variables for U.S. and world wheat exports were the most significant while the exchange rate variable was insignificant—in all four first-step regression equations. The rest-of-the-world equations indicated the importance of population growth and of the availability of production and stocks. Again, the exchange rate variable was not significant, and it was the fifth to drop out of the stepwise procedure.

Corn. The statistical significance of all eight variables together for the four corn equations is not as good as it was for wheat, except for the rest-of-the-world equation for 1973-71 (table 2).[6] In fact, the equation for U.S. exports in 1972-71 is not quite significant at the 5-percent level. The significant variable for the U.S. equations was the change in the actual exports by the rest of the world. But though this variable is statistically significant, it is

[5] The wheat equations are:

Y_1 wheat 1972-71 = $f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, \text{and } X_9)$

Y_2 wheat 1973-71 = $f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, \text{and } X_9)$

Y_3 wheat 1972-71 = $f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, \text{and } X_8)$

Y_4 wheat 1973-71 = $f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, \text{and } X_8)$

[6] The corn equations are:

Y_1 corn 1972-71 = $f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, \text{and } X_9)$

Y_2 corn 1973-71 = $f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, \text{and } X_9)$

Y_3 corn 1972-71 = $f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, \text{and } X_8)$

Y_4 corn 1973-71 = $f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, \text{and } X_8)$

Table 1.--Wheat equations 1/

Dependent variable	Independent variable 2/	Constant	Exchange rate change	Per capita Y growth	Population growth	CPI or WPI	Foreign supply	Expected U.S. exports	Expected rest of world exports	Actual U.S. exports	Actual rest of world exports	R^2	F-statistic	Status of exchange rate variable
U.S. exports of wheat 1972-1971 Difference	First step	10176.33 (432515.29) 0.02	12292.90 (11051.81) 1.11	26357.25 (16270.12) 1.62	68136.32 (161252.89) 0.42	-35205.18 (21564.55) 1.63	5713.29 (11435.98) 0.50	85.84** (37.59) 2.28	-0.47* (0.16) 2.85		-0.41 (0.40) 1.03	.89	14.56	
	Best step	28233.71 (69324.94) 0.41						124.48* (12.14) 10.25	-0.60* (0.08) 7.93			.88	52.91	5th out of 8 variables to drop out; + sign throughout
	Last step	Same as best step equation												
U.S. exports of wheat 1973-1971 Difference	First step	-497091.78 764048.14 -0.65	-8345.62 (10018.95) 0.83	19074.84 (13531.64) 1.41	88735.75 (112783.92) 0.79	5418.60 (21768.90) 0.25	-3104.17 (9558.99) 0.32	205.58* (35.50) 5.79	-3.77* (0.68) 5.57			.95	33.87	
	Best step	182562.29 (130131.62) 1.41						197.71* (11.39) 17.35	-3.51* (0.28) 12.49		0.02 (0.44) 0.05	.96	151.90	5th out of 8 variables to drop out; - sign throughout
	Last step	Same as best step equation												
Rest of world exports of wheat 1972-1971 Difference	First step	-544647.17 (343857.30) -1.58	-1407.28 (11476.68) 0.12	21260.84 (16299.99) 1.30	278201.59 (105352.12) 2.64	-14876.19 (23770.58) 0.63	17978.33** (8259.53) 2.18	-41.33 (45.63) 0.91	0.08 (0.24) 0.34	-0.37 (0.36) 1.03		0.86	11.69	
	Best step	-631258.00 (214219.84) -2.95		22172.76** (11180.74) 1.98	262784.06* (83105.32) 3.16		15009.42* (6393.32) 2.35	-25.92* (9.39) 2.76		-0.44* 0.13 3.33		.89	22.81	1st out of 8 variables to drop out; - sign throughout
	Last step	67830.41 (71878.08) 0.94								-0.78 0.10 7.87		.81	61.99	
Rest of world exports of wheat 1973-1971 Difference	First step	-384784.14 (723786.39) -0.53	-3324.50 (9821.07) 0.34	-1553.22 (14613.11) 0.11	37371.97 (109927.65) 0.34	13353.49 (19761.62) 0.68	-2599.76 (8971.37) 0.29	-73.26 (79.97) 0.92	1.23 (1.49) 0.82	0.02 (0.38) 0.05		.72	5.46	
	Best step	-53261.85 (105489.96) -0.50						-73.17* (9.24) 7.92	1.27* (0.23) 5.56			.82	31.86	5th out of 8 variables to drop out; - sign throughout
	Last step	Same as best step equation												

1/ The numbers in parentheses below the regression coefficients are the standard errors of the coefficients. The 3rd number is the t-value.
2/ *Means significant at .05 level and ** means significant at .10 level.

Table 2.--Corn equations 1/

Dependent variable	Independent variable 2/	Constant	Exchange rate change	Per capita Y growth	Population growth	CPI or WPI	Foreign supply	Expected U.S. exports	Expected rest of world exports	Actual U.S. exports	Actual rest of world exports	R^2	F-statistic	Exchange rate variable
U.S. exports of corn 1972-1971 Difference	First step	1195966.77 (862836.24) 1.39	20485.22 (22854.88) 0.90	-37227.40 (28039.24) 1.33	-987105.13 (789372.78) 1.25	-9437.66 (44330.20) 0.21	27071.27 (22842.42) 1.19	-249.65** (295.86) 0.84	16.56 (15.13) 1.09		-0.94* (0.30) 3.11	.77	5.99	
	Best step	114479.01 (93006.47) 1.23									-0.56* (.07) 8.63	.86	74.40	3rd out of 8 variables to drop out; + sign throughout
	Last step	Same as best step equation												
U.S. exports of corn 1973-1971 Difference	First step	322984.00 (542180.21) 0.60	-727.69 (9642.94) 0.08	1158.90 (14593.44) 0.08	116158.99 (404534.30) 0.29	-16389.37 (20409.50) 0.80	-3056.73 (17039.13) 0.18	51.83 (113.97) 0.45	1.17 (11.84) 0.10		-0.64 (0.30) 2.17	.84	9.05	
	Best step	250590.11 (245078.00) 1.02			167166.70* (48212.45) 3.47	-16711.40** (11248.61) 1.49					-0.65* (0.06) 10.55	.92	48.08	1st out of 8 variables to drop out; - sign throughout
	Last step				171707.80* (50936.80)						-0.66* (.07) 10.05	.91	63.37	
Rest of world exports of corn 1972-1971 Difference	First step	1529971.90 (541920.28) 2.82	28400.85 (17279.29) 1.64	-40004.02 (22432.17) 1.78	-1455533.86* (402909.12) 3.61	-13213.23 (39259.33) 0.34	39891.27* (12821.39) 3.11	-429.05 (190.29) 2.25	25.61 (8.57) 2.99	0.75 (0.24) 3.11		.93	21.90	
	Best step	1041653.63 (331569.20) 3.14			-1444728.16* (472094.62) 3.06		35199.00** (14722.56) 2.39	-396.40** (217.78) 1.82	27.18* (9.94) 2.74	-0.89* (0.27) 3.31		.91	24.15	3rd out of 8 variables to drop out; + sign throughout
	Last step	116466.24 (160780.81) .72								-1.55* (.81) 8.63		.86	74.40	
Rest of world exports of corn 1973-1971 Difference	First step	645990.76 (561887.62) 1.15	-2093.23 (11005.48) 0.19	-9026.78 (16111.68) 0.56	-468471.23 (405394.89) 1.16	-732.48 (25193.48) 0.03	20185.62 (16800.43) 1.20	-75.64 (128.45) 0.59	17.82 (10.25) 1.74			.88	12.24	
	Best step	144526.85 (120982.69) 1.19										.92	72.73	2nd out of 8 variables to drop out; - sign throughout
									6.33* (1.67) 3.78	-1.27*				
	Last step	Same as best step equation												

1/ The numbers in parentheses below the regression coefficients are the standard errors of the coefficients. The 3rd number is the t-value.
2/ * Means significant at .05 level and ** means significant at .10 level.

not satisfactory as to the expected theoretical effects. Since it was positive, the implication is that exports from the rest of the world and from the United States move in the same direction. The exchange rate variable was not important. For the rest-of-the-world equations, actual U.S. corn exports were consistently significant at 5- or 10-percent levels. Expected trends were also important for the 1972-71 equations. The exchange rate variable was not statistically significant in the first-step equation, and it was the third to drop out of the stepwise procedure.

Soybeans. The explanatory power of the seven variables was markedly poor for all soybean equations except U.S. exports in 1972-71 (table 3).[7] There, the exchange rate variable was the second explanatory variable to drop out in the stepwise procedure, and its sign (+) was inconsistent theoretically. The best equation in the stepwise procedure also indicated that, as world exports of soybeans moved, both in trends and actual behavior, so did U.S. soybeans.

Soybeans face many competing commodities, such as cottonseeds, flaxseed, anchovies, and, where countries lack crushing facilities, soybean oil and meal and other vegetable oils. However, because soybeans and some of these other commodities are produced in very few countries, few countries bother to keep any production and stock figures on these commodities. It is apparent, however, that the cross-elasticities for these commodities would affect demand for soybeans. Thus, production and stock figures were not included in the soybean equations, which explain why in these equations, the independent variables had such little significance and explanatory power. Nevertheless, the equations indicate the unimportance of the exchange rate variables.

Implications

Based on results of the equations presented, certain statements can be made. For the change in quantities exported for 1972 from 1971 and for 1973 from 1971, almost none of the variation in imports and exports among trading partners can be explained by the variation in exchange rates. The United States did not export relatively more or less to countries whose currencies had changed most against the dollar. At the same time, as a

[7] The soybean equations are:

Y_1 soybeans $= f(X_1, X_2, X_3, X_4, X_5, X_6, X_7,$ and $X_9)$ 1972-71

Y_2 soybeans $= f(X_1, X_2, X_3, X_4, X_5, X_6, X_7,$ and $X_9)$ 1973-71

Y_3 soybeans $= f(X_1, X_2, X_3, X_4, X_5, X_6, X_7,$ and $X_8)$ 1972-71

Y_4 soybeans $= f(X_1, X_2, X_3, X_4, X_5, X_6, X_7,$ and $X_8)$ 1973-71

Table 3.--Soybean equations 1/

Dependent variable	Independent variable	Constant	Exchange rate change	Per capita Y growth	Population growth	CPI or WPI	Foreign supply	Expected U.S. exports	Expected rest of world exports	Actual U.S. exports	Actual rest of world exports	R^2	F-statistic	Status of exchange rate variable
U.S. exports of soybeans 1972-1971 Difference	First step	-97265.71	2567.16	26513.64*	18799.67	-11698.33		6256.25	-0.63**		-0.66	.77	7.68	
		(116115.21)	(3044.82)	(5193.00)	(32091.29)	(11794.98)		(3534.28)	(0.19)		(0.25)			
		-0.84	.84	5.11	0.59	0.99		1.77	3.35		2.61			
	Best step	-128621.89		28768.27					-0.67*		-0.80*	.76	16.17	2nd out of 7 variables to drop out; + sign throughout
		(37987.31)		(-0.67)					(0.18)		(0.20)			
		-3.39		-0.80					3.69		3.98			
	Last step	Same as best step equation												
U.S. exports of soybeans 1973-1971 Difference	First step	166163.19	7468.85	10332.97	36053.58	-11322.37		2151.72	-0.93		-0.38	-0.21	.65	
		(357881.93)	(5919.36)	(12062.79)	(57897.43)	(15472.17)		(7122.04)	(.82)		(1.38)			
		.46	1.26	.86	.62	.73		.30	1.13		.27			
	Best step	135436.04	4652.31									.02	1.30	7th out of 7 variables to drop out; + sign throughout
		(80008.02)	(4081.56)											
		1.69	1.14											
	Last step	Same as best step equation												
Rest of world exports of soybeans Difference	First step	-173906.79	-1677.83	20373.96	29559.89	2832.49		4567.54	-0.65	-0.75		.37	2.16	
		(112388.28)	(3356.78)	(9288.47)	(3312.42)	(13422.87)		(4205.15)	(0.28)	(0.29)				
		-1.55	.50	2.19	.89	.21		1.09	1.60	2.61				
	Best step	-87989.72		22095.86*					-0.51*	-0.73*				2nd out of 7 variables to drop out; - sign throughout
		(44607.21)		(6839.98)					(0.21)	(0.18)				
		-1.97		3.23					2.47	3.98				
	Last step	Same as best step equation												
Rest of world exports of soybeans 1973-1971 Difference	First step	-32629.92	-1531.13	5312.58	10490.57	2261.35		-2284.14	-0.32	-0.03		.21	1.52	
		(98443.30)	(1694.58)	(2820.28)	(15749.40)	(4299.15)		(1756.63)	(0.21)	(0.10)				
		-0.33	0.90	1.88	0.67	0.53		1.30	1.53	0.27				
	Best step	24128.35	-1517.53	5497.81*				-2535.05	-0.30			.38	3.11	
		(46463.57)	(1232.99)	(2268.55)				(1511.75)	(0.17)					
			1.23	2.42				1.68	1.73					
	Last step	18713.80		3606.53								.06	1.87	
		(42281.90)		(2636.79)										
		0.44		1.37										

1/ The number in parentheses below the regression coefficients are the standard errors of the coefficients. The 3rd number is the t-value.
2/ * Means significant at .05 level and ** means significant at .10 level.

check on these results, the equations for exports from the world minus the U.S. share also indicate that the change in the U.S. exchange rate neither positively nor negatively affected exports from the rest of the world to the countries studied.

Can any inferences be drawn from these results to explain the changes in the value of U.S. exports during this same time? Value consists of quantity and price together. U.S. wheat prices stayed noticeably stable from January 1971, through the August 1971 announcement that the dollar would be allowed to float, until July 1972, when they began a precipitous rise. The recorded U.S. Gulf port export price per bushel of hard winter wheat rose from $1.76 in July 1972 to $2.95 in July 1973; by the end of 1973, it had risen to $5.44 per bushel. Soybean prices were equally stable until November 1972, when they also began to rise. Corn prices generally moved downward from January 1971 to October 1971, stabilized for the next 12 months and started to rise in September/November 1972 from about $1.50 per bushel. They continued to rise in 1973, reaching $2.83 per bushel by mid-December. Even allowing for a 3- or a 6-month lag, these enormous price rises suggest that neither the August 1971 nor February 1973 devaluations were instrumental in raising the domestic prices of these commodities. The rise in these prices was much greater than that of either or both official U.S. devaluations.

TIME SERIES ANALYSIS OF EXCHANGE RATE CHANGES IN SELECTED COUNTRIES

Did changes in exchange rates explain variations in imports and exports over time? The U.S. devaluations represent only one case study in one country. To determine whether the U.S. devaluations represented a special case, another analysis was made concerning exchange rate changes in other countries. The analysis measured the impact of exchange rate changes on other countries' agricultural imports from the United States and the world.

Time Period and Selection of Countries

The study period, 1960 to mid-1969, was chosen because exchange rates were generally stable; one country's devaluation or revaluation was not followed by retaliatory or "tied" devaluations or revaluations. The one exception was the pound sterling devaluation in 1967, which was followed by devaluations throughout much of the area where sterling is used. The period selected also represented one of stable currency relationships between the United States and its major trading partners.

The 20 countries selected had devalued or revalued their currencies at least once during 1960-69 (table 4). Of these countries 17 had devalued or revalued once,

Table 4.—Devaluations and revaluations vis-a-vis U.S. dollar, from January 1, 1960 to June 30, 1969, selected countries

Country	Date of devaluation	Percentage change[a]
Iceland	2/22/60	-57
	8/4/61	-11
	11/27/67	-25
	11/12/68	-35
Turkey	8/20/60	-69
Germany	3/6/61	+5
Netherlands	3/7/61	+5
Ecuador	7/14/61	-17
Costa Rica	9/3/61	-15
Israel	2/9/62	-40
	11/19/67	-14
Canada[b]	5/2/62	+2
Ghana	7/19/65	-58
	2/23/67	+20
	7/8/67	-30
Yugoslavia	7/26/65	-76
Philippines	11/8/65	-49
Finland	10/12/67	-24
Ireland	11/18/67	-14
United Kingdom	11/18/67	-14
Cyprus	11/20/67	-14
New Zealand	11/20/67	-19
Spain	11/20/67	-14
Denmark	11/21/67	-8
Jamaica	11/21/67	-14
	9/8/69	-50
Trinidad and Tobago	11/22/67	-14

[a] + = Revaluation vis-a-vis U.S. dollar.
- = Devaluation vis-a-vis U.S. dollar.
[b] From September 30, 1950 to May 1, 1962, no par value was agreed on with the International Monetary Fund.

two devalued twice, one devalued three times, and one devalued four times. None of these countries had multiple or floating exchange rate systems during this time nor were the majority of their agricultural imports from U.S. concessional sales.

Regressions were run on U.S. exports (by value and quantity) to these 20 countries for five commodities from 1954 to 1969. The five commodities—wheat, corn, cotton, tobacco, and oilseeds—together accounted for an average 55 percent of all U.S. agricultural exports in the last 5 years (1965-69) of the period studied. Regressions were also run on imports of these same five commodities from the world to these countries. Exceptions to this procedure occurred when any country did not import significant amounts of a particular commodity, which meant that no trade data were recorded for that commodity for that country. Time served as a simple proxy for income, population, and any other structural variables. The year of the devaluation or revaluation and each succeeding year was specified by a dummy variable value of one, unless the change occurred in the last half of the year. Any change during July-December was recorded for the next year. For years before an exchange rate change, the dummy variable was defined as zero. A separate dummy variable was included for each change in the exchange rate.

Initial Results

For each commodity, four regressions were run: (1) quantity of U.S. exports[8], (2) value of U.S. exports, (3) quantity of imports from the world, and (4) value of imports from the world. Each of the four was regressed on time and in the dummy variable.

Since each equation represents exports of one commodity to one country, results cannot be misinterpreted although wide variation existed in the amount of exchange rates changes between countries. The purpose of this analysis was the same as that of the cross-sectional analysis. That is, to determine whether a change in the exchange rate had a statistically significant effect on a country's imports and on U.S. exports of agricultural commodities. No effort was made to determine if those countries experiencing a relatively smaller percentage change in their exchange rates were affected more than those experiencing a larger percentage change. The emphasis was not on determining the degree of impact, simply to find if there was an impact.

Table 5 summarizes essential information for each commodity. The most noticeable indicator is the generally low R^2 for most commodities for most equations. This behavior suggests that time and a change in the exchange rate explained very little of the variability in quantity or in value—of U.S. exports or world imports—of these commodities. At the same time, the average F statistic for each commodity for each country equation was significant, indicating that for many countries the explanatory power of both independent variables was good. Finally, the average *t*-statistic for almost all commodities, by quantity or by value, from the United States or from the world, falls below the acceptable 5-percent level. Exceptions include some of the corn and cotton equations.

Results Summarized Through Two Tests

To summarize results of each individual country equation, two kinds of nonparametric tests were conducted. The first (table 6), involving signs, was used to test the hypothesis, at the 5-percent level, that the majority of countries for any one equation did not have

[8] Exports to countries from the United States are differentiated from imports from the world to these countries because of data availability. Export data (f.o.b.) are from the U.S. Department of Agriculture, while import data (c.i.f.) are reported by countries to the Food and Agricultural Organization of the United Nations.

Table 5.--Summary of Test Statistics of Time Series Analysis

Test Statistic / Equation	R^2	F-test	t-statistic only first devaluation	t-statistic all devaluation
Wheat				
(1) Quantity of imports from World				
N	18	18	18	.24
$\bar{X}$ 1/	.41	7.58	1.31	1.27
S.D. 1/	.29	11.8	1.27	1.43
(2) Value of imports from World				
N	18	18	18	24
$\bar{X}$	.44	6.78	1.30	1.34
S.D.	.26	7.60	1.28	1.23
(3) Quantity of exports from U.S.				
N	19	19	19	25
$\bar{X}$	.33	5.62	.93	1.17
S.D.	.27	11.67	.88	2.09
(4) Value of exports from U.S.				
N	19	19	19	24
$\bar{X}$	.32	3.66	.96	.94
S.D.	.22	4.25	.89	1.41
Corn				
(1) Quantity of imports from World				
N	14	14	14	20
$\bar{X}$	.74	30.60	1.25	1.77
S.D.	.32	35.35	.92	1.50
(2) Value of imports from World				
N	14	14	14	20
$\bar{X}$	.68	24.35	1.05	1.36
S.D.	.33	27.50	.82	1.17
(3) Quantity of exports from U.S.				
N	15	15	15	
$\bar{X}$	.52	16.97	1.78	
S.D.	.36	21.30	1.13	
(4) Value of exports from U.S.				
N	15	15	15	16
$\bar{X}$	.56	16.98	1.81	2.04
S.D.	.38	15.40	1.45	1.35
Tobacco				
(1) Quantity of imports from World				
N	17	17	17	18
$\bar{X}$	.57	16.07	1.36	1.30
S.D.	.27	26.20	1.31	1.29
(2) Value of imports from World				
N	17	17	17	17
$\bar{X}$	.53	13.88	1.41	1.38
S.D.	.33	14.48	.32	.96
(3) Quantity of exports from U.S.				
N	18	18	18	22
$\bar{X}$	.42	7.86	1.33	1.33
S.D.	.30	9.27	.78	1.04
(4) Value of exports from U.S.				
N	18	18	18	22
$\bar{X}$	.46	13.57	1.30	1.34
S.D.	.31	22.57	.84	1.20
Oilseeds				
(1) Quantity of imports from World				
N	16	16	16	17
$\bar{X}$	.45	4.49	1.28	1.29
S.D.	.24	4.30	.84	.80
(2) Value of imports from World				
N	15	15	15	16
$\bar{X}$	.57	13.87	1.29	1.37
S.D.	.33	20.02	1.00	1.03
(3) Quantity of exports from U.S.				
N	9	9	9	10
$\bar{X}$	.55	19.33	1.47	1.40
S.D.	.35	29.00	1.03	.99
(4) Value of exports from U.S.				
N	9	9	9	10
$\bar{X}$	.63	24.71	1.20	1.19
S.D.	.39	25.50	.73	.69
Cotton				
(1) Quantity of imports from World				
N	16	16	16	17
$\bar{X}$	.49	9.96	1.82	1.81
S.D.	.44	10.5	1.70	2.03
(2) Value of imports from World				
N	16	16	16	17
$\bar{X}$	.48	7.54	1.28	1.31
S.D.	.15	7.45	.88	.85
(3) Quantity of exports from U.S.				
N	9	9	9	10
$\bar{X}$	.41	4.61	.65	.65
S.D.	.23	3.30	.39	.33
(4) Value of exports from U.S.				
N	9	9	9	
$\bar{X}$	.39	4.41	.48	
S.D.	.23	3.79	.11	

1/ The mean for each test statistic was calculated by taking the test statistic(s) for each country's equation and dividing by the number of countries (or number of exchange rate changes). The standard deviation is the deviation of each test statistic about the mean value of the test statistic.

significant *t*-statistics for the exchange rate dummy variable. The first set of exchange rate changes per country was counted as observations. In only one test out of forty was the null hypothesis rejected, which indicates that there were enough acceptable *t*-statistics only in this one instance. The case in question was the value of tobacco imported from the world, when all exchange rate changes per country were counted. Quite possibly, tobacco, a nonfood item and, to some degree, a luxury item, would exhibit a higher inelasticity of demand than would the other commodities. Since quantity did not vary significantly but value did, it seems likely that the exchange rate change did affect price. With this exception, test results indicated that the majority of countries importing these commodities did not significantly change the level of their trade from the United States or from the world after they had changed their exchange rate.

The results of the next test are more difficult to interpret and appear more ambiguous. For the commodities, two at a time for each of the same four equations as in the previous test, their *t*-statistics were ranked for a U-test (table 7). The results indicate whether the two samples had different distributions. Coupling this information with that in table 5, we can draw some inferences as to which commodities were more likely to be affected by the exchange rate variable.

For commodities imported from the world, by quantity, equation (1), imports of cotton seemed more likely to be affected by the exchange rate variable. The average *t*-statistic for the exchange rate variable was also highest

Table 6.—Sign tests of hypothesis that the majority of countries selected did not have significant *t*-statistics for devaluation or revaluation variables

	Wheat: 1st exchange rate changes	Wheat: all exchange rate changes	Corn: 1st exchange rate changes	Corn: all exchange rate changes	Tobacco: 1st exchange rate changes	Tobacco: all exchange rate changes	Oilseeds: 1st exchange rate changes	Oilseeds: all exchange rate changes	Cotton: 1st exchange rate changes	Cotton: all exchange rate changes
	(1) Quantity of Imports from World									
Total number of devaluation or revaluation variables	18	24	14	20	17	18	16	17	16	17
Number of plus signs[a]	7A	9A	3A	7A	6A	6A	3A	3A	7A	7A
Number of minus signs[a]	11	15	11	13	11	12	13	14	9	10
	(2) Value of Imports from World									
Total number of devaluation or revaluation variables	18	24	14	20	17	19	15	16	16	17
Number of plus signs	4A	6A	2A	6A	12A	14R	3A	4A	5A	6A
Number of minus signs	14	18	12	14	5	5	12	12	11	11
	(3) Quantity of U.S. Exports									
Total number of devaluation or revaluation variables	19	25	15	15	18	22	9	10	9	10
Number of plus signs	3A	4A	7A	7A	6A	7A	2A	2A	1A	1A
Number of minus signs	16	21	8	8	12	15	7	8	8	9
	(4) Value of U.S. Exports									
Total number of devaluation or revaluation variables	19	25	15	16	18	22	9	10	9	9
Number of plus signs	3A	4A	6A	7A	6A	7A	1A	1A	0A	0A
Number of minus signs	16	21	9	9	12	15	8	9	9	9

A = Accept null hypothesis.
R = Reject null hypothesis.
[a]Number of plus signs indicates the number of exchange rate variables that were above the critical *t*-statistic while number of minus signs indicates the number of exchange rate variables that were not above the critical *t*-statistic at the .05 level.

for cotton. For equation (2), the results were somewhat different, but wheat seemed less affected than tobacco, oilseeds, or cotton by the exchange rate variable. Equations (1) and (2) also suggested fewer instances of one commodity sample being from a different population than did commodities exported from the United States.

Thus, a country's level of imports from all sources of a particular commodity apparently varies less because of exchange rate changes than when imports are from one source; here, the United States. In addition, there may have been particular factors affecting the demand for U.S. exports that were not present in imports from all the world. This situation is analogous to the supply and demand conditions faced by a single farmer versus those faced by the agricultural sector as a whole. At the same time, the results of equations (3) and (4) are, in several cases, internally contradictory. For example, more of the exchange rate *t*-statistics come closer to being significant in equation (3) for wheat rather than corn and for tobacco rather than wheat. The difference between tobacco and corn rankings, however, appears to be insignificant. The inconsistency indicates the roughness of the U-test results; thus, not too much confidence should be placed in its comparisons. The paired comparisons may indicate significant differences where none exist because of the wide variance in the observations of each sample.

Implications

Occurrence of a change in the exchange rate of a country other than the United States, whether revaluation or devaluation, did not significantly change the

Table 7.—U-Test: Comparison of commodities by type of equation, based on ranked *t*-statistics for all devaluation variables

Equation and commodity	Sample sizes compared	Z-test statistic	Difference between samples
(1) Quantity of imports from world:			
Corn/wheat	20/24	0.20	No
Corn/tobacco	20/18	1.26	No
Corn/oilseeds	20/17	1.10	No
Corn/cotton	20/17	1.52	No
Wheat/tobacco	24/18	0.77	No
Wheat/oilseeds	24/17	0.26	No
Wheat/cotton	24/17	1.05	No
Tobacco/oilseeds	18/17	1.62	No
Tobacco/*cotton	18/17	2.90	Yes
Oilseeds/*cotton	17/17	3.41	Yes
(2) Value of imports from world:			
Corn/wheat	20/17	1.71	No
Corn/tobacco	20/19	1.49	No
Corn/oilseeds	20/16	0.97	No
Corn/cotton	20/17	1.43	No
Wheat/*tobacco	17/19	3.03	Yes
Wheat/*oilseeds	17/16	7.66	Yes
Wheat/*cotton	17/17	2.09	Yes
Tobacco/oilseeds	19/16	1.39	No
Tobacco/cotton	19/17	1.66	No
Oilseeds/cotton	16/17	0.05	No
(3) Quantity of exports from United States:			
*Wheat/corn	25/15	5.14	Yes
Wheat/*tobacco	25/22	2.27	Yes
Wheat/*oilseeds	25/10	3.80	Yes
*Wheat/cotton	25/10	3.25	Yes
Corn/tobacco	15/22	1.42	No
Corn/oilseeds	15/10	0.72	No
*Corn/cotton	15/10	2.78	Yes
Tobacco/oilseeds	22/10	0.32	No
Tobacco/cotton	22/10	1.52	No
Oilseeds/*cotton	10/10	2.04	Yes
(4) Value of exports from United States:			
Wheat/*corn	25/16	3.50	Yes
Wheat/*tobacco	25/22	3.40	Yes
*Wheat/oilseeds	25/10	3.37	Yes
*Wheat/cotton	25/10	3.16	Yes
Corn/tobacco	16/22	0.84	No
Corn/oilseeds	16/10	0.71	No
*Corn/cotton	16/10	2.40	Yes
Tobacco/oilseeds	22/10	0.04	No
*Tobacco/cotton	22/10	2.00	Yes
*Oilseeds/cotton	10/10	2.40	Yes

*Indicates larger *t*-statistic rankings between paired samples.

country's level of agricultural imports from the United States or from the world.[9] Since the quantity purchased did not change much nor did the value (price times quantity), the price of these commodities—in terms of the devaluing or revaluing country's currency—did not change much either.

CONCLUSIONS

These two studies strongly imply that the change in the exchange rate of the United States, a major supplier of agricultural commodities on the world market, did not significantly affect agricultural trade. Nor did changes in exchange rates of major or minor importers have any great effect on their agricultural trade. Though these conclusions may appear somewhat surprising in terms of balance-of-payments and exchange rate theory, they actually are not when one views a particular sector, agriculture, and the conditions within that sector. For agriculture, such conditions are the inelasticities of demand and supply of agricultural commodities, particularly in the short run.

Combining exchange theory with these special conditions provides a logical explanation of why the exchange rate variable was insignificant. For further explanation, refer to William Kost's article in this issue.

Kost postulates a small shift in demand with an exchange rate change for agricultural goods. In my study, two major explanations can be offered for this small shift in demand. Naturally, the maximum amount that demand could shift would be by the amount of the devaluations. The trade-weighted exchange rates, using only countries covered in the study, indicated maximum price changes for wheat (after both devaluations) and for corn (after the second devaluation) were less than the amount of the official U.S. dollar devaluation vis-a-vis gold. This lesser change occurred because not all currencies reacted similarly to the U.S. devaluations. Some currencies floated down with the dollar, others floated down only partially, and the rest appreciated by varying amounts vis-a-vis the U.S. dollar. To the degree that the wheat, corn, or soybean trade-weighted exchange rate is less than the full amount of the U.S. devaluation vis-a-vis gold, the demand curve for exports of that commodity would shift that much less than the full amount of the U.S. devaluation vis-a-vis gold.

Secondly, institutional factors prevented the full impact of the devaluation from manifesting itself in shifts of the demands for U.S. agricultural exports, particularly in EC member countries. Provisions of the Common Agricultural Policy of the European Community keep some commodities, particularly grains, from coming

[9] For those few countries which revalued their currencies—Germany, the Netherlands, and Canada—no appreciable difference was found in the level of imports either.

into the EC at a lower price than those produced domestically. Therefore if a commodity brings a lower price in EC currencies because of the devaluation, it receives a higher EC variable levy. This action eliminates any price advantage, because the importer pays the variable levy. The result is a constant price within each EC member's currency, and, therefore, a constant price to the EC consumer. Thus, any immediate reduction caused by the devaluation in European domestic prices of U.S. exports would be negated by an increase in the variable levy. To the degree that this change occurred, the demand curve would shift by that much less than the official amount of the U.S. devaluation.

The long-term analysis indicated that the change in import quantity demanded by countries revaluing or devaluing was also quite small and perhaps even zero. For a devaluing country's currency (for example, Spain in 1967), a devaluation appears as a shift to the left of the import supply curve. This shift occurs for the same reason that the shift in the demand curve for exports occurred. Here, however, the devaluing country is the importer; a devaluation of its currency means that its currency buys fewer units of another country's currency by the amount of devaluation. In effect, the importers within the devaluing country will now be able to buy less of other countries' currencies with the same amount of money. For this to be true, a decrease in supply from all other countries occurs; that is, supply shifts to the left for the devaluing country's imports. Given that this shift occurs, two theoretical reasons can be found for the insignificant change in quantity imported that we noted for the majority of countries and commodities in the time series analysis. The shift of the import supply curve was quite small and/or demand for imports would have to be fairly inelastic. (Demand for agricultural imports is generally considered to be inelastic.)

The study also determined that the change in value due to exchange rate changes was also quite small. Thus, if the change in value and quantity were both small, as they were shown to be in the time series analysis, and value equals price times quantity, then the change in price must also be small. For this to be true, there must be only a small shift in import supply. The shift in import supply must be so small that it prevents the inelastic demand curve from producing a very great increase in price. Theoretically, the shift will be no larger than the change in the exchange rate of the devaluating or revaluing country. In addition, to the extent that the value equations are more significant than the quantity equations, it is possible to say that any measurable effect would be a price effect.

In sum, Kost's theoretical analysis indicates that one would expect only a small impact on agricultural trade because of a devaluation or revaluation. The degree to which either affects exports, imports, or both, depends principally on the degree of elasticity of the export supply and import demand curves, respectively. Particularly in the short run (the period covered by the cross-sectional analysis), the inelasticity of supply and demand in the agricultural sector suggests that exchange rate changes by countries seeking to improve their balance-of-payments position will not greatly affect the level of their agricultural trade.

Analysis presented here provides empirical support for theoretical conclusions outlined in the Kost article. Together, these analyses indicate that we must find the explanation for high U.S. agricultural prices in 1972-73 elsewhere. The U.S. devaluations were not pivotal causes.

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