5-1986

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Patrick C. Westhoff
Iowa State University

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One important concern during the course of debate on the 1985 Farm Bill was how farmers in other countries were likely to respond to changes in U.S. Policies. Those arguing for policies which would reduce commodity prices contended that lower prices would be a major disincentive to foreign production. On the other hand, those favoring price-increasing policies contended that little additional foreign production was likely to result from higher prices.

This paper will outline a method to measure foreign supply response to changes in U.S. commodity prices, and the approach will be applied to the case of Argentine field crops. It will be argued that the proper measurement of foreign supply response requires consideration of the likely response o foreign governments, traders and farmers to changes in world prices. The model developed here links U.s. and Argentine farm prices, and allows for cross-commodity effects.

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Agricultural and Resource Economics | Agricultural Economics | International Economics

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Working Paper 86-WP 9
July 1986

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Theoretical Specification

The 1979 AJAE paper by Bredahl, Meyers, and Collins focused attention on the importance of modeling price linkages correctly. If foreign markets are insulated by government policies or the actions of traders, changes in world prices are unlikely to affect foreign production or consumption of agricultural commodities. Thus, measurement of the "price transmission elasticity" is a key to measuring foreign supply response.

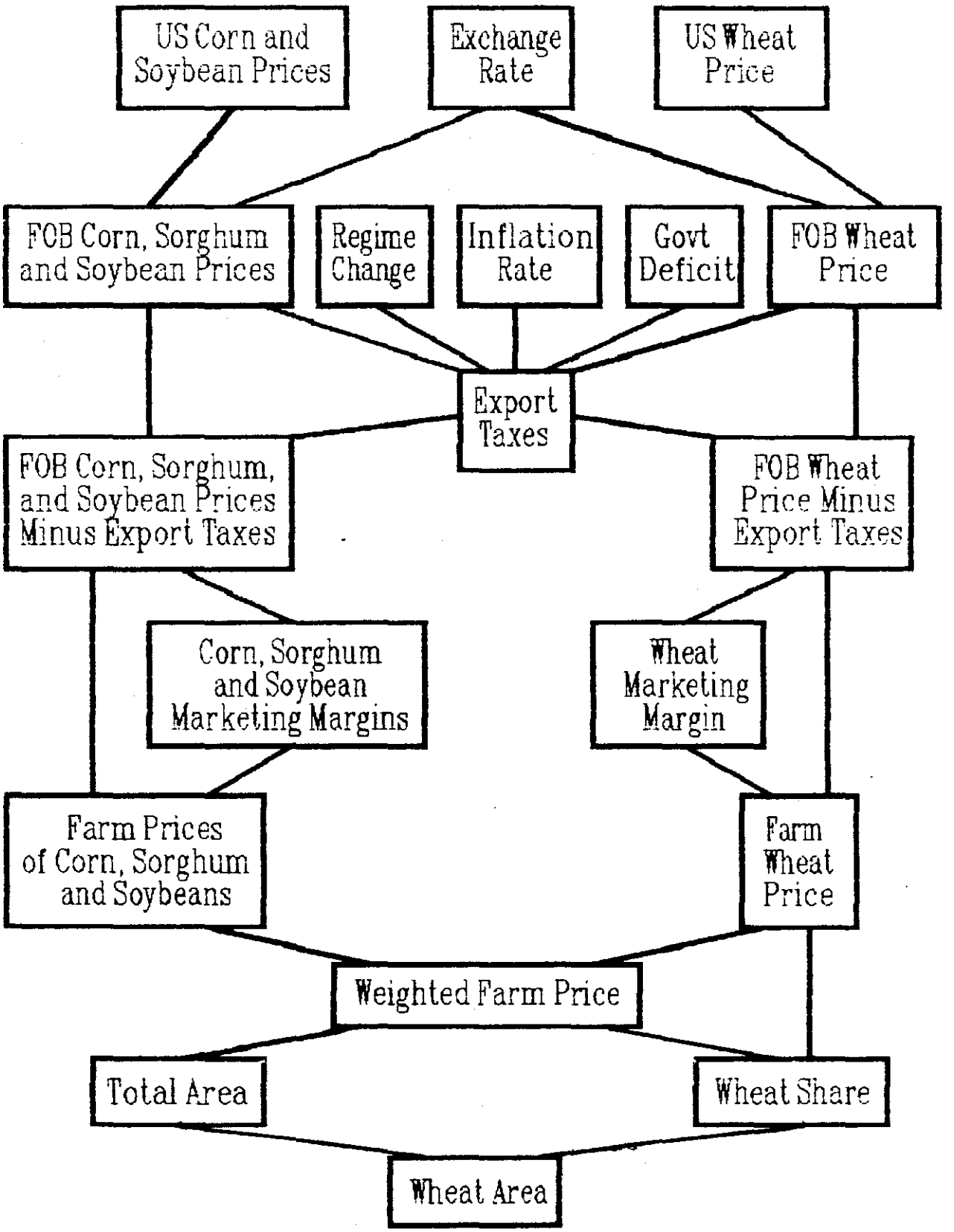
A portion of the model developed here is illustrated in Figure 1. The complete model endogenizes prices, supply, demand and trade for Argentine wheat, corn, sorghum, and soybeans. Due to space limitations, this paper will focus on the determinants of Argentine prices and supplies of wheat, with some attention to cross-commodity effects.

Figure 1 shows that the Argentine FOB wheat price is determined by U.S. wheat prices, which serve as a proxy for world wheat prices, and the exchange rate. FOB prices of corn, sorghum, and soybeans are determined in a similar manner. Since Argentina is a major exporter of all four commodities, it is not completely appropriate to treat world prices as exogenous. However, it does seem safe to assume that the export demand curve facing Argentina is very price elastic, so that treating world prices as exogenous should not bias model results significantly.

The export tax rate is shown to be a function of the FOB prices of all four commodities, the government deficit, the inflation rate and regime changes. As FOB prices increase, the government can increase tax rates and still allow farm prices to increase. Since export taxes are an important

Figure 1:

Response of Argentine Wheat Area to Changes in World Prices



revenue source, increases in the government deficit are likely to result in higher export taxes. Export taxes may be increased when inflation rates are high in order to moderate domestic price increases, since higher export taxes would reduce domestic grain prices. Finally, regime changes like the military takeover in 1976 can result in important shifts in trade policy.

The difference in world and Argentine farm wheat prices cannot be explained completely by export taxes. Instead, the evidence indicates that marketing margins are positively correlated with the FOB price minus export taxes, as indicated in Figure 1. This implies that traders tend to absorb some of the variability in world prices.

The farm wheat price is simply the FOB wheat price minus export taxes, minus the marketing margin. The farm corn, sorghum, and soybean prices are determined in a similar manner.

In the model, total cropped area is a function of the weighted farm price of wheat, corn, sorghum, and soybeans, lagged one year. Weights adjust for the importance of each crop and its mean price. Other variables affecting total area harvested include area harvested in the previous year, cattle production and weather.

The wheat share of total cropped area is a function of the lagged wheat price divided by the weighted lagged price of all four crops. The wheat share in the previous year and weather are other factors affecting the proportion of total cropped area devoted to wheat production. Wheat area, of course, is simply the wheat share multiplied by total cropped area.

The approach described here allows consideration of cross-commodity effects without the estimation problems which often result from collinear prices. It implies a two-stage decision-making process: in the first stage, farmers decide how much land to devote to the four crops and to other uses (such as cattle grazing). In the second stage, they decide how to allocate cropped land among the different crops.

The Model

Data used in estimating the model were obtained from a variety of sources. Argentine FOB prices were obtained from Hazera (1985). Export tax rates were taken from Mielke (1984). Farm prices were obtained from FAO (1985). Area harvested was obtained from USDA (1986). Other data were taken from a World Bank (1985) study.

Key equations in the model are presented in Appendix Table 1, and variable definitions are presented in Appendix Table 2. Other equations, such as those used to determine the real farm prices of corn, sorghum, and soybeans, are not presented due to space limitations. The model is recursive, and parameter estimates are obtained using OLS. Of course, if the Argentine model were part of a larger trade model where world prices were determined endogenously, another estimation technique would be in order.

The dependent variable in the first estimated equation presented in Table 1 is the real FOB price of wheat (WHPXEARR). The first term in the

equation is the average U.S. wheat price in the current and previous U.S. crop years, converted to real Argentine pesos per metric ton. The calculated price transmission elasticity of 0.82 is only slightly less than the expected value of 1.00. A dummy variable for 1980 is included to reflect any premium which might have been paid for Argentine wheat during the U.S. embargo on sales to the Soviet Union. The variable is not significant in this equation, but is significant in the corresponding equation for the corn export price.

The dependent variable in the second equation is the average export tax rate (CRTAXAR). Since 1978, export tax rates have been the same for wheat, corn, sorghum, and soybeans, so an average tax rate is estimated, rather than rates for each commodity. The first variable in the equation is the weighted real export price of the four commodities. The second variable is the government deficit, expressed as a percentage of GDP. The third variable is the log of the inflation rate (logarithms are used to reduce the impact of years with runaway inflation). The final variable is a dummy variable for years beginning in 1977, when the new military government slashed export taxes as part of a sudden move to "free market" policies. All coefficients have the expected sign, and all but the weighted FOB price are statistically significant at standard confidence levels.

The real marketing margin for wheat (WHPDFARR) is the dependent variable in the third equation. The first term in the equation is the FOB price minus export taxes. The coefficient of .344 indicates that about one-third of any increase in FOB prices minus export taxes is not passed on to farmers. Other variables included in the equation are a trend variable, a dummy variable for the last Peron administration, when marketing margins were unusually high, and a dummy variable for 1981 and 1982, when margins were unusually low.

The total area harvested in wheat, corn, sorghum, and soybeans (CRAHHAR) is the dependent variable in the fourth equation. The coefficient on lagged area harvested has the expected positive sign, but is small and not statistically significant. The estimated coefficient on the weighted farm price of the four commodities indicates that Argentine farmers respond strongly to price signals in determining how much land to devote to crop production, as the calculated short-run price elasticity is 0.50. The coefficient on lagged cattle numbers has the expected negative sign, consistent with the observation that cattle grazing is an important alternative use of land. Other variables in the equation include a trend variable and three variables which primarily account for unusual weather.

The final three estimated equations presented in Appendix Table 1 determine the share of total cropped area devoted to corn, sorghum and soybeans, respectively. Each equation includes a lagged dependent variable, a term representing relative farm prices in the previous year, and variables reflecting weather and other factors affecting crop shares.

The model identities reported in Appendix Table 1 are straightforward. The real farm price of wheat (WHPFMARR) is the FOB price minus taxes, minus the marketing margin. Weights used in creating the weighted FOB price (WHPXEARR) reflect export earnings and mean prices. The wheat export tax rate (WHTAXAR) is simply the average rate plus any deviation, and there has been no deviation since 1978. Weights used in creating the weighted farm price (CRPFMARR) reflect shares of total area harvested and mean prices. The wheat

share (WHAHHARP) is one minus the corn, sorghum, and soybean shares. Wheat was chosen to be the residual, since the area devoted to wheat is greater than that devoted to any other crop. Wheat area harvested (WHAHHAR) is the wheat share multiplied by total area.

The reader is reminded that the equations reported here are just part of a larger model, details of which can be obtained upon request.

Validation

Figures 2 and 3 show how the model was able to fit historical data for two important variables, the farm price of wheat and wheat area harvested. In the model, the farm price of wheat depends on the FOB prices of wheat and the other three commodities, the export tax rate, and the marketing margin, all of which are endogenous in the model. As can be seen in Figure 2, the model tracks historical changes in the farm price of wheat quite well.

Wheat area harvested depends on all the other equations in the model, so it is surprising to see how well the model fits historical data. Particularly noteworthy is the model's performance over the last six years. The model captured the sharp increase in wheat area harvested which occurred between 1980 and 1983, as well as the decline between 1983 and 1985.

Shocks to the Baseline Model

Table 1 shows the results of introducing shocks to the model in 1982 and 1983 by changing world prices and the exchange rate. Interesting results include the following:

1. The point price transmission elasticity in 1983 is .58 for wheat, .66 for corn, .42 for sorghum, and .41 for soybeans. A ten percent increase in the U.S. price of wheat results in a 38,300 peso (8.2 percent) increase in the FOB price of wheat, but only a 19,000 peso (5.8) percent increase in the farm price of wheat. Thus, about one-half of the increase in FOB prices goes to farmers, about one-fourth to the government (in the form of export taxes), and about one-fourth to "middlemen." Note that an increase in the price of one commodity actually reduces farm prices of other commodities. Increasing the FOB price of any commodity results in higher export taxes, which in turn reduces the farm prices of other commodities.

2. Increasing the U.S. price of one commodity results in an increase in area devoted to that crop which exceeds the sum of the decreases in area devoted to other crops. For example, a 10 percent increase in the U.S. price of wheat in U.S. crop years 1982/83 and 1983/84 results in a 187,500 hectare (2.9 percent) increase in wheat area in 1984, a 46,500 hectare (1.4 percent) decrease in the area devoted to corn, a 21,800 hectare (0.9 percent) decrease in sorghum area, and a 21,100 hectare (0.7 percent) increase in soybean acreage. Thus, the total area harvested increases by 140,200 hectares (0.9 percent).

Fig. 2: Arg. Wheat: Real Farm Price

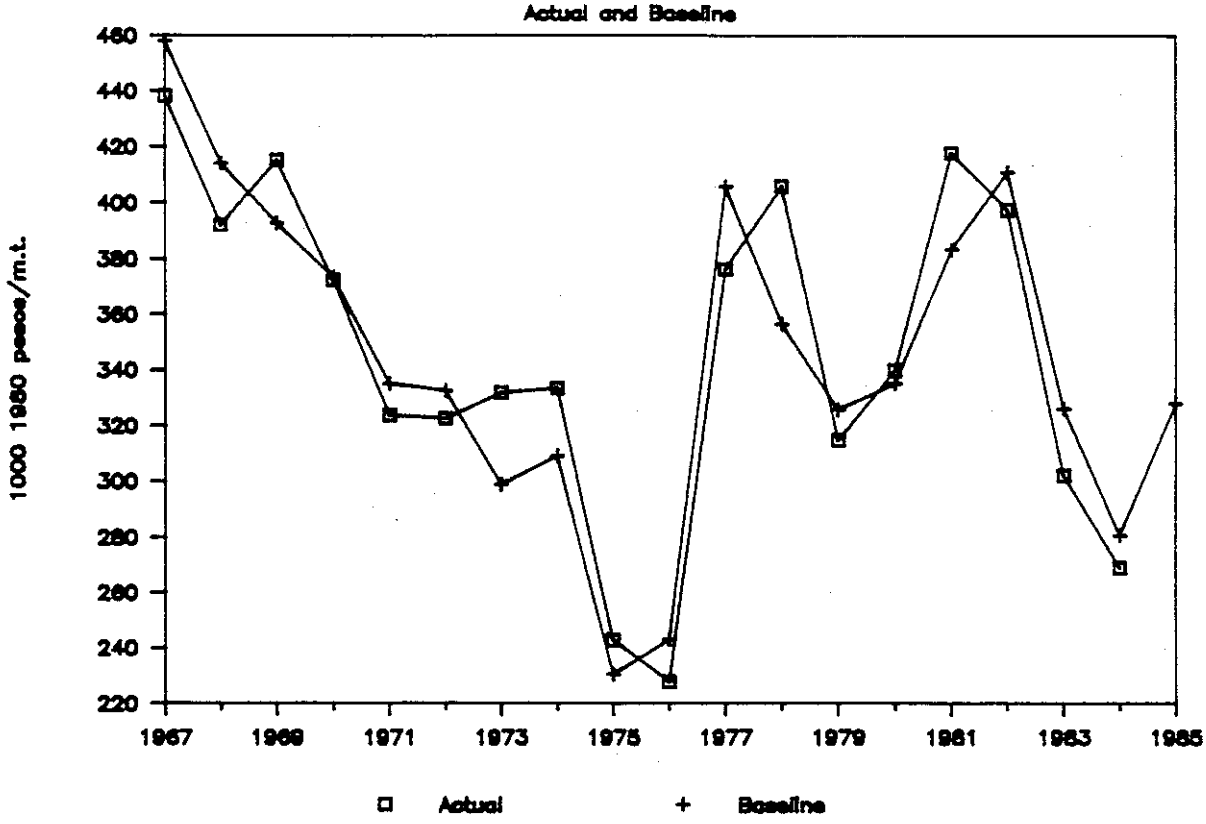


Fig. 3: Arg. Wheat: Area Harvested

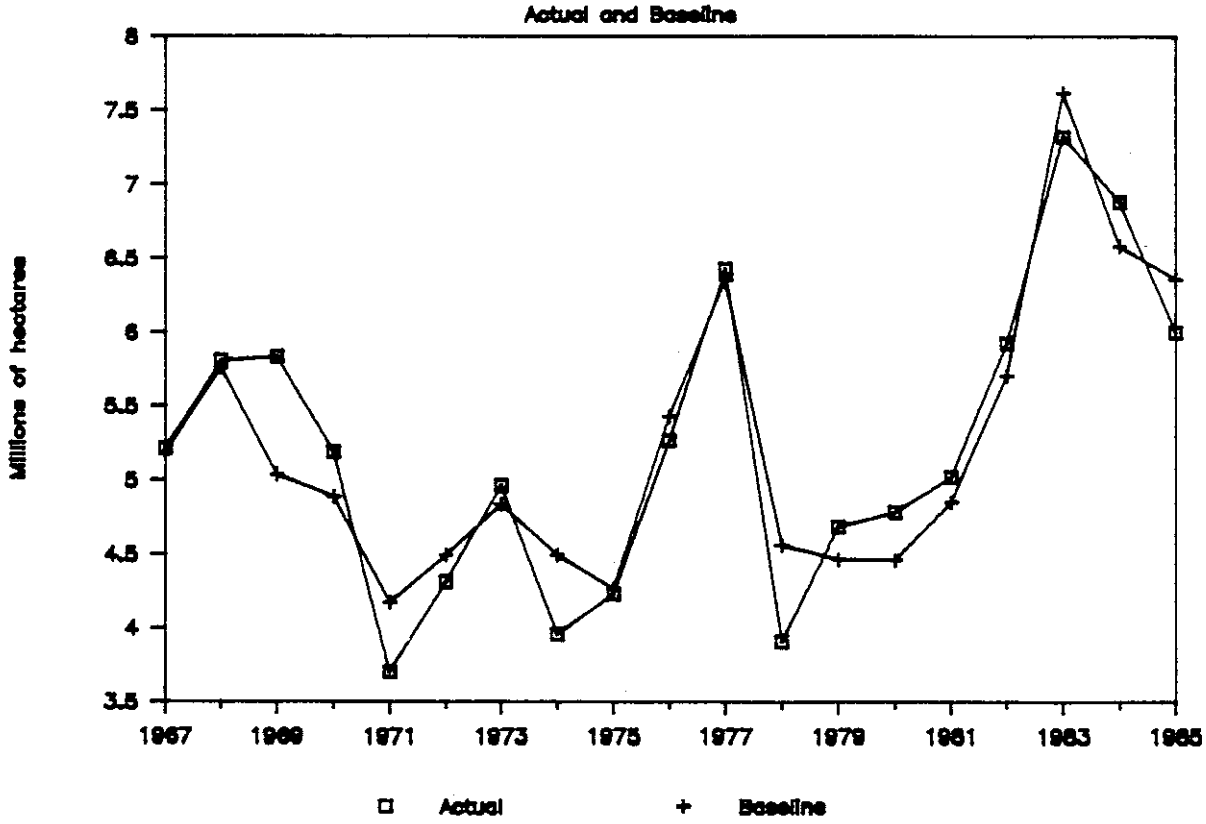


Table 1. Shocks to the Baseline Model

	Change in Selected Endogenous Variables Due to:			
	A 10% Increase in 1982/83 and 1983/84 U.S. Prices of:			A 10% Peso Devaluation in 1982 and 1983
	Wheat	Corn	Soybeans	
Variables Affected in 1983:				
WHPXEARR--Wheat FOB Price				
1000 1980 Pesos/MT	38.3	0.0	0.0	38.3
Percent	8.2	0.0	0.0	8.2
WHTAXAR--Wheat Export Tax				
Tax Rate (%)	0.4	0.7	0.2	1.3
Percent	1.9	3.6	1.2	6.8
WHPDFARR--Wheat Margin				
1000 1980 Pesos/MT	10.0	-1.1	-0.4	8.4
Percent	19.2	-2.2	-0.8	16.1
WHPFMARR--Wheat Farm Price				
1000 1980 Pesos/MT	19.0	-2.2	-0.7	15.9
Percent	5.8	-0.7	-0.2	4.9
COPFMARR--Corn Farm Price				
1000 1980 Pesos/MT	-1.1	21.1	-0.7	19.1
Percent	-0.3	6.6	-0.2	6.0
SGPFMARR--Sorghum Farm Price				
1000 1980 Pesos/MT	-0.6	10.5	-0.4	9.4
Percent	-0.2	4.2	-0.2	3.8
SBPFMARR--Soybean Farm Price				
1000 1980 Pesos/MT	-1.2	-2.4	26.4	22.4
Percent	-0.2	-0.4	4.1	3.6
Variables Affect in 1984:				
WHAHHAR--Wheat Area				
1000 Hectares	187.5	-108.7	26.7	105.4
Percent	2.9	-1.7	0.4	1.6
COAHHAR--Corn Area				
1000 Hectares	-46.5	159.0	-12.1	110.2
Percent	-1.4	4.7	-0.4	3.3
SGAHHAR--Sorghum Area				
1000 Hectares	-21.8	54.6	-5.6	28.3
Percent	-0.9	2.3	-0.2	1.2
SBAHHAR--Soybean Area				
1000 Hectares	21.1	17.9	14.2	55.5
Percent	0.7	0.6	0.5	1.9
CRAHHAR--Total Area				
1000 Hectares	140.2	122.8	23.2	299.4
Percent	0.9	0.8	0.2	2.0

3. A peso devaluation results in an increase in total area, but changes the relative shares, due in part to differences in price transmission elasticities. Corn area harvested increases the most rapidly, due both to a higher price transmission elasticity and a more elastic response to domestic prices. Note that total area harvested increases by 2 percent in response to a 10 percent devaluation.

Conclusion

This paper has suggested a method to measure foreign supply response to changes in U.S. prices. The method outlined here allows one to measure the price transmission elasticity and consider cross-commodity effects. The method is general enough that it could be applied to other countries or regions with only minor modifications.

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APPENDIX TABLE 1: SELECTED MODEL EQUATIONS

OLS Estimates of Selected Behavioral Equations in the Model
(t-values in (), elasticities in [])

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1. WHPXEARR = 85.8 + .958 [(.5*WHPFMUS+.5*WHPFMUS.1)*39.37*NIMECAR/WPI80AR]
(2.09)(10.01)
[0.82]

+ 45.0 DM180
(1.13)

R^2: .878 DW: 1.70 Period: 1967-84

2. CRTAXAR = -13.0 + 14.2 CRPXEARR + 1.19 NAGDFARP + 3.92 Log(WPINFAR)
(1.32) (1.59) (3.39) (2.56)
[0.83] [0.51] [0.23]

- 23.7 DM1S77
(6.01)

R^2: .906 DW: 1.35 Period: 1966-83

3. WHPDFARR = -5855 + .344 WHPXEARR*(1-WHTAXAR/100) + 2.91 TREND
(3.38)(4.43) (3.33)
[2.88]

+ 99.1 DM17376 - 80.2 DM18182
(10.06) (5.65)

R^2: .946 DW: 2.42 Period: 1966-83

4. CRAHHAR = -854013 + .132 CRAHHAR.1 + 5671 CRPFMARR.1 - 401 CASNARR.1
(8.72) (1.29) (4.34) (9.03)
[0.50] [-1.90]

+ 172 CRYHHARD + 445 TREND - 1795 DM17172 + 2570 DM17677
(0.98) (8.83) (5.47) (5.44)

R^2: .976 DW: 2.20 Period: 1967-85

5. COAHHARP = 5.87 + .596 COAHHARP.1 - .0030 TREND
(1.42)(3.35) (1.45)

+ .000468 COPFMARR.1/CRPFMARR.1 - .0664 DM177
(2.71) (3.15)
[0.49]

+ .0198 COYHHARD/.387-CRYHHARD)
(2.73)

R^2: .927 DW: 1.71 Period: 1967-85

OLS Estimates of Selected Behavioral Equations in the Model
(t-values in (), elasticities in []) (continued)

6. SGAHHARP = 8.32 + .261 SGAHHARP.1 - .0043 TREND
(3.22)(1.31) (3.28)

+ .000390 SGPFMARR.1/CRPFMARR.1 + .0332 TRND6671
(1.13) (3.90)
[0.57]

+ .0117 (SGYHHARD/.332-CRYHHARD) - .0604 DM172
(1.74) (2.36)

R^2: .833 DW: 1.89 Period: 1967-85

7. SBAHHARP = .0051 + .282 SBAHHARP.1 + .0339 TRND7780
(1.18) (1.79) (5.71)

+ .000023 DM1S74*SBPFMARR.1/CRPFMARR.1 - .0506 DM18183
(2.80) (5.70)
[0.13]

R^2: .984 DW: 2.66 Period: 1967-85

Selected Model Identities

1. WHPFMARR = WHPXEARR * (1 - WHTAXAR/100) - WHPDFARR

2. CRPXEARR = .31*COPXEARR/415 + .19*SGPXEARR/348 + .32*WHPXEARR/479
+ .18*SBPXEARR/829

3. WHTAXAR = CRTAXAR + WHTAXARD

4. CRPFMARR = .24*COPFMARR/306 + .17*SGPFMARR/249 + .45*WHPFMARR/347
+ .14*SBPFMARR/655

5. WHAHHARP = 1 - COAHHARP - SGAHHARP - SBAHHARP

6. WHAHHAR = WHAHHARP * CRAHHAR

APPENDIX TABLE 2: VARIABLE DEFINITIONS

Endogenous Variables

COAHHARP: Corn area harvested divided by total wheat, corn, sorghum and soybean area harvested.
COPFMARR: Corn, real farm price, in 1000 1980 pesos per metric ton (Equations not shown).
COPXEARR: Corn, real FOB price, in 1000 1980 pesos per metric ton (Equation not shown).
CRAHHAR: Wheat, corn, sorghum and soybean area harvested, in 1000 hectares
CRPFMARR: Weighted real farm price of wheat, corn, sorghum, and soybeans; mean equals 1.
CRPXEARR: Weighted real FOB price of wheat, corn, sorghum, and soybeans; mean equals 1.
CRTAXAR: Average export tax for wheat, corn, and sorghum, in percent.

SBAHHARP: Soybean area harvested divided by total wheat, corn, sorghum, and soybean area harvested.
SBPFMARR: Soybeans, real farm price, in 1000 1980 pesos per metric ton (Equations not shown).
SBPXEARR: Soybeans, real FOB price, in 1000 1980 pesos per metric ton (Equations not shown).
SGAHHARP: Sorghum area harvested divided by total wheat, corn, sorghum, and soybean area harvested.
SGPFMARR: Sorghum, real farm price, in 1000 1980 pesos per metric ton (Equations not shown).
SGPXEARR: Sorghum, real FOB price, in 1000 1980 pesos per metric ton (Equation not shown).
WHAHHAR: Wheat area harvested, in 1000 hectares.
WHAHHARP: Wheat area harvested divided by total wheat, corn, sorghum, and soybean area harvested.
WHPDFARR: Difference between the FOB price of wheat minus export taxes and the farm price of wheat, in 1000 1980 pesos per metric ton.
WHPFMARR: Wheat, real farm price, in 1000 1980 pesos per metric ton.
WHPXEARR: Wheat, real FOB price, in 1000 1980 pesos per metric ton.
WHTAXAR: Wheat, export tax, in percent.

Exogenous Variables

CASNAAR: Cattle numbers, in million head.
COYHHARD: Corn, deviation from trend yield, mt/ha.
CRYHHARD: Weighted deviation from trend yield for wheat, corn, sorghum, and soybeans, standard deviations.
DM17172: Dummy variable, 1 from 1971-72; 0 otherwise.
DM172: Dummy variable, 1 in 1972; 0 otherwise.
DM17376: Dummy variable, 1 from 1973-76; 0 otherwise.
DM17677: Dummy variable, 1 from 1976-77; 0 otherwise.
DM177: Dummy variable, 1 in 1977; 0 otherwise.
DM180: Dummy variable, 1 in 1980; 0 otherwise.

DM18182: Dummy variable, 1 from 1981-82; 0 otherwise.
DM18183: Dummy variable, 1 from 1981-83; 0 otherwise.
DM1S74: Dummy variable, 1 beginning in 1974; 0 otherwise.
DM1S77: Dummy variable, 1 beginning in 1977; 0 otherwise.
NAGDFARP: Argentine government deficit, as a percent of GDP.
NIMECAR: Commercial exchange rate, in pesos per dollar.
SBYHHARD: Soybeans, deviation from trend yield, mt/ha.
SGYHHARD: Sorghum, deviation from trend yield, mt/ha.
TREND: Calendar year.
TRND6671: Trend variable, 1 in 1967, 2 in 1968, 3 in 1969, 4 in 1970, 5 in 1971 and all years thereafter.
TRND7780: Trend variable, 0 before 1977, 1 in 1977, 2 in 1978, 3 in 1979, 4 in 1980 and all years thereafter.
WHPFMUS: Wheat, U.S. farm price, dollars/bushel.
WHTAXARD: Difference between average export tax for wheat, corn, and sorghum and the export tax for wheat, in percent.
WPI80AR: Wholesale Price Index, 1980 equals 1000.
WPINFAR: Wholesale Price Index inflation rate.

NOTE: A ".1" suffix indicates a one-year lag.