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**Agricultural Trade Modeling – The State of Practice and
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A COMPARISON OF THE SIMULATION RESULTS FROM FIVE INTERNATIONAL TRADE MODELS

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The previous papers have described the results of simulating a 5-percent reduction in U.S. grain production and a trade liberalization scenario, using five different international trade models. The five models and model builders are: (1) the World Wheat Trade Model (WTM) of Dixit and Sharples; (2) the Food and Agricultural Policy Research Institute Model (FAPRI) of Meyers, Devadoss, and Helmar; (3) the Michigan State University Model (MSU) of Shagam; (4) the USDA-Grain, Oilseeds, and Livestock Model (GOL) of Liu and Roningen; and (5) the International Institute for Applied Systems Analysis Model (IIASA) of the Food and Agricultural Program presented by Klaus Frohberg.

My task is to compare the simulation results from the models in such a way that similarities and, perhaps, contradictions among the models are highlighted. Before proceeding to this task, however, it is important to note several characteristics of the models that may influence the results of the simulation exercises. Table 1 shows that the commodity and country coverage of the various models differs considerably. Commodity coverage varies from 1 (wheat) for WTM to 20 for GOL, while the number of countries and regions covered varies from 8 for soybeans in the FAPRI model to 34 in IIASA. Of perhaps more importance for this exercise, two of the models (WTM and FAPRI) allow for no cross-commodity effects in their simulations, while MSU allows for interaction among wheat, coarse grains, and soybeans but not with livestock. GOL allows interaction among grains, oilseeds, and livestock, and IIASA allows for interaction among the agricultural sectors and with the nonagricultural sector. These differences in the extent of cross-commodity interaction might result in significantly different results across the various models. In general, we would expect the partial elasticities calculated from WTM and FAPRI to be larger than the total elasticities calculated from MSU, GOL, and IIASA.

Two of the five models, WTM and GOL, are synthetic, using consensus elasticity estimates for the simulations. In both cases, dynamics are ignored and stockholding behavior is incorporated implicitly into the domestic demand elasticity estimates. It should be noted that the intellectual basis for all of the above models is neoclassical microeconomic theory and, at the most basic level, the simulation results will reflect the reaction of supplies and demands, in the various models, to price changes.

Shortrun Effects of a 5-Percent Decline in U.S. Grain Production

Each of the modelers was asked to simulate the effects, over 5 years, of a 1-year 5-percent decline in U.S. grain production. The impacts of the production decline, in the year in which it occurred, are summarized in table 2 for wheat, coarse grains, and soybeans.

The following tentative conclusions, based on the results from all of the models, seem to be in order.

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1. The initial price increase resulting from a yield reduction would be greatest for soybeans (11-20 percent), followed by coarse grains (8-9 percent), then wheat (1.5-5.5 percent). The very large price increase predicted by FAPRI for coarse grains seems inconsistent with the large stocks held in the United States during the year of the production shock. In the simulations of FAPRI, however, government stocks were held constant and as the authors note "this makes all price impacts larger than they would be under current conditions when government stock programs absorb much of the yield variation impact" (4). 1/ Given that tendency, it is surprising that FAPRI's wheat price change forecast is similar to that found using the other models.

2. The export demand elasticity estimates from the various models are most consistent for the soybean market. The models agree that the shortrun U.S. export demand elasticity for soybeans is inelastic with the MSU model generating the smallest estimate (-0.1) and FAPRI the largest (-0.8).

3. In the wheat market, three models show U.S. export demand to be elastic, while in FAPRI it is extraordinarily inelastic (-0.1). In the MSU model, wheat exports are forecast to increase in the face of a production decline and price increase because of the larger price increase in the coarse grain market, that is, cross-price effects offset the direct price effect.

It is worth considering the wheat export demand elasticity of -1.0 from the WTM and the -0.1 elasticity from FAPRI because both are partial demand

1/ Underscored numbers in parentheses refer to sources cited in the References.

Table 1--Selected characteristics of five international trade models 1/

WTM	:	FAPRI	:	MSU	:	GOL	:	IIASA
Commodities (number and type)								
1: Wheat		3 separate models: Wheat, c. grains, soybeans		3: Wheat, c. grains, soybeans		20: Grains, oilseeds, livestock		10: 9 agricultural groups, 1 nonagricultural
Countries/regions								
23: 6 Exporters, 17 Importers		Wheat: 8/1 C. grains: 10/3 Soybeans: 6/2		6/5		16/9		20/14
Synthetic or estimated								
Synthetic		Estimated		Estimated		Synthetic		Estimated
Cross-commodity effects allowed in simulation								
No		No		Yes		Yes		Yes

1/ Partially adapted from a table by Praveen Dixit and Walter Gardiner (2).

elasticities and illustrate the fairly general result that econometrically estimated export demand elasticities tend to be much smaller than estimates derived indirectly. In the WTM, synthetic excess supply and demand elasticities are used. In 8 of the 17 importing regions, accounting for 31 percent of total imports, the excess demand curve is assumed to be totally inelastic and the weighted excess demand elasticity for the remaining price responsive importers is about -0.5. Two of the five exporters (excluding the United States), accounting for 37.5 percent of the non-U.S. exports, are also assumed to be totally unresponsive to price changes, while the weighted average excess supply elasticity of the price-responsive exporters is 0.33. Yet even with these rather conservative estimates, the excess demand elasticity facing the United States is -1.0. What then must lie behind the -0.1 excess demand elasticity emanating from the FAPRI model? It could only result from considerably more than one-third of the world's imports and non-U.S. exports being completely unresponsive to prices, or a large number of countries with excess demand elasticities of less than -0.5 or excess supply

Table 2--A comparison of price changes and selected impact elasticities from five international trade models for wheat, coarse grains, and soybeans

Item	Unit	WTM 1/	FAPRI 1/	MSU 2/	GOL 2/	IIASA 2/
Wheat:						
Price change	Percent	5.5	4.9	1.5	4.6	3.6
Export demand	Elasticity	-1.0	-.1	1.0	-1.7	-1.7
Stock demand	Elasticity	NI	-1.1	-6.5	NI	-1.0
Domestic demand	Elasticity	NI	-1.8	NR	-.5	-.3
Total demand	Elasticity	NI	-.8	NR	-1.1	NR
Coarse grains: 3/						
Price Change	Percent	NI	24.3	7.9	7.8	9.2
Export demand	Elasticity	NI	-.1	-.2	-1.1	-1.2
Stock demand	Elasticity	NI	-.2	-1.3	NI	-1.8
Domestic demand	Elasticity	NI	-.2	NR	-.4	Neg.
Total demand	Elasticity	NI	-.2	NR	-.6	NR
Soybeans: 4/						
Price change	Percent	NI	11.0	20.8	20.2	13.4
Export demand	Elasticity	NI	-.8	-.1	-.5	-.5
Stock demand	Elasticity	NI	-.4	NR	NI	-.4
Domestic demand	Elasticity	NI	-.2	NR	-.1	-.2
Total demand	Elasticity	NI	-.4	NR	-.3	NR

NI = Not included.

NR = Not reported.

1/ Partial elasticities, no cross-commodity effects allowed.

2/ Total elasticities, cross-commodity effects included.

3/ For GOL and FAPRI corn only.

4/ For the IIASA model, the results for protein feeds are reported. The FAPRI and GOL models also include endogenous soybean oil and meal sectors, while the MSU model includes an endogenous soybean meal sector.

elasticities less than 0.3. This seems highly doubtful and simply illustrates the well known difficulty of estimating excess demand and supply parameters econometrically. In case this might be considered a criticism of only the FAPRI model, this is not the intention as a perusal of the export demand elasticities compiled by Gardiner and Dixit shows (3). Of the nine econometric estimates of U.S. shortrun excess demand elasticities for wheat, eight are below -0.45 and most fall in the range of -0.14 to -0.26. At least for wheat, it seems clear that the method used to generate excess demand elasticities largely predetermines the size of the elasticity that will be found.

4. Although not readily apparent from table 2, the elasticity of stock demand in the United States plays a major role in determining shortrun price variations. Stock demand changes, unfortunately, are incorporated into domestic demand in the WTM and GOL models and were not reported for the MSU soybean model. In the soybean market, both the FAPRI and IIASA models incorporate a stock demand elasticity of -0.4. In the coarse grain market, stockholding is elastic in the MSU and IIASA models and very inelastic in the FAPRI model. For wheat, the FAPRI and IIASA models both incorporate elasticities close to unity, while stockholding in the MSU model is very elastic at -6.5.

Dynamic Effects of a 5-Percent Decline in U.S. Grain Production

Table 3 shows the impact of the U.S. production shock on U.S. prices, production, and net exports in the year of the shock (year 1), the following year (year 2), and the fifth year (year 5). By year 5, the values of most of the variables in all of the models appear to be returning to the baseline levels. Nonetheless, there are clear differences in the degree of dampening of dynamic effects across the models and also some subtle differences across commodities.

The GOL model appears to return to baseline values most quickly with only small differences appearing in the year following the production shock. Likewise, the FAPRI model returns close to baseline values by the second year following the shock. For both of these models, prices, production, and exports are within 1 percent of the baseline values by the fifth year of the simulation.

Dynamics appear more pronounced in the MSU model than in FAPRI or GOL. In several cases, second year impacts are nearly as large as, or larger than, the first year impacts. Even in the fourth year after the shock, about one-half of the variables shown in table 3 differ from their baseline values by more than 2 percent.

As in the MSU model dynamic effects in the IIASA model appear more pronounced than in GOL or FAPRI, even though only first and fifth year results are reported. Although not shown in table 3, cross-commodity effects outside the grain sector also appear significant in the IIASA model, particularly in the short run, whereas they are negligible in GOL and ignored in the other models.

Table 3 suggests that the coarse grain market is the most stable, while the soybean and wheat markets encompass more dynamic effects.

Trade Liberalization

The model builders were given considerable latitude in modeling trade liberalization, and they made full use of this leeway. The most complete trade liberalization scenario is performed with the IIASA model by removing border protection for all agricultural commodities in all regions (excluding China and the Council for Mutual Economic Assistance (CMEA) countries). In FAPRI, trade liberalization is "evaluated by removing existing policies that inhibit the transmission of world market price variability to domestic markets" (4) in the countries included explicitly in the model (excluding the CPE's) for grains only. In the MSU model, trade is liberalized only for the developed markets (European Community (EC), Japan, other Western Europe, and South Africa) and again only for grains. The WTM liberalized wheat trade in the United States, Japan, and the EC.

Even though the trade liberalization scenarios in these models are quite different, some evidence indicates that EC trade policies for wheat and coarse grains are responsible for much of the policy-induced price depression in the world wheat and coarse grain markets (1). Consequently, a comparison of the results of trade liberalization from the FAPRI, MSU, WTM, and IIASA models, particularly in terms of world price impacts and production and trade effects in the EC, may be of some interest. These results are reported in table 4 for the fifth year following trade liberalization.

In the wheat market, the results from FAPRI and IIASA are roughly comparable. U.S. wheat prices increase by about 20 percent, while those in the EC decline by roughly 30 percent. EC wheat production declines 20-30 percent, and their

Table 3--A comparison of selected dynamic effects from four international trade models for wheat, coarse grains and soybeans

Item	FAPRI			MSU			GOL			IIASA 1/	
	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year
	1	2	5	1	2	5	1	2	5	1	5
	<u>Percent change from base run</u>										
Wheat:											
Price	4.9	9.3	-1.0	1.5	6.7	2.3	4.6	-1.2	0	3.6	-1.8
Production	-5.0	1.1	-1.0	-5.0	-.2	3.4	-5.0	NR	NR	-5.0	1.2
Exports	-.4	-.8	-.1	1.5	5.8	2.0	-7.8	.4	-.3	-6.0	0
Coarse grains:											
Price	24.3	-.2	-.2	7.9	6.6	1.4	7.8	-1.4	-.2	9.2	-2.5
Production	-4.9	.3	0	-5.0	.7	.6	-5.0	NR	NR	-5.0	.5
Exports	-2.6	-4.7	0	-1.5	-.8	-1.0	-8.3	-1.0	-.2	-10.7	1.2
Soybeans:											
Price	11.0	-5.6	.5	20.8	8.5	0	20.2	1.5	.5	13.4	2.2
Production	-5.0	2.6	-.3	-5.0	-1.2	-1.3	-5.0	NR	NR	-5.0	NR
Exports	-9.1	.9	-.7	-1.3	-3.1	-5.0	-9.1	2.3	0	6.8	-1.3

NR = Not reported.

1/ Results were only reported for the first and fifth years of the simulation.

exports decline by 60-80 percent. The directions of change for the identical variables in the MSU model are all in the same direction, but the responses are considerably smaller. In WTM, the trade effects are similar to FAPRI and IIASA, but the world price effect is the smallest in the four models.

The predicted changes in the coarse grains market are more variable across models than in the wheat market, except that in all cases they show less response to trade liberalization than for wheat. The MSU and IIASA models both predict an increase in EC coarse grain production as a result of the decline in EC wheat prices relative to coarse grain prices. All of the models predict a decline in EC coarse grain exports ranging from insignificant in the MSU model (-0.5 million metric tons (MMT)) to sizable (-5.4 MMT) in IIASA.

Conclusions

I had hoped by the end of this review to be able to draw five or six solid conclusions from the exercises that could be incorporated into our thinking as representing conventional wisdom. However, it appears that this is not possible. Several general tendencies of the models were identified, but the models differ so much in terms of commodity coverage and cross-commodity effects that it is difficult to know if the economic truth has been discovered or just some random similarities.

The trade liberalization results illustrate a difficulty in our profession with this type of exercise. Constructing policy models for countries other than the EC, Japan, United States, Canada, and Australia is extraordinarily difficult because of the lack of an adequate information base. Where do we

Table 4--A comparison of trade liberalization results 5 years
after liberalization for wheat and coarse grains

Item	Unit	FAPRI		MSU 1/		IIASA		WTM 2/	
		Unit	Percent	Unit	Percent	Unit	Percent	Unit	Percent
			change		change		change		change
Wheat:									
U.S. price	\$/metric ton	NR	(26.8)	8.5	(9.2)	NR	(17.3)	6.0	(4.1)
EC price	\$/metric ton	NR	(-30.0)	NR	(NR)	NR	(-35.3)	44.0	(-22.0)
EC production	Million MT <u>3/</u>	-19.0	(-27.0)	-4.1	(-4.9)	-14.0	(-21.8)	NI	(NI)
EC exports	Million MT <u>3/</u>	-9.6	(-64.0)	-3.0	(-32.3)	-16.1	(-79.4)	-11.6	(-77.3)
Coarse grains:									
U.S. price	\$/metric ton	NR	(12.4)	1.4	(1.3)	NR	(17.3)	NI	(NI)
EC price	\$/metric ton	NR	(-23.0)	NR	(NR)	NR	(-20.0)	NI	(NI)
EC production	Million MT <u>3/</u>	-2.1	(-3.0)	2.0	(1.8)	3.5	(4.5)	NI	(NI)
EC exports	Million MT <u>3/</u>	-4.7	(NR)	-0.5	(-1.9)	-5.4	(-43.0)	NI	(NI)

NR = Not reported.

NI = Not included.

Numbers in parentheses show percent change.

1/ Changes reported for the EC are for the region defined as developed markets in the MSU model.

2/ Longrun results.

3/ Million metric tons.

turn as a profession to find a time series of (1) effective consumer prices, (2) effective producer prices, and (3) a listing of the important policy variables, and their values, used in most countries for most agricultural commodities? Until we can obtain this type of information, we will not make much progress in comprehensive policy evaluations. As an aside and concluding comment, it is interesting to note that although four of the five models evaluated are based in the United States, only WTM and IIASA attempted to liberalize U.S. grain policy. Also, in both of these cases, the U.S. acreage reduction programs were handled using ad hoc side calculations carried on outside the modeling framework.

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