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*A Discussion of Long-Term Agricultural Commodity Forecasts***

INTRODUCTION

The comparison of the properties and projections of agricultural commodity models is a relatively recent phenomenon (Meilke, 1987). However, it is an important way to: (1) foster improvements in commodity modeling; and (2) to expose the profession to areas of consensus and disagreement that exist among the handful of large scale models being used on a regular basis. It is equally important for any model commentators to acknowledge that it is far easier to criticize a model than it is to build one. Criticism is easy because model building involves an exercise in constrained optimization. The constraints in model building are capital, labour, data and perhaps just as importantly the ability to assimilate, understand and describe the results of the analysis. Because of these constraints, model building involves trade-offs and compromises. These choices are often guided by the original purpose for which the model was developed; and while we sometimes argue the need for all-purpose models, what we generally have are models that were developed for a single purpose that then evolve and are adapted to fulfil other roles.

The difficulties are well illustrated by the two tasks assigned to the model builders. First, they had to forecast future supply, demand and prices under different assumptions (such as GDP and population growth rates); and second, they had to analyse a trade liberation scenario. The size and detail of the models necessary to perform the two assigned tasks are quite different; with the analysis of trade liberalization requiring a higher level of sophistication. In the remainder of the paper our comments are organized under four broad headings: (1) model design and scope; (2) policy implementation; (3) model inputs and assumptions; and (4) model results.

MODEL DESIGN AND SCOPE

The FAPRI model (Johnson, *et al.*, 1988) was initially designed to provide detailed short to intermediate run forecasts of the US agricultural economy. As US agriculture has become more open to international forces, the 'foreign' component of the FAPRI model has been expanded to include econometric

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**A discussion of the previous three papers.

representations of many major trading nations. Nonetheless, while the country coverage of the FAPRI grains model is now fairly extensive its 'US forecasting roots' are still obvious. Detailed and comprehensive evaluations of policy changes on the welfare of nations outside the US are beyond the scope of the FAPRI model because of the limited country/commodity coverage. Even for the US the calculation of standard welfare measures from FAPRI is not a trivial matter. Most commodities involve multiple demands and complex expectations mechanisms that make calculating producer and consumer surplus difficult.

Conversely, SWOPSIM (Roningen, *et al.*, 1988) is an example of a model designed to evaluate trade liberalization scenarios. It was not intended to be used in a forecasting mode and it is normally calibrated on a historical time period. SWOPSIM is similar in design to other synthetic models developed by OECD, and Cahill (1988). These models tend to provide comprehensive country coverage, although only five of SWOPSIM'S eleven regions are single countries. Twenty-two commodities are produced and consumed in each SWOPSIM region, although in a few cases commodities are aggregated. Given the simple static supply/demand structure of SWOPSIM, welfare analysis involves rather straightforward calculations of consumer and producer surplus. We should not leave the impression that SWOPSIM has solved all of the problems involved in analysing trade liberalization. SWOPSIM is a static model and as such it can say nothing about the time path of adjustment from one equilibrium solution to another. In particular, the biological constraints and dynamics of livestock production are largely ignored. Stockholding, which is crucial in the short and medium run for grains, is modeled explicitly in FAPRI and WB but stocks are assumed fixed in SWOPSIM. In addition, policy interventions are treated exogenously and incorporated as price wedges rather than as explicit policy variables (de Gorter, 1987).

FAPRI and the World Bank (Akiyama and Mitchell, 1988) models are dynamic, and one of their strengths is their ability to trace the time path of adjustment resulting from a policy change or exogenous shock (for example drought). Stockholding is modeled explicitly and for the United States most policy instruments, which are set exogenously, are embedded in the structure of the model. The WB model for grains is an annual econometric model as are the coffee, tea and cocoa models which have features specific to perennial crop modelling. However, like FAPRI, the WB grains model began its life as a US forecasting model. Its eclectic choice of countries to be modelled and the lack of policy detail in non-US countries do not lend themselves to an analysis of multi-commodity trade liberalization. The WB models do highlight a serious shortcoming in most of the current generation of multi-region, multi-commodity models in that they are almost without exception focused on temperate zone products and countries, even though the export value of tropical products, sugar and beverages accounts for almost 14 per cent of the value of the world's agricultural exports (FAO, 1987).[1] Sugar and rice appear to be the only commodities of direct interest to LDCs that have been given much attention in current models.

All of the models at this session are partial equilibrium models, thus negating our ability to calculate the welfare costs and employment effects of agricultural protectionism on the nonagricultural sector. Similarly, agricultural inputs other than feed have been almost totally ignored in our modeling efforts. This implicitly

assumes that agricultural inputs purchased from the general economy have perfectly elastic supply schedules.

Trade liberalization and technological change also have important consequences for the value of agricultural assets. The wealth of the agricultural community is largely determined by the value of land. Thus, it is crucial to know the impact of various types of market interventions on the value of agricultural land since the effects can vary greatly across potential instruments (Hertel, 1988).

POLICY IMPLEMENTATION

The way in which agricultural policies are accounted for in the SWOPSIM and FAPRI models differs significantly (explicit policy variables do not appear in the WB model outside the US and a trade liberalization scenario was not conducted). Trade liberalization in SWOPSIM involves more commodities but fewer individual countries than FAPRI. Agricultural trade liberalization in FAPRI is limited to grains in the US, EC, Japan, Brazil, Argentina and most importing countries, plus livestock in the US, EC and Japan.

In SWOPSIM, policy interventions are accounted for by using calculated price wedges (between domestic and world prices) and policy insulation by using elasticities of price transmission of less than one. The size of the price wedge in SWOPSIM is equated to the producer subsidy equivalent for each commodity, in each country, using a broad definition of policy intervention (USDA, 1988). To illustrate this point and to provide a contrast with FAPRI, we chose to investigate the treatment of Canadian wheat.

In SWOPSIM, the Canadian market price for wheat is 117 C$/mt but the supply inducing price is 200.1 C$/mt. Canada's price transmission elasticity is assumed to be one. To model trade liberalization, the per unit PSE in Canada, as well as in all other countries, is set to zero, and for some countries the elasticity of price transmission is increased. The maintained assumption is that a dollar transferred to producers under any programme has the same effect on their production choices. In contrast, in FAPRI, no changes are made to the Canadian grains submodel to simulate trade liberalization. Implicitly it is assumed that the parameters estimated in FAPRI reflect the response of both producers and the Canadian government as prices and policy transfers vary, and that these would be unchanged in the face of trade liberalization by other nations.

Neither of the extreme assumptions utilized in the SWOPSIM and FAPRI models are likely to be correct, with the truth probably lying somewhere in between. In fact, with the exception of the Canadian transportation subsidies, two-priced wheat, and fuel rebates, it is unclear exactly how to model Canadian grain policy. The Western Grain Stabilization Act and the Special Canada Grains Program are prime examples. Johnson, *et al.* (1988) argue that the effect of these programmes (53 per cent of total support in 1986) on supply decisions is zero and Roningen, *et al.* (1988) argue that it has raised long-run price expectations by more than 35 per cent of the market price. While this example may over-state the differences between SWOPSIM and FAPRI in regions where both have mod-

elled trade liberalization, it does illustrate the different approaches taken by the two models.

Both SWOPSIM and FAPRI assume that the values of policy variables are determined exogenously and are not influenced by the economic environment (FAPRI analysts do interact with the model in determining the baseline forecasts) even though casual empiricism suggests that this is not the case. Why then, have most large commodity models not endogenized policies? First, policy analysis, almost by definition, requires that the value of key policy instruments be treated exogenously. In this way policy variables are easily manipulated to generate alternative 'policy scenarios'. Second, for short-run forecasting policy, variables are often specified in legislation, or are relatively easy to project on the basis of historical trends. In addition, short-run forecasts are normally, although not always, dominated by non-policy factors (drought, livestock cycles, and so on). However, for long-run forecasts, the endogenization of key policy variables would have the advantage of getting away from the assumption of invariant policies (or a policy black box) in the face of a changing economic environment.

MODEL INPUTS AND ASSUMPTIONS

Commodity models can be no better than the data that are used to construct them. It is by now a cliché to state that as a profession we have invested far more resources in model building than in data improvement. Estimates of production, consumption and trade for the major agricultural commodities, in most countries, are generally available. However, reliable data on commodity stocks, producer prices and consumer prices are spotty or non-existent. Good data on livestock production, herd size, the age/sex composition of livestock populations and average grain consumption per animal type is difficult to obtain for industrial countries and unreliable or not available for most other countries. Our data difficulties also extend to the policy arena where we have little easily accessible information on the policy instruments used in various countries and the values of these instruments over a reasonable period of time. One of the lasting benefits of the USDA's work in calculating producer subsidy equivalents is likely to be a better understanding of the key policies in a number of countries.

Most of the assumptions embedded in our agricultural commodity models follow from neoclassical economic theory; although most models fail to exploit the full richness of this theory. However, a key assumption of all current large models is that of homogenous products (Goddard, 1987; de Gorter and Meilke, 1987). We find that for grains, let alone animals products, this assumption is not easy to defend. Trade in animal products often involves two-way trade in differentiated processed and semi-processed products; with trade further restricted to certain trading groups because of technical regulations. If this is a general representation of the trading environment, then the gains from trade liberalization are likely to be overstated in a homogenous product model unless the demand for new differentiated varieties increases substantially, an effect which is unlikely to be captured in an empirical model.

MODELS RESULTS AND LONG TERM OUTLOOK

The three groups of modellers have different commodity coverage, different levels of aggregation for commodities and countries and different base periods for their simulations. In contrast with the WB and SWOPSIM models, FAPRI's predictions do not extend to the year 2000. There are significant differences in the forecasts of the three models. These differences can be attributed largely to the unique nature of each model's design. However, it should be noted that the alternative scenarios and some of the assumptions regarding exogenous variables are not identical across the models.[2] This undoubtedly contributes to the divergence in the predictions.

Prices

The SWOPSIM model predicts that by the year 2000 the real aggregate agricultural price index will be 3.8 per cent lower than in 1986/87. Wheat, coarse grains, and soybean prices are expected to decline by 8.8, 9.6 and 9.8 per cent, respectively, while dairy products and ruminant meats become more expensive by 3.1 and 10.2 per cent. Within its narrower commodity coverage, the WB model forecasts larger price declines. Real prices for wheat (No. 1 CWRS), corn and soybeans are forecast to be 23.0, 16.4 and 31.6 per cent lower in 2000 than in the 1987 base year (Table 1). FAPRI's price predictions are more optimistic. Johnson, *et al.* (1988) expect real prices for both wheat and corn to increase slightly by 1995 relative to 1986/87, while the real price of soybeans should decline by 9.2 per cent.

To determine the degree of sensitivity of the predictions, the modelers were asked to run different scenarios by modifying exogenous variables such as yields, GDP and population growth rates. In addition, they were asked to simulate trade liberalization in developed countries. The predictions of prices prove to be sensitive to the new assumptions. Under a low growth scenario, SWOPSIM projects dairy prices to be 15.7 per cent below the base run in 2000 as opposed to a rise of 18.3 per cent under optimistic conditions. Such variations clearly reveal the high income elasticity of demand for dairy products. FAPRI's wheat price under the base run scenario for the year 1995/96 is US$124/mt. If high growth or low yield conditions were to prevail, FAPRI anticipates the price of wheat to rise by 41.1 and 48.0 per cent, respectively. The low growth/high yield scenarios would reduce the prices to US$86/mt and US$84/mt. WB prices for wheat, corn and soybeans, like SWOPSIM's, do not increase as much as FAPRI's in high growth scenario. In such a scenario, WB real prices for wheat, com and soybeans would be 17.7, 16.3 and 22.5 per cent higher in 2000.[3] This is somewhat surprising since FAPRI's 1995 projections do not benefit from the high growth taking place between 1995 and 2000. Based on FAPRI's results, it is evident that there is no substitute for rapid economic growth if the objective is to raise prices.

Due to the high level of trade distortions present in animal product markets (for example, quotas and technical regulations), SWOPSIM anticipates freer trade to be more effective in raising animal products prices than high growth.

TABLE 1 *Percentage change in real prices for different scenarios*

	Base 1995/ Base 1986[a]	Freer Trade[b]/ Base 2000[c]	High Growth/ Base 2000[c]	Low Growth/ Base 2000[c]
Wheat				
FAPRI	6.0	12.9	41.1	–30.6
WB 1995	–19.3	n.a.	12.5	–5.7
2000	–23.0	n.a.	17.7	–9.4
SWOPSIM	–8.8	25.9	15.9	–13.8
Maize				
FAPRI	10.0	18.4	44.8	–29.9
WB 1995	–13.2	n.a.	10.2	–7.5
2000	–16.4	n.a.	16.3	–9.6
SWOPSIM[d]	–9.6	18.8	10.8	–9.8
Soybeans				
FAPRI	–9.2	–9.6	52.1	–31.4
WB 1995	–30.1	n.a.	15.0	13.0
2000	–31.6	n.a.	22.5	–14.8
SWOPSIM[e]	–9.8	6.8	14.2	–11.6

Notes: [a]The base for WB is 1987.
[b]Trade scenarios differ between models.
[c]FAPRI's farthest projections are for 1995.
[d]Coarse grains prices.
[e]Oilseeds and products.

Prices are not directly comparable across models because the modellers have chosen prices for different products and the wedges between these prices are not constant over time (for example, the WB price for wheat is the Canada No 1 CWRS price while FAPRI's price is for a US No. 2 H.W. 13 per cent).

Freer trade's relative efficacy in increasing prices can also be extended to include wheat and coarse grains (in contrast with FAPRI).

FAPRI and SWOPSIM predictions also contrast in a freer trade environment. According to FAPRI, prices for soybeans and its by-products would decrease while the price of corn would rise. This may be attributed to the EC market where trade liberalization would lower the demand for protein meals and increase the demand for coarse grains. SWOPSIM's freer trade world is kinder to oilseeds and its products with a projected 6.8 per cent price increase over the base scenario for 2000. According to SWOPSIM, the price for dairy products would experience a tremendous boost in a less distorted world.

Production

SWOPSIM's results are aggregated and cannot be directly compared to FAPRI or WB. SWOPSIM projects aggregate supply to be 16 per cent larger in the year 2000 than in 1986/87. Freer trade would imply a decrease in aggregate supply of 11 per cent when compared to the base run supply for 2000. Moreover, SWOPSIM's aggregate supply is not very sensitive to changes in GDP growth

rates. SWOPSIM and WB agree that production will increase relatively more in LDCs than in developed countries.

As shown in Table 2, both FAPRI and WB expect wheat, coarse grains and soybean production to increase by 1995. The WB model predicts higher production growth for the three commodities that the two models have in common. FAPRI and the WB model seem to confirm that production is not sensitive to changes in GDP with perhaps soybeans in the WB model being the one exception. One may suppose that the income elasticities for wheat and coarse grains are fairly low and/or that their supply curves are very inelastic.

Only FAPRI provided production changes on a commodity basis under a freer trade scenario. According to the model's results (Table 2), trade liberalization would have no impact on aggregate soybean production and very little effect on wheat and coarse grain production (0.5 per cent decrease and 0.7 per cent increase respectively).

Exports

For net trade, SWOPSIM'S results are aggregated over commodities, which makes it difficult to compare them with the FAPRI and WB predictions. SWOPSIM forecasts an improved agricultural trade balance for developed countries by the year 2000 (9.5 per cent rise). The same holds for CPEs but to a lesser extent since their net agricultural exports increase by only 2.6 per cent as opposed to a fall of 12.1 per cent for the LDCs. Higher GDP growth rates would raise developed countries' net exports by 23.3 per cent and reduce the LDCs' agricultural trade balance by 6.1 per cent. Freer trade would have the opposite effect by increasing the LDCs' self-sufficiency ratio by 9.1 per cent and diminishing the developed countries' net exports by 12.5 per cent. This could be explained by the higher (world) prices that would prevail in a world where trade was freer. These higher prices would reduce the LDCs' demand for imports from the industrialized world and would induce them to produce more.

Table 3 indicates the net trade of wheat, coarse grains and soymeal in 1995 predicted by the FAPRI and WB models. The two models have very similar forecasts for both soymeal and coarse grains. In the case of wheat, WB anticipates a larger volume of trade than FAPRI whose estimates for developed countries' net exports and LDCs' net imports are smaller.

Table 3 also shows the percentage change in expected net trade between 1990 and 1995. Again, the WB model shows more pronounced growth in developed countries' net exports and in LDCs' net imports than FAPRI. In general, both models agree on the direction of the changes (for example, industrial countries' net exports of wheat and coarse grains should rise between 1990 and 1995). The exceptions are CPEs' wheat net imports and soymeal net exports from developed countries. As opposed to WB, FAPRI expects CPEs' wheat imports to decrease between 1990 and 1995 and industrial countries' imports of soymeal to increase during the same time period. FAPRI's net exports in 1995 are not as sensitive to changes in demand assumptions as are the WB forecasts. According to FAPRI, freer trade would have no effect on soymeal net exports and would have only minuscule effects on wheat and coarse grain trade.

TABLE 2 *Percentage change in production for different scenarios*

	Base 1995/ Base 1986	Freer Trade/ Base 1995	High Growth/ Base 1995	Low Growth/ Base 1995
Wheat				
FAPRI	15.7	–0.5	1.5	–1.0
WB	23.5[a]	n.a.	4.2	–2.0
Coarse grains				
FAPRI	13.2	0.7	1.7	–1.3
WB	17.4[a]	n.a.	2.7	–1.8
Soybeans				
FAPRI	28.6	0	3.2	–3.2
WB	41.0[a]	n.a.	7.2	–4.8
Aggregate supply growth				
SWOPSIM[b]	28.0	–1.0	3.0	–4.8

Notes: [a]The base used by WB is 1985.
[b]The base used by SWOPSIM is 2000.

CONCLUSION

Although there is some disagreement among the models on how real prices will evolve over the next decade, there is a consensus that agricultural price projections are quite sensitive to changes in GDP and that prices would rise under a freer trade scenario (except for soybeans in FAPRI). All three models agree that production will increase in the future. FAPRI does not expect freer trade to change the global production of soybeans, coarse grains and wheat, as the production efficiency gains from trade are largely offset by the removal of production subsidies. SWOPSIM on the other hand forecasts that aggregate supply of the developed countries would decline by 11 per cent under free trade. Net exports of wheat and coarse grains by developed countries should be higher by 1995 (FAPRI, WB) and more so if trade was liberalized (FAPRI), but a more global outlook shows that the agricultural trade balance for developed countries is likely to deteriorate in a freer trade scenario (SWOPSIM). SWOPSIM's analysis also shows that producer surplus in developed countries would be considerably reduced by trade liberalization which indicates the need for decoupled assistance programmes, if maintaining farmers' well-being is to remain a major goal of farm policy.

It is difficult to judge the validity of the above predictions. It was argued at the outset that some of the assumptions used to simplify the structure of the models are too restrictive and perhaps unrealistic. Nevertheless, we believe that this forecasting exercise has generated useful information if it is interpreted with caution. Regardless of the choice of analytical instrument (empirical models vs economic theory), one has to impose assumptions in order to obtain tractable results. As long as the results emerging from the models are consistently close to reality, the choice of assumptions should not be overly questioned. This rule is

not exclusive to empiricists. The Heckscher-Ohlin-Samuelson model is still the best theoretical trade model despite the well-known limitations of its assumptions. Like 2x2x2 theoretical models, econometric models are useful approximations of reality. As such, they do not have to be perfectly accurate to be valuable.

NOTES

[1]In 1985, exports of tropical products, sugar and beverages contributed only 2.9 per cent to the value of agricultural exports in developed countries as opposed to 36.6 per cent for the LDCs (FAO).

[2]For example, FAPRI uses slightly different GDP growth rates and the WB low and high growth scenarios include different population growth assumptions.

[3]As the time horizon is shortened, the impact of higher or lower GDP growth rates on real prices is reduced. For the year 1995, price increases due to higher GDP for wheat, corn and soybean would be 12.5, 10.2 and 15 per cent respectively.

TABLE 3 *Net trade – the impact of high growth (% change)*

	Developed Countries (net exports)		LDCs (net imports)		CPEs (net imports)	
	FAPRI	WB	FAPRI	WB	FAPRI	WB
Wheat						
Volume 1995 (million tons)	89.0	100.6	70.8	85.3	17.2	15.3
Base 1995/ Base 1990 (%)	9.9	17.2	14.0	19.1	–9.0	7.0
High Growth/ Base 1995 (%)	6.7	25.9	10.0	21.8	–0.6	49.0
Coarse grains						
Volume 1995 (million tons)	62.0	67.8	42.8	40.9	19.2	26.8
Base 1995/ Base 1900 (%)	29.2	45.8	32.1	36.3	23.1	63.4
High Growth/ Base 1995 (%)	19.4	32.3	21.5	31.8	19.8	33.6
Soymeals						
Volume 1995 (million tons)	–3.9	–4.9	–12.9	–13.7	9.0	8.8
Base 1995/ Base 1990 (%)	–8.3	7.5	–16.2	–7.0	20.0	18.9
High Growth/ Base 1995 (%)	21.1	18.4	–2.3	21.9	12.2	17.0

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