GTAP-AGR[1]: A Framework for Assessing the Implications of Multilateral Changes in Agricultural Policies

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[1] Pronounced gee-tap-ag, the 'R' is silent.

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GTAP-AGR Specific Sets

Set Name[3]	**Description**	**Elements**[4]
AGRI_COMM	Farm Level Sectors	pdr, wht, gro, v_f, osd, c_b, pfb, ocr, ctl, oap, rmk, wol
FOOD_COMM	Food Processing Sectors	cmt, omt, vol, mil, pcr, sgr, ofd, b_t
LSTK_COMM	Livestock Prod. Sectors	ctl, oap, rmk
FEED_COMM	Feedstuffs Commodities	pdr, wht, gro, v_f, osd, c_b, pfb, cmt, omt, vol, mil, pcr, sgr, ofd
PROG_COMM	Program Commodities	pdr, wht, gro, osd, c_b
NAGR_COMM	Non-Agricultural Commodities	*PROD_COMM* less *AGRI_COMM* elements

[3] For standard GTAP sets and their composition, please see McDougall and Dimaranan (2002).
[4] For definitions of these codes for aggregate commodities, please see Table 1 describing the commodity/sector aggregation. For more information regarding the composition of the aggregate commodities/sectors, please see McDougall and Dimaranan (2002).

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Abstract

Global models of agricultural trade have a long and distinguished history. The introduction of the GTAP data base and modeling project represented a significant advance forward as it put modelers and trade policy analysts on common ground. After an initial generation of GTAP based modeling of agricultural trade policy using the standard modeling framework, individual researchers have begun introducing agricultural specificity into the standard modeling framework in order to better capture the particular features of the agricultural economy pertinent to their research questions. This technical paper follows in that same tradition by reviewing important linkages between international trade and the farm and food economy and introducing them into the standard GTAP modeling framework, offering a special purpose version of the model nicknamed GTAP-AGR.

We introduce this agricultural specificity by introducing new behavioral relationships into the standard GTAP framework. We focus particular attention on the factor markets, which play a critical role in determining the incidence of producer subsidies. This includes modifying both the factor supply and derived demand equations. We also modify the specification of consumer demand, assuming separability of food from non-food commodities. Finally, we introduce the important substitution possibilities amongst feedstuffs used in the livestock sector. Where possible we support these new behavioral relationships with literature-based estimates of both the mean and standard deviation of behavioral parameters. The express purpose of this is to support systematic sensitivity analysis with respect to policy reform scenarios performed with GTAP-AGR.

In addition to documenting these extensions to the standard modeling framework, the paper has an additional goal, and that is to gauge the performance of the GTAP-AGR model and how it differs from the standard GTAP framework. We do this primarily by comparing the farm level supply and demand response in terms of policy incidence for the two frameworks. In addition, we evaluate the ability of both models to reproduce observed price volatility in an effort to validate the performance of these models. Finally, we evaluate the results of the two models in a side-by-side comparison of results from full liberalization of agricultural and non-agricultural support.

1. Introduction

There is a long and distinguished history of global modeling of agricultural markets and the impact of developed country liberalization on the developing world (van Tongeren *et al.* 2001). Some of the earliest work in this area was that of Valdes and Zietz (1980) who conducted a highly disaggregated, commodity by commodity analysis of the developing country impacts of trade reform. Following in this tradition, extensive work was undertaken at ERS/USDA in the 1980's using the multi-commodity, partial equilibrium SWOPSIM framework (Roningen and Dixit, 1989; Krissoff, Sullivan and Wainio, 1989). Meanwhile, the econometrically-based, partial equilibrium analysis of Tyers (1985) and Tyers and Anderson (1986) contributed effectively to raising public awareness of the "disarray in world food markets" due largely to developed country policies. In Europe, and especially at the OECD, the general equilibrium modeling work of Burniaux and his co-authors also had a substantial impact in the 1980's and early 1990's (Burniaux and Waelbroeck, 1985; Burniaux et al., 1990; Burniaux and van der Mensbrugghe, 1991). At the International Institute for Applied Systems Analysis (IIASA) there was an important project seeking to build a global model "from the ground up" by linking a series of unique national general equilibrium models sponsored by IIASA, and culminating in the publication of the volume by Parikh, Fischer, Frohberg, and Keyzer (1988).

All of these efforts represented multi-year, indeed sometimes decade-long, commitments by the authors to gather data, program models, estimate parameters and conduct policy simulations to assess the impact of agricultural policies on world food markets. Each one of these models had its own unique features, seeking to capture different key aspects of world food markets. For example, Tyers and Anderson emphasized the dynamics of supply and world-domestic price transmission. Burniaux and Waelbroeck focused heavily on factor markets and rural-urban migration. The IIASA model sought to bring in more of the physical constraints on food production. As such, each of these efforts represented many different "views of the world". Indeed these models were generally seen as extensions of the authors, as they were rarely used by others who were not co-authors (SWOPSIM being an important exception).

Since the mid-1990's, the analytical landscape has changed dramatically with the advent of the Global Trade Analysis Project – nick-named GTAP (Hertel, 1997). Now, almost all of the individuals and agencies conducting analysis of the global implications of agricultural liberalization make use of the GTAP data base – and a global applied general equilibrium model.[5] Proponents of the GTAP approach will argue that this has facilitated great strides in our understanding of global trade due to improved data quality, the associated advancement of greatly improved tools for modeling and analysis, and the widespread replication of results (largely non-existent in the global modeling area prior to GTAP – with the exception of the SWOPSIM work). With regard to agricultural trade in particular, the shift towards general equilibrium modeling has had many advantages, including: (a) greater theoretical consistency, (b) improved welfare analysis, (c) exhaustive coverage of the farm and food complex, and (d) integrated treatment of agriculture and non-agriculture liberalization.

However, there have also been disadvantages associated with this GTAP-based, general equilibrium approach to the modeling of agricultural trade. One of these has been the tendency to abstract from specific structural features that characterize global food and agricultural markets. Critics argue that the GTAP-based models are overly simplistic and do not capture many

[5] A few examples are: (Anderson *et al*. (2001).; Diao *et al*. (2003); Francois, van Meijl, and van Tongeren (2003); Frandsen *et al.* (2002); Harrison *et al.* (1996)). For a more extensive, but still very partial, listing, visit the GTAP web site: www.gtap.org . A simple search for the keyword "agriculture" turns up more than 100 GTAP applications.

important characteristics of the agricultural economy. They also argue that the GTAP parameters need more solid econometric foundations.[6] While we count ourselves among the advocates of the GTAP approach, and shudder to think of developing a unique global data base and model for each project/institution, we are also inclined to agree with the criticisms of model structure and parameters. Therefore, the primary purpose of this paper is to outline one approach to redressing some of these concerns, while retaining the advantages of the GTAP-based, global general equilibrium approach.

The goal of this paper is two-fold. The first goal is to re-introduce detailed agricultural structure into global general equilibrium trade modeling and underpin this with econometric estimates from the literature. In so doing, we build on recent work by the OECD (2001) which seeks to characterize the degree of factor market segmentation between the farm and non-farm sectors as well as improving the representation of input substitution possibilities in farm production. We also explicitly identify farm households as entities which: (a) earn income from both farm and non-farm activities, (b) pay taxes, and (c) consume food and non-food products based on an explicit utility function. Our consumer demand system is based on recent work by Seale, Regmi and Bernstein (2003) which provides international cross-section estimates of price and income elasticities of demand for food products in more than 100 countries. Finally, we incorporate newly available estimates of trade elasticities[7] (Hertel, Hummels, Ivanic and Keeney, 2003).

The second goal of this work is to assess the difference in model outcomes that occur due to the altered specification of structure and parameters. We do this in terms of an agricultural liberalization experiment focusing on the three pillars of support, oft discussed in the literature assessing WTO implementations. Specifically, we fully liberalize export subsidies, tariffs, and agricultural domestic support, and focus on the welfare, trade, and price impacts that arise from this experiment with an eye toward identifying the sources of difference in simulation results between the two models.

2. *Model Design*

The GTAP-AGR model represents a special purpose version of the GTAP model, designed to capture certain structural features of world agricultural markets that are not well-reflected in the standard GTAP model – or indeed in most other global trade models currently in use. These features are required in order to provide a more realistic representation of the farm and food system. They are also necessary in order to capitalize on recent econometric work on key elasticities in the global agricultural economy.

The discussion of model design is broken into subsections, each dealing with a different aspect of the model. At each stage we discuss both the revised economic theory as well as the parameters used to specify that part of the model. Due to the specificity of this model structure and the associated parameters, GTAP-AGR is no longer as readily flexible with respect to commodity and region aggregation. (The standard GTAP model can be run, without modification, for any commodity aggregation, ranging from 1 to 57, and for any number of regions up to 85 using the version 6 data base.) In particular, the user must either leave the farm and food sector fully disaggregated or she must undertake her own calibration of certain key parameters. The 20 farm and food products as well as the aggregate manufacturing and services sectors are identified

[6] See Hertel (1999) for an assessment of GTAP-based analysis of global trade policy in light of John Whalley's "hidden challenges for AGE analysis" (Whalley, 1986).

[7] These trade elasticity estimates are from Hertel *et al* (2003) and they have recently been incorporated into the public release of GTAP Version 6.

in GTAP-AGR are listed in Table 1. Aggregation of non-food activities is less problematic, as the structure here follows that in the standard GTAP model. Non-food activities have been grouped into 6 broad sectors for purposes of the present study. Regional disaggregation requires the user to specify additional parameters – the easiest approach is to let the disaggregated regions inherit the parameters from the parent region. However, it is hoped that the user will supplement the parameter file with estimates from the newly disaggregated focus countries. In the present study, we work with the 23 regions identified in Table 2.

2.1 Standard GTAP: The Point of Departure

Our initial point of departure is the GTAP model of global trade (version 6.2). GTAP is a relatively standard, multi-region model which includes explicit treatment of international trade and transport margins, a "global" bank designed to mediate between world savings and investment, and a relatively sophisticated consumer demand system designed to capture differential price and income responsiveness across countries. As documented in Hertel (1997) and on the GTAP web site[8], the model includes: demand for goods for final consumption, intermediate use and government consumption, demands for factor inputs, supplies of factors and goods, and international trade in goods and services. The model employs the simplistic but robust assumptions of perfect competition and constant returns to scale in production activities. Bilateral international trade flows are handled using the Armington assumption by which products are exogenously differentiated by origin.

This technical paper was under taken with the GTAP 6 database, pre-release 3, available in October of 2004 (see Dimaranan and McDougall, 2005, for documentation of the version 6 data base). We are particularly interested in the specification of domestic support, as the impacts of these subsidies on agricultural production is a contentious issue, and depends importantly on the specification of the agricultural component of the model (OECD, 2001). In the GTAP database, all the different components of OECD PSE data except for market price support are distributed into four classifications of domestic support namely: output subsidies intermediate input subsidies, land-based payments and capital based payments (Jensen, 2002).

2.2 Primary Factor Supply

Since the path-breaking work of T.W. Schultz (1945), agricultural economists have recognized the importance of off-farm factor mobility – particularly for labor – in determining farm incomes. In his review of US agriculture, Bruce Gardner (1992) highlights this fact and notes that, in the US, farm and non-farm wages have moved together (with the former being lower throughout) since the second World War – largely as a result of steady off-farm migration of workers. Despite this long-term co-movement of wages, there is significant evidence that wage differentials persist in developed economies and that the policy implications of these can be important (Kilkenny, 1993). The limitations of agricultural labor markets have been prominently featured in the development economics literature, as an explanation for the very low level of agricultural supply response in developing countries (de Janvry *et al*., 1991). If labor and capital were perfectly mobile between agriculture and non-agriculture, as is commonly assumed in applied general equilibrium models, then we would expect to see wages equalized at each point in time for farm and non-farm workers with comparable skills. However, this is not the case. And in some

[8] www.gtap.org

countries (China is an extreme example), rural-urban wage differentials are quite large (Zhao, 1999).

Ideally, we would like to explain the factor market segmentation in terms of underlying barriers to factor mobility – for example the system of *Hukou* registration in China. However, successfully explaining this limited farm/non-farm, rural/urban mobility across the full range of countries in our model would be a lifetime project. Instead, we specify a constant elasticity of transformation (CET) function which "transforms" farm-labor into non-farm labor (see Figure 1). There are several important characteristics of this function. Firstly, it is constrained by the total labor endowment in the economy. Increased supplies of labor to manufacturing and services must be drawn from agriculture. This is important, as it will force the economy to respect the aggregate resource constraints. Secondly, with a finite elasticity of transformation, it permits wages to diverge between the farm and non-farm sectors. And thirdly, the elasticity of transformation can be calibrated to replicate any desired (non-negative) elasticity of labor supply to agriculture. This third point is particularly handy in light of the econometric evidence available on this subject which typically comes in the form of such factor supply elasticities. Within agriculture, labor is assumed to be perfectly mobile, and similarly for non-agriculture.

In addition to segmentation of labor markets, evidence suggests that the segmentation of capital markets may also be appropriate. Therefore, we also introduce a CET function governing capital movements between agriculture and non-agriculture, with full capital mobility (a unique rental rate on capital) within these respective sectors. Land is specific to agriculture in the GTAP database, and only one type of land is distinguished so the modeling of land supply to alternative agriculture activities is treated with the same CET function as the standard GTAP model where land in a given use is imperfectly mobile amongst agricultural uses[9]. Equations (1) and (2) below represent the CET agricultural and non-agricultural supply of factors in GTAP-AGR, where the index **i** represents the mobile endowment commodities (labor and capital) and **r** is a regional index.

$$qoagr(i,r) = qo(i,r) + ETRAEAGNAG(i,r) * [pm(i,r) - pmagr(i,r)] \quad (1)$$

$$qonagr(i,r) = qo(i,r) + ETRAEAGNAG(i,r) * [pm(i,r) - pmnagr(i,r)] \quad (2)$$

Variable	Description (all variables in percent change)
qoagr	Supply of endowment to agricultural sectors
qonagr	Supply of endowment to non-agricultural sectors
qo	Total Supply of endowment
pm	Market price for endowment
pmagr	Market price for endowment in agriculture
pmnagr	Market price for endowment in non-agriculture

Parameter	Description
ETRAEAGNAG	Elast. of Transformation between Ag. and Non-Ag. use

[9] Huang *et al.* introduce multiple land types into their GTAP-PEM model to restrict the mobility of land among agricultural uses.

In order to parameterize the agricultural CET supply functions in GTAP-AGR, we draw on the excellent report prepared by the OECD (2001). Among the valuable contributions of this report, the annexes provide extensive econometric literature reviews for the EU (Salhofer, 2001) and for North America (Abler, 2001). These authors provide central parameter values for factor supply elasticities for land, labor, and capital supplied to agriculture (see tables A1.3 and A1.4; OECD, 2001), which we use to calibrate the GTAP-AGR CET supply functions. These elasticities[10] are reproduced in Table 3 along with the associated standard deviation. The latter are derived based on parameter ranges supplied in the OECD report, coupled with the assumption that these values follow a symmetric, triangular distribution[11].

Note that the estimated factor supply elasticities are less than one, which is a sharp contrast to the assumption of perfect factor mobility for labor and capital used in most AGE analyses. This means that commodity supply will also be less price-responsive, and more of the benefits of farm subsidies (or losses from their elimination) will accrue to farm households, as opposed to consumers of the farm products.

The OECD report also attempts to come up with supply elasticities for purchased inputs. However, there is little econometric evidence to draw on here. One advantage of the general equilibrium framework offered by GTAP-AGR is that these commodity supply responses are endogenously determined – as a function of the factor market assumptions as well as the cost structure of the industry. Therefore, we dispense with the OECD estimates of input supply for fertilizer and other purchased inputs. The supply prices for intermediate inputs are endogenous in the model and determined by the interaction of supply and demand in each of these markets.

2.3 Derived Demands for Agricultural Inputs

On the factor demand side, we employ a nested-CES production function which can be calibrated to the three key elasticities of substitution available from the OECD report (Table 4). Specifically, we postulate that output is produced using a constant elasticity of substitution (CES) production function combining two inputs, which are themselves composite inputs (see Figure 2). The first of these is a purchased input aggregate. This is what distinguishes the GTAP-AGR production function from that in the standard GTAP model. The second composite input is a farm-owned (value-added) aggregate. The individual inputs in each of these groups are assumed to be separable from one another. The equations describing the CES input demands for aggregate value added and purchased inputs by agricultural sectors (i.e. the index **j** refers only to elements of the set *AGRI_COMM*) follow as (3) and (4). Demands for individual inputs (endowments and intermediates) are given in (5) and (6). In all equations below **j** refers to an element of *AGRI_COMM*, **r** refers to an element of *REG*, and **i** refers to an element of *TRAD_COMM*.

The purchased input and farm-owned aggregates are themselves each a CES function of individual farm inputs, the latter corresponding to the value-added aggregation function in the standard GTAP model. This gives us a total of three CES substitution parameters which need to be calibrated. They are calibrated to the OECD central values for the Allen partial elasticities of substitution between: (i) land and other farm-owned inputs (ESUBVA), (ii) land and purchased

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[10] As a reviewer points out we assume the same transformation elasticity for skilled and unskilled labor even though the expectation is that unskilled labor is more mobile. Our assumption is driven by the lack of econometric evidence to support differential transformation frontiers for the two types of labor employed in agriculture in the GTAP database.

[11] The conversion of a mean and lower bound to a standard deviation for the symmetric triangular distribution follows the formula $\sigma = \left(mean - lower\ bound\right)/\sqrt{6}$

inputs (ESUBT), and (iii) among purchased inputs (ESUBPURCH). The values we use for regions in the GTAP-AGR model are based on the OECD (2001) report and are presented in Table 4 along with the implied standard deviation assuming a symmetric triangular distribution[12]. The user should note that in the parameter file we make use directly of the Allen elasticities and include calibration equations within the model code to determine the actual ESUBVA and ESUBPURCH parameters for sectors in the set *AGRI_COMM*[13].

*qva(j,r) = qo(j,r) - ESUBT(j,r) * [pva(j,r) - ps(j,r)]* (3)

*qpurch(j,r) = qo(j,r) - ESUBT(j,r) * [ppurch(j,r) - ps(j,r)]* (4)

*qf(i,j,r) = qpurch(j,r) - ESUBPURCH(j,r) * [pf(i,j,r) - ppurch(j,r)]* (5)

*qfe(i,j,r) = qva(j,r) - ESUBVA(j,r) * [pfe(i,j,r) - pva(j,r)]* (6)

Variable	**Description (all variables in percent change)**
qva	Demand for farm-owned aggregate input
qpurch	Demand for purchased inputs aggregate
qf	Demand for individual intermediate input
qfe	Demand for individual endowment input
qo	Sector output
pva	Price index for farm-owned aggregate
ppurch	Price index for purchased input aggregate
pf	Price of individual intermediate input
pfe	Price of individual endowment input
ps	Supply price of output

Parameters	**Description**
ESUBT	Elast. of Sub. between farm-owned and purchased inputs
ESUBPURCH	Elast. of Sub. among purchased inputs
ESUBVA	Elast. of Sub. among farm-owned inputs

Adapting the production parameter ranges from the OECD (2001) report, which covers just six countries, to the 23 regions in the GTAP-AGR model requires a mapping from 6 to 23 regions. We specify this mapping based on similarities in agricultural economies and regions. There is limited evidence available on what supply and substitution elasticity values might be in developing countries. In GTAP-AGR, we simply set the parameter values in all non-OECD countries equal to those for Mexico. It is hoped that future authors will remedy this gap by providing additional

[12] Ibid.
[13] This facilitates sensitivity analysis since we key all agricultural technology model parameters off of the six regional parameters given by OECD (2001). This allows a complete sensitivity analysis to be conducted with respect to these six Allen elasticities for which we have econometric evidence.

parameter estimates for some of these other countries. For purposes of the present analysis, this limited coverage in developing countries is not viewed as a significant drawback since agricultural support – the subject of our analysis below -- is largely a developed country phenomenon, and the change in producer response to liberalization of support we focus on will occur largely in developed regions. Of course, further work on the parameter file that will allow differentiation of producer responsiveness remains a priority for future versions of this model.

2.4 Crop-Livestock Interactions

Another important aspect of the farm and food marketing system relates to the crop-livestock interactions generated by the use of feedstuffs in livestock production. The potential for alternative feedstuffs to substitute for one another in livestock rations constrains crop prices to move together, at least to some degree. For example, while wheat is not a predominant ingredient in livestock production, if it gets cheap enough, it will be fed. And indeed it is fed to livestock in many parts of the world.

Analysis of European grains policy in the face of CAP reform and the Uruguay Round Agreement on Agriculture brought a great deal of focus to the interactions of the livestock and crops sectors as cheaper imported grain substitutes were replacing European grains in feed rations. The literature of this period is ably reviewed by Peeters and Surry (1997), with regard to approaches and empirical findings. These authors note that the majority of this work modeled the compound feed sector due to ready access to data for that sector and the demand for feed ingredients being closely linked to that of livestock sectors.

From the Peeters and Surry (1997) review of approaches, it is clear that a best representation would be to incorporate a separate feed cost-minimizing linear program in the model for each livestock type in each region to capture the responsiveness of crop ingredient demand in livestock production. However, this is also well-beyond the scope of this project, and would require a degree of ingredient disaggregation that is not possible in our data base. Instead, we seek to capture the average degree of feedstuff substitution in a single, constant elasticity of substitution among crop and food products used in livestock production following Rae and Hertel (2000) and as depicted in Figure 3. The demand for feedstuffs is treated as a further CES nest below the purchased inputs aggregate. The associated equation is given below in (7). Demand for non-feedstuff intermediate inputs in livestock sectors is identical to that given in (5) above. For the case of feedstuffs inputs however, we use the equation in (8) to capture the close substitution in feed rations for livestock, where *qfs* and *pfs* are CES quantity and price aggregates of feedstuff demand.

$$qfs(j,r) = qpurch(j,r) - ESUBPURCH(j,r) * [pfs(j,r) - ppurch(j,r)] \quad (7)$$

$$qf(i,j,r) = qfs(j,r) - ESUBFS(j,r) * [pf(i,j,r) - pfs(j,r)] \quad (8)$$

Variable	Description (all variables in percent change)
qfs	Demand for feedstuffs aggregate
pfs	Price for feedstuffs aggregate
Parameters	Description
ESUBFS	Elast. of Sub. between feedstuffs

Given this modeling choice, we turn to the literature described above to find a suitable estimate for parameterizing livestock sector behavior. We derive our measure of livestock feedstuffs substitution from the matrix of feed price elasticities estimated by Surry (1990). He uses a two-stage model of the compound feed mixing sectors and separate livestock sectors to estimate derived demands for feed ingredients. We take as our CES substitution parameter the share-weighted average (0.9) of the off-diagonal elements of the matrix of Allen-Uzawa elasticities of substitution (AUES) as depicted in Table 5. We also select from this matrix the lowest positive substitution parameter AUES (corn, protein concentrate = 0.15) to reflect the lower bound on the CES substitution parameter's symmetric triangular distribution.

2.5 Consumer Demand

There is a rich tradition of econometric analysis of demand for food in agricultural economics reaching back to the work of Waugh, and summarized in Tomek and Robinson (1981). More recently the complete demand system work by Huang and Haidacher (1983) and Huang (1985), as well as Cranfield et al. (2002) has highlighted the role of food demand in the consumer budget. Unfortunately, little of this rich tradition is reflected in most models of global trade.

Historically, the standard GTAP representation draws on two studies[14] of international cross-country demand, and the resulting elasticity estimates, for parameterizing consumer demands in the model. The first is the World Food Model of the Food and Agriculture Organization, which comprises a collection of literature-based estimates (FAO, 1993). The second source is the work of Theil, Chung, and Seale (1989) which is based on the data in the International Comparison Project (ICP) data for 51 countries collected in 1980. The GTAP CDE expenditure system is calibrated to eleven aggregate consumption goods using these region specific estimates of income elasticities and a set of target own-price elasticities derived from these income elasticities and the assumption of directly additive preferences embodied in the Linear Expenditure System (Dimaranan, McDougall, and Hertel, 2002). These authors note that the CDE expenditure system is flexible enough to allow independent information on own-price elasticities to be used in the calibration of preferences, but that cross-country studies of demand are generally not focused on generating good measures of price response.

Fortunately, a new study, based on more recent information has become available. This utilizes the 1996 ICP data base and it devotes considerable attention to the measure of cross-country aspects of price response (Seale, Regmi and Bernstein, 2003). This international, cross-

[14] The GTAP Version 6 database parameter file will feature estimated target income elasticities using the AIDADS demand system and 1996 ICP database Reimer and Hertel (2003). This parameter change was not yet available in the version 6 pre-release 3 that we use for comparing the GTAP and GTAP-AGR models.

section study is ideally suited to our needs, as it provides estimates of income and own-price elasticities of demand for eight disaggregated food products. Their study estimates a non-homothetic, two-level, strongly separable demand system in which total food expenditure is determined at the top-level, in conjunction with eight non-food categories of expenditure (see Figure 4). The lower-level demand system estimates the share of total food expenditure allocated to each of eight categories, including: beverages and tobacco, breads and cereals, meats, fish, dairy, fats and oils, fruits and vegetables, and other food products.

Ideally, we would like to incorporate the complete two-level demand system of Seale, Regmi and Bernstein (2003) directly into our model. Unfortunately there are several complications associated with this model extension. The most important is the fact that their demand system is not derived from an explicit utility function, so we need to develop a nested function which is flexible enough to calibrate to these elasticities, while retaining the global regularity properties necessary for policy simulations.

Recent advancements in the field of two-level expenditure systems for consumption goods in CGE models have shown promise. Gohin (2003) offers a GTAP-based application incorporating the earlier work of Perroni (1992) and Perroni and Rutherford (1995) on non-nested CES demand systems. Gohin calibrates his non-homothetic system drawing on the concept of latent separability to determine shares of food goods that enter into each level of the CES nesting within the food sub-utility aggregate. This calibration generates third order effects that force the modeler to choose whether to calibrate to the evolution of income elasticities or price elasticities. Unfortunately, demand studies offer little evidence for making this choice. In addition, the calibration relies on cross-price effects for determining the nesting procedure, another area where cross-country demand evidence is severely limited.

The incorporation of a two-level nested demand system remains an important goal for the future development of GTAP-AGR. However, this is part of a much broader field of research and we leave such an undertaking to future work. In the current specification of GTAP-AGR we simply calibrate the CDE demand system in the standard GTAP model to own-price and income elasticity targets for nine consumption categories: those derived from the estimated parameters of Seale, Regmi, and Bernstein's demand system for the eight good food sub-nest and one aggregate, non-food good. This means that we do not differentiate the price and income elasticities of demand for non-food goods in the model. The resulting final demand specification should be adequate for most scenarios of agricultural liberalization, but is potentially problematic when impacts of non-food liberalization are important to the analysis. Table 6 provides the specific mapping of disaggregate GTAP commodities to the eight calibrated pairs of elasticities.

The Frisch own-price elasticities of demand for the disaggregated food products for selected countries and the (total) expenditure elasticities of demand from Seale, Regmi and Bernstein (2003) are reported in tables 7 and 8 respectively[15]. These are the target elasticities used to calibrate the GTAP-AGR model parameters SUBPAR and INCPAR using the method described in Dimaranan, McDougall, and Hertel (2002). The entries in these tables are ordered by increasing levels of per-capita expenditure, and as Seale, Regmi, and Bernstein (2003) note, we generally observe an increasing responsiveness in expenditure and price response moving up the column. The relative responsiveness of poorer countries such as India and Egypt (for breads and cereals more than 3 times larger, and fats oils roughly 2.5 larger), compared to that of richer

[15] The Frisch elasticities hold the marginal utility of total income constant in computing the household's price response. Note that these price and expenditure elasticities are "unconditional" in the terminology of the Seale, Regmi and Bernstein. I.e. they include the change in aggregate food consumption induced by a change in the price of (e.g.) meats.

countries like Australia and Germany, is a hallmark of international cross-section consumption studies.

Establishing appropriate standard errors for these consumer demand parameters in the model is at the forefront of refining the GTAP-AGR model. These elasticities are based on a different functional form and a means of translating the associated estimation errors for given elasticities in the estimated model to the CDE functional form we use for simulation needs to be developed. The challenge of translating the authors' standard errors into distributions on model parameters is further confounded by the calibration process we use which takes the database shares as given and adjusts the target estimated elasticities to generate a globally regular demand representation. Finally, since our primary purpose in providing standard errors is to facilitate Systematic Sensitivity Analysis (SSA) with respect to model parameters, the regional specificity of elasticities presents a problem. A method for generating SSA variations on the consumer demand parameters in large regional groupings needs to be developed. As with the two-level demand modeling aspect addressed above, we view this as a more general issue of model development which will benefit from ongoing research well-beyond the scope of this particular technical paper.

2.6 International Trade Elasticities

The most important parameters in any global trade model are the trade elasticities. The most common specification here is that of Armington (1969) – here the elasticity of substitution among imports from competing sources is key. For small countries, this dictates their export elasticity of demand, while for larger countries, it provides an upper bound, with the difference being attributable to market share. As such, these parameters are the key to determining the TOT effects associated with export expansion, as well as the degree of preference erosion that occurs.

It is also common to relate the import-domestic elasticity of substitution to the import-import substitution elasticity using the "rule of two", i.e. the latter is twice the former. This is the approach to parameter specification in the GTAP model. Unfortunately, the studies upon which the original GTAP parameters were based are rather old now, and rather aggregated – having only a single value for agricultural products and one for food.[16]

For purposes of this study, we draw on a more recent set of parameter estimates as presented in Hertel, Hummels, Ivanic and Keeney (2003). These are estimated based on the methodology outlined in Hummels (1999). He uses detailed trade, tariff and transport cost data for a variety of importing countries in North and South America to estimate a differentiated products model of import demand. The variation in bilateral transport costs permits him to get quite precise estimates of these parameters – in sharp contrast to much of the earlier work in this area which is plagued by insignificant estimates and even signs that are inconsistent with theory.

The resulting import elasticities of substitution for food products (the ones that remain disaggregate in our model) are reported in Table 9, along with their standard errors. We continue to use the "rule of two" to obtain the import-domestic elasticities of substitution for use in the model, so that the latter are one-half the values reported in Table 9[17]. This table also reports the trade elasticities previously in use in the GTAP model. Note that the latter contain far less variation (e.g., just one elasticity of substitution for all agricultural products), whereas the former

[16] At the time this is being written, the newly estimated trade elasticities are also being incorporated into the version 6 GTAP data base.
[17] Liu, Arndt, and Hertel (2004) test the rule of two using the GTAP database and model and fail to reject its validity.

are estimated at the individual GTAP product level. On average, the new set of elasticities is somewhat larger, and this is the case for most farm and food products as well. For example, the estimated elasticity for wheat is twice as large as the GTAP default value for agriculture. On the other hand, the estimated elasticity for beverages and tobacco is only about one-third as large as the GTAP value.

3. OECD Farm Households in GTAP-AGR

The regional household of the GTAP framework provides very little information on potential distributional impacts of agricultural liberalization. Farm households in the OECD are likely to be adversely impacted by WTO agricultural reforms, and due to the relatively small size of the farm economy as a proportion of the whole in these regions, the regional welfare results can be misleading in terms of political feasibility. A welfare gain by the regional household is likely not a good indicator of whether policy makers will view a set of agricultural reforms as an improvement – as the robustness of farm subsidies has demonstrated in the past.

Anderson (1995) reviews rich country protection of agriculture and models an archetype rich economy to show the ‘lobbying incentive’ rationale behind this phenomenon. That work sought to explain the ‘development paradox’ by which low income economies tax agriculture and high income economies subsidize it. The basic argument is that, OECD economies, farmers constitute a small group with fairly consistent interests in influencing the political process, while consumers are a much larger and more diverse group that barely recognizes the additional costs they face by not countering the farm lobby. Given the strong interest in farm household incomes when designing agricultural policy in the OECD countries, it is important to explicitly disaggregate this group of households.

The advantages of explicitly modeling the farm household agents in an OECD economy extend well beyond the political economy of reform. A detailed accounting of the farm household can provide insights into farm supply response as well as farm structural change as subsidies are eliminated or re-instrumented. This second point is especially noteworthy since the fifteen year trend on OECD agricultural support has been to maintain the level of support via changes in the composition, favoring less distorting transfers to farmers.

3.1 Approaches to Modeling Farm Households in CGE Settings

Differentiated household treatment in CGE models is marked by a variety of approaches. We discuss three here, beginning with the most complete, and ending with the simplest (the GTAP-AGR implementation), commenting on the advantages of each approach. The first approach is the standard CGE approach of modeling multiple households within a given region, whereby each differentiated household optimizes separately and interact through factor and product markets in order to achieve the general equilibrium outcome. The second approach is the macro-micro model approach in which a CGE model determines the impacts on a set of market level economic variables, and these results are then passed to micro-simulation models of households for determination of the distributional effects. The final approach is the one we pursue in GTAP-AGR, which is to focus solely on earnings differences across households, assuming that they share the same utility function with the representative household. We then use the household-specific income change, along with the representative utility function, in order to compute the change in farm household welfare.

The standard CGE model with multiple households requires the largest amount of additional parameters and data, as each household type's behavior must be separately specified as well as the initial equilibrium values for all representative agents, in such a way that the aggregate production, consumption, savings etc. in the data are reproduced. This approach is exemplified in the work of Hanson and Somwaru (2003). Using as a basis the ERS United States CGE Model, they disaggregate seven farm households according to the USDA-ERS farm typology, giving each representative disaggregate household its own behavioral response in terms of output, on- and off-farm employment, and consumption. They use aggregated household survey data to describe this population of seven representative farm households. Their focus is on distributional impact within the U.S. farm economy, highlighting the differential responses by household type to reductions in coupled versus decoupled payments.

The second approach makes use of two distinct models – one "macro" and one "micro" in scope. The macro model generates economy-wide impacts, while the micro model takes those economy-wide predictions for variables such as prices and quantities, and models the impact on individual agents. Typical of this work, a global model is used to generate price impacts of trade reform, and these are passed to a series of representative farm household models characterized by differences in their ability to adjust to farm versus off-farm differentials in returns to imperfectly mobile factors of production.[18] The data and modeling information requirement here is still substantial, in that behavior and base equilibrium values for households must be known. However, this approach allows one to focus squarely on household types of interest, without worrying about the reconciling of predictions from the micro model with those of the macro model. As a result, the behavioral specification of the micro model has greater flexibility since the aggregation and regularity conditions that constrain the CGE model are not inherited in the micro model, and if the predicted changes that enter the micro model are in a regular region (e.g. of the price space) of the micro model, one can make use of very detailed representations of behavior.

The final, simplest approach, and that employed in GTAP-AGR, is to apply the single representative household preferences to each of the farm households and impute a welfare measure for each of these households based on their individual income changes – which differ from that of the regional household due to their differing endowments. Incomes in the OECD for farm households tend to be on par with median incomes of non-farm households, so this seems like a reasonable assumption (although clearly much less valid in many developing countries). The obvious advantage of this approach is the low data hurdle, as all one needs is an estimate of the component parts of net farm income. This can be obtained from a combination of benchmark data, supplemented with some outside information on the amount of farm household income that is derived from off-farm employment. The expansion of this approach to multiple farm households is limited only by the availability of data, as well as the comfort of the researcher in applying the preferences of the regional representative household to a more disaggregated sets of farm households. We find this approach to be a suitable compromise for approximating farm household welfare in the OECD, given the goals of this work. The next logical step in this area will be to incorporate some of the farm household survey information available for OECD countries. This would enable the user to also consider the macro-micro modeling approach, or even the fully integrated representative household approach.

[18] Extensive work using the macro-micro modeling approach has also been done with the standard GTAP modeling framework, in the context of poverty analysis in developing countries (e.g., Chen and Ravallion, 2004; Hertel et al., 2004).

3.2 Implementing the GTAP-AGR Farm Household

This section provides an overview of our approach to farm households in the model, as well as the potential use of the farm income variable. We assume that farm households maximize utility subject to a budget constraint. The utility function is assumed to be the same as for the representative household in each region, encompassing a demand for private goods (via the CDE functional form) as well as the demand for public goods (government spending) and future consumption (savings). The assumption of identical preferences seems quite reasonable in the developed economies, where farm income levels rival those in the non-farm sector.

The farm household's budget constraint equates spending on consumption goods to income, net of taxes. Income includes earnings from both agriculture and non-agriculture employment, with the initial share of the latter obtained from external data. From these initial shares, we update the value of farm household factor income by source using the differential factor returns the model predicts for agriculture and non-agriculture uses (see Section on Factor Supply). Farm households are assumed to face the same average tax rate as non-farm households, -- a simplification that could be improved with better information.

Key pieces of data for our specification of off-farm earnings are the shares of labor and capital owned by the farm household but employed in non-agricultural activity. Estimates are available for the OECD (OECD 2003). The resulting estimates employed in the model are given in Table 10. Clearly there is considerable scope for incorporating more detailed information in the modeling of the GTAP-AGR regional farm household and future work and users are encouraged to seek out better sources for these key pieces of information.

One of the advantages of this real farm income module is that this variable can be can be exogenized and treated as a policy target, to be attained (or simply maintained) using alternative policy instruments (see Dimaranan, Hertel, and Keeney 2003). For example, one can determine the change in subsidy of a given type that must be given to farmers in order to hold their welfare constant in the wake of multilateral trade reforms. This is thought to be useful in scenarios where it is anticipated that reforms leave some room for compensation – e.g., reductions in market price support, with compensating increases in domestic support.

3.3 Farm Household Real Income Specification in GTAP-AGR

This section details algebraically the farm income module as it is coded in the GTAP-AGR framework. Our measure of real farm income for OECD countries takes into account both on and off-farm income generation and is driven by the assumption that all endowments employed in primary agriculture are farm-owned endowments. The equations and formula that follow outline our model-based determination of real farm household income. In the text equations we reserve the index **i** for the set *ENDW_COMM*, the index **j** for an element of *PROD_COMM* or one of its subsets (*AGRI_COMM, NAGR_COMM*), and **r** will index the set of regions *REG*. The actual GEMPACK code for the farm household module includes percentage change variables for both on- and off-farm real income.

Coefficients from the standard GTAP framework are not described here as they are directly inherited by the farm household income module from the standard model, as documented on the GTAP web site. It is important to note that all of these coefficients are updated by the model variables either directly or indirectly, and the farm household module is driven by a single parameter, *FYHHLDSHR(r)*, defined as the share of regional farm household income that comes from farm activity (i.e. employment of endowment in an *AGRI_COMM* sector). This parameter is derived from OECD region-wide estimates and is given in Table 10. Since we are using a single income share to drive off-farm employment, we need to make an assumption regarding the off-farm employed endowments of the regional farm household. For this we calculate the shares of capital and labor employed in non-agricultural sectors as the total use of endowments in these sectors. We attribute these proportions to the off-farm income of the farm household to differentiate the sources of that measure in order to appropriately update off-farm income via the differential price responses.

$$GAMMA(i,r) = \frac{\sum_{j \in NAGR\_COMM} VFM(i,j,r)}{\sum_{k \in ENDW\_COMM} \sum_{j \in NAGR\_COMM} VFM(k,j,r)} \quad (9)$$

$$FVA(r) = \sum_{i \in ENDW\_COMM} \sum_{j \in AGRI\_COMM} VFM(i,j,r) \quad (10)$$

$$NFVA(r) = \left[\frac{(1 - FYHHLDSHR(r))}{FYHHLDSHR(r)}\right] \times FVA(r) \quad (11)$$

$$NFVOM(i,r) = GAMMA(i,r) \times NFVA(r) \quad (12)$$

Coefficient	Description
GAMMA(i,r)	Proportions of labor and capital in total off-farm employed resources of the farm household
FVA(r)	Basis for on-farm income of farm household
NFVA(r)	Basis for off-farm income of farm household
FYHHLDSHR(r)	Share of farm household income assumed to be from farming activities
NFVOM(i,r)	Calculated values of farm-owned endowments employed off-farm

At this point we have calculated the total endowments of the farm household by endowment type and by employment (on or off-farm use). At this point we know the total capital returns of the farm household and we can value the depreciation associated with these capital assets. Here we assume that the amount of depreciation for farm household capital is proportional to the share of farm household capital in regional capital (see expressions (13) and (14). With the level of depreciation known, we can calculate the total farm factor income net of depreciation as is done in (15) below, and calculate the change in this measure of farm income as seen in expression (16).

$$FHHCAPSHR(r) = \frac{\left[\left\{\sum_{j \in AGRI\_COMM} \sum_{i \in CAP\_COMM} VFM(i, j, r)\right\} + \sum_{i \in CAP\_COMM} NFVOM(i, r)\right]}{\sum_{i \in CAP\_COMM} VOM(i, r)} \quad (13)$$

$$FHHDEP(r) = FHHCAPSHR(r) \times VDEP(r) \quad (14)$$

$$FFY(r) = \left[\left\{\sum_{j \in AGRI\_COMM} \sum_{i \in ENDW\_COMM} VFM(i, j, r)\right\} + \sum_{i \in ENDW\_COMM} NFVOM(i, r)\right] - FHHDEP(r) \quad (15)$$

$$\begin{aligned} FFY(r) \times ffincome(r) = & \\ & \sum_{i \in LAND\_COMM} \sum_{j \in AGRI\_COMM} VFM(i, j, r) \times [pm(i, r) + qfe(i, r)] + \\ & \sum_{i \in ENDWM\_COMM} \sum_{j \in AGRI\_COMM} VFM(i, j, r) \times [pmagr(i, r) + qoagr(i, r)] + \\ & \sum_{i \in ENDWM\_COMM} NFVOM(i, r) \times [pmnagr(i, r) + qonagr(i, r)] - \\ & FHHDEP(r) \times [pcgds(r) + kb(r)] \end{aligned} \quad (16)$$

Coefficient	**Description**
FHHCAPSHR(r)	Share of farm household capital in regional capital
FHHDEP(r)	Farm household's value of depreciation
FFY(r)	Farm household value of income net of depreciation

Variable	**Description**
ffincome(r)	Change in payments to farm household owned factors

In order to get from this factor payment-based measure of income to disposable household income measure we need to account for taxes. Recall that, in the GTAP model, government accounts are not separately identified. Rather, the representative regional household derives utility from the consumption of public as well as private goods, and present as well as future consumption (i.e., savings). Thus all tax revenue accrues to the regional household, to be allocated as voters see fit, between these different categories of final demand. In terms of the GTAP-AGR disaggregation of the farm household, there are two important implications. First of all, we need to allocate some of the tax revenue to the farm household. The most natural way to do so is on the basis of the farm household's share in total factor income in the region (see expressions (17) and (18). We now have a net (of taxes) measure, and equation (19) computes the change in this measure. Thus, if spending on farm subsidies rises, thereby reducing tax receipts, a share of this fiscal impact will be felt by the farm household through equation (19).

The second implication of the specification of regional household welfare over private, public and future consumption pertains to the price index used to deflate farm income. This price index should measure the cost of attaining a given level of regional utility, taking into account not only current private consumption, but also public consumption and savings. The change in this price index is denoted p(r), and is used to deflate net farm income, thereby obtaining real farm income (as in equation (20)).

$$FINDTAX(r) = \left[\frac{FFY(r)}{FY(r)}\right] \times INDTAX(r) \tag{17}$$

$$FARMINCOME(r) = FFY(r) + FINDTAX(r) \tag{18}$$

$$\begin{aligned} &FARMINCOME(r) \times yf(r) = \\ &\quad FFY(r) \times ffincome(r) + \\ &\quad 100 \times FARMINCOME(r) \times del\_indtaxr(r) + \\ &\quad FINDTAX(r) \times yf(r) \end{aligned} \tag{19}$$

$$yfreal(r) = yf(r) - p(r) \tag{20}$$

Coefficient	Description
FINDTAX(r)	Farm household's value of indirect taxes
FY(r)	Regional factor income
FARMINCOME(r)	Net farm household income

Variable	Description
yf(r)	Change in net farm income
yfreal(r)	Change in real farm income

4. Implications for General Equilibrium Analysis

In this section we explore the implications of these model modifications for general equilibrium analysis. We do so by looking at the implications of these changes for general equilibrium demand and supply behavior, as well as for the consequent incidence of subsidy interventions in agricultural markets. Finally, we consider the validity of the overall model. Throughout this section, we compare the results based on the GTAP-AGR model with those obtained from the standard GTAP model.

As it turns out, the GTAP model is itself a moving target. Not long after we developed the GTAP-AGR model, the trade elasticities of Hertel et al., 2003, were adopted in the final release of the version 6 GTAP data base. (As noted above, all of this work has been undertaken with a prerelease of the version 6 data base.) The methodology for deriving consumer demand elasticities has also changed. Finally, the version 6 data base itself has been through a few additional modifications prior to its public release in the spring of 2005. These changes have made our comparison challenging. However, in order to eliminate the major source of discrepancy between the earlier GTAP model and the one presently in use, we have adopted the same (version 6, final release) trade elasticities in both the GTAP and GTAP-AGR simulations.

This should benefit future users seeking to evaluate how much difference the remaining features would likely to make to their analysis.

4.1 General Equilibrium Elasticities

A good way of summarizing all of this information and its implications for agricultural product markets is the farm-level equilibrium elasticity of demand (Brandow, 1961; Hertel and Tsigas, 1988; Hertel *et al.*, 1997). Farm-level elasticities are the result of a small perturbation to agricultural supply, via an output tax, designed to identify the slope of the farm-level, general equilibrium demand curve in the model. This “general equilibrium” (GE) demand schedule actually combines movement along the farm-level demand schedule with shifts in this schedule due to changes in income, output and other commodity prices. Thus, it answers the question: If the farm-gate price of (e.g.) US wheat were to fall by 1%, how much would demand increase? Alternatively, the inverse of this elasticity tells us how much price is expected to rise, if farm-level supplies are reduced by one percent.

Figure 5 provides graphical intuition of this concept in both the partial and general equilibrium context. In the left-hand graph, the PE farm-level demand elasticity can be approximated by perturbing the supply curve a small amount via an output tax (or subsidy), and evaluating the slope of the demand curve by calculating the changes in quantity and prices. This is contrasted with the right-hand graph, where the demand and supply curves shift due to changes in prices and quantities in related markets. In this case, the final direction of movement in the two schedules is indeterminate. In this graph, the shift in demand as the farm-level tax is imposed, causes the general equilibrium demand curve (depicted as D*) to be more elastic than the partial equilibrium representation.

Given the GTAP-AGR focus on modeling the incidence of agricultural and farm policy, the GE elasticities of demand are obviously of great interest. We focus the discussion here on GE elasticities for the United States and Canada[19] and how these elasticities differ between the standard GTAP and GTAP-AGR frameworks – the subject of the next section. Table 11 presents the GTAP-AGR farm level demand elasticities: first for Canada and then for the United States. Comparing the two regions’ GE demand elasticities for the GTAP-AGR model, we note that the elasticities are generally larger for Canada as we would expect of a small, open-economy which exports a significant share of its agricultural production.

To better understand the comparisons between the regions and the models, we need to evaluate the GE elasticities in terms of individual demand components. Tables 12 and 13 depict the empirical GE elasticities in detail for the GTAP-AGR model focusing on Canada and the US respectively, for purposes of discussion. These two tables decompose the GE demand elasticity for both Canada and the United States into the portions arising from different demanding agents in the model. For example, the farm level demand elasticity for Canadian wheat is -4.53, and virtually all of this is driven by export demand (”Exports” column of Table 12). In the US, export demand is not as elastic (due to the fact that the US is a larger player in world markets and also that a smaller share of total output is exported, so this is a smaller contributor to overall demand) and domestic demand for wheat by firms plays a more important role in determining the farm-level demand elasticity for wheat.

[19] The full set of GE demand elasticities for all farm and food products, all regions, and both models are provided in the appendix to this technical paper.

In general, direct sales of farm products to households and government are small and contribute only modestly to the price responsiveness of farm level demand. Fruits and vegetables are the most notable exception. For the two regions, we see that the export component of the demand elasticity is important contributing a large share of the total demand elasticity for several products. Only for rice, cotton, and animal products, however, is the U.S. relatively (as a share of the total elasticity) more dependent on the export component of demand. This is entirely due to the export shares in the data since the trade elasticities used in the model are region-generic.

As can be seen from Figure 5, the slope of the farm-level demand curve is critical to determining the incidence of farm-level subsidies or taxes (removal of subsidies). Given the slope of the supply curve, the higher the demand elasticity, the more likely are the benefits of the subsidy to be passed back to producers in the form of higher factor returns and higher farm household income. Dalton's Law states that the share of the subsidy passed back to producers can be well-approximated by the absolute value of the ratio of the demand and supply elasticities. We have calculated this share for each farm commodity/region and it is reported for Canada and the US in the last column of Tables 12 and 13. From these columns, we see that producers of wheat and other crops receive the highest share of the benefits, while producers of fruits and vegetables and sugar receive the smallest share. A comparable ordering exists in the US. [20]

4.2 Comparison with Standard GTAP and Implications for Incidence of Policy Reforms

Comparing the GE demand elasticities across the two models -- GTAP-AGR vs. the standard GTAP model -- we see that the GTAP-AGR demand elasticity for Canada is always at least as large as that based on the GTAP model and parameter file. For the United States, this is not the case as the GE elasticities in GTAP-AGR for both fruits and vegetables and animal products are lower than the GTAP counterpart. Digging deeper into these differences, Table 14 provides the same decomposition of US farm level demand as Table 13, but for the standard GTAP model. The most striking result from comparing these two tables is the increase in demand responsiveness from domestic firms' purchases of farm level products in the GTAP-AGR model. This is due to the incorporation of substitution among feedstuffs in livestock production as well as the added substitutability among intermediate inputs and for farm owned inputs. The contribution of export demand to farm level demand response is also noticeably larger for rice and wheat in the GTAP-AGR model owing to the larger trade elasticities that have been estimated for these products (recall Table 9).

The larger demand elasticity leads to a larger value for Dalton's producer share of farm subsidies. This is further reinforced by the smaller GE supply elasticities for agricultural products in the GTAP-AGR model as a result of factor market segmentation. The combination of these two forces has a striking impact on the predicted share of subsidies accruing to producers in the two models. Figure 6 illustrates this point nicely with a scatter-plot of the Dalton ratio for the GTAP-AGR model (x-axis) and the standard GTAP model (y-axis).The fact that nearly all of these points lie below the 45 degree line indicates that the standard GTAP model systematically under-predicts the share of subsidy benefits accruing to producers, when compared to the GTAP-AGR

[20] Given the high level of own-use of intermediate inputs in livestock production, the supply elasticities for these sectors are misleading and sometimes negative in sign.

alternative.[21] Which of these models is a better representation of reality? We turn next to the issue of model validation.

4.3 Model Validation

While we have capitalized on the most recent econometric evidence relating to the supply and demand for agricultural products, there remains the question of how well the individual parts fit together, and how closely they track observed behavior in global markets. This is basically a question of *model validation*. Validating a general equilibrium model is a fundamentally difficult task, since, by its very nature, the GE model purports to endogenously determine all variables. Yet we know that in any given period, there are many disruptions to the world economy that are not captured in the model, but which are also very important for world trade. How can we distinguish the impact of droughts, wars, oil price shocks and financial crises from the impact of trade policy changes? The few attempts that have been undertaken to date (Kehoe et al.; Arndt and Robinson, Liu et al.; Gehlhar) have struggled with these issues and the fact that these studies number so few is a reflection of the fundamental challenges involved.

Fortunately, agricultural markets – particularly those for crops – offer a unique opportunity for model validation. The weather-induced supply shocks offer a natural series of experiments for validating the demand side of a global trade model. Hertel, Keeney and Valenzuela (2003) have capitalized on this idea in a paper on model validation. They utilize the GTAP-AGR model presented here –with some additional aggregation to more composite regions. Figure 7 presents a scatter-plot of their findings. The horizontal axis measures the predicted standard deviation in wheat prices using the GTAP-AGR model to solve a stochastic simulation whereby only weather induced output variability in wheat production perturbs the model. The vertical axis measures the standard deviation in year to year wheat price changes calculated from FAO data. In this figure, individual points represent countries and the bars represent regions where only a range of wheat price volatility could be obtained.

Hertel, Keeney and Valenzuela (2003) conclude that the GTAP-AGR model performs reasonably well in reproducing wheat price volatility, noting however the tendency for over-prediction (below the 45 degree line) for net-importers and under-prediction for net-exporters[22]. The authors also find that their assumption of a policy-neutral experiment for model predictions is inadequate to reproduce the variability in prices observed in the FAO data. Many net importers such as Brazil and Japan act to stabilize wheat prices and therefore reduce the volatility of wheat prices within their borders. Also, the most notable outliers (relative to the 45 degree line), Argentina and Brazil, are two countries which experienced significant macroeconomic shocks over the time period of the FAO price data. Overall, this information provides some degree of confidence in model performance relative to observed data, so we now move ahead to our discussion of model extensions that fall under the category of side calculations or substitutions in many cases but that have been incorporated directly into the GTAP-AGR model. We also discuss how this set of policy extensions provides extra flexibility in modeling policies by allowing the user to make certain closure changes and solving for enodogenous instrument levels.

[21] Tables A4 and A5 present the full set of commodity and region specific calculations of Dalton's measure of producer incidence.

[22] These authors also conclude that the GTAP-AGR framework performs somewhat better than the standard framework with regard to reducing the degree of under-prediction for net exporters.

5. *Agricultural Policy Modeling in GTAP-AGR*

The representation of policy instruments is one of the more difficult challenges modelers face. "Real world" agricultural policies are quite complex in design, but the very practice of modeling necessitates significant abstraction. The empirical front is advancing however, as policy modeling from quality applications are noted for their nuanced representations of policies. Burfisher, Robinson, and Thierfelder (2003) argue strongly for the modeling of endogenous policies targeted to the evolution of agricultural market variables. For instance, they model endogenous export subsidies as variable per unit output subsidies triggered by the relative movement of domestic and world prices.

Frandsen, Gersfelt, and Jensen (2002) go to great lengths in their analysis of EU decoupling to adapt the database to represent an accurate picture of the EU CAP, reallocating portions of payments within EU member states from output subsidies to land and capital input subsidies to reflect the per hectare/per head nature of EU member implementations. These authors also explicitly model the EU CAP's budget representing the importance of that constraint on reform and re-instrumentation of EU agricultural policies.

In each instance, the level of policy nuance being incorporated into the modeling framework is quite dependent on the objectives of the research. For our purposes of modeling multilateral trade reform, we have instituted three additional features to the modeling framework: a recalculation of the database to reflect the minimally distorting historical based payments in the United States and European Union, a calculation of the percent producer support estimate (PSE), and additional land subsidy instruments for providing alternate levels of decoupling via an endogenously determined decoupled area payment. All of these features are not included in the application to be discussed here, but have been incorporated for research applications during the development phase of the GTAP-AGR model.

Historical payments to land are assigned in the OECD-PSE (Producer Support Estimate) database according to the cropping sector in which they were received. This distinction carries over as the OECD-PSE data is incorporated into the GTAP data on agricultural support. As shown in OECD (2001) the initial level of support is a critical issue to be taken into account when modeling impacts of agricultural policies. While the accounting of the subsidy load on land in a given sector is correct, we have found it preferable in our modeling of 'area payments' to remove this differential in historical payment loadings on crops as it is an artifact of flexible cropping decisions rather than specificity of program (Dimaranan, Hertel, and Keeney, 2003).

The OECD-PSE provides the historical payment shares of total support to land. We draw on this information for five sectors (paddy rice, wheat, coarse grains, oilseeds, cane and beet sugar) and three regions identified in the OECD-PSE data as making use of historical payments to the land base, and show these in Table A5.This information is also included on the parameter file that accompanies this document. The table shows that almost all PROCAMPO payments made to land in Mexico take a historical basis. In the United States, 88 percent of rice land payments, 71 percent of wheat land payments, and 73 percent of coarse grains land payments are allocated on a historical basis[23]. The shares are much smaller in the EU as many of their reforms moving from output subsidies to land payments have been output specific and tied to acreage reduction.

[23] In our 2001 base year US oilseeds received no historical land payments. Changes in the US 2002 Farm Bill have instituted payments to soybean farmers on a historical basis.

Our approach to altering this feature of the data is to use the shares from Table A5 to calculate the total of land payments allocated on a historical basis and then calculate a common subsidy rate that reallocates this total back to the different sectors. The use of this calculation is included in the code and can be changed to suit the modeler's need for adjusting the allocation of land payments. This function can be turned off by merely editing the shares to be zero in the data header on the parameter file.

The second addition we make to the model is the calculation of a measure of support, the percent PSE. The percent PSE is an accounting of the total transfers to farmers from consumers and taxpayers as a portion of farm returns (i.e. the returns to farm factors above market prices). Equation (21) shows this as Ω representing our PSE measure equal to the portion of total revenue due to subsidies. Equation (22) gives the change in this ratio as a function of percent change in revenues $\hat{r}$ and percent change in subsidy revenue $\hat{s}$. As can be seen, the change in Ω can be computed in a variety of decomposed ways along either the commodity or the subsidy instrument dimension to compare changes in support composition or relative changes in support by commodity.

$$\Omega = \frac{Subsidy\ revenue}{Total\ revenue} \tag{21}$$

$$d(\Omega) = \Omega(\hat{s} - \hat{r})/100 \tag{22}$$

$$d\Omega^{j} = \frac{(R \times \hat{t}) + S(\hat{p}_m^{j} + \hat{q}_m^{j}) - S(\hat{p}_f^{j} + \hat{q}_m^{j})}{100 \times R} \tag{23}$$

Equation (23) above shows a typical component PSE representation from our framework, where Ω represents the percent PSE for commodity *j*, *R* is the revenue from producing output *j*, *S* is the subsidy revenue, *p* and *q* are prices and quantities, and *t* is the change in the subsidy with hats representing percentage change variables and the subscript *m* representing a market price and *f* representing a farm price. From (23) we see that the first term calculates the change in revenue derived from changes in the subsidy rate, the second and third terms combine to give the net effect of market price and quantity movement contributions to the change in the proportion of support from the subsidy.

The PSE is a common tool used for tracking changes in policy and it provides this same purpose in our model. In addition, incorporating the percent PSE in our model allows us to model endogenous policies in scenarios designed for re-instrumentation (similar to Frandsen, Gersfelt, and Jensen's (2002) explicit modeling of the CAP budget). A typical use of the PSE variable in agricultural policy analysis (and one we will employ below) might be to solve the model with the PSE change exogenous reflecting a policy goal of maintaining transfers to agriculture while reforming from more to less distorting methods of support. E.g. to re-instrument from an output subsidy we could shock the model to eliminate the output subsidy and solve for the endogenous area payment necessary to hold the PSE fixed in the model.

The final policy modeling issue we incorporate into our framework is designed to address the issue of area payments to land that are not specific to production decisions made. The objective is to differentiate the scenarios we design by the degree of flexibility afforded producers in planting decisions. We introduce a set of common land payment variables that differ in the degree to which they drive the differential between returns to land in different sectors. Equation

(24) below represents the land price linkage equation in the GTAP modeling framework. The variables are in percentage changes with j indexing the agricultural commodities, ps_j^{land} representing the supply price of land, tf_j^{land} representing the tax/subsidy on land, and pm_j^{land} equaling the agricultural firm's change in cost for land.

$$ps_j^{land} = tf_j^{land} + pm_j^{land} \tag{24}$$

We can substitute for tf_j^{land} with a set of instruments that allow us to model differing degrees of decoupling in land payments and these substitutions are shown below as (25) and (26). Recalling the set *AGRI_COMM* which consists of agricultural producing sectors, we can form a subset *PROG_COMM* of sectors for which receipt of land payments is not conditional on the level of production of a particular commodity rather for land in the *PROG_COMM* set a uniform land rate subsidy is applied.

$$tf_j^{land} = greenbox^{land} + tf\_2_j^{land} \quad \forall j \in PROG\_COMM \tag{25}$$

$$tf_j^{land} = tf\_2_j^{land} \qquad \forall j \notin PROG\_COMM \tag{26}$$

Equation (25) shows this as the new variable which is not specific to a sector $greenbox^{land}$ is included along with the sector specific exogenous instrument $tf\_2_j^{land}$. Observing that in equation (26) only the sector specific payment is included, we see now that if we choose $greenbox^{land}$ to be our endogenous policy while making our policy target (e.g. change in the PSE or farm income) that we have a partially decoupled payment similar to area payment programs in the United States. To move to a more fully decoupled payment that provides a common change for the wedge between supply and demand prices for land we simply expand the coverage of the set *PROG_COMM* and reorient its complement set (relative to *AGRI*_COMM) accordingly.

As mentioned previously, the degree of policy and accounting detail included in a modeling framework is heavily dependent on the orientation of the research. Our goal here is to identify farm level impacts of multilateral trade reforms and compare the results between two models rather than deal with the intricacies of policy. There are many other applications where researchers have extended the model or database to deal with their specific areas of interest. Notably, the issue of agricultural tariff rate quotas has been analyzed enough that the GTAP Technical Paper Series has published separate documentation for implementing quotas and TRQ's (Pearson and Arndt, 2000; Elbeheri and Pearson, 2000). In accord with the theme of improving agricultural specificity, this section has been included as a short guide to the ideas we have incorporated into our policy modeling applications that have arisen as a by-product of the development phase of the GTAP-AGR framework. We now turn to our specification of a multilateral trade scenario, the topic of the next section.

6. Specification of the Multilateral Trade Liberalization Scenario

The intended purpose of the GTAP-AGR specialized version of the GTAP model is to provide analysis of multilateral trade liberalization of agricultural markets. Since the implementation of the URAA, WTO negotiations have been the primary inducement to agricultural liberalization in terms of tariffs as well as disciplines on domestic farm programs and export subsidies. As such, it is expected that where agricultural impacts are the focus of analysis, the GTAP-AGR model will provide a well-suited framework for modeling shocks associated with multilateral reform scenarios.

Our purpose in this technical paper is to demonstrate the enhanced capabilities of the GTAP-AGR framework relative to that of the standard model. As a result, we eschew the current debate over what exact form agricultural disciplines might take in the final WTO agreement on agriculture from the Doha round of negotiations[24], and instead examine full liberalization of the WTO agricultural pillars as a means of comparing the two models in an experiment that looks at the upper bound on gains from liberalization, essentially describing the full scope of impacts that could be generated[25]. In this manner, we can compare the two frameworks to see how modeling assumptions for agriculture affect predictions regarding what is in play in terms of increased trade and world prices, as well as efficiency and terms of trade welfare impacts.

7. Results

In this section we explore the implications for world trade, agricultural employment, farm household welfare and national welfare of multilateral trde reform. For purposes of comparison we report results obtained from the standard GTAP model alongside those obtained from the modified, GTAP-AGR model. We also decompose the total impact of the full liberalization experiment according to the WTO agricultural pillars of market access, export subsidies, and domestic support in the OECD, as well as market access in non-OECD regions.

7.1 Impacts on Trade

Table 15 reports the percentage change in world trade volume, by commodity, for the full liberalization scenario described above. The columns on the left decompose these results, by policy instrument, using the standard GTAP model and the columns on the right decompose those from the GTAP-AGR model. The total trade volume changes for farm and food commodities are very similar. This is a reflection of the dominance of market access in the results, and the similarity of market access outcomes due to the same trade elasticities being used in both models. As expected, the proportionate differences in the impacts of domestic support reductions are larger. On average, the share of total trade by product arising from domestic support reductions is smaller by around two percent. In the case of coarse grains and plant fibers, this is more pronounced as domestic support reductions contribute around ten percent less to the total trade

[24] Josling and Hathaway (2003) provide a detailed look at what 'meaningful cuts' means in terms of the WTO pillars of support and their proposed scenario was used with an earlier version of the GTAP-AGR model in Hertel and Keeney (2005). Using the full liberalization scenario here where focus is on comparing the two frameworks for analysis allows us to sidestep the difficult issues of TRQ's and binding overhang that commonly frustrate analysis of partial liberalization.

[25] Hertel and Keeney (2004) provide a more detailed look at what full liberalization looks like in terms of the GTAP version 6 database in their analysis of potential gains from agricultural reforms in the Doha Round.

impact in the GTAP-AGR framework. This is the area where the alternative specification of supply behavior and dampened supply response has the greatest impact.

Table 16 indicates changes in the index of regional trade in all products, again decomposed according to the liberalization component for each of the two models. Here we see a somewhat smaller increase in trade volumes in the GTAP-AGR model – due to the more tightly constrained supply response in that model. However, the differences are not all that large suggesting that the two models are quite similar with respect to trade predictions. But this is less true when we turn to variables of greater direct interest to the farm sector.

7.2 Impacts on Agricultural Employment and Farm Household Welfare

Table 17 reports the two model results decomposed by instrument for changes in agricultural employment. The effect of segmented factor markets and the reduced mobility of labor in the GTAP-AGR framework can be clearly gleaned from these results. In cases where reduction in agricultural support causes unskilled labor to move out of agriculture such as in Japan, EU, and the USA, we see that the exit is moderated considerably by the assumption of less than perfect factor mobility. Similarly, in regions where demand for agricultural unskilled labor rises due to liberalization and this resource is bid away from the non-farm economy, we see that the restricted movement causes lower increases in agricultural employment (e.g. Oceania, and Canada).

The case of Oceania (comprised primarily of Australia and New Zealand) offers the clearest picture of the predominance of reduced labor mobility impacts. Australia and New Zealand have the lowest amounts of agricultural protection among the OECD economies (OECD 2001), and therefore nearly all of their gains for reform, and by extension draws on agricultural labor, are due to other OECD liberalization. If we look at the ratio of changes in agricultural employment for the GTAP versus GTAP-AGR model in terms of the total change, and the change due to OECD agricultural market access and export subsidies, we see that in all these cases the GTAP change in employment is right around three times larger than that from GTAP-AGR. In this case, external shocks that improve domestic agricultural returns in Oceania cause a fairly uniform impact on Australian production[26] and thus employment of agricultural labor.

As noted above, our farm welfare calculation in the model is a measure of real income change for the farm household assuming identical preferences to that of the representative household for the region. We only maintain these assumptions, and perform the welfare calculations, for OECD regions and Table 18 is limited to results for those regions. The farm income changes reported in this table provide an interesting set of results. In regions where off-farm income are dominant such as the USA and Canada (recall Table 10), the changes from the two models are similar and very small. This is due to the dominant effect of non-agricultural liberalization on farm household income for these regions. In contrast, for regions such as the EU and EFTA, where farm income is a much larger share of total farm household income, the losses under multilateral trade reform are much larger in the presence of perfect labor and capital mobility (-21.73 vs. -15.60 in GTAP-AGR).

[26] It must be noted that actual production impact is a net effect of reduced labor mobility and increased substitution possibilities in agricultural sectors since there is now a smooth CES isoquant determining the tradeoff between value added and purchased inputs.

7.3 Impacts on National Welfare

The last two tables focus on regional welfare decomposed both by liberalizing instrument and into the standard GTAP welfare decomposition components. Table 19 shows that national welfare impacts from liberalization are relatively small and tend to be driven by access to OECD markets for agricultural products. The difference in the two modeling frameworks at this level of aggregation is quite small. Not surprisingly, the segmentation of factor markets inhibits the efficiency gains from trade reform in countries where there is currently overinvestment in agriculture due to heavy protection (e.g., Japan and Korea). Despite this, the two models produce nearly the same degree of regional welfare impacts as well as agreeing on OECD market access for agriculture being the area of liberalization where most gains can be made.

8. Conclusions and Directions for Future Work

This paper has developed a new model for use in the analysis of trade policy impacts on global food and agricultural markets. By incorporating into the standard GTAP model, additional structural features of world markets that are specific to agriculture, we believe that we are better able to capture the likely impacts of agricultural trade policy and domestic reforms on world food markets. Specifically we have introduced: segmentation of factor markets, crop-livestock interactions through cost-minimizing feedstuff formulations, and separability between food and non-food in consumption. This new structure has been supported by econometrically-based parameter estimates from the literature. Validation of a key portion of this model (price volatility in wheat markets) against historical data reveals that it performs reasonably well.

In addition to obtaining point estimates for key elasticities, we are also able to specify distributions for most of the new associated parameters, thereby explicitly identifying the degree of uncertainty associated with each of these values. For an example of how this can be used to place confidence intervals on model results, see Hertel and Keeney (forthcoming), as well as Hertel, Hummels, Ivanic and Kenney (2003).

The policy under evaluation in this paper is one of full liberalization of the WTO pillars of support for agriculture as well as market access in non-agricultural trade. Our results suggest that all regions except USA, Mexico, and SSA gain from this scenario. From a political standpoint, the farmer welfare impacts in OECD region where domestic support has been pervasive over the past three decades provides some important information on the likelihood of such a scenario being achieved. Large farm welfare losses in the EU and EFTA are unlikely to be politically palatable, and given the past history of liberalization one would expect that these regions might try and reorient their transfers to farmers in a WTO-compatible way. This type of constraint can indeed be incorporated into the GTAP-AGR model by fixing the level of farm welfare and requiring decoupled payments to adjust sufficiently to offset the losses due to liberalization (see for example Dimaranan, Hertel, and Keeney, 2003).

Future model developments should focus on improving both the representation of agricultural features and the modeling of policies. One of the simplest modifications would be to introduce specific, rather than *ad valorem* subsidies on land and output subsidies. Burfisher *et al.* (2003) show that when removing policies in isolation or unilaterally, the representation of policies matters a great deal to the predictions on price and quantity changes. We have not adopted these as the importance of representing policies is quite specific to the experiment being considered, and the focus of our model adaptation has been to improve specificity in agricultural market behavior in the model while maintaining a still general framework for modelers to build from[27].

As mentioned in the section on final demand, a two-level demand system would enhance the ability of the model to represent simultaneously the separability in the budget between food and non-food so often assumed in demand analysis, as well as allowing the model to capitalize more fully on the information generated in that body of literature. Previous versions of this work also included substitution in the processed foods industries, between raw agricultural and marketing inputs. This important component of farm-level demand has since been removed due to lack of robust econometric information on this substitution relationship. When more information that is relevant for a larger set of regions is available regarding this, that work should be incorporated into the model. In short, there remains a long list of potential improvements. Finally, the lack of econometric evidence for parameterizing agricultural production in developing countries stands out as a need for further work. We have assumed that all developed countries inherit the agricultural production parameters of Mexico, the only developing country for which we have estimates. As the focus of analysis on impacts agricultural trade reforms continues to adopt the developing country perspective, it is likely that more information of the type we incorporate for OECD economies will become available. As with any work, especially that geared toward developing a new model, a primary finding of the effort is how distinctly it points to the need for further work. However, we hope that this technical paper will provide a solid starting point for authors seeking to make the GTAP modeling framework more relevant and appropriate for the analysis of multilateral reform of food and agricultural trade.

[27] A reviewer points out that a modeler interested in contributing to the decoupling debate using GTAP-AGR would need to introduce distinct policy instruments for differentiating the standard land payments to the fixed land base for a region from a pure decoupled income transfer to the regional household.

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Table 1. Sector Aggregation (29 Aggregated Sectors)

Sector Code	GTAP Version 6 Database Sectors
pdr	Paddy rice
wht	Wheat
gro	Cereal grains
v_f	Vegetables, fruit, and nuts
osd	Oil seeds
c_b	Sugar cane, sugar beets
pfb	Plant based fibers
ocr	Crops
ctl	Bovine cattle, sheep, goats, horses
oap	Animal products
rmk	Raw milk
wol	Wool, silk-worm cocoons
fsh	Fishing
cogm	Coal, oil, gas, minerals
cmt	Bovine meat products
omt	Other meat products
vol	Vegetable oils and fats
mil	Dairy products
pcr	Processed rice
sgr	Sugar
ofd	Other food products
b_t	Beverages and tobacco
twl	Textiles, wearing apparel, leather products
rbmnfcs	Wood products, paper products, publishing, petroleum, coal products, mineral products, ferrous metals, other metals, metal products
omnfcs	Motor vehicles and parts, other transport equipment, electronic equipment, machinery, other manufactures
utilcons	Electricity, gas manufacture and distribution, water, construction
tt	Trade, other transport, water transport, air transport
firec	Communication, financial services, insurance, business services
osvcs	Recreation, public administration, defense, education, health, dwellings

Table 2. Regional Aggregation (23 Aggregate Regions)

Region	Abbreviation	GTAP Version 6 Database Regions
Oceania	ANZ	Australia, New Zealand, ROW
China	CHK	China, Hong Kong
Japan	JPN	Japan
Korea	KOR	Korea
Taiwan	TWN	Taiwan
Indonesia	IDN	Indonesia
South East Asia	OSEA	Malaysia, Phillipines, Singapore, Thailand, Vietnam
India	IND	India
South Asia	OSA	Bangladesh, India, Sri Lanka, Rest of South Asia
Canada	CAN	Canada
United States	USA	United States
Mexico	MEX	Mexico
Latin America	OLAC	Cent. America and Caribbean, Colombia, Peru, Venezuela, Rest of Andean Pact, Chile, Uruguay, Rest of South America
Argentina	ARG	Argentina
Brazil	BRZ	Brazil
European Union	EU15	Austria, Belgium, Denmark, Finland, France, Germany, United Kingdom, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden
European Free Trade Area	EFTA	Switzerland, Rest of EFTA
Russia	RUS	Russian Federation
EU New Entrants (2004)	EUX	Estonia, Latvia, Lithuania, Poland, Czech Republic, Slovakia, Hungary, Cyprus, Malta, Slovenia
Other Eastern Europe and FSU	OEEFSU	Central and Eastern Europe including Former Soviet Union
Middle East and North Africa	MENA	Rest of Middle East, Morocco, Rest of North Africa
Sub-Saharan Africa	SSA	Malawi, Mozambique, Tanzania, Zambia, Zimbabwe, Other Southern Africa, Uganda, Rest of Sub-Saharan Africa
South African Customs Union	SACU	Botswana, Rest of SACU

Table 3. Factor Supply Parameters Determining Elasticity of Supply to Agriculture

Region	**Land**		**Labor**		**Capital**	
	Mean	***Std. Dev.***	***Mean***	***Std. Dev.***	***Mean***	***Std. Dev.***
Oceania	0.40	0.08	0.40	0.12	0.40	0.12
China	0.40	0.08	0.50	0.08	0.50	0.08
Japan	0.25	0.06	0.50	0.16	0.50	0.16
Korea	0.25	0.06	0.50	0.16	0.50	0.16
Taiwan	0.40	0.08	0.50	0.08	0.50	0.08
Indon.	0.40	0.08	0.50	0.08	0.50	0.08
SE Asia	0.40	0.08	0.50	0.08	0.50	0.08
India	0.40	0.08	0.50	0.08	0.50	0.08
S. Asia	0.40	0.08	0.50	0.08	0.50	0.08
Canada	0.40	0.08	0.40	0.12	0.40	0.12
U.S.	0.40	0.08	0.40	0.12	0.40	0.12
Mexico	0.40	0.08	0.50	0.08	0.50	0.08
Lat. Amer	0.40	0.08	0.50	0.08	0.50	0.08
Argent.	0.40	0.08	0.50	0.08	0.50	0.08
Brazil	0.40	0.08	0.50	0.08	0.50	0.08
EU (15)	0.25	0.06	0.50	0.16	0.50	0.16
EFTA	0.25	0.06	0.50	0.16	0.50	0.16
Russia	0.25	0.06	0.50	0.16	0.50	0.16
EU (10)	0.25	0.06	0.50	0.16	0.50	0.16
C&E Eur.	0.25	0.06	0.50	0.16	0.50	0.16
MENA	0.40	0.08	0.50	0.08	0.50	0.08
SSA	0.40	0.08	0.50	0.08	0.50	0.08
SACU	0.40	0.08	0.50	0.08	0.50	0.08

Source: OECD (2001)

Table 4. Elasticities of Substitution in Agricultural Production

Region	**Farm-Owned & Purch.**		**Farm-Owned**		**Purchased**	
	Mean	***Std. Dev.***	***Mean***	***Std. Dev.***	***Mean***	***Std. Dev.***
Oceania	0.90	0.37	0.10	0.04	0.10	0.04
China	0.50	0.20	0.50	0.20	0.15	0.06
Japan	0.40	0.16	0.30	0.24	0.30	0.12
Korea	0.40	0.16	0.30	0.24	0.30	0.12
Taiwan	0.50	0.20	0.50	0.20	0.15	0.06
Indon.	0.50	0.20	0.50	0.20	0.15	0.06
SE Asia	0.50	0.20	0.50	0.20	0.15	0.06
India	0.50	0.20	0.50	0.20	0.15	0.06
S. Asia	0.50	0.20	0.50	0.20	0.15	0.06
Canada	0.90	0.37	0.10	0.04	0.10	0.04
U.S.	0.80	0.33	0.30	0.20	0.15	0.06
Mexico	0.50	0.20	0.50	0.20	0.15	0.06
Lat. Amer	0.50	0.20	0.50	0.20	0.15	0.06
Argent.	0.50	0.20	0.50	0.20	0.15	0.06
Brazil	0.50	0.20	0.50	0.20	0.15	0.06
EU (15)	0.90	0.24	0.40	0.20	0.50	0.20
EFTA	0.90	0.24	0.40	0.20	0.50	0.20
Russia	0.90	0.24	0.40	0.20	0.50	0.20
EU (10)	0.90	0.24	0.40	0.20	0.50	0.20
C&E Eur.	0.90	0.24	0.40	0.20	0.50	0.20
MENA	0.50	0.20	0.50	0.20	0.15	0.06
SSA	0.50	0.20	0.50	0.20	0.15	0.06
SACU	0.50	0.20	0.50	0.20	0.15	0.06

Source: OECD (2001)

Table 5. Estimates of Feedstuff Substitution in Livestock Rations

Feedstuff	**Wheat**	**Corn**	**Barley**	**High-Protein**	**Brans**	**Share**
Wheat	-11.93	2.94	9.22	-0.46	2.47	0.17
Corn	2.94	-1.76	-0.15	0.15	0.92	0.35
Barley	9.24	-0.15	-22.21	0.81	3.36	0.09
High-Protein	-0.46	0.15	0.81	-0.33	0.40	0.28
Brans	2.47	0.93	3.36	0.41	-11.55	0.10

Source: Surry (1990)

Table 6. Mapping of GTAP Commodities to Aggregate Commodities in Private Consumption

Commodity	Composition
Beverages and Tobacco	b_t
Breads and Cereals	pdr, wht, gro, ocr, pcr
Meats	ctl, cmt, omt
Fish	fsh
Dairy	rmk, mil
Fats and Oils	osd, vol
Fruits and Vegetables	v_f, pfb
Other Foods	c_b, oap, sgr, ofd

Table 7. Frisch Own-price Elasticities of Demand for Selected Countries

Region	Beverages & Tobacco	Breads & Cereals	Meat	Fish	Dairy	Fats & Oils	Fruits & Vegetables	Other Foods
Zambia	-1.223	-0.480	-0.674	-0.804	-0.752	-0.492	-0.554	-0.671
India	-0.778	-0.350	-0.603	-0.676	-0.651	-0.377	-0.483	-0.602
Eqypt	-0.726	-0.332	-0.554	-0.623	-0.599	-0.354	-0.445	-0.552
Brazil	-0.709	-0.327	-0.536	-0.604	-0.581	-0.347	-0.431	-0.534
Russia	-0.706	-0.326	-0.532	-0.600	-0.576	-0.346	-0.428	-0.530
China	-0.718	-0.313	-0.567	-0.631	-0.610	-0.342	-0.452	-0.565
Indonesia	-0.735	-0.304	-0.590	-0.654	-0.633	-0.340	-0.468	-0.588
Mexico	-0.653	-0.291	-0.510	-0.570	-0.549	-0.315	-0.408	-0.508
Argentina	-0.542	-0.199	-0.444	-0.489	-0.474	-0.235	-0.349	-0.443
Korea	-0.466	-0.151	-0.387	-0.424	-0.412	-0.189	-0.302	-0.385
Japan	-0.314	-0.129	-0.252	-0.279	-0.270	-0.145	-0.200	-0.251
Canada	-0.304	-0.125	-0.245	-0.271	-0.262	-0.140	-0.194	-0.244
Germany	-0.325	-0.124	-0.265	-0.292	-0.284	-0.143	-0.209	-0.264
Australia	-0.314	-0.115	-0.257	-0.283	-0.275	-0.136	-0.202	-0.256
Taiwan	-0.271	-0.110	-0.218	-0.242	-0.234	-0.124	-0.173	-0.218
USA	-0.108	-0.040	-0.089	-0.098	-0.095	-0.047	-0.070	-0.088

Source: Seale, Regmi, and Bernstein (2003)

Table 8. Income Elasticities of Demand for Selected Countries

Region	Beverages & Tobacco	Breads & Cereals	Meat	Fish	Dairy	Fats & Oils	Fruits & Vegetables	Other Foods
Zambia	1.513	0.594	0.833	0.994	0.930	0.608	0.685	0.830
India	0.963	0.433	0.746	0.836	0.805	0.466	0.598	0.744
Eqypt	0.898	0.411	0.685	0.770	0.741	0.438	0.550	0.683
Brazil	0.877	0.404	0.663	0.747	0.718	0.429	0.533	0.661
Russia	0.873	0.403	0.657	0.742	0.712	0.428	0.529	0.655
China	0.888	0.387	0.701	0.781	0.754	0.423	0.559	0.699
Indonesia	0.909	0.376	0.730	0.809	0.783	0.421	0.579	0.728
Mexico	0.807	0.360	0.630	0.704	0.679	0.389	0.504	0.628
Argentina	0.670	0.246	0.549	0.604	0.587	0.290	0.432	0.547
Korea	0.576	0.187	0.478	0.524	0.510	0.234	0.374	0.477
Japan	0.388	0.160	0.312	0.345	0.334	0.179	0.247	0.311
Canada	0.376	0.155	0.302	0.335	0.324	0.174	0.240	0.301
Germany	0.402	0.153	0.328	0.362	0.351	0.177	0.259	0.327
Australia	0.388	0.143	0.318	0.350	0.340	0.168	0.250	0.317
Taiwan	0.335	0.137	0.270	0.299	0.289	0.154	0.214	0.269
USA	0.134	0.050	0.110	0.121	0.117	0.059	0.086	0.109

Source: Seale, Regmi, and Bernstein (2003)

Table 9. Elasticities of Substitution among Imports: GTAP and GTAP-AGR

Sector	GTAP	GTAP-AGR	
		Mean	Std. Dev.
Rice	4.40	10.10	4.00
Wheat	4.40	8.90	4.20
Coarse Grains	4.40	2.60	1.10
Veg. and Fruits	4.40	3.70	0.40
Oilseeds	4.40	4.90	0.80
Raw Sugar	4.40	5.40	2.00
Plant Based Fibers	4.40	5.00	2.40
Oth. Crops	4.40	6.50	0.40
Cattle	5.60	4.00	0.70
Oth. Animal Prod.	5.60	2.60	0.30
Raw Milk	4.40	7.30	0.80
Wool	4.40	12.90	2.70
Fish	5.60	3.81	0.60
Cattle Meat	4.40	7.70	1.90
Other Meat	4.40	8.80	0.90
Veg. Oils and Fats	4.40	6.60	0.70
Dairy	4.40	7.30	0.80
Proc. Rice	4.40	5.20	2.60
Proc. Sugar	4.40	5.40	2.00
Other Foods	4.40	4.00	0.10
Bev. & Tobacco	6.20	2.30	0.30

Source: Hertel *et al*. (2003)

Table 10. Share of Farm Owned Resources Employed in Non-agricultural Sectors

Region	**Farm Income Share**
Oceania	0.59
Japan	0.12
Korea	0.46
Taiwan	0.46
Canada	0.10
U.S.	0.05
EU (15)	0.60
EFTA	0.73
EU (10)	0.71

Source: OECD (2003) for OECD countries, and default value of 1.0 for others

Table 11. G.E. Elasticities for US and Canada in GTAP and GTAP-AGR

Sector	**Canada**		**United States**	
	GTAP	***GTAP-AGR***	***GTAP***	***GTAP-AGR***
Rice	-4.03	-4.08	-1.42	-1.47
Wheat	-4.44	-4.53	-1.78	-1.84
Coarse Grains	-0.51	-0.82	-0.16	-0.44
Fruits & Veg.	-1.07	-1.36	-0.50	-0.50
Oilseeds	-1.49	-1.77	-0.92	-0.99
Raw Sugar	-0.53	-0.63	-0.23	-0.26
Plant Fibers	-2.34	-2.48	-0.69	-0.70
Other Crops	-4.80	-4.80	-1.13	-1.14
Cattle	-1.42	-1.43	-0.37	-0.46
Anim. Products	-1.73	-1.77	-0.26	-0.27
Raw Milk	-0.26	-0.43	-0.10	-0.11

Table 12. G.E. Demand Elasticity Decomposition for Canada in GTAP-AGR

Sector	**Firms**	**Hhlds.**	**Govt.**	**Exports**	**Total**	**Producer Incidence**
Rice	-1.01	-1.59	0.00	-1.48	-4.08	0.53
Wheat	-0.11	0.00	0.00	-4.42	-4.53	0.62
Coarse Grains	-0.51	0.00	0.00	-0.31	-0.82	0.08
Fruits & Veg.	-0.41	-0.31	-0.01	-0.62	-1.36	0.11
Oilseeds	-0.47	-0.02	0.00	-1.27	-1.77	0.35
Raw Sugar	-0.52	0.00	-0.11	0.00	-0.63	0.01
Plant Fibers	-0.33	-0.01	-0.29	-1.85	-2.48	0.02
Other Crops	-0.19	0.00	-0.07	-4.54	-4.80	1.00
Cattle	-0.76	0.00	0.00	-0.66	-1.43	0.27
Anim. Products	-1.43	-0.01	0.00	-0.33	-1.77	0.15
Raw Milk	-0.38	-0.03	-0.01	-0.01	-0.43	-0.16

Table 13. G.E. Demand Elasticity Decomposition for U.S. in GTAP-AGR

Sector	**Firms**	**Hhlds.**	**Govt.**	**Exports**	**Total**	**Producer Incidence**
Rice	-0.33	0.00	0.00	-1.14	-1.47	0.27
Wheat	-0.28	0.00	0.00	-1.56	-1.84	0.40
Coarse Grains	-0.34	0.00	0.00	-0.09	-0.44	0.09
Fruits & Veg.	-0.12	-0.19	-0.01	-0.17	-0.50	0.12
Oilseeds	-0.33	0.00	0.00	-0.67	-0.99	0.15
Raw Sugar	-0.26	0.00	0.00	0.00	-0.26	0.04
Plant Fibers	-0.09	0.00	0.00	-0.61	-0.70	0.07
Other Crops	-0.50	-0.22	-0.04	-0.39	-1.14	0.39
Cattle	-0.43	0.00	0.00	-0.02	-0.46	-0.19
Anim. Products	-0.12	-0.03	-0.01	-0.11	-0.27	0.01
Raw Milk	-0.11	0.00	0.00	0.00	-0.11	0.01

Table 14. G.E. Demand Elasticity Decomposition for U.S. in Standard GTAP

Sector	**Firms**	**Hhlds.**	**Govt.**	**Exports**	**Total**	**Producer Incidence**
Rice	-0.26	-0.01	0.00	-1.16	-1.43	0.19
Wheat	-0.20	0.00	0.00	-1.58	-1.78	0.40
Coarse Grains	-0.07	0.00	0.00	-0.09	-0.16	0.05
Fruits & Veg.	-0.12	-0.19	-0.01	-0.17	-0.49	0.09
Oilseeds	-0.24	0.00	0.00	-0.68	-0.92	0.10
Raw Sugar	-0.23	0.00	0.00	0.00	-0.23	0.02
Plant Fibers	-0.08	0.00	0.00	-0.61	-0.69	0.05
Other Crops	-0.47	-0.22	-0.04	-0.40	-1.13	0.25
Cattle	-0.35	0.00	0.00	-0.02	-0.37	-0.18
Anim. Products	-0.11	-0.02	-0.01	-0.11	-0.25	0.01
Raw Milk	-0.10	0.00	0.00	0.00	-0.10	0.01

Table 15. Exports by Commodity: Model Variable – qxwcom(TRAD_COMM)

	Standard GTAP Model							GTAP-AGR Model						
		Agriculture				Non-Agriculture			Agriculture				Non-Agriculture	
Sector	**Total**	**OECD Market Access**	**Export Subsidies**	**Domestic Support**	**Non-OECD Market Access**	**OECD Market Access**	**Non-OECD Market Access**	**Total**	**OECD Market Access**	**Export Subsidies**	**Domestic Support**	**Non-OECD Market Access**	**OECD Market Access**	**Non-OECD Market Access**
pdr	39.79	26.27	0.07	6.73	5.59	-0.67	1.81	38.10	26.59	-0.03	4.98	5.29	-0.85	2.12
wht	14.48	11.63	-2.11	-2.95	8.72	0.38	-1.18	14.55	12.85	-2.00	-3.33	7.98	0.38	-1.33
gro	4.67	1.64	-0.39	-1.20	4.75	0.15	-0.28	5.27	3.12	-0.39	-1.90	4.63	0.14	-0.33
v_f	10.82	7.38	-0.49	-0.59	4.54	-0.04	0.02	10.05	6.57	-0.55	-0.49	4.57	-0.07	0.03
osd	8.06	1.41	-0.37	3.67	2.48	0.55	0.30	5.20	0.04	-0.50	2.45	2.48	0.51	0.22
c_b	91.98	82.86	-0.82	0.84	6.12	-0.37	3.34	81.11	71.59	-0.85	0.61	7.10	-1.21	3.88
pfb	8.55	0.13	-0.09	0.32	2.93	4.54	0.71	7.39	-0.01	-0.10	-0.41	3.07	4.36	0.46
ocr	13.82	5.39	-0.22	-0.81	9.48	-0.16	0.15	13.31	4.44	-0.28	-0.73	9.89	-0.20	0.18
ctl	-5.46	-5.86	-0.73	0.73	0.82	0.11	-0.52	-5.35	-4.99	-0.73	0.08	0.69	0.10	-0.50
oap	2.94	0.41	-0.34	-0.15	1.92	0.81	0.30	2.82	0.66	-0.38	-0.37	1.96	0.67	0.28
rmk	117.66	5.73	-1.67	4.59	108.06	-0.32	1.27	127.00	5.20	-1.77	4.75	117.23	0.16	1.44
wol	-0.79	-4.19	-0.64	-1.44	2.26	1.98	1.24	-1.05	-4.44	-0.60	-1.60	2.07	2.18	1.33
fsh	3.62	-0.18	-0.25	-0.09	0.27	2.80	1.08	3.46	-0.40	-0.26	-0.09	0.30	2.84	1.06
cogm	3.96	0.02	-0.01	-0.01	-0.04	2.06	1.94	3.85	-0.01	-0.01	-0.03	-0.04	2.03	1.91
cmt	87.73	85.29	-4.91	1.44	5.53	-0.53	0.91	84.44	82.49	-5.12	1.18	5.59	-0.50	0.79
omt	40.13	31.23	-4.40	-0.64	14.22	-0.06	-0.22	39.77	31.13	-4.52	-0.78	14.29	-0.10	-0.27
vol	49.27	22.09	0.02	3.28	26.35	-0.23	-2.24	49.78	22.06	0.01	2.94	27.47	-0.25	-2.45
mil	21.93	28.54	-15.79	0.17	9.34	-0.06	-0.26	21.61	28.68	-16.19	-0.03	9.52	-0.02	-0.34
pcr	28.03	11.84	-0.20	0.24	18.45	-1.10	-1.21	27.25	11.00	-0.10	0.29	18.03	-1.03	-0.93
sgr	33.07	30.04	-8.73	-0.21	12.25	-0.05	-0.22	33.74	30.09	-9.11	-0.25	13.29	-0.06	-0.22
ofd	11.33	7.46	-0.73	-0.02	4.70	-0.10	0.02	11.57	7.60	-0.75	-0.08	4.90	-0.11	0.01
b_t	12.53	8.54	-0.74	-0.06	4.85	0.04	-0.09	12.55	8.25	-0.71	-0.03	5.13	0.06	-0.15
twl	21.37	0.14	0.00	-0.14	0.12	11.22	10.03	20.37	0.11	0.01	-0.11	0.10	10.55	9.71
rbmnfcs	6.92	0.15	0.03	-0.01	-0.04	2.41	4.39	6.79	0.11	0.03	-0.03	-0.05	2.38	4.35
omnfcs	5.00	0.15	0.04	0.00	-0.10	1.44	3.46	4.84	0.12	0.04	-0.01	-0.10	1.41	3.38
utilcons	1.04	0.15	-0.01	0.05	0.00	0.59	0.27	0.97	0.07	-0.02	0.05	0.02	0.59	0.26
tt	1.73	0.56	-0.10	-0.03	0.28	0.36	0.66	1.76	0.52	-0.09	-0.05	0.30	0.39	0.68
firec	0.63	0.19	0.02	0.02	-0.04	0.38	0.07	0.65	0.16	0.01	0.00	-0.04	0.39	0.11
osvcs	0.50	0.16	-0.03	0.01	-0.04	0.16	0.23	0.54	0.11	-0.02	0.02	-0.03	0.18	0.28

Table 16. Aggregate Exports by Region: Model Variable – qxwreg(REG)

	Standard GTAP Model							GTAP-AGR Model						
		Agriculture				Non-Agriculture			Agriculture				Non-Agriculture	
Region	**Total**	**OECD Market Access**	**Export Subsidies**	**Domestic Support**	**Non-OECD Market Access**	**OECD Market Access**	**Non-OECD Market Access**	**Total**	**OECD Market Access**	**Export Subsidies**	**Domestic Support**	**Non-OECD Market Access**	**OECD Market Access**	**Non-OECD Market Access**
Oceania	9.41	0.82	-0.25	-0.25	-0.04	8.32	0.82	9.18	0.84	-0.26	-0.34	-0.03	8.14	0.83
China	16.48	0.34	-0.02	0.01	0.64	2.01	13.49	16.25	0.26	-0.03	-0.01	0.67	1.97	13.38
Japan	7.32	1.68	-0.02	0.05	0.10	2.96	2.55	7.45	1.81	-0.03	0.07	0.10	2.94	2.56
Korea	9.22	1.56	-0.04	0.01	0.04	6.04	1.60	8.92	1.50	-0.04	0.03	0.04	5.85	1.54
Taiwan	6.87	-0.01	-0.03	0.00	1.13	0.25	5.53	6.75	-0.01	-0.04	0.00	1.13	0.24	5.42
Indon.	6.27	0.05	-0.06	-0.10	0.48	0.73	5.16	6.13	0.04	-0.06	-0.11	0.47	0.71	5.07
SE Asia	5.05	-0.09	-0.08	-0.11	0.39	-0.30	5.24	4.96	-0.07	-0.07	-0.12	0.42	-0.30	5.10
India	45.10	0.20	0.01	0.05	6.07	1.52	37.26	45.05	0.09	-0.01	-0.02	6.44	1.47	37.08
S. Asia	20.31	0.25	-0.14	-0.08	4.11	1.21	14.95	20.37	0.13	-0.15	-0.14	4.46	1.16	14.92
Canada	2.50	1.53	-0.15	-0.16	-0.02	1.01	0.29	2.46	1.55	-0.15	-0.21	-0.02	1.00	0.30
U.S.	6.89	0.59	-0.08	-0.09	0.17	5.07	1.23	6.61	0.54	-0.10	-0.07	0.16	4.85	1.22
Mexico	8.78	-0.04	-0.09	-0.08	1.86	0.46	6.67	8.40	-0.02	-0.09	-0.08	1.84	0.55	6.19
Lat. Amer	11.17	-0.05	-0.14	-0.16	1.92	0.60	8.99	10.90	-0.10	-0.14	-0.18	1.93	0.58	8.81
Argent.	11.95	-0.18	-0.10	-0.26	0.48	0.61	11.40	11.10	-0.46	-0.13	-0.55	0.38	0.62	11.24
Brazil	14.62	-1.31	-0.13	-0.46	1.42	0.89	14.21	12.88	-2.70	-0.20	-0.89	1.56	0.94	14.17
EU (15)	2.68	1.25	-0.07	0.07	0.00	0.76	0.67	2.53	1.18	-0.08	0.03	0.00	0.74	0.66
EFTA	3.67	2.40	-0.31	0.31	0.06	0.88	0.32	3.53	2.45	-0.29	0.28	0.02	0.75	0.32
Russia	5.58	0.19	-0.36	-0.05	1.18	0.50	4.12	5.33	0.17	-0.38	-0.07	1.25	0.49	3.86
EU (10)	6.35	2.32	-0.33	0.00	-0.01	3.93	0.43	6.08	2.32	-0.33	-0.01	-0.01	3.69	0.42
C&E Eur.	5.97	2.20	-0.37	-0.07	0.04	4.02	0.15	6.04	2.10	-0.33	-0.04	0.14	4.04	0.14
MENA	12.50	0.22	-0.39	-0.10	2.05	0.42	10.31	12.26	0.25	-0.38	-0.10	1.94	0.42	10.13
SSA	13.52	-0.11	-0.38	-0.09	4.61	-0.04	9.52	13.55	-0.11	-0.42	-0.10	4.68	-0.04	9.53
SACU	5.91	-0.12	-0.10	-0.09	1.30	0.27	4.65	5.71	-0.21	-0.11	-0.11	1.32	0.28	4.53

Table 17. Change in Agricultural Labor Employment (Unskilled): Model Variable – qoagr(REG)

	Standard GTAP Model							GTAP-AGR Model						
		Agriculture				Non-Agriculture			Agriculture				Non-Agriculture	
Region	**Total**	**OECD Market Access**	**Export Subsidies**	**Domestic Support**	**Non-OECD Market Access**	**OECD Market Access**	**Non-OECD Market Access**	**Total**	**OECD Market Access**	**Export Subsidies**	**Domestic Support**	**Non-OECD Market Access**	**OECD Market Access**	**Non-OECD Market Access**
Oceania	12.35	9.92	2.04	0.55	1.05	-0.89	-0.32	4.17	3.39	0.72	0.51	0.35	-0.61	-0.18
China	1.71	1.07	0.16	0.42	-0.20	0.29	-0.02	0.58	0.49	0.08	0.26	-0.16	0.07	-0.16
Japan	-7.25	-6.73	0.28	-0.47	0.02	-0.08	-0.27	-4.52	-4.24	0.16	-0.12	-0.01	-0.10	-0.22
Korea	-2.16	-1.78	-0.05	0.18	0.18	-0.43	-0.26	-2.42	-2.04	-0.03	0.25	0.09	-0.43	-0.26
Taiwan	-2.60	0.17	0.21	0.91	-3.66	0.20	-0.42	-2.26	-0.23	0.13	0.66	-2.47	0.05	-0.42
Indon.	-0.47	0.46	0.17	0.39	-0.14	-0.44	-0.91	-0.56	0.11	0.09	0.29	-0.10	-0.29	-0.67
SE Asia	2.19	2.58	0.34	0.49	0.48	-0.08	-1.60	0.71	1.29	0.19	0.38	0.17	-0.08	-1.24
India	0.64	0.25	0.07	0.34	-0.84	0.18	0.64	-0.08	0.07	0.03	0.19	-0.52	0.08	0.08
S. Asia	1.32	1.54	0.14	0.45	-1.25	0.06	0.39	0.15	0.69	0.07	0.27	-0.82	0.00	-0.05
Canada	6.93	1.45	1.79	1.14	1.20	1.14	0.20	2.40	0.33	0.55	0.85	0.33	0.35	-0.01
U.S.	-0.87	1.13	0.45	-3.18	0.22	0.24	0.27	-0.09	0.29	0.18	-0.71	0.06	0.04	0.06
Mexico	-1.08	0.64	0.38	0.77	-2.56	0.36	-0.67	-0.82	0.23	0.19	0.49	-1.38	0.21	-0.56
Lat. Amer	5.09	4.47	0.29	0.81	-1.11	-0.05	0.69	2.09	1.99	0.12	0.52	-0.61	-0.05	0.12
Argent.	5.24	2.15	0.28	1.46	0.81	0.19	0.35	2.63	1.05	0.14	0.86	0.41	0.09	0.09
Brazil	10.43	8.29	0.47	2.12	-0.50	-0.07	0.12	4.65	3.80	0.19	1.05	-0.24	-0.06	-0.09
EU (15)	-11.20	-6.82	-2.41	-2.47	0.72	0.45	-0.68	-4.11	-2.61	-1.03	-0.48	0.25	0.12	-0.36
EFTA	-13.07	-8.09	-1.90	-5.66	2.34	0.36	-0.12	-6.12	-4.53	-0.96	-1.87	1.31	0.05	-0.11
Russia	0.26	0.51	0.84	0.56	-1.58	-0.10	0.04	-0.47	0.05	0.35	0.26	-0.79	-0.10	-0.23
EU (10)	0.95	-0.64	0.69	0.06	1.37	-0.30	-0.23	-0.21	-0.73	0.29	0.25	0.62	-0.48	-0.16
C&E Eur.	0.50	-1.86	0.44	0.65	1.69	-0.20	-0.23	-0.67	-1.14	0.17	0.33	0.64	-0.52	-0.15
MENA	-0.71	0.72	0.42	0.47	-2.75	0.09	0.35	-0.84	0.21	0.21	0.28	-1.51	0.02	-0.06
SSA	1.59	1.03	0.19	0.78	-1.36	0.26	0.68	0.06	0.14	0.07	0.37	-0.69	0.09	0.07
SACU	9.39	8.57	0.82	1.17	-1.24	0.22	-0.16	3.52	3.41	0.30	0.60	-0.56	0.06	-0.29

Table 18. Farm-Household Income Impacts of Liberalization: Model Variable – yfreal(REG)

	Standard GTAP Model							GTAP-AGR Model						
		Agriculture				Non-Agriculture			Agriculture				Non-Agriculture	
Region	**Total**	**OECD Market Access**	**Export Subsidies**	**Domestic Support**	**Non-OECD Market Access**	**OECD Market Access**	**Non-OECD Market Access**	**Total**	**OECD Market Access**	**Export Subsidies**	**Domestic Support**	**Non-OECD Market Access**	**OECD Market Access**	**Non-OECD Market Access**
Oceania	19.40	15.01	2.77	0.89	1.60	-0.53	-0.35	13.45	10.39	1.96	1.43	1.04	-0.95	-0.42
Japan	-1.25	-1.38	0.04	-0.13	0.01	0.09	0.13	-1.65	-1.77	0.05	-0.08	0.00	0.06	0.09
Korea	-0.25	-0.85	-0.07	0.14	0.28	-0.14	0.41	-2.28	-2.63	-0.07	0.38	0.21	-0.41	0.25
Taiwan	-2.08	0.22	0.23	0.98	-3.86	0.55	-0.20	-2.97	-0.33	0.20	1.01	-3.82	0.38	-0.41
Canada	1.67	0.59	0.31	0.44	0.24	0.05	0.04	0.95	0.30	0.16	0.44	0.13	-0.07	0.00
U.S.	-0.09	0.16	0.05	-0.34	0.04	0.00	0.01	-0.03	0.06	0.03	-0.11	0.02	-0.02	-0.01
Mexico	-2.62	1.21	0.75	1.72	-5.61	0.30	-1.00	-3.16	0.75	0.64	1.73	-4.98	0.25	-1.56
EU (15)	-11.13	-5.83	-3.15	-3.24	1.28	0.51	-0.70	-8.45	-5.44	-2.20	-1.07	0.67	0.18	-0.60
EFTA	-21.73	-15.66	-3.23	-10.59	6.96	0.96	-0.15	-15.60	-12.22	-2.78	-5.26	4.35	0.54	-0.23
EU (10)	0.80	1.01	1.55	1.07	-3.06	0.06	0.17	-0.24	-1.37	0.64	0.64	1.58	-1.44	-0.29
C&E Eur.	2.14	-0.53	1.08	0.19	2.41	-0.75	-0.27	-2.49	-3.50	0.42	1.10	2.30	-2.33	-0.49

Table 19. Regional Welfare Impacts of Liberalization: Model Variable – u(REG)

	Standard GTAP Model							GTAP-AGR Model						
		Agriculture				Non-Agriculture			Agriculture				Non-Agriculture	
Region	**Total**	**OECD Market Access**	**Export Subsidies**	**Domestic Support**	**Non-OECD Market Access**	**OECD Market Access**	**Non-OECD Market Access**	**Total**	**OECD Market Access**	**Export Subsidies**	**Domestic Support**	**Non-OECD Market Access**	**OECD Market Access**	**Non-OECD Market Access**
Oceania	1.87	1.15	0.11	0.13	0.10	0.33	0.06	1.75	1.07	0.11	0.15	0.10	0.28	0.05
China	0.44	0.01	-0.01	-0.03	0.00	0.49	-0.02	0.45	0.02	-0.01	-0.02	0.00	0.48	-0.03
Japan	0.34	0.09	-0.02	-0.02	0.00	0.11	0.18	0.33	0.08	-0.02	-0.03	0.00	0.11	0.18
Korea	1.58	0.49	-0.02	-0.08	0.03	0.41	0.75	1.50	0.42	-0.02	-0.08	0.04	0.41	0.74
Taiwan	0.44	-0.01	-0.01	-0.07	0.04	0.25	0.24	0.44	0.01	-0.01	-0.07	0.03	0.24	0.25
Indon.	0.69	-0.03	-0.02	-0.02	0.00	0.53	0.23	0.65	-0.04	-0.02	-0.02	0.00	0.51	0.22
SE Asia	1.21	0.15	-0.02	0.02	0.39	0.48	0.20	1.22	0.13	-0.02	0.02	0.43	0.47	0.20
India	0.54	-0.01	0.00	0.00	0.17	0.21	0.18	0.50	-0.01	0.00	0.01	0.16	0.20	0.14
S. Asia	0.64	0.11	-0.02	0.00	0.11	0.33	0.12	0.63	0.13	-0.03	0.00	0.11	0.30	0.12
Canada	0.11	0.15	0.00	0.07	0.03	-0.14	0.00	0.10	0.15	0.00	0.08	0.03	-0.15	0.00
U.S.	-0.02	0.00	0.00	0.02	0.01	-0.03	-0.02	-0.01	0.01	0.00	0.02	0.01	-0.02	-0.02
Mexico	-0.06	-0.02	-0.01	-0.09	0.05	-0.29	0.30	-0.06	-0.01	-0.01	-0.09	0.03	-0.30	0.32
Lat. Amer	0.06	0.30	-0.01	0.01	-0.05	0.20	-0.37	0.02	0.29	-0.02	0.02	-0.06	0.17	-0.38
Argent.	0.58	0.23	0.03	0.12	0.14	0.01	0.05	0.57	0.22	0.03	0.14	0.14	0.01	0.04
Brazil	1.80	1.02	0.07	0.20	0.08	0.10	0.33	1.72	1.00	0.06	0.22	0.07	0.09	0.28
EU (15)	0.30	0.10	0.07	0.00	0.01	-0.03	0.15	0.26	0.07	0.07	-0.01	0.01	-0.04	0.15
EFTA	0.83	0.37	-0.05	0.07	0.04	0.37	0.03	0.75	0.32	-0.06	0.04	0.06	0.37	0.03
Russia	0.60	0.04	-0.11	-0.02	0.03	0.25	0.40	0.61	0.06	-0.11	-0.02	0.05	0.25	0.38
EU (10)	0.27	0.33	-0.06	0.01	0.05	-0.17	0.11	0.29	0.33	-0.06	0.01	0.06	-0.15	0.11
C&E Eur.	0.16	0.33	-0.06	0.02	0.17	-0.33	0.02	0.13	0.33	-0.06	0.01	0.15	-0.32	0.02
MENA	0.02	0.09	-0.11	-0.03	0.05	0.10	-0.09	0.03	0.10	-0.10	-0.03	0.06	0.09	-0.08
SSA	-0.69	0.05	-0.17	0.04	-0.03	-0.06	-0.52	-0.93	0.01	-0.21	0.06	-0.05	-0.09	-0.65
SACU	0.89	0.36	0.01	0.02	0.05	0.05	0.40	0.80	0.34	0.01	0.03	0.05	0.04	0.34

Table 20. Welfare Decomposition by Component (percentage of initial income)

Region	Standard GTAP Model				GTAP AGR Model			
	EV Total	Allocative Efficiency	Terms of Trade	Investment Savings Bal.	EV Total	Allocative Efficiency	Terms of Trade	Investment Savings Bal.
Oceania	1.87	0.83	1.01	0.03	1.80	0.79	0.97	0.04
China	0.44	0.29	0.10	0.05	0.45	0.31	0.08	0.05
Japan	0.34	0.17	0.19	-0.01	0.33	0.15	0.19	-0.01
Korea	1.58	1.05	0.63	-0.09	1.50	0.95	0.64	-0.10
Taiwan	0.44	0.26	0.15	0.02	0.43	0.24	0.17	0.02
Indon.	0.69	0.15	0.57	-0.02	0.66	0.14	0.54	-0.02
SE Asia	1.21	0.67	0.45	0.09	1.22	0.70	0.43	0.09
India	0.54	1.12	-0.61	0.03	0.50	1.10	-0.62	0.03
S. Asia	0.64	0.84	-0.26	0.06	0.62	0.86	-0.29	0.06
Canada	0.11	0.16	-0.11	0.05	0.10	0.17	-0.13	0.05
U.S.	-0.02	0.03	-0.03	-0.01	-0.01	0.03	-0.03	-0.01
Mexico	-0.06	0.62	-0.68	0.00	-0.06	0.61	-0.67	0.00
Lat. Amer	0.06	0.34	-0.15	-0.13	0.02	0.33	-0.19	-0.13
Argent.	0.58	0.20	0.36	0.02	0.58	0.20	0.36	0.02
Brazil	1.80	1.03	0.78	-0.02	1.73	0.99	0.76	-0.02
EU (15)	0.30	0.30	-0.02	0.02	0.26	0.26	-0.02	0.02
EFTA	0.83	0.97	-0.23	0.09	0.77	0.89	-0.22	0.09
Russia	0.60	0.54	-0.14	0.19	0.59	0.52	-0.11	0.19
EU (10)	0.27	0.39	-0.06	-0.05	0.29	0.39	-0.05	-0.05
C&E Eur.	0.16	0.70	-0.41	-0.13	0.14	0.71	-0.45	-0.13
MENA	0.02	0.78	-0.70	-0.06	0.03	0.77	-0.68	-0.06
SSA	-0.69	0.63	-0.96	-0.36	-0.76	0.65	-1.04	-0.37
SACU	0.89	0.46	0.23	0.20	0.88	0.45	0.23	0.20

Figure 1. GTAP-AGR Factor Market Segmentation

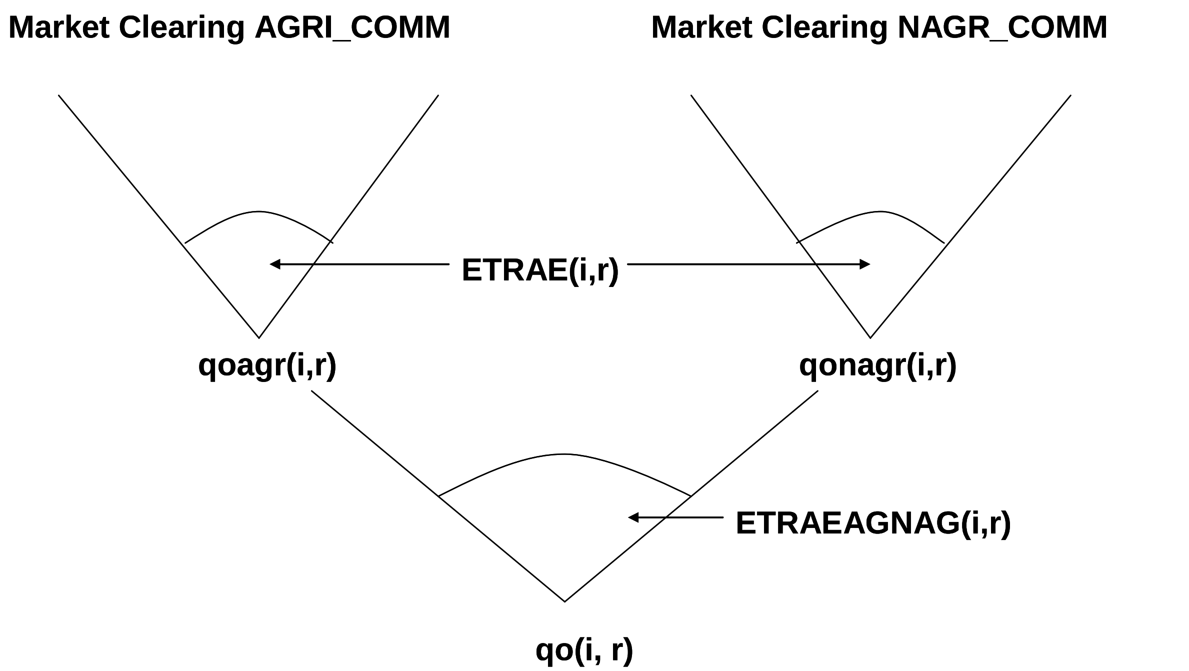


Figure 2. GTAP-AGR Agricultural Production Technology

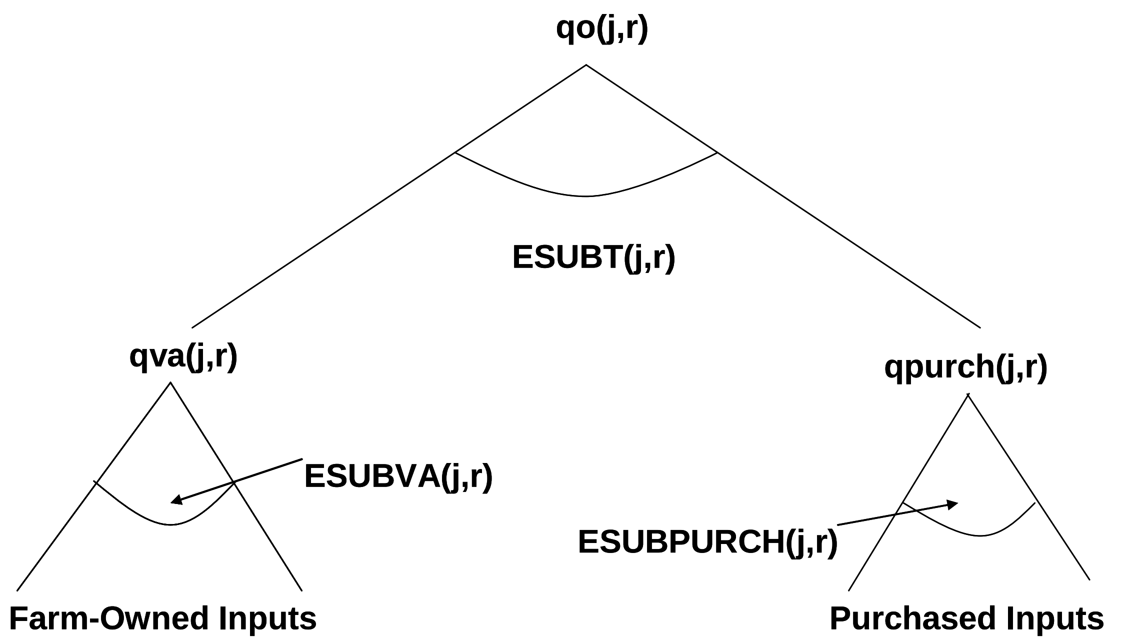


Figure 3. GTAP-AGR Livestock Feedstuffs Substitution

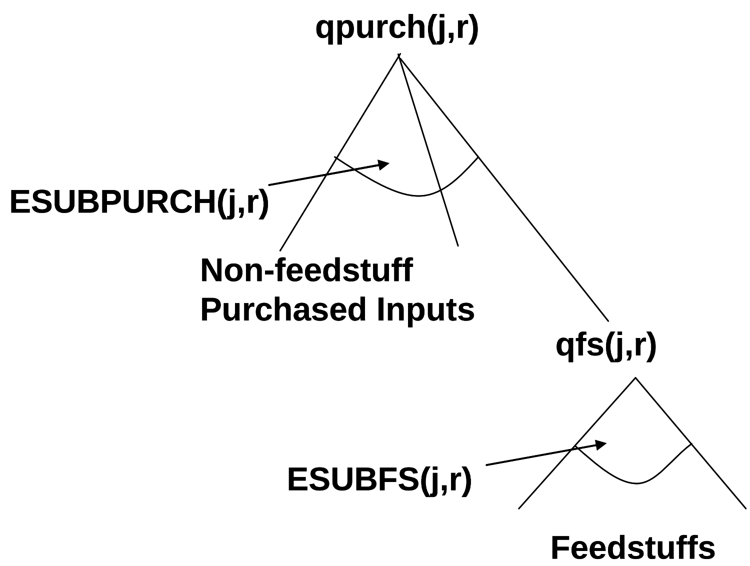
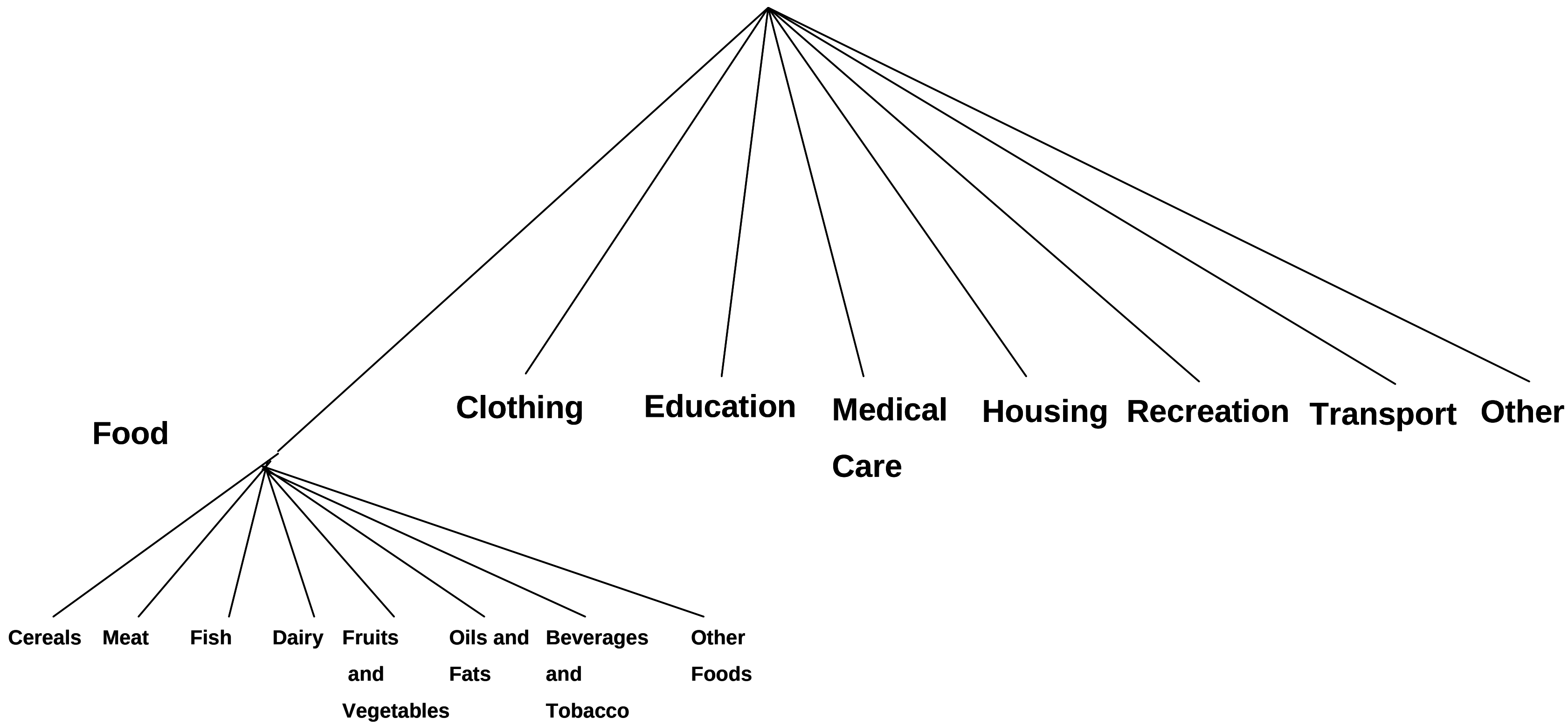


Figure 4. Seale, Regmi, and Bernstein's Estimated Two Stage Expenditure System



Source: Seale, Regmi, and Bernstein (2003).

Figure 5. Eliciting Partial and General Equilibrium Farm-Level Demand Elasticities

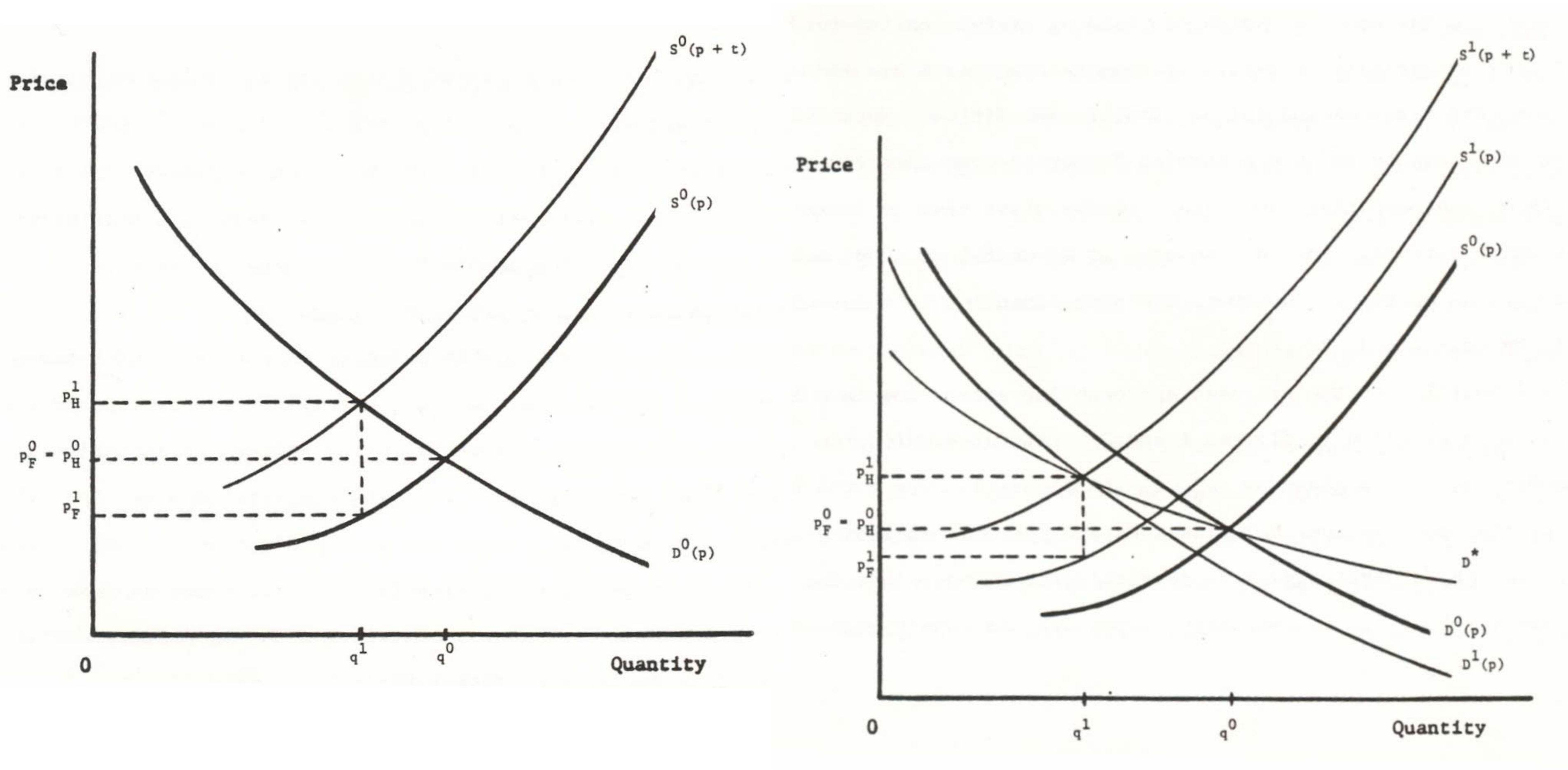
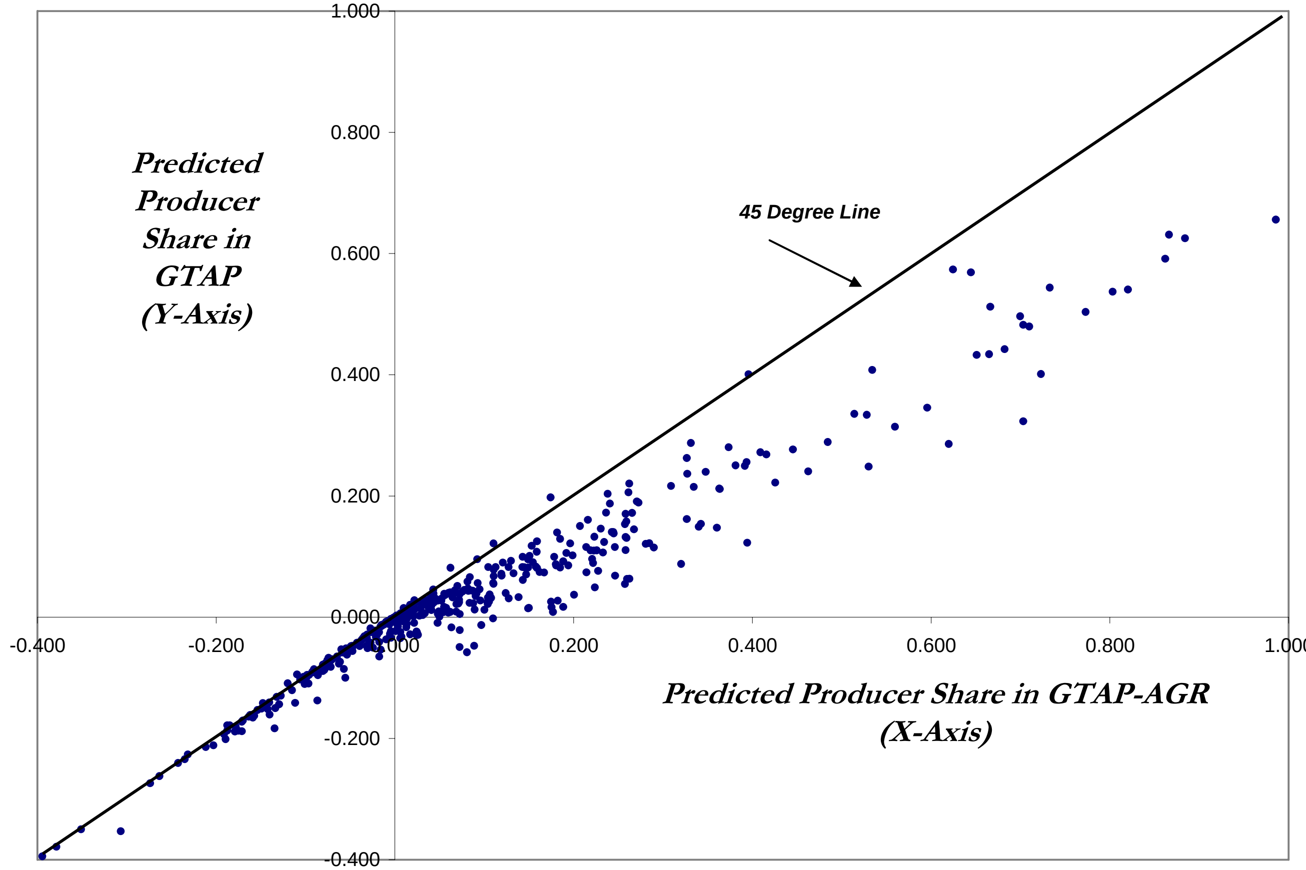
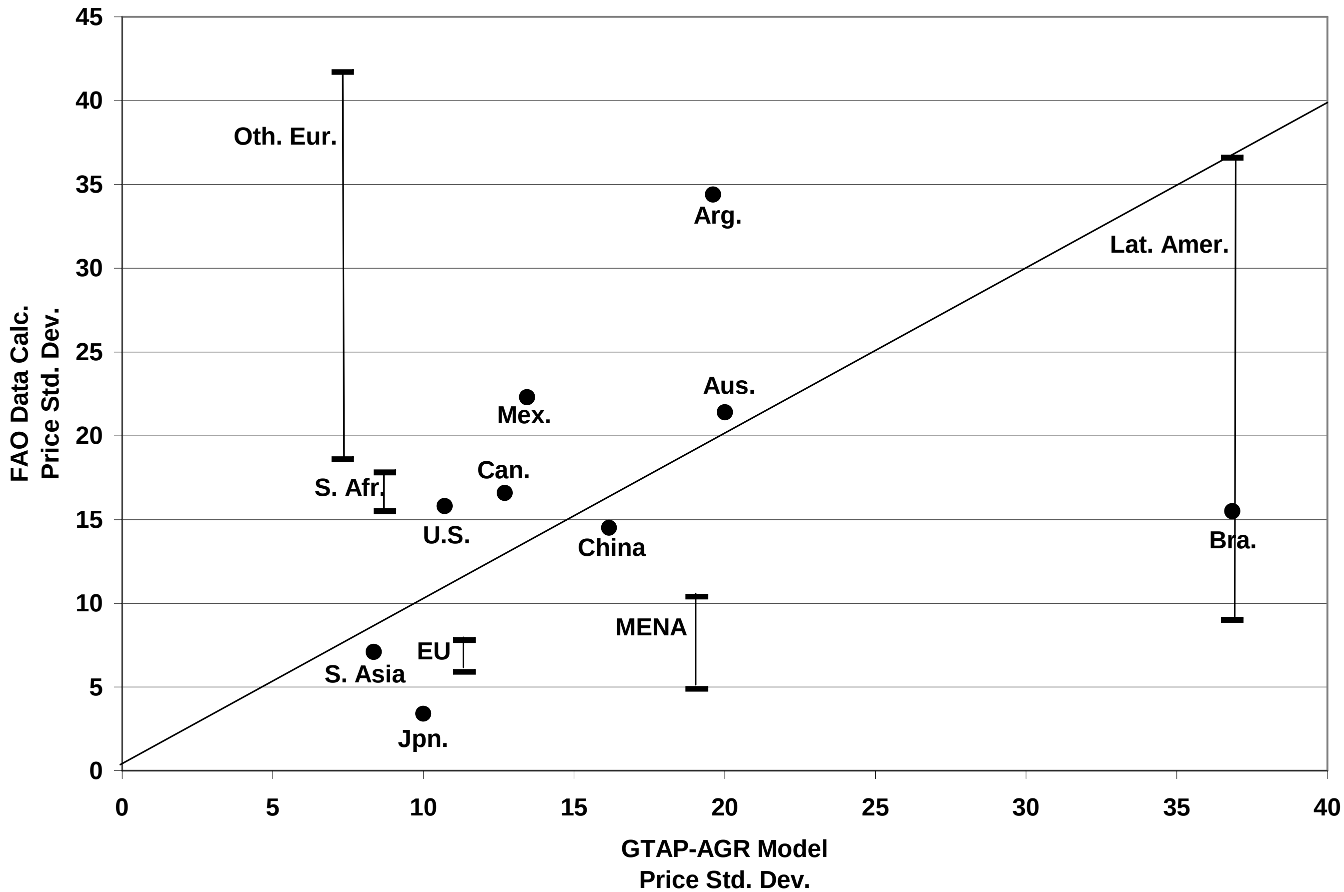


Figure 6. Dalton's Measure of Incidence: GTAP vs GTAP-AGR Compared (-ED/ES)



Source: Authors' Calculations.

Figure 7. Model Validation: Predicted and Observed Variability in Wheat Prices



Source: Hertel, Keeney, and Valenzuela (2003)

Table A1. GE Elasticities of Demand for Agricultural Products in GTAP

Region	pdr	wht	gro	v_f	osd	c_b	pfb	ocr	ctl	oap	rmk	wol
Oceania	-1.4	-4.0	-0.4	-1.0	-2.7	-0.4	-2.7	-1.6	-1.0	-1.1	-1.3	-2.4
China	-0.1	-0.2	-0.1	-0.3	-0.6	-0.5	-0.2	-2.3	-0.1	-0.4	-0.1	-0.8
Japan	-0.1	-3.5	-0.8	-0.4	-2.6	-0.1	-0.8	-0.5	-0.4	-0.5	-0.2	-1.0
Korea	-0.1	-2.9	-1.1	-0.4	-2.2	-0.9	-3.3	-1.4	-0.3	-0.3	-0.2	-3.1
Taiwan	-0.8	-1.6	-0.3	-0.3	-1.1	-0.2	-1.2	-2.3	-0.1	-0.3	-0.4	-3.2
Indon.	-0.2	-7.2	-0.2	-0.2	-0.4	-0.2	-2.2	-4.6	-0.2	-0.2	-0.1	-1.3
SE Asia	-0.5	-1.6	-0.3	-0.5	-1.4	-0.4	-1.8	-3.0	-0.2	-0.6	-0.3	-3.1
India	-0.1	-0.2	0.0	-0.2	-0.1	-0.1	-0.3	-0.7	-0.1	-0.1	-0.1	-3.9
S. Asia	-0.1	-0.4	-0.1	-0.2	-0.3	-0.1	-0.6	-1.8	-0.1	-0.2	-0.1	-4.0
Canada	-4.0	-4.4	-0.5	-1.1	-1.5	-0.5	-2.3	-4.8	-1.4	-1.7	-0.3	-11.9
U.S.	-1.4	-1.8	-0.2	-0.5	-0.9	-0.2	-0.7	-1.1	-0.4	-0.3	-0.1	-1.0
Mexico	-1.0	-1.6	-0.2	-0.4	-1.8	-0.2	-0.4	-3.4	-0.5	-0.4	-0.3	-1.3
Lat. Amer	-0.6	-1.1	-0.4	-0.8	-1.1	-0.1	-1.2	-2.2	-0.2	-0.2	-0.2	-0.7
Argent.	-1.1	-2.2	-0.8	-0.5	-1.4	-0.1	-0.6	-2.2	-0.1	-0.2	-0.2	-1.7
Brazil	-0.2	-1.0	-0.4	-0.2	-1.4	-0.4	-0.8	-2.6	-0.5	-0.7	-0.2	-11.8
EU (15)	-1.6	-1.4	-0.3	-0.8	-1.3	-0.2	-1.6	-1.3	-0.3	-0.4	-0.2	-8.9
EFTA	-2.3	-1.6	-0.4	-0.4	-2.3	-0.3	-4.6	-1.8	-0.2	-0.4	-0.4	-12.2
Russia	-0.8	-0.5	-0.1	-0.4	-1.7	-0.1	-3.1	-0.9	-0.2	-0.3	-0.2	-4.3
EU (10)	-1.1	-0.5	-0.2	-0.6	-1.4	-0.1	-2.3	-0.8	-0.3	-0.5	-0.2	-1.9
C&E Eur.	-0.7	-0.7	-0.1	-0.5	-0.7	-0.1	-0.9	-0.8	-0.2	-0.2	-0.2	-0.5
MENA	-0.1	-0.6	-0.2	-0.2	-0.3	0.0	-0.6	-0.3	-0.2	-0.1	-0.1	-0.4
SSA	-0.3	-2.1	-0.2	-0.4	-0.6	-0.3	-1.8	-2.4	-0.1	-0.2	-0.1	-0.8
SACU	-0.9	-1.1	-0.4	-1.3	-1.5	-0.3	-1.9	-1.5	-0.3	-0.4	-0.1	-4.6

Table A2. GE Elasticities of Demand for Agricultural Products in GTAP-AGR

Region	**pdr**	**wht**	**gro**	**v_f**	**osd**	**c_b**	**pfb**	**ocr**	**ctl**	**oap**	**rmk**	**wol**
Oceania	-1.5	-4.1	-0.6	-1.1	-2.7	-0.4	-3.1	-1.9	-1.1	-1.2	-1.4	-2.3
China	-0.3	-0.6	-0.8	-0.5	-1.1	-0.7	-0.2	-2.3	-0.2	-0.6	-0.1	-0.8
Japan	-0.2	-3.6	-0.9	-0.3	-2.6	-0.1	-0.9	-0.6	-0.5	-0.5	-0.2	-1.0
Korea	-0.2	-3.0	-1.1	-0.4	-2.3	-1.0	-3.3	-1.4	-0.3	-0.4	-0.2	-3.0
Taiwan	-1.0	-1.9	-0.6	-0.4	-1.4	-0.3	-1.2	-2.3	-0.3	-0.3	-0.4	-3.3
Indon.	-0.3	-7.2	-0.3	-0.5	-0.4	-0.3	-2.2	-4.9	-0.3	-0.4	-0.2	-1.2
SE Asia	-0.7	-2.1	-0.6	-0.7	-1.5	-0.6	-1.9	-3.2	-0.4	-0.9	-0.6	-3.2
India	-0.5	-0.5	-0.4	-0.6	-0.4	-0.5	-0.6	-0.9	-0.5	-0.6	-0.6	-3.9
S. Asia	-0.4	-0.8	-0.4	-0.5	-0.5	-0.5	-0.8	-2.0	-0.5	-0.6	-0.5	-4.1
Canada	-4.1	-4.5	-0.8	-1.4	-1.8	-0.6	-2.5	-4.8	-1.4	-1.8	-0.4	-11.9
U.S.	-1.5	-1.8	-0.4	-0.5	-1.0	-0.3	-0.7	-1.1	-0.5	-0.3	-0.1	-1.0
Mexico	-1.0	-1.7	-0.5	-0.6	-1.8	-0.3	-0.5	-3.5	-0.7	-0.6	-0.5	-1.0
Lat. Amer	-0.6	-1.3	-0.5	-0.9	-1.2	-0.2	-1.3	-2.3	-0.3	-0.4	-0.4	-0.7
Argent.	-1.2	-2.3	-1.0	-0.5	-1.4	-0.1	-0.6	-2.2	-0.2	-0.3	-0.4	-1.7
Brazil	-0.3	-1.2	-0.6	-0.3	-1.6	-0.6	-0.8	-2.6	-0.7	-0.9	-0.4	-11.7
EU (15)	-1.6	-1.6	-0.7	-0.8	-1.3	-0.2	-1.6	-1.3	-0.4	-0.4	-0.3	-8.9
EFTA	-2.4	-1.7	-0.8	-0.5	-2.4	-0.4	-4.6	-1.8	-0.3	-0.5	-0.6	-12.2
Russia	-0.9	-1.0	-0.5	-0.7	-1.8	-0.3	-3.1	-1.2	-0.6	-0.6	-0.6	-4.4
EU (10)	-1.3	-0.9	-0.6	-0.7	-1.5	-0.2	-2.4	-1.2	-0.5	-0.6	-0.5	-2.1
C&E Eur.	-0.8	-1.2	-0.6	-0.7	-0.9	-0.3	-1.0	-1.2	-0.5	-0.6	-0.4	-0.6
MENA	-0.1	-1.0	-0.5	-0.4	-0.4	-0.1	-0.7	-0.5	-0.3	-0.4	-0.2	-0.4
SSA	-0.4	-2.2	-0.3	-0.6	-0.7	-0.5	-1.9	-2.4	-0.4	-0.4	-0.4	-0.8
SACU	-1.0	-1.3	-0.6	-1.5	-1.5	-0.4	-1.9	-1.6	-0.6	-0.7	-0.4	-4.6

Table A3. Dalton's Estimate of Producer Incidence for Agricultural Products in GTAP

Region	**pdr**	**wht**	**gro**	**v_f**	**osd**	**c_b**	**pfb**	**ocr**	**ctl**	**oap**	**rmk**	**wol**
Oceania	0.25	0.41	0.04	0.17	0.20	0.06	-0.18	0.22	0.14	0.08	0.15	0.21
China	-0.14	-0.35	0.01	0.10	0.07	0.03	0.03	0.48	-0.07	0.13	-0.01	0.17
Japan	0.03	0.29	0.06	0.10	0.25	0.00	0.08	0.07	-0.19	0.02	0.01	0.03
Korea	0.11	0.61	0.32	0.51	0.88	0.04	1.27	0.65	0.00	0.00	0.01	0.61
Taiwan	0.13	0.02	0.02	0.20	0.22	-0.03	0.24	0.63	0.00	-0.09	0.03	0.73
Indon.	0.12	0.00	0.09	0.12	0.07	0.03	0.88	1.90	0.08	0.07	0.04	0.04
SE Asia	0.15	0.54	-0.06	0.31	0.40	0.10	0.50	1.72	0.06	0.00	0.01	0.54
India	-0.05	-0.05	0.03	0.15	0.09	0.05	0.11	0.29	0.05	0.06	0.09	0.96
S. Asia	-0.01	0.01	0.03	0.15	0.12	0.02	0.21	0.59	0.02	0.04	0.06	1.01
Canada	0.33	0.57	0.04	0.07	0.24	0.00	0.02	0.56	0.19	0.12	-0.16	0.78
U.S.	0.19	0.40	0.05	0.09	0.10	0.02	0.05	0.25	-0.18	0.01	0.01	-0.01
Mexico	0.12	0.27	0.08	0.24	0.44	0.04	-0.21	0.84	0.14	0.12	0.07	0.22
Lat. Amer	0.06	0.14	0.04	0.26	0.14	0.00	0.02	0.54	0.02	-0.03	0.01	0.08
Argent.	0.12	0.43	0.16	0.14	0.48	-0.03	-0.17	0.54	0.04	0.04	-0.02	0.43
Brazil	0.02	0.08	0.02	0.00	0.11	-0.01	0.01	0.34	-0.02	0.11	0.01	0.63
EU (15)	-0.02	0.12	-0.01	0.03	0.09	0.01	0.02	0.11	0.00	0.01	-0.01	0.28
EFTA	0.27	0.29	0.01	0.07	0.15	0.04	0.66	0.17	0.02	0.05	0.15	0.57
Russia	0.13	0.02	-0.02	0.09	0.28	-0.03	0.26	0.09	-0.03	0.02	-0.14	0.50
EU (10)	-0.05	0.03	-0.06	0.13	0.19	-0.04	0.01	0.16	0.00	0.10	-0.02	0.07
C&E Eur.	0.00	-0.03	-0.09	0.11	-0.05	-0.03	-0.17	-0.05	0.02	-0.05	-0.01	-0.09
MENA	-0.01	-0.14	-0.15	0.01	-0.01	-0.07	-0.09	-0.19	-0.01	-0.11	-0.06	-0.05
SSA	-0.05	0.01	-0.04	0.04	0.02	-0.04	0.13	0.35	-0.02	-0.02	-0.02	-0.15
SACU	0.04	0.07	0.03	0.21	0.11	0.02	0.10	0.16	-0.03	0.01	0.01	0.09

Table A4. Dalton's Estimate of Producer Incidence for Agricultural Products in GTAP-AGR

egion	pdr	wht	gro	v_f	osd	c_b	pfb	ocr	ctl	oap	rmk	wol
Oceania	0.38	0.53	0.07	0.27	0.24	0.09	-0.13	0.31	0.18	0.10	0.21	0.26
China	-0.11	-0.31	0.18	0.18	0.25	0.11	0.04	0.70	-0.06	0.26	0.01	0.24
Japan	0.10	0.62	0.14	0.20	0.53	0.02	0.19	0.17	-0.18	0.04	0.03	0.13
Korea	0.26	1.35	0.70	0.67	2.13	0.09	3.26	1.28	0.02	0.01	0.04	1.22
Taiwan	0.22	0.19	0.15	0.17	0.43	-0.01	0.33	0.88	0.07	-0.11	0.05	1.03
Indon.	0.28	0.01	0.19	0.39	0.12	0.14	1.44	2.46	0.16	0.21	0.07	0.04
SE Asia	0.34	1.17	0.08	0.56	0.72	0.22	0.77	2.17	0.11	0.11	0.10	0.82
India	0.09	0.07	0.18	0.34	0.22	0.26	0.29	0.48	0.22	0.26	0.32	1.43
S. Asia	0.10	0.15	0.17	0.36	0.25	0.18	0.33	0.86	0.10	0.20	0.26	1.50
Canada	0.53	0.62	0.08	0.11	0.35	0.01	0.02	1.00	0.27	0.15	-0.16	1.01
U.S.	0.27	0.40	0.09	0.12	0.15	0.04	0.07	0.39	-0.19	0.01	0.01	-0.01
Mexico	0.20	0.41	0.23	0.46	0.68	0.09	-0.20	1.29	0.24	0.23	0.15	0.26
Lat. Amer	0.11	0.27	0.11	0.39	0.24	0.03	0.08	0.73	0.09	0.02	0.06	0.11
Argent.	0.21	0.67	0.33	0.24	0.71	-0.02	-0.16	0.80	0.08	0.08	0.06	0.65
Brazil	0.04	0.15	0.07	0.05	0.23	0.05	0.02	0.51	0.02	0.19	0.05	0.87
EU (15)	0.00	0.11	0.02	0.10	0.13	0.02	0.04	0.23	0.03	0.02	0.01	0.37
EFTA	0.42	0.33	0.09	0.12	0.23	0.07	0.99	0.26	0.03	0.04	0.26	0.64
Russia	0.26	0.10	0.07	0.19	0.45	0.02	0.33	0.18	-0.02	0.07	-0.13	0.70
EU (10)	-0.02	0.11	-0.02	0.16	0.24	-0.02	0.01	0.22	0.02	0.09	0.00	0.08
C&E Eur.	0.02	0.01	-0.06	0.22	-0.03	-0.02	-0.17	-0.05	0.04	-0.05	-0.01	-0.10
MENA	-0.01	-0.09	-0.13	0.05	0.00	-0.06	-0.09	-0.18	0.01	-0.10	-0.05	-0.05
SSA	-0.02	0.06	-0.01	0.12	0.06	-0.03	0.19	0.60	0.00	0.01	0.01	-0.14
SACU	0.06	0.13	0.07	0.36	0.16	0.04	0.14	0.26	0.03	0.05	0.03	0.15

Table A5. Historical Payments to Land in EU, Mexico, and US

Commodity	**European Union**	**Mexico**	**United States**
Rice	0.002	0.978	0.879
Wheat	--	0.972	0.705
Coarse Grains	0.007	0.987	0.731
Oilseeds	0.002	0.952	--
Sugar	0.090	--	--

Source: 2001 OECD-PSE Database.